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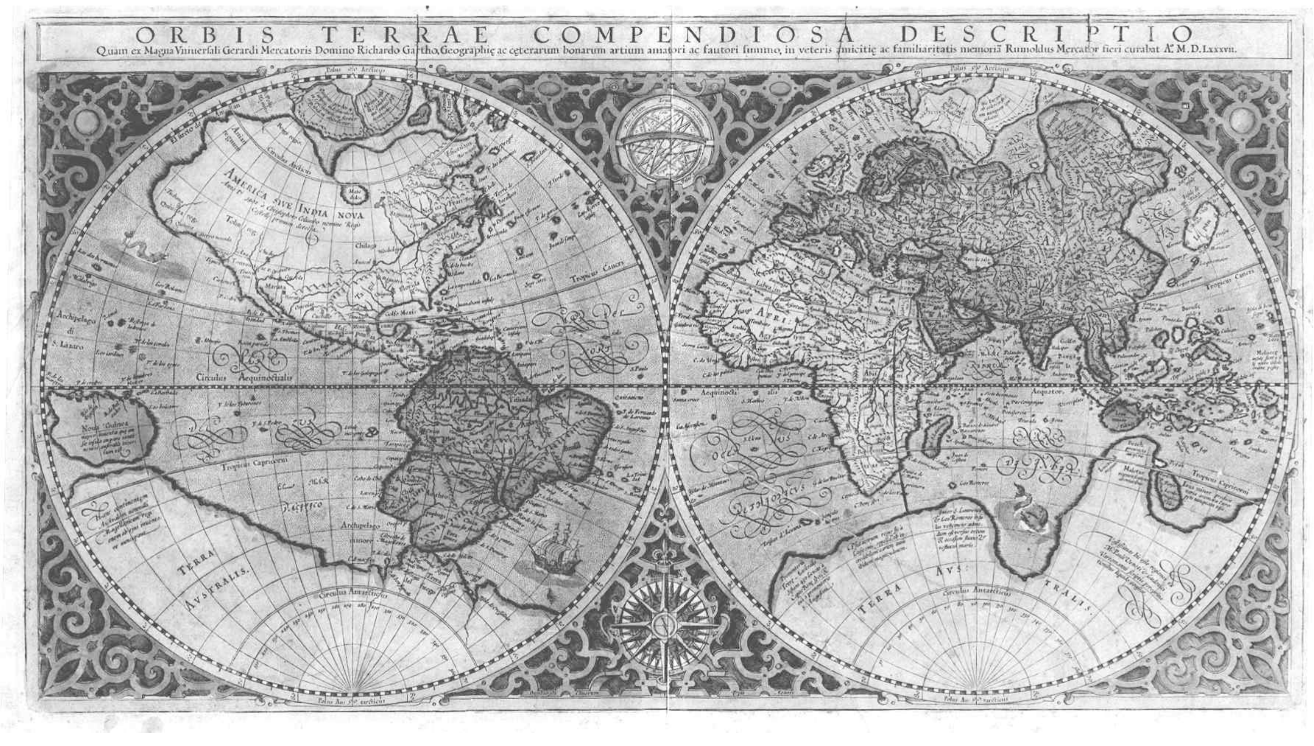

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SECTION I

NAVIGATION AND MARITIME TRANSPORT

LEGAL PROVISIONS ON LAYTIME AND DEMURRAGE IN CHARTERPARTIES

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ABSTRACT

The article presents the main forms of calculating laytime and legal conditions for their suspension, contractual provisions on demurrage or, in the absence of express provisions in the charterparty for demurrage, conditions for damages for detention to become payable.

Keywords: *laytime; demurrage; damages for detention; charterparties;*

1. INTRODUCTION

The period of time within which the loading or discharging operation is required to be completed will be prescribed in the charterparty is known as laytime [1]. If the period is exceeded, he will have to pay compensation to the shipowner in the form of demurrage or damages for detention [1].

Laytime and demurrage constitute a complicated field, both from a technical and a legal standpoint [2]. As a consequence of this complexity, laytime and demurrage give rise to many difficulties and frequent disputes [2].

2. THE CALCULATION OF LAYTIME

Most of charterparties contain an express term fixing laytime and this can be done directly specifying the number of days or less directly by an agreement that a specified weight or measurement of cargo will be loaded or discharged in a particular period of time [2]. In a general cargo charterparty it is usual to exclude days which are not worked at the port from the computation of laytime such as Saturdays and Sundays or Thursday afternoon Fridays in Muslim countries [3]. In this cases only working day şi weather working may count as laytime [3].

Working days means all days on which work is ordinarily done at the port excluding Sundays and holidays (Fridays in Muslim countries) [4].The term describes a day of work and it is immaterial that on a working day the charterer is prevented from loading unless the cause of delay is covered by an exception [4]. Evidence of custom is admissible to explain the meaning of working day [4]. The number of hours in a particular working day on which a ship is required to load will depend on the custom of the port and Saturday will normally count as a whole day although it may not be customary to work in the afternoon [1]. The number of hours in a particular working day may be settled by express or implied agreement [4].

Weather working day excludes from the calculation of laytime those working days on which loading would have been prevented by bad weather [1]. In jurisprudence it was held that weather must affect the loading process and not merely the safety of the vessel with the result that the mere threat of bad weather which resulted in a ship being ordered from berth by the harbour master did not prevent the period in question from counting as weather working days [1]. When bad weather occurs for a part of the *weather working day* a reasonable apportionment should be made of a day according to the incidence of the weather upon the length of the day that the parties either were working or might be expected to have been working at the time [4]. Therefor if two hours are lost due to rain, laytime is not suspended for two hours out of 24, rather for one quarter out of 24 hour conventional day if the normal working hours are eight [5]. It is irrelevant if no work is actually taking place on a working day although the weather was fine [5].

Where the clause refers to a *weather working day of 24 consecutive hours* the ratio method is not used and a deduction is made of the actual amount of time that has been lost or in a case of a vessel waiting for a berth would have been lost [5].

In a tanker charterparty there are not like to be such exceptions to laytime due to the nature of work period at the oil terminal [3]. However there will be other express exceptions to the laytime such as the time it takes to shift the ship from her anchorage place to her berth (in a berth charterparty this will be considered as part of the voyage even though the charterparty has allowed the notice of readiness to be given earlier than arrival on berth) or deballasting as this is a ship operation to make the ship ready to load [3].

Cargo to be discharged at the average rate of not less than- tons per day.Such clause where the tonnage of the cargo divided by the average rate of discharge gives a fraction over a day does not allow the charterer the whole of the last day [4]. Probably the fraction is to be computed by the proportion of hours used to the hours in the working day [4]. The weight of cargo actually loaded or discharge and not the nominal cargo on which freight may be payable must be used for the calculation [4].

Cargo to be loaded at the average rate of tons per hatch per weather working day.The provision requires the stipulate rate to be multiplied by the number of hatches which the vessel possesses the product being divided into the tonnage of cargo carried [4].

Cargo to be loaded at the average rate of not less than 150 metric tons per available working hatch per day.A working hatch is a hatch into which there is still cargo to be loaded or from which there is still cargo to be discharged [4].Permitted laytime is ascertained by dividing by 150 the greatest weight of cargo loaded into any one hold and the making any necessary adjustments if loading into any hatch was prevented by non-availability [4].

Cargo to be discharged at the average daily rate of 1000 mt basis 5 or more available working hatches pro rata if less number of hatches per weather working day. The wording provides an overall rate for the ship provided rather than a rate for hatch [4]. In consequence provide there are five hatches available when the ship commences discharging the daily rate will aply [4].

If a hatch becomes temporarily unavailable during loading or discharging the relevant period will not count as laytime but the laytime available will not increase simply because loading or discharge of a particular hold is complete [4].

To count as laytime. A provision that a certain period of time, e.g. overtime is to count as laytime will normally be construed as if were intended for the benefit of the shipowner [4]. Conversely a provision that time is not to count as laytime will normally be construed as if it were intended for the benefit of the charterer [4]. It will not, however avoid the running of demurrage since in default of the clearest words “time”, which is or is not to count, is laytime and not time on demurrage [4].

Sometimes a clause provides that in certain circumstances time is to count as used as used laytime [4]. If the laytime clause provides that certain days- such as Saturdays, Sundays and holidays are to count as laytime if used these days will be treated as laytime for the purpose of such a clause [4].

Once loading and discharging has been completed, laytime comes to an end even if the cargo operations have been concluded within the laytime allowed and there is unexpired laytime [3].Thus if loading is completed within the laytime allowed but the ship is delayed due to the charterers failure to give the Master instructions or because cargo documents are delayed, the charterer will be liable for damages for detention [3].

3. SUSPENSION OF LAYTIME

Charterparties, in regard to the time for loading or discharge fall into two classes: for discharge in a fixed time and second, for discharge in a time not definitely fixed [4]. The approach to be applied where laytime is not fixed is summarized in jurisprudence as if no time be fixed expressly or impliedly by the charterparty, the law implies an agreement by the charterers to discharge the cargo within a reasonable time, having regard to all the circumstances of the case as they actually existed, including the custom or practice of the port, the facilities available thereat, and any impediments arising therefrom which the charterers could not have overcome by reasonable diligence [2].

The charterers will be excused for any obstruction such as a strike of the dock labourers, the lack of an available berth due to congestion in the port or arrest of the vessel-which effectively interrupts the loading, provided that is out of his control and that otherwise they had conducted the operation with reasonable dispatch [1]. However, circumstances to be taken into account do not include those which the charterer could be expected to have avoided [2].

If by the terms of the contract, laytime is fixed, the charterer has an absolute and unconditional engagement for the non-performance of which he is answerable, whatever be the nature of the impediments which prevent him from loading it, unless such impediments are covered by exceptions in the charter [4]. In the absence of the exceptions the charterers will be held liable for the delay caused by congestion in port, strikes of stevedores employed by the shipowner, the need to remove temporarily the ship from the port for her own safety during bad weather, civil commotions [1], insufficient supply of cargo, ice preventing loading [4].

In jurisprudence it was held that the charterer in order to gain protection of an exception must prove not only the existence of the excepted cause but also that he could not by reasonable exertion or precaution have prevented the operation of the cause [4]. It was held too that where an obstacle, which is within an exception, prevents loading or discharging in the method adopted by the charterer but does not affect other available methods, the charterer is allowed a reasonable time to make up his mind whether the obstacle will continue and to make arrangements for using the other methods available if continues [4].

The charterer will not be held liable if impediments arise from the loading or discharging being illegal by law of the place where they have to be performed or arise from the fault of the shipowner or those for whom he is responsible or from a frustrating event [4].

4. PROVISIONS RELATING TO DEMURRAGE

Once the laytime has expired the charterer is in breach and would be liable for damages for detention [3]. However the majority of charterparties include a clause providing that he may retain the vessel for additional days in order to complete the loading or discharging operation on payment of a fixed daily amount, known as demurrage [1]. It is common practice in voyage charters to specify a demurrage rate, that is, an amount payable as agreed damages for each day or part of a day that a vessel is detained by the charterer [2]. The charter stipulates for a fixed number of days on demurrage or no time limit is expressed as e.g. “eight days for loading after which demurrage at £ 2,000 per diem” [1].

An agreement to demurrage is not, therefore, the payment of the contractual price for the exercise of a right to detain, it is no different in nature from any agreement providing for payment of liquidated damages [2]. The demurrage is recoverable by the shipowner irrespective of whether he suffered damage by the detention of the vessel [7]. Demurrage will cover losses of freight arising under subsequent charterparties affected by the delay or from consequent reduction in the number of voyages possible under a consecutive voyage charterparty [1]. An agreement to pay demurrage is normally treated as preventing the shipowner recovering from the charterer more than the agreed sum for the wrongful detention of his vessel. This is so however the delay is caused, whether by simply failing to load or discharge within the laytime, even if the delay could be described as deliberate: *Suisse Atlantique v NV Rotterdamsche Kolen Centrale* [1976] or by failing to provide a cargo: *Inverkip Steamship v Bunge* [1917] or by providing a cargo of the wrong sort: *Chandris v Isbrandtsen-Moller* [1951] [2]. The position of the shipowner is anomalous since he is unable to rescind the contract and withdraw the ship during the demurrage period unless the failure of the charterer to load amounts to a repudiation of the contract on his part or the delay is so substantial as to frustrate the object of the contract [1; 5].

Demurrage is primarily due from the charterer but recovery may also be made from a bill of lading holder, provided that the bill of lading incorporates the terms of the charter and the demurrage clause is worded so as to encompass the liability of a bill of lading holder [5].

A demurrage clause may be struck down by the courts as a penalty if the rate is fixed so high as to be extravagant and unconscionable in comparison with the greatest possible loss that court could flow from the breach [1; 7]. In such circumstances the courts would consider the shipowner adequately compensated by being allowed to recover his actual loss [1; 7]. In reverse cases where the rate is fixed at an unreasonably low level, the shipowner is unable to recover his actual loss but is limited to the specified demurrage clauses rate even though the delay has been deliberately caused by the charterer for his own benefit [1].

Liability for the payment of demurrage accrues immediately on the expiration of the laydays and runs continuously through Sundays, holidays and other periods normally excluded from laytime e.g. bad weather working days [1]. The maxim which defines the situation is "Once on demurrage, always on demurrage" and means that times count for demurrage unless the parties have unambiguously provided otherwise [2;3;6;7]. Thus in Asbatankvoy charterparty the allowance of six hours after giving notice of readiness does not apply if the ship is already on demurrage when notice of readiness is given [3]. Laytime exceptions are held not to be applicable to a demurrage period unless expressly worded to that effect [1;5]. A general specific clause is unlikely to be specific enough [3].

These types of clauses which excludes or limits the liability in demurrage or it may be one which suspends the continuing obligation to discharge and therefore, *pro tanto*, suspends the breach which would otherwise have given rise to the obligation to pay demurrage [2]. These clauses must be clearly expressed if they are to have that effect. Unclear or ambiguous clauses will be ineffective for that purpose [2]. In a case where the charterers claimed to be excused from any liability to pay demurrage by a clause in the charter which provided that '. . . unavoidable hindrances which may prevent . . . discharging . . . always mutually excepted' it was held that the clause was not clear enough to exempt the charterers from liability in respect of periods when the vessel was on demurrage and they were in breach of contract [2].

If the wording of the exception is ambiguous it will be construed against the charterer, as the party seeking to rely on it. The burden of proof is on the charterer to show that the terms of the exception apply [3].

An exception can be expressly worded so as to cover the demurrage period as , for example, where it was provided that demurrage was to be paid at 12 s 6 d per hour unless detention arise from a lock-out strikes etc.[1] Similarly where the clause provided that 'Charterers shall not be liable for any delay in . . . discharging . . . which delay . . . is caused in whole or in part by strikes . . . and any other causes beyond the control of the charterers' [2]. In jurisprudence it was held as clear exceptions: fire, storm, causes beyond the control of the Merchant which will cover the breakdown of loading equipment as result of bad maintenance on the part of the operator, who was an independent contractor of the charterer; breakdown of machinery or equipment in or about the Plant of the charterer, supplier, shipper or consignee of the cargo [3].

Demurrage will not accrue during a period where delay was due to the fault of the shipowner or resulted from action taken by him for his own convenience [1;7]. This will be the case even if the shipowner fault is rendered non-actionable by an exception clause [5]. If they were not set out in the charter, the period during which a vessel may remain in demurrage will depend on the circumstances [7].

5. DAMAGES FOR DETENTION

Where there is no provision in the charterparty for the payment of demurrage, a charterer will be liable for damages for detention for all the time he detains the vessel after the expiration of the laydays [1]. Another situation where damages for detention are payable is where a charterparty stipulates a fixed number of days for the payment of demurrage and these days have expired [1;2]. If the charterer is in breach of the charterparty in other respects and delay is caused the charterer will not be liable for demurrage but for damages for detention [3]. Thus, for example, if the charter delays the ship at the load port once loading has been completed either because it has not paid his agents and therefor the ship is prevented from leaving, or the charter fails to nominate the discharge port [3]. Even delays in loading or discharging may give rise to losses that fall outside the demurrage provisions [5].Thus, delay my cause less cargo to be loaded then required by the charter and this will give rise to a claim for dead freight [5].

It is important to determine whether a claim is one for demurrage or for damages for detention for a number of reasons [3]. First, the rate of damages is at an agreed rate for demurrage but not for damages for detention unless the charterparty expressly provides otherwise [3]. Therefore the owner would have to prove its loss and adduce evidence as to the market rate for the ship [3].

Where there are no provisions in the charterparty for the payment of demurrage damages are at large and will be asserted by the court in relation to the actual loss suffered by the shipowner [1].

If the charterparty provides a fixed number of days for the payment of demurrage and those days have expired, the court will normally assess the damages at a figure corresponding to the agreed demurrage rate, though it is open to either party to prove that such a rate does not represent the actual loss suffered by the shipowner [1]. Secondly, charterparty sometimes require presentation of all documents relating to a demurrage claim within quite a short time limit, failing witch the claim is time barred [3]. If the time bar applies to demurrage claims, but not claims for damages for detention, the latter claim will be subject to the general contractual time bar of six years from the breach of contract [3]. Thirdly, unless the charterparty expressly provides for a lien for demurrage and damages for detention there will be no lien for either of the claims not expressly referred to [3].

Once the specified demurrage period has expired, the shipowner is no longer obliged to remain in port to complete the loading operation and to be restricted to a claim for damages for detention [1]. If part of cargo has been loaded may sail and claim compensation in the form of dead freight, or if the charterer has failed to ship any cargo, he may rescind the charter and sue for damages at large [1]. On the other hand, if the delay occurs at the discharging port, he has little option except to complete the loading operation and claim damages for detention [1].

6. CONCLUSIONS

There are a number of legal and technical implications relating on laydays, demurrage and damages for detention. First, they refer to conditions in which charterer will not be held liable: lack of exceptions in contract, if impediments arise from the loading or discharging being illegal by law of the place where they have to be performed or arise from the fault of the shipowner or those for whom he is responsible or from a frustrating event. Secondly, they refer to types of clauses which exclude or limit the liability in demurrage. These clauses must be clearly expressed if they are to give rise to the obligation to pay demurrage. Thirdly, it is important to determine whether a claim is one for demurrage or for damages for detention for the correct evaluation of damages awarded to shipowner.

7. REFERENCES

[1] WILSON John F., *Carriage of Goods by Sea*, 7th. ed., London: Longman, 2010;

[2] DOCKRAY Martin, *Cases & Materials on the Carriage of Goods by Sea*, Third Edition, Cavendish Publishing Limited, 2004;

[3] BAATZ Yvonne, Charterparties in *Southampton on Shipping Law*, Institute of Maritime Law, London, Informa 2008;

[4] EDER Bernard, FOXTON David, QC; BERRY Steven, QC; SMITH Christopher, QC; BENNETT Howard, *Scrutton on Charterparties and Bills of Lading*, 22nd Edition, Sweet & Maxwell, 2011;

[5] BAUGHEN Simon, *Shipping Law*, 4th ed, Routledge Cavendish, 2009;

[6] CARR Indira, *International Trade Law*, 4th ed., Routledge Cavendish, 2010;

[7] DERRINGTON Sarah, PANNA Andrew în M. W. D. White(ed.), *Australian maritime law*, 2 Ed., Federation Press, Annandale, N.S.W., Australia, 2000;

STANDARD CLAUSES OF VOYAGE CHARTER SHIFTING RISK OF DELAY AND READINESS

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ABSTRACT

The article aims to describe the main features of the standard clauses of voyage charterparties that transfer risk of delay. Use of the clauses relating either to a port or a specific berth determines the moment when laytime will begin to run. These clauses are an exception to the usually rule which states that the moment laytime starts to run is the moment notice of readiness is given.

Keywords: *clauses requiring charterer to nominate a reachable berth; clause time lost waiting for a berth; time to count weather in berth or not/ time to count weather in port or not clauses; clauses designed for specific ports; notice of readiness.*

1. INTRODUCTION

The very moment the vessel becomes an arrived ship, charterer is entitled to full use of the laydays. A series of standard clauses are designed to transfer risk of delay from the charterer to shippowner. The outcome depends on the type of charterparties i.e.berth charterparties or port charterparties.

2. CLAUSES REQUIRING CHARTERER TO NOMINATE A REACHABLE BERTH

Voyage-charterparties may contain clauses which require the charterer to nominate a “berth reachable upon arrival” or a “berth always accessible” [1].

In jurisprudence it was held that the berth was not reachable upon arrival and the charterer was in breach with his obligations in situations where the berth was congested, lack of tugs or pilots or prohibition of night navigation [2]. It was held too that unlike *wibon* or *time lost* clauses, there is no distinction between congestion and bad weather [3]. Also the berth was not reachable on arrival if there is no sufficient depth of the water in the berth or in the port [1].

On the other side the word arrival means arrival at the point, weather within or outside the commercial or fiscal limits of the port, where the indication or nomination of the particular loading place would became relevant if the vessel where to be able to proceed without being held up [1]. From that moment, the charterer will have to bear the risk of any delay in that he will be liable for damages for breach of contract in failing to nominate a reachable berth [4].

Since the clause has no incidence on laytime, the time which normally is excluded from laytime(eg. Sundays and holidays) is not excluded from the computation of the damages [1].

From the time the vessel is an arrived ship the charterers are entitled to full use of the permitted laytime and the owners cannot recover damages at full large for the breach during the running of such time and cannot recover both demurrage and damages for the same delay [1]. The charterers, instead, could trade off the time saved in loading against the initial time lost while they were prevented from nominating a reachable berth [4].

If the ship isn’t an arrived ship, shipowner can recover damages for the delay and their calculation must take into account delays which would have occurred in any event if the ship have berthed at once [1].

Time saved on discharge cannot be credited against time lost waiting for a reachable berth to be nominated [4].

3. CLAUSE TIME LOST WAITING FOR A BERTH

Usually used in Gencon contracts provides that time lost waiting for a berth to count as loading/unloading time [4].The use of the *time lost* clause or of standard clauses related to particular ports whose waiting place is outside the limits of the port may well seem to be particularly appropriate to cases where the charterparty reserves to the charterer an option to chose a loading/unloading place out of a range of ports at some of which the risk of congestion may be greater than at others or at some of which the risk of congestion may be greater than at others or at some of which the usual waiting place lies inside and at others outside the limits of the port [5].

In English doctrine it was argued that in the absence of any express provisions the existence of the option means that the charterer by the way he requires the contract to be carried out may influence the incidence or extent of the risk to be borne by the shipowner [5].

The clause shifts the risk before the vessel becomes an arrived ship, i.e. from the moment when it could have entered a berth had one been available [4]. When the clause operates, the charterer will still be able to rely on the laytime exceptions [3].

Specifically the clause would not allow the shipowner to count as laytime periods when excepted causes such as holidays, bad weather and strikes would have prevented laytime from running had the vessel been in berth [1]. Likewise, in case of a port charterparty the clause does not allow the shipowner to count as laytime, the period covered by exceptions had the vessel been an arrived ship [1].It is irrelevant that notice of readiness has not be given because it cannot be owing since no berth being available [1]. It must be noticed that when together with the lost waiting for a berth clause operates a *force majeure* clause relating to delay the later shall prevail [1; 3; 4].

In the case of a berth charterparty the clause will cover the period while the vessel is waiting in port for a berth until a berth become available [4]. In a port charterparty it will operate while the vessel is waiting outside the port and even while the vessel is waiting inside the port in circumstances where it isn't immediately and effectively at the disposal of the charterer [4].

In berth charterparties there is no conflict between time lost and a exception clause [3].

The situation is different in a port charterparty case. If the vessel waiting for a berth is also an arrived ship laytime provisions take precedence and time lost clause is regarding as surplusage [4]. The only possible exception is where the usual waiting place is outside the ports limits [3].

4. TIME TO COUNT WEATHER IN BERTH OR NOT/ TIME TO COUNT WEATHER IN PORT OR NOT CLAUSES

Shall mean that if no loading or discharging berth is available on her arrival the vessel, on reaching any usual waiting-place at or off the port, shall be entitled to tender notice of readiness from it and laytime shall commence in accordance with the charter party. Laytime or time on demurrage shall cease to count once the berth becomes available and shall resume when the vessel is ready to load or discharge at the berth [6].

In *The Kyzikos* [1989] case it was held that such a clause preempts laytime run where no berth is available but not in situations where a berth is reachable but can't be reached due of fog [1;2]. A recent decision, *Suek AG v Glencore International AG* [2011] recognised as valid(in a cif contract) a notice of readiness in circumstances where a vessel was prevented from reaching a berth because of concurent conditions, unavailable berth and tidal conditions[7].

To take advantage of a wipon clause, the vessel must be within a usual waiting area for ships seeking to enter port [1].

5. CLAUSES DESIGNED FOR SPECIFIC PORTS

In the case of ports which are frequently congested or where the normal waiting place is outside the port limits, standard clauses standard clauses are designed which provides that laytime is to run from the moment from the time the vessel reaches a specific point but is unable to proceed further because of the shortage of berths or other obstruction [4]. Such clause will be effective even though the vessel does not become an arrived ship at that time [4].

6. NOTICE OF READINESS

The charterers require notice of arrival of the ship so that it can arrange to load the ship promptly [2]. The moment notice of readiness is given provides a starting point for the calculation of laytime [4]. Usually the moment is precisely determined in charterparties [4].

Unless the charterparty provides to the contrary, for a notice of readiness to be valid, the requirements which entitles the notice to be given, such as arrived ship and ship ready to load, must exist at the moment the notice of readiness is given [4]. In this respect, in jurisprudence it was held that where the holds require fumigation after the notice was given after the notice was given, such notice is invalid even though the work necessary to make the vessel ready takes only a short time and is completed before a loading berth becomes available [3].However it was recognised that a valid notice of readiness could be given even though some preliminary routine matters such as removal of hatch covers, still needed to be attended to, provided that they were unlikely to cause delay [3].

Where an invalid notice of readiness is given it will not become valid when the facts change so as to justify a notice being given [1]. In other words an invalid notice could not be treated as inchoate becoming effective when the cargo become available for discharge [8; 9].

In the absence of a valid notice of readiness, laytime will not start and as a consequence not only that the owners have earned no demurrage but also they are obliged to pay charterers dispatch money [8]. Laytime will not count even the ship commences loading/discharging operations [1]. By contrast to the normal position a charterparty may indicate that laytime is to run after the service of a notice of readiness even if the ship was not in fact ready, provided that the notice was served in good faith [1].

Usually charterparty provides that the laytime shall not commence before the commencement date except with the charterer sanction [2]. If the charterer requests the ship to tender notice of readiness and berth before the earliest lay day, then the charterer has sanctioned the earlier commencement of the laytime [2].

If an owner gives notice of readiness which is premature because it is before the earliest permissible lay day then, by contrast with a notice which is invalid due to the ship being unready for loading/discharging or it is not an arrived ship, it takes effect in the earliest lay day [1].

Most charterparties requires the shipowner to obtain *free pratique* before giving the notice of readiness and laytime will not commence before that moment [3]. Other clauses may provide that notice of readiness may be tendered after arrival of the vessel in loading port, at any moment, provided that the vessel is cleared by the port authorities [10].

The commencement of laytime shall run from the moment the notice of readiness was served provided that the requirement for port clearance to be given before notice of readiness was waived by charterers [10]. Many standard forms of charterparty provide that laytime will not commence until six hours after notice of readiness has been tendered or received or until the ship has berthed, whichever is earlier [2].

In this respect English law takes a strict view and a notice of anticipated readiness is ineffective even though the vessel was in fact ready to load at the time the notice was given [4]. For such a notice of readiness to be effective it is required an express or an implied agreement to dispense with the need for a notice, or a waiver or an estoppel binding on charterers in respect of the necessity for a further valid note [4].

In jurisprudence it is considered that this means a supplementary factor-something else- necessary to be ad to the mere knowledge of readiness on the part of the charterers [4]. This point of view is different from the European jurisdictions where it is considered that an anticipatory notice of readiness is effective provided that the vessel is ready at the time the notice expires [4].

Several decisions have considered the issue in English law. In *The Happy Day* [2002] charterers argued that no valid notice was ever given and laytime never commenced under cl/30. The charterers claimed dispatch [8]. It was held that the doctrine of waiver may be invoked and applied and the commencement of loading by the charterer or receiver without rejection or reservation regarding the notice of readiness could be treated as the „something else" which was required to be added to mere knowledge of readiness on the part of charterers in order for a finding of waiver or estoppel to be justified [8].

In other case *The Front Commander* [2006] the instance held that if a charterer uses a vessel, known to be ready at the time of use, which has been tendered to him by a valid notice of readiness, or by an invalid notice whose invalidity is known, he must expect time to run against him, allowing for any relevant notice time, and subject to any express contrary agreement [11]. In that case the charterers not only consented to an early tender of notice of readiness, berthing, and commencement of loading, but gave orders to that effect [11].

If the charterers accept the notice of readiness so as to give rise to a waiver or estoppel it has been said that acceptance cannot be withdrawn unless induced by fraud [1].A notice of readiness with inaccurate statements will be void unless it is accepted by the charterer or its agents or there is a waiver of the requirement for a notice of readiness [2].

7. READINESS

A ship must be ready to load so as to prevent the cancelling clause from operating although she may not have complied with some requirement necessary before laytime starts [1]. Whether or not a ship is ready to load depends on a variety of factors such as position of the vessel, weather it is physically capable of receiving the cargo, and whether it has complied with all the port health and documentary requirements [4].

The ship must actually be ready subject to *de minimis* [2]. Notice of readiness to load can be given even though it is impossible to commence the loading operation because the vessel is not in berth [4]. The test of readiness to load is less stringent if applied in respect of port charters than in the case of berth charters [4]. Berthed vessels have normally to be prepared in all respects to receive cargo before notice of readiness can be given [4]. It has been held that an arrived ship could give notice of readiness even though the hatches had not been removed or the discharging gear rigged, provided that such work could be completed by the time the vessel berthed [4].

Provided that other requirements are met a vessel may be ready to load when it becomes an arrived ship under a port charter party or where the charter provides that laytime shall begin to run „whether the ship is in berth or not" [4].

The ship must be discharged and with ready in all her holds so as to give charterer complete control of every portion of the ship available for cargo, except so much is reasonably required for ballast to keep her upright [4].

In jurisprudence it was held that so long as even the smallest portion of the previous cargo remains to be discharged or ready to unload if overstowed cargo has to be removed before access can be gained to the charterer's cargo, the vessel is no ready to load [4]. The vessel must be fit to receive the agreed cargo i.e. the holds must be clear and free from contamination, the required loading gear must be fixed [4].

Where the charterer is given the choice between a range of cargoes, the vessel may legally be ready to load even though not fit to receive the particular cargo selected by the charterer [4].

Where there is more than one port of loading with optional cargoes and the charterer seeks to cancel on the ground of insufficiency of the loading gear he must prove that at the cancelling date the ship was in such a condition that the shipowner would be necessarily unable to load some cargo which the charterer was entitled to call upon him to take on board at the first or some subsequent port [1].

Legal requirements such as satisfying the health requirements and obtaining the necessary documentation have been regarded as mere formalities and shipowners have been allowed to give notice of readiness even though they have not received *free pratique* [4]. Such notice will be presumably effective in such circumstances if the required documentation is obtained by the time or shortly after the ship berthed [4].

Notice of readiness will be void if the ship is not ready and no time will count at all until the she is ready even though it may not take long to make her ready [2]. Contractual clauses which provide that laytime will count even the ship is not ready, except the time making her ready, must imply a term that the notice of readiness must be given in good faith [2].

8. CONCLUSIONS

The moment notice of readiness is given provides a starting point for the calculation of laytime. Charterers seek to use charterparty provisions shifting risk of delay.

Risk transfer is accomplished in voyage charterparties through a variety of ways. According to Clauses requiring charterer to nominate a reachable berth owners cannot recover damages at full large for the breach during the running of such time and cannot recover both demurrage and damages for the same delay.

Another option is through the clause *time lost waiting for a berth* which means that the existence of the option has the significance that the charterer by the way he requires the contract to be carried out may influence the incidence or extent of the risk to be borne by the shipowner.

Clauses *Time to count weather in berth or not/ Time to count weather in port or not* provides that laytime shall resume when the vessel is ready to load or discharge at the berth.

9. REFERENCES

[1] Bernard EDER, FOXTON David, QC; BERRY Steven, QC; SMITH Christopher, QC; BENNETT Howard, *Scrutton on Charterparties and Bills of Lading*, 22nd Edition, Sweet & Maxwell, 2011;

[2] BAATZ Yvonne, Charterparties in *Southampton on Shipping Law*, Institute of Maritime Law, London, Informa 2008;

[3] BAUGHEN Simon, *Shipping Law*, 4th ed, Routledge Cavendish, 2009;

[4] WILSON John F., *Carriage of Goods by Sea*, 7th. ed., London: Longman, 2010;

[5] DOCKRAY Martin, *Cases & Materials on the Carriage of Goods by Sea*, Third Edition, Cavendish Publishing Limited, 2004;

[6] Voyage Charter Party Laytime Interpretation Rules 1993;

[7] *Suek AG v Glencore International AG* [2011] disponibilă la http://www.onlinedmc.co.uk ;

[8] *Glencore Grain Ltd. v. Flacker Shipping Ltd* (The Happy Day) [2002] vol.2, Lloyd's Law Reports;

[9] *Glencore Grain Ltd. v.Goldbeam Shipping Inc, Goldbeam Shipping inc v. Navios International Inc.* (The Mass Glory) [2002] vol.2, Lloyd's Law Reports;

[10] *Emeraldian Limited Partnership v Wellmix Shipping Ltd* (The Vine) [2010] EWHC 1411 (Comm), Queen's Bench Division [2011] vol.1, Lloyd's Law Reports;

[11] *Tidebrook Maritime Corporation v Vitol SA* (The Front Commander) [2006] vol.2, Lloyd's Law Reports.

LEGAL IMPLICATIONS OF THE VOYAGE CHARTERPARTY PERFORMANCE

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ABSTRACT

This Article aims at present the role of the master as agent of necessity for the shipowner. Based on jurisprudential decisions it also presents the division of responsibility in case of discharging operations and reallocation of risk by agreement which transfers responsibility for loading, stowage and discharge operations from the shipowners to shippers, charterers or consignees.

In practice, problems result for the charterer where he delivers the goods to another person than one entitled or when he confronts the situation of the absence of any consignee ready to receive the cargo. Last but not least, problems arise where goods with similar condition, destined for different consignees, are shipped together and lose their identity during the voyage due to the obliteration of leading marks or becoming irretrievably intermixed with other cargo.

Keywords: *agent of necessity; division of responsibility; delivery of goods.*

1. INTRODUCTION

Liability is different in various stages of the voyage charterparty. It can be channelled to the master in the carrying voyage or delivery of goods stage. It also may be a division of responsibility between the shipowners and a multitude of actors involved in discharge operation.

Only by express contractual provisions or exemptions the responsible person will be discharged.

2. THE CARRYING VOYAGE

On completion of the loading operation, the responsability for continued performance of the charterparty will be transferred to the shipowner [1]. Thus the captain is the agent of the owners in providing those necessaries for the voyage which by the terms of the charter are to be paid for by the owners [1] or as agent of necessity under two obligations: the necessity for an extraordinary action such as sale, borrowing money on bottomry, salvage agreements, transhipment, jettison and second, no posibility of communicating with, or obtaining instructions from his principals wheather shipowners or cargo-owners [2].

The necessity remains if it proves imposible to obtain instruction because, although the cargo-owners have been comunicated with, they have failed to give instructions [2].

In modern times, however, the master has lessened authority owing to the increased facility of comunication [2] and the quality as agent of necessity will be rare in practice. If an agency of necessity is established it may entitle the agent to reimbursement from the principal of the necessary expenses incurred and in some circumstances remuneration for necessary services [2].

In recent case *Ene I Kos v. Petroleiro Brasileiro* (the Kos) [2010] it was held that the owners were not entitled to remuneration after the vessel was withdrawn. The owners were not doing anything more than required of a gratuituous bailee by way of caring for the cargo during the 2,64 days that elapsed before before the vessel sailed away. Where there was no element of accident, emergency or necessity, remuneration which had not been expressly or impliedly agreed could not be due [3]. In substantion of the decision *the Cargo ex Argos* [1872] case was cited: not merely is a power given but a duty is cast on the master in many cases of accident and emergency to act for the safety of the cargo in such maner as may be best under the circumstances in which it may be placed; and as a correlative right he is entitled to charge its owner with the expenses properly incurred in so doing [3].

Also, if an agency of necessity is established it may afford the agent a defence to a tort action, e.g. for conversion [2].

The master has the duty of taking reasonable care of goods entrusted to him by by doing what is necessary to preserve them on board the ship during the ordinary incidents of the voyage, e.g. ventilation, pumping or other proper means [2]. Reasonable measures include also that necessitating expenses to prevent or check the loss or deterioration of goods by reason of accidents for the necessary consequences of which the shipowner is by reason of the bill of lading under no original liability and the shipowner will be liable for any neglect of such of duty by the master [2].

The Master will have a lien on the goods for any expenses incurred in the performance of such duty [2].

As the Master has to exercise a discretionary power, his owner will not be liable unless it is affirmatively proved that the master has been quilty of a breach of duty [2].

In jurisprudence it was held that if the master cannot comunicate with cargo-owner will be entitled to sell the goods which are damaged or perishable [2]. If however the master can but does not, comunicate with cargo owner before selling goods, the cargo-owner will be entitled to recover damages for conversion even though sale is reasonable [2].

Where the vessel in which goods are shipped is hindered by an excepted peril from completing the contract voyage, the shipowner must, if the obstacle can be overcome by reasonable expenditure or delay, do his best to overcome it [2]. It is only where an excepted peril renders the completion of the voyage physically impossible, or so clearly unreasonable as to be imposible from the bussines point of view that the shipowner is justified in throwing up the voyage without the consent of the charterer or shipper [2].

The test of weather completion of the voyage is imposible may depend on the possibility of effecting repaires or the cost of repaires [2].

Where the shipowner is prevented from completing the contract voyage by a peril which cannot be overcome in reasonable time or by damage which cannot be repaired at a reasonable expense he is not bound either to repair or tranship though he elects to do neither he must hand over his cargo to the cargo-owner freight free or, if the cargo-owner is not present to receive it and cannot be communicate with, the master must act for the best as the cargo-owner's agent [2]. He has, however, the right to earn freight either by repairing his own ship and proceedeing to the port of destination or by transshipping the goods into another vessel to be forwarded thither and he may delay the transit a resonable time for either of these purposes [2].

In case of justifiable transhipment by the master as agent for the shipowner, the cargo-owner will be bound to pay the full freight originally contracted for, though the transhipment was effected by the shipowner at a smaller freight [2]. Semble, the master cannot, without express authority, bind the cargo-owner to more unfavorable terms in the contract of transhipment as by wider exceptions or to pay a larger freight than that originally contracted for, unless comunication with cargo-owner is imposible, and forwarding the cargo on such terms as would appear to a reasonable man to be the most beneficial course of the interest of cargo [2].

If the hidrance of the ship's voyage is not caused by an excepted peril, the shipowner is not entitled as of right to tranship on his own account on terms more onerous to the shipper than the original contract(though he may be bound to do so on account of the cargo-owner). Instead, he is liable for delay or failure to deliver [2].

The shipowner will normally indicate to the consignee the estimated time of arrival at the discharging port but there will be no cancelling clause for this voyage since the cargo owner for obvious reasons will have little interest in cancelling the charterparty at this stage [1].

3. PERFORMANCE OF CONTRACT-UNLOADING

Laytime will run from the moment the vessel arrives at the port and is ready to unload [1]. The right of naming the discharging berth is vested to the master where the cargo is deliverable to several consignees or indorsees of bill of lading [2].

If the ship is under a charter this right belongs: to the charterers if the charterers hold the bill of lading; if the bills of lading are not held by the charterers, to the bills of lading holders, if all agree on the place of discharge, or to the majority of the bills of lading holders so long at any rate as the minority do not disent; if there is no agreement, to the charterers or possibly to the bill of lading holder with the preponderating interest [2].

Where the charterer is given the express right to nominate a berth, the vessel will not become an "arrived ship" until it reaches the specific berth nominated by him [1]. In exercising this option, the charterer is under no obligation to consult the convenience of the shipowner and may even nominate a congested berth so long as the resultant delay is not so prolonged as to frustrate the object of the charter [1].

Discharge is a joint operation, the shipowner being responsible for moving the cargo from the hold to the ship's side and the consignee for taking it from alongside [1]. This division of responsibility may be modified by the custom of the port or by express provisions in the charterparty [1]. Thus it may be agreed that the shipowner will be responsible for the cost of discharging in which case he will have to bear such incidental expenses as the cost of any necessary rebagging of the cargo [1]. Alternatively, the charter may provide that discharge is to be free of expense to vessel with the result that the charter will be liable for stevedoring costs.

In *Jindal Steel v. Islamic Sipping* (Jordan II) [2005] the central issue was whether (as shippers and consignees argue) art. III, r. 2 of the Rules defines the irreducible scope of the contract of service to be provided by the carrier by sea or (as the carrier argues) art. III, r. 2 merely stipulates the manner of performance of the functions which the carrier has undertaken by the contract of service [4].

In cases where the parties to a contract of carriage agree that loading, stowage and discharge are to be performed by shippers, charterers, and consignees, the specific question is whether the carrier is nevertheless liable to cargo owners when the latter, or their stevedores, perform those functions improperly or carelessly [4]. In other words, the question is whether such an agreement, which transfers responsibility for these operations from the shipowners to shippers, charterers or consignees, is invalidated by art.III, r. 8 [4]. It was held that such a reallocation of risk by agreement is permissible and that in the postulated circumstances the carrier is not liable [4].

3.1. Notice of readiness to discharge

English Law does not require notice of readiness to unload to be given in the port of discharge in the absence of custom of port or special contract [1]. Is the responsibility of the consignee to keep a lookout for the arrival of the ship [1]. If however the charterers or consignees have been prevented by the shipowner's wrongful act or omission from learning by reasonable diligence of the ship readiness to unload they will to that extent be discharged [2].

In practice, few problems result for the charterer, since modern standard forms invariably contain an express provision requiring the shipowner to give notice of readiness [1]. Even at common law, notice must be given in cases where the shipowner fails to reach the designated port but invokes the so near thereto as she can safely get clause [1].

Where the ship already arrives on demurrage, days on demurrage begin to count on arrival, even if notice of readiness would have been required under the charterparty for the commencement of the laydays [2].

3.2. Delivery of goods

3.2.1. Delivery to the entitled person

Normally the requirement is to deliver to the consignee named in the bill of lading or to any person to whom the consignee has validly indorsed the bill [1]. In the event of no bill of lading having been issued, the consignee will normally have been designated either in the charterparty or in a non-negociable receipt [1].

The shipowner or master is justified in delivering the goods to the first person who presents to him a bill of lading, making the goods deliverable to him on his giving security, though the bill is only one of a set, provided that he has no notice of any other claims to the goods or knowledge of any other circumstances raising a reasonable suspicion that the claimant is not entitled to the goods [2].

If the shipowner is aware of adverse claims, he may run the risk of liability in conversion for the full value of the goods should he deliver anyone other than the person rightfully entitled [1]. In case of doubt he should interplead and refuse to deliver the goods until the rival claimants have resolved the issue in court at their own expense [1].

The shipowner is not entitled to deliver to the consignee named in the bill of lading, without the production of the bill of lading, and does so at his risk if the consignee is not in fact entitled to the goods [2]. If a shipowner who delivers the goods to another person than that entitled, is in fundamental breach of the contract and he is prevented from relaying for protection on the bill of lading exceptions [1].

The shipowner is liable if he delivers to someone who is not in fact the holder of the bill of lading even if he does so without negligence [2]. Clauses exempting the shipowner from loss or damage after discharge do not apply to delivery to a person who is not the holder of the original bill of lading [2].

Another possibility is that the person who claims the goods as entitled to them is unable to produce the bill of lading and in such a case, the captain can deliver them to him on his giving security or an indemnity against possible adverse claims by others [2].Under a bill of lading contract he is under no obligation to do so, nor save in exceptional circumstances can he be ordered to effect such delivery under a time or voyage charter [2].

3.2.2. Delivery when consignee fails to accept delivery

On arrival at the port of discharge the shipowner may confront the situation of the absence of any consignee ready to receive the cargo [1]. In such a situation he is required to allow the consignee a reasonable time in which to collect the cargo, after which he may land or warehouse it at the consignee's expense [1].

The shipowner still preserves a lien on goods and it is his duty to act reasonably in doing so rather than render the charterers, if they are not the defaulting consignees, liable for demurrage [2]. It is doubtful whether the shipowner can divest himself of his strict liability as carrier merely by warehousing the goods although to counterbalance any such potential liability he will retain the protection of the carriage exceptions [1].

Personal delivery may be excused if in certain ports delivery to a dock company or to harbour porters may is accepted [1]. Semble, if there are express contractual provisions to that effect [1].

In jurisprudence was held as effective clauses in excluding the shipowner from liability when landing agents employed by them fraudulently delivered the cargo without presentation of a bill of lading [1].

If in unloading, the master owing to the delay or absence of the consignee, difficulties arise from the inaccurate description of the goods in the bill of lading the consignee must bear the resulting lost [2].

3.2.3. Delivery of mixed and unidentifiable goods

Problems arise where goods with similar condition, destined for different consignees, are shipped together and lose their identity during the voyage due to the obliteration of leading marks or becoming irretrievably intermixed with other cargo [1].

In jurisprudence have been established rules to follow for most of the situations encountered in practice, rules in which the liability of the shipowner depends on whether or not the event causing the loss of identity is covered by an exception or a peril of the sea for the event that lead to loss of identity [1].

In such an event while the shipowner will avoid liability, the unidentifiable cargo will become the property of the bill of lading holders who will hold as tenants in common of the whole, in the proportion in which they severally contributed to it [1].

The principle applies where the parcels of cargo shipped have all arrived to the destination [2].The situation is different where part of the whole cargo have been lost at sea or a part of them have arrived unidentifiable [2].

The solution is the principle upon which the same percentage can be applied both to cargo lost at sea and to the unidentifiable cargo and the share of each consignee's loss is in the proportion which the difference between the number of marked goods delivered to each consignee bears to the total of such differences for all the consignments [2].

Where the occurrence is not covered by an exception, the shipowner will be in breach of his obligation to deliver the specified goods to the consignee and will not be able to reduce his liability by requiring the consignee to accept an appropriate proportion of the mixed goods [1].

Another possible situation is where part of cargo shipped in bulk is lost or damaged during the voyage as the result of an excepted peril [1]. In such a case the shipowner is not required to apportion the loss or damage between the various consignees but can deliver the full quantity of sound goods to the first consignee to take delivery [1].

4. CONCLUSIONS

There are a number of legal implications for the voyage charter party performance- the carrying voyage and unloading stage. First, the quality as agent of necessity will be rare in practice. If an agency of necessity is established it may entitle the agent to reimbursement from the principal of the necessary expenses incurred and in some circumstances remuneration for necessary services. Also, if an agency of necessity is established it may afford the agent a defence to a tort action. Secondly, from a legal point of view the carrying voyage is question of responsibility. The division of responsibility in case of discharge operations may be modified by the custom of the port or by express provisions in the charterparty. In jurisprudence it was established that such a reallocation of risk by agreement is permissible and the shipowner will be exonerated. Thirdly, the shipowner is liable if he delivers to someone who is not in fact the holder of the bill of lading. Due to express contractual provisions, the shipowner may be excused to deliver to an entitled person. Finally, in case of mixed or unidentifiable goods, the liability of the shipowner depends on whether or not the event causing the loss of identity is covered by an exception that lead to loss of identity.

6. REFERENCES

[1] WILSON John F., Carriage of Goods by Sea, 7th. ed., London: Longman, 2010;
[2] EDER Bernard, FOXTON David, QC; BERRY Steven, QC; SMITH Christopher, QC; BENNETT Howard, Scrutton on Charterparties and Bills of Lading, 22nd Edition, Sweet & Maxwell, 2011;
[3] *Ene I Kos v. Petroleiro Brasileiro* (The Kos) [2010] vol.2 Lloyd's Law Reports;
[4] *Jindal Steel v. Islamic Shipping* (Jordan II) [2005] vol.1 Lloyd's Law Report 57

BEHIND THE THEORY OF SAFETY AGAINST CAPSIZING AND ASSESSING SHIP STABILITY

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ABSTRACT

The paper presents considerations about the mathematical modelling and the use in assessment of ship stability. Stability criterion is defined in the context of an expression. The connection between that stability criteria and the safety against capsizing is expressed as ordinal measures. The paper proposed a classification of stability criteria according with their possibility of dissimilarity.

Keywords: *safety, capsizing, stability, criteria.*

1. INTRODUCTION

Part of our life and moreover of the researches is mathematics. One of the definitions for mathematics as "something where neither know what we are talking about not if what we are saying is write or wrong", was given by the English philosopher and mathematician Bertrand Russel. If we analyse this definition we can affirm that this is hallucinatory because in general terms the mathematics can be considered as the most exactly and purest science.

Of course this can be considered real only in respect to pure mathematical exercises, where the theorems, axioms and definitions can prove what are we doing and the results we are obtaining. The problem is completely different in the situations when we try to interpret our mathematical findings, like for example when we use mathematical models to express the real facts.

There are areas of study, like engineer education, where sometimes the difference between the mathematics, on the one hand, and the interpretation of mathematical relationship correlated with the validity of application in real facts, on the other hand, is widely neglected. This is an extremely important problem because they are not aware of how to correlate the mathematical expressions with models of real situations. This aspect is very important if it is trying to make mathematical models of real situations which are not yet sufficient modelled.

The development of a pure mathematical relationship is a logical determined straight forward operation but to make a mathematical model is not. The mathematical model can be considered a practical act of research in order to find a mathematical relationship that might be used as a model to express real situations and or facts. Of course, the heuristically created relationship can not be considered all the time as a valid model of reality due to the fact that this is only a hypothesis which still has to be proven. In respect to reality, each mathematical model has deficiencies in proving procedures.

To make the mathematical model practicable, in majority of the situations, it is hard to avoid or to neglect some of the conditions and facts which are present in reality and the necessity of simplification is involved. The effect of such simplifications will be discovered only by applying repeatedly the hypothesis and interpret the results against what really happens.

Analysing the hypothesis, there are two situations that have to be differentiated: Firstly the value and integrity of a mathematical model may be to explain qualitatively what really happens, like for example it can be taken from the Mathieu equation that under certain conditions extremely heavy rolling of a ship travelling in head or following seas may occur or follows from linearized equation of the roll motion that the roll amplitudes depend on the excitation frequency. We can agree such explanatory models and there is nothing wrong with them but, can be a improper use of mathematics if the authors protrude the models as exact solutions of a problem, especially in case of a real problem.

Secondly, the main purpose of a mathematical model is to provide quantitative predictions. Almost in all cases, such predictions are subject to errors. Those errors are, in some of the situations, measuring errors which inevitably occur when the input and output of a model is determined in the corresponding reality in order to test the accuracy of the model. In other situations, more frequently, the errors came from the neglects in the model. In this way, the validation of the model is made formally, although a formal judgement of the errors could be made by another methods like for example statistical methods. Hence, is taken into account the practicality degree of accuracy. Thereby, the accuracy of the model is compared against its complexity and usually the engineers does not pay attention for the maximum achievable physical correctness but for results which are good enough for his purposes and can be obtained with an acceptable effort.

In the view of the problem related to capsizing of ships there are various mathematical models issued but there is not yet a comprehensive and valid one. Many of the mathematical models that abounds the literature pretend that are offering a solution related to capsizing, although those models only explain some qualitatively aspects of the problem or, sometimes, derive from the mathematical complexity of the methods used that the results are valid. The latter aspect has been amply described and criticized in [1]:"Put all your faith in mathematical theorems and terminologies and the problems of the ship stability will disappear."

2. AN ATTEMPT TO DEFINE THE SHIP STABILITY CRITERIA

In particular terms, the word "stability" used in naval architecture did not correspond with the same meaning in engineer mechanics.

In the field of naval architecture and ship design, ship "stability" is related to safety against capsizing. If this word is expressed in combination with other terms like initial stability, range of stability, stability calculation, it reveals aspects which are correlated with the safety against capsizing.

As opposed with the aspect presented above, related to the meaning of the word "stability", the expression "stability criterion" is used in naval architecture in a more accurate and precise sense. Moreover, this sense is expresses in conformity with the definitions stated in the dictionaries (e.g.[2]): "Criterion" means "standard for making a judgement" and "standard" means "model" or "measure".

Having in view the above definition, we can say that the expression "stability criterion" may have the following meanings:

- The model which is the base for judging safety against capsizing;
- A measure of the safety against capsizing.

If we have a look over the actual stability criterion, issued by IMO, we can state that some of the actual criteria appear more as a requirement than as a measure (e.g. "the righting lever GZ shall not be smaller than…")

In this case, it can be affirmed that the requirements are the values of the safety measures for which a vessel is considered unsafe.

As we can see from the above definition, the "stability criterion" is in strong correlation with the capsizing of the ship. In this context the meaning of "capsizing" can involve the following aspects:

- Which are the circumstances that we shall speak of capsizing in connection with stability criteria (e.g. a ship that is in unstable equilibrium it is not automatically considered as capsized, in spite of the fact that its condition is the same as when capsized);
- In the context of stability criteria it can be pertinent that a ship can be considered capsized if the inclination (heeling angle) has values that exceeds the limit for the ship to be safe and to comply with her scope. A ship can not be considered capsized only if it is upside down.

There are multiple situations that cause capsizing of a ship. A general classification can divide these causes in two main categories:

- The causes which can be controlled by the Master (e.g. neglecting the free surfaces of liquid in tanks, improper lashing of cargo and shifting of cargo, errors in assessment of ship's KG, uneven transversally distribution of cargo, human errors, etc);
- The causes which cannot be controlled by Master (e.g. stability failure due to ship design and construction, shipping of large amount of water on deck, stability failure due to incorrect declared weight of cargo by shippers, heavily rough seas).

For both categories of causes presented above, the safety against capsizing can be realized by taking proper actions to avoid those dangerous situations and may avoid the capsizing of ship.

Considering what just had been said one might wonder why it has been tried to define the meaning of the word "stability criterion" in place of directly defining a measure of safety against capsizing. It will be shown in the next section that there are some good reasons to differentiate between stability criteria on the one hand and a measure of safety against capsizing (in a strict sense) on the other hand. There is no difference with respect to the final aim; but with regard to the means, i.e. the philosophy of modelling, it is useful to make a difference.

3. SAFETY AGAINST CAPSIZING ON THE MODELING OF STABILITY CRITERIA

The fact that total safety cannot be achieved was learned from the continuously researches and engineers work. Even after years and years of researches, has been widely accepted, as a rational measure of safety against the occurrence of such events, the probability that certain unwanted events will not occur during a prescribed time.

The concept of probability has led to important progresses in many fields of research and proved to be very useful. Moreover, in the last decades it turned out that is almost always possible to apply in practice due to lacking of relevant information as well as sufficient knowledge of physical relationships.

The probability that a ship will not capsize during its lifetime is the fields where this concept has proven to be true, and was very well explained and presented by engineers [3].

Additionally, in this explanation was mentioned the idea that would not be enough even if it would be possible to calculate the probability that a vessel will not capsize during its lifetime and the value of probability of non-capsizing would have to be determined, as a function of ship characteristics and at which the ship is considered safe enough.

Hence, the concept of probability raised to aspects:

- It would not make such sense that to choose a arbitrary value to be as safety limit after passing through all the laborious work of calculating the probability;
- Instead of ascertain the probability of non-capsizing, to determine a rationally safety limit would be a more necessary and demanding task.

In this way, would be more than necessary to be considered the relationships between safety and economics as well as the problem of minimizing the total loss.

In our days, researches on individual risk ahs shown that rationally determined acceptable risks are not necessarily accepted [7] while in the past engineers were convinced to accept a rationally safety limits as normative requirements.

The probability of non-capsizing of a ship during its lifetime is the result of an average of many probabilities of occurrence of events and situations and even a very small probability of non-capsizing is not sufficient because the proper safety is considered in respect to particular situations.

In this sense, to achieve a proper safety means that the product of the probability for the occurrence of a certain situation (e.g. heavily rough seas, shifting of cargo) times the probability of capsizing in such situation must be very near to zero. The result of this product deducted from one is also a probability and in this context will be a measure of safety. Even though this idea can be considered simpler than the probability of non-capsizing of a ship during its lifetime, our knowledge is not sufficient to apply it for real facts. In this sense a safety limit would be in strong connection with the rationally based safety limit and for every ship, taken as a particular case, the one or other may dominate.

In the end can be concluded that basically known how safety against capsizing in a strict sense should be measured; but things are too complicated to actually do it.

4. STABILITY CRITERIA AS ORDINAL SAFETY MEASURES

In most of the situations, naval architects are able to design ships which have adequate safety against capsizing although this aspect (i.e. safety against capsizing) cannot be ascertained in a strict sense. One thing is sure, the naval architects are actually applying for that purpose and they have never reflected on the concept. This is the result for much confuses thinking about this problem.

The highest level of measurement is that the safety measurement in a strict sense to be an absolute or ratio scale. In the situations when measurements on this level are not possible they can be made on a lower level and in this way an ordinal measure of safety against capsizing can be the interpretation of stability criteria.

Many times in the situation of two ships of same type and size, although we have been taught that the ship with higher GM value is safe than the one with a lower GM value (within certain limits), the judgement of the safety was actually the history of safety records of the ships from which could be ascertained that the safer one is the one with higher GM. It is very well known, especially in practice, that is difficult to generalize the ship behaviour in a random seaway and in many times accompanied by heavily storms only from the GM value.

The situation just described corresponds exactly to the procedure when establishing an ordinal scale for an attribute of a set of items. In the first instance, based on the experience, we have to be able to state for pairs of ships S and V of a set of ships if

Ship S is safer than ship V (a)
Ship V is safer than ship S (b)
Ship S and V are equally safe (c)

Then, it is necessary to find a “f” of the particulars of the ships S and V which corespond for the above three cases respectively:

f(S) > f(V) (a’)
f(V) > f(S) (b’)
f(S) = f(V) (c’)

(S and V are used here to designate particular pairs of ships as well as their characteristics).

It can be deducted that any function “f” which complies with the above requirements constitutes an ordinal measure of the safety against capsizing. Moreover, the obvious parallelism between stability criteria and such a measure of the safety against capsizing is obvious. It also covers the fact that to a wide variety of stability criteria comply with the infinite number of possible ordinal scales.

We can conclude that once the ordinal scale was established this may represent a special category of mathematical modelling, a mathematical relationship (i.e. the function f) is connected with real facts (i.e. the experience that a ship S is safer than a ship V etc.).

5. ASSESSMENT OF THE SAFETY AGAINST CAPSIZING

In the field of ship stability, assessment of the safety against capsizing means to find that measure of stability expressed as a value of a stability criterion beyond which a ship is considered safe. Such a value will be called limiting value. The values of stability criteria do not indicate the levels of safety, having in view that those criteria are only ordinal measures. However, those criteria allow the comparison of the safety of ships. The function f(S) can be considered as limiting value only if the ship S is known to be sufficiently safe. Another ship V will be at least as safe as ship S only if exists the relationship $f(V) \geq f(S)$.

It is very important to be mentioned that when stability criteria are derived as ordinal measures it was assumed that the ships are of same type and size. Moreover, for a valid comparison of the safety of ship S and of ship V, the environment in which a ship V operated has to be similar to that of a ship S.

Of course, the best way is to find a proper “calibration ship” but this has been proven that is not an easy task. Even the widely used limiting values for stability criteria, proposed by Rahola, may be interpreted as derived from an imaginary “average” ship and it is quite evident that those values cannot be valid for particular ships which not correspond or are significantly different from the average. That’s why, one of the deficiencies of Rahola method is the insufficient definition of the average ship and the result is that naval architects and Masters are in many situations not able to establish that in a particular case the limiting values may not be valid.

It seems that making use of model tests it is possible to adapt the limiting values of the average ship for other different ships This situation is illustrated by the findings derived from an investigation of the capsize of a coastal tanker in ballast condition [8].

For simplify the matter, it was considered only the area under the righting arm curve up to a heeling angle of 30°, and the data from [8] was derived in form of the table as follows:

Limiting values of Area up to 30°	
IMO Criterion	0.055 m rad.
From test for Ballast Condition	0.041 m rad.
From test for Loaded Condition	0.026 m rad.

Actual values of Area up to 30° Criterion	
Loaded condition	0.055 m rad.
Balast condition	0.096 m rad.

Based on the stability calculations and the above figures, the interpretation of the results may be as follows:

- For the ship in loaded condition a lower limiting value of area under the curve up to 30° will satisfy the IMO limiting value only if it assumed that the environmental conditions used in experiments are similar to those on which the IMO limiting value is based;
- In order to provide sufficient safety for the vessel in ballast condition, the limiting value in this sense is according to the test results and is higher than IMO value.

The interpretation of the results from the actual values is based on the facts that the seaway used for the tests (which corresponded to the seaway during the accident) was less severe than that underlying the IMO value. In this situation is valid even a greater limiting value for vessel in ballast condition than the value derived from the test. We can make a sarcastic comment and affirm that it was necessary the accident of the ship and then the capsizing tests to discover those values. Accidentally or not one of the purposes of the test programs presented at that time [4] was to adapt limiting values from ships considered safe for vessels which the safety cannot be estimated sufficiently.

6. CLASIFICATION AND COMMENTS OF STABILITY CRITERIA

The stability criteria were divided by some researchers [11] in two categories

- "Statistical approach" - which includes the criteria based on the fact that the values of freeboard and metacentric height to be derived from the righting arm curve;
- "Physical approach" – which includes criteria based on the comparison of the areas under the heeling angles and righting moment curves (known as weather criterion).

As both categories of stability criteria mentioned above are based, more or less, on physical relationships and moreover both relay on statistical information, this division does not make such sense. A very important aspect that has to be mentioned is that in both cases the stability criteria fail to cover the most essential physical phenomenon and this is the dynamic behaviour of a ship in random seas.

Grading the efficacy of stability criteria seems to be a more efficient classification. As was shown in [5], a possible way to do this is to introduce a measure of the discrimination ability of the particular criteria. Another possible way is to state how widely the limiting values of various criteria scatter for a set of different ships. An example for this may be derived from [4]. It should be mentioned here that criteria are not explanatory models and by contrary are predictive models and in this sense another classification would apply for explanatory models.

The stability criteria based on the values of righting arm curve in still water are the most used. Those criteria are based on a pure empirical relationship between characteristics of the righting arm curve and safety against capsizing and without any reserve takes care of the effect of the waves and all kinds of heeling moments. This can be considered the first step that in those stability criteria it is improper to be assumed that the limiting values are the same for all kinds of ships. However, astonishingly was the fact that it was found possible to obtain limiting values from casualty statistics of not too well defined sample of ships. Beyond any doubt, the people who would never rely on such statistically derived limiting values will be the naval architects because they would assess the stability for each kind of ship by comparing its righting arm curve with that of similar ships, existing ones and - if casualties available – capsized ones. Sometimes the view is held that information from existing ships is of little use because they might become casualties in the future. This does not apply if severe weather experience of the existing ships is considered.

The main advantage of the stability criteria based on the interpretation of righting arm curve is the fact that they lend themselves to very simple improvements. As was shown in [5] a criterion derived by properly combining different characteristics of the righting lever curve provides a better discrimination between safe and unsafe ships of a sample than if the characteristics are used individually. The results in limiting values of criteria which are valid for a wide range of ships than the up to now criteria are the application of the hull factor form proposed in [4].

The comparison of the heeling and righting arm curve is another well known type of stability criteria, where only the levers at various heeling angles as well as the area under the levers (calculated from zero or windward angle) are compared. In this case of stability criteria are used either the ratio between certain areas under righting arm curve or the difference between heeling and righting levers. As in the case of stability criteria based on the values of righting arm curve in still water, here also the relation between safety against capsizing and criteria is pure empirical and in this way there is no differences between this type of criteria and the type of criteria based only on the righting lever curve. Practically, it is the same procedure if have to be determined the differences between righting and heeling levers or the limiting values of the righting levers according to experience with similar ships.

The only goal remained is the problem of quantifying correct the moments and the windward heeling angle because the criteria using heeling levers in addition to righting levers have no automatic advantage against those based solely on the righting lever curve. Of course some engineers can consider as superior the criteria which use the values of heeling levers but this can be attributed to misunderstanding that more complexity automatically provides better models. Therefore, it would be of great interest among maritime community of engineers and researchers to carry out investigations for quantifying the discrimination ability for criteria including heeling moments in order to determine their superiority.

The safety level guaranteed to the ships by the compliance with stability criteria, however, is in general unknown and it is still a big open problem. It is indeed typical to open the way to alternatives by stating that "a level of safety has to be guaranteed, as a minimum, by any alternative assessment". Statements like this are often used to try to avoid excessive relaxation of safety standards, but in fact are less meaningful than they could appear. Of course, ship safety at sea was greatly improved by the development and implementation of present stability criteria, as contained in IS Code, and other measures (for example the assignment of freeboard), although being these measures recommendatory in nature or not so widely adopted.

In order to achieve sufficient level of safety with respect to stability, all elements creating stability system have to be taken into account. Taking into account the fact, that less than 20% of all casualties are caused by faulty or bad design of the ship, the safety requirements that refer mainly to design features of the ship cannot ensure sufficient level of safety, in particular with regard to ships having design features.

In the end we can conclude that since 1962 the use of stability criteria based on the probability of capsizing was proposed [9]. The superiority of this method over conventional criteria it has not been proved till today and it is clear that its efficiency and extension of the validity for all kinds of ships would not be so good. Probably, this aspect is one of the reasons that the stability criterion based on probability did not become accepted.

7. CONCLUSIONS

It is right to emphasize that mathematics by itself cannot solve a physical problem. The most important step is the modelling, i.e. a formulation which includes the most significant features of the problems to a sufficient approximation, and this must be tested by experiment in the history of ship hydrodynamics. The cases where theories are obviously physical relevant or where mathematics has preceded the experiments and vice versa are abundant in the literature. The examples are revealed in the calculation of virtual mass, development of ocean spectra and breaking waves or the wave motion in a rolling tank.

In the fields where mathematics is not yet developed the engineer's insight and experience can offer an adequate solution. In this fundamental problem of stability criterion based on values of righting lever a mathematician might note that nobody appears to have counted the numbers of independent dimensionless parameters and that the criterion is not a dimensionless relation but that GZ is expressed as a length.

Can be conclude that is correct to affirm that safety as a concept should be measured with ordinal scales. By ordinal scales is qualitatively measured whether an object has more or less the same attribute in question, in addition to giving distinction between objects. However, an ordinal scale cannot indicate by how much an attribute is more or less than some other attribute, i.e. no quantification. In the other way, the same will not apply to intact ship stability since for this specific element of safety a higher order measurement scale exists, as recommended in IMO resolutions related to intact stability.

Today, capsizing accidents were occurred very often in quartering and following seas conditions. In a quartering sea, the most dangerous situation is subjected to the dynamic effect of a ship motion especially due to shipping water on deck and cargo shifting. It is well understood that these situations are occurred in a operation at relatively higher ship speed. From the above point of view, may be affirmed that ship stability criteria must be set up as a function of sea state, ship speed, heading angle of encounter wave in proper way.

The responsibility of the ship's officers is for understanding the behaviour of the vessel and they should always be ready to adjust its stability for the circumstances that the ship is in at the time

There is a necessity of rethinking of the stability problems, arising from the new ship design trends, new ship's operation from economical point of view, as well as competitive officers on board vessels capable to face the new challenges, generating new requirements that will protect lives, environment and proprieties.

In particular situation the safety against capsizing is of course depending on the parameters mentioned. There are even more parameters to be considered (as e.g. wind, shifting of cargo). Because we are not yet able to determine the safety against capsizing theoretically we are using criteria which are based on experience and which implicitly take care of all effects which as yet cannot be dealt with in a physical correct and comprehensive manner, of course it would be possible to develop criteria which explicitly depend on the seaway, ship speed etc.

The maritime industry efforts still have not solved the problem of stability problems, especially for particular ships, particular types of cargoes, particular loading conditions as well as severe weather conditions.

Development of prevention measures, in a form of stability criteria, to avoid accidents or loss of ships remained an open issue and should therefore continue to a final and reliable solution.

However, till reliable solutions will be available, the main responsibility remains in the hands of the master and navigation officers who must recognize very quickly the symptoms of stability loss and to take action in due time, by using the only available means for the moment, in order to minimize the risk of damage to ship and cargo.

Of course, all possible solutions of prevention show good promise but involve high expenses from the owner side and the possibility of introducing still remains as a prospect and based on the individual owner's preference. Moreover, all those solutions will have an impact on the vessel's terms of speed and cargo carrying capacity which are not negligible factors.

8. REFERENCES

[1] KUO C., WELAYA Y., *Reply to a critique by A.Y. Odabasi*, Ocean Engineering 1982.
[2] THORNDIKE B., *Comprehensive Desk Dictionary*, Garden City, N.Y. 1958.
[3] KRAPPINGER O., *Stability of Ships and Modern Safety Concepts*, International Conference on Stability, Glasgow 1975.
[4] BLUME P., HATTENDORFF H.G., *An investigation on Intact Stability of Fast Cargo Liners*, Second International Conference on Stability, Tokyo 1982.
[5] KRAPPINGER O, SHARMA S.D., *Sicherheit in der Schiffstechnik*, Jahrbuck STG 1974.
[6] KRAPPINGER O, *On the philosophy behind assessing ship stability*, Second International Conference on Stability, Tokyo 1982.
[7] DIERKES M., *Technological risk*, Cambridge, Mass 1980.
[8] KURE K., BANG C.J., *The Ultimate Half Roll, International Conference on Stability*, Glasgow 1975.
[9] KRAPPINGER O., *Uber Kenterkriterien*, Schiffstechnik 1962.

ROMANIAN NAVAL AUTHORITY AND THE MARINE ENVIRONMENT PROTECTION

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ABSTRACT

The article presented is intended to highlight the activity and efforts developed by the Romanian Naval Authority (RNA) in order to fulfil the obligations assumed by Romania and required by the IMO Conventions and EU Directives. The organizational structure reveals that RNA is complying with the new requirements and recommendations regarding the pollution prevention and pollution response. It is stressed the good cooperation with the International Maritime Organization (IMO) and the European Maritime Safety Agency (EMSA) and the important achievements concerning the application and the enforcement of the MARPOL requirements in the area of jurisdiction has been brought. The new equipment and advantages of the CleanSeaNet System is described. A real case of marine pollution shows how MCC is functioning by applying the satellite image information in order to suppress any form of violation in respect with national and international legislation for marine pollution prevention

Keywords: *CleanSeaNet System, pollution, marine environment protection, action plan, maritime*

1. INTRODUCTION

Cleaner seas represent an objective which involves the maritime states all over the world. The European Union member states are strongly committed to act in a harmonised manner to protect and intervene in case of maritime pollution as per the requirements of specific IMO conventions and European directives and regulations.

To understand how important the struggle against marine pollution is and also the role played by the National Administration, is important to shortly present the Romanian Naval Authority (RNA), specialized technical body, acting as a state authority in the field of the safety of navigation, that represents and fulfils the obligations assumed by Romania with regard to international agreements and conventions such as those connected with environmental protection against marine pollution from ships.

Maintaining a competitive level and a sustainable development are the major objectives even in the context of the world crisis' negative effects. RNA provides high quality level services in accordance with the provisions of the legal and regulatory requirements which are included in the quality system policy and the procedure of the Management System having an essential contribution in the company competitiveness. The Romanian Naval Authority's motto "Safety through Quality" represents the importance given to the highest standards within the company.

The main tasks of the Romanian Naval Authority regarding the fight against pollution have been defined including the following:

- Inspection, control and surveillance of navigation in Romanian maritime waters and inland waterways;
- Fulfilment of the obligations assumed from the international agreements and conventions to which Romania is part of;
- Representing the Romanian Government within the international organizations in the field of naval transports;
- Implementation of international rules, regulations and conventions into Romanian legislation;
- Development, endorsement and submission of drafts laws and mandatory norms to the Ministry of Transports for approval;
- Port State Control and Flag State Control;
- Coordination of search and rescue activities in the Romanian navigable waters and of the actions to be taken in case of navigation accidents and casualties;
- Protection of navigable waters against pollution by vessels;
- Sanctioning of the contraventions and investigation of the navigation accidents and casualties;
- Technical surveillance and certification of maritime and inland water ships, offshore drilling units flying the Romanian flag and of naval equipments, as per RNA regulations;
- Supervising the compliance of the Romanian naval transports with the provisions of the ISM Code and ISPS Code.

To meet and apply the requirements set in the international conventions such as SOLAS/1974, SAR/1979, MARPOL 1973/1978 and OPRC/1990, Romanian Naval Authority has been legally appointed as the responsible authority to perform the management and mission co-ordination for SAR and Oil Response activities and also to monitor the vessels' traffic within the area under Romania responsibility, through Maritime Coordination Centre.

The one roof concept, as per IMO recommendation, which includes VTS and SAR-OPRC under a single umbrella, is one of the strongest points of the related centre which permits to act in a unitary manner for monitoring, controlling, coordinating and intervention in case of maritime incidents, casualties and pollution.

The Maritime Coordination Centre (MCC), through SAR - Pollution Department and VTS Department, performs activities regarding search and rescue, prevention and response to marine pollution, as well as the surveillance and management of the vessels' traffic, 24 h/day. The Maritime Coordination Centre has full responsibility in cooperating between RNA and other international organizations involved in the field of search and rescue of human lives at sea and marine pollution. By attending national and international programs in this field, such as seminars, trainings, conferences and organizing national and international exercises in order to reach the specific standards at highest level has increased the role and importance of the Romanian Marine Coordination Centre within the region.

2. ROMANIAN NATIONAL PREPARATION, RESPONSE AND COOPERATION IN CASE OF MARINE POLLUTION

MCC is involved with the International Maritime Organization in working groups, within the Marine Environment Protection Committee (MEPC) and Sub-Committee on Radio communications and Search and Rescue (COMSAR), providing technical assistance, issuing international legal regulation regarding SAR and oil response activities. MCC has been also designated as national operational contact point (NOCP), according to the National Contingency Plan for Oil and HNS pollutions.

For the application of the stipulations of art.6 of the International Convention (1990) regarding the preparation, response and cooperation in case of hydrocarbons pollution, there is established a harmonized system for action in case of pollution with hydrocarbons named the National System which includes the measures for preparation and response in case of pollution with hydrocarbons.

The National Plan for preparation, response and cooperation in case of marine pollution with hydrocarbons is part of National System.

The authorities involved with this Plan are:

- Ministry of Water and Environmental Protection (Designated Department) - for coordination of activities connected with the function of National System, elaboration and updating of National Plan, Contact National Point with international authorities;
- Civil Protection Commandment - for terrestrial intervention;
- Romanian Naval Authority of the Romanian Ministry of Transport - for maritime operations;
- Ministry of Defence - Navy Forces - for military navies.

The Plan consists in application of the provisions of International Convention for preparation, response and cooperation in case of pollution with Hydrocarbons, adopted at London in 30 November 1990 (OPRC 1990). The application of this Plan covers the Romanian Black Sea coast, territorial sea and Romanian exclusive economic area, with the aim to mitigate promptly and efficiently the incidents with hydrocarbon pollution, for protecting the sea environment, coastal area and human life and health. The Plan includes also the requests for organizing at national level preparations, cooperation and intervention in case of pollution, the methods of action after receiving the report regarding the hydrocarbon pollution, promoting the international cooperation and research for mitigation of marine pollution with hydrocarbons.

At national level the coordination for the application of the Plan is performed by the Ministry of Waters and Environmental Protection, in cooperation with the Ministry of Transports, the Ministry of Internal Affairs, the Ministry of Public Administration and the Ministry of Defence, which have responsibilities in coordination of actions for preparation, cooperation and response, through their designated departments and subordinated units, as set in the Plan.

For interpretation of the Plan, regarding the juridical status of interior maritime waters, territorial sea, contiguous area and Romanian exclusive economical area, the terms are defined as per art.2 of OPRC 1990 and as per those specified in Law 17/1990 as amended.

Commanders of maritime navies under Romanian flag, commanders of marine drillings units, of ports and installations for hydrocarbons, have the obligation to immediately report at RNA all incidents of hydrocarbons pollution by them or by others or the presence of hydrocarbons in water.

Pilots of civil or military airplanes must report to the Centre for air traffic all incidents of hydrocarbons pollution observed in water.

The Centre for control of air traffic will transmit immediately the information to RNA or if the case, to National Agency “Romanian Waters”, DADL.

The Operative Commandment for Marine De-pollution (CODM) – is the coordinator of activities in case of marine pollution with hydrocarbons and is conducted by a General Coordinator (Prefect of Constanta County) and by a Deputy General Coordinator (President of Constanta County Council).

CODM is the National Centre for Intervention in case of Emergency, the operational base of all actions for mitigation of marine pollution, in case of entrance in action of Plan or in case of regional cooperation.

CODM organizes and leads annually for all units included in the National System a general exercise for intervention in case of major marine pollution with hydrocarbons. List of intervention forces, the equipments for response and communication of the units which are parts of National System is permanent updated and kept by the Permanent Secretariat of CODM.

Rules of the Plan are stipulated by the Governmental Decision nr.1232/2000 for approving the Methodological norms for implementation of provisions of International Convention regarding the civil responsibility for damages produced by hydrocarbons pollution, 1992 (CLC, 1992).

In case of pollutions other than those stipulated in 1992 Protocol, according by Governmental Ordinance nr.15/2000, compensation of spending for de-pollution and restoration is made under the principle *polluter pays*.

As an important tool within MCC, Constanta VTS is a modern and integrated system for maritime traffic management and it has the responsibility of monitoring, conducting, surveillance and coordinating vessel traffic, in order to improve the safety and efficiency of navigation and to protect the environment in the VTS area fully connected with AIS and LRIT systems.

As an obligation for an EU costal state, Romania, performs the application of the CleanSeaNet service, which is a satellite based monitoring system for marine oil spill detection, tracing and surveillance by checking on scene the satellite images.

MCC is also connected to SafeSeaNet (SSN) System for port and alert notifications. This system consists essentially of setting up an electronic network between the maritime administrations of the member states in order to facilitate the implementation of maritime safety aspects.

The connection with the Global Integrated Shipping Information System (GISIS) database of the International Maritime Organization, allows introducing all information regarding port reception facilities, SAR and marine pollution incidents.

To protect the marine environment by coordinated prevention response and limitation of consequences of pollution from ships as well as by monitoring and managing the vessel traffic, RNA is committed to

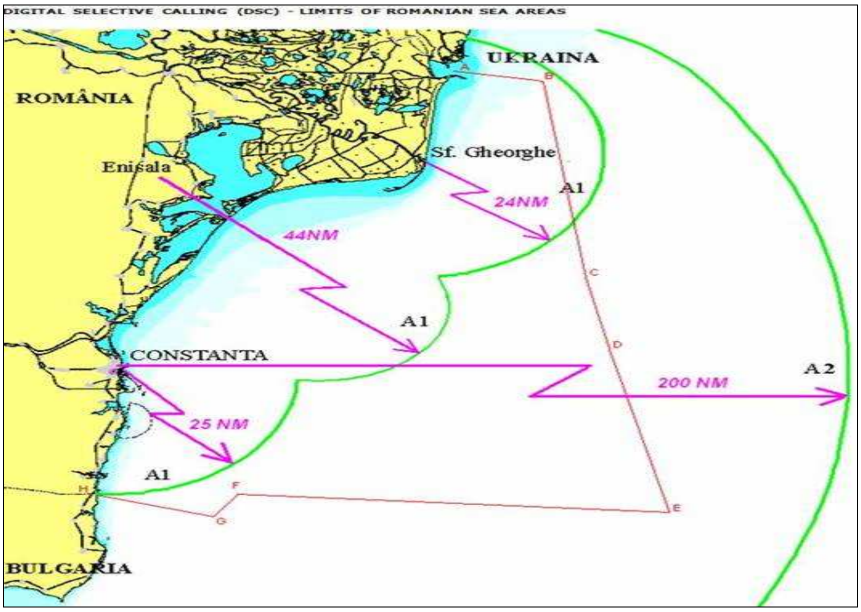

Figure 1

Figure 1 Area of responsibility for national intervention in case of pollution and SAR operations minimize loss of life, injury, property damage and risk to the environment by maintaining the highest professional standards.

These objectives are permitting to provide an effective SAR services for all risks, to protect the marine environment and to improve the safety and efficiency of navigation within maritime responsibility area.

The legislative frame has been implemented containing all the relevant provisions with regard to EU Directives and IMO Conventions. Romania has ratified important conventions, protocols and agreements concerning the protection of the marine environment such as MARPOL 73/78 with all annexes; OPRC1990; CLC 1992; Bunkers 2001, as well the regional agreements: Bucharest Convention, 1992, Odessa Ministerial Statement, 1993, Regional Contingency Plan. The following EU Directives were transposed, implemented and enforced:

- Directive 2000/59/EC on port reception facilities for ship-generated waste and cargo residues;
- Decision 2850/2000/EC setting up a Community framework for cooperation in the field of accidental or deliberate marine pollution;
- Directive 2005/33/EC amending Directive 1999/32/EC as regards the sulphur content of marine fuels;
- Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002.

At EU level, Constanta MCC is part of the Consultative Technical Group for Marine Pollution Preparedness and Response.

All staff of the Maritime Coordination Centre is duly qualified and trained by authorized body of the International Maritime Organization to act as coordinators for SAR missions and Oil response incidents. The MCC’s entire personal are trained to operate all the modern equipments, being able to perform missions in a close cooperation with the other appropriate organizations from the Black Sea region. In order to improve the efficiency of personnel and for maintaining a high level of response, trainings and the exercises are carried out at regular intervals of time.

With regard to oil preparedness, prevention, response and cooperation, MCC**:**

- Coordinates the prevention and response of pollution activities within RNA system including Harbour Master Offices (elaborating operational procedures for these activities);
- Participates to the investigation of oil incidents and evaluation of oil spill effects, in accordance with national legislation;
- Is connected to the CleanSeaNet service delivered by European Commission through EMSA, receives analyzed satellite images, for routine monitoring of illegal discharges from sea going ships and coordinates the activities of checking by aircrafts and surface units available;
- Introduces alerts in SSN system and updates system database;
- Monitors the sulphur content in the fuels of the vessels on Romanian territory;
- Elaborates pollution statistics for IMO, Black Sea Commission, EMSA, annually and on request;
- Coordinates and participates to all types of national and regional pollution response exercises.

In case of a major pollution, MCC:

- Receives alerts for oil pollution incidents and ensures off-shore response communications;
- Participates to the evaluation of the effects and establishes the causes of major marine pollution incidents, in conformity with its competences;

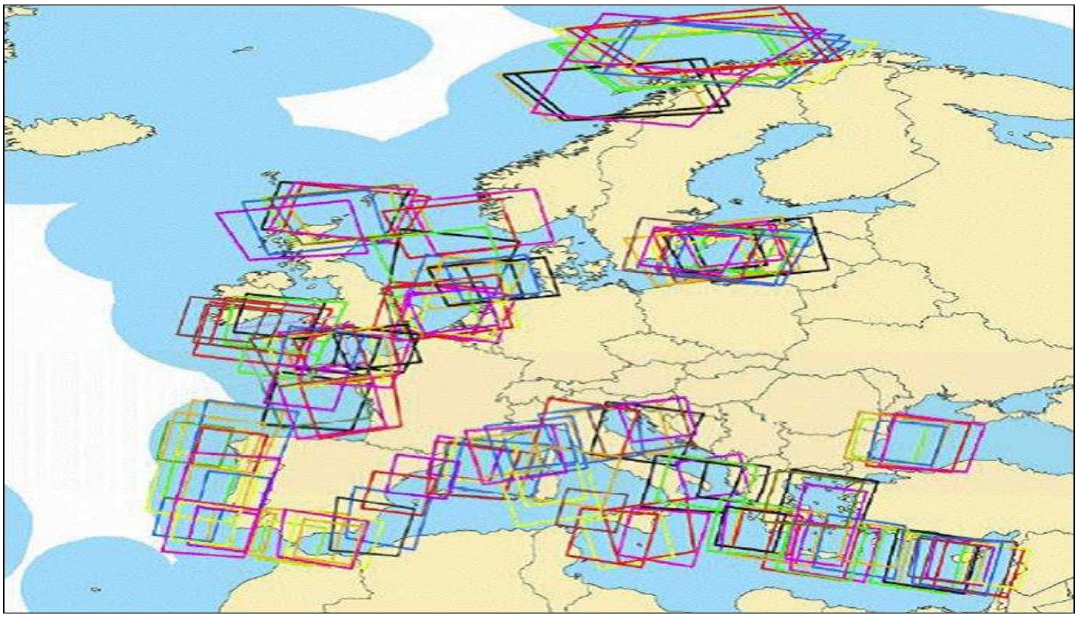

Figure 2 CleanSeaNet EU planned images

- In case of marine heavy pollution, asks partial or total activation of the National Contingency Plan (NCP), through General Coordinator of Operative Commandment for Marine Pollution (OCDM);
- Sends alerts and keeps the contact for the emergency situations with relevant national and international authorities (including IMO, EMSA and Black Sea Commission).

According to NCP, MCC has been designated as Maritime National Operational Contact Point (M-NOCP), 24 hours capability.

The main tasks of MCC as M-NOCP are to receive alerts for oil pollution incidents and to ensure off-shore response communications, directly or through RADIONAV SA.

In accordance with the Regional Contingency Plan, M-NOCP exchanges information with Black Sea Commission and all Black Sea MCC's regarding the major pollution incidents in Black Sea and keeps informed national competent authorities on related situations.

The CleanSeaNet system was developed for the detection of oil slicks at sea using satellite surveillance and was offered by EMSA to all EU member States, according Directive 2005/35/EC. The system is based on marine oil spill detection by checking on scene the satellite images.

The service integrated into the national and regional response chain, aims to strengthen operational pollution response for accidental and deliberate discharges from ships and assist Coastal States to locate and identify polluters in areas under their jurisdiction. CleanSeaNet is delivering oil spill alerts in near real time (30 minutes) to both the Coastal State(s) and EMSA for detected slicks as well as giving access to the satellite image(s) and associated information over the web (and via email for low resolution images). In case of a detected oil slick, an alert message is delivered to the operational contact point.

3. CLEANSEANET SYSTEM

Each Coastal State has access to the CleanSeaNet service through the dedicated CSN Browser. This web map interface tool allows the viewing of all low resolution images, with oil spill detection analysis results, wind information and other additional information. The CSN browser also includes a list of the ordered satellite scenes. High resolution images are delivered by EMSA upon request.

In June 2007 Romania signed Conditions of Use for receiving the EMSA satellite based oil spill monitoring service when MCC Constanta was designated as alert contact point for CSN service. From September 2007, MCC Constanta receives analyzed imagery and alert messages from EMSA, for routine monitoring of illegal discharges from ships.

A very important support is given also by EMSA with the Stand-by Oil recovery Vessel located in Constanta Port.

Up to 20 NM from the coast, the visual verification is ensured by ships belonging to ARSVOM - dedicated Romanian SAR and oil pollution response Agency, patrol vessels from Coast Guard or navy. Over 20 NM from the coast visual verification is performed by airplanes belonging to Regional Air Services according to the cooperating protocol signed with this company.

In order to better understand how the company is acting in case of pollution incident it is important to present a real case which occurred on 3rd of November 2008 at 08.12 utc., when Constanta MCC has received from Italian Monitoring Satellite Image Centre an alert message regarding the existence of a large oil sleek of 340 metres width and 20, 33 km long oriented direction SW - NE. Located position Lat. 44^{o} 53’ 100” N and Long.029^{o} 49’350” E.

Following the cooperation with the ECDIS system, analysing the satellite image received in accordance with the vessel traffics’ monitoring has been revealed that the polluter was m/v GUZIDE S, Turkish flag.

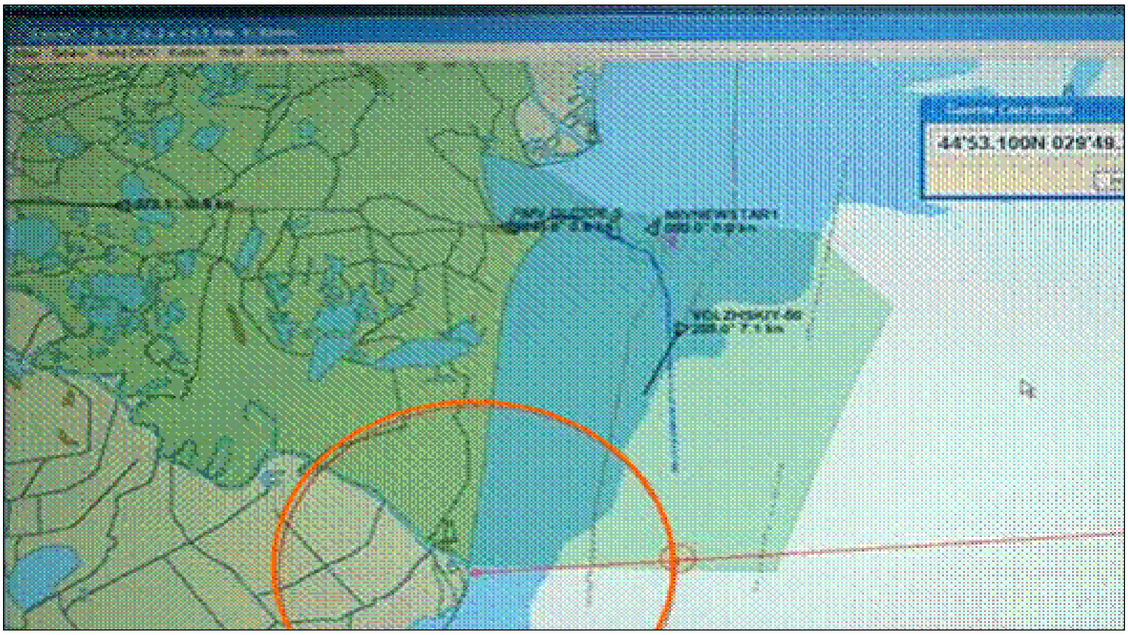

Figure 3 Satellite image received showing the existence of an oil sleek

The said vessel was navigating from Turkish port Martas to Romanian port Galati located on the Danube River.

On 4th of November 2008 at 14.00 lt m/v GUZIDE S arrived in the port of Galati and after the completion of the arrival formalities the representatives of pollution department within RNA commenced the investigation of the reported pollution incident.

The investigation consisted in analysing and verification of the ship’s certificates, navigation log book, engine log book and the log book for oil and bunkering evidence. The notifications transmitted by the ship to Galati Harbour Master prior arrival and the documents submitted upon arrival were analysed as well. An expended control regarding the ship’s fulfilment with MARPOL requirements including the inquiry of the crew has been performed. As evidence it was found that the quantity of bilge water from the port side bilge tanks was smaller than the quantity of bilge water mentioned in the Oil Record Book.

The figures from the Oil Record Book did not correspond with the reality revealed by tanks soundings. According the ship’s Navigation Log Book, on the 3rd of November 2008 at 08.12 UTC the vessel was in the position reported by Italian Monitoring Satellite Image Centre in fully accordance with the pollution moment.

After such evidences the captain of the vessel has recognized the violation of the MARPOL requirements and that marine pollution was related to his ship due to negligent transfer of the bunker.

According with the provisions of the Government Decision 876/2007, the Captain of the ship was punished with a substantial contravention fine.

4. CONCLUSIONS

Ecological disasters that occurred in recent years within the Europe have demonstrated the importance of compliance with the MARPOL provisions of all ships. The major pollution from ships can be avoided only through an efficient organization, preparedness for response and cooperation between countries in order to develop all national systems by strengthening the *cleaner seas* concept.

The organizational system described in this article and the case report presented having access to new technology imposed in EU could be an example for improving other national systems and an incentive for cooperation in the benefit of all mankind.

5. REFERENCES

[1] www.imo.org.
[2] www.emsa.europa.eu
[3] http://www.rna.ro

DEVELOPMENT OF THE COMPUTER-BASED QUALITY CONTROL SYSTEM USED FOR TRAINING SPECIALISTS IN NAVIGATION

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ABSTRACT

The paper presents the analysis of the objective computer-based quality control system intended for training specialists in marine navigation. This system of quality control has been applied at the Navigation and Ship Handling Department of Kyiv State Maritime Academy (KSMA) in the process of training the students of 2 - 4 proficiency levels. The informational and methodological computer-based assessment tool package for the students trained for Bachelor, Specialists and Master Degrees has been developed on the basis of the following constituents:

a) the system of control,

b) three e-textbooks on basic theoretical subjects,

c) built-in matrix for self-assessment to verify the testing results.

Both experimental and current implementation of the computer-based quality control system proved to be a reliable and objective assessment tool used for quality evaluation of training on basic theoretical subjects included into the curriculum during the whole course of studies. Saving time and reducing financial resources spent for carrying out control sessions are significant. The main advantage of the system has been its efficiency which currently demonstrates the serious increase of the competency level of the students in Navigation.

Keywords: *navigation, computer-based quality control system, efficiency of testing*

1. INTRODUCTION

Disregarding the difficulties and complexities which took place during the long period of reforms in the field of higher education, Ukraine managed to preserve the best features of "the old school" and to bring the Maritime education and training (MET) to prominent results thus playing the leading roles in the world's shipping industry as far as the qualified work force supply is concerned.

The evidence is the great demand in seafarers with Ukrainian diplomas (Bachelor or Master) in the Merchant Navy. According to the statistics of BIMCO (Baltic and International Maritime Council), Ukraine occupies the leading place in the world by the percentage of higher ranks (Captains, Chief Officers, Chief Engineers) and the 5th place by the total number of seafarers supplied to the world's labour market. Eastern Europe has become increasingly significant with a large increase in officer numbers. Thus, improved training and recruitment levels need to be maintained to ensure a future pool of suitably qualified and high calibre seafarers (BIMCO 2010:1). Preservation of this status for the longer period in future is the priority of Ukrainian Maritime institutions.

This task is directly connected to national standards and quality of MET in Ukraine. Several factors affect the situation among which the most challenging are:

- the quality and integrity of international and national standards in the field of training the crew high ranks;
- the level of the general proficiency level of school leavers or students entering the Academy;
- the proficiency level of the teaching staff, especially those having the experience of command positions in Merchant Navy;
- the availability of up-to-date certified training facilities and simulator base;
- the availability of the objective computer-based quality control system for training specialists in navigation.

Most of these parameters are supported by the national regulations which standardize the process of maritime education and training and specify its quality requirements. At the same time, the system of quality control of trainees' academic and professional competency level hasn't been standardized in some aspects. In most of Ukrainian Maritime institutions the only version of quality control instruments both in semester sessions and final (state) examinations for all proficiency levels is the traditional assessment with the help of examination cards and face-to-face teacher-student contact.

This approach being acceptable in common practice, doesn't always allow to evaluate objectively and in full scope the quality of a student's educational level, mainly referring to the requirements of the branch standard for higher education developed by the Ministry of education and science, youth and family of Ukraine in the 'Educational qualification curriculum' for Bachelors, Specialists and Masters. This national standard specifies that the final/state assessment for Bachelors and Specialists on 14 academic subjects should be held in the format of testing.

From the point of view of objective characteristics, this number of subjects presumes the application of tests and rejects the traditional way of evaluation. In addition, the traditional form of final examinations usually brings to extreme physical overloading both of the examination board members and the students.

Purposing the higher qualitative characteristics in the process of training, the attention was paid to the major subjects teaching which was carried out on the basis of three up-to-date e-textbooks with the built-in self-assessment control systems for each chapter (2, 3, 4). This self-assessment system has a feedback for the questions not answered correctly. The further procedure presumes the involvement of the database of the e-textbooks which makes possible to find the correct answer to the question in the test.

The methodology and techniques of creating tests have been researched according to the present requirements to testing systems which was described in research papers (5, 6). The results of the research were implemented into the new design of teaching/learning materials approved by the Ministry of education and science, youth and family of Ukraine and published in 2012.

2. THE MAIN PARAMETERS OF THE COMPUTER-BASED QUALITY CONTROL SYSTEM

The structure of the computer quality control complex has been developed on the basis of the rational parameters including networks resources and informational safety. The structure itself incorporates the software, PC, servers and networks. The software based on “Opentest-2” version makes possible to correlate the primary evaluation mark with the probability of guessing the right answer. From the point of view of the statistical evaluation of testing results, the error affected by guess-ing is a random magnitude influenced by several factors, mostly, by the duration of the test and the type of assignments included into the test.

The probability of guessing (**P***i*) for each type of assignments is defined in the formulae given below and depends on the total number of variants of the answer (m) and the number of correct answers (k). Thus, the chance of guessing for the 1st type of assignments (multiple choice with one correct answer) is

$$\mathbf{P}_i = \frac{\mathbf{1}}{\mathbf{m}}, \tag{1}$$

for the 2nd type of assignments (multiple choice with several correct answers) it is

$$\mathbf{P}_i \cong \frac{\mathbf{1}}{\mathbf{2^{m-k+1}}}. \tag{2}$$

So, the average probability of guessing (**P***av*) is

$$P_{cp} = \frac{\sum_{i=1}^{N} \mathbf{P}_i \cdot B_i}{\sum_{i=1}^{N} B_i}, \tag{3}$$

where **B***i* is the mark in points for each assignment of the test; **N** is the total number of assignments in the test. The initial score for the testing session is defined as a fraction of correct answers according to the formula:

$$\mathbf{Y}_H = \frac{\sum_{i=1}^{N} B_i}{\sum_{i=1}^{N} B_i^{\max}} \cdot \mathbf{100\%}, \tag{4}$$

where **B** *max* is the maximum score for one session. With the account of probability of guessing coefficient, the percentage of correct answers is calculated as

$$Y_K = \frac{Y_H \cdot A_{cp} - 100\%}{A_{cp} - 1}; \tag{5}$$

where $A_{cp} = \frac{1}{P_{cp}}$,

is the average alternation value per the testing session. In accordance with these parameters the system is able to correct automatically the results obtained, with the value of the guessing factor taken into account. The comparison of frequency analysis on two basic subjects for the testing sessions was performed in 2012. The objective character and authenticity of testing results were also proved out by the analysis of selective groups and subjects.

3. CONTENTS OF THE COMPUTER-BASED QUALITY CONTROL SYSTEM

The comparative analysis takes into account the number of students in the groups taking the tests on “Navigation and piloting” - 208 Bachelors; on “Safety of navigation’ - 113 Specialists. Both results are valid when considered from the point of view of Gaussian probability Law of normal distribution. The database for tests corresponds to the contents of the modules of the national standards in “Marine and river transport” training curriculum for the specialists in Navigation and to the minimum competency standards for OOW which are defined in STCW – 78/95. The total number of tests’ assignments included into the final (state) examination is: 2843 on 15 basic subjects for Bachelors; 1760 on 15 basic subjects for Masters.

The general information on the academic subjects and parameters of testing, methods of defining the number of assignments depending on the number of modules in a credit were analysed in research papers published during the period of preparation and implementation of the informational computer-based complex of quality control beginning with the year of 2006. Since then, more than 2000 students of the 2-4 educational levels have passed testing. The diagram below (Figure 1) presents the main data on testing the students’ theoretical competency during final examinations where vertical vector represents the number of students; horizontal vector indicates the year(s) of final testing; red colour depicts Bachelors; blue colour depicts Specialists; green colour represents Masters. All teachers and instructors of the leading departments performed the final examinations using materials of the computer testing. Hence, the total number of students subjected to this type of final control is 4.5 thousands which is statistically reliable for the further research aiming the increase of quality of students’ training in theoretical subjects.

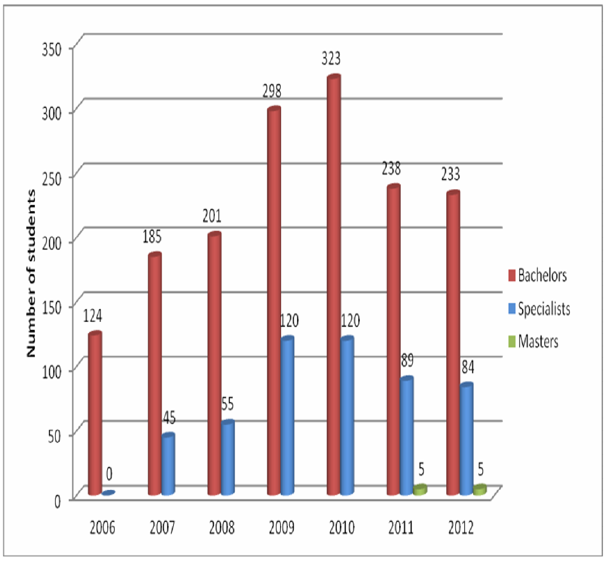

Figure 1 Comparative diagram of applying the computer-based system of quality control in 2006-2012

The demand for the computerized control system and its objectivity and authenticity have created preconditions for designing 'The Informational and Methodological Complex of Quality Control Tools of Deck Officers'. Its principal characteristics are a) the application of "Opentest-2" software designed by the Kharkiv National Radioelectronics University; b) the implementation of the improved database comprising four types of assignments with different levels of complexity and the new design presentation; c) the implementation of the self-assessment system supplemented to the 3 e-textbooks on major subjects; d) the flexibility and multifunctional character of the quality control complex are based on combination of its educational, training and controlling functions, as well as its functional re-arrangement for a specific purpose.

Objectivity and authenticity of competency quality assessment are achieved owing to the following factors: the results of testing being independent on subjective interference; application of similar criteria used for the final assessment and the same parameters of testing approved by the corresponding Testing Regulations in the Academy; sufficiently abundant database for each module (subject) 10 times increasing the number of questions suggested in the test by means of random sample; the variable sequence of questions; the correlation of correct answers and probability of guessing as per the primary mark and its scaling.

4. CONCLUSIONS

The profound research and 7-year-long experience of objective computer quality control system for training specialists in navigation of the 2-4 proficiency levels brings to the following conclusion:

1. The department of navigation and ship handling of Kyiv State Maritime Academy has created the informational and methodological complex of computer-based tools for quality control of navigational students' proficiency which comprises a) computer-based system of quality control; b) e-textbooks with the built-in system of self-assessment.

2. The multifunctional character of this complex makes possible to assess the quality of theoretical training of Bachelors and Masters in Navigation by means of computer-based testing on 15 subjects included into the curriculum of each educational-qualification level. This type of control can be performed under the guidance of an instructor in the computer laboratory, as well as in the Internet in a distance teaching/learning format.

3. The implementation of informational-methodological complex allows to improve considerably the assessment quality in theoretical training and to reduce the amount of finance and time spent for control sessions.

4. The assessment quality is defined by the assignment database quality which corresponds to the contents of all professional functions, typical skills and abilities of graduates according to the requirements of STCW-78/95 with the emphasis on Manila amendments, 2010, about the "list of knowledge, understanding and proficiencies associated with each competence; the methods of demonstrating each competence; and the criteria for evaluating each competence (STCW Convention Comprehensive Review 2010:2)

5. The informational and methodological computer-based complex comprising the tools for the navigation students training quality control aims to be validated through the National Standard of Maritime education and training and approved by the Ministry of education and science, youth and family of Ukraine as "The means of quality evaluation" for specialty "Navigation", qualification "Chief Officer".

5. REFERENCES

[1] BIMCO Web site https://www.bimko.org/ */Manpower_Study_handout_2010.ashx*

[2] MYKHAILOV V., KUDRIAVTSEV V., DAVYDOV V., *Navigation and Piloting*, E-textbook, Kyiv State Maritime Academy, 2009

[3] MYKHAILOV V., KUDRIAVTSEV V., DAVYDOV V., *Practical nautical astronomy*, E-textbook, Kyiv State Maritime Academy, 2009

[4] KUDRIAVTSEV V., DAVYDOV V., SOKOLOVSKY D., *Insuring Safety of Navigation*, E-textbook, Kyiv State Maritime Academy, 2012

[5] DAVYDOV V., *On the problem of step-by-step training of senior officers for sea and river transport*, Water transport, Kyiv State Maritime Academy, Issue 10, 2009, pp.149–158.

[6] DAVYDOV V., SOKOLOVSKY D., *Informational and methodological complexes of quality control as a means of quality improvement of deck officers proficiency*, Water transport, Kyiv State Maritime Academy, Issue 12, 2011m pp.121–126.

[7] *STCW Convention Comprehensive Review*, IAMU, 2010

CONTRIBUTIONS AT QUAY CRANES EXPLOITATION OPTIMIZATION

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ABSTRACT

Quay cranes play an important role in cargo operations in ports and are considered leaders of the port operators' technological process. This paper presents calculations of determination grab's efforts and there are proposed changes in grab's structure for optimizing the exploitation of quay cranes.

Keywords: *quay crane, grab, exploitation, port,cargo*

1. INTRODUCTION

Quay cranes are means of production that allow hard and low-skilled work replacement with easier highly skilled work, mechanization and automation of production processes, thus ensuring increased productivity, reduced cost price and shorted execution time in all areas of the economic activity. They play an important role in the development of maritime transport, inland waterways, road and rail. They also lead to increased productivity in industrial and civil construction bridge construction, viaducts, railways and other domains.

Quay cranes forms the group of the main lifting machinery used in ports. With them is done most of the loading and unloading of ships. This is the reason for which quay cranes are considered leaders of the whole technological process.

In order to load and unload vessels, quay cranes must perform a series of movements (maneuvers), so that goods can be placed or removed from any part of the ship.

In order to optimize the traffic of ships in the port of Constanta, and to optimize ships' operation, must be analyzed the structural characteristics and specific functions of each type of ship, closely related to structural features of operating berths [1]. Achieving high productivity quay cranes is imposed by the need to ensure quick loading and unloading of ships and barges, which is a prime importance necessity in activities of operating ports.

Current and future trend in solving loading and unloading, transport and handling of goods, materials and spare parts of quay cranes is to create machinery with reliable operation, with high degree of mechanization and automation that occupy small workspaces, are effective, with increased productivity and with maintenance and operation easy to achieve.

2. DETERMINATION OF GRAB EFFORTS

A clamshell or grab consists of hoist drum lagging, clamshell bucket, tag line, and wire ropes to operate holding and closing lines [2].

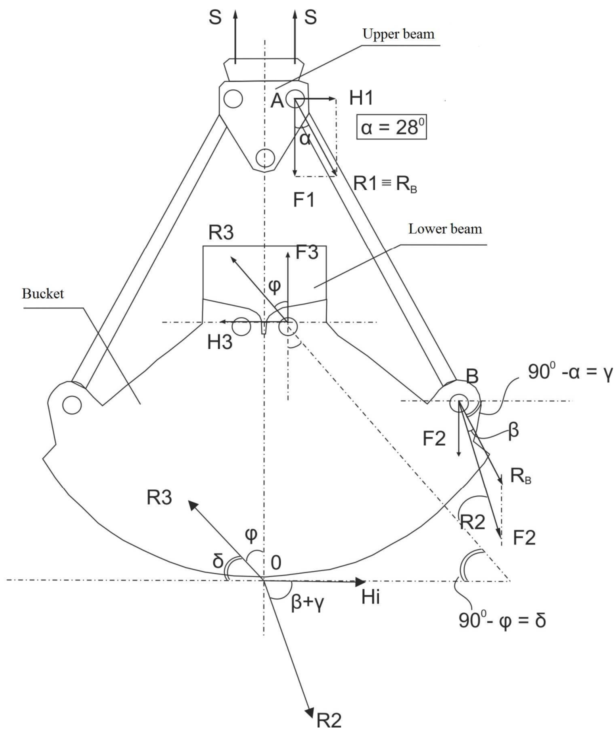

Figure 1 Grab forces

In figure 2 there are the following forces:

- F_B is force in the arm
- H_i is closing force
- S is force in the cable.

Weights of the empty grab's main components are:

$$G_0 = G_1 + G_2 + G_3 = g\,(m_1+m_2+m_3)\ [kN] \qquad (1)$$

where:

m_1 - mass of the upper beam
m_2 – mass of buckets
m_3 – mass of the lower beam

According to the literature, the masses of empty grabs' components can be approximated according to the below algorithm [3].

$$\begin{cases} m_1 = 0{,}3\,M_0[t] \\ m_2 = 0{,}5\,M_0[t] \\ m_3 = 0{,}2\,M_0[t] \end{cases} \tag{2}$$

where M_0 is grab's empty mass (M_0 = 8t).

Empty grab's main components weights are:

$$\begin{cases} G_1 = m_1 \cdot g\ [kN]; \\ G_2 = m_2 \cdot g\ [kN]; \\ G_3 = m_3 \cdot g\ [kN]; \end{cases} \tag{3}$$

$$\begin{cases} G_1 = 0{,}3 \cdot 8 \cdot 10 = 24\ kN \\ G_2 = 0{,}5 \cdot 8 \cdot 10 = 40\ kN; \quad g = 10\ m/s^2 \\ G_3 = 0{,}2 \cdot 8 \cdot 10 = 16\ kN \end{cases} \tag{4}$$

2.1. Vertical forces acting on grab

$$\begin{cases} F_1 = G_1 + (i \cdot \eta - 1) \cdot S \quad [kN] \\ F_2 = G_2 \quad [kN] \\ F_3 = G_3 + i \cdot \eta \cdot S \quad [kN] \end{cases} \tag{5}$$

where:

F_1 – force in the upper beam;

F_2 – force in the articulation of bucket with bars;

F_3 - force in the lower beam;

i - transmission ratio (for corn, with ρ = 760 kg/m^3, *i* has values between 3...4, [3] we choose i = 3);

η - efficiency of closing hoist (from calculations, η = 997)

Discussion: When choosing the transmission ratio *i*, is taken into account that is favorable a report as high as possible. This assumes, however, more cable wounded on the drum, therefore an increase of the time of closing cups.

By default, the grab's productivity decreases. Therefore, we chose the lowest value in the range to get an increase in productivity.

Calculations:

S force in the cable, S results from the calculus:

S = 90,32 kN; (6)

F_1 = 24 + (3 · 0,97 - 1) · 90,32 = 196,51 kN

F_2 = 40 kN

F_3 = 16 + 3 · 0,97 · 90,32 = 278,83 kN

2.2 The equilibrium of forces

All the forces acting in the grab are concurrent in O. Reducing these forces in point O, the grab bucket will be in equilibrium under the action of R_2 and R_3 resultants, respectively of closing force H_i.

Following, we must calculate the resultants R_2 and R_3, as well as the angles under them are from the horizontal, in order to write the equation of equilibrium, ie:

$$H_i + R_2 \cdot \cos(\beta + \gamma) = R_3 \cdot \cos\delta \tag{7}$$

2.3 Determination of R_1 reaction force

The titles of sections and subsections will be aligned left and numbered consequently. Determination of R_1 reaction force results from fig. 2.b.

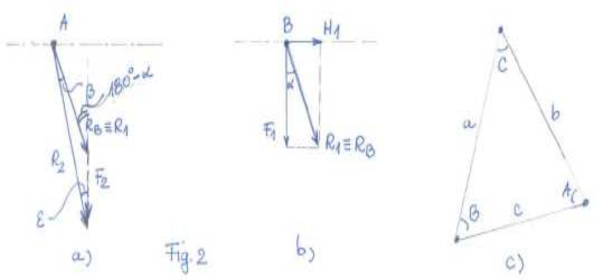

Figure 2 Determination of reaction forces

$$\cos\alpha = \frac{F_1}{R_1} \Rightarrow R_1 = \frac{F_1}{\cos\alpha} \tag{8}$$

resulting

$$R_1 = \frac{F_1}{\cos\alpha} \tag{9}$$

Angle α=28^0, according to the model

$$R_1 = \frac{196{,}51}{\cos 28^0} = \frac{196{,}51}{0{,}88} \Rightarrow R_1 = 223{,}30\ kN \tag{10}$$

2.4 Determination of R_2 reaction force

We apply the cosines theorem (see fig. 2.c)

$$a^2=b^2+c^2-2 \cdot b \cdot c \cdot \cos A \tag{11}$$

$$R_2^2=F_2^2 + R_1^2 - 2 \cdot F_2 \cdot R_1 \cdot \cos(180^0-\alpha) \tag{12}$$

$$\Rightarrow R_2^2 = 40^2 + 223{,}30^2 - 2 \cdot 40 \cdot 223{,}30 \cdot \cos 152^0$$

$$R_2^2=1600 + 49862{,}89 - 17864 \cdot (-0{,}88)$$

$$R_2^2= 67183{,}21 \tag{13}$$

So,

$$R_2=259{,}19\ kN$$

2.5 Determination of β angle

By applying the cosines theorem, results:

$$F_2^2=R_1^2 + R_2^2 - 2 \cdot R_1 \cdot R_2 \cdot \cos\beta \tag{14}$$

That is,

$$\cos\beta = \frac{R_1^2 + R_2^2 - F_2^2}{2 \cdot R_1 R_2} \tag{15}$$

result

$$\beta = \arccos\frac{R_1^2 + R_2^2 - F_2^2}{2 \cdot R_1 \cdot R_2} \tag{16}$$

Calculus:

$$\beta = arc\cos\frac{(223{,}30)^2 + (259{,}19)^2 - 40^2}{2 \cdot 223{,}30 \cdot 259{,}19} = \frac{115442{,}34}{115754{,}25}$$

$$\beta = \arccos 0{,}997 \Rightarrow \beta \approx 5^0$$

2.6 Determination of δ angle

$$\delta = 90^0 - \varphi \quad (17)$$

φ –maximum angular half opening of the cups

According to [3] , $2\cdot\varphi = 156^0 ... 160^0$; we choose

$$2\cdot\varphi = 160^0 \Rightarrow \varphi = 80^0$$

Resulting: $\delta = 90^0 - 80^0 \Rightarrow \delta = 10^0$

2.7 Determination of β+γ angle

$$\gamma = 90^0 - \alpha$$

$$\gamma = 90^0 - 28^0$$

Resulting:

$$\gamma = 62^0 \quad (18)$$

$$\beta + \gamma = 5^0 + 62^0 \Rightarrow \beta + \gamma = 67^0 \quad (19)$$

2.8 Determination of closing force

The titles of sections and subsections will be aligned left and numbered consequently. Is resulting from the equilibrium equation of forces, reduced in point O.

$$H_i = R_3 \cdot \cos\delta - R_2 \cdot \cos(\beta + \gamma) \quad (20)$$

R_3 is resulting from $R_3F_3H_3$ triangle:

$$\cos\varphi = \frac{F_3}{R_3} \quad (21)$$

$$R_3 = \frac{F_3}{\cos\varphi} \quad (22)$$

Resulting $$R_3 = \frac{278{,}83}{\cos 80^0} = \frac{278{,}83}{0{,}17}$$

$$R_3 = 1640{,}17 \text{ kN}$$

Therefore,

$H_i = 1640{,}17 \cdot \cos 10^0 - 259{,}19 \cdot \cos 67^0$

$H_i = 1640{,}17 \cdot 0{,}98 - 259{,}19 \cdot 0{,}39$

$H_i = 1607{,}36 - 101{,}08$

$H_i = 1506{,}28$ kN

3. PROPOSED CHANGES IN GRAB'S STRUCTURE FOR QUAY CRANE'S EXPLOITATION OPTIMIZATION

We propose the following measures for grab exploitation optimization:

1. To increase the closing force (in order to minimize cargo loss between buckets and to increase the digging force) the lower beam weight must be reduced.

2. According to studies, the closing force is maximum when the grab is opened and decreases as it closes, because H_i is proportional with the weight of the grab and with *i* gear ratio of the hoist. For these reasons it is recommended a transmission report as high as possible. This however requires more cable winding drum, so a higher closing time, which leads to lower productivity. If is needed a higher closing force, *i* gear ratio must be led to the upper end of the range, ie *i* = 4. If is needed a higher productivity (with lower closing time), then the value of *i* remains 3.

3. Welding of steel strips overlaid on the cups edges, to limit the loss of cargo, would not affect the stress distribution in the grab.

4. To reduce grabs' weight in order to ease the lifting equipment, if the operated cargo type has high granulation (eg. corn cobs), it can be made cuttings in the buckets' jaws. In this way it can be extend the grab's operability for high granulation cargo and the empty grab's weight is reduced.

5. Tie rods are designed to ensure connections between key elements of the crane [4]. They take over load by supporting the main beam and the cups. In grab modeling using FEMAP software appear problems of tie rods bending.

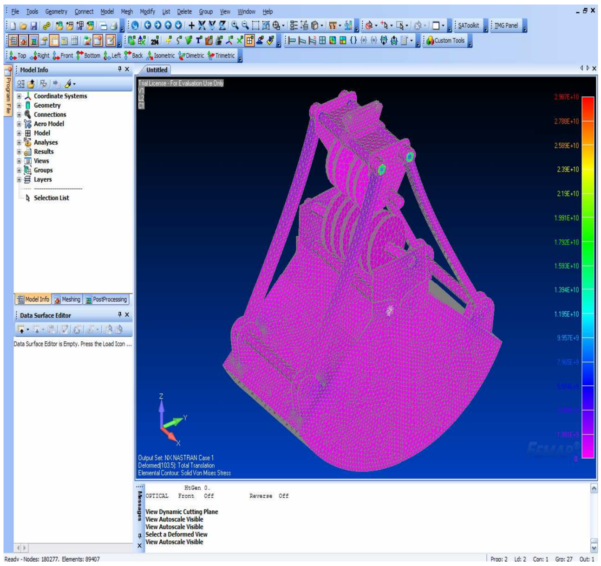

Figure 3 Rods bending in FEMAP

For optimization, tie rods could be replaced by hydraulic cylinders.

4. CONCLUSIONS

By replacing a pair of rods with a single hydraulic cylinder, the grab's weight is reduced. Due to hydraulic action, the closing force increases and closing time decreases.

Also hydraulic action ensures good sealing of jaws and eliminates cargo losses during exploitation. Hydraulic drive can be separated on each bucket, ensuring a more precise control over each cup (together or separately).

5. REFERENCES

[1] BERESCU, Ş., *Studiu constructiv dinamic al acvatoriului portului Constanța și considerații privind creșterea eficienței operaționale în port*, Ed. Nautica, Constanța, 2012.

[2] http://www.tpub.com/eqopbas/147.htm, accessed at 20.11.2012

[3] ALĂMOREANU, M., COMAN, L., NICOLESCU, Ş., *Maşini de ridicat*, vol. I, Ed. Tehnică, Bucureşti, 1996, p.245-255.

[4] TOADER, M., SAMBOTIN, N., BALANESCU, D., Maşini termice şi instalații navale şi portuare, Ed, Didactică şi Pedagogică, București, 1982, p. 131.

THE ANALYSIS OF INTACT SHIP STABILITY REGULATIONS

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ABSTRACT

The present paper presents the history and the problems of the intact ship stability regulations entered into force over the years. The problems involving ships stability loss as well as ships capsize concerned the maritime community from the first beginning, this type of problems being always a part of maritime safety. Maritime casualties related to loss of ship intact stability continue to be present despite the fact that ships comply with stability criteria. The necessity of new generation of stability criteria is to be taken into account using additional factors involved.

Keywords: *ship stability, stability criteria, weather criterion, righting moments, metacentric height, lever arm curves, capsize.*

1. INTRODUCTION

The history and analysis of the regulations related to intact ship stability as well as improvement of a practical methodology for assessment of ship stability on board vessel, is the main objective of this article. The basic motivation came from the feeling that key advances in the knowledge, understanding, and applicability of ship stability principles, stated in regulations, correlated with practical problems, can be integrated within a single framework.

2. THE HYSTORY AND ANALYSIS OF INTACT SHIP STABILITY REGULATIONS

The problem of stability of the floating bodies, which can be traced back to Arhimede himself, has never ceased to interest scientists and engineers and has become an important part of academic studies. Intact Ship Stability have been known for a very long time in terms of positive righting moments. Since from 1747 *Bouguer* define in his work *"Traite du navire, de sa construction et de ses mouvements"* the metacentre as the intersection of two vertical axes passing through the centre of buoyancy (de centre of gravity of the displaced fluid) at two slightly different angles of heel. Two years later, *Euler* in "*Scientia navalis sea Tractatus de Construendis ac Dirigendis Navibus"* (1749) gave a general criterion of the ship stability, based on the restoring moment: the ship remains stable as far as the couple weight (applied in vessel's center of gravity) and the buoyancy force (applied in vessel's center of buoyancy) creates a restoring moment. In 1757, *Bernoulli*, discovered the relationship between metacentric height (GM) and the rolling period of ships. Later on, *Moesley*, introduced the dynamic approach with respect to the area under level arm curves. Around 1900, the problem of ships stability was considered as solved based on knowledge to evaluate the dynamic stability of existing ships. In fact, only the theoretically considerations were solved, but the main problem was to apply these fundamentals as a practical calculations of ships stability related to righting levers, having in view the complex geometry of ships hulls. This problem remained up until last decades of 20th century, several methods, based on approximations, were invented to overcome this problem, but the final solutions came with the appearance of computers. Ship stability was judged mainly on the calculated value of metacentric height which also in nowadays is still wrongly viewed as a main factor.

In 1939 *Rahola* carried out extensive statistical investigations into ship stability. Various still water lever arm curves of capsized ships were analyzed and he concluded that a large number of ships had righting levers below the minimum values of righting levers recommended by experts at that time. He identified that the ships had various values of righting levers, from too small, according to maritime board, to "critical" levers and sufficiently large lever arms. His investigations resulted finally in the definition of a "standard" lever arm curve defined by minimum levers at 20 and 30 degrees heel, the maximum lever being at 35 degrees heel and the angle of vanishing stability at 60 degrees. All lever arm curves are accepted as equivalent when the enclosed area up to 40 degrees is of the same amount or larger as the standard curve.

Rahola's investigation was a success and proved, later on, to be the base of minimum stability criteria adopted over the years. Even the present intact ship stability criterion, issued by International Maritime Organization through Resolution MSC.267 (85), is based on Rahola's conclusions. From his investigation, it is important to note that ships that capsized due to dynamic effects like resonant rolling or shifting of cargo has been categorized as safe ships with sufficient large still water lever arms in most of the situations. Thus, dynamic influences were neither considered directly, nor indirectly, in Rahola's minimum requirements.

Provisions concerning intact ship stability were introduced at a later stage in international regulations of ship safety. The necessity of intact stability rules was indeed uncertain until SOLAS '48, as stated in Recommendations contained in Annex D, recommends to the Administrations a more detailed examination of intact ship stability. The first international intact ship stability rule at IMO was originated by a recommendation contained in the conclusions of SOLAS'60, when for the first time was recommended to initiate studies on the basis of information referred by ships types, as intact stability for passenger ships, cargo ships and fishing vessels as well as standards of stability information.

As a result, the General Stability Criteria based on righting arm characteristics was adopted in 1968 with IMO Resolution A.167. This recommendation, known as "statistical criterion" is originated from the studies of *Rahola* and was developed in terms of global quantities related to initial metacentric height, static and dynamic stability arms satisfying a set of standards obtained empirically from statistics of casualties. The requirements in Res. A.167 consisted of a minimum GM value, a minimum lever arm value at 30 degrees heel and three minimum areas below the lever arm curve. However, dynamic effects were not taken into account. When Res. A.167 was developed, data in sufficient quantity was only available for smaller ships, thus the resolution was applicable only to ships smaller than 100 meters in length. On one hand, it was simply to use but on the other hand it was difficult to improve as has no physical modeling and no mention to sea state and moreover the level of safety was unknown. The introduction of Res. A.167 constituted a tremendous improvement of previous state of art regarding stability at international level but practically…was nothing. In comparison, all subsequent changes and new introduction can be considered only as smooth changes.

Again, as an answer to recommendations given in the conclusions of SOLAS'74, where was recommended the improvement of international standards on intact stability of ships taking into account the external forces affecting ships in seaway which may lead to capsize or unacceptable angles of heel, the Weather Criterion was adopted in 1985 by IMO Res. A.562. The main aim of this criterion was to assure that ships are able to withstand heeling moments due to incoming waves and wind without exceeding certain roll angles. The structure of the criterion was prescriptive as well, whereas the threshold values were based on statistical long-term evaluations of accidents made since the first formulation in the stability requirements of the Soviet Register of Shipping from 1947. The critical KG value was adjusted to fit the mean of all KG values of ships in the statistics, which were considered safe in operation.

Shortly after its introduction, from the first time in 1985, the weather criterion was criticized. The main point of critics was, beside the partly unrealistic simplifications regarding the constant heeling lever due to wind and wave induced roll motion, that the criterion is calibrated for old ship types with traditional hull forms, moderate to small lateral areas and small B/T – ratios.

The general outcome of resolutions A.167 and A.562 is typically in the form of limiting curve for GM and KG as a function of ship draft. Comparisons have been made for families of ships of same typology between statistical and weather criteria requirements, generally finding that the second one is more severe. Comparison has been made also between resolutions A.167, A.562 and SOLAS'90, for particular types of ships, like the modern large passenger cruise ships. It has to be observed that Res. A.167 is usually only subject to criticism while the other two instruments are severely criticized.

All recommendations and regulations relating to ship intact stability and safety against capsizing issued by the International Maritime Organization (IMO) were consolidated in Code on Intact Stability of All Types of Ships Covered by IMO Instruments, adopted by Res. A.749(18) on 4th November 1993.

With the adoption of Res. A749, which incorporates Res. A.167 the upper limitation in ship length was lost apparently without prejudice and both criteria, the general criteria and weather criteria, were considered for ships of 24 m in length and over.

The general intact stability criteria regarding lever arm curves proprieties are almost unchanged from those stated in Res. A.167.

All the general intact stability requirements were applicable to ships of 24 meters in length and larger. Surprisingly and in contrast to the old regulation A.167, they also applied to ships of more than 100 meters in length, although the majority of the ships represented in the statistical example on which the requirements were based, has a length of less than 60 meters.

It was widely accepted that the general intact stability criteria, in the form of Res. A.749 (18), do neither provide a sufficient level for large ships, nor do they assure a uniform safety level for ships of different size or type. One major reason for these problems was the fact that the minimum requirements were not being scaled with the ship size. In practice, this leads to the situations that a large container vessel of 300 meters in length is allowed to sail with the same minimum GM of 15 centimeters as a small coaster with a length of approximately 80 meters. Applying Froude's similarity law, it follows that lever arms increase with the geometrical scale λ with increasing ship size. Thus, in order to provide the same ability to resist heeling moments in the above mentioned example, the GM value would have to be increased for the large ships by the factor 300m/80m = 3.75. The 'severe wind and rolling criterion", originally introduced by IMO Res. A.562(14) in 1985, was also part of the IMO Res. A.749(18).

As a consequence of the container ship development in the early 1980's, a clear trend could be noted to ship designs with increasing beam of ships, without similar increase of the depth. This is simply, because this type of ship typically carries large amounts of deck cargo resulting in relative large vertical centers of gravity. Under the pressure to optimize the ship's economically, designers usually try to maximize the number of containers carried on deck. To fulfill the minimum stability requirements it is an appropriate measure to increase the ship's beam and thus, to maximize the waterline area of the vessel. This results in larger initial stability, but reduced form stability, whereas an increase in depth is always unfavorable for the initial stability of the vessel (not for the form stability). Large initial stability, low additional form stability and a relative small range of positive righting levers characterize the lever arm curves of the resulting ship designers.

Hull forms having large values B/T and B/D need larger righting levers than conventional hull forms. This may be explained by the reduced form stability combined with larger alteration on righting lever in waves. It was found that in bow or stern quartering seas, those vessels were endangered where the centre of gravity was significantly higher than the still water line. The explanation might be that the difference between the alternating restoring moment due to the wave action and heeling moment takes larger values. Moreover, hull forms having large ratio of waterline coefficient over block coefficient are suspected to have large righting lever alterations in waves and therefore more vulnerable rolling.

The revision of Intact Stability Code started in 2001 and completed in 2006. The first step consisted in an important structural reorganization and in the development of an alternative way on experimental basis to fulfill the requirements of weather criterion for ships having parameters outside the original range.

All recommendations and regulations relating to ship intact stability and safety against capsizing issued by the IMO are consolidated nowadays in the International Code on Intact Stability (2008 IS Code) adopted by Res. MSC.267(85) on 4th December 2008. Compliance with the new Code was required under changes to the SOLAS and Load Line Conventions, for ships whose keels are laid on or after July 1st, 2010, to which these Conventions apply.

The stability criteria as included in the revised Code are virtually the same as the original IMO Res. A.167 adopted in 1968 (statistical criteria) and in Res. A.562 adopted in 1985 (severe wind and rolling criterion) with small amendments and some relaxations. As a first main difference from the previous regulations, the new Code, which is referred to as the 2008 IS Code, has two parts: Part A which is mandatory, contains general intact stability criteria for cargo and passenger ships and Part B, which is recommendatory, contains intact stability criteria for certain types of ships as recommendations and additional guidelines.

What has changed? There are two significant changes. The first is the requirement for all ships to demonstrate compliance with wind and wave criteria. If the standard criteria are not applicable to the vessel, due to the vessel dimensions falling outside those relevant for the formulae given, model tests may be used to derive a value for the angle of roll. Model tests may also be used to identify the wind heeling lever for all vessels.

The assumed weather criteria is simply to use, it is based on physical phenomena / modeling but was adjusted with capsizing casualties in the form of the wind velocity. In other words, the wind velocity in the weather criteria does not represent the actual sea state and has rather empirical meanings. Since the weather criteria involve such an empirical factor, it is not easy to improve the criteria. However, the simplified modeling takes into account only beam waves and wind, why no internal degree of freedom, like shifting of cargo or water on deck, was introduced. In fact, it concerns only one mode of ships loss and the level of safety is largely unknown.

Although it considers the dynamics of ship roll motions, at least in a simplified way, the prescriptive scenario of weather criteria is not suitable to assess phenomena endangering ships in head, following and quartering waves and it also never was intended to be used in such a way.

The second significant change is the requirement for flag administration approval of stability instruments, in cases where an instrument is proved to supplement the stability book. However, to be applied this requirement it is necessary the development of guidelines for the approval of stability instruments, defining acceptable tolerances.

The Code is still based on the same assumptions, according to which the ship indicator of stability safety is the righting arm curve on calm water.

There were still some other pending issues, connected with the possible consequences of a mandatory IS Code making impossible the adoption of some alternatives currently used by Administrations. The most important is connected again with the required minimum value for the angle of maximum righting lever.

The safety level guaranteed to the ships by the compliance with stability criteria, however, is in general unknown and it is still a big open problem. It is indeed typical to open the way to alternatives by stating that *"a level of safety has to be guaranteed, as a minimum, by any alternative assessment"*. Statements like this are often used to try to avoid excessive relaxation of safety standards, but in fact are less meaningful than they could appear. Of course, ship safety at sea was greatly improved by the development and implementation of present stability criteria, as contained in IS Code, and other measures (for example the assignment of freeboard), although being these measures recommendatory in nature or not so widely adopted.

A black box is constituted by the sentence *"to the satisfaction of the Administration"* that often accompanies these alternative measures. Actually, these sentences should be accompanied by some guidelines or codes of practice.

In addition it is clear that the safety level is unequally distributed among different ship typologies and, even inside a given ship typology, it appears to be strongly dependent on ship size. This is particularly true for the General Criterion, which is the result of a global re-active approach. It mixes indeed in the same pan good and bad designs in a set of standards most of which not having a clear physical relation with the phenomena they are trying to avoid. Also the present version of Weather Criterion, due to its relatively poor, although physical, modeling spreads unevenly the safety level among ship types. A study conducted in Japan on the capsizing probability of a sample of 29 passenger and 46 cargo ships marginally complying with both provisions of Intact Stability Code revealed that this quantity is spread in a wide interval covering many orders of magnitude. The results also indicate that the safety level is generally higher for ships with length higher than 100 m.

From point of view of ship safety this is however, not the final solution. From time to time, stability casualties happen in spite of the fact that the particular ship meets all existing IMO criteria. The existing criteria may also be not applicable to some type of modern ships incorporating novel design features especially because original criteria as Res. A.167 developed more than forty years ago were based on casualty statistics that included mainly vessels under 100 m in length. With many modern ships there is no previous experience in relation to safety and stability and satisfying existing criteria may not assure required level of safety.

In order to achieve sufficient level of safety with respect to stability, all elements creating stability system have to be taken into account. Taking into account the fact, that less than 20% of all casualties are caused by faulty or bad design of the ship, the safety requirements that refer mainly to design features of the ship cannot ensure sufficient level of safety, in particular with regard to ships having design features.

3. CONCLUSIONS

The general belief is that current ship stability regulations reflect little of the state of the art of ships behavior and seakeeping in different practical situations, especially in rough seas. Additionally, ships that are categorized as safe continue to loss their intact stability due to influence of factors, which depend, directly or indirectly, on minimum stability requirements. There is a necessity of rethinking of the stability problems, arising from the new ship design trends, new ship's operation from economical point of view, as well as competitive officers on board vessels capable to face the new challenges, generating new requirements that will protect lives, environment and proprieties.

4. REFERENCES

[1] Belenky V, Jan Otto de Kat, Umeda N – *On Performance-Based Criteria for Intact Stability*, ABS Technical Papers 2007

[2] Francescutto A. - *Intact ship stability-the way ahead, Marine Technology*, Vol. 41,2004, pp.31-37

[3] Francescutto A. – *The intact ship stability code – present status and future developments*, Marine Technology, 2009, pp.199-206

[4] Kuo C. and Welaya Y. – *A review of intact ship stability research and criteria*, Ocean Engineering, Vol.8, Issue 1, pp.65-85

[5] Res. A 167 – *Recommendation on intact stability for passenger and cargo ships under 100 metres in length*, IMO, London 1968

[6] Res. A 562 – *Recommendation on a severe wind and rolling criterion (weather criterion) for the intact stability of passenger and cargo ships of 24 metres in length and over*, IMO, London 1985

[7] Res. A 749(18) - *Code on Intact Stability for All Type of Ships Covered by IMO Instruments, as amended by MSC. 75(69)*, IMO, London 1999

[8] Res. MSC. 267(85) – *International Code on intact Stability, 2008 (2008 IS Code)*, IMO, London 2008

RISK MANAGEMENT IN HIGHER EDUCATION

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ABSTRACT

Risk management is "the formal process by which an organization establishes its risk management goals and objectives, identifies and analyzes its risks, and selects and implements measures to address its risks in an organized fashion". Today's risk management process encompasses more than just insurance, work safety and health and legal liability management. It also includes an ongoing and complex process of evaluating and minimizing inherent, enduring organizational risks-in this case, those of the academic institution, students, community agencies, community members, and others involved in the service-learning experience. To avoid health and legal liability, risk management procedures need to be considered before starting any service-learning experience. This fact sheet provides background information and describes a systematic approach to establishing a safe, minimal risk environment for all participants: students, faculty, supervisors, transporters, community agency representatives, and others.

Keywords: *risk management, students, process, objectives, components*

1. INTRODUCTION

Start by inquiring about the policies and procedures that may already be in place on your campus: does your campus have a risk management policy for community-based educational experiences, for community service, or for clinical placements? To avoid duplication of effort, be sure to consult with administrators and faculty in other schools and departments on your campus that have an existing service-learning or community-based learning program in place. If your campus has an Office of Service-Learning or related office, consult with them as well. Learn from their stories of both successes and challenges involved in managing risks and avoiding liability. When available, request pertinent documents - such as student and agency orientation materials, consent forms, university-agency agreement forms, liability policies - to review as templates for your program.

In general, the more the service-learning environment is sanctioned by the academic institution, the greater the potential for liability to the academic institution. Conversely, the less the service-learning environment is sanctioned by the academic institution, the greater the potential for liability to the participating students and agency. For example, if the student does community service on his or her own - outside the scope of a credit-bearing course or official campus program - the student is probably not covered by the institution's liability insurance. In either scenario, it is important to create signed agreements that clarify the liability insurance coverage provided by the community partner and the academic institution involved in service-learning. Be sure to check your state's requirements; for example, worker's compensation insurance may be required by state law. Worker's compensation for students is often the responsibility of the academic institution if the service-learning experience is a requirement.

Although it is critical to have some form of liability insurance coverage at both the community agency and the academic institution, financial losses will only be an issue if an adverse event occurs - the ultimate goal is to prevent any adverse occurrences. It is not just financial losses that are at stake; one must also consider prevention of other losses, including loss of trust and mutual understanding in community-campus relations, which is the foundation of a successful partnership.

Liability prevention involves the systematic identification, analysis, measurement and reduction of risks. It encompasses several aspects of the service-learning experience, including the community agency (e.g., slipping on a wet stairway), product or service delivery (e.g., quality of care provided), transportation (e.g., motor vehicle accident), and worker's compensation, among others. An example of risk prevention includes training students in safe needle disposal before working in health clinics. An example of risk reduction includes assuring that gloves are available for student use in health care environments, or a review of emergency response procedures, such as fire exits.

If an adverse event occurs that involves legal intervention, consider the following:

- Injury to student in service-learning experience: typically, medical costs are paid through workers' compensation when the students' injuries resulted while he/she was providing service within the scope of the SL experience
- Injury to someone else by student or faculty in service-learning experience: in this case, there is the possibility of litigation…anybody involved in the situation could be named as a defendant, including the student, the academic institution, the faculty member, or the community agency. The academic institution would defend and indemnify the student and the faculty if each were operating within the scope of their student or faculty roles.

Risk management is an ongoing process that requires continuous revision in response to changing governmental and workplace policies. To assure sustainability of your community-campus partnership, adequate planning, orientation, and continual evaluation are essential. Furthermore, involving all stakeholders from the community and the campus in the risk management process will assure a safe, trusting, and enjoyable service-learning experience.

2. CONDUCT A RISK AND LIABILITY ASSESSMENT

Minimizing potential risks to all service-learning participants requires adequate time for planning and orientation. Conduct a thorough review of potential risks before embarking upon the service-learning experience. Discuss your questions and concerns with your community agency partners and campus colleagues. This assessment might include such questions as:

- What are the potential risks to service-learners of having contact with agency clients? For example, are clients likely to be under the influence of drugs or alcohol? What policies and procedures are in place at the agency to protect their staff, volunteers and service-learners from risks due to contact with agency clients? Will students ever work unsupervised with clients?
- What are the potential risks to service-learners of traveling to and from their homes, the campus, and the agency? For example, what is the rate of various crimes in the immediate and general vicinities of the agency? How and during what times of day will students travel to and from the campus, their homes and their service-learning sites? Is parking provided? Is public transportation accessible? Are escorts needed or provided for staff, volunteers, or service-learners to safely travel from the agency to public transportation, parking lot, etc.?
- What are the potential risks to agency staff and clients of having student service-learners on-site, and how might they be minimized? What are the existing requirements for staff and volunteers at the agency? For example, do they need to be fingerprinted, have criminal background checks, and be tested for tuberculosis or other communicable diseases?
- How is risk and liability insurance provided to cover service-learners? Does the community agency cover insurance for liability, worker's compensation, volunteers? Does the university?
- How is confidentiality of students, agency staff, and clients assured? Are there policies in place for confidentiality? Are pictures or video allowed?

3. THE COMPONENTS OF A RISK MANAGEMENT PROGRAM

Under the Occupational Safety and Health Administration's (OSHA) Voluntary Safety and Health Program Management Guidelines (1989) an effective occupational safety and health program includes four essential elements: 1) management commitment and employee involvement; 2) work-site examinations to identify existing hazards as well as conditions and operations in which changes might occur to create hazards; 3) hazard prevention control; and 4) safety and health training. OSHA's experience in the Voluntary Protection Program has illustrated that effective management of safety and health protection improves employee morale and productivity, as well as significantly reduces workers' compensation costs and other less obvious costs of work-related injuries and illnesses.

With these points in mind, consider having the following policies, procedures, and processes in place for your service-learning program:

- *Site Visits*

Visit with your community partner and talk through the questions posed above. Visit the community settings and organizations that your students are likely to be in during their service-learning experience. Visit these settings and organizations when your students are there, to gain first-hand knowledge of the situations in which they are serving and learning. Meet with your community partners after the service-learning experience has ended, to "debrief" about the experience from the risk management and liability standpoints - what would you do differently next time?

- *Supervision*

Having adequate supervision on-site and in the community - whether an agency staff member, volunteer, campus faculty or campus staff - will help to create a safe environment for service-learning. Be sure that direct supervisors are oriented to risk management and liability issues, in part to assure that the policies of your academic institution and the community partner are being adhered to.

- *Orientation*

Risk management and liability issues should be covered in your program's orientation for participating students, faculty, and community partners. Students should be made aware of risks associated with service-learning, but they should be presented in context so as not to unduly frighten or intimidate students from participating. It can be helpful to involve students who have previously completed the service-learning experience as speakers during the orientation. Students often feel more comfortable about the situation if they hear about the positive experiences of other students. It is especially important to spend time orienting and training students in safety procedures, potential dangers, and the risk management policies of your school and community partners. Time spent here can help avoid future problems by bringing potential problems to the attention of participants. When orienting students and community partners, provide a summary handout or handbook with checklists, appropriate forms, and emergency contact information.

- *Communication*

Open, frequent, and clear lines of communication are key to reducing risks in service-learning. For example, your community partners and your students should know whom to contact at the campus should any questions or emergencies arise in the course of the service-learning experience. Frequent communication with your community partners should help to identify any issues or concerns and to address them early in the process.

- *Transportation*

Campuses will often state that they are not liable for students getting to and from community sites in an informed consent form. When the vehicle is either university-owned or operated, or community agency-owned or operated, these practices can minimize risks to both student and driver: screen all drivers, follow safety precautions, develop and implement training for all drivers, ensure all vehicles are safe (with appropriate maintenance schedules), provide policies for passenger behavior. When using public transportation, determine the risks of bus, train, subway, walking, etc. and take actions to minimize these risks (e.g., by organizing car pools, pairing students who travel by bus together to the site).

- *Risk Management Policy and Procedures Manual*

We recommend developing a risk management policies and procedures manual that contains these documents:

1. Mission, goals, and objectives of the service-learning program.
2. Mission, goals, and objectives of the risk management program
3. Relevant policies and procedures: for example, liability policies, sexual harassment policies, human subjects protection policies, campus or community vehicle policy, state and federal laws and regulations.
4. Contact information for campus and community partner staff dedicated to the process of risk management and liability.
5. List of approved service-learning and volunteer placements with contact information, highlighting any site-specific forms that need to be completed (i.e., fingerprinting, background checks).
6. Service-learning agreement or contract. This form should explicitly state the legal roles and responsibilities of community and campus participants engaged in service-learning.
7. Student-related documents: a checklist of forms that students need to review and/or complete, and copies of those forms. For example, waiver, permission, and informed consent forms. Informed consent forms should provide clear, explicit information about the possible dangers of the service-learning experience, should be obtained in writing and kept on file. A good informed consent procedure can minimize the possibility of a claim alleging that the harmed party would not have participated in the experience had s/he been better informed of the risks (Tremper & Kostin, 1997).
8. Community partner-related documents: A checklist of forms that community partners need to review and/or complete, and copies of those forms. For example, service-learning contracts, memoranda of understanding, certificate of liability insurance, log to keep track of student hours and participation on-site.
9. "Do's and don'ts" safety and risk management tips for service learners - a list ideally developed collaboratively by representatives of both the community and campus. "Do's and don't" might include, for example, do not give agency staff or clients a ride in a personal vehicle, do not engage in any type of business with clients during the term of your service, do not give or loan a client money or other personal belonging.

- *Loss Reporting File*

Often overlooked, this file should include records of accidents, safety violations, training and orientation sessions and participant sign-up sheets. It also should include any relevant maintenance schedules (e.g., for campus vans used to transport service-learning students), reports of recommended corrective actions, claims reports, and so forth. Having this resource available can serve to diminish future violations and/or injury.

- *Special considerations for international service-learning experiences*

Although many of the above-mentioned issues also apply in international settings, there are some additional issues to consider. For example, students must adhere to health and safety requirements related to the country they will be visiting; there may be vaccines or prophylactic medications required before entry. The pre-travel orientation should include such information as local customs and laws, contact information for the U.S. embassy in the country, medical services available and plans for communicating regularly with the school while on-site.

4. REFERENCES

[1] *Boise State University*
http://servicelearning.boisestate.edu/aboutsl/risk.asp.
This site includes Risk Management and Insurance with Service-Learning FAQ's, an Informed Consent Form for service-learning trips, incident report procedures, and safety tips for students.

[2] *Brigham Young University – Idaho*
www.byui.edu/ServiceLearning/subpages/fgliability.htm
This page describes the set of steps BYUI staff and faculty should take in ensuring students are properly covered when leaving the campus for service-learning experiences, including a Master Service-Learning Placement form and a BYUI Student Service-Learning Agreement.

[3] *California State University System*
http://www.calstate.edu/cce/resource_center/servlearn_risk.shtml.
This guidebook on Managing Risk in Service-Learning offers guiding principles to reduce risk in service-learning, describes a process for implementing risk management, and provides a number of tools and checklists.

[4] *Iowa State University*
http://www.celt.iastate.edu/ServiceLearning/risk.html
This page on Risk Management and Service-Learning is intended to assist faculty in assessing program risk issues.

[5] *Maricopa Community College*
www.maricopa.edu/legal/rmi/
This extensive site, created by Maricopa's Office of the General Counsel Risk Management Division, includes forms, information, resources, presentations, and new items in areas such as assumption of risk, claims, insurance, international education, and motor vehicle usage.

[6] *St. Edward's University*
http://www.stedwards.edu/risk
This site includes a risk management manual, procedures for international trips and study abroad, and a checklist of when to use risk management forms.

[7] *Suffolk University*
blogs.cas.suffolk.edu/servicelearning/resources-for-faculty/suffolk-university-service-learning-risk-management-manual/

This online Service Learning Risk Management Manual covers Suffolk's programmatic and risk management approach to design and implement service learning into a class. It includes a community-based organization site visit checklist, service learning agreements, and assessment materials.
[8] *University of San Francisco*
serve.usfca.edu/OSL/resources/links.html
This Service-Learning Packet for Faculty includes many forms useful for the planning and implementation of a service learning course, as well as general information on liability and risk management.
[9] *University of Texas at Austin*
www.utexas.edu/diversity/ddce/vslc/comsum.php
The Student Service Orientation Training Module Summary addresses risk management along with other topics important for preparing students for community-based activities.

THE BENEFITS OF THE IMPLEMENTATION MECHANISMS FOR THE INTEGRATED SYSTEM IN SMES

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ABSTRACT

To survive and achieve to develop their activities in an increasingly competitive environment, small and medium sized enterprises have to increase their competitiveness and, progressively, reduce their operational cost.

It is necessary to develop a flexible and unique management system for these enterprises to use to integrate all management systems or activities related to quality, safety and environmental issues and improve their overall business performance and also to get prepared for certification according to the relevant international standards.

The output of this paper is a route map of activities for the implementation of the integrated management system, incorporating tools addressing specific management areas using quality, safety and environmental issues to focus them. The route-map has the potential to integrate the overall management activities of an organization. The tools of the route map were partially implemented to two SMEs, giving positive validation of the concepts.

Key words: *standard, SMEs, route map, safety, quality*.

1. INTRODUCTION

SMEs are and will be a significant task to work on within the framework of the European Union economy. The global trend indicates that today and in the near future big firms will be united to giant enterprises, which will dominate the market, influencing all its parameters and determining prices.

Due to these reasons, SMEs will face many perils and run the risk of being excluded from the marketplace, if they do not manage issues like cost reduction and competitiveness immediately and in the most efficient way.

The European Union's concern about enabling SMEs to survive in a rather difficult business environment is very obvious. It is important to mention that:

- In the 1996 British Quality Foundation & EFQM edition of the Business Excellence Model and the process of Self Assessment, special guidance for Small Businesses is provided for first time.
- The Regulation (EEC) 1836/93 for Eco-Management and Audit Scheme (EMAS) gives emphasis to the way that it can be implemented to SMEs.
- Most of the Research Programs funded by the European Union provide opportunities for projects that deal with SMEs development and their performance improvement

Additionally, management system standards like the ISO 14004: 2005 "Environmental Management Systems - General Guidelines on Principles, Systems and Supporting Techniques" and the BS 8800: 1996 "Guide to Occupational Health and Safety Management Systems" make special reference to their applicability to SMEs.

Quality, safety and environmental issues reflect all aspects of competitiveness. More precisely:

- the concept of Quality Management, as a means to achieve benefits for all stakeholders groups through sustained customer satisfaction (ISO 9001: 2008 "Quality Management Systems - Guidelines"),
- Safety, as a management field for controlling and reducing all kinds of losses and the relevant cost
- Environment, as a synthesis of internal and external parameters to be managed for the benefit of both the organization and the society create, in synergy, a triangle basis for developing a management system that SMEs need and are able to implement and which can be extended to serve the overall management needs of these enterprises.

2. DEVELOPMENT OF AN INNOVATIVE UNIQUE GENERIC SYSTEM FOR MANAGING QUALITY, SAFETY AND ENVIRONMENTAL ISSUES

By examining the special characteristics and needs of SMEs, among which the necessity for cost-effective management systems and procedures and the limited resources are the most critical ones, the importance of establishing and using management systems that unify a number of issues in these organizations becomes very obvious.

Although a number of articles have addressed the IMS approach for quality, safety and environmental issues, no generic management basis has been established yet for SMEs. Standards, models and regulatory documentation demonstrate a structural relationship between the management methodologies of these three issues but there is a big difference between their objectives and orientation as they appear to be put in practice at the moment:

- Quality management basically aims at satisfying customer expectations and needs
- Safety management primarily aims at fulfilling legal obligations
- Environmental management aims at proving the existence of a social responsibility.

By integrating these issues through the development of a unique management system and a common framework of objectives, a significant aid is provided for SMEs to achieve competitiveness and continuous improvement targets.

3. PREPARATION OF SMES FOR ISO 9000 AND ISO 14000 CERTIFICATION

ISO 9001 and ISO 14001 certification is very important to SMEs for various reasons:

- It provides strong marketing tools to these companies that really need them
- It increases their products or services reliability
- It creates a sound background for culture change
- It produces "formal paths" of communication to SMEs where the high rate of informality could cause problems
- It gives SMEs the opportunity to become suppliers of bigger organizations which consider such certification a requirement for starting a collaboration with a supplier
- It upgrades their image to all groups of stakeholders.

4. INCREASE OF SMES ORGANIZATIONAL FLEXIBILITY

An advantage of SMEs is that their size helps them maintain their flexibility. Apart from that, the organizational structure is a critical parameter for an organization's flexibility. By integrating management systems eventually a lean-structured cross-functional process-oriented organization is gradually formed.

Fewer horizontal functions substitute separate vertical ones and fewer people are needed while more activities are accomplished. The IMS route-map implementation should lead SMEs to create more flexible organizational structures and increase their efficiency.

5. REDUCTION OF SMES OPERATIONAL COST

Quality, safety and environmental management systems provide cost reduction benefits to companies, through:

- minimization of cost of non – conformity
- improvement of productivity
- continuous reduction of losses and of the relevant cost
- improvement of process management
- implementation of preventive actions instead of corrective actions

The synergy achieved by integrating these management systems will multiply the benefits mentioned above. The IMS route-map will additionally help SMEs control their overall operational activities more effectively and efficiently through specific tools.

6. ESTABLISHMENT OF MECHANISMS FOR SMES CONTINUOUS ASSESSMENT OF ERFORMANCE IMPROVEMENT

Based on the eight quality management principles and the principles of Business Excellence Model, the IMS route-map introduces ideas and techniques of continuous improvement assessment that suit SMEs.

It must be mentioned that SMEs needs for performance assessment are different from these of big enterprises; for SMEs, parameters like time and response speed are much more critical, as their time horizons are inevitably shorter and their financial and other resources are limited.

Their assessment system must continuously monitor their overall performance, giving them the possibility to take immediate action as soon as problems or system deficiencies occur.

7. INCREASE OF SMES COMPETITIVENESS

The combination of organizational flexibility, operational cost reduction and continuous total performance improvement assessment will increase SMEs competitiveness dramatically.

An IMS route-map can act as a platform for the development of a new management style that will be based on:

- simplified purposeful procedures
- value-adding process planning
- front-line management practices

7.1. Inducing vertical subcontracting: the korean way

Korea's experience is of special interest since the rapid development of its subcontracting system allowed the SME sector to greatly expand its role in manufactured output and exports in a relatively short period- the two decades since the mid 1970s. The radical change in industrial size structure during that period was partly a result of the changing composition of industrial output by sector, and partly due to a policy imperative to spread the fruits of industrial growth more widely (Baek, 1992). The later shift from low-wage strategy a development model in which interfirm networks gained importance (Cho, 1995, 2) also played a role. A dense subcontracting system was built on cultural, economic and policy factors, and on direct incentives. Many linkages rest on mutual trust and interpersonal respect based on social relationships, such as common schooling and regional or family background (Cho, 1995, 13). At the same time, market forces encouraging subcontracting were complemented by government policy and pressure. Some of the new small firms are spin-offs from the large enterprises for which they subcontract, while others have arose independently. Legislation enacted in 1982 specified the SME industries to be promoted, excluded large firms from activities reserved for small ones and promoted subcontracting (Cho, 1995, 4). Since the late 1980s, externalization (transfer of production activities formerly handled within the large firm) to small subcontractors occurred rapidly. Korea has thus been unusually vigorous in its promotion and mandating of large-small linkages, as it has in overall SME support policy, where a wide variety of institutions and programs cater to perceived needs. Kim et al (1995, 18) report that though few of these publicly provided services were given high average ratings for importance by a set of SME exporters in four industrial sectors, virtually all firms reported considerable benefit from one or another of the sources. The support system as a whole thus appears to have a considerable positive impact. The question from the perspective of other countries is the extent to which Korea's policy of mandating and nurturing increased vertical linkages might be replicable.

8. STEPS OF THE IMS ROUTE-MAP DEVELOPMENT PROCEDURE

As the IMS route-map addresses to SMEs, the first issue that had to be studied and analyzed was their special characteristics and needs as they were indicated by the literature review and the data collection procedure. The analysis led to two groups of results:

- results showing how these organizations operate, their overall weaknesses and strengths and what they actually need and the IMS route-map should provide
- results related to the way quality systems are usually implemented to SMEs and to the characteristics of these systems.

The former group of results strongly influenced the content of the IMS route-map as the input of the user group, whereas the latter group of results influenced the structure of the IMS route-map and the points related to its applicability.

A very important aspect of the IMS route-map development procedure was the design and development of a number of particular tools to be implemented within its framework, or even independently.

9. IMS ROUTE-MAP TOOLS DEVELOPMENT

The particular tools of the IMS route-map aim at:

- introducing a systems approach to areas that, generally, are not managed that way in SMEs
- fulfilling the needs of SMEs
- satisfying the requirements of the applied standards
- providing simple, cost-effective ways for SMEs to cope with specific issues, by integrating activities
- facilitating the IMS implementation in SMEs

The development of each tool was based on the following axis:

- determination of the areas of concern to be addressed by the tool, that would ultimately specify its aims
- identification of the standards requirements to be met by the implementation of the tool
- design of the tool, by modifying the content of its particular step or phase and the sequence between them, based on the expected final output of the tool.

The priority of the tools introduction within the framework of the IMS route-map was determined by the integrated basis of quality, safety and environmental management standards.

10. CONCLUSIONS

The fundamental elements of the paper were:

- the special characteristics of SMEs and their needs for survival and development, as they were determined by the literature review and the analysis of the results of the relevant standards
- the quality, safety and environmental management principles and the requirements and / or guidelines of the relevant standards.

11. REFERENCES

[1] ISO 9001: 2008 “Quality Systems - Model for quality assurance in design, development, production, installation and servicing”.

[2] ISO 14001:2005 “Environmental Management Systems - Specification with guidance for use”

[3] PARIS, CHRISTOPHER, *The Complete Guide to Understanding & Implementing ISO 9001´s Process Management Requirements*, 2003.

[4] Brassard, Michael & Diane Ritter, *A Pocket Guide of Tools for Continuous Improvement & Effective Planning*, First Edition, Salem, the United Sates of America, 1994.

[5] SMEUREANU, I., ANGHEL, L.D., ONETE, B.C., NISTOREANU, P., *Small and Medium Enterprises in Contemporary Society*, Ed. KMV, Haan, 2006.

[6] TRICKER R., *ISO 9000 for SMEs*, Ed. All Beck, Bucureşti, 1999.

COCONET – PUTTING TOGETHER SEAS WITH ROMANIA AS WORK PACKAGE LEADER FOR BLACK SEA PILOT PROJECT

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ABSTRACT

CoCoNet is the abbreviation for a research project called in full as "Towards COast to COast NETworks of marine protected areas, coupled with sea-based wind energy potential" funded under the OCEAN.2011-4 theme of the European Union's Seventh Framework Programme (better known as FP-7 project). This collaborative project comprises 39 partner institutions from 22 countries, including Romania. Environmental policies focus on protecting habitats that are considered valuable because of the biodiversity they encompass. Such policies also aim at producing energy in cleaner ways. The establishment of Marine Protected Area (MPA) networks and installation of Offshore Wind Farms (OWF) are important ways to achieve these goals. The scope of this paper is to highlight work packages (WP) established within CoCoNet Project – on one hand and, on the other hand, pointing out Romanian partnership to CoCoNet Project.

Keywords: *CoCoNet Project, Black Sea, Mediterranean Sea, marine protected areas, work package.*

1. INTRODUCTION

CoCoNet Project is intended to identify groups of putatively interconnected MPAs in the Black and the Mediterranean Seas, shifting from local (single MPA) to regional (Networks of MPAs) and basin (network of networks) scales.

Amongst other points of interest, one is that coastal focus will be widened to off shore and deep sea habitats, comprising them in MPAs Networks.

These activities will also individuate areas where Offshore Wind Farms might become established, avoiding too sensitive habitats but acting as stepping stones through MPAs.

Socioeconomic studies will integrate to knowledge-based environmental management aiming at both environmental protection (MPAs) and clean energy production (OFW).

Current legislations are crucial to provide guidelines to find legal solutions to problems on the use of maritime space.

Two pilot projects (one in the Mediterranean Sea and one in the Black Sea) will test in the field the assumptions of theoretical approaches.

The Project covers a high number of countries and involves researchers covering a vast array of subjects, developing a timely holistic approach and integrating the Mediterranean and Black seas scientific communities through intense collective activities and a strong communication line with stakeholders and the public at large [1].

It is project aim to produce the guidelines to design, manage and monitor network of MPAs, and an enriched wind atlas for both the Mediterranean and the Black Seas, creating a permanent network of researchers that will work together also in the future, making their expertise available to their countries and to the European Union.

CoCoNet project has two main themes [1]:

- to identify prospective networks of existing or potential Marine Protected Areas (MPAs) in the Mediterranean and the Black Sea, shifting from a local perspective (centred on single MPAs) to the regional level (network of MPAs), and finally to the basin as a whole (network of networks). The identification of the physical and biological connections that exist among MPAs will then be useful to elucidate the patterns and processes of biodiversity distribution.
- to explore where offshore wind farms might be established, producing an enriched wind atlas for the Mediterranean and the Black Sea.

2. WORK PACKAGES WITHIN COCONET

There were several work packages (WP) established within CoCoNet Project that have been split between participants, as follows [1]:

2.1. WP1-Management

Objectives:

- manage, direct and monitor the overall performance of the project;
- ensure the correct progress of the work so that the results of the project adhere to the contract's requests;
- ensure the adequate collaboration between the groups working in different work packages within the project;
- coordinate the production of deliverables and the organization of meetings both in person and video conferences;
- prepare and deliver the periodic progress report to the Commission;
- administer project resources;
- supervise the decision making process
- create the processes, templates and instructions to control the performance of work plans and resources with the support of a specific web based system;

- identify and resolve any problems or disputes that may arise within the Consortium.

2.2. WP2-Habitat mapping: state of knowledge, data integration and scenarios of protection

The knowledge about habitat distribution and extent is critical for the conservation and the management of the marine system. Both data gathering through habitat mapping and data management systems to synthesize the available information about habitat distribution at large scale require the use of standard approaches to enable comparisons between areas and organize information in maps and reports. Different key concepts and methods in dealing with marine habitat classifications and mapping have been developed by different disciplines (e.g. marine geologists and ecologists, oceanographers). A unifying approach focusing on the definition of habitats, the measurable features to describe it, the scale and the hierarchical framework to be used is needed to provide up to date information about the distribution of habitats at basin scale.

WP2 will integrate EU and non-EU experience in habitats classification and mapping from coastal areas to the deep sea. Data about habitat distribution will be combined to a spatial analysis of the distribution of overlapping threats at basin scale. Data modelling will further refine results of habitat mapping and use of site selection algorithms will combine results from different disciplines to provide scenarios of MPA networks.

The aims of WP2 are:

- revision of habitat classification schemes and identification of common criteria to combine multi-scale geological, oceanographic and biological data to derive habitat maps at Mediterranean and Black Seas scales;
- review of habitat distribution and extent including the Mediterranean and Black Sea. Data mining, integration and production of a multi scale habitat cartography, with specific focus for habitats included in the Habitats Directive (92/43/EEC);
- mapping of human threats in coastal and deep sea habitats at basin scale;
- use of site selection algorithms to combine results coming from the contribution of different disciplines (i.e. modelling approaches) to provide scenarios of MPA networks at Mediterranean scale.

2.3. WP3-Species assemblages, dispersal and connectivity

Objectives are defined through questions:

- what is the existing network of connectivity?
- what is the current effectiveness of the present network of MPAs for favouring conservation?
- what knowledge is lacking and how to expand the existing network of MPAs in order to maximize the conservation of biodiversity and resilience of ecological communities, while minimizing the surface area of the zones restricted to fishing?

2.4. WP4-Scenarios of environmental change (natural and human induced). Role and response of the MPAs

Objectives:

- to provide further insights into the role of climate variability and climate change on ocean circulation and coastal risks and into their implications for establishment of marine protected area (MPA) networks;
- to examine the main biotic and human driven non-biotic changes and threats that can affect the functioning and dynamics of Mediterranean and Black Sea ecosystems and determine their implications for establishment of MPA networks;
- to synthesize the ecological, social and economical benefits of existing MPAs, to assess the correlates of their management effectiveness, to guide the establishment and management of MPA networks and to develop a framework for assessing MPA networks effectiveness.

2.5. WP5-Offshore wind farms and marine protected areas

The work is organized around the following main objectives:

- estimation of the available offshore wind power potential over the Mediterranean and Black Seas under current and future climate conditions;
- review of existing and in-progress technology of offshore wind farm elements and of offshore wind turbines;
- development of a smart wind chart for the entire Mediterranean and Black seas.

2.6. WP6-MPA Socio-Economic Issues, Management and Legislation

The overall objective is to develop management strategies for implementing regional networks of MPAs, including measures such as common designation guidelines, management best practices, regulations to limit and ban certain practices, dynamic closures of certain areas, and legal approaches for managing MPAs in trans-boundary areas and high seas.

In particular, the objectives are:

- develop economic cost benefit analysis using The Economics of Ecosystems and Biodiversity (TEEB) methods for MPA networks in the Mediterranean and Black Seas;
- improve methods and evidence-based tools for developing holistic planning and integrated management approaches and practices for the implementation of regional or sub-regional networks of MPA;

- evaluate ecological impact assessment methods for offshore wind energy potential in the Mediterranean Sea and the Black Sea;
- support the EU maritime spatial planning initiative and the development of an Integrated Maritime Policy in the Mediterranean and Black Sea basins;
- contribute to commitments under international/regional conventions and agreements as well as EU regulations and policies regarding the implementation of regional or sub-regional networks of MPAs.

2.7. WP7-Information Dissemination and Outreach

Objectives:
- to disseminate the outputs (information, data, know-how, etc) made by the Project to all stakeholders in the most effective ways;
- to raise awareness of the stakeholders, particularly policy makers, students, and teachers, on MPAs and wind energy;
- to create and provide a common platform to facilitate the dialogue between all stakeholders.

2.8. WP8-Training and capacity building

Objectives:
- background for the WPs through Focus workshops;
- training students, researchers and stakeholders through summer school courses.

2.9. WP9-Data Management and synthesis

This work package is designed to provide a common framework for data management and final synthesis of the outcomes of WPs 2, 3, 4, 5, 6, 10 and 11.

A decentralized '*Geodatabase*' and a WEBGIS system will be the linking tool for all partners, regions and thematic research (WPs 2-6, 10, 11).

It will involve the entire consortium at different levels in topics such as data provision, GIS products, GIS interpretation, data archiving and data exchange.

The work is organized around the following main objectives:
- assess the rules for data and metadata sharing between partners reviewing the existing common European protocols and standards;
- design and implement data repositories (*Marine Geodatabase*) to store and retrieve the spatial data collected during the lifespan of the project for the Mediterranean and Black Sea areas and for the pilot study areas;
- develop the '*COCONET WebGIS'* to integrate the multi scale GIS layers derived from WP 2-6, 10, 11 in all regions;
- develop an analytical and evaluative framework for designing, managing and monitoring regional networks of MPAs, including wind farms, centered on science-based guidelines, criteria, concepts and models;
- deliver digital maps of networks of marine protected areas and offshore wind farms (OWF) as final synthesis of the outcome from all Wps.

2.10. WP10-Black Sea Pilot Project

Objectives:
- acquisition of new geological, biological, oceanographic data in the Black Sea pilot area relevant for MPAs implementation;
- identification, within the pilot area, of key variables regarding connectivity (distance, size, strength and direction of currents, propagate supply) to be considered in the design of MPA network;
- definition of what is specific to the Black Sea and what can be generalized at larger scale within management plans in terms of connectivity processes;
- examination of the main natural and human driven causes of changes, potentially affecting the functioning and dynamics of the Pilot Areas ecosystems and description of potential implications for establishment of MPA networks;
- assessment of ecosystem resilience and implications for MPA network design and management in the Pilot area;
- evaluation of the impacts of offshore wind farm development on ocean circulation, wave action, bottom morphology and marine life near or within the pilot network of MPAs in the pilot area;
- identification of socio-economic impacts caused by offshore wind farm development within the network of MPAs;
- transfer of the field data generated by WP10 to the WP9 '*Geodatabase'*, and to contribute via other WPs to the final synthesis.
  Note: Romania is designated as work package leader for this part of CoCoNet Project.

2.11. WP11-Mediterranean Sea Pilot Project

Objectives:
- acquisition of new geological, biological, oceanographic data in the Mediterranean Sea pilot area relevant for MPAs implementation;
- identification, within the pilot area, of key variables regarding connectivity (distance, size, strength and direction of currents, propagate supply) to be considered in the design of MPA network;
- definition of what is specific to the Mediterranean Sea and what can be generalized at larger scale within management plans in terms of connectivity processes;
- examination of the main natural and human driven causes of changes, potentially affecting

the functioning and dynamics of the Pilot Area ecosystems and determine their implications for establishment of MPA networks;

- assessment of ecosystem resilience and implications for MPA network design and management in the Pilot area;
- evaluation of the impacts of offshore wind farm development on ocean circulation, wave action, bottom morphology and marine life near or within the pilot network of MPAs in the pilot area;
- identification of socio-economic impacts caused by offshore wind farm development within the networks of MPAs;
- transfer of the field data generated by WP11 to the WP9 *Geodatabase*, and to contribute via other WPs to the final synthesis.

3. ROMANIAN PARTICIPATION TO SUSTAINABLE DEVELOPMENT OF BLACK SEA REGION – PART OF COCONET PARTNERSHIP

At governmental level, Romania is part of following regional agreements [2]:

- Bucharest Convention, 1992
- Odessa Ministerial Statement, 1993
- Regional Contingency Plan

The following EU Directives were transposed, implemented and enforced within the national legislation through main activity of Romanian Naval Authority (RNA) [3]:

- Directive 2000/59/EC on port reception facilities for ship-generated waste and cargo residues;
- Decision 2850/2000/EC setting up a Community framework for cooperation in the field of accidental or deliberate marine pollution;
- Directive 2005/33/EC amending Directive 1999/32/EC as regards the sulphur content of marine fuels;
- Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002

As part of CoCoNet partnership, Romania is participating through two entities:

a) GeoEcoMar- is a research and development institute of national interest, performing research in geology, geophysics and geo-ecology, with focus on aquatic, marine, deltaic and fluvial environments.

GeoEcoMar represents an excellence pole in the marine research, working as a European and national center for studies of sea-delta-fluvial macro systems. A modern research infrastructure, based mainly on marine and fluvial research vessels, enables *Geoecomar* to undertake complex, multidisciplinary studies in national and international programs [6].

b) Romanian Marine Research Institute (RMRI) has been established in 1970 by unification of the existing marine research institutes from Romania, at that time. In 1999, it was reorganized as National Institute for Marine Research and Development '*Grigore Antipa*' (NIMRD), according to the Governmental Decision 686/ 23.08.1999.

NIMRD carries out basic, applied and technological research, crucial for the knowledge, protection and management of the coastal zone and marine environment, oceanography, marine and coastal engineering, also management of the marine living resources in the Black Sea and Planetary Ocean.

Along Romanian maritime shore there is only one reserve Marine - *Marine Seaside aquarium Vama Veche - 2 Mai* (declared as Special Area of Conservation under the European ecological network *Natura 2000*, *ROSCI0269*) in custody of NIMRD *'Grigore Antipa'* [7].

Promotion/dissemination of CoCoNET project has been carried out proactively by NIMRD *'Grigore Antipa'* in the frame of the last celebration of the International Black Sea Day aiming to the broad dissemination of the importance of the Black Sea ecosystem to the public and also to the decision makers for better results and more effective management of the Black Sea living resources.

4. CONCLUSIONS

Being well known as typical continental sea, under a continuous stress caused by human factors (pollution, overexploitation of resources, tourism and so on), finding solutions for the Black Sea to that continuous stress and restore marine environment is imperative and one way is the creation of marine protected areas (MPAs) [3].

It is important, however, that these protected areas are not simple scattered oases but work as a whole.

FP-7 project - CoCoNet (inter-coastal networks of marine protected areas) in which NIMRD *'Grigore Antipa'* and *GeoEcoMar* are partners, aim to interconnect individual marine protected areas through consistent management practices, and to promote education and cooperation between the various administrations and people who work and live in these areas.

5. REFERENCES

[1] www.coconet-fp7.eu

[2] BERESCU, S., „*MARPOL and OPA conventions regarding oil pollution*", Ovidius University Annals Series: Civil Engineering Volume 1, Issue 12, June 2010.

[3] BERESCU, S., NIȚĂ, A., RAICU, G., "*Modern Solutions used in Maritime Pollution Prevention*", Ovidius University Annals Series: Civil Engineering Volume 1, Issue 12, June 2010.

[4] HAMILTON, DANIEL AND MANGOTT, GERHARD (eds.), *The Wider Black Sea Region in the 21st Century: Strategic, Economic and Energy Perspectives* (Washington, D.C.: Center for Transatlantic Relations, 2008).

[5] www.blacksea-commission.org

[6] www.geoecomar.ro

[7] www.rmri.ro

[8] GRIGORUT, CORNEL, ANECHITOAE, CONSTANTIN, GRIGORUT, LAVINIA-MARIA, *The Systematization of Maritime and Port Legislation*, Constanta Maritime University Annals, 2011

[9] GRIGORUT, CORNEL, ANECHITOAE, CONSTANTIN, GRIGORUT, LAVINIA-MARIA, *Port Practices*, Constanta Maritime University Annals, 2011.

COLLISIONS RISK ANALYSIS

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ABSTRACT

The review on shipping accident analysis indicates that the current approaches have only targeted certain perspectives. However, the occurrence of shipping accidents commonly depends upon various shortfalls in different segments of safety barriers. The principal focus of this paper is to provide an analysis, which aims at clarifying the probability and importance of the various factors leading to a shipping accident.

Keywords: *accidental loads, collision, fault tree, navigational area, human factor.*

1. INTRODUCTION

In the last decade, international maritime authorities have made significant efforts to promote safety at sea in the shipping transportation industry.

Especially, the International Maritime Organization (IMO) encouraged the establishment of a safety management system (SMS) in shipping companies in accordance with the international management code for the safe operation of ships and for pollution prevention (ISM Code).

The first international probabilistic concept for damage stability regulation, Resolution A, 265, IMO (1971), was adopted by IMO in 1971. The probabilistic rules were an optional alternative to the deterministic passenger vessel regulation in the SOLAS Convention and were developed for passenger vessels only.

The passenger vessel regulation was in 1990 followed by the adoption of subdivision and damage stability rules for dry cargo vessels, SOLAS (1990), also based on the probabilistic concept. While the probabilistic rules for cargo vessels are generally based on the same overall principles and damage statistics as the passenger vessel rules, there are some differences, specially the treatment of the vertical extent of damage.

The damage statistics for the passenger vessel A, 265 regulation is based on data collected for casualties occurring in the 1950's and 1960's and covers vessels commonly used at that time. These vessels were considerably different from the ship design of today. Many of the vessels were often designed with many decks.

Even though the shortcomings of the statistics were well known, the same statistics was used for the dry cargo regulation in 1990. The shortcomings mainly arise from lack of updating the statistics, but also from the fact that the statistics is based on only 296 ship collisions.

The International Maritime Organization (IMO) is currently seeking to harmonise the damage stability regulation for all types of vessels using the probabilistic damage stability concept.

Following, introduction of the probabilistic damage stability requirements of dry cargo ships, SOLAS Part B-l, IMO put on their work program for harmonisation of all damage stability requirements in SOLAS, using a probabilistic concept of survival.

The main framework of these new harmonised regulations should follow the concept of SOLAS Part B-l, but include the main features of IMO Res, A,265 and the current deterministic regulations of SOLAS Chapter 8, also referred to as SOLAS 90.

The recently published statistical reports have highlighted that there are still an enormous number of shipping accidents.

The consequent impacts of shipping accidents include loss of life, marine pollution, damage to ship or cargo, and others.

The factors that lead to shipping accidents can be human errors, technical and mechanical failures, and environmental factors.

In this condition prevention of shipping accidents is still a focal matter of maritime interests.

2. PROBABILITY OF A COLLISION

When is determine the probability of a collision all factors related to the risk of a collision must be identified.

In the present analysis a method of splitting the probability of a collision into two separate analyses is used.

First the number of possible ship collisions is estimated, if no aversive manoeuvres are made.

The result from this analysis is mostly concerned with the waterway and the size of the involved vessels. Then the causation probability which result in a collision event is estimated.

The causation probability is influenced by a large number of factors related both to the waterway, the involved vessels and to the human factor.

Methods of analyses for finding the causation factor may include fault trees.

When all factors related to the risk of a collision are identified, they can be separated into two groups.

- The first group contains the factors which can be controlled. Factors in this group may be denoted as risk control options.
- The other group contains factors which cannot be controlled. Factors in this group are mainly related to the environmental conditions.

Factors which may reduce or increase the consequences of the collision must be found.

The consequences cannot only be related to the structural deformation of the vessel.

Also human safety, the effect on the environment, the economic consequences, the reputation of the shipping company and the amount and the type of the oil outflow may be included in this analysis.

A way of evaluating the collision risk could be an analysis of the combination of the frequency and the consequences of collision. To bring a vessel from an intolerable to an acceptable situation may be performed by reducing the frequencies and/or the consequences of the collisions. By this method the risk involved in shipping can be compared with other transportation forms.

The risk assessment or the cost-benefit analysis may provide a decision tool or recommendations for specific risk reduction measures, either preventive as vessel traffic systems (VTS) or protective as new design criteria for the structure of the involved vessels.

Making a cost- benefit analysis could be a way of quantifying the consequences, in this process it is needed to quantify values for statistical life, pollution and property. The term cost-benefit refers to the costs of risk reduction in relation to the achieved benefits.

The critical review on shipping accident analysis indicates that the current approaches have only targeted certain perspectives. However, the occurrence of shipping accidents commonly depends upon various shortfalls in different segments of safety barriers. There is an urgent need for a new approach capable of addressing this issue.

In this paper it is presented an analytical framework based on a fault tree analysis, which aims at clarifying the probability and importance of the various factors leading to a shipping accident.

A fault tree analysis is a logical and diagrammatic method to evaluating the occurrence probability of an accident resulting from sequences of faults and failure events. A fault tree analysis is useful for understanding the mode of occurrence of an accident. Furthermore, given the failure probabilities of system components, the occurrence probability of the top event can be obtained.

Traditionally, it is usually assumed that the basic events within a fault tree are independent of each other and could be represented in terms of probabilistic numbers.

The probability of a collision is described by a fault tree. If two vessels collide it is required that the vessels are on collision course and none of the vessels take any action to avoid the situation.

The probability of no action, given that the other vessel as well does not act, is called the causation factor, which can also be defined as the fraction of the collision candidates, which result in an accident.

The probability of a collision can be determined from the number of possible ship collisions and be estimated as:

$$P = 1-e^{-N}$$

Where: P is the probability of a collision and N is the expected number of ship to ship collisions.

N is determined using the next formula:

$$N = \text{causation possibility x the number of ship collisions}$$

The number of possible ship collisions may be ignored during the analysis by assuming that all vessels will experience the same level of traffic during their lifetime. This could happen if the same sizes and types of vessels are compared, which is the case in many analyses.

3. RISK FACTORS IN A COLLISION

The first step of the analysis is to define the system of interest. This means to define the structure, group the elements and their relationship by defining the output from the system and the impacts of interest.

Determination of the probability analysis of a collision requires combination of knowledge and modelling of risk, involving human factors, the nature of the waterway, description and modelling of the ship structure deformation, global motions of the vessels and technical installations, both in connection with the waterway and on board the vessels.

Reducing the probability of a collision may also be referred to as preventing the vessels from collisions. Preventing a vessel from accidents is one of the main objectives of the shipping industry, as accidents in many cases will result in loss of life, lost operational time, lost income and insurance claims from passengers, authorities or cargo owners.

The factors that may influence a collision are: the navigational area system, the involved vessels and the human factor.

The vessels cannot be analysed isolated from the waterway, and the ship and the waterway are a complex and interdependent systems that involves physical and human elements.

Although, to identify factors related to risk and to identify where to implement actions of prevention, it seems to be a good separation.

Some of the factors are difficult to change, but most of the factors mentioned in the following can be considered as risk control options, which can be used as parameters in cost-benefit analyses.

3.1 The navigational area system

The navigational area system is analysed considering the traffic in that particular area, the management of the navigational area system and the environmental conditions.

The analysis of the traffic includes information about the types and sizes of passing vessels and of the traffic intensity. Factors describing the traffic can normally not be changed, as they are a result of the surrounding harbours.

Most regions in the world are not restricted in navigation, only the rules of the sea apply. Other areas are equipped with a vessel traffic system (VTS) or pilotage as a mandatory or voluntary system, VTSs are land-based marine vessel systems usually operated by government authorities.

The main objective is to ensure safe navigation in restricted shipping areas, such as coastal waters, heavy traffic areas, and areas of difficult navigation. The management of the VTSs varies depending on the size and the navigational difficulties of the location, but generally the system is equipped with radars for location of objects and vessels and has equipment for inspection of navigational aids as buoys, light houses etc. Most VTSs have mandatory or voluntary reporting systems, where radio communication is often used.

Most of the factors involved in the management of the traffic can be changed and they are therefore risk control options.

Environmental conditions should also be considered. The navigational conditions may be restricted because of the water depth or the complexity of the waterway.

Current and wind may set the vessel, or the visibility can be restricted because of heavy rain, fog, smoke, or sea spray. In this case the complexity of the waterway and perhaps the water depth can be risk control options, whereas the other factors normally cannot be changed.

3.2 The vessels involved

The vessel analysis includes design, instrumentation and management. The design and the instrumentation are directly related to the particular vessel, whereas the management of the vessel may both be related to the crew on board and the shipping company.

The International Maritime Organization (IMO) has laid down conventions and guidelines for education of the crew on board, guidelines for the equipment, and contingency planning for emergencies. The maintenance of both the vessel and the equipment on board is normally examined by classification societies or authorities at regular intervals.

The introduction of the automatic identification system (AIS) on ships and on shore-based VTS stations may in the future have a large impact on the number of accidents at sea. The system makes it possible to identify and track vessels from other vessels and from shore stations. Unfortunately, the system cannot be reliable before all vessels are equipped with AIS transponders, which might take several years.

All factors involved in describing the vessel system are risk control options, except for the size of the vessel.

3.3 Human factor

Today is well known that almost 80 percents of maritime accidents are based on human factors and human failures in managing of different activities onboard ships. In the same time, experts have recognized the importance of teamwork in almost all activities realized onboard ships.

The human factors resulting in ship collisions are normally due to the officer on watch, but also the communication on board the vessel is of great importance.

Multi-cultural crew with several languages makes it important to have one and only one language of communication.

Personnel information is important for determining the effects of crew training and experience as well as such factors as fatigue or stress.

Personnel information may also point to demographic sources of error. A secondary result of the data is identification of specific individuals as recurring sources of error.

Human error has a substantial impact on the reliability of complex systems, and it may occur in any phase of design, construction or operation. Due to the large number of accidents caused by human error, success in reducing tanker risk depends directly on measures to improve human performance.

4. THE NUMBER OF POSSIBLE SHIP COLLISIONS

The number of possible ship collisions, is here defined as the number of collisions if no aversive manoeuvres are made.

A method for determining the number for the purpose of comparing alternative routes or estimating the navigational difficulties of waterways has been presented by Pedersen (1995).

4.1 The causation probability

The causation probability is the fraction of the collision candidates resulting in an accident.

This number can be estimated on the basis of statistical accident data, but another approach is to analyse the cause leading to human inaction or external failures.

The causation probability is the conditional distribution of no action from own vessel, given that the other vessel does no act.

The reason for no action can be separated into: action that is not possible or action that is possible but the officer on watch does not act or makes a wrong decision.

These events are a mixture of mechanical failures, human errors or failures due to environmental conditions. The input ’action not possible’ is a mixture of mechanical failures and environmental conditions. The mechanical failures are engine, steering engine, rudder or thrusters problems.

These failures might depend on the maintenance of the vessel or the experience and the education of the crew.

The environmental conditions are related to the navigational area or location. Also sudden wind squalls or current might surprise the officer on watch.

The navigational area or the location can be presented as both visible and invisible, the traffic intensity and the number of possible collision candidates are factors given directly from the location, but also other causes leading to failure states are affected by the location.

If the vessel is passing a trafficked area, the officer on watch will probably be more attentive and aware of the situation.

The human factors such as experience and education are as well related to many failure states, but also a factor as fear of reprimands, which is not directly mentioned, may be of great importance.

Many failures may arise from the lack of competence on board the vessel.

5. CONCLUSIONS

The consequence of a collision involves the consequences for the vessel, consequences for human safety or for the environment. From these may follow consequences for the shipping company.

Human safety is affected by a collision in the case of severe damage to the vessel or where the vessel may capsize and lives may be lost. Minor injuries may also arise during the collision.

The consequences for the vessel can be separated into four cases, minor and severe damage, capsizing, and total loss of the vessel. Severe damage is damage to the vessel resulting in fracture of the ship's hull. The consequence is repair of the vessel, which has economic consequences.

The vessel will normally be delayed and cargo owners or passengers might consider the use of another shipping company the next time.

Fracture of the hull may also result in oil outflow leading to environmental consequences or stability problems, which may again result in capsizing of the vessel.

Capsizing can be a result of severe damage, but a vessel may also capsize due to reduced stability in connection with water inflow from smaller damages. Capsizing might cause oil outflow and have environmental consequences. A result of a total loss will normally be both economic and problems of reputation.

Environmental consequences arising from oil outflow. It can be separated into three categories: the consequences for the commercial industry, the restoration and the consequences of non-commercial value as loss of recreation areas, social losses and ecological losses.

A collision involving environmental pollution can result in bad publicity. Authorities, cargo owners or passengers might be influenced by the press, especially nowadays when the political consumer is in focus. Also a delay of the vessel may lead to a bad reputation and cargo owners or passengers might consider the use of another shipping company the next time. A bad reputation is normally followed by economic consequences.

6. REFERENCES

[1] METIN CELIK, SEYED MIRI LAVASANI, JIN WANG, *A risk-based modelling approach to enhance shipping accident investigation*, 2010

[2] MARIE LUTZEN, *Ship collision damage: Developing a General Overseeing Model for Small Queues*, Ph.D. thesis, Technical University of Denmark, 2001

[3] KOLOV K., BELEV BL., *Development of models and scenarios of navigational accident's realization in maritime transport system*, Varna, 2011

[4] RADU HANZU PAZARA, CORINA POPESCU, VARSAMI ANASTASIA, *The role of teamwork abilities and leadership skills for the safety of navigation*, IAMU, 2011

A CONSEQUENCE OF THE SECOND WORLD WAR: THE BELGRADE AGREEMENT (AUGUST, 18, 1948) AND ITS CONSEQUENCES UPON THE NAVIGATION ON THE DANUBE

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ABSTRACT

Today, Belgrade Agreement (August, 18, 1948) is, with minor revisions, the official document that regulates the navigation on the Danube. The Convention is not unfavorable to small Danube riparian states, but the undiplomatic and unceremonial treatment applied to the great Western powers (especially Great Britain, France and the United States) when the text was drafted and voted had serious consequences on trade and navigation on the Danube. The economic spoliation of the small Danubian communist countries by their Soviet "comrade", and the manner in which Stalin circumvented the principles of the Belgrade Convention along with his conflict with the Jugoslavian leader, Tito, managed to negatively affect the navigation on the Danube. The Danube's "Thaw", occurred after Stalin's death (after 1953), managed to partially correct the wrong that had been committed – the Danube's removal from the great international commercial routes.

Keywords: *the Danube, the Belgrade Conference (July 30 to August 18, 1948), the Belgrade Agreement (August, 18, 1948), the Stalinist period, the Tito-Stalin conflict.*

1. INTRODUCTION

In 1945, the same year the Allies achieved their military goals through the capitulation of Germany and Japan, the war coalition fell apart and misunderstandings between the Great World Powers – United States, Great Britain and The Soviet Union – began to determine the new world policy. In fact, the crisis between East and West was triggered by the problematic status of the European regions declared "free" by the Red Army.

Without taking account of the Western sensibilities, Moscow considered opportune to export communism in Eastern Europe at that time. Previously, on a diplomatic level, Stalin tried to quench the fears and precautions of his Western allies. "We don't have – stated the soviet leader on November 6, 1941 – and we shall never have a war objective aiming towards imposing our regime and will on the Slavic people or the other European nations that count on our help" [1].

However, during the war, Stalin's perceptions had changed and, in the course of major conferences (Tehran, Yalta and Potsdam) or unofficial meetings, the communist leader was able to impose his views in front of the Western allies who so eagerly ceded territories to Kremlin's army and propaganda.

Furthermore, the United States and the Great Britain didn't even have a common standpoint considering the means to counter the Soviet influence. While the president of the United States, F. D. Roosevelt, was determined to support international moralism based on the democratic principles of state sovereignty, ethically hostile to the concept of dividing the world into spheres of influence, Winston Churchill, the British Prime Minister, in the spirit of "realpolitik", embraced this kind of delimitation – as we can see from the agreement between Churchill and Stalin, concluded after the British Prime Minister's visit to Moscow (9-17 October 1944). London considered that the only way to save some countries was sacrificing others to their greedy Eastern ally. The discussions seem to have continued also during the famous meeting between the three great leaders – F.D. Roosevelt, W. Churchill and I.V. Stalin – at Yalta (February 1945), although in recent years, international and Romanian historians tend to deny the existence of such negotiations.

Moscow's policy "*a faits accomplish*" transformed the conflict between East and West, from a mere diplomatic dispute between the two global superpowers, into a fierce existential struggle between two social systems and ideologies (communism versus capitalism) which could not come through without the triumph of only one camp. Therefore, what happened within the Danube Conference, held between July 30 and August 18, 1948, in the capital of Jugoslavia, went beyond the normal understanding of the international negotiations. Our study does not aim to legaly analyze the Soviet project or the western contradictions, but the manner in which these works were carried out, especially, the consequences of the Belgrade Agreement on the navigation on the Danube river [2].

2. PRELIMINARIES OF THE BELGRADE DANUBE RIVER CONFERENCE

Establishing communist totalitarianism in Eastern Europe was a process that took place on two levels that were almost inseparable: imposing the communist totalitarianism in the countries and the formation of the "anti-imperialist and democratic camp" at first, which afterwards became "socialist" [3]. The Soviet military presence and the inclusion of the Eastern European countries under the military and political control of the Soviet Union were crucial for the coming to power of the communist parties in these countries. Moreover, the communization of the states around the Soviet Union, regarded as a protection line, was also used as a disguise through which Moscow sought to control a strategic area: the Danube and the Black Sea.

In order to achieve her goals – control over the Danube – the Soviet Union acted in the areas the Red Army controlled to obtain the following results:

1) political subordination of the states in the Danube basin through their communization. The diplomacy of the future satellite states (communist) of the Soviet Union reached aberrant forms, because the representatives of these countries have come to no longer act on behalf of national interests, but to conform to their big brother's view, the Soviet Russia. By establishing such relations, the Soviet Union managed to secure a comfortable majority at the next Danube Conference in Belgrade, where the new Danube regime would be discussed.

2) economic subordination of the same states, by imposing Soviet economic monopoly of the means of production, with special reference, in our case, to the infrastructure and water park. Gradually, simultaneously with the advance of the Soviet troops and the occupation of the former enemy state teritories – Romania, Bulgaria, Hungary and Eastern Austria, the Danube River became a crucial means of communication and was put under the direct control of the Soviet Union.

Wishing to obtain all possible economic advantages and, from a geostrategic point of view, to have a dominant position on the establishment of a new river regulation in the upcoming Conference, the Soviet Union forced the states occupied by the Red Army to form a series of joint transport and trade ventures on the Danube. Thus, joint ventures were organized: Sovromtransport (1945, Soviet – Romanian company), Meszhart (1946, Soviet – Hungarian company), Juspad (1947, Soviet – Jugoslav company, worked for only one year until the conflict between Tito and Stalin started), naval Soviet – Bulgarian company (1948) [4].

In less than five years (1944-1948), tenaciously fighting, Stalin managed to extend the communist system in eight other countries from Central and Eastern Europe: Czechoslovakia, Hungary, Jugoslavia, Bulgaria, Romania, Albania, Poland and East Germany. By the time the Belgrade Conference (August 1948) started, out of the seven of the Danube Basin countries, without taking in consideration the Soviet Union, five of them were communist (Czechoslovakia, Hungary, Jugoslavia, Bulgaria, Romania) and only two – Austria and West Germany (the sectors controlled by France, the United Kingdom and the United States) – remained untouched by this ideology. These two non-communist riparians were blocked by the Soviets from involving in the issue of establishing a new regime of the Danube. Their pretext was that they had the status of conquered countries and had not signed any peace treaty at that time. Finally, in response to the repeated requests of the Western powers, only Austria was granted the right to attend the meetings, but without any voting rights.

3. CONDUCTING THE BELGRADE CONFERENCE (JULY 30 TO AUGUST 18, 1948) – SOVIET UNION'S FORCE DIPLOMACY

Present at the Belgrade meetings were the folowing delegates: Cavendish W. Cannon (ambassador of the United States in Belgrade), Adrien Thierry (ambassador of France in Belgrade), Charles Peak (Belgrade extraordinary representative of the United Kingdom), Evgenij Kamenov (Bulgaria), Ana Pauker (Romania's Minister of Foreign Affairs), Erik Molnar (Hungarian Ambassador in Belgrade), Vladimir Clementis (Czechoslovakia's Minister of Foreign Affairs), Ales Bebler (Deputy Prime Minister of Foreign Affairs of Jugoslavia), Andrei Ianuarevici Vychinski (Deputy Prime Minister of Foreign Affairs Soviet Union), Vladimir Baranovsky (Ukrainian Soviet Socialist Republic) and Felix Rosenberg Rossini (observer from Austria) [5].

The rivalry between the two sides was unleashed at the first meeting and was provoked by the establishment of the official working language. Specifically, in addition to the inclusion of French and Russian language, they also challenged English on "the illogical and unrealistic grounds" exposed by Vychinski that it "put some delegations in minority". When voted, as expected, the Communist block prevailed with seven votes for and only three against.

Practice has shown that the last discussions between the delegates were held either in French, Russian or in their own language (including English), with the text being translated in either Russian or French by the Conference Secretaries. Subsequently, throughout the conference, the undiplomatic and uncollegial character by which Western countries were treated by most of the communist majority can be easily demonstrated. By the dispositions of Stanoje Simićs (Jugoslavian First President of the Conference), Andrei Vychinski's dissertations and that of the communist delegates were fully printed and officially presented as work programs for the meetings while those belonging to France, Great Britain and the United States were written only as abstracts. Here it is a report made by some of the British delegates (from unofficial transcripts) [6].

The Soviet delegate's behavior was simply unceremonious. In front of France and Great Britain's legally argumented responses, Andrei Vychinski replied with expressions such as: "doors serve for both entering and exiting", "history is not meant to be used as you would an old coat" or "it is impossible to continue playing the old songs of the Danube" [7]. At this point, the two West European delegates were very close to leaving the conference, but, ultimately, all three Western democracies remained until the end of the talks in spirit of solidarity. In its entirety, the organisation and the evolution of the Belgrade Conference disregarded the traditional diplomatic rules of such an international debate, being led from beginning to end by a single power – Soviet Russia. The results of the conference do not leave room for doubt given that a minority of three Western powers (United States, Britain and France), with Austria not having the right to vote, disputed their common point of view in front of a compact block of seven communist countries (The Soviet Union, Jugoslavia, Czechoslovakia, Hungary, Romania, Bulgaria and Ukraine), grouped around a single voice, that of Moscow. In fact, the Western Allies were quite aware that they would not actually obtain a regime that would ensure freedom of navigation for each and every ship banner, but in the name of compromise, they were hoping to get a series of concessions made by the Soviets. Faced with a hostile atmosphere in which they could not freely express their views, the Western Powers were asking why their presence was accepted in Belgrade [8].

As expected, the Soviet Union and its docile subordinates, representatives of the satellite communist states, voted the project proposed by Andrei Vychinski in Belgrade. The Soviet project became the new Danube Convention. This matter did not come as a pleasant surprise to the Western minority (United States, Britain and France) and was eloquently described by Cavendish Cannon. “This is a unique event in the history of international negotiations where most participants here, with a cynical solidarity, avoided proposing even the smallest changes to the text resulting from their discussions” [9]. Basically, the project proposed by the Soviet delegate was adopted without changing even one letter or word, which prompted the historian Josef L. Kunz to say: “In painting, the Belgrade Conference can only be a caricature of an international conference under a totalitarian regime, (...) dangers of a new era of barbarism, marked by a pronounced decline of good manners in diplomacy” [10].

On August, 18, 1948, the text of the Convention received, through vote, seven for (Soviet Union, Ukraine, Romania, Bulgaria, Jugoslavia, Hungary, and Czechoslovakia) and one against (United States). The American delegate abstained to vote individual items and, under the consideration that the new regime did not contain sufficient safeguards to ensure freedom of navigation and equal treatment to all naval flags, was against the entire document. The French and British representatives left the voting room ostensibly, refusing to accept the new Convention under the pretext that the legal conditions did not repeal the older statute of 1921 [11]. Rossini Felix Rosenberg, the Austrian delegate, attended the debate only as an observer and stated that his country cannot enforce this agreement without the consent of his government [12].

4. POLITICAL AND DIPLOMATIC CONSEQUENCES OF THE BELGRADE AGREEMENT OF AUGUST 18, 1948

The Western Powers present in Belgrade did not recognize the new Convention and up to a point made similar protest: France emphasized the validity of the 1912 Statute, which was included in the European Danube Commision; Great Britain, invoking the major commercial interests in the Danube basin, demanded her inclusion in the new Commission; and the United States, without having any economic interests, acted as a defender of the right to navigate and trade for all the states.

Officially, on 15 November 1949, just four days after the Danube Commission met for the first time in Galati, United States, France and Britain submitted separate notes to the governments of Bulgaria, Czechoslovakia, Hungary, Romania, Jugoslavia and the Soviet Union, which stated they did not recognize the validity of the Convention of August, 18, 1948, because it flagrantly violated the principle of navigable waterways of international concern which had been approved as a basic principle for the future discussions on the new regime of the Danube by the Council of the Ministers of Foreign Affairs on December, 12 1946 [13].

The American diplomats felt that the Soviet Union wished to block the rest of the world from naturally reaching the Danube. This remark was true and the Soviets did not take any measures in order to change this impression [14].

In parallel, other interested countries (Belgium, Italy, Greece and Austria), appealed to the benefits of the 1921 Convention and made separate notes to the Secretary of the Belgrade Conference in which they exposed their legal reserves on the 1948 Convention [15].

Responses to these international protests, came only from the Soviet Union (March 9, 1950) and Bulgaria (March, 28, 1950), both rejected as unfounded Western criticism, by reiterating the argument that the new regime of the Danube repaired the injustices of her previous status, the one through which internationalization of the navigable waterways limited the jurisdiction of the riparian states [16].

In response, considering that the conditions necessary to repeal the Statute of 1912 were not met, and therefore it was still valid, the authorities from London and Paris reestablished the European Danube Commission in Rome. The exile Commission formed by French, British, Italian and Greek representatives seized the 51 kg/s of gold, deposited prior to the World War by the former authority of the Mouths of the Danube in Italian banks. Only in the '80s, Romania managed to reach an agreement with Britain, France and Italy, through which the gold was transferred with the help of a Swiss bank to the Romanian state reserves [17].

The prestigious American historian and diplomat John C. Campbell [18], just one year after the episode from the Jugoslavian capital, was rhetorically asking himself what kind of triumph did Andrei Ianuarevici Vychinski get in the Belgrade Conference. He also replied: “practically, *the Soviet Union granted herself the juridic control she already had*”. The new Convention was not recognized by the nations outside of the communist block, and the Danube Commission could not operate on the Upper Danube, except for the area under the Soviet control. Therefore, Austria and Germany (whose territory has the first navigable section of the river) remained outside the jurisdiction of the committee. Without the participation and support of the Western Powers, the development and technical work on the river basin was significantly affected [19].

5. IMMEDIATE CONSEQUENCES OF THE BELGRADE AGREEMENT ON TRADE AND NAVIGATION ON THE DANUBE

It is a well established fact that during the Stalinist period (1948-1953), the links of the Danube with other trade routes were completely blocked. There was no contact, not even on an informal basis with the West, Austria or Federal Germany authorities. The Danube Commission, under orders from Moscow, refused to meet the demands of the United Nations and its specialized agencies. There were no vessels under western flags on the communist side of the river. They were only navigating on the Austrian and West Germany sector thanks to the communicating Rhine and Danube channels [20].

Until 1953, when the Soviet control over the Danube was at its peak, technical activities to develop the river were minimum. Moscow had turned its attention to the political side of her domination, encouraging the uniformity of navigation, police, customs and sanitary regulations in the sattelite countries in order to meet her personal commercial and economic interests. Moreover, in addition to preventing the development of navigation on the river, Moscow managed to cut off any connection to the outside world through its desinterest in maintaining the Sulina canal functional. This canal was placed under special Romanian –Soviet administration and although considered to be a segment of the international Danube, it was not dredged and repaired as it should have been [21].

Corroborating all items discussed, including the economic spoliation of the satellite states (Romania, Hungary and Bulgaria) through joint ventures, especially those based on water transportation, we are able to state that the riparian communist states were discouraged by Stalin's policy to restore their pre-war navy. The recoil suffered by Danube navigation, only six years after the signing of the Belgrade Convention, in particular, by the navigable potential of riparian states, can easily be demonstrated by comparing the naval traffic of some flags through the Sulina bar (statistics include only the flags interested in our study) [22]:

Statistics after the flag entry of vessels through Sulina channel into the Danube river				
Flag	Year 1924		Year 1954	
	Total Number	Total Tonnage	Total Number	Total Tonnage
Soviet Union	-	-	515	560,952
Great Britain	126	255,729	-	-
Italy	136	242,541	6	19,318
Germany	41	93,533	4	9,316
Romania	55	107,048	16	20,430
Bulgaria	2	2,474	16	31,542
Hungary	14	42,684	38	21,842
Jugoslavia	11	17,838	-	-
Greece	233	288,465	2	3,880
Turkey	7	938	97	122,126

Statistics show that the non-inclusion of the Danube River among the international river waterways seriously affected the international trade and, at the same time, the development of the Soviet transportation on the Danube was realized by the efforts of their satellite states, especially of Romania.

6. STALIN – TITO CONFLICT (1949-1953) – A NEW BLOW TO THE DANUBE NAVIGATION

The Soviet Union did not enjoy her success in Belgrade for long because the relations between Tito and Stalin deteriorated fast. After their break, Moscow believed that their relations could be quickly remedied by removing the Jugoslavian leader, but they were wrong. The solution adopted on August, 18, 1948, based on imposing a single regime of the Danube, established and led by the riparian countries through a single Danube Commission (actually there were two other Special committees created for the Iron Gates and Sulina) gave way to multiple interpretations and proved to be a utopia. Kremlin's project seemed functional and worked for the Soviet Union as long as the decisions of the small riparian states revolved around Moscow.

Under the Soviet domination over the river, the Tito-Stalin conflict broke the Danube into three areas: 1) from the Austrian limit to the small port Baračka – around 312 miles, a route through which the river passes through a part of Austria, Czechoslovakia and Hungary; 2) the Jugoslavian Danube, crossing its territory only – 236 miles from Baračka to Kasilievo (on the Romanian bank, Bazias), plus other 161 miles, which consist of the Romanian - Jugoslavian border and also the Cataracts and the Iron Gates area; 3) lower Danube – 289 miles of border between Romania and Bulgaria, plus 142 miles, in which the river passes exclusively through the Romanian teritory until the river Prut. From here, there are another 40 miles through the Mouth of Sulina until its flow into the Black Sea [23]. Due to the Jugoslavian latch, Moscow maintained her political influence over the first and third sector of the Danube, but, in reality, the Soviet control over the river was stopped at the Jugoslavian border of the river, Belgrade blocking the upstream Soviet ship navigation.

Another consequence of Jugoslavia drifting away from Kremlin was the deliberate delay in setting a joint Romanian – Jugoslavian special administration at the Iron Gates [24]. This item, recorded in the 1948 Convention, remained until the end of 1953 and Stalin's death a mere concept. Shortly after they managed to establish this administration her power was seriously diminished in favour of the Danube Commission [25]. In parallel, in order to restore her prestige, the Soviet Union intensely sustained the Danube – Black Sea Canal and forced the Romanian government to spend huge amounts of capital in order to dig it [26].

The Soviet – Jugoslavian conflict regarding the Danube began by Moscow refusing the direct implication of Belgrade authorities in managing the newly created Danube Commision. In the first session held in Galati, on November 11, 1949, the Soviet Union took control entirely over the new body through the Secretariat and the rights that the Soviet Secretary, Morozov, had gained. Thus, Morozov named all the members of the Secretariat. Their appointment was not based on geographic or state criteria, but “on their merit” – a formula which hid Moscow’s right to impose desirable personnel. Therefore, Jugoslavia received only four minor posts in the Secretariat and related services which managed to block her influence and power within the Commission [27]. The same Morozov organized and decided the permanent personnel’s work and negotiated on its behalf with the authorities. At the same time, there were no mechanisms provided through which the riparian states could inspect and subordinate the activity of the Danube Commission Secretaryship [28].

In the following years, Jugoslavia’s situation in the Danube Commission considerably weakened, and her representative suffered enough humiliation: he was presented with documents that had to be signed immediately and his requests for gaining additional time to study and consult with his government were refused; his requests to be informed were also not answered; he was not called in to participate in the subcommittees created to discuss certain issues between the semi-annual sessions or he was intentionally placed in a committee that met at the same time with the plenary session, which put him in the awkward position of choosing; he barely obtained a visa to enter Romania in order to participate at the Danube Commission meetings, and, during his stay in Galati, had great difficulty in getting accommodations.

Simultaneously, the Jugoslavian ships came up against different incidents, the violences between the Serbian and the Romanian Danubian side intensified, and the Jugoslavian sailing agencies were seriously disadvantaged in Romania and Bulgaria and banned in the Soviet Union [29].

At first, Jugoslavia’s response consisted in protests, and by 1950 the country established the withdrawal of her representatives from the Danube Commission and ceased the financial contribution to this organization [30]. The Soviet Union did not wish to exclude or entirely suspend Jugoslavia from the Danube Commission although it could have done so. Until Stalin’s death (March 1953), the Soviet Union pressured Belgrade, through the Danube Commission, in accepting the rivers status-quo and rules.

Fortunately, the Soviet attitude towards the Danube had considerably changed after Stalin's death (March 1953). In the ninth plenary session of the Danube Commission, in December 1953, the new dictator from the Kremlin, Nikita Sergeyevich Khrushchev, reached a compromise with Josip Broz Tito by increasing the number and the importance acquired by the Jugoslavians within the Commission. In response, the authorities from Belgrade allowed the passage upstream, through their Danube sector, of 26 Soviet ships. In the ordinary session of the Danube Commission, held on December 1953, the model imposed by Stalin was completely repudiated. In this session, the Jugoslavian delegate requests focused on two issues: moving the Danube Commission headquarters from Galati to Budapest (this was realized in 1954) and making an equitable distribution of the Secretaryship permanent posts. Under pressure from Belgrade, the new administration was chosen: the Jugoslavian Djurič as general secretary, the Hungarian Silk as president and as vice-president, the Bulgarian Guenov. Some work procedures of the Commission were also changed and, in consequence, the attributions of the Secretaryship were diminished [31]. From this moment, through the innovations of the new leadership from Kremlin, the Danube Commission became a mere experiment of the Soviet foreign policy [32] meant to: extinguish the conflict with Tito and resume relations with Jugoslavia; change the bilateral relations to multilateral within the communist block, especially in the technical field; resume trade and economic relations with Western countries and technical cooperation with the United Nations specialized agencies [33].

7. THE POLITIC AND ECONOMIC “THAW” OF THE DANUBE AFTER STALIN’S DEATH (AFTER 1953)

Moscow’s new policy towards her satellite states, characterized by granting more freedom, not only on the Danube, was transposed by the abolition of the joint ventures (so called Sovroms) in 1954 [34]. The end of the Stalinist totalitarianism over Danube navigation did not mean an abandonment of Kremlin’s domination over the mentioned area. Soviet hegemony simply became more diplomatic and indirect. The development of commercial relations around the Danube was another major change assumed by the Soviet authorities after Stalin’s death. The Danube Commission’s “thaw” manifest by sending delegates to international conferences on transport and trade development. Because of her transparent activity, in June 1956, an observer from the European economic institutions participated for the first time at the plenary session by launching a number of projects on arranging the Danube for better navigation. In order to gain better credibility and attract technical cooperation of Western democracies and in order to reintegrate the Danube in the major international commercial routes, the communist states had to truly unify the navigation on the river. Therefore, mutual information between the communist and the two non-communist riparian states became a necessity. After receiving invitations to participate at the plenary session of June 1957 and the ongoing works of the various subcommittees, the two countries sent their representatives [35].

After a first attempt (on May 23, 1955, the Soviet Union had asked Austria to become a member of the Danube Commission, but Vienna refused the invitation) [36], Austria’s accession to the Danube Commission became effective in January 1960. This was not the case also with West Germany. On the contrary, blocking the participation of this riparian state, by the Soviets, at the Belgrade Conference proved to be wrong. The German Federal Republic was forced, with the financial aid of Western countries, to finalize the Nazi project meant to unify the Upper Danube with the Rhine. Once their goal was achieved, it had two major negative effects on navigation on the communist side of the Danube: 1) German Commercial traffic in the Upper Danube was conducted through the Rhine into the Baltic Sea; 2) West Germany was no longer interested in joining the Danube Commission.

8. CONCLUSIONS

On paper, The Belgrade Agreement from August, 18, 1948, was more favorable to the small riparian states than the interwar international regime. Their sovereignty over their small portions of the river was only apparent, at least until Stalin's death. As we know, during the communist regime, the principles included in the Agreement were not important, but rather how they could be avoided or interpreted. Stalin's total subordination of the Danube Commission and his conflict with the Jugoslavian communist leader, Tito, badly influenced the Danube navigation and commerce. Only after Stalin's death, in 1953, through the elimination of joint ventures and the reopening of Danube international trading routes the situation improved, unfortunately without the development that other river routes, untouched by communist influence, achieved in the postwar period. The evil was already made during the Belgrade Conference (July 30- August 18 1948), when the undiplomatic treatment applied to the great Western commercial powers, removed the Danube River from international trading routes.

9. REFERENCES

[1] Apud SOULET, J.F., *Istoria comparată a statelor comuniste din 1945 până în zilele noastre*, Bucharest 1998, p.20.
[2] For more details, see LOCH, W., *Împărțirea lumii. Istoria războiului rece (1941-1955)*, Bucharest 1997, p.81-208.
[3] POPA, C., "Modalități de administrare a crizelor şi tensiunilor din blocul sovietic (1944-1948)", *Revista Istorică*, 12/1-2 (2001), p.135.
[4] SPULBER, N., "The Danube – Black Sea Canal and the Russian Control over the Danube", *Economic Geography*, 3 (1954), p.238.
[5] KASTORY, A., "La conférence de Belgrade de 1948 et la nouvelle organisation de la navigation danubienne", *Revue Roumain d'Histoire*, 43/1-4 (2004), p.296.
[6] FOCAS, S. G., *The Lower Danube River in the Southeastern European Political and Economic Complex from Antiquity to the Conference of Belgrade of 1948*, New York 1987, p.597-598.
[7] Ibid.; GOGEANU, P., *Dunărea în relațiile internaționale*, Bucharest 1970, p.257-258.
[8] FOCAS, S.G., *op. cit.*, p.596.
[9] Ibid., p.621.
[10] KUNZ, J.L., "The Danube Regime and the Belgrade Conference", *The American Journal of International Law*, 43/1 (1949), p.113.
[11] KASTORY, A., *op. cit.*, p.300-301.
[12] "Council of Foreign Ministers", *International Organization*, 3/1 (1949), p.179.
[13] "Danube Commission", *International Organization*, 4/3 (1950), p.542.
[14] HARRINGTON, J.F., COURTNEY, B.J., *Relații româno-americane. 1940-1990*, Iasi 2002, p.102.
[15] "Danube Commission", *International Organization*, 5/4 (1951), p.844.
[16] Ibid.
[17] BĂDESCU, G., "Dunărea din 1945 până azi", *Revista Română de Studii Internaționale*, 26/5-6 (1992), p.342.
[18] See FLORESCU, R.R., "John C. Campbell – istoric şi diplomat", *Magazin Istoric*, 38/4 (2004), p.14-18.
[19] CAMPBELL, J.C., "Diplomacy on the Danube", Foreign Affairs, 27 (1949), p.326.
[20] CATELL, D.T., "The Politics of the Danube Commission under Soviet Control", *American Slavic and East European Review*, 19/3 (1960), p.387.
[21] Ibid., p.387-388.
[22] Ibid., p.388.
[23] SPULBER, N., *op. cit.*, p.238.
[24] For Romanian – Jugoslav relations until 1947, see PREDA, G., "Relațiile româno-iugoslave în primii ani postbelici. Percepții româneşti", *Omagiul istoricului Constantin Buşe*, Focsani 2004, p.647-658.
[25] SPULBER, N., *op. cit.*, p.238; CATELL, D.T., *op. cit.*, p.386.
[26] For more details, see COJOC, M., "Rolul factorului sovietic şi al propagandei socialiste în construcția Canalului Dunăre – Marea Neagră (1949-1953)", *Analele Dobrogei. Serie Nouă*, 6/1 (2000), p.342-352.
[27] CATELL, D.T., *op. cit.*, p.384-385.
[28] "Danube Commission", *International Organization*, 4/3 (1950), p.542.
[29] CATELL, D.T., *op. cit.*, p.385-386.
[30] "Danube Commission", *International Organization*, 5/4 (1951), p.844-845; and 7/2 (1953), p.300-301.
[31] "Danube Commission", *International Organization*, 8/3 (1954), p.417.
[32] BĂDESCU, G., *op. cit.*, p.340-341.
[33] CATELL, D.T., *op. cit.*, p.389.
[34] For more details, see ANTON, M., "The End of Hegemony. The Joint Romanian – Soviet Commission and the Danube Question", *Romanian Naval Museum Yearbook*, 7 (2004), p.196-202.
[35] CATELL, D.T., *op. cit.*, p.392-393.
[36] For more details, see KASTORY, A., "L'Austriche et ses premières tentatives pendant la période de l'après – guerre (1955-1956) pour une adhésion à la Commission Danubienne (D'après les documents britanniques et français)", *Revue Roumain d'Histoire*, 44/1-4 (2005), p.279-292.

MAIN GOVERNING EQUATIONS FOR A SHIP INVOLVED IN A SOFT GROUNDING EVENT

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ABSTRACT

Ship structures cover a range of constructions varying from fast vessels built of front edge technology materials to very large commercial ships built according to traditional procedures and of conventional constructional steels. With collision, grounding and fire as accidental loads, it is clear that the field of Rational Design of Ship Structures for Accidental Loads could focus on highly varying topics. Many problems within the field of accidental loads in marine engineering are still unsolved and it is true that even if many resources are allocated to the field, it will take years, may be even decades, before the marine community can claim to have a fully rational design basis with respect to accidental loads. The purpose of the present paper is to contribute to the understanding of ship grounding events and thus to try to minimize the damages induced to the marine environment as a result of a grounding event.

Keywords: *ship, soft grounding, governing equations.*

1. INTRODUCTION

An overall view on groundings categorize the accidents in two major groups:

1. Grounding on soft sea beds, so-called *Soft Groundings*. The damage to the hull in terms of crushing at the point of ground contact is limited but the hull girder may fail in a global mode due to shear force and bending moment exceeding the hull girder capacity.
2. Grounding on hard bottoms, so-called *Hard Groundings*. The primary concern here is the local crushing and tearing of the ship bottom due to a cutting rock.

The work concerning grounding on soft sea bottoms includes the following main aspects:

- Identification of the governing grounding mechanics. The hull girder is modelled as a linear elastic beam and the loads considered are gravity, hydrostatic pressure, hydro- dynamic pressure and a ground reaction.
- Establishment of a model for the hydrodynamic loads which takes into account the generation of waves and shallow water effects.
- Establishment of a model for the ground response to the penetrating bow. Based on observations from laboratory experiments, the idea of this theoretical model is that the bow generates a flow of pore water in the soil. The pressure of the pore water on the bow becomes decisive for the soil reaction.
- Derivation of the governing equations for the hull girder based on the Timoshenko beam theory. The solution is found both by the finite element method and by a modal super-position approach and the results of the two approaches are shown to be equivalent.
- Investigation of the sectional forces compared to the strength of a ship in a grounding event on a soft sea bed. It is shown that the grounding-induced loads may well exceed the wave bending moment and shear force capacity of the hull girder. The effect of the hull flexibility is found to be important in a dynamic analysis because the flexible deformation of the hull girder unloads the grounding force and because the dynamic amplification of the sectional forces is significant for some grounding events. The effect of bow lift due to a receding tide is also investigated and it is shown that even a very smooth grounding event may lead to catastrophic failure if it is followed by a receding tide.

2. GOVERNING EQUATIONS

2.1 Generalities

When a ship runs aground on a soft seabed the principal energy absorbing mechanisms which stop the ship are normally:

1. Deformation of the sea bed.
2. Friction between sea bed and hull.
3. Change of potential energy of the ship and the surrounding water.
4. Deformation of the hull.
5. Hydrodynamic damping.

The solution method applied here for theoretical analysis of the soft-grounding problem is numerical integration of the equations of motion for the ship, i.e. time simulation.

Alternatively, an overall simplified approach based on the conservation of energy and momentum could be applied. Such an approach was presented by the specialty literature and it gives a good picture of the overall grounding mechanics.

However, to obtain detailed information about loads during the impact, it is necessary to resort to time simulation. The following sections describe the load modeling corresponding to the five effects listed above and the corresponding equations of motion.

Previous experimental and numerical studies focused on the rigid body motion of the ship. This is relevant in connection with the design of protective islands for bridges and for the prediction of the tug-load necessary to refloat the ship. The finite crushing strength of the bow could also be included but as a first approximation, it is assumed rigid. The flexible deformation of the hull girder has been determined from Timoshenko beam theory.

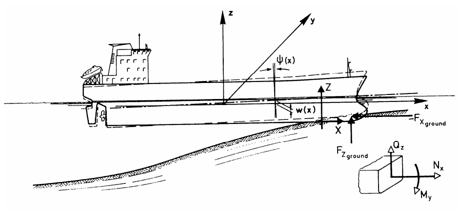

Figure 1 Coordinate systems (x; y; z) and (X; Y; Z) and definition of sectional forces.

It is assumed that both the centre of gravity of the structural and hydrodynamic mass per unit length and the bending neutral axis of the hull girder can be considered as a straight line. This line is the x - axis of a coordinate system fixed with respect to the ship and with origin amidships. The y - axis points towards the port side and the z - axis points upwards, see Figure 1.

A global coordinate system, (X; Y; Z), is fixed on the ground with origin at the point of the initial contact between bow and seabed.

Displacement and rotation in surge, heave and pitch in the (x; y; z) coordinate system is denoted (u; w; ψ). Sway and yaw is not considered. The basic idea is to calculate accelerations in the local coordinate system, transform these to the global system and perform time integration in the global system to get the time history of velocities and displacements.

2.2 Loads from Water and Gravity

Hydrostatic Loads - By combining the loads from the hydrostatic pressure with the gravity load on the structure in the so-called restoring load, modelling becomes simple. The ship is assumed to be in equilibrium in the initial configuration.

Then, when a section is lifted out of the water, it experiences a static downward load due to the difference between weight and buoyancy.

Since the weight is unchanged by lifting, the restoring force/moment is approximately given by the change of buoyancy alone. By assuming that the sides of the hull are parallel (vertical), the restoring load due to a static lift, w(x), of a hull section can be expressed as

$$q_{hs,z(x)} = -\rho_w g B(x) w(x) \qquad (1)$$

The assumption of vertical ship sides is good for large tankers with CB ≈ 0.85 but for the small fast vessels, Equation 1 will only hold true during the initial impact.

Hydrodynamic Loads, Added Mass and Damping - Since modeling of the hydrodynamic loads on a ship is of interest in several areas of marine engineering such as maneuverability, see-keeping and ship vibration, a substantial amount of literature has been published in this field. The characteristics for whole ships can be determined experimentally but since this is expensive and inconvenient at the design stage, many theoretical approaches have been attempted. The so-called 'strip-theory' is a convenient approach which takes advantage of the fact that ships are normally long and slender such that the overall flow pattern is two-dimensional. The ship is divided into a series of transverse sections ('strips') and each of these strips is considered separately assuming a two-dimensional flow. Determination of the two-dimensional flow is significantly less complex than the three-dimensional problem and several usable analytical solutions exist.

When an infinitely long cylinder is forced to move in an oscillating heave motion on the surface of a fluid it is subjected to hydrodynamic pressure loads. When the motion is harmonic with the frequency ω, the force working on a unit length of the cylinder can be expressed as

$$q_{hd,z}(\omega, t) = -a_z(\omega)\,\ddot{w}(t) - b_z(\omega)\,\dot{w}(t) \qquad (2)$$

where the coefficients $a_z(\omega)$ and $b_z(\omega)$ are denoted 'added mass' and 'damping'. The added mass is seen to be the part of the force which is in phase with the acceleration and the damping is the part in phase with the velocity. Equation 2 holds true for a harmonic motion with a well-defined frequency. In the general case of a transient motion the specialty literature says that the hydrodynamic load can be written

$$q_{hd,z}(x,t) = -\mu_2(x)\,\ddot{w}(x) - \int_0^t h_z \tau \left\{ \dot{w}(x, t-\tau) - \dot{w}(x, t-\tau=0) \right\} d\tau \qquad (3)$$

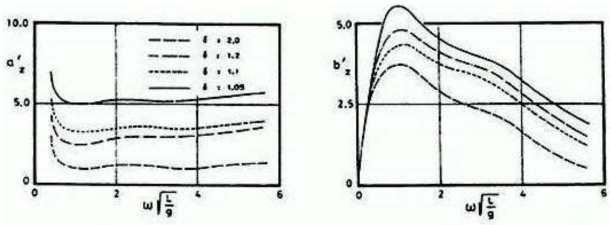

Figure 2 Experimental data for added mass and damping for a 310 m tanker (CB = 0.85) at restricted water depths. The non-dimensional quantities are defined as $a_z^{'} = a_z / \rho_W \nabla, b_z^{'} = b_z / (\rho_W \nabla \sqrt{g/L})$ and $\delta = h/T$.

where μ_z is the added mass at infinite frequency:

$$\mu_z(x) = \lim_{\omega \to \infty} a_z(x, \omega) \qquad (4)$$

and $h_z(x;t)$ is the unit response function:

$$h_z(x,t) = \frac{2}{\pi} \int_0^{\infty} b_z(x,\omega) \cos \omega t d\omega \qquad (5)$$

where $b_z(x;\omega)$ is the two-dimensional damping of the cross-section in heave at frequency ω. Since the damping thus comes as a weighted integral of the velocity history from the beginning of the motion, it is often denoted a 'memory effect' - contrary to the added mass, it is a function of the past. With Equation 3, the problem is now determination of the added mass and the damping coefficients, $a_z(\omega)$ and $b_z(\omega)$. As mentioned, several theoretical methods exist for unrestricted water depth but as groundings - by their very nature - occur at restricted water depths, this must be taken into account. Figure 2 shows results presented by the specialty literature, for added mass and damping in heave for a ship at different water depths.

It is seen that for a water depth to draught ratio of $\delta = h/T = 1{,}05$, the added mass is $a'_z \approx 5$, indicating an increase due to restricted water depth by a factor of approximately 5. Likewise, the effect of the restricted water depth on the damping is seen to be significant. The approach adopted here for calculation of the damping is to use strip theory together with the data of Figure 2. The graphs for b'_z shown in Figure 2 are transformed according to Equation 5, and the unit response function for a ship section with a given depth to draught ratio, δ, is then found by interpolation.

The added mass at infinite frequency is determined by a slightly more sophisticated approach. At infinite water depth, the added mass can be determined with good accuracy by use of the results of the specialty literature. By conformal mapping of the solution for potential flow around a cylinder, it has been found the added mass at infinite frequency to be given by

$$\mu_z = C_V \rho_w A_S \tag{6}$$

where A_S is the submerged cross sectional area of the considered section and C_V is defined from the draught to breadth ratio β and the sectional area coefficient C_S as:

$$C_V = \frac{(1+a_1)^2 + 3a_3^2}{1 - a_1^2 - 3a_3^2}$$

$$C = \left\{ \frac{3}{2}(1+\beta) - \sqrt{1/4(1+\beta)^2 + 2\beta(1 - 4C_S/\pi)} \right\}^{-1}$$

$$a_1 = C(1-\beta)$$

$$a_3 = C(1+\beta) - 1$$

$$\beta = 2T/B$$

$$C_S = A_S / BT$$

A semi-empirical expression for the modification of added mass due to restricted water depth was given by the specialty literature, as:

$$\frac{\mu_z(h,T,C_S)}{\mu_z(h=\infty,T,C_S)} = 1 + 2(C_S - 0,2)\left(\frac{T}{h}\right)^2 \tag{7}$$

The expression is based on experiments with $\delta = h/T$ exceeding 1.5 and it is seen to have a maximum of 2.6 when $\delta = C_S = 1$. Thus, it does not depict the behaviour shown in Figure 2 for very small bottom clearances. The idea here is to retain the functional dependence on the sectional geometry and find another function for the dependence on δ = draught=depth based on the results presented by the specialty literature. The final result for the modification of added mass at infinite frequency due to restricted water depth becomes

$$\frac{\mu_z(h,T,C_S)}{\mu_z(h=\infty)} = 1 + 0,54(C_S - 0,2)\left(\frac{2}{\delta - 1}\right)^{0,91} \tag{8}$$

To limit the added mass at the point of contact (δ = 0) in Equation 8 it is necessary to take into account the three-dimensional flow near the ends of the ship. Based on the results of the specialty literature, the maximum value of the correction factor, Equation 8, is here assumed to be 6.0. As this large added mass only occurs in a very limited area around the point of contact, the final results are not sensitive to this assumption so its validity will not be discussed in further detail.

3. GROUND REACTION

The greatest challenge of developing a theoretical model for grounding on soft sea beds is establishing a model for calculation of the soil reaction. As the soil reaction induces the hull girder loads and eventually causes the ship to stop, it is of paramount importance to have a good model for the response of the ground to the penetrating bow.

In the analysis presented by the specialty literature, the bow was assumed to move in the plane of the undisturbed slope and an efficient coefficient of friction was adopted. To obtain a good correspondence between theory and model tests, an effective coefficient for the bow/soil interaction equal to μ = 0.78 was assumed. The coefficient of friction between steel and sand is typically 0.3 - 0.4 so this effective coefficient of friction includes the normal pressure on the bow which must thus be quite significant. In the present analysis it is necessary to have a more sophisticated model for the soil behavior so that it can be applied to a time simulation scheme.

The stopping force acting on a beaching ship is the result of ruptures in the soil in the areas of contact between bow and soil. The mechanics of this rupture is complicated, which is illustrated by an example where a ship with a cylinder bow with vertical sides is rammed horizontally into a slope of sand of 1:6, see Figure 3. The bow is semi-circular in shape with a radius of r = 378 mm and it has a at bottom. The sand is very uniform in gradation with a mean diameter of d_m = 0:125 mm, permeability coefficient k = 9 · 10^{-5} m/s and frictional angle φ = 39°. The ship is forced with a constant velocity and it is locked in the horizontal position so that it cannot heave or pitch. Figure 3 shows the horizontal and vertical soil reactions for different impact velocities as functions of the horizontal position for both dry and submerged slopes.

It is noted that the force in the submerged case is 10 - 20 times greater than for the corresponding dry case. Figure 3 also shows that the reaction is clearly a function of impact velocity. It could be claimed that the dependence on impact velocity is due to the change in momentum of the soil being pushed by the bow but since no dependency is seen on impact velocity for the dry sand is observed, this cannot be the case. The results are important because they show that in a grounding event on a sand beach, the behavior of the soil is strongly influenced by the pressure of the fluid present in the pores of the material.

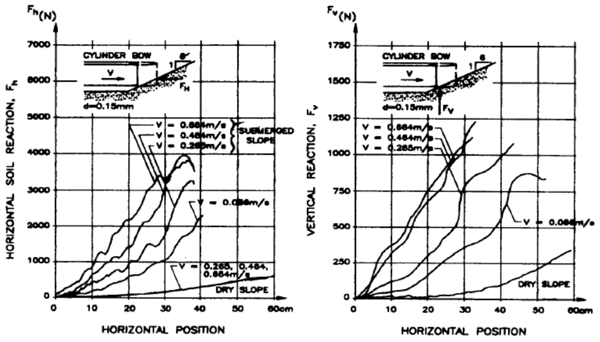

Figure 3 Soil reactions on a penetrating bow. Dry and submerged slopes, different velocities

In classical soil rupture theory, conditions are assumed to be either drained or un-drained. If conditions are drained an incremental load increase on a soil element is carried solely by additional stresses in the grain skeleton ('effective stresses'), and if conditions are un-drained an additional load is carried by an additional pressure in the pore fluid alone. Both drained and un-drained conditions are considered independent of the time history of the load - in this case of the impact velocity. According to Figure 3, which shows a clear dependence on impact velocity, neither of the two theories would therefore be suited for modeling of ship grounding events. The consolidation theory is a theory which includes the time variance of loads and deformations. The specialty literature presented a general set of equations governing the behavior of a saturated linear elastic porous solid under dynamic conditions. For standard geotechnical consolidation problems, however, the grain skeleton is most often assumed to be linear-elastic and inertia forces neglected. Obviously, these restrictions do not apply to grounding problems where strains are far beyond the elastic limit. The equations can be generalized to non-linear material behavior if the constitutive relation is written incrementally. A fully consistent theoretical analysis of a ship grounding event would require numerical solution of these equations, for example by use of the finite element method. The solution would include phenomena like elastic compression, rupture with very large strains, liquefaction, dilatation of the soil in rupture and flow of pore water. Use of such a model for grounding simulations would require extensive computer facilities and would be prohibitively time consuming. Therefore, the soil mechanics model used here has been based on very substantial simplifications and it is to some extent phenomenological.

The pore-water creates strong effective stresses in the soil which act on the hull both as normal and tangential stresses. The question is how these large effective stresses are generated. Two mechanisms seem possible:

1. At the rupture, the sand dilates and thus creates a large suction in the pore water in the rupture zones. This suction results in a corresponding increase in the effective stresses. This phenomenon can be observed in an un-drained tri-axial test.

2. During impact, the grain skeleton is compressed and pore water is squeezed out in the compression zone creating an additional pore water flow. This pore water builds up large effective stresses in areas of the grain skeleton. In other areas liquefied zones are formed.

4. CONCLUSIONS

Over the past decades there has been a continuous increase in the public concern about general risk issues. Many of the past improvements in safety of marine structure have been triggered by disasters but there is a change in this trend. The maritime society is beginning, albeit slowly, to think and work in terms of safety assessment of individual ships instead of the much generalized prescriptive regulations, which have evolved over the past 150 years.

In line of these aspects, it is clear that rational procedures for evaluating the consequences of accidental loads are highly desirable, not to say necessary. A fundamental problem with rational consideration of grounding and collision in rules is that there are no simple measures of a ships defense against these loads. An idea would be to consider the statistical correlation between major design changes and the amount of oil spilled but the amount of oil spilled seems to be a random process. Within a reasonable time span this makes it impossible to draw cause and effect conclusions from statistics alone and attempts of doing so would most likely be highly reactionary with questionable effectiveness.

5. REFERENCES

[1] BARSAN, E., MUNTEAN, C., *Combined Complex Maritime Simulation Scenarios for Reducing Maritime Accidents Caused by Human Error*, Proceedings of the WSEAS 3rd International Conference on Maritime and Naval Science and Engineering, Constanta, Romania, 2010.

[2] PEDERSEN, P.T., *Collision and Grounding Mechanics*, pages 125-158. Danish Society of Naval Architecture, Copenhagen, May 1995.

[3] VARSAMI, A., POPESCU, C., DUMITRACHE, C., HANZU, R., CHIRCOR, M., ACOMI, N., *The Influence of Grounding Events on Maritime Industry*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, volume 22, no. 1, Viena, Austria, 2011.

THE DEVELOPEMENT OF FORUM NON CONVENIENSAND LIS ALIBI PENDENS' DOCTRINES IN THE INTERNATIONAL MARITIME LAW

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ABSTRACT

Forum non conveniens doctrine, referred by prominent authors as the choice of foreign jurisdiction by a court, is generally considered as a constructive development in the jurisdictional system of the English courts. *Lis alibi pendens* is referred to as a case where a legal action concerning the same parties and the same matter is adjudicated simultaneously in two diverse jurisdictions. The authors of this study, take the view that a significant relationship seems to exist between *forum non conveniens* and *lis alibi pendens,* since the later is considered a supplementary factor relevant to the determination of the natural forum in *forum non conveniens* cases; both doctrines operate basically under the same legal principles and; they are in search of the same objective i.e. to render better justice in legal disputes, particularly in maritime disputes considering the international nature that this domain reflects. Despite the negative opinions surrounding the doctrine, *forum non conveniens* is regarded as an improvement in the rule of jurisdiction since it assists the litigants to consider advantages of diverse legal systems and to be adjudicated according to 'the most appropriate forum'; promoting thus better fairness and justice in the dispute resolution in maritime affairs.

Keywords: *Maritime law, international law, forum non conveniens, lis alibi pendens, legal disputes, maritime disputes, natural forum, law of the sea, English maritime law.*

1. INTRODUCTION

Conflict of laws or private trans-national law is a significant discipline dealing with legal actions involving a foreign element[1].The principal purpose of conflict of laws "is to resolve trans-jurisdictional disputes by reference to the laws of all jurisdictions involved"[2]. Important functions within this discipline play the doctrines of *forum non conveniens* and *lis alibi pendens* Although the genesis of these doctrines is relatively old, their effective application in the common law, as well as to some extend in the civil law system, has received wider acceptance only in the last 30-40 years.

These doctrines are regarded as constructive approaches towards the clarification of incongruity issues in the conflict of laws[3], since their implementation in the judiciary system assists the courts to prevent injustice in legal disputes, allowing thus the litigants to be adjudicated according to the 'most appropriate forum' principle[4]. Consequently, by providing better fairness and justice in the resolution of legal cases, the application of these doctrines appears to be a positive step towards the development of the jurisdiction system.

Several notable scholars, such as William Tetley in its prominent study *International Conflict of Laws*, Dicey and Morris in *Conflict of Laws*, and Cheshire and North in *Private International Law*, have shed light towards a comprehensive analysis of these important doctrines. Nevertheless, recent developments in the international and domestic legal domain necessitate the requirement for further research concerning the relevance and application of these doctrines.

In this respect, the purpose of this paper is to analyse the interrelationship among the aforesaid doctrines by seeking to answer questions such as: What are the main features of these doctrines? What is their contribution towards the legal dispute resolution? What are the positive and negative points of the doctrines? Most importantly, is there any relationship among them? In light of these considerations, this paper will first contain a discussion regarding the evolution and the fundamental principles of *forum non conveniens;* secondly, the doctrine of *lis alibi pendens* viewed from the *forum non conveniens* perspective will be analysed*;* finally a comprehensive examination will be attempted towards the relationship among *forum non convenience* and *lis alibi pendens* with the focal point on the later.

2. EVOLUTION OF THE *FORUM NON CONVENIENS* DOCTRINE

The roots of the doctrine of *forum non conveniens* are found back in the nineteenth century from the deliberations of the Scottish Courts[5]. The principle behind the *forum non conveniens* doctrine was that the court, after taken into account the interests of the litigants and the requirement of justice, may refuse to exercise jurisdiction based on the position that some other forum rather than the Scottish court is more appropriate for the case to be adjudicated[6].

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[1] Albert Venn Dicey, *Dicey and Morris on the Conflict of Laws*, 13th ed. (London: Sweet and Maxwell, 2000), at 3.

[2] Proshanto K Mukherjee, The Law of Maritime Liens and Conflict of Laws, *JIML 9* (2003)6, at p.546

[3] William Tetley, *International Conflict of Laws: Common, Civil and Maritime* (Montreal, Quebec: International Shipping Publications, 1994), at 43.

[5] Dicey, *Dicey and Morris on the Conflict of Laws*, at 389.

Although the doctrine of *forum non conveniens* was comprehensively evolved in U.S.A[7], its role there is described as a parallel development, and to some extent is diverse from the Scottish doctrine[8]. Moreover, it seems that the progress of the Scottish-English *forum non conveniens* approach was not directly influenced by the parallel development of this doctrine applied by the U.S authorities[9] whereby aside from the private interests of litigants, the public interests of the State must be considered in order for the court to stay an action[10].

In England, the application of the *forum non conveniens* was restricted until *The Atlantic Star* case, wherein the House of Lords perspective regarding this matter eventually changed[11]. Notwithstanding that *forum non conveniens* was somehow taken into account in both *The Atlantic Star,* and later in the *McShannon v. Rockware Glass Ltd* case, the House of Lords refused to accept the doctrine as part of the English Law[12]. Nonetheless, it must be underlined that during that period of time the doctrine has been a significant element in the exercise of judgment by the English courts to serve out of their jurisdiction (under Rule 27), but until *The Abedin Daver* case the courts refused to accept that the jurisdiction to stay action based on *forum non conveniens* would initiated against defendants who were sued in England[13].

In light of these considerations, it appears that the application of the *forum non conveniens* doctrine in England has been vague for a certain time period after *The Atlantic Star,* due to the incompatibility mainly caused by the implementation of this new philosophy within an existing old legal system[14] .Moreover, in the opinion of this writer, the evolution and the application of the doctrine seemed to have been controversial during these time period based on the grounds that different viewpoints regarding the "interpretation"[15], definition, concept and application of *forum non conveniens* doctrine prevailed among English Lords[16].

The doctrine of *forum non conveniens* was finally accepted in the *Abedin Daver* case. Lord Diplock noted in this respect that " the judicial chauvinism has been replaced by judicial comity to an extend which I think the time is now right to acknowledge frankly it is, in the field of law with which this appeal is concerned, indistinguishable from the Scottish legal doctrine of *forum non conveniens*"[17]. The English law position on the doctrine of *forum non conveniens* was however, clarified and summarized in the prominent case on 'stays of actions' i.e. in the *Spiliada* case, whereby the House of Lords approved the judgment of the *Abedin Daver* deliberations regarding the *forum non conveniens* doctrine[18]. In this respect, the fundamental theory of the doctrine was that "a stay will only be granted on the ground of *forum non conveniens* when the court is satisfied that there is some other available forum, having competent jurisdiction, and which is suitable forum for the trial of this action"[19].

The main draughtsman of the developed law of *forum non conveniens* is considered Lord Goff of Chieveley, who portrayed the doctrine as the most civilised of legal values[20]. It was in the *Spiliada* case that Lord Goff proposed the general principles regarding the application of the doctrine of *forum non conveniens*[21], and later on in the *Connelly v. RTZ Corpn plc* case he confirmed and further clarified these principles before the House of Lords[22]. In light of these events, it appears that in the later case the doctrine of *forum non conveniens* was legally consolidated and begun to serve effectively in the adjudication of subsequent cases by English courts.

The adoption of the *forum non conveniens* doctrine by the House of Lords is considered a valuable contribution towards the common law jurisdictional philosophy[23]. What is significant in this doctrine is that a court which has jurisdiction over a case, may decline to exercise it, based on the judgment that another court of a different state which may be the natural court, can render superior justice under the particular circumstances[24].

After the *Spiliada case*, several common law States such as Canada, New Zeeland, Singapore, India, Ireland and Australia embraced the doctrine of *forum non conveniens*[25]. In Australia, the doctrine's approach is considered vague, and the decisions of the courts are criticized due to the application of *vexation or oppression* requirement for the grant of a stay, where the real meaning of it, yet, is unclear among the Australian judges[26]. Also, similarly to civil law judicial system,

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[7] David McClean, *Morris: The Conflict of Laws* (London: Sweet & Maxwell Ltd, 2000), at 117-18.
[8] See *Bank of Tokyo Ltd v. Karoon* (1987)1 A.C. 45N, 61 (C.A.)
[9] Dicey, *Dicey and Morris on the Conflict of Laws*, at 390.
[10] McClean, *Morris: The Conflict of Laws*, at 117-18.
[11] See *The Atlantic Star* (1974) A.C. 436
[12] Dicey, *Dicey and Morris on the Conflict of Laws*, at 390.
[14] David W. Robertson, *Forum Non Conveniens in America and England: A Rather Fantastic Fiction* (103 L.Q.R 398, 1987), at 411.
[15] See the judgments of Lord Salmon in the *McShannon v. Rockware Glass Ltd* (1978) A.C. 795 at 819
[16] See the judgments of Lord Wilberforce, Lord Kilbrandon and Lord Reid in *The Atlantic Star* (1974) A.C. at 467- 469 and 477- 478
[17] Dicey, *Dicey and Morris on the Conflict of Laws*, at 390.
[18] See *Spiliada Maritime Corp. v. Cansulex Ltd* (1987) A.C. 460
[19] Dicey, *Dicey and Morris on the Conflict of Laws*, at 390.
[20] Adrian Briggs, *The Conflict of Laws* (Oxford: Oxford University Press, 2002), at 95.
[21] See *Spiliada Maritime Corp. v. Cansulex Ltd* (1987) A.C. 460
[22] Peter North, *Cheshire and North's Private International Law*, 13th ed. (London: Butterworths, 1999), at 336.
[23] Briggs, *The Conflict of Laws,* at 94.
[24] Tetley, *International Conflict of Laws: Common, Civil and Maritime*, at 799.
[25] North, *Cheshire and North's Private International Law*, at 335.
[26] Ibid.

when to Australian courts is given the jurisdiction, it requires comprehensible and compelling grounds before refusing to exercise it based on *forum non conveniens* doctrine; focusing thus on the suitability of their court when considering a action rather than making a comparative legal analysis with the other foreign forum[27]. These essential factors indicate that the Australian judge has the duty to exercise the jurisdiction vested on him, which subsequently will prevent him to circumvent the statutory legislation in the *forum non conveniens* cases[28]. Accordingly, it is submitted that, the principles of the two incompatible legal systems which are embraced by the Australian courts may create ambiguity and obscure the dispute resolution in *forum non conveniens* cases. This issue is more relevant taking into account that *forum non conveniens* doctrine is generally inapplicable and not accepted by the civil law lawyers and their respective countries[29] whose courts are forbidden by national constitution to give up jurisdiction[30].

3. FUNDAMENTAL PRINCIPLES OF *FORUM NON CONVENIENS*

The *forum non conveniens* doctrine is generally considered as a constructive development in the jurisdictional system of the English courts[31]. Tetley, in this respect, is referring to the *forum non conveniens* as a "choice of foreign jurisdiction by a court", and giving its significance proposes that the doctrine should be a suitable alternative in civil law countries as well[32]. The *forum non conveniens,* thus, appears to be a useful legal instrument whereby the courts may establish equality in dispute resolutions.

The Commercial Court and the Admiralty Court[33] are normally the forums where the most stay application cases, as well as the maritime disputes are adjudicated. From the maritime and shipping viewpoint, the *forum non conveniens* doctrine is mainly applied in collision cases[34]. Normally, *forum non conveniens* cases involve rival jurisdictions in which a stay will be approved only if the foreign court is the natural or suitable forum. Nonetheless, there will be residual category of cases in which English proceedings will be stayed even though England is the natural forum, though these cases will be exceptional and the burden on the defendant to establish injustice will be a heavy one[35].

The key principle which summarizes the entire basis of the *forum non conveniens* judgment as described by the House of Lords, is that a stay will only be approved when the court is contented that there is another available forum, having competent jurisdiction, which is the appropriate forum for trial of the action, i.e. wherein the action may be tried more rightfully for the interests of all parties and for the ends of justice[36].

According to Lord Goff the application of *forum non conveniens* requires the fulfilment of several conditions before becoming effective[37]: 1- Normally, the legal burden of proof rests on the defendant to convince the court to exercise its judgment to grant a stay. 2- If the first condition is *prima facie* satisfied, the burden will shift to the claimant to prove that under the particular circumstances by reasons of which justice requires, the trial should however adjudicated in England. 3- The defendant should establish in court that there is another forum which is clearly more appropriate than the English forum, rather than proving that the English court is not the suitable one.

The most crucial elements affecting the court's decisions regarding the application of the *forum non conveniens* in a dispute resolution are the principles of 'availability', and 'appropriateness' or the 'natural forum'. With regard to availability, the foreign forum must be open to the claimant at the time of the application for a stay, and must be the one in which the claimant has the right in practice to bring his claim[38]. This is best illustrated in *Mohammed v. Bank of Kuwait and the Middle East KSC* case wherein Evans LJ noted that availability means "available in practice to this plaintiff to have a dispute resolution", and that whether substantial justice is expected to be achieved in this case[39]. However, it appears that the term availability in the legal context sometimes may generate ambiguity, since in practice it is difficult to recognize 'what substantial justice means' due to the different perception that many jurisdictions around the world have regarding this issue.

The other important element affecting the implementation of *forum non conveniens* is the fulfilment of the 'appropriateness' condition or as otherwise noted the 'natural forum'. In this respect, it appears that the natural forum principle has originated from the *MacShanon case* and is referred by Lord Keith as the State with which the action has the most real and substantial connection[40].The court before granting a stay of proceedings will normally take into account which is the natural forum for the particular dispute[41]. In the *MacShanon* case the court examined the connection factors affecting convenience or expenses for the parties,

[27] Briggs, *The Conflict of Laws*, at 94.
[29] Kennet Wendy, *Forum Non Conveniens in Europe* (C.L.J. 552, 1995), at 555.
[30] Tetley, *International Conflict of Laws: Common, Civil and Maritime*, at 798.
[31] Wendy, *Forum Non Conveniens in Europe*, at 555.
[32] Tetley, *International Conflict of Laws: Common, Civil and Maritime*, at 798-800.
[33] N.J.J Gaskell O.C Giles, C. Debatista & R.J Swatton, , *Chorley and Giles Shipping Law,* 8th ed. (London: Financial Times Pitman Publishing, 2003), at 11.
[34] Proshanto K. Mukherjee, *Conflict of Laws Unpublished Lecture*, WMU, 2008
[35] Dicey, *Dicey and Morris on the Conflict of Laws*, at 391.
[36] North, *Cheshire and North's Private International Law*, at 336.
[37] Dicey, *Dicey and Morris on the Conflict of Laws*, at 395.
[38] Ibid., at 397.
[39] North, *Cheshire and North's Private International Law*, at 336-37.
[40] Ibid., at 338-39.
[41] Dicey, *Dicey and Morris on the Conflict of Laws*, at 396.

the laws governing the particular case, and primarily the domicile or the State where the parties respectively live or carry on business[42]. The House of Lords in this case held that since the dispute involved all Scotsman who were living and working in Scotland, the injuries were suffered in Scotland, and all the witnesses lived in Scotland, consequently the appropriate or natural forum for trial was in Scotland [43].Other determinant factors concerning the natural forum principle may include: the forum under consideration should have jurisdiction *per se*; the existence or lack of jurisdiction or arbitration clauses in contracts; the lack of independence in the foreign court; the incompetence or inexperience of the other forum; and the law surrounding the claim should be of the other forum and must be superiorly presented and considered there[44].

In light of these considerations, when the defendant satisfies the court that another forum is clearly *prima facie* more appropriate than the English court for the trial of the action, a stay will commonly be ordered[45], unless the claimant can establish that he will be deprived of genuine justice by the foreign forum[46]. In determining whether justice requires that a stay should not be approved, all circumstances of the case will be taken into account by the court, which will consider facts such as the autonomy of the judiciary abroad[47], the potential rejection of the claimant's action by the other forum, and the inordinate delay of the order of magnitude of ten years before an action comes to trial, which is normally considered as a denial of justice[48]. In general, there are considerations that a stay may not be declined merely because the claimant will thereby be deprived of a "legitimate personal or juridical advantage"[49], because as commonly speaking "the plaintiff will have to take that forum as he finds it, even if it is in certain respects less advantageous to him than the English forum, and in this regard not all the advantages can be considered when exercising the *forum non conveniens* doctrine"[50].

Nevertheless, in absence of another natural forum for the trial of the action, the court will ordinary refuse a stay, such as in the *European Asian Bank* case, wherein the Court of Appeal rejected a stay of proceedings since neither India nor Singapore was considered clearly more suitable for trial of the action than England[51]. Normally, in these sorts of cases the legal system of the courts in question may be substantially different and complicated, and consequently the English courts will either appoint another suitable forum such as in the *Banco Atlantico S.A.* case,[52] or will reject a stay in proceedings. It is relevant to note that when an action arises out of a collision on the high seas it appears that there may be no natural forum for trial and a stay of proceedings will normally be refused by the court[53], as it is also in cases when the court is likely to recognize the natural forum and this is England[54]. Furthermore, where a claim form has been served out of the jurisdiction under Order 11 of the Supreme Court Rules, the stays in proceedings are usually declined[55].

A substantial factor against a stay of the proceedings exists when parties in a dispute have agreed that the law governing the contract is English law, such as in the *Kuwait Oil Co(KSC)* case[56] ; but when there is an agreement by the parties to trial in a foreign country, and this is predetermined in the choice of jurisdiction article in their contract, than there is a strong evidence that the suitable forum is abroad and the substantial factor is in favour of a stay of the English proceedings being established under the *forum non conveniens*[57].

There are different viewpoints among scholars as regards to the application of *forum non conveniens* doctrine. On the one hand, there are negative opinions arguing that the doctrine allows parties to take legal action in relation to where to litigate, and that is undesirable when what they ought to be doing is to dedicate their sources towards the core claim[58]. In addition, it has been argued that when an English court stays its proceedings in favour of another court, and subsequently, the second one refuses jurisdiction, than this situation may bring controversy and problems to dispute resolution[59]. Also, there is an allegation by civil lawyers that the doctrine can lead to arbitrary decisions, and moreover, may not provide certainty and predictability[60]. On the other hand, there are notable scholars which highlight that *forum non conveniens* doctrine "is a final possible step in the methodology through which the problems of incongruities can be clarified"[61].

In the opinion of this writer, the procedures of *forum non conveniens* may be occasionally time consuming due to the additional procedures emanated from the 'choice of forums' dispute, may inflict additional costs, and can complicate sometimes the legal practice when the legislations of the States involved in the case,

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42 See *Rockware Glass Ltd v. MacShanon* (1978) AC 795

44 Tetley, *International Conflict of Laws: Common, Civil and Maritime*, at 801-02.

45 Briggs, *The Conflict of Laws*, at 94.

46 O.C Giles, *Chorley and Giles Shipping Law*, at 12.

47 See *The Abedin Daver* (1984) AC 398 at 411

48 See *Vishva Abha (1990)* 2 Lloyd's Rep 558 at 560

49 Dicey, *Dicey and Morris on the Conflict of Laws*, at 396.

50 North, *Cheshire and North's Private International Law*, at 342.

51 See *European Asian Bank A.G. v. Punjab and Sind Bank* (1982) 2 Lloyd's Rep. 356 (C.A.)

52 Dicey, *Dicey and Morris on the Conflict of Laws*, at 398.

53 See *Vishva Abha (1990)* 2 Lloyd's Rep 312 at 314

54 See *OTM Ltd v. Hydronautics* (1981) 2 Lloyd's Rep 211

55 North, *Cheshire and North's Private International Law*, at 341.

56 See *Kuwait Oil Co (KSC) v. Idemitsu Tankers KK, The Hida Maru* (1981) 2 Lloyd's Rep 510 at 514

57 See *Trendtex Trading Corpn v Credit Suisse* (1980) 3 ALL ER 721 at 737

58 Briggs, *The Conflict of Laws*, at 95.

59 J.P Kropholler, *Handbuch des Internationalen Zilverfahrensrechst* (Tubingen 1882) vol.I, ch.III, p. 282

61 Tetley, *International Conflict of Laws: Common, Civil and Maritime*, at 43.

particularly in parallel proceedings, are incompatible. Nonetheless, the doctrine of *forum non conveniens* doctrine, generally, appears to be a valuable and an effective instrument for the ends of justice, since it assists the litigants to consider advantages of diverse jurisdictions; it provides a comprehensive and flexible legal practice consistent with contemporary developments in the private law domain; and primarily because renders better fairness and justice in dispute resolutions. In addition, the doctrine validates itself as a kind of alternative dispute determination, wherein the assessment of respective jurisdictions may permit the litigants to measure the strength of the other's case"[62]. Therefore, in this respect, the doctrine of *forum non conveniens* may be regarded as an improvement in the rule of jurisdiction[63].

4. LIS ALIBI PENDENS VS. FORUM NON CONVENIEN*S*

Lis alibi pendens is referred to as a case where a legal action concerning the same parties and the same matter is adjudicated simultaneously in two diverse jurisdictions[64]. In this regard, the question before the English courts is not basically to determine which of the alternative forums the claimant must sue; but the decisions of the court are based on the considerations whether a stay is declined, or a stay is granted. In the former, the court may allow the parties to have trial in England as well as trial abroad; and in the later case, the parties may be allowed by the court to have the trial abroad[65].

The *lis alibi pendens* regulatory provisions may be found in the 1968 Brussels Convention and 1988 Lugano Convention. In this respect, the Articles 21 to 23 of the Brussels Convention contain the most relevant provisions regarding the concurrent actions pending in different Contracting States between the same parties and involving the same legal action[66]. The principles of these Conventions are incorporated into English Law by the Civil Jurisdiction and Judgment Act 1982, which stipulates that the courts may apply the *forum non conveniens* doctrine, providing, is not contradictory with the main philosophy of the Conventions[67].

The legal practice of the English courts has shown that the interrelated applicability of both doctrines based on the principles of the Conventions, appears to be effective in England and among the Contracting States[68]. However, issues may arise regarding the application of *forum non convenience* within the framework of *lis alibi pendens* principles contained in the Conventions when a defendant resident in Contracting State may claim a stay on the ground that a court in a non-Contracting State is the suitable forum[69]. Another difficulty may arise when the court has jurisdiction over the defendant, but the legal action has a real connection with a non-Contracting State (action *in rem* in this State), were it would deprive the court of its jurisdiction[70].Albeit the above-mentioned issues, it appears that the core principles of the 1968 Brussels Convention and Lugano Convention may allow the application of *forum non conveniens* within the *lis alibi pendens* doctrine, which may indicate as a result a substantial relationship between two doctrines.

The doctrine of *lis alibi pendens* appears to share similar principles and legal values with *forum non conveniens* doctrine. Notwithstanding the consideration that there are specific factors prevailing in cases of *lis alibi pendens*, it seems that its existence is just a supplementary factor relevant to the determination of the natural forum in *forum non conveniens* cases[71]. In the *Abedin Daver* case Lord Diplock noted that, when legal actions were pending in a foreign forum between parties, then concurrent proceedings in two diverse jurisdiction could only be justified if the potential plaintiff in England could establish objectively by rational evidence that there was some 'personal or juridical advantage' that would be available to him only in England and which was of such significance that it would cause unfairness to deprive him[72]. Tetley also notes that when there is a litigation on the same issue between the same parties in another jurisdiction i.e. *lis alibi pendens*, the national court in its judgment will typically stay the proceedings based on *forum non conveniens*, but on the condition that the plaintiff keenly follow its suit in the other jurisdiction[73], which is the more appropriate forum for him. Similarly, Lowe comments that the doctrine of *lis alibi pendens* indicates that if a significant identical case is already pending before a competent tribunal, a second forum may reject to exercise its own jurisdiction[74]. All these indications are leading towards the theory that the doctrine of *lis alibi pendens* through the application of the 'natural forum' principle may assist the judges to apply the doctrine of *forum non conveniens.*

Furthermore, when considering the connection between the two doctrines, of a great significance is the analysis of the conditions under which both doctrines can become effective. As it was noted, under the doctrine of *forum non conveniens* the denial of a stay in English proceedings will usually lead to a *lis alibi pendens* situation and vice-versa. In this regard, the architect of the *forum non conveniens* doctrine Lord Goff did not explain how the new reaffirmed principles or conditions of *forum non conveniens* would operate in

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[62] Briggs, *The Conflict of Laws*, at 95.
[63] Wendy, *Forum Non Conveniens in Europe*, at 555.
[64] North, *Cheshire and North's Private International Law*, at 347.
[66] ***C****onvention on jurisdiction and the enforcement of judgments in civil and commercial matters*, Brussels, Articles 21, 22, 23, 1968
[67] Dicey, *Dicey and Morris on the Conflict of Laws*, at 391.
[68] Ibid., at 392-93.
[69] See *Re Harrods (Buenos Aires) Ltd* (1992) Ch. 72 (C.A.)
[70] Dicey, *Dicey and Morris on the Conflict of Laws*, at 394.
[72] See *The Abedin Daver* (1984) AC 398 at 411-412
[73] Tetley, *International Conflict of Laws: Common, Civil and Maritime*, at 796.
[74] Joost Pauwelyn, *Conflict of Norms in Public International Law* (Cambridge: Cambridge University Press, 2003), citation of Lowe at 115-16.

cases involving *lis alibi pendens*[75] . Nevertheless, mainly from the legal practices of the English courts, it appears that the same conditions applied in *forum non conveniens* (natural forum and availability requirements) are relevant also in the proceedings pending in the alternative forum i.e. *lis alibi pendens*[76]. Dicey notes in this regard that the conditions enunciated in *Spiliada* case and later confirmed in the *de Dampierre* case are applying now whether or not there are other proceedings already pending in the alternative forum[77].

The most notable case wherein the *lis alibi pendens* approach can be best illustrated is the *Cleveland Museum of Art* case. The interrelationship between the doctrines of *forum non conveniens* and *lis alibi pendens* in this particular case appeared to be significant. This dispute involved parallel proceedings in Ohio and England between the same parties for the same legal action. In this case Hirst J applied the same *forum non conveniens* principles from the *Spiliada case* by investigating the detrimental outcomes of concurrent proceedings in terms of the factors such as possibility of conflicting judgment, and the inconvenience and expenses to the parties, reaching ultimately to the conclusion that the Ohio forum was obviously the most suitable forum for trial of the action, and subsequently a stay of English proceedings was granted[78]. As a result, the deliberation of the case reveals a comprehensive relationship between *lis alibi pendens* and *forum non conveniens* doctrine i.e. from *lis alibi pendens* situation the court based on the same principles applied *forum non conveniens*.

With regard to *lis alibi pendens* proceedings is important to note that when an action is commenced abroad to avoid being time-barred, as well as there is a lack of substantial progress made in the foreign proceedings the court will normally refuse the *lis alibi pendens*[79]. In contrast, if genuine proceedings have developed abroad to the stage where they have some impact upon the dispute[80], as well as when the claimant has no rights to bring the entire of his claim before one forum, then parallel proceedings may be considered as rational, and the claimant should not be required to choose[81].

Notwithstanding the similarities and the possible interrelationship between the afore-mentioned doctrines, it appears that *lis alibi pendens* is characterized by some negative points. First, in contrast to *forum non conveniens*, the *lis alibi pendens* doctrine is more criticized by legal scholars because it promotes a court racing[82], such as the inappropriate race and estoppels issues in *Abedin Daver* case; and secondly, the application of *lis alibi pendens* may involve more expenses and inconvenience to the parties[83]. The opposition to *lis alibi pendens* is even stronger if a negative declaration[84] is involved in one of the courts[85]. Another substantial deficiency by the doctrine is that *lis alibi pendens* rules are considered inflexible because they may provide precedence to the forum initially seized without accepting the possibility of choice between diverse jurisdictions offered by the *forum non conveniens* philosophy[86]. Consequently, in light of these considerations, it appears that the English courts and its lawyers favour the application of the well established *forum non conveniens* doctrine[87], which after the *Spiliada* case has replaced in England the old doctrine of *lis alibi pendens*[88] criticised for its deficiencies.

5. CONCLUSIONS

As a result, after a certain time period of ambiguity and uncertainty in the English courts, the doctrine of *forum non conveniens* was finally accepted by the English judicial system in the *Abedin Daver* case and subsequently in *Spiliada* case, wherein its main principles were laid down and summarized effectively by the House of Lords. Whereas many common law jurisdictions have adopted effectively the doctrine, the Australian approach appears to be ambiguous due to the integration of civil law principles within its practice, which in turn may obscure the application of the *forum non conveniens* doctrine.

Notwithstanding the negative opinions surrounding the doctrine that its procedures may be time consuming; may lead to arbitrary decisions; and can sometimes complicate the legal practice, the doctrine of *forum non conveniens* is regarded as an improvement in the rule of jurisdiction since it assists the litigants to consider advantages of diverse legal systems and to be adjudicated according to 'the most appropriate forum'; promoting thus better fairness and justice in the dispute resolution. Therefore, the doctrine appears to be a valuable, effective and well established principle, particularly, in common law jurisdictions.

In addition, this paper revealed that a significant relationship seems to exist between *forum non conveniens* and *lis alibi pendens* since the later is considered a supplementary factor relevant to the determination of the natural forum in *forum non conveniens* cases; both doctrines operate basically under the same legal principles and; they are in search of the same objective i.e. to render better justice in legal disputes. Moreover, *forum non conveniens* may be

[75] North, *Cheshire and North's Private International Law*, at 348.
[76] See *De Dampierre v De Dampierre* (1988) AC 92, 1987 2 ALL ER 1
[77] Dicey, *Dicey and Morris on the Conflict of Laws*, at 401.
[78] See *Cleveland Museum of Art v Capricorn Art International SA* (1990) 2 Lloyd's Rep 166
[79] North, *Cheshire and North's Private International Law*, at 349.
[80] See *Henry v Henry* case (1995) 185 CLR 571
[81] Dicey, *Dicey and Morris on the Conflict of Laws*, at 401.

[82] Marco Pistis, *Forum non conveniens,* at 4-5
[83] North, *Cheshire and North's Private International Law*, at 347.
[85] North, *Cheshire and North's Private International Law*, at 347.
[86] Marco Pistis, *Forum non conveniens*, at 10
[87] Ibid., at 3

applied within the framework of *lis alibi pendens* principles stipulated in Brussels and Lugano Conventions. Nonetheless, *lis alibi pendens* may promote court racing, and is considered mechanistic since it may provide precedence to the forum initially seized; therefore, after the *Spiliada* case, this doctrine has been replaced in England by the doctrine of *forum non conveniens*.

All in all, it appears that *forum non conveniens*, *lis* and *alibi pendens*' doctrines share basically the same fundamental legal values and principles, reflecting thus a system of complementary and interrelated legal elements operating under a common legal philosophy seeking the same final objective, i.e. 'better and superior justice towards the legal dispute resolution'. In light of these considerations, it may be submitted that, a substantial interrelationship exists among these legal doctrines.

6. REFERENCES

BOOKS

[1]. Adrian Briggs, *The Conflict of Laws* (Oxford: Oxford University Press, 2002)

[2]. Albert Venn Dicey, *Dicey and Morris on the Conflict of Laws*, 13th ed. (London: Sweet and Maxwell, 2000)

[3]. David McClean, *Morris: The Conflict of Laws* (London: Sweet & Maxwell Ltd, 2000)

[4]. David J. Sharp & Wylie W. Spicer, *New directions in maritime law*, (Toronto: Carswell, 1984)

[5]. Joost Pauwelyn, *Conflict of Norms in Public International Law* (Cambridge: Cambridge University Press, 2003),

[6]. Peter North, *Cheshire and North's Private International Law*, 13th ed. (London: Butterworths, 1999)

[7]. O.C. Giles, N.J.J. Gaskell, C. Debatista & R.J Swatton, *Chorley and Giles Shipping Law*. (8th ed. London: Financial Times Pitman Publishing, 2003).

[8]. William Tetley, *International Conflict of Laws: Common, Civil and Maritime* (Montreal, Quebec: International Shipping Publications, 1994)

[9]. William Tetley, *International Maritime and Admiralty Law, Forum non conveniens and anti-suit injunctions* at 412-413, (Cowansville Quebec: Edition Yvon Blais, 2002)

ARTICLES

[10]. Proshanto K Mukherjee, The Law of Maritime Liens and Conflict of Laws, *JIML 9* (2003)6

[11]. David W. Robertson, *Forum Non Conveniens in America and England: A Rather Fantastic Fiction* (103 L.Q.R 398, 1987)

[12]. Kennet Wendy, *Forum Non Conveniens in Europe* (C.L.J. 552, 1995)

[13].John H. C. Morris, *The Proper law of Contract*, (1951) 64 Harvard. L .Rev

[14].Marco Pistis, *Forum non conveniens,* Article

[15].Yvonne Jefferies, Jurisdiction: Forum non conveniens and Anti-Suit Injunctions, *Commercial Conflict of Laws* 2, no. 4, (2003)

UNPUBLISHED LECTURES

[16]. Proshanto K. Mukherjee, *Conflict of Laws,* Unpublished Lecture, WMU, 2008

TREATY INSTRUMENTS

[17]. Convention on jurisdiction and the enforcement of judgments in civil and commercial

[18]. Convention on the law applicable to contractual obligations, Rome 1980,

[19]. Convention on jurisdiction and the enforcement of judgments in civil and commercial matters, Lugano, 1988

LEGAL CASES

[20]. *Bank of Tokyo Ltd v. Karoon* (1987)1 A.C. 45N, 61 (C.A.)

[21]. *The Atlantic Star* (1974) A.C. 436

[22]. *Spiliada Maritime Corp. v. Cansulex Ltd* (1987) A.C. 460

[23]. *Rockware Glass Ltd v. MacShanon* (1978) AC 795

[24]. *The Abedin Daver* (1984) AC 398

[25]. *Vishva Abha (1990)* 2 Lloyd's Rep 558 at 560

[26]. *European Asian Bank A.G. v. Punjab and Sind Bank* (1982) 2 Lloyd's Rep. 356 (C.A.)

[27].*OTM Ltd v. Hydronautics* (1981) 2 Lloyd's Rep 211

[28].*Kuwait Oil Co (KSC) v. Idemitsu Tankers KK, The Hida Maru* (1981) 2 Lloyd's Rep 510 at 514

[29]. *Trendtex Trading Corpn v Credit Suisse* (1980) 3 ALL ER 721 at 737

[30]. *Re Harrods (Buenos Aires) Ltd* (1992) Ch. 72 (C.A.)

[31]. *De Dampierre v De Dampierre* (1988) AC 92, 1987 2 ALL ER 1

[32]. *Henry v Henry* case (1995) 185 CLR 571

[33]. *Cleveland Museum of Art v Capricorn Art International SA* (1990) 2 Lloyd's Rep 166

[34]. *E I Du Pont de Nemours & Co v Agnew and Kerr* (1987) 2 Lloyd's Rep 585

[35]. *Boissevain v. Weil* (1949) 1 K.B. 482, at pp. 490-491 (C.A.)

[36]. *The Assunzione* (1953) 2 Lloyd's Rep. 716, (1954) P. 150 (C.A.)

[37]. *Rockware Glass Ltd v. MacShanon* (1978) AC 795

SECTION II
MECHANICAL ENGINEERING AND ENVIRONMENT

CLAMSHELL BUCKET - DIGITAL MODELING METHOD

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ABSTRACT

I've realized the whole modeling using NX 7.5 software. This method has the advantage that can change the design (even "Freeform" geometry) and works with information from other CAD systems, leading to increased design productivity.

A bibliographic study on the current status of various types of construction equipment solutions to load clamshell type was necessary for clamshell type aggregate 3D modeling.

Keywords*: equipment, clamshell buckets, 3D modelling, software*

1. INTRODUCTION

Clamshell buckets are automatic loading and unloading devices. Considering their way of action, they could be cable operated (one, two or four command cables), electric rotor or hydraulically operated.

Clamshell buckets' design varies according to their specific task. Single cable operated clamshell buckets are those with flexible traction devices used for lifting, lowering, opening or closing operations.

Double cable clamshell buckets are the most utilized due to their simple design and efficiency.

The hoist drum braking, the winding and unwinding of the closing wire rope lead to clamshell bucket closing or opening. Simultaneous winding and unwinding of both wire ropes, at the same speed, lifts or lowers the clamshell bucket.

Maintaining the same speed is absolutely necessary for a proper clamshell bucket running.

A simple or double pulley is required to open or close the clamshell bucket. Double wire rope sagging clamshell bucket increases operating stability.

Clamshell digging is a result of clamshell bucket's own weight so the clamshell buckets with a lower weight than the required one according to the load consistency will slip over the surface of the material, impeding the loading, and a higher one will lead to clamshell bucket dipping into the load.

Grapple buckets are recommended equipments for handling bulk higher granulated loads.

2. ASSEMBLY MODELING

Clamshell buckets are operated closing and opening devices attached to lifting equipments. They dig and grab the materials and unload it to a designated place or to transportation equipment. Any clamshell bucket has two mechanisms: closing-opening clamshells mechanism and the lifting-lowering one.

Grabbing and releasing the load are automated operations compared to other grabbing devices (hooks, buckets) in which case an operator is required.

Double clamshells buckets hold a certain volume.

They are designed to handle finely granulated material: sand, gravel, salt, cement, etc.

Clamshell bucket's modeling using NX7 software allows 3D solids parametric design. 3D model is based on sketches (Sketch) created using 'Sketcher' application when Sketch command is activated. 'Sketcher' environment is left after designing the curves and applying the sketch's restraints.

After that, the sketch is used in order to create solids or surfaces utilizing modeling operations.

The solids can be modified by adding extra operations to get to desired shape.

The technical characteristics of the designed assembly are: bucket's capacity - 6,3m^3; Tmaximum opening: 4500mm; closed clamshell bucket height: 4150mm; opened clamshell bucket height: 5120mm; closing wire rope diameter: Φ28; lifting wire rope diameter: Φ28.

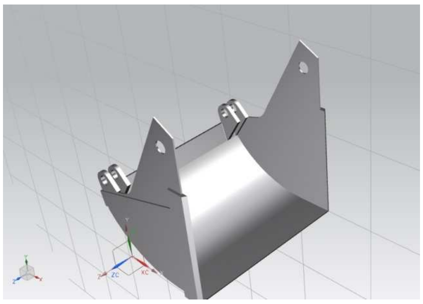
Each component was designed using NX 7.5. software.

It started with a sketch for every single part using the commands as it follows: Sketch, Profile (Line), Arc, Circle, Quick trim, Quick extend, Constraints. Extra commands can be used according to each part design requirements: Chamfer, Rotate, Mirror curve, Offset curve, etc.

Dimensioning and extruding was realized after sketching, using the commands 'Extrude' and 'Revolve', considering each particular case.

At this stage, the design could be modified according to the requirements (holing, detaching certain volumes to obtain certain shapes or surface particularities).

Achieving that involved the using of certain commands: Hole, Edge blend, Chamfer, Unite, Subtract, etc.



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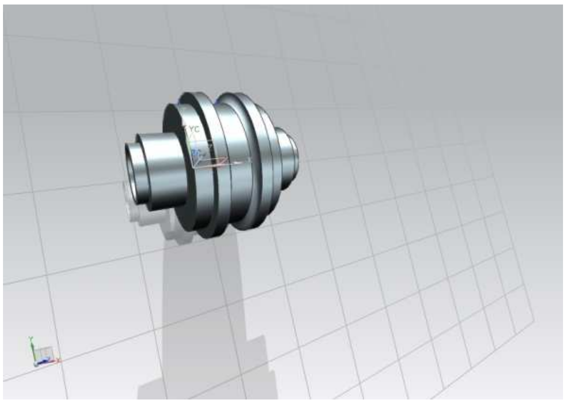

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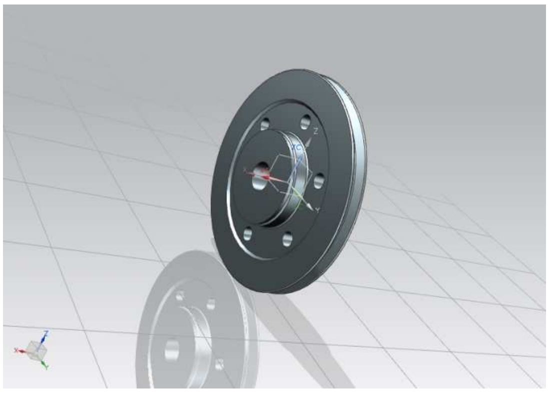

d)

Figure 1 – Clamshell bucket's parts
a) clamshell; b) fork; c) small roller; d) big roller

I have realized the assembly after each component was designed. In order to do that, I have brought the parts' files in the working window and assembled the equipment piece by piece.

I have used assembling constraints (Touch Align, Angle, Fix, Parallel, Concentric and Distance) for a more accurate assembling process.

3. MODELING RESULTS

The modeling results are illustrated as it follows:

Figure 2

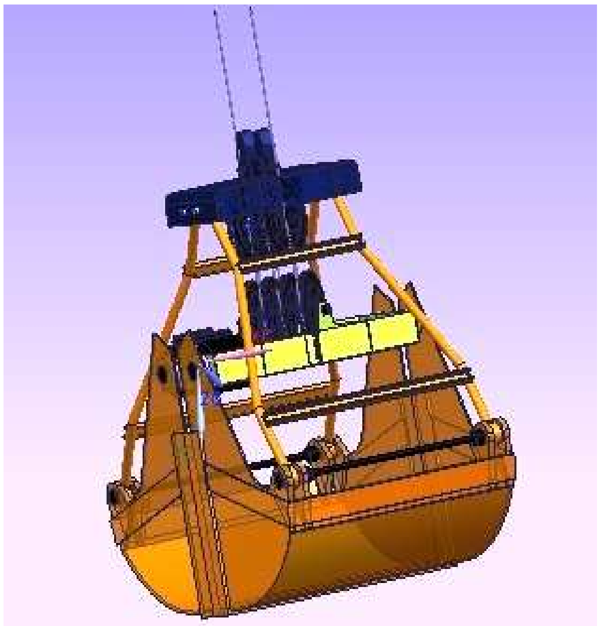

Figure 3

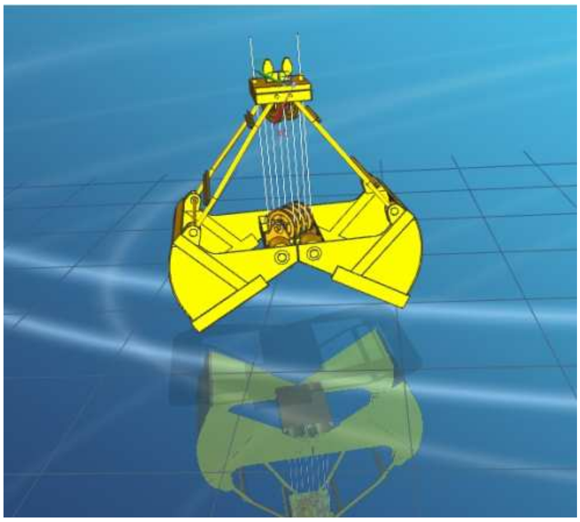

Figure 4

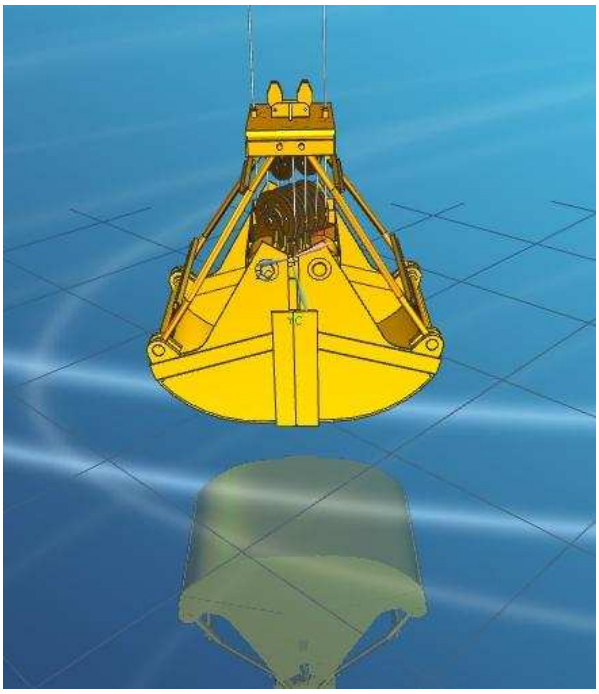

Figure 5

The components of the clamshell bucket have been assembled piece by piece. The modeling results have been presented in images. First, I have presented the clamshell bucket with closed clamshells but without the wire ropes – Figure No.2, then the components assembled one by one- Figure No.3, after that, the clamshell bucket with opened clamshells- Figure No.4 and the last image, the clamshell bucket with closed clamshells – Figure No.5.

4. CONCLUSIONS

There are different types of clamshell buckets and their efficiency and price varies according to the producer.

Their productivity also varies according to their specific task. The production costs get lower as the design solution gets versatile and the production well managed.

I have paid attention to technical parameters analysis, considering the advantages and disadvantages of each design solution according to different assignments.

The comparative analysis involving different design and constructive solutions considered the dimensioning and specific calculation starting with 2D model.

5. REFERENCES

[1] ALAMOREANU. M. - *Maşini de ridicat. Organe specifice, mecanismele şi acţionarea maşinilor de ridicat,* Ed. Tehnică, Bucureşti, 1996.

[2] MING C. LEU, KEITH AND PAT BAILEY PROFESSOR – *NX 7 for Engineering Desig*

[3] RANDY H. SHI - *Parametric Modeling with* DEAS 1, 2008

[4] OPROESCU GHE. - *Masini si instalatii de transport industrial,* Editura EDMUNT – 2001

INFLUENCE OF NOISE ON THE PHYSIOLOGICAL ACTIVITY OF THE BLUE MUSSEL *(MYTILUS GALLOPROVINCIALIS)* FROM THE BLACK SEA

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ABSTRACT

In the last period, the ecosystem of the Black Sea has been highly changed and disturbed: extensive pollution, coastal development, disturbance caused by extensive vessel traffic, over-fishing, etc. , were several of the causes . In this paper we present the influence of vibration (as a source of noise) on the physiological activity of the Black Sea blue mussels (*Mytilus galloprovincialis*, Lamarck, 1819). Marine organisms are forced to implement their own strategy of defence against stress factors. Along their evolution, under the influence of environmental factors, mussels put in place anti-oxidant enzyme - systems and non-enzymatic defence systems against the action of harmful free radicals resulting from metabolic processes of organic xenobiotics. We can consider that in the Black Sea shallow waters, where, on rocky substrata the dominant species is the blue mussel, noises or vibrations with high frequency are harmful for the ecosystem.

Keywords: *Mytilus galloprovincialis, oxidative stress, noise, spectrogram, physiological activity, ,*Black Sea

1. INTRODUCTION

Free radicals of oxygen (ROS) are transitory molecules or molecular fragments of high complexity, able to interreact with all bio-molecules (lipids, proteins, carbohydrates and nucleic acids), altering them structurally and functionally. The free radicals of oxygen are the superoxid radical, the hydroxyl radical, the hydrogen peroxide radical (hydrogen peroxide) and singlet oxygen [9].

In marine organisms, the free radicals of oxygen can be generated under hypoxia or experimental induced environmental hyperoxia conditions [15].

The oxygen free radicals can be neutralized by cellular antioxidant defence system consisting of enzymes such as superoxid dismutase (SOD), catalase (Cat), glutathione peroxidase (GPX) and some nonenzimatice antioxidants such as vitamin A, C, E, GSH, flavonoids, ubiqinona [6][7].

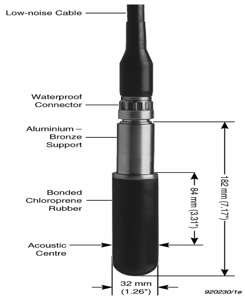
In the body of molluscs (bivalves) were discovered the components of the antioxidant enzyme system, such as superoxid dismutase, catalase and glutathione peroxidase, as well as numerous non-enzymatic substances with antioxidant activity and with high molecular weight, for example vitamins A, C, E and GSH [1][2][12][15].

2. MATERIALS AND METHODS USED FOR EXPERIMENTAL RESEARCH OF ACCOUSTIC EMISSIONS ON THE PHYSIOLOGICAL ACTIVITY OF THE BLUE MUSSEL

The quipment used in experiments was obtained under the RoNoMar contract, from Bruel & Kjaer Company (B & K), and was used to perform measurements of underwater noise. The following equipment was used: 3 8106 hydrophones type 2 hydrophones type 8104, type 2713 power amplifier, data acquisition system XI LAN, laptop 14 PULSE software, cables, type 4229 calibrator (Figure 1).

Underwater sound measurements were processed and analyzed by the help of the FFT analysis (Fast Fourier Transform) and the Wavelet analysis.

In order to study the influence of vibration (as a source of noise) on the physiological activity of the Black Sea blue mussels (*Mytilus galloprovincialis*, Lamarck, 1819), healthy individuals were collected by scraping mussels off the epybiosis of berth no. 79, located to the south of Constanta Port, less influenced by port operations. A quantity of 180 l seawater was taken from the same area to fill the experimental ponds / tanks. (Figure 2).



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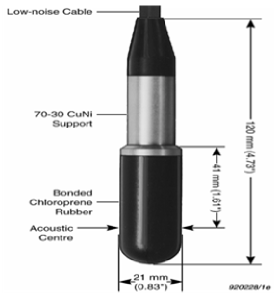

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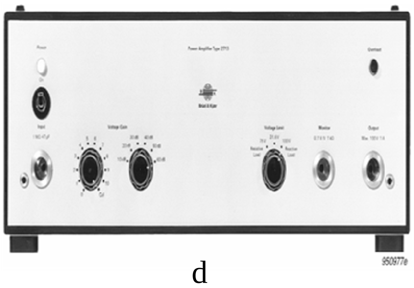

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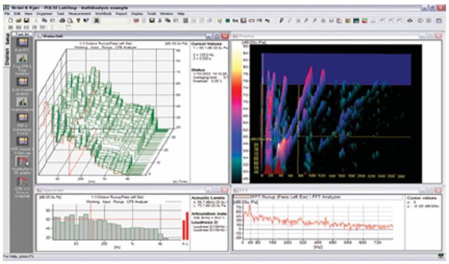

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Figure 1 Equipment used for the experimental research on accoustic emissions in the coastal marine environment: components of a 8106-type hydrophone; b -8104 type hydrophone; LAN-XI data entry system; d- type 2713power amplifier; e- the screenshot representing the PULSE 14 software from Bruel & Kjær's

a

b

Figure 2 Place of sampling mussels (a) by scraping the epybiosis (b)

Vibration in the sample zone was determined (16/03/2010 and 09/04/2010), together with the biochemical parameters of collected mussels as reference values for the two series of experiments (Figure 3),

a

b

Figure 3 Determination of vibration values of the marine environment when sampling: a - an overview of the equipment used, b - recording the vibrations on the laptop screen

A total of 80-90 mussels (length class of 35-40 mm and 45-50 mm) were kept in ponds / tanks / aquariums of 40 L, or in 60 L glass ponds, at temperatures ranging from 10 to 13 ° C, salinity from 14.1 to 14.6, pH = 8.2 to 8.4 IU, food being provided by algal cultures obtained from existing diatoms in seawater enriched by culture sp. *Tetraselmis*. Water oxygen tanks were provided by bubbling air.

For each experimental stage 2 tanks of different dimensions were used: the first, a 30 litre tank, and the latter, a 50 litter one. For all the experiments a witness tank was used for monitoring the mussels evolution in normal conditions (Figure 4).

a

b

c

Figure 4 Ponds (aquariums) used in the experiment : a experimental ; b, c witness

The experiment was conducted over a period of 4 weeks (19.03 -22.04.2010), and two repetitions every 2 weeks for each of them. During this period, mussels were "stressed" with acoustic signals of different frequencies. By using the PULSE program from B & K, was generated and sent to 7071 V RMS signal through LAN DAQ XI, and the power amplifier type 2713 to two hydrophones type 8104. Noise was measured with two hydrophones type 8106, which were connected to the DAQ, and then the signals were transmitted to the laptop

(Figure 5). Position hydrophones type 8106 in the tanks were placed about 6-7 cm from the bottom and 8.9 cm from the sides.

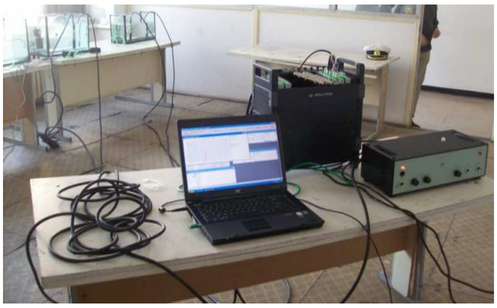


Figure 5 Experimental configuration

In the first experiment the emission frequency was 300 Hz signal, while in the second it was 16000 Hz. Signals were generated using the 8104 type hydrophone as transmitters. A second source of noise was the air pump, with a fundamental frequency of 50 Hz. In conclusion, during the experiment two sources of noise were continuously provided in the basins.

After a period of 72 hours from the beginning of the experiment the blue mussels were sacrificed for analysis; their tissue was examined in order to state some metabolic parameters of oxidative stress: the superoxide dismutase activity, the catalase, the reduced concentration of glutathione (GSH) and the protein concentration. In determining the metabolic oxidative stress parameters we used the following methods:

• Superoxide dismutase (SOD) - method based on its ability to inhibit the reduction of tetrazolium salt - Nitro Blue tetrazolium (NBT) with superoxide radicals [14]

• The activity of catalase (CAT) - kinetic method based on the decomposition of hydrogen peroxide radicals existing in the reaction medium, as a result of catalase activity, using a spectrophotometer at 240 nm and 25 ° C, dt = 60 seconds [3].

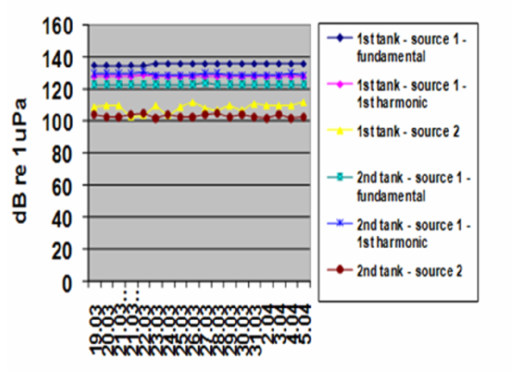
• Reduced glutathione (GSH) - classical colorimetric method based on DTNB reaction in the presence of GSH in the environment using a spectrophotometer at 412 nm [4].

• Malonildialdeide (MDA) - conventional colorimetric method described by Drapper and Hadley, 1990 [5].

All of the reagents used for the completion of these experiments were purchased from Sigma-Aldrich (Steinheim, Germany). The data were statistically interpreted using statistical analysis software Origin Pro75. The difference is considered statistically significant when $p \leq 0.05$.

3. MEASUREMENTS (RECORDS) OF THE NOISE EMISSIONS, AND THEIR EFFECTS ON THE SPECIES *MYTILUS GALLOPROVINCIALIS*

It was observed that the oxidative stress is not obvious if appropriate equipment and experimental approaches are used (experimental values for noise measurements were summarized by number of experiments, pools and sources (Figure 6);



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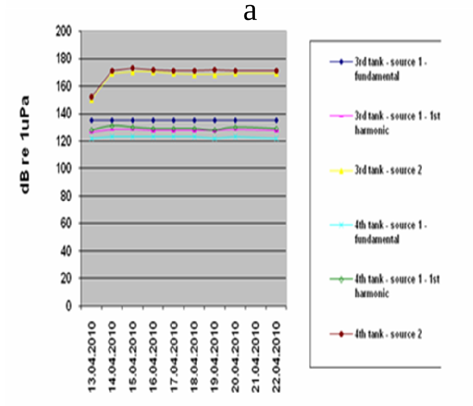

b

Figure 6 Measured values of noise and graphic representation of its evolution in the two experiments: a - graphical representation of the evolution of noise for the first experiment, b - graphical representation of noise evolution for experiment no 2

We found that biochemical indicators for oxidative stress (superoxide dismutase, catalase, glutathione reduced malonildialdehida) in tissues of mussels exposed to different noise emissions reveal that the action of low frequency sounds (from 300 Hz) in experimental ponds over 144 hours, do not induce oxidative stress (Table 1).

Table 1 Mean values of superoxide dismutase, catalase, reduced glutathione and of malonildialdehide after 144 hours of exposure at vibrations of 7 V RMS at 300 Hz

Experimental group	Statis-tics index	SOD	CAT	GSH	MDA
		EU•mg of proteins^{-1}		ng• mg of proteins^{-1}	nmol• mg of proteins^{-1}
laboratory control group	X±ES	4.54±2.93	1.04±0.63	1.10 ± 0.28	2.59±0.92
	n	9	9	10	10
	t	-	2.54	9.68	5.33
	P	NS	0.02	0.001	0.001
	+/- M%	+ 12.09	+ 116.6	- 141.81	+ 172.6
experimental group 1	X±ES	5.80±3.00	1.47±1.09	2.91 ± 0.12	1.61±0.31
	n	10	8	9	9
	t	-	-	2.06	3.16
	P	NS	NS	0.03	0.001
	+/-	+	+	+	

	M%	27.75	41.34	164.54	60.86
experi-mental group 2	X±ES	2.82± 1.06	0.63± 0.30	1.17 ± 0.42	2.12± 0.84
	n	9	10	9	9
	t	2.29	-	-	-
	P	0.03	NS	NS	NS
	+/- M%	- 60.99	- 65.07	+ 6.36	- 22.16

LEGEND: X ± ES - arithmetic mean ± standard error, *n*= the number of individual values which lead to the average**,** *t* = test 't' of Student, *p* ≤ threshold of statistical significance, *NS* = statistically insignificant**.**

After a longer period of exposure to noise (216 hours), comparing the mean values of the studied biochemical parameters with those obtained for the control group, it has been ascertained a noticeable decrease in superoxide dismutase (*SOD*) activity in experimental groups 1 and 2, due to the mobilization of the enzyme in order to catalyze the reaction in which superoxide radicals are involved [8]

Catalase (*CAT*) acts on the substrata generated by superoxide dismutase, and as it is seen in the described experiments, the enzyme activity decreases, which indicates that at this level, the concentration of hydrogen peroxide radical has exceeded the normal limit for the mussel's cell. The oxygen free radicals may affect the morphological constitution of lipids, eventually leading to cell death.

Malonildialdehide (*MAD*) is an index of lipid peroxidation of membrane concentration and this parameter increases only when cell membranes are suffering changes. In our experimental model we observe an increase in concentration of malonildialdehide, information that supports the hypothesis of the presence of oxidative stress [13] (Table 2)

Table 2 Mean values of superoxide dismutase, catalase, reduced glutathione and of malonildialdehide after 216 hours of exposure at vibrations of 7 V RMS at 300 Hz

Experi-mental group	Statis-tics index	SOD	CAT	GSH	MDA
		EU•mg of proteins^{-1}		ng• mg of prote-ins^{-1}	nmol• mg of prote-ins^{-1}
labora-tory control group	X±ES	7.81± 2.54	1.41 ± 0.37	1.92 ± 0.30	2.03± 0.61
	n	10	10	10	10
	t	4.48	7.02	3.37	4.92
	P	0.001	0.001	0.003	0.001
	+/- M%	+ 92.83	+ 182.00	- 29.68	+ 113.68
experi-mental group 1	X±ES	4.10 ± 1.02	0.65 ± 0.20	2.80 ± 0.80	4.61± 1.96
	n	10	10	9	10
	t	4.27	6.38	2.96	3.96
	P	0.001	0.001	0.001	0.001
	+/-	-	-	- 45.83	+

experi-mental group 2	X±ES	4.05± 1.47	0.83 ± 0.36	2.31 ± 0.46	4.65± 0.48
	n	10	10	10	10
	t	4.03	3.40	2.22	10.57
	P	0.001	0.003	0.03	0.001
	+/- M%	- 92.83	- 69.87	+ 20.31	+ 129.0

During the experiments, we chose a fixed frequency for the signal generated by the hydrophones over a broadband signal in order to identify the contribution of hydrophones to SPL. For lower frequencies the oxygen injectors noise spectrum dominates the frequency spectrum, and when we have higher frequencies, the noise of hydrophones is the only noise source.

In the second experiment, the two experimental groups were labeled 3 and 4, and were exposed to sounds with an intensity of 173 dB at 16 kHz. The other environmental conditions (temperature, water salinity, pH, and algal diet, equally air injectors) were the same as in the first experiment.

The values of the studied biochemical parameters determined for the mussels collected from the Constanta Harbour are in concordance with those offered by the references. [11]

If mussels are exposed to 72 hour high frequency sound (starting with 16 kHz) (Table 3) or for more than 72 hours (Table 4), induction of oxidative stress is observed, together with an activation of the biosynthesis mechanisms of superoxide dismutase (*SOD*) and catalase (*CAT*), directly involved in cell defense against damaging actions of oxygen free radicals resulting from metabolic processes.

GSH can react directly with the oxygen free radicals or through enzyme whose cofactor is. This explains why the concentration of *GSH* decreases in experimental group 3. Lipid peroxidation index (*MDA*) concentration remains constant, proving that the cellular antioxidant system still gets through the concentration of free radicals.

Table 3 Mean values of superoxide dismutase, catalase, reduced glutathione and of malonildialdehide after 72 hours of exposure at vibrations of 173 dB at 16 kHz

Experi-mental group	Statis-tics index	SOD	CAT	GSH	MDA
		EU•mg of proteins^{-1}		ng• mg of prote-ins^{-1}	nmol• mg of prote-ins^{-1}
har-bour control group	X±ES	1.69± 0.14	0.57± 0.18	2.35± 0.59	0.38± 0.08
	n	10	10	10	10
labora-tory control group	X±ES	7.69± 0.67	0.71± 0.25	2.11± 0.32	0.36 ± 0.02
	n	8	9	10	10
	t	27.67	-	-	-
	P	0.001	NS	NS	NS
experi-mental group 3	X±ES	4.39± 0.98	0.65± 0.23	1.42± 0.24	0.46± 0.14
	n	10	9	10	10

	t	8.52	-	4.80	-
	P	0.001	NS	0.001	NS
experi-mental group 4	X±ES	7.04± 1.08	0.93± 0.23	1.94± 0.35	0.59± 0.38
	n	10	10	10	10
	t	15.42	4.59	-	-
	P	0.001	0.002	NS	NS

Table 4 Mean values of superoxide dismutase, catalase, reduced glutathione and of malonildialdehide after 144 hours of exposure at vibrations of 173 dB at 16 kHz

Experi-mental group	*Statis-tics index*	*SOD*	*CAT*	*GSH*	*MDA*
		EU•mg of proteins^{-1}		*ng• mg of prote-ins*$^{-1}$	*nmol• mg of prote-ins*$^{-1}$
labora-tory control group	X±ES	4.69± 1.26	0.76± 0.32	0.52± 0.22	0.80± 0.68
	n	10	10	10	10
	t	7.46	-	9.55	-
	P	0.001	NS	0.001	NS
experi-mental group 3	X±ES	6.22± 1.01	1.22± 0.22	0.22± 0.08	0.49± 0.29
	n	10	10	10	10
	t	2.97	3.67	4.02	-
	P	0.008	0.001	0.001	NS
experi-mental group 4	X±ES	6.09± 1.79	1.46± 0.15	0.36± 0.18	0.51± 0.24
	n	10	10	10	10
	t	2	6.12	-	-
	P	0.05	0.001	NS	NS

In the last 72-hour exposure to a noise of 173 dB (totaling 216 hours), the mean values of biochemical parameters analyzed showed a direct involvement of cellular antioxidant defense systems in the free radicals, and even an inability to protect the cells (Table 5), which is a proof of the fact that medium oxidative stress appeared.

Marine organisms are forced to implement their own strategy of defense against stress factors. Along their evolution, under the influence of environmental factors, mussels put in place anti-oxidant enzyme - systems and non-enzymatic defense systems against the action of harmful free radicals resulting from metabolic processes of organic xenobiotics [11]. Dissolved oxygen is a critical component of the aquatic environment. During normal cell metabolic reactions, oxygen is converted to 0.1-0.2% oxygen free radicals [10]

Table 5 Mean values of superoxide dismutase, catalase, reduced glutathione and of malonildialdehide after 216 hours of exposure at vibrations of 173 dB at 16 kHz

Experi-mental group	*Statis-tics index*	*SOD*	*CAT*	*GSH*	*MDA*
		EU•mg of proteins^{-1}		*ng• mg of prote-ins*$^{-1}$	*nmol• mg of prote-ins*$^{-1}$
labora-tory control group	X±ES	6.50± 0.52	1.14± 0.28	1.75±0. 22	0.78± 0.24
	n	10	10	10	10
	t	27.55	5.57	3.11	4.91
	P	0.001	0.001	0.005	0.001
experi-mental group 3	X±ES	5.56± 1.07	1.07± 0.27	1.93± 0.45	1.12± 0.50
	n	10	10	10	10
	t	2.22	-	-	-
	P	0.03	NS	NS	NS
experi-mental group 4	X±ES	3.86± 1.98	1.10± 0.43	2.04±0. 33	1.43± 0.20
	n	10	10	10	10
	t	4.07	-	2.30	6.52
	P	0.001	NS	0.03	0.001

4. CONCLUSIONS

Studying the impact of underwater sound / noise on a few Black Sea populations determined us to introduce the experimental method in the working protocol; the mussels (*Mytilus galloprovincialis*) experimentally exposed to different noise emission, according to analysis carried out on tissues, presented changes of biochemical indicators for oxidative stress (superoxide dismutase, catalase, reduced glutathione and malonildialdehida), from which we can draw the following conclusions:

- action of low frequency sounds (from 300 Hz) for 144 hours do not induce oxidative stress;
- increase of malonildialdeide concentration , for a higher exposure (216 hours) to low frequency sounds, explains the oxidative stress hypothesis;
- mussels exposure to high frequency sound (16 kHz), over 72 hours, induces oxidative stress.

5. REFERENCES

[1] Akcha, F., Izuel, C., Venier, P., Budzinski, H., Burgeot, T., Narbonne, J.-F., *Enzymatic Biomarker Measurement and Study of DNA Adduct Formation in Benzo Pyrene-Contaminated Mussels, Mytilus galloprovincialis*, Aquat. Toxicol, 49, 2000: 269–287

[2] Akcha, F., Izuel, C., Venier, P., Budzinski, H., Burgeot, T., Narbonne, J.-F., *Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L.* and other molluscs. Funct. Ecol. 4, 2000: 415–424

[3] Beers, R.F, and Sizer, I.W., *A Spectrophotometric Method for Measuring the Breakdown of H_2O_2 by Catalase*, J. Biol. Chem, 195,1952: 133-140

[4] Beutler, E., *Red Cell Metabolism* in: A manual of biochemical methods 2, Ed. Grune and Stratton publishers London, 1975

[5] Bîrcan, A., Sutcu, R., Gokirmak, M., Hiczlmaz, H., Akkaya, A., Ozturk, O., *-Total antioxidant capacity and C-Reactive protein levels in patients with community – acquired pneumonia. Turk. J. Med. Sci.* 38 : (6), 2008: 537 – 544

[6] Christopher, PI., Wenke, JC., Nofal, T., Armstrong, RB., *Adaptation to Lenghthening Contraction-Induced Injury in Mouse Muscle*, J.Appl.Physiol: 97, 2004
[7] Diplock, AT., *Introduction: markers of Oxidative Damage and Antioxidant Modulation*, Free. Radic. Res. 33 Sppl: S21-S26, 2000
[8] Gamble, S.C., Goldfarb, P.S., Porte, C., Livingstone, D.R., *Glutathione Peroxidase and other Antioxidant Enzyme Function in Marine Invertebrates (Mytilus edulis, Pecten maximus, Carcinus maenas and Asterias rubens),* Marine Environ. Res. 39,1995: 191–195
[9] Halliwell, B., and Gutteridge, J., *Free Radicals in Biology and Medicine*, Oxford, UK: Oxford Univ. Press, 2007
[10] Livingstone, D.R., Garcia Martinez, P., Michel, X., Narbonne, J.F., O'Hara, S., Ribera, D., Winston, G.W., - *Oxyradical Generation by Invertebrates and Fish*, Comp. Biochem. Physiol., A 120, 1990: 43– 49
[11] Livingstone, D.R., , *Contaminant-Stimulated Reactive Oxygen Species Production and Oxidative Damage in Aquatic Organisms*, Mar. Pollut. Bull. 42, 2001:656–666
[12] Manduzio, H., Monsinjon, T., Rocher, B., Leboulenger, F., Galap, C., *Characterization of an Inducible Isoform of the Cu/Zn Superoxide Dismutase in the Blue Mussel Mytilus Edulis*, Aquat.Toxicol. 64, 2003: 73–83
[13] Sies H., - *Oxidative stress*. London Academic,1985
[14] Winterbourne, C.C., *Comparison of superoxide with other Reducing Agent in the Biological Production of Hydroxyl Radicals*, J. Biochem.182,1979: 625-628
[15] Winston, G.W., Di Giulio, R.T., *Prooxidant and Antioxidant Mechanisms in Aquatic Organisms*, Aquat. Toxicol, 19, 1991: 137–161

CONTACT STRESS ANALYSIS IN ROLLING BODIES BY FINITE ELEMENT METHOD

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ABSTRACT

Analysis of contact stress in rail and wheel is very important in mechanical and railway engineering. In this research is presented the contact stress for two rolling bodies by the use of the finite element method (FEM). The model considers the wheel and the rail as elastic deformable bodies and it is solved using numerical methods. Next, critical area in rail and wheel are determined, based on the results of the stress numerical analysis. Prediction of critical points uses this numerical method and its results. To analyse the pressure of contact between the wheel and the rail, elliptical, rectangular and circular contact surfaces are assumed for this study. Based on these assumptions, according results are achieved. The rail fracture, failure and analysis of stress should be studied to prevent rail fracture and accidents. The analysis of contact stress is performed by FEM and the results are compared with respect to the shape of the contact surface initially assumed. Moreover, the results are valuable for analysing the crack creation in critical points and surfaces. Comparing the results of the finite element study with the results of analytical studies for the determination of the contact stress in rolling bodies, one can notice the convergence of these results.

Keywords: *contact stress, rolling bodies, FEA results, analytic study results, convergence of results*

1. INTRODUCTION

The recent evolution of railway systems in the world has emphasized the necessity of more efficient management and, at the same time, of developing new, more accurate, design approaches to reducing costs and increasing safety and reliability of railway systems. Among all the sub-systems and the components that are a part of a railway system, the wheel/rail interface is one of the most delicate, as performances of the train, as well as safety. Through the wheel/rail interface, in fact, the dynamic and static loads pass from the rail to the wheel ia a really small contact area, whose extension and geometry can vary during the in-service period. The behaviour of the wheel/rail interface is paramount for being certain that adequate comfort, stability and safety is guarantied during the train trip. Computer based methods are the appropriate instruments of investigation which offer an overview regarding the phenomenon in engineering [3], [4].

2. MATERIAL AND METHODS

In this paper, analysis of contact stress for two rolling bodies is presented using the finite element method (FEM). The first stage is to determine the critical surface of stress, the positions of critical stresses being identified by FEM. From the beginning it is expected to be some differences of the values of these stresses, aspect presented in the section of stress analysis theory. Vertical cracks will grow faster than other cracks. According to analytical and numerical results, the direction of the crack growth and also the prediction of the fracture depend on the values of maximum stress and displacement or the value of multiplying of maximum stress and displacement. All these, maximum stress, displacement and critical surface and stress may be calculated by the use of the FEM. In order to analyse the contact stresses, numerical methods are used.

The induced loads in the contact area have been done by FEM analysis. Figures present the standard rail profile UIC60 and position of forces in the contact surface. The induced load of a wheel is about 10 tones. The contact surfaces are assumed to be elliptical, rectangular and circular. In this research the axial load is considered about 22 tones. The loadings that are induced to the rail and the wheel are 50 to 200 KN. The model of the wheel and the rail, uses the rail profile UIC60 and two axial wheel of bogie H665.

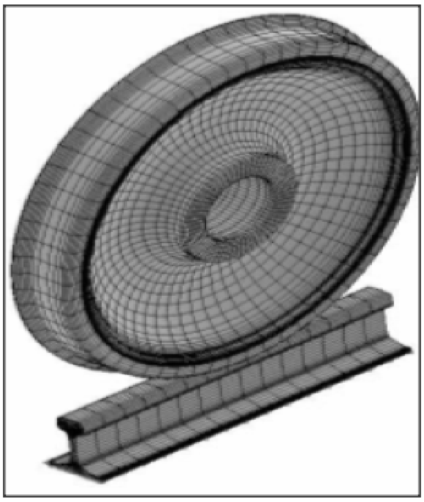

Figure 1 Finite element model of wheel and rail

Due to nonlinearity of contact analysis, the region requires a very fine mesh. In this research, it is used a fine mesh with an average length less than 2 mm near the contact area. Using pilot node at the wheel centre, in this important place a pilot point is connected to the wheel using rigid link element. All the external loading and boundary conditions of the wheel load are applied on the pilot point. Both loadings and boundary conditions can be obtained through field measurements or from numerical simulation of the track system motion analysis.

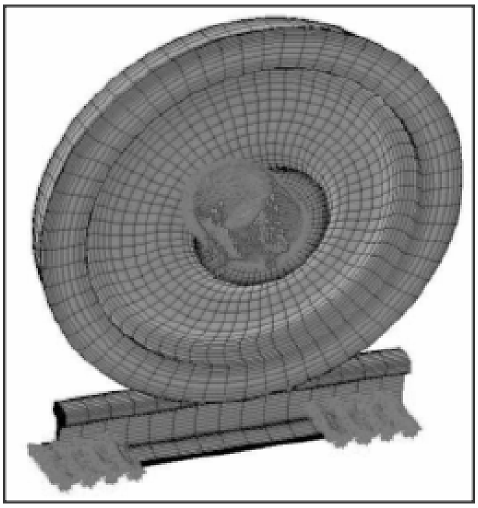

Figure 2 Finite element modeling wheel and rail with static loads

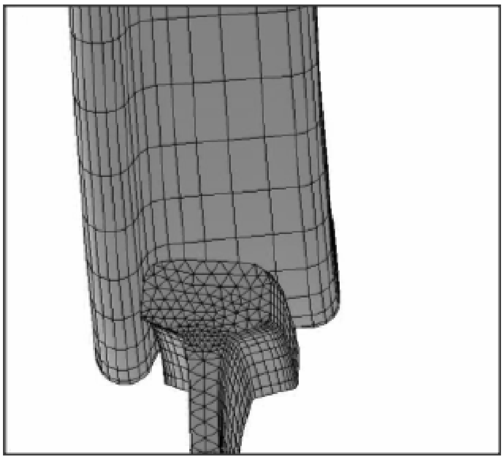

Figure 3 Finite element modeling wheel and rail contact

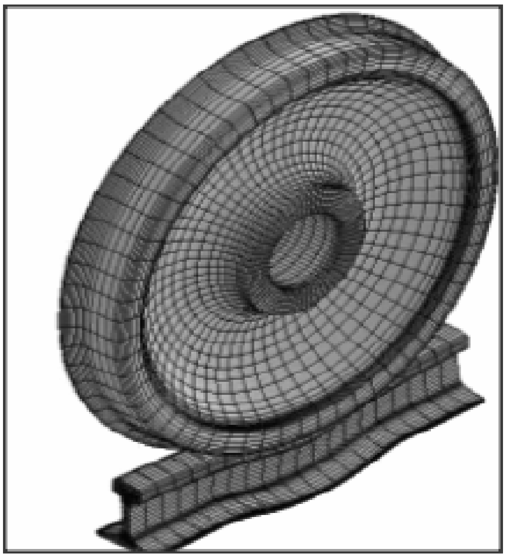

Figure 4. Deflection of the wheel and rail

Stress distribution individually has been investigated by finite element analysis (FEA) and the results are presented in figures 5 and 6, where the critical surfaces may be noticed.

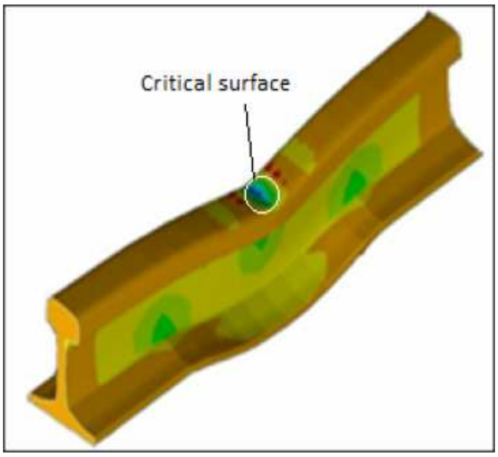

Figure 5 Stress distribution in rail

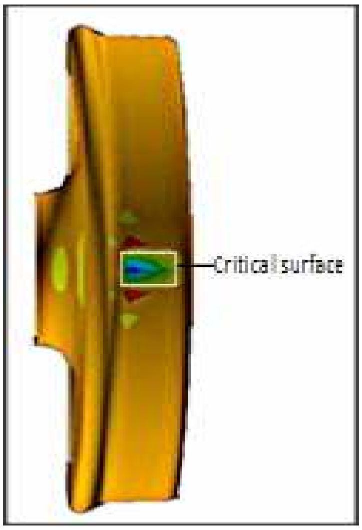

Figure 6 Stress distribution in wheel

3. DESCRIPTION OF THE CONTACT FATIGUE CRACK INITIATION MODEL

A comprehensive model of the contact fatigue life prediction of mechanical elements should consider the time history of applied contact loads, regarding their range of variation. The rolling–sliding contact loads, typical for mechanical elements such as gears, wheels and rails, rolling bearings etc., are generally stochastic in a certain range, due to the stochastic character of some contact parameters. For a description of a general case of contact loading, one has to estimate average normal and tangential contact forces for computational determination of surface and subsurface contact stresses.

The actual contact problem is transformed into its generalised form applying the Hertzian theory, i.e. the equivalent contact cylinder is generated from the curvature radii of the considered contact mechanical elements at the point of the actual contact. The equivalent Young's modulus and Poisson's ratio are also computed from respective data of contacting bodies (figure 7).

According to the Hertzian theory, the distribution of normal contact pressure in the contact area can be determined using the expression:

$$p(x) = \frac{2F_N}{\pi a}\sqrt{1-\frac{x^2}{a^2}} \tag{1}$$

where F_N is the normal contact force per unit width, a is half length of the contact area, which can be determined from

$$a = \sqrt{\frac{4RF_N}{\pi E}} \tag{2}$$

where E and R are the equivalent Young's elastic modulus and the equivalent radius, respectively, defined as

$$\frac{1}{E} = \frac{1-\vartheta_1^2}{E_1} + \frac{1-\vartheta_2^2}{E_2} \tag{3}$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \tag{4}$$

where E_1, R_1, n_1 and E_2, R_2, n_2 are the Young's modulus, the curvature radii and Poisson's ratio of contacting cylinders, see figure 2. Next, the maximum contact pressure $p_0=p(x=0)$ can be determined as

$$p_0 = \sqrt{\frac{EF_N}{\pi R}} \tag{5}$$

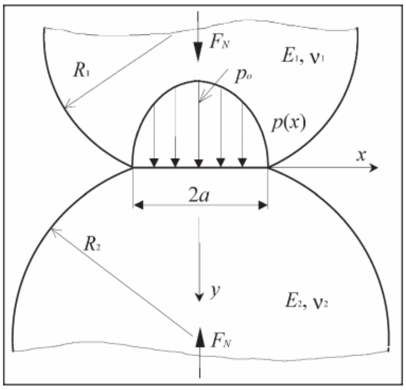

Figure 7 Equivalent model of two contacting cylinders

In the analysing of real mechanical components, some partial sliding occurs during time-dependent contact loading, which can originate from different effects (complex loading conditions, geometry, surface, etc.) and it is often modelled with traction force due to the pure Coulomb friction law. In the analysed case frictional contact loading $q(x)$ is a result of the tractive force action (tangential loads) due to the relative sliding of the contact bodies and is here determined by utilising the previously mentioned Coulomb friction law

$$q(x)=\mu p(x) \tag{6}$$

where m is the coefficient of friction between contacting bodies.

For the general case of elastic contact between two deformable bodies in a standing situation, the analytical solutions are well known. However, using general Hertzian equations it is hard to provide the loading cycle history and/or simulation of a contact pressure distribution of moving contact in the analytical manner. Therefore, the finite element method is used for simulating two-dimensional friction contact loading in this case and the same procedure is usually used when dealing with complex contact loading conditions. The equivalent contact model is spatially discretised in the region of interest, where finer mesh is used around material points (x_i, y_i) on and under the contact region.

The computational model for evaluating contact stresses is a two-dimensional rectangle, with assumed plain strain conditions, Figure 8.

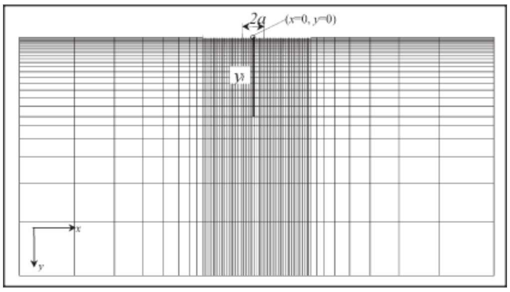

Figure 8 Finite element model for determination of contact loading cycles

The loading boundary conditions comprise the Hertzian normal contact loading distribution and tangential contact loading due to frictional forcers in the contact. The loading is moving along the contact surface of the generalised computational model.

The stress analysis of the generalised contact model is performed in the framework of the finite element method. The appropriate stress state for each observed material point is computed for each position of the moving contact loading. This procedure results in generation of real stress loading cycles of material points in one pass of the rolling–sliding contact, which are necessary for the following contact fatigue analysis.

4. NUMERICAL EXAMPLE

The rail profile is chosen according to UIC regulation, the considered rail is the most common UIC60 profile that is shown in the UIC technical documentation. The wheel diameter is about 0.89 m and the wheel profile is chosen according to the AAR standard having a wide flange contour. The vertical load is assumed to be the maximum design load, which is 146.2 kN.

In this study the rail length is considered to be 700 mm. The initial contact point is assumed to occur at the railhead centre and wheel tread centre. The results of the static load analysis of the wheel and rail contact are shown in figures 9 and 10. Figure 9 presents the von

Mises stresses from different section views. Figure 10 presents in-plane shear stress. From the figure 9, it can be noticed that the maximum von Mises occurs at some depth below the head surface. The stress decreases quickly as the depth increases. The high stress occurs within a small region of the contact location. The study reveals that the maximum stress occurs at a depth of about 5-10 mm below the head surface of the rail. The stresses in the other regions of the rail is nearly zero. From figure 12, a butterfly-wise pattern of the shear stress can be observed.

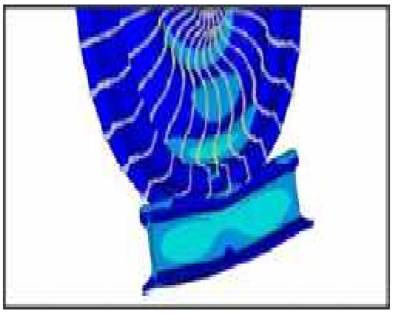

Figure 9 Von Mises stress distribution of wheel/rail contact.

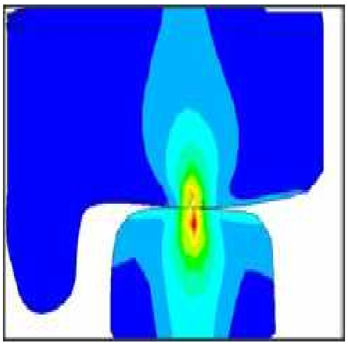

Figure 10 Front section view

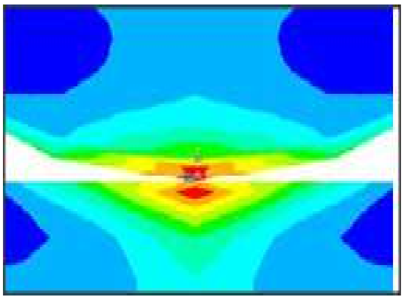

Figure 11 Left section view

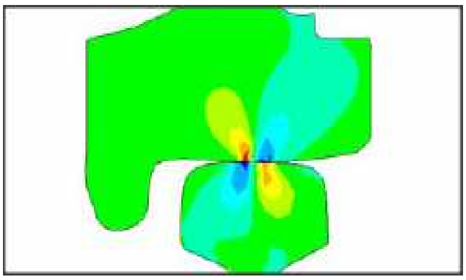

Figure 12 In plane shear stress distribution of wheel/rail contact

From Figure 9, 10, 11 and 12, the stress pattern indicates multiple contact points between the wheel/rail interfaces.

The point of maximum von Mises stress is considered as the critical location for fatigue crack initiation.

5. CONCLUSIONS

A multiaxial fatigue life prediction investigation is presented in this paper. In this study, the effects of different parameters have been studied individually. Future research needs to consider interactive effects of those parameters because the wheel/rail contact problem is highly nonlinear. Also, other effects, such as residual stress from manufacturing, brake loading, thermal loading, dynamic and impact loadings, material defects, etc. need to be included in the proposed methodology.

Nevertheless, the presented numerical model enables a better understanding of the process of fatigue crack initiation, in the contact area—rolling–sliding boundary conditions on the contact surface are taken into consideration. This causes permanent damage to mechanical elements. Moreover, this model may be also used for practical applicability of contact fatigue of mechanical elements, e.g. the contact fatigue of gear teeth flanks

6. REFERENCES

[1] HOWELL, M., HAHN G.T., RUBIN, C.A., Finite element analysis of rolling contact for nonlinear kinematic hardening bearing steel, ASME J Tribol 1995; 117:729–36

[2] GUO, Y.B., BARKEY M.E,. Modeling of rolling contact fatigue for hard machined components with process-induced residual stress, Int J Fatigue 2004; 26(6):605–13

[3] OANTA E., NICOLESCU B., *Computer-aided approaches – a path to the information of synthesis in engineering*, Proceedings of the 5th International Conference on Quality, Reliability and Maintenance – QRM2004, ISBN 1-86058-440-3, University of Oxford, 1-2 April 2004, pag. 265-268.

[4] OANTA E., NITA A., *An Original Method to Compute the Stresses in Applied Elasticity*, Journal of Optoelectronics and Advanced Materials - Rapid Communications (OAM-RC), Editor in-chief: Prof. Dr. Mihai A. Popescu, ISSN: Print: 1842-6573, Vol. 3, No. 11, November 2009, pp. 1226-1230.

[5] SLADKOWSKI, A., SITARZ, M., 2005, *Analysis of wheel–rail interaction using FE software*, Wear. 258, 1217–1223.

[6] WIEST, M., KASSA, E., DAVES, W., Assessment of methods for *calculating contact pressure in wheel-rail/switch contact*, Wear., 265, 1439–1445.

FINITE ELEMENT MODELLING OF CONTACT INTERACTION BETWEEN WHEEL AND RAIL

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ABSTRACT

The development of contact theories and numerical solutions for various applications is a field which expands rapidly. Although railway system is a transportation system with a long tradition, still a large number of unsolved problems exist. One of these problems is the assessment of the stress and strain status of the rail and the wheel under rolling contact conditions. The assessment requires the investigation of the mechanically originated damage of wheel and rail, as cracklike damage, prediction of wear and fatigue as well as change of material properties. Since the mechanical problem is of high complexity because of the contact condition and the material behavior, only a numerical approach seems to be appropriate. This paper presents a method which has the advantage that the structural analyst is allowed to solve both the contact problem and material nonlinearity using an unique simulation model.

Keywords: *finite element, mesh, nonlinearity, contact.*

1. INTRODUCTION

Fatigue is progressive damage occurring in materials subjected to cyclic loads. The study of this phenomenon assumes special importance in the design of machinery and structures, since this is the most frequent cause of service rupture. As railways axle loads and speed increase, and wear prevention methods become more effective, it is crucial to implement solutions to prevent rolling contact fatigue. For example, increasing wear resistance of rails may imply that incipient surface cracks previously eliminated by wear, are no longer eliminated.

On wheels, fatigue cracks can be initiated not only on the surface but also under it. The initiation of surface cracks seems to be highly influenced by the presence of residual stresses and thermal loads, caused by a forced brake. According to elastic analyses the maximum shear stress appears between 4 and 5 mm under the wheel surface, however some cracks can be initiated at depths between 4 and 20 mm.

The phenomenon of fatigue in rail is more complicated because of load randomness. Maximum shear stress appears at a depth of 3 mm and cracks initiate between 3 and 15 mm below rail surface. Initiation of cracks under rail surface is very common in heavy haul rail.

2. FINITE ELEMENT MODEL

A 300 mm long rail was used to simulate the passage of the wheel and special attention was given to the contact surfaces, where smaller elements where used to correctly define it, since contact stresses are highly dependent of contact surface geometry. Figure 1 presents the mesh used for the rail. In order to reduce computational time, only a small part of the wheel was used as presented in figure 2, because only its surface geometry was needed. As shown in figure 3, a refined mesh was used on the contact surfaces.

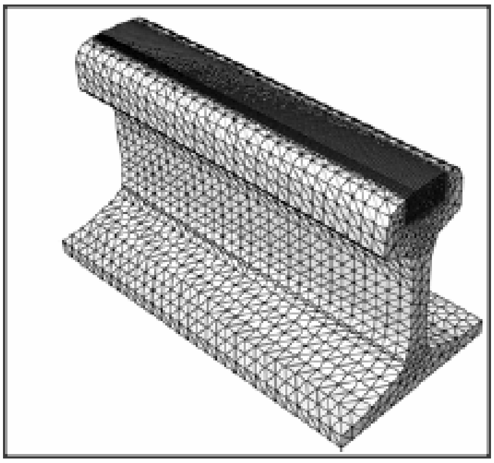

Figure 1 Rail mesh

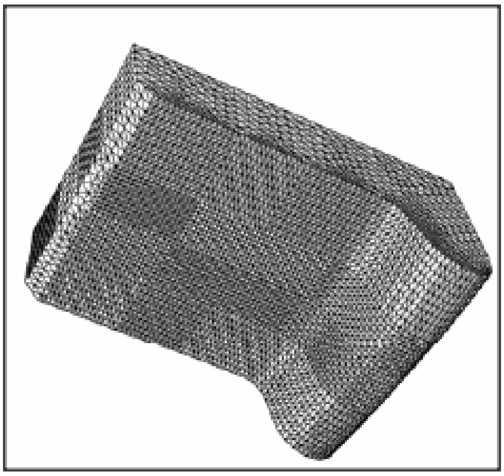

Figure 2 Wheel mesh

Parametric studies have been carried out for free rolling in order to obtain the contact stresses in normal and tangential direction. These data are fundamental for the investigation of friction and wear and they are offered to tribology experts for evaluation. In the next section there will be presented the results of the rolling contact of a wheel S1002 and a rail UIC60.

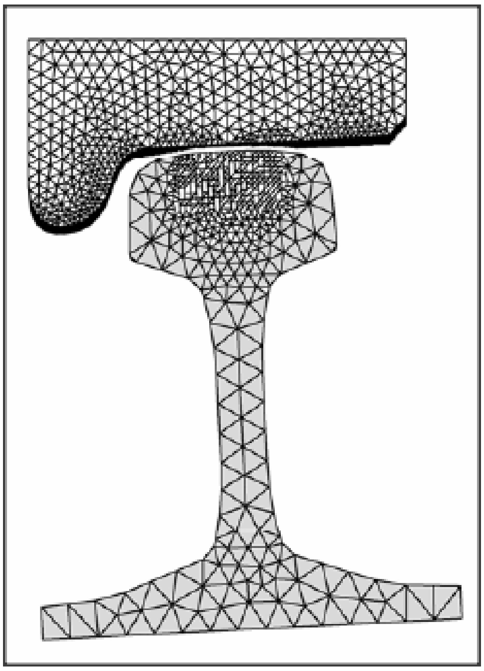

Figure 3 Model mesh

Dang Van proposed a fatigue initiation criteria based on the instantaneous value of shear stress $\tau_a(t)$ and hydrostatic stress $\sigma_h(t)$, [4]. This criterion states that fatigue failure will occur if the condition (1) is verified:

$$\tau_a(t) + a_{DV} \text{ x } \sigma_h(t) > \tau_{-1} \quad (1)$$

where:

- $\tau_a(t)$ - instantaneous shear stress value on a specific point;
- $\sigma_h(t)$ - instantaneous hydrostatic stress value on the considered point;
- τ_{-1} - material fatigue limit in reversed torsion;
- a_{DV} - adimensional constant, which represents the influence of hydrostatic stress, and can be determined by:

$$a_{DV} = \frac{\tau_{-1} - \frac{\sigma_{-1}}{2}}{\frac{\sigma_{-1}}{3}} \quad (2)$$

where σ_{-1} is the material fatigue limit in pure bending.

3. THE WHEEL-SET/RAILS SYSTEM

The shape profile of the wheels and of the rails section are S1002 and UIC60.

Table 1 summarizes the main geometric features of the wheel-set - rails system.

Table 1. Main geometric features of the wheel-rails

Internal gauge	1360 mm
Wheel radius	0,457 mm
Rail tilt	1/20

Figure 4 presents the axle, the two wheels (wheel-set) and the track considered in this investigation.

When not constrained, the wheel-set requires six degrees of freedom. These degrees-of-freedom reduce to two due to the constraints introduced by continuous contact with the rails. Thus, only two independent variables need to be prescribed to compute the spatial position of the wheel-set.

According to figure 5, a fixed and a moving righthand Cartesian coordinate systems are introduced. The fixed inertial coordinate system, denoted by SRo, has its origin O in the middle of the gauge, the axis Xo tangent to the rails and the Zo axis directed upwards.

The moving coordinate system, denoted by SRG, has its origin in the center of mass G of the wheel-set, axis YG directed along the axis of the axle and the ZG axis directed upwards. Initially the axes of the fixed and moving coordinate systems are all parallel and the center of mass G is on Zo axis at a distance rw from the origin O. The absolute coordinates of G will be denoted xg, yg, zg whereas θx, θy, θz denote the angles between couples of x, y and z axes respectively.

The displacement yg and the yaw angle θz are assumed to be independent variables; therefore, the four dependent variables should be deduced by imposing a continuous physical contact between rails and wheel-set.

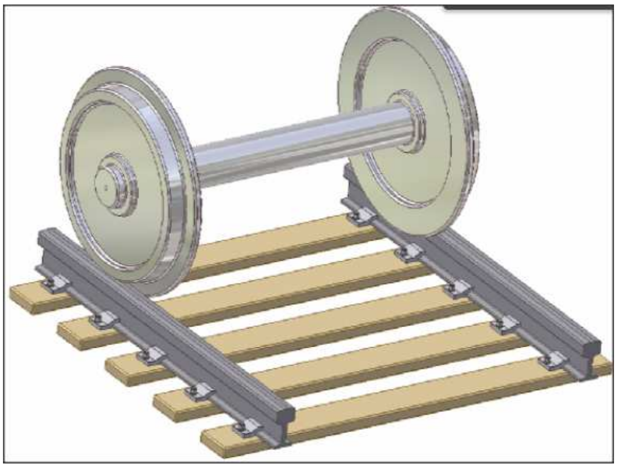

Figure 4 Physical model

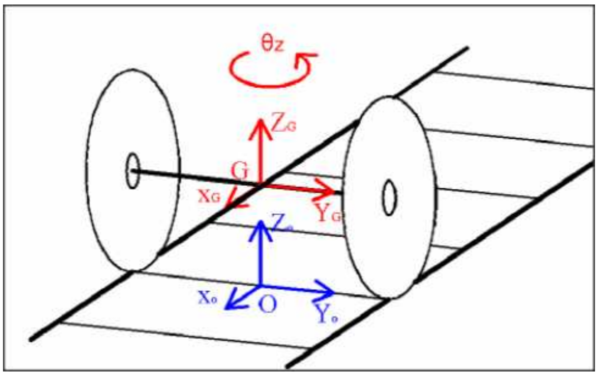

Figure 5 Cartesian coordinate systems and independent degrees of freedom of the axle

4. NUMERICAL RESULTS

The geometry of the investigated wheel as well as an appropriate finite element discretization is presented in figure 6. The wheel has a diameter of approximately 0.5 m, the contact zone has a size of approximately 2 cm^2. Further details of the discretization are also presented in figure 7.

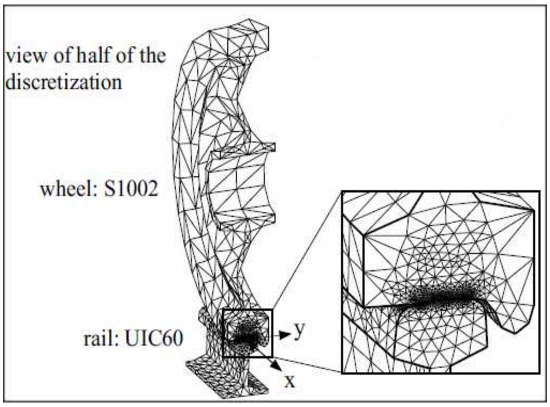

Figure 6 Finite element discretization of the wheel-rail contact

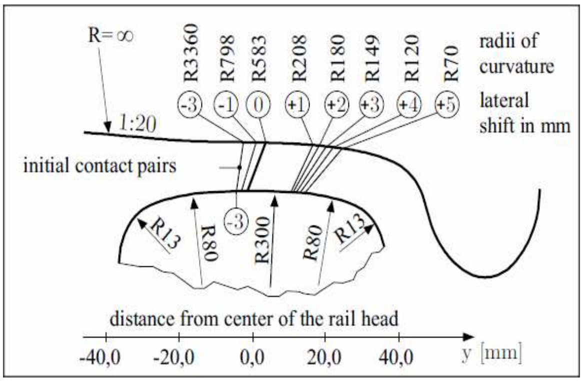

Figure 7 Parameter definition of the contact setup, radii of curvature

Linear elastic material behavior has been assumed with E = 210 GPa and ν = 0,3.

The results are significantly dependent on the contact conditions of wheel and rail at the contact point due to the different radii of curvature of the wheel with lateral shift. In general rolling conditions, the lateral wheel position on the rail is not fixed to the center line. Thus, parametric studies for different laterally shifted positions of the wheel were carried out, as presented in figure 7. For the velocity v = 200 km/h and a wheel load of 90 kN the comparison of the contact patches is presented in figure 8.

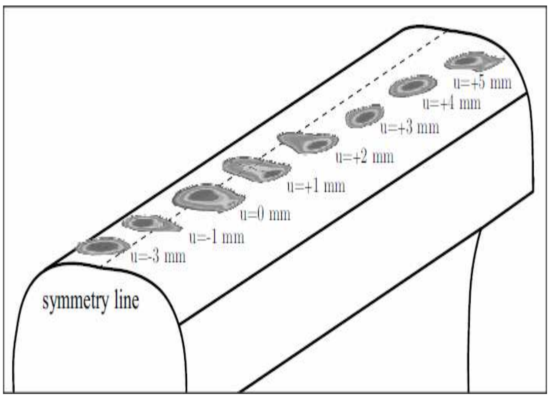

Figure 8 Comparison of the position of the contact patches for the variation of the lateral shift

Table 2. Scaled values of stresses for free rolling

lateral shift	$p^{(90)}$	$p^{Hertz(90)}$
mm	MPa	
-2	825,61	1162,7
-1	851,32	1854,64
0	805,61	2864,31
1	532,21	0
2	642,24	1482,0
3	835,15	1462,5
4	857,65	1354,6
5	622,22	0

One can notice the following aspects:
- the numerical solutions differ significantly with respect to the HERTZian solution, because of the nonlinerity of the finite element model;
- the maximum contact pressure is overestimated by the HERTZian theory;
- for some cases no corresponding HERTZian solution can be found, due to the curvature at the initial contact points.

5. WHEEL-RAIL CONTACT APPROACH

The rigid-contact hypothesis is based mainly on two approximations:
(1) the elastic deformation of the wheel and the rail is insignificant, allowing both of them to be treated as rigid solids;
(2) the contact is maintained between the wheel and the rail throughout the trajectory, ignoring the possibility of the wheel occasionally becoming separated from the rail.

Given the wheel and rail profiles, for each specific pair of values for the wheelset degrees of freedom *y* and a, only one specific pair of values (*z*, f) satisfies the rigid contact condition for both wheels (rigid contact hypothesis).

The elastic-contact hypothesis takes into account the existence of contact patches between the bodies, due to their elasticity; they are no longer regarded as rigid solids. The *z* and f degrees of freedom which were dependant in the rigid-contact hypothesis now become independent, since the condition that the contact between the wheel and the rail occurs at a point is not applicable any longer.

The phenomenon of a double contact point between wheel and rail can be resolved simply, identifying the two interpenetration areas and calculating the normal forces separately, figures 9, 10 and 11.

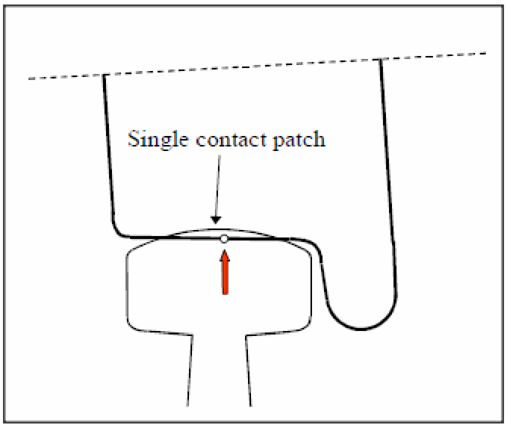

Figure 9. Single-point contact

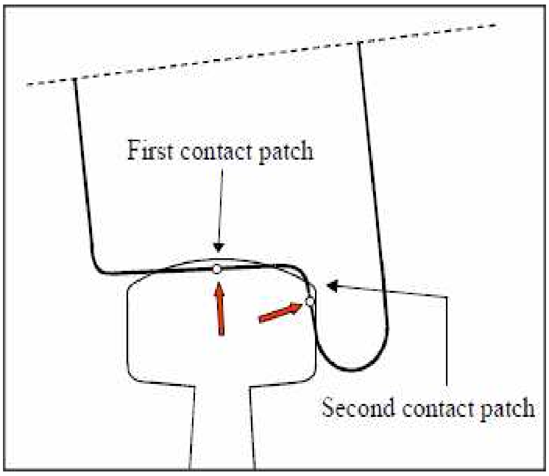

Figure 10. Two-point contact

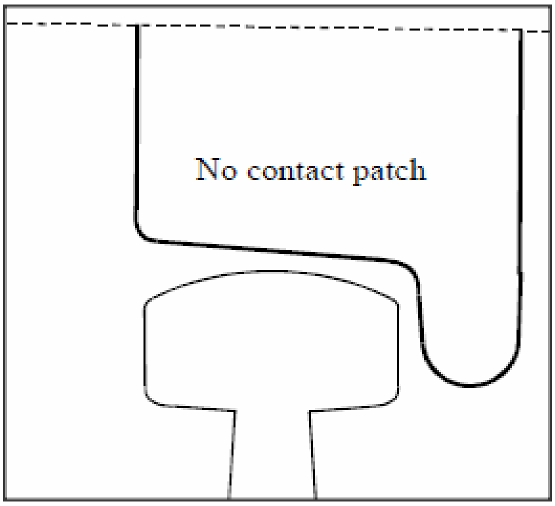

Figure 11 No point contact

The search for the contact patches between the wheel and the rail, and the calculation of the corresponding normal forces, is relatively expensive in computational terms. For this reason, to reduce the calculation times, the problem is normally solved in two dimensions, assuming that the contact patches are located on a vertical diametric section of the wheel. This is equivalent to consider that the influence of the yaw angle ‘a’ on the location of the contact patches is ignored. By neglecting this degree of freedom, the location and dimensions of the contact patches depend only on the values of *y*, *z* and f.

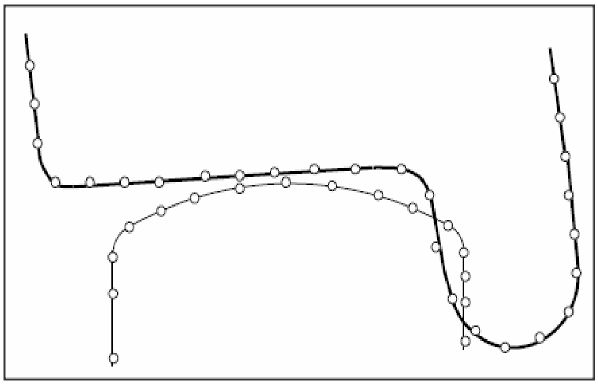

Figure 12. Wheel and rail profiles are defined by discrete points

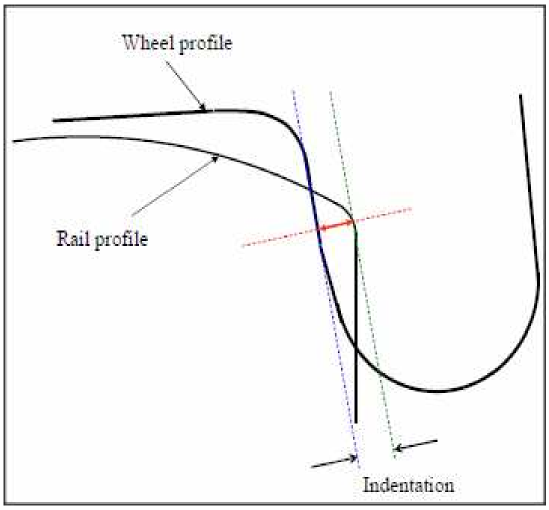

Figure 13. Indentation of the contact patch

To model the profiles, discrete points are used (separated by 0.5 mm to 3 mm), and spline equations are used to interpolate between these points, figure 12. Spline functions offer a set of important advantages in the creation of the computer based models where interpolation is required, [5]. The profile of the wheel is scanned to delimit the zone or zones where interpenetration occurs. In each of these zones, by using the cubic spline curves, the maximum indentation that occurs in the direction normal to the wheel profile is calculated, figure 13. Using the Hertz theory, and given the value of maximum indentation, the radii of curvature of the solids at the contact point and the elastic constants of the material, the normal force that would have to be applied in order to produce such indentation can be calculated. The relationship between force and indentation is nonlinear, and is governed by the well-known expression: $N = C \cdot \delta^{3/2}$, where N is the normal force, d is the indentation and C is a constant that depends on the curvatures and the elastic constants of the bodies.

The data that is strictly necessary for the subsequent dynamic simulation is the number and position(s) of the contact point(s), and the contact angles, indentations and curvatures of each of them. The normal forces could be calculated from the indentations and the curvatures, but in order to speed up the subsequent dynamic calculations, they are also stored in the look-up table. Since they may be of interest, the dimensions of the contact ellipse are also stored. It is important to realise that these dimensions do not correspond to the interpenetration regions obtained by superimposing the two rigid solids, due to the elastic deformation of the bodies, and they have to be derived using the Hertz theory.

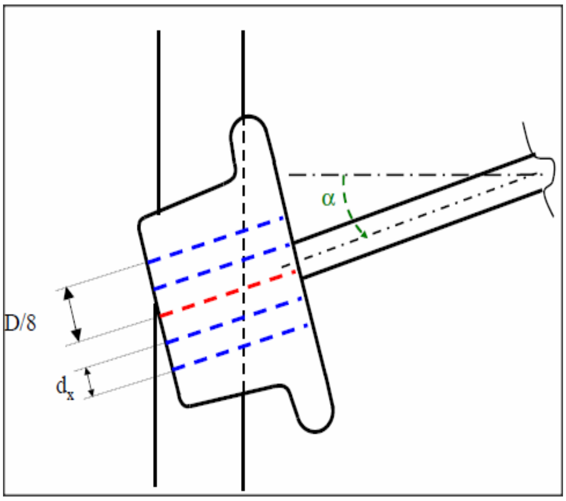

Figure 14. Longitudinal scan of the solids and the contact patch

In order to include all the possible positions that the wheelset could reach during a dynamic simulation, it is necessary to calculate the wheel-rail contact data for a large amount of cases. During the simulation, the elastic contact information at each integration step is obtained by interpolation of the adjacent data in the table. The crucial point is that the number of discrete positions calculated in the tables has to be large enough to detect the two-point contact cases if this may happen. For example, when the wheelset moves laterally and the contact point jumps from the tread to the flange of the wheel, two-point contact will probably occur for certain lateral displacements and angles of attack (*y*, a) of the wheelset.

The size of the table should be adequate in order to include enough realistic cases of two-point contact for these displacements. In this way, their interpolation will be possible during the simulation.

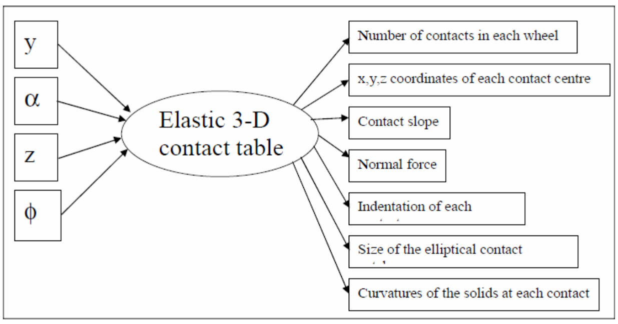

Figure 14. Inputs and outputs of the look-up table with the elastic three-dimensional contact data

Having established the number of discrete positions that will be calculated for each degree of freedom, and the range of values to be used, the elastic contact problem has to be solved for each combination of *y*, a, *z* and f. The results are stored in the elastic contact table. If the number of combinations is very high, the time required to calculate the entire table might be so high that the advantages of the proposed method are lost. In order to speed up the table calculations, a number of techniques are used, including the use of symmetries and their corresponding relationships (which allows just one half of the wheel to be scanned) and splitting the scan into two phases: the search phase, with a large scan step, to detect the regions of contact, and the fine scan, in which the maximum indentations are calculated using smaller steps.

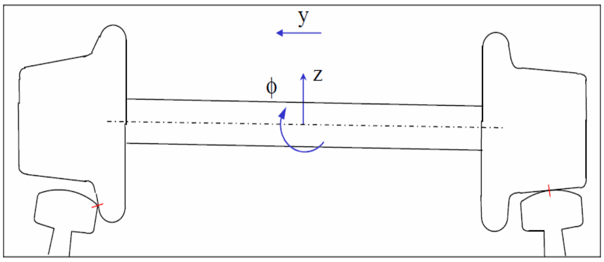

Figure 15.Rigid contact approach

However, the technique that probably contributes most to the efficiency of the method described here is the use of the results obtained for the rigid-contact problem as a base for the elastic-contact calculations. The values of indentation are very small, since the wheel and the rail are made of steel and their stiffnesses are high.

There is a direct relationship between the position of the wheelset relative to the track and the indentations in the contact patches, which can be obtained using linear interpolation. The normal forces, however, are related to the indentations by the expression:

$$N = C \cdot \delta^{3/2} \quad (3)$$

so their relationships to the degrees of freedom of the wheelset are non-linear.

One option, since the value of indentation is known, is to recalculate the corresponding normal force using the Hertz theory.

The other option is to interpolate the coefficients:

$$C_i = \frac{N_i}{\delta_i^{\frac{3}{2}}} \quad (4)$$

instead of interpolating the normal forces.

This coefficient and the interpolated indentation give the normal force using (3).

It has been concluded that this method greatly improves the accuracy of the results.

The semiaxes of the contact ellipse also depend non-linearly on the indentation value. The relationship in this case is:

$$a = K \cdot \delta^{1/2} \quad (6)$$

$$b = K' \cdot \delta^{1/2} \quad (7)$$

where a and b are the dimensions of the major and minor axes of the contact ellipse. The interpolation procedure is the same as that described for the normal forces, except that we now interpolate the K coefficients, obtained from:

$$K_i = \frac{a_i}{\delta^{\frac{1}{2}}} \quad (8)$$

5. CONCLUDING REMARKS

A nonlinear analysis of the stress/strain state resulting of the passage of one wheel on a segment of rail was performed using non-linear finite elements.

The analysis is presented in the present paper through the data corresponding to the first passage; subsequent work will consist of a fatigue behaviour characterization of the rail using a more refined mesh and simulating the number of passages necessary to reach a steady state characterized by the repetition of the loading path. Residual stress state is another direction of investigation, prior experience being available, [7].

The differences in wear indices, running safety coefficient and forces in the contact areas can differ significantly, depending on whether a 2-D or 3-D contact analysis is used, as long as the yaw angle reaches significant values. These differences become insignificant on straight tracks or in large-radii curves.

Therefore, the aforemetionned method is specially suitable when analysing vehicles that will be used on rails with tight curves.

6. REFERENCES

[1] BATHE, K., *Finite-Elemente-Methoden*, Springer-Verlag, Berlin 1990.

[2] CRISFIELD, M. A.: *Non-Linear Finite Element Analysis of Solids and Structures – Advanced Topics*, Wiley & Sons, New York 1998.

[3] DANG VAN, K., GRIVEANU, B., O., *On a new multiaxial fatigue limit criterion: theory and applications, Biaxial and Multiaxial Fatigue*, Edited by M. W. Brown and K. J. Miller, 1989, Mechanical Engineering Publications, London p.479-496.

[4] DANG VAN, K., MAITOURNAM, M. H., *On some recent trends in modelling of contact fatigue and wear in rail*, *Wear*, Vol. 253 (2002), p 219-227.

[5] GAVRILA G., OANTA E., *Interpolation and Computer Based Models*, Annals of DAAAM for 2009 & Proceedings of The 20th DAAAM World Symposium Vienna, 25-28 Nov 2009, Vienna, Austria, Organized by Danube Adria Association for Automation & Manufacturing, Vienna University of Technology, University of Applied Sciences Technikum Vienna,
Austrian Society of Engineers and Architects - OIAV 1848, Editor B. Katalinic, ISBN 978-3-901509-70-4, ISSN 1726-9679, ID 835, pag. 579-580

[6] JOHNSON, K.L., 1985, *Contact Mechanics,* Cambridge University Press.

[7] NITA A., OANTA E., *Improving the quality of the molded polymeric parts by reducing the residual stress*, Proceedings of the 2nd International Conference on Manufacturing Engineering, Quality and Production Systems (MEQAPS '10), ISSN: 1792-4693, ISBN: 978-960-474-220-2, pp. 77-82, Constantza Maritime University, Constantza, Romania, September 3-5, 2010.

[8] VADILLO, E.G., GIEMENEZ, J.G., 1985, *Influence of the yaw rotation on the wheel – rail contact parameters*, Procceedings of the 8th international wheelset congress 1 II.4 1-15.

SCIENCE BASED DECISIONS IN COMPLEX EMERGENCY SITUATIONS

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ABSTRACT

Because of the complex and dynamic nowadays conditions, the paper proposes a general frame of a decision making process based on scientific information. There are analyzed the main classes of information to be used, the location of the headquarters together with the appropriate equipment, the advanced graphic facilities which can be used and the complex models employed to support the decision process. A later development of the concept must take into consideration the partial access to the information and a fuzzy logic employed to suggest the best options to be chosen. Experienced and scientific-based minds are the most important human resources for the decision making process in emergency situations.

Keywords: *knowledge management, advanced graphical facilities, complex models, science-based decisions*

1. INTRODUCTION

Actual world is complex and dynamic and the instruments employed to explore its unknown facets must be fast, accurate and intelligent.

Emergency situations are events which require decisions to minimize the losses of lives, financial losses and the additional long run threats, which must be made in a short period, taking into account various aspects.

Because of the high complexity of the emergency situations, optimum decisions must be supported on accurate qualitative and quantitative instruments which allow the analyst to observe the events, to predict the evolution, to elaborate the decision and to control the outcomes.

Information technology offers versatile instruments employed to assist the decision and the paper presents three directions of such instruments: knowledge management, advanced graphics for the emergency scene representation and complex science-based models for emergency situations.

2. ASPECTS REGARDING THE KNOWLEDGE MANAGEMENT FOR EMERGENCY SITUATIONS

The process of data acquisition and reduction employed to support decisions has three aspects:

- selection of the classes of information which are useful for the decision support;
- methods of data reduction which can offer refined information;
- equipment necessary for data management from different locations of the headquarters.

2.1 Classes of information

Several classes of information are necessary in order to have an overview regarding the on-going phenomena, [4].

Geographical information represents the 'stage' of the emergency situation. GIS systems offer such information. It is important to export the content in order to create a customized representation of the 'stage'.

Weather conditions are important for both expansion of the pollutants or fire and for the intervention means. There are sites which present the wind speed and temperature. Additional information is needed, such as the speed of the marine currents.

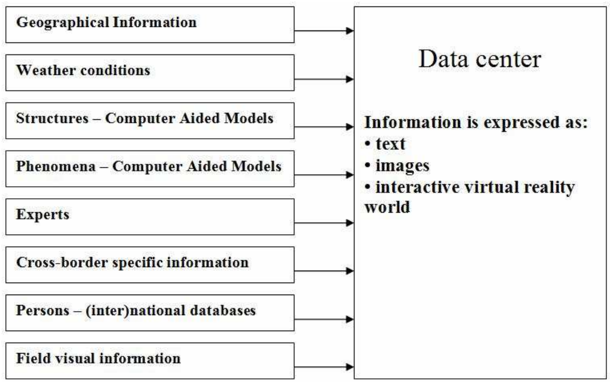

Figure 1 Data concentration for emergency situations

Computer aided models of different structures, such as buildings, towers, bridges, tunnels, dams, piers, cranes. At least some parameterized prototypes are necessary in order to create a particular model of that given structure.

Computer aided models of the phenomena are important in order to predict the evolution of the pollutant/fire and to select the most effective option of intervention.

Pollution scenarios must consider a domain which may be in several countries. This is why it is important to gather information from all the countries which may be involved in the event, including the law which may be applied in that given case.

Access to the databases regarding the persons involved in the event must be allowed, prior agreements being important to be signed with various countries and institutions.

Field visual information must be gathered from various sources such as satellites, cameras, field observers and others.

2.2 Data processing

The information system of a company offers a dashboard of specific updated indicators for each level of the management staff. In this way each manager is able to make the most appropriate decision. As well, the management of a crisis situation must rely on updated information and a set of indicators which may be either so called ‘classic’, or specific for the features of that given phenomenon.

A first stage is to gather the data in a datacenter which may be remotely consulted and archived for a later analysis.

Incoming data must be processed, assembled and refined in order to offer a high degree of relevancy.

Some of the data is already integrated using specialized simulators, like the oil leak simulator

2.3 Location of the situation managing board

The headquarters of the crisis managing board is usually the so-called situation room which offers access to all the aforementioned information and to extensive communication facilities.

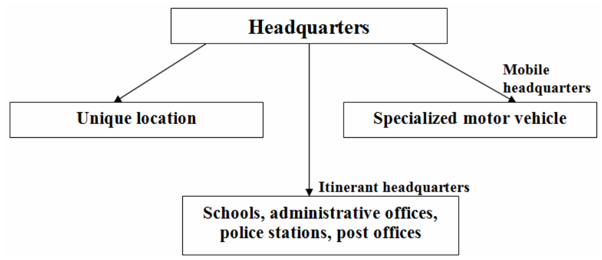

Figure 2 Equipment for the situation room within the headquarters of the emergency committee

The headquarters must offer fast links to the data sources or to the datacenter. Because of this condition, there are three possible locations: a unique location which has fast connections, itinerant headquarters which can use the network of an administrative organization in order to set-up a situation room or a specialized vehicle which is used to access the refined data, ready to be interpreted and used.

These three possibilities reveal some measures to be undertaken in terms of data acquisition, data processing, technical teams and expert teams which must backup the management level and equipment which must be installed in all these types of headquarters.

It should be also considered a certain degree of redundancy of the headquarters to be used in these operations. Moreover, all the equipment must be periodically tested and updated in order to maintain it operational capacity.

As a final remark, one can notice that in all these situations data protection is paramount.

3. ADVANCED GRAPHICS FACILITIES

A word of wisdom says ‘an image prevails one hundred words’. Human eye has the paramount capacity to integrate the information and to notice the according trends. Human vision has a dedicated ‘processor’, it means a ‘brain’ of its own.

From this standpoint, the advanced graphics facilities are very important for the decision making process of an emergency situation.

Virtual reality is an intelligent resource which has not proved yet its power. Several research projects were dedicated to the use of virtual reality for various purposes, including emergency situations.

Figures 3 and 4 present some applications of the virtual reality for an oil leak scenario.

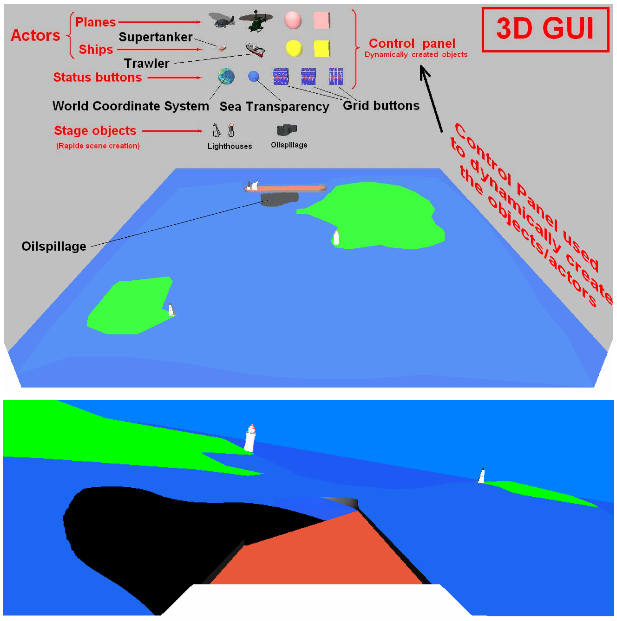

Figure 3 A virtual reality solution which uses ECMA script for the ‘engine’ of functionalities

Figure 3 proposes a set of specific functionalities based on ECMA and VRML.

First of all, it should be noticed that the scenario is included in a quadrant which presents the geographical particulars: islands, light towers, depths of the seabed. The sea has the transparency attribute adjustable, so the user can see the objects underneath the sea surface, including the seabed.

Objects hanging on the front wall may be touched and consequently they are introduced into the virtual world. Once included in the ‘scene’, if the object is touched a system of axes appears. The object can be moved into the scene if the axes are touched. The lines of the axes are used for the translation motion and the arrows are used for rotations. If the object is touched one more time, the axes disappear and the vehicle is realistically presented into the 3D scene.

Beside the ‘vehicles’, there are also instruments, such as: system of axis, grids on horizontal or on side geometrical planes.

Geometrical data are generated by the geographical information which is converted in such a way the elevations of the land and undersea surfaced are computed in the nodes of a grid which is used in the virtual reality code.

Several viewpoints may be set on land or on the ship, so there can be noticed the images which can be seen from the navigation bridge and compared with the photos taken and sent by the field operators.

Infrared photography is another source of valuable information, especially when fog and/or smoke are covering the scene.

The application may be operated by a unique operator who moves the objects along the scene, sets various attributes of the ‘environment’ and sends the screen shots to the screens of the situation room.

The operator is also responsible for the creation of the geometry of the quadrant, using the virtual objects stored in the library of the application, as well as the geometrical information.

This approach is dedicated to the Windows operating system terminals. It is not cross-platform, so it was not considered for further development.

A Java based solution is presented in figure 4.

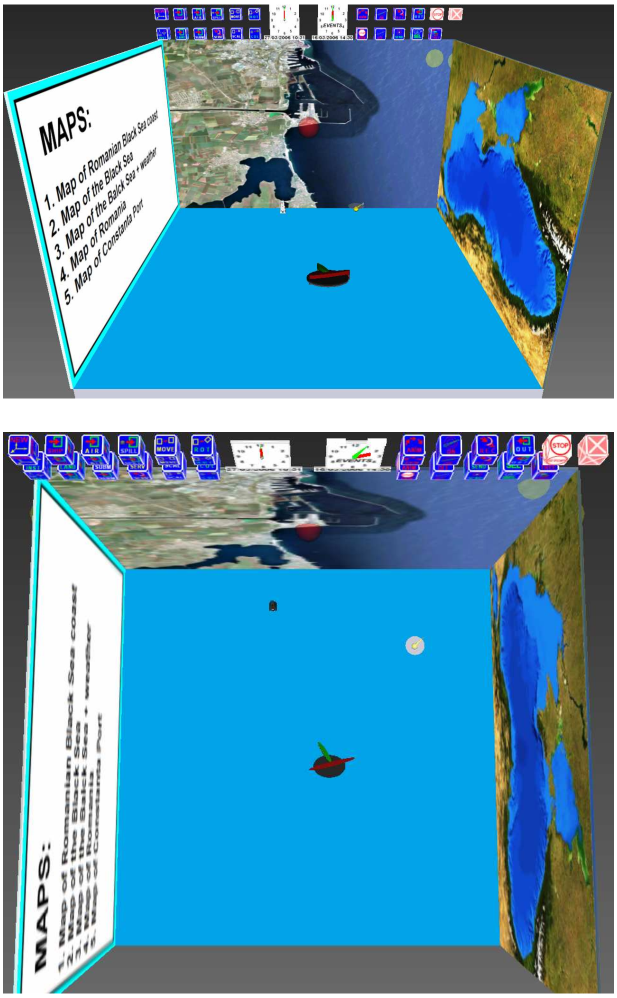

Figure 4 Advanced virtual reality solution which uses JAVA for the ‘engine’ of functionalities

As it can be used the domain is also organized on quadrants. On the walls of the quadrant there are presented different images who may present maps, reports, ‘actors’ who act on the ‘scene’ and others.

The domain is defined as in the previous case, by the analyst who is supervising the virtual reality system.

The huge difference of this solution with respect to the previous one is that the control of the vehicles is distributed to their representatives. In this way the captain of a ship can move its own ship in the virtual scene, fact which offers a higher degree of accuracy of the virtual reality 3D aid. Moreover, if the connection between the remote representative/captain and the virtual world is lost, the virtual reality analyst is allowed to seize the command of the virtual ship.

Buttons on the upmost edge of the front wall are employed to operate the vehicles. The images displayed on the buttons were chosen in order to be clearly understood by people originating from various cultures.

Figure 4 also presents a helicopter which enters the scene in order to analyze the crisis and to assist the crew on the collided ships.

The analyst is allowed to use several instruments. In the second image of figure 4, it can be noticed a set of circles located over of the oil spill, which are employed to measure the surface of the polluted area.

Operations done in the virtual world are stored in a database for a later analysis. Clocks presented at the upmost edge of the front plane present the real time as well as the event-time, for the movie-like presentation of a given emergency situation scenario.

To conclude, virtual reality has the ‘ingredients’ of the most successful method to present the visual information in an emergency situation. Java offers the facilities to create game-like applications which have important strengths, such as: realistic graphics, remote operated vehicles, various viewpoints, high flexibility, cross-platform versions of the software.

It results that the software applications based on virtual reality have a huge potential of development in the upcoming years.

4. BASIC CONCEPTS REGARDING THE COMPLEX MODELS

Complex emergency situations require intelligent instruments of investigation and prediction which offer a solution in a small amount of time. Decisions in emergency situations are supported by relevant information and there must be noticed that certain levels to approach a problem offer distinct results in terms of intelligence and relevancy.

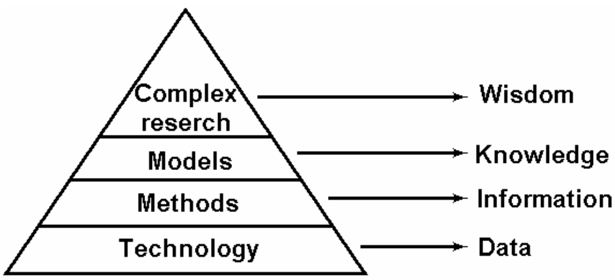

Figure 5 – Outcome of the levels of intelligence of the approach

Figure above depicts the idea that complex models which take into account several influences offer a more profound vision regarding the phenomena.

An important strategy to reach a high level of understanding of the phenomena is to use instruments which integrate various methods of interdisciplinary and inter-domain research. Most of these instruments are computer-based and they may be applied with small changes in several types of studies.

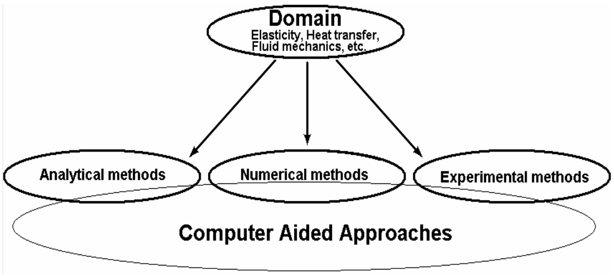

Figure 6 Integration of the results of various models in engineering

A set of generalized complex models for most common scenarios of emergency situations may be created, such as fluid-structure interaction, study of the building-soil system under various loads, dissemination of a pollutant, minimum path for emergency situation vehicles, metal structures under extreme temperatures, new chemical and biological means of depollution. Identification of the methods to calibrate these models according to the on-going event is another problem to be solved in order to have accurate results.

5. CONCLUSIONS

Science offers today the technologies and the instruments which may be very useful to support decisions in emergency situations.

The paper is a synthesis of ideas which offer the opportunity to explore some directions to be followed in the upcoming years in order to create the grounds of the scientific based decisions in a world where the intelligence has an increasing importance.

6. ACKNOWLEDGEMENT

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7. REFERENCES

[1] BERESCU, S., MARPOL and OPA conventions regarding oil pollution, Ovidius University Annals Series: Civil Engineering Volume 1, Issue 12, June 2010

[2] BERESCU, S.; NITA, A.; RAICU, G, Modern Solutions used in Maritime Pollution Prevention, Ovidius University Annals Series: Civil Engineering Volume 1, Issue 12, June 2010

[3] OANTA, E., *Virtual Reality Original Instrument Employed in Crises Management*, Proceedings of the 12th International Congress of the International Maritime Association of the Mediterranean (IMAM2007), Varna, Bulgaria, 2-6 September 2007, Maritime Industry, Ocean Engineering and Costal Resources – Editors: Guedes Soares & Kolev, 2008 Taylor & Francis Group, London, ISBN 978-0-415-45523-7, pg. 1095-1102

[4] OANTA, E.; TAMAS, I.; ODAGESCU, I., *A Proposal for a Knowledge Management System for Emergency Situations*, Proceedings of the 4th International Conference on Knowledge Management: Projects, Systems and Technologies, Section III. KM Projects, Organized by Project Management Association, "Carol I" National Defense University, Academy of Economic Studies, November 6-7, 2009, Bucharest, Romania, Editors: Toma Plesanu, Luiza Kraft, ISBN DVD 978-973-663-784-1, ISBN hardcopy: 978-973-663-783-4, pp. 143-145

[5] OANTA, E.; PANAIT, C.; MARINA, V.; MARINA, V.; LEPADATU, L.; CONSTANTINESCU, E.; BARHALESCU, M. L.; SABAU, A. & DUMITRACHE, C. L.: *Mathematical Composite Models, a Path to Solve Research Complex Problems*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISBN 978-3-901509-83-4, ISSN 1726-9679, pg. 0501-0502, Editor Branko Katalinic, Published by DAAAM International, Vienna, Austria 2011

A NEW INNOVATIVE DIRECT DISTRIBUTED INJECTION SYSTEM OF FUEL FOR INTERNAL COMBUSTION ENGINES

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ABSTRACT

This paperwork is proving via numerical simulation using the renowned software Fluent that the proposed Invention Patent is feasible as a viable solution to improve the combustion conditions inside the combustion chambers of the internal combustion Engines. The Romanian Invention Patent Number 123482 is protected according the International Laws. Fuel injection is a system for admitting fuel into an internal combustion engine. It has become the primary fuel delivery system used in automotive engines, having replaced carburetors during the 1980s and 1990s. A variety of injection systems have existed since the earliest usage of the internal combustion engine. The Authors are proposing a new concept of a new Direct Distributed Injection System of Fuel for Combustion Engines. The fuel injection systems that exist and are deployed in practice have an essential shortcoming: the fuel is injected inside the cylinder using a single injector that disregarding the complexity, being placed in a central position, it cannot fill completely the combustion chamber and the mixture rates between fuel-air, due to the fact that the fuel droplets are leaving from a single central point, cannot collide one against other, so that the said fuel-air mixing rates are lower since the dimensions of the fuel droplets are relatively rough. The Invention is proposing a shift of the injection paradigm, instead of using one central injector to have in place an injection system which is leading to better colliding conditions of fuel droplets against each-other, with the end of a finer diameter of the resulting fuel droplets which in turn will lead to better combustion conditions.

Keywords: *Fuel Injection; Internal combustion Engines; Direct Distributed Injection System; Injection Plate; Numerical Simulation; Invention Patent*

1. INTRODUCTION/HISTORY

Fuel injection is a system for admitting fuel into an internal combustion engine. It has become the primary fuel delivery system used in automotive engines, having replaced carburetors during the 1980s and 1990s. A variety of injection systems have existed since the earliest usage of the internal combustion engine.

The primary difference between carburetors and fuel injection is that fuel injection atomizes the fuel by forcibly pumping it through a small nozzle under high pressure, while a carburetor relies on suction created by intake air accelerated through a Venturi tube to draw the fuel into the airstream.

Modern fuel injection systems are designed specifically for the type of fuel being used. Some systems are designed for multiple grades of fuel (using sensors to adapt the tuning for the fuel currently used). Most fuel injection systems are for gasoline or diesel applications.

The functional objectives for fuel injection systems can vary. All share the central task of supplying fuel to the combustion process, but it is a design decision how a particular system is optimized. There are several competing objectives such as:

- Power output
- Fuel efficiency
- Emissions performance
- Ability to accommodate alternative fuels
- Reliability
- Driveability and smooth operation
- Initial cost
- Maintenance cost
- Diagnostic capability
- Range of environmental operation
- Engine tuning

The modern digital electronic fuel injection system is more capable at optimizing these competing objectives consistently than earlier fuel delivery systems (such as carburetors). Carburetors have the potential to atomize fuel better (see Pogue and Allen Caggiano patents).

Operational benefits to the driver of a fuel-injected car include smoother and more dependable engine response during quick throttle transitions, easier and more dependable engine starting, better operation at extremely high or low ambient temperatures, increased maintenance intervals, and increased fuel efficiency. On a more basic level, fuel injection does away with the choke, which on carburetor-equipped vehicles must be operated when starting the engine from cold and then adjusted as the engine warms up.

Fuel injection generally increases engine fuel efficiency. With the improved cylinder-to-cylinder fuel distribution of multi-point fuel injection, less fuel is needed for the same power output (when cylinder-to-cylinder distribution varies significantly, some cylinders receive excess fuel as a side effect of ensuring that all cylinders receive sufficient fuel).

Exhaust emissions are cleaner because the more precise and accurate fuel metering reduces the concentration of toxic combustion byproducts leaving the engine, and because exhaust cleanup devices such as the catalytic converter can be optimized to operate more efficiently since the exhaust is of consistent and predictable composition.

Herbert Akroyd Stuart developed the first device with a design similar to modern fuel injection using a 'jerk pump' to meter out fuel oil at high pressure to an injector. This system was used on the hot bulb engine and was adapted and improved by Bosch and Clessie Cummins for use on diesel engines (Rudolf Diesel's original system employed a cumbersome 'air-blast' system using highly compressed air). Fuel injection was in widespread commercial use in diesel engines by the mid-1920s.

The first use of gasoline direct injection (i.e. injection of gasoline, also known as petrol) was on the Hesselman engine invented by Swedish engineer Jonas Hesselman in 1925. Hesselman engines use the ultra lean burn principle; fuel is injected toward the end of the compression stroke, then ignited with a spark plug. They are often started on gasoline and then switched to diesel or kerosene.[3]

Direct fuel injection was used in notable WWII aero-engines such as the Junkers Jumo 210, the Daimler-Benz DB 601, the BMW 801, the Shvetsov ASh-82FN (M-82FN). German direct injection petrol engines used injection systems developed by Bosch from their diesel injection systems. Later versions of the Rolls-Royce Merlin and Wright R-3350 used single point fuel injection, at the time called "Pressure Carburettor". Due to the wartime relationship between Germany and Japan, Mitsubishi also had two radial aircraft engines utilizing fuel injection, the Mitsubishi Kinsei (*kinsei* means "venus") and the Mitsubishi Kasei (*kasei* means "mars").

Alfa Romeo tested one of the very first electronic injection systems (Caproni-Fuscaldo) in Alfa Romeo 6C2500 with "Ala spessa" body in 1940 Mille Miglia. The engine had six electrically operated injectors and were fed by a semi-high pressure circulating fuel pump system.[4]

In internal combustion engines, Gasoline Direct Injection(GDI), also known as Petrol Direct Injection or Direct Petrol Injection or Spark Ignited Direct Injection(SIDI) or Fuel Stratified Injection(FSI), is a variant of fuel injection employed in modern two-stroke and four-stroke gasoline engines. The gasoline is highly pressurized, and injected via a common rail fuel line directly into the combustion chamber of each cylinder, as opposed to conventional multi-point fuel injection that happens in the intake tract, or cylinder port.

In some applications, gasoline direct injection enables a stratified fuel charge (ultra lean burn) combustion for improved fuel efficiency, and reduced emission levels at low load.

The major advantages of a GDI engine are increased fuel efficiency and high power output. Emissions levels can also be more accurately controlled with the GDI system. The cited gains are achieved by the precise control over the amount of fuel and injection timings that are varied according to engine load. In addition, there are no throttling losses in some GDI engines, when compared to a conventional fuel-injected or carbureted engine, which greatly improves efficiency, and reduces 'pumping losses' in engines without a throttle plate. Engine speed is controlled by the engine control unit/engine management system (EMS), which regulates fuel injection function and ignition timing, instead of having a throttle plate that restricts the incoming air supply. Adding this function to the EMS requires considerable enhancement of its processing and memory, as direct injection plus the engine speed management must have very precise algorithms for good performance and drivability.

The engine management system continually chooses among three combustion modes: ultra lean burn, stoichiometric, and full power output. Each mode is characterized by the air-fuel ratio. The stoichiometric air-fuel ratio for gasoline is 14.7:1 by weight, but ultra lean mode can involve ratios as high as 65:1 (or even higher in some engines, for very limited periods). These mixtures are much leaner than in a conventional engine and reduce fuel consumption considerably.

Ultra lean burn or stratified charge mode is used for light-load running conditions, at constant or reducing road speeds, where no acceleration is required. The fuel is not injected at the intake stroke but rather at the latter stages of the compression stroke. The combustion takes place in a cavity on the piston's surface which has a toroidal or an ovoidal shape, and is placed either in the center (for central injector), or displaced to one side of the piston that is closer to the injector. The cavity creates the swirl effect so that the small amount of air-fuel mixture is optimally placed near the spark plug. This stratified charge is surrounded mostly by air and residual gases, which keeps the fuel and the flame away from the cylinder walls. Decreased combustion temperature allows for lowest emissions and heat losses and increases air quantity by reducing dilation, which delivers additional power. This technique enables the use of ultra-lean mixtures that would be impossible with carburetors or conventional fuel injection.[1], [2], [3]

• Stoichiometric mode is used for moderate load conditions. Fuel is injected during the intake stroke, creating a homogeneous fuel-air mixture in the cylinder. From the stoichiometric ratio, an optimum burn results in a clean exhaust emission, further cleaned by the catalytic converter.

• Full power mode is used for rapid acceleration and heavy loads (as when climbing a hill). The air-fuel mixture is homogeneous and the ratio is slightly richer than stoichiometric, which helps prevent knock (pinking). The fuel is injected during the intake stroke.

It is also possible to inject more than once during a single cycle. After the first fuel charge has been ignited, it is possible to add fuel as the piston descends. The benefits are more power and economy, but certain octane fuels have been seen to cause exhaust valve erosion.

Swirl injectors are used in liquid rocket, gas turbine, and diesel engines to improve atomization and mixing efficiency.

The circumferential velocity component is first generated as the propellant enters through helical or tangential inlets producing a thin, swirling liquid sheet. A gas-filled hollow core is then formed along the centerline inside the injector due to centrifugal force of the liquid sheet. Because of the presence of the gas core, the discharge coefficient is generally low. In swirl injector, the spray cone angle is controlled by the ratio of the circumferential velocity to the axial velocity and is generally wide compared with nonswirl injectors.[23]

2. A NEW DIRECT DISTRIBUTED INJECTION SYSTEM OF FUEL FOR COMBUSTION ENGINES-INVENTION PATENT NO. 123482 PRESENTATION

The Authors are proposing a new concept of a new Direct Distributed Injection System of Fuel for Combustion Engines. As a general conclusion derived from the above short history, the fuel injection systems that exist and are deployed in practice have an essential shortcoming: the fuel is injected inside the cylinder using a single injector that disregarding the complexity, being placed in a central position, it cannot fill completely the combustion chamber and the mixture rates between fuel-air, due to the fact that the fuel droplets are leaving from a single central point, cannot collide one against other, so that the said fuel-air mixing rates are lower since the dimensions of the fuel droplets are relatively rough.

The Invention is proposing a shift of the injection paradigm, instead of using one central injector to have in place an injection system which is leading to better colliding conditions of fuel droplets against each-other, with the end of a finer diameter of the resulting fuel droplets which in turn will lead to better combustion conditions.

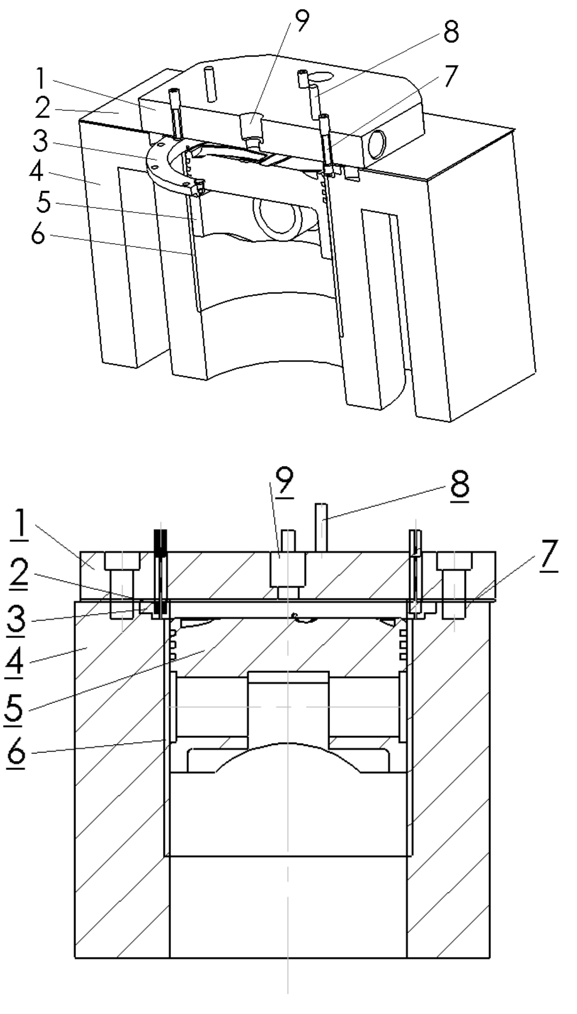
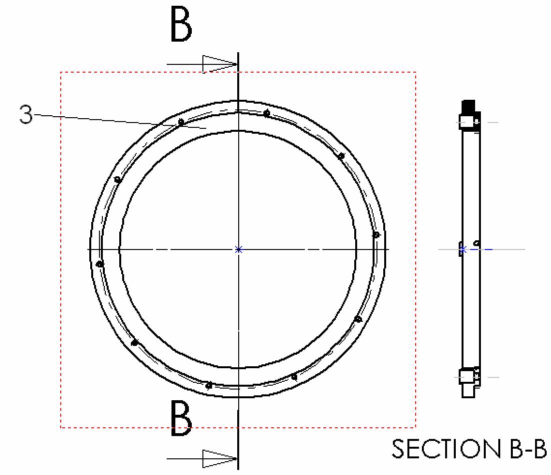
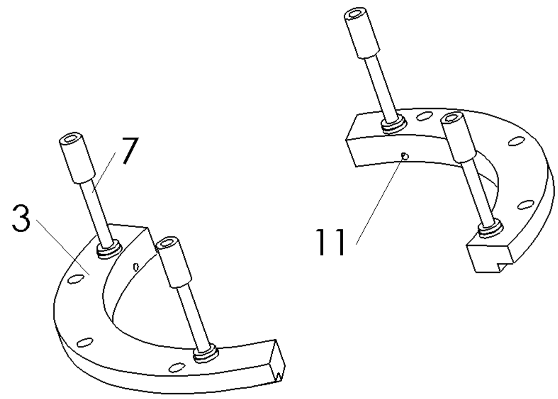


Figure 1 3D View and Cross-section of a combustion cylinder with Direct Distributed Injection System

In Figure 1 are given some details regarding the proposed injection system in which: (1)-is the cylinder cover; (2)-the sealing between cylinder cover and crank case; (3)-the injection plate which is the core-component of the system; (4)-crank-case; (5)-the piston with a special design having the upper part machined with guiding grooves for the fuel jet; (6)-piston sleeve; (7)-high pressure duct for fuel; (8)-admission-exhausting valves; (9)-the spark thread.



a.



b.

Figure 2 The injection plate

In the figure above are shown two versions of the Injection Plate (3) which can be made in one piece (Fig.2-a) or out of two separate pieces (Fig.2-b) or put from multiple pieces. If made out of multiple pieces the machining of the fuel injection nozzles (11) is simpler but problems in ensuring the sealing between cylinder cover and the crank case are to be expected whereas if made out a single circular piece the machining of the nozzles is more difficult but more effective in terms of sealing.

The functioning of the system is simple: the fuel is coming via (7)-high pressure duct for fuel to the injection plate (3) that having machined the nozzles (11) will spray the fuel inside the combustion chamber.

A detail of the nozzle (11 penetrating the injection plate (3) is given in the figure below).

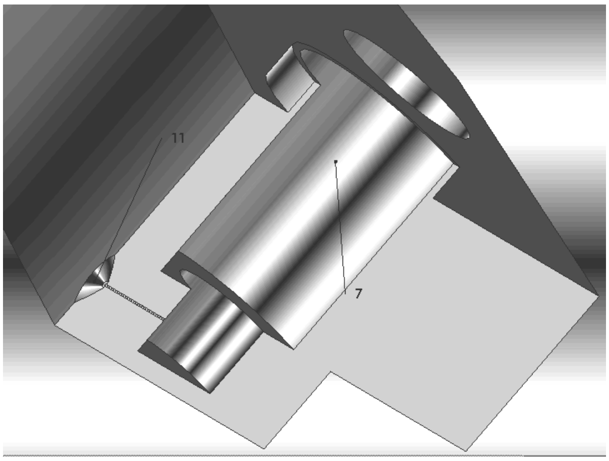


Figure 3 Detail of the nozzle (11) inside the injection plate (3)

Functionally the position of the nozzle (11) against of the center of the combustion chamber is of a paramount importance.

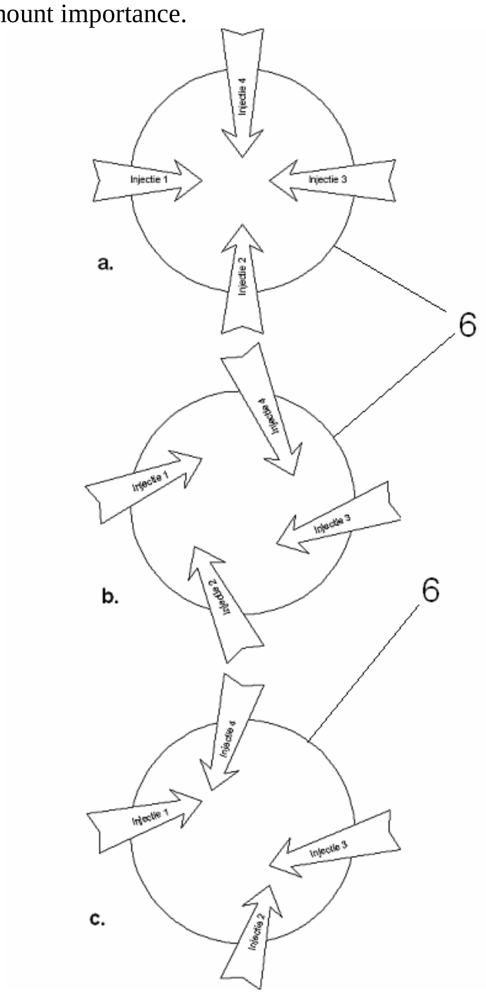


Figure 4 Position of the direction of nozzles (11) against of the center

If as in Figure 4-a the direction of nozzles are targeting the center then this is the arrangement which is leading to the most intense collision rates between fuel droplets which in turn lead to the best dimensions of droplets due their fragmentation.

If as in Figure 4-b the direction of nozzles are targeting sidelong equiangular, then a swirl effect may be induced to the fuel jets.

If as in Figure 4-c the direction of nozzles are targeting sidelong one against the other, then a combination of the two above effects may be induced to the fuel jets.

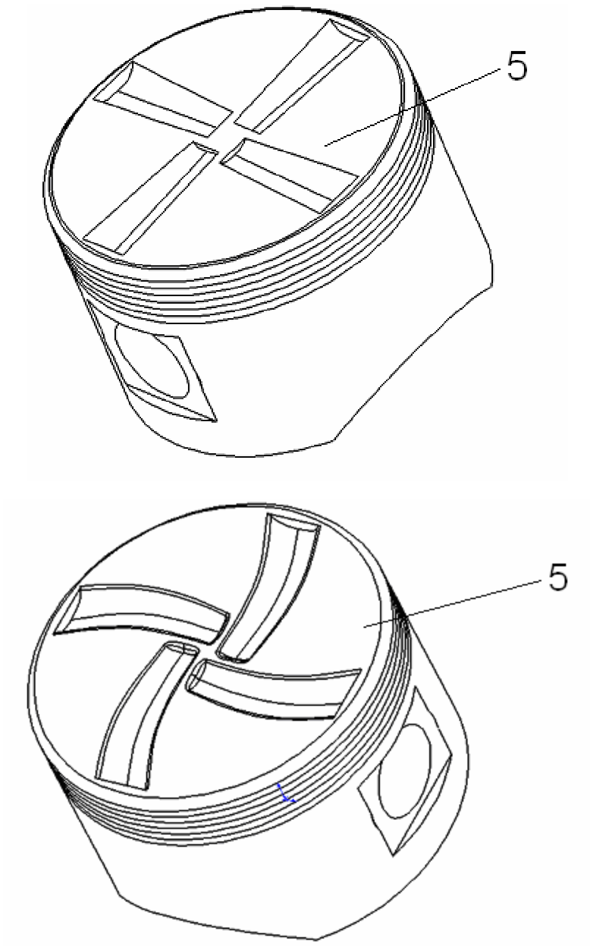


Figure 5 Pistons upper part machined with guiding grooves

As already mentioned the pistons may have a special design having the upper part machined with guiding grooves for the fuel jet (Figure 5). These grooves may lead the fuel jets and ensure enough space for the jets to develop taking into account that at the moment of the injection the width of the combustion chamber is very narrow.

The proposed injection system is not taking into account how and which are the means of pressurizing the fuel before the injection stage. Any system electro-mechanic-hydraulic may be deployed to ensure this function. In plain words the invention is replacing the Spray Tip of a normal fuel injector with an injection plate, the rest of the injector remaining the same.

3. NUMERICAL SIMULATION

In order to demonstrate the efficiency of the proposed invention a numerical simulation was conducted following two separate scenarios. The geometry of the combustion chamber is given below, the cylinder having the diameter of 200 mm and the height of 15 mm.

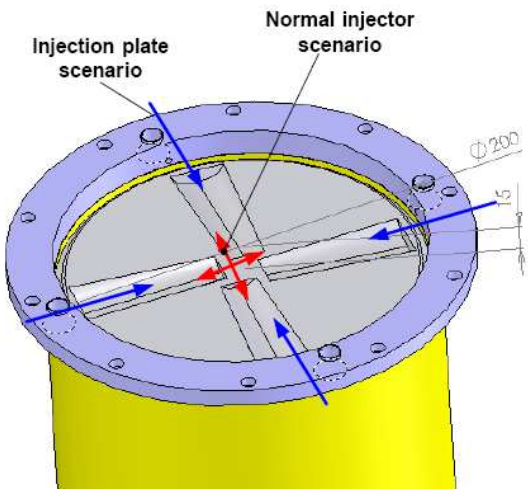


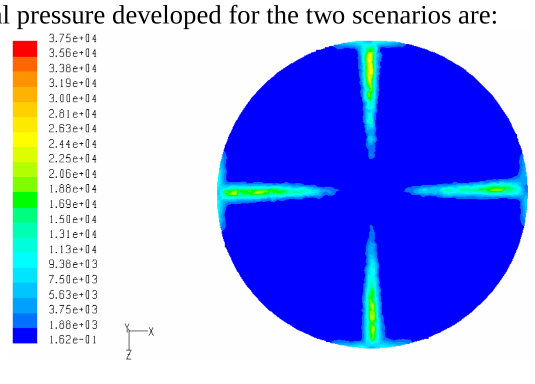
Figure 6 Geometry of the combustion chamber

Keeping constant the geometry and the injection parameters, two scenarios were evaluated; the first scenario is supposing the existence of a normal central injector with nozzles of 0.22 mm and length of 0.006 m. The second scenario is supposing the existence of the injection plate with the same type of nozzles.
The software involved was Fluent.

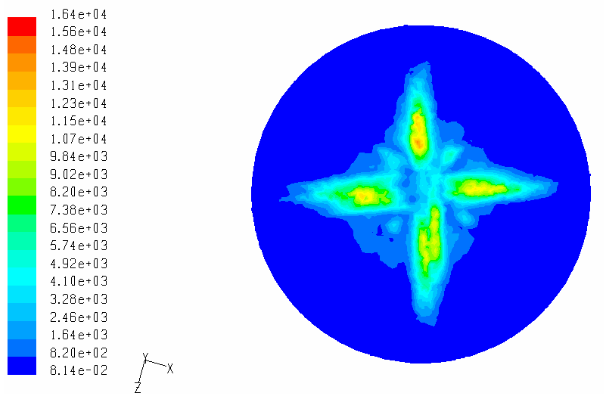
The model used 133,339 finite volume cells with 27,326 nodes. The fuel was injected via a plain orifice atomizer, with 10 particle streams each, starting to inject the droplets at time 0.0 sec to 0.0026 sec. The calculation followed the evolution of the combustion process from 0.0 sec to 0.065 sec. The flow rate of the injection is 0.013 kg/sec at temperature of 350 ^{0}K. The turbulent dispersion was modeled via the stochastic tracking model with the time scale constant of 0.15. The under relaxations factors used were 0.3 for pressure, 1 for density, 1 for body forces and 0.7 for momentum. All the rest of the model settings had pretty much the standard values, the solver used is the segregated-implicit-unsteady-3D one, the viscous model used was k-epsilon standard model. The model was iterated until the convergence was reached.

3.1 Computed Dynamic and Total Pressure

As seen in the following figure the dynamic and total pressure developed for the two scenarios are:

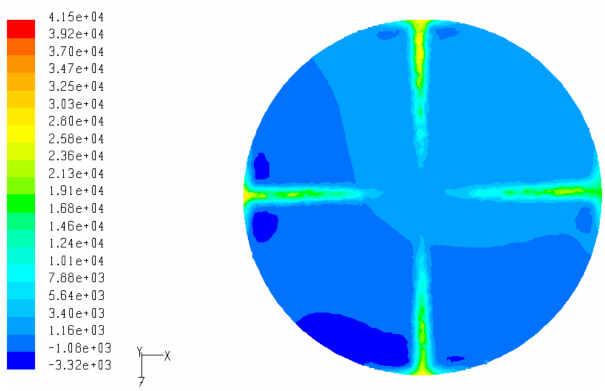


Normal injection

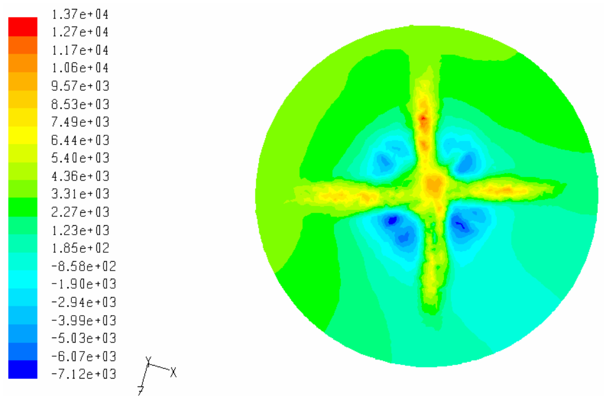


Injection plate
Figure 7 Dynamic pressures for the computed scenarios

- Maximum of 3.75 e4 Pa for the normal injection reached near the walls of the combustion chamber,
- Maximum of 1.64 e4 Pa reached at the center of the chamber.



Normal injection



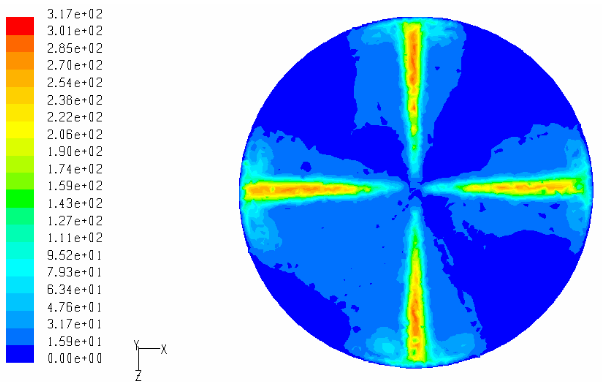
Injection plate
Figure 8 Total pressures for the computed scenarios

- Maximum of 4.15 e4 Pa for the normal injection reached near the walls of the combustion chamber,
- Maximum of 1.37 e4 Pa reached at the center of the chamber.

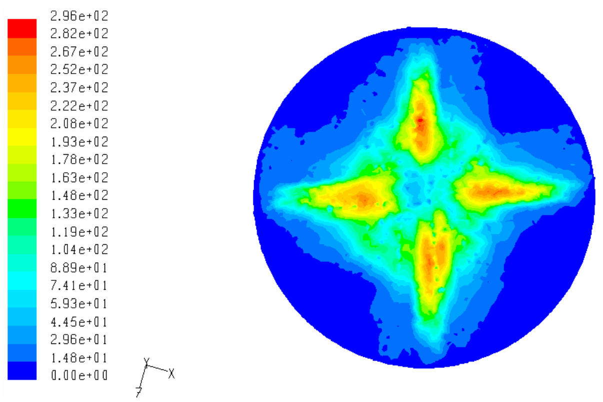
Judging the pressure distribution after 65 ms from the injection start, for the computed scenarios, is quite visible that the pressures distribution inside the combustion chamber in the normal injection has bigger values with bigger pressure peaks whereas for the plate injection the pressure has a better distribution across the section of the chamber, this being the first clue regarding the superior combustion condition ensured by the injection plate.

3.2 Computed Velocity

As seen in the following figure the velocities fields developed for the two scenarios are:



Normal injection



Injection plate

Figure 9 Velocities for the computed scenarios

- Maximum of 3.17 e2 m/s for the normal injection reached near the walls of the combustion chamber,
- Maximum of 2.96 e2 m/s reached at the center of the chamber.

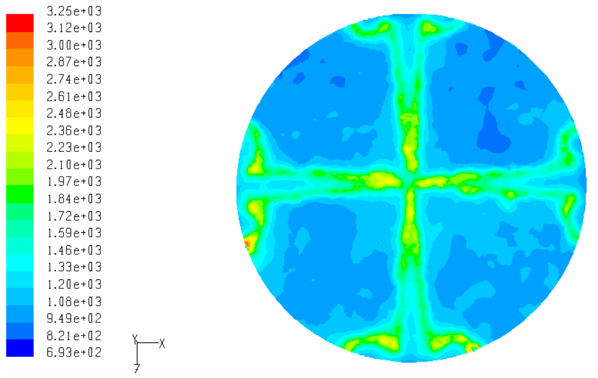
Once again one may see that the velocity distribution inside the combustion chamber has a smoother shape.

3.3 Computed Temperatures

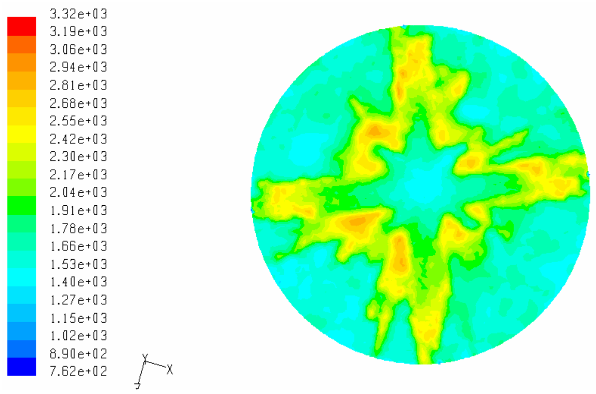
As seen in the following figure the temperature fields developed for the two scenarios are given in the Figure 10.

- Maximum of 3.25 e3 ^{0}K for the normal injection reached near the walls of the combustion chamber,
- Maximum 3.32 e3 ^{0}K reached at the center of the chamber.

By now is quite clear that the injection plate ensure a better combustion condition since the maximum reached temperatures are bigger and the shape of temperatures fields is better distributed inside the combustion chamber.



Normal injection

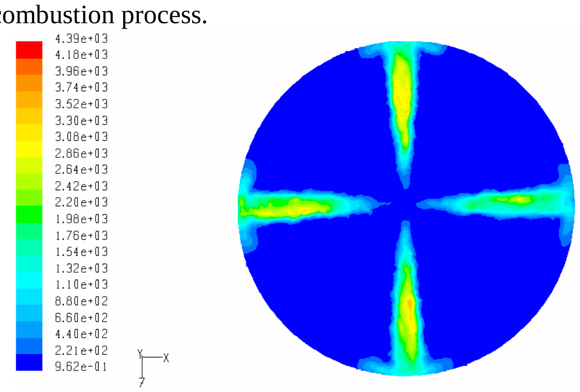


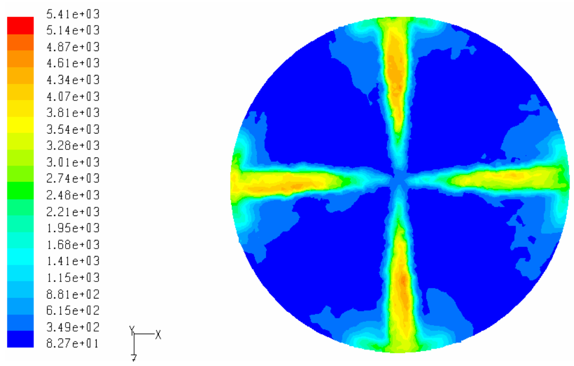
Injection plate

Figure 10 Temperatures for the computed scenarios

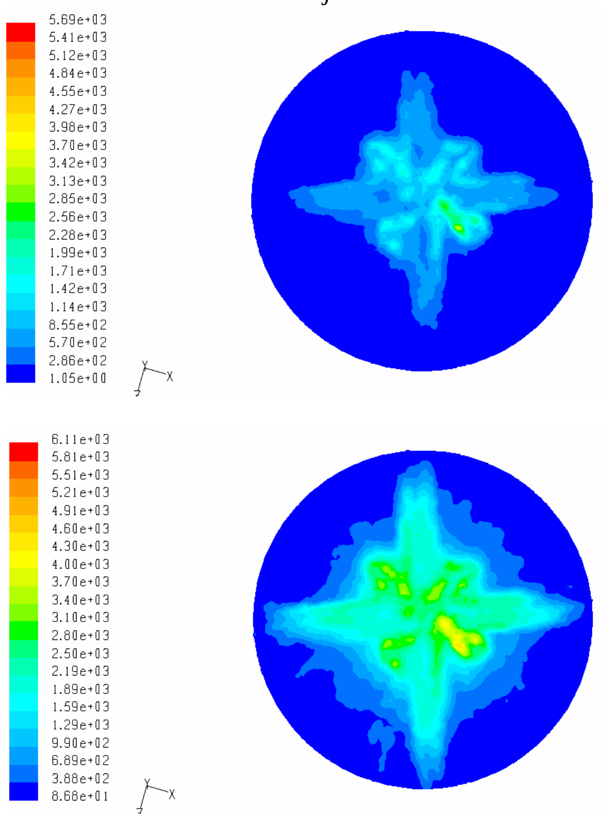
3.4 Computed turbulence kinetic energy and turbulence intensity

As known the turbulence developed inside the combustion chamber is a key parameter for a good combustion process.





Normal injection



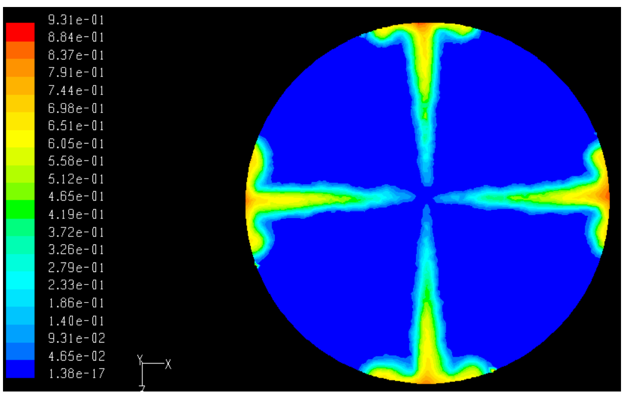
Injection plate

Figure 11 Turbulent kinetic energy and turbulence intensity for the computed scenarios

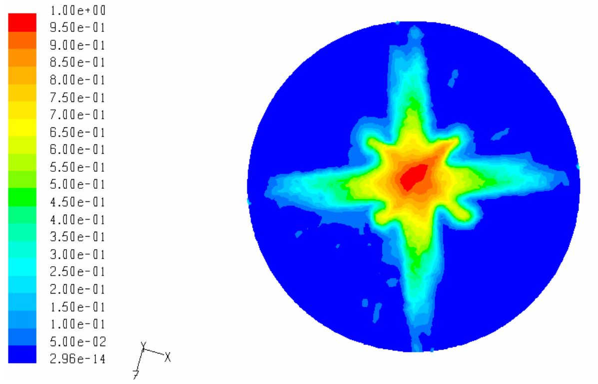
As seen in the figure 11 the turbulent kinetic energy and turbulence intensity fields developed for the two scenarios are:

- Maximum of 4.39 e3 m2/s2 for turbulent kinetic energy and 5.41 e3 % for turbulence intensity for the normal injection reached near the walls of the combustion chamber,
- Maximum of 5.69 e3 m2/s2 for turbulent kinetic energy and 6.11 e3 % for turbulence intensity reached at the center of the chamber.
-

3.5 Computed Mean mixture fraction



Normal injection



Injection plate

Figure 12 Mean mixture fractions for the computed scenarios

As seen in the above figure the mean mixture fractions fields developed for the two scenarios are:

- Maximum of 9.31 e-1 for the normal injection reached near the walls of the combustion chamber,
- Maximum 1 reached at the center of the chamber.

The mean mixture fraction is defining the reaction rates developed in the combustion process and as seen the normal injection provide only 10% of the solution proposed via the invention patent.

5. CONCLUSIONS

This paperwork is proving via numerical simulation using the renowned software Fluent that the proposed Invention Patent is feasible as a viable solution to improve the combustion conditions inside the combustion chambers of the internal combustion Engines. The Romanian Invention Patent Number 123482 is protected according the International Laws.


ROMÂNIA

OFICIUL DE STAT PENTRU INVENŢII ŞI MĂRCI

Brevet de invenţie

Nr. 123482

Acordat în temeiul Legii nr.64/1991 privind brevetele de invenţie, republicată în Monitorul Oficial al României, Partea I, nr.541, din 08 august 2007.

Titular: CĂLIMĂNESCU IOAN, CONSTANŢA, CT, RO; GRIGORESCU LUCIAN, CONSTANŢA, CT, RO

Titlul invenţiei: DUZĂ MULTIPLĂ PENTRU INJECŢIA COMBUSTIBILULUI LA MOTOARELE CU ARDERE INTERNĂ

Inventatori: CĂLIMĂNESCU IOAN, CONSTANŢA, CT, RO; GRIGORESCU LUCIAN, CONSTANŢA, CT, RO

Descrierea invenţiei, revendicările şi desenele la care se face referinţă în acestea, fac parte integrantă din prezentul brevet de invenţie.
Durata brevetului de invenţie este de 20 ani, cu începere de la data de 10.03.2009, cu condiţia plăţii taxelor anuale de menţinere în vigoare a brevetului.

Director General

Bucureşti, Data eliberării 30.10.2012

Figure 13 Invention Patent No.123482

5. REFERENCES

[1] LINDH, BJÖRN-ERIC (1992) (in Swedish), *Scania fordonshistoria 1891-1991*, Streiffert. ISBN 978-91-7886-074-6

[2] OLSSON, CHRISTER (1990) (in Swedish), *Volvo – Lastbilarna igår och idag*, Förlagshuset Norden. ISBN 978-91-86442-76-7.

[3]"*The Direct Injection Engine Will Likely Power Your Next Car*". HybridKingdom.com. http://www.directinjectionengine.com. Retrieved 2012-02-09.

[4]*"1940 6C 2500 Touring "Ala Spessa""* (in Italian) digilander.libero.it.http://digilander.libero.it/spideralfaromeo/1940b.htm. Retrieved 2012-02-09.

[5] *Circle Track*, 9/84, pp.82-3.

[6] WALTON, HARRY (March 1957). *"How Good is Fuel Injection?"*. Popular Science 170 (3): 88–93. http://books.google.com/books?id=byEDAAAAMBAJ&pg=PA88. Retrieved 2012-03-24.

[7] DAVIS, MARLAN (October 2010). *"What You Need To Know About Mechanical Fuel Injection"*. Hot Rod Magazine. http://www.hotrod.com/techarticles/engine/hrdp_1010_what_you_need_to_know_about_mechanical_fuel_injection/index.html. Retrieved 2012-02-09.

[8] INGRAHAM, JOSEPH C. (March 24, 1957), *"Automobiles: Races; Everybody Manages to Win Something At the Daytona Beach Contests"*. The New York Times: p. 153. http://select.nytimes.com/gst/abstract.html?res=F60C16FD355A137A93C6AB1788D85F438585F9. Retrieved 2012-02-09.

[9] *Consumer Reports* 22: 154. 1957.

[10] HOLDER, WILLIAM, KUNZ, PHIL (2006). *Extreme Muscle Cars: The Factory Lightweight Legacy*. Krause Publications. p. 16. ISBN 978-0-89689-278-1. http://books.google.com/books?id=Pn8cAHTaaKQC&pg=PA16. Retrieved 2012-02-09.

[11] *"An Invitation to Happy Motoring... (Excerpts from the 1957 Rambler Rebel Owner's Manual)"*. AMX-files.com. Archived from the original on 2009-03-28 http://web.archive.org/web/20090328031431/http://www.amxfiles.com/amc/rebel_57.html. Retrieved 2012–02–09.

[12] Auto Editors of *Consumer Guide* (2007-08-22). "Rambler Measures Up". http://auto.howstuffworks.com/1957-1960-rambler-rebel2.htm. Retrieved 2012–02–09.

[13] AIRD, FORBES (2001). *Bosch fuel injection systems*. HP Trade. p. 29. ISBN 978-1-55788-365-0

[14] KENDALL, LESLIE. *"American Musclecars: Power to the People"*. Petersen Automotive Museum.http://www.petersen.org/default.cfm?docid=1034. Retrieved 2012–02–09.

[15] 1975 Chevrolet Cosworth Vega Overhaul Supplement - general information.

STUDY ON THE EFFECT OF NOISE ON THE PHYSIOLOGICAL ACTIVITY OF THE ROUND GOBY FROM THE BLACK SEA

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[1,2,3,4]"Mircea cel Batran" Naval Academy, Constanta, [5]Constanta Maritime University, [6,7,8] Ovidius University Romania

ABSTRACT

The Romanian coastal area of the Black Sea presents all types of artificial noise sources (ranging from naval activities, to military applications, construction activities, drilling platforms etc.,) with strong effect on acoustic sensitivity of hydrobionts. In this paper we present the influence of antropogenic sound on the physiological activity of the Round goby (*Apollonia* (*Neogobius*) *melanostomus*, Pallas, 1814) kept in cages. The analysis of some biochemical indicators for the oxidative stress (superoxid dismutase, catalase, reduced glutathione and malonildialdehide) performed on liver tissue of the round goby from the Black Sea exposed to different qualities of antropogenic noise, indicated that in shallow waters parts of the Black Sea, where goby fishes (with different species, characteristic for each biotope) are the dominant fish species, noises/vibrations with high intensity are harmful for the ecosystem.

Keywords: *Apollonia (Neogobius) melanostomus, oxidative stress, noise, spectrogram, physiological activity, goby fishes,* Black Sea

1. INTRODUCTION

This paper presents the results of the MUNROM project as part of RoNoMar (Romanian and Norwegian Maritime Project) which had the following objectives: to determine the ambient underwater noise level in the coastal region and in the harbor areas of the Romanian Black Sea coast, to determine the impact of noise produced by artificial sources on some species characteristic to NW area of the Black Sea: goby, blue mussel, dolphins.

The effect of anthropogenic sounds on fish may vary and depends upon: (1) properties of the sound, such as frequency spectrum, source level, duration, rise and fall times in level, and repetition rate, (2) background noise (masking), (3) sound level, duration and spectrum of the sound as received by the animal, (4) hearing properties of the species (sensitivity, directivity index and critical ratio), and (5) species-specific or individual variation in reaction to sound [13].

For the reasons mentioned above, extrapolation of the effects of anthropogenic sound upon fish are notoriously difficult making the results of an experiment on caged fish to be applicable only to that specific situation. The effects of sound are also known to vary within a species; Popper *et al*. [15], found that the effect of sound on rainbow trout, tested under the same conditions, varied with groups of fish tested in different years. The reason for this was not entirely clear but may be a result of genetics or difference in the conditions during early life history of the fish [20].

For animals living in aquatic environment, total dissolved oxygen is a particularly important factor for the normal physiological processes. Some 2-4% from the total amount of oxygen consumed in metabolic processes is transformed into intermediate chemical species or oxygen free radicals (ROS). Oxygen free radicals are highly complex transient chemical species, able to react with almost all bio-molecules, altering their biochemical and functional properties.

The cellular antioxidant defence system against oxygen free radicals consists of substances both enzymatic and non-enzymatic. The main antioxidant enzymes are superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase and the non-enzymatic antioxidant defence system is represented by vitamins A, E, C, reduced glutathione (GSH), Coenzyme Q10, bilirubin, uric acid and β-carotene. [9], [10], [18].

There is a close balance between the concentration of oxygen free radicals and the substances involved in the cellular defence system. If the antioxidant system is outdated, the phenomenon of oxidative stress is observed.

So, in biological systems, the oxidative stress is characterized by the increase of concentration of oxidizing chemical species, the decrease of low-molecular-weight antioxidants, frequent redox-balance disturbances and some injuries of bio-membranes, proved by the increase of malonildialdehide (MDA) concentration [1], [11].

2. MATERIALS AND METHODS

In order to study the influence of vibrations (as source of noise) on the physiological activities of fishes, healthy individuals of Round goby *Apollonia* (*Neogobius*) *melanostomus* Pallas 1814 were collected from the southern rocky shore of the Romanian littoral and transported in 100 l barrels with filled sea water at 16°C (Figure 1).

Figure 1 Preparing the fish for transport

The experiment took place around the maritime station where the ship "Noordkaap" was moored (Figure 2); three experimental cages were carried on board.

Figure 2 The site of the experiment (www.joie.ro/2010/07/gara-maritima-constanta/)

The cages were made of two kinds of fishing net: one, with the mesh of 12 mm was used to build the side walls of a one meter cube. The same material was used to make the upper wall which presents a trap that allows access into the cage. Fishing net with the mesh of 7 mm was used to make the bottom of the cage (to allow mussels attachment).The cage's walls were reinforced with 7 mm diameter metal rods (Figure 3).

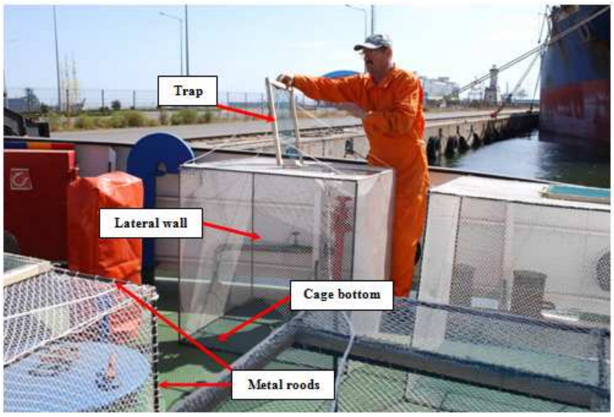


Figure 3 Structure of the cages

There were 30 fish placed in each cage by the help of a fish landing; the fish was given its favourite food [3]: live mussels and chunks of fish meat and beef.

Cages were sunk in the water column, 12 m deep, one meter above the seabed. A cage containing the control group (GC) was located in the starboard side of another vessel - ("Pompier -8") located approximately 200 m away from the noise source.

The three cages containing the experimental groups (GE) with fish were hooked as follows: GE-1, at the bow, GE-2 near the engine room, and GE-3 at the stern (Figure 4**)**.

Figure 4 The « Nordkaap » ship and the cages location
1, 2, 3 –the cages with experimental groups; 4, 5 – hydrophones; 6 –the source of noise

The experiment was conducted between 8^{th} -18^{th} October, the sea was calm, and there were no rains or strong winds. The water temperature at surface varied between 15.5° C and 18 ° C (average value 16.9° C). The equipment used in the experiment consisted in two hydrophones type 8106 (with a general purpose transducer with a frequency range from 7Hz to 80 kHz) (Bruel & Kjaer), a LAN XI for the acquisition system (Bruel & Kjaer), and a laptop with 14 Pulse software installed.

As a source of underwater noise we used a hydro - pneumatic mechanism based on an air compressor (11 bars), with a fundamental frequency of 61-90 Hz, located near the EG-2 at 0.5 m above the top of the cage. This mechanism was used 8 hours a day, in successive steps of one hour emission, two hours break. The hydrophones were placed 1 m away from the cage, on the side. The source of noise had to be placed near the cage no. 2, because the sound was quickly attenuated: the first hydrophone (located near the source) recorded a higher level of noise as compared to the second hydrophone (located 5-6 m away from the source). The difference between the two hydrophones ranged from 6 dB to 9 dB, depending on the variation of air pressure in the compressor tank (when air pressure in the tank drops below 6 bars, its engine starts automatically, increasing the pressure value to 11 bars - 11 atmospheres).

After a period of 72 hours from the beginning of the experiment the fish were sacrificed for analysis; their liver tissue was examined in order to state some metabolic parameters of oxidative stress: the superoxide dismutase activity, the catalase, the reduced concentration of glutathione (GSH) and the protein concentration. In determining the metabolic oxidative stress parameters we used the following methods:

• Superoxide dismutase (SOD) - method based on its ability to inhibit the reduction of tetrazolium salt - Nitro Blue tetrazolium (NBT) with superoxide radicals [19].

• The activity of catalase (CAT) - kinetic method based on the decomposition of hydrogen peroxide radicals existing in the reaction medium, as a result of catalase activity, using a spectrophotometer at 240 nm and 25 ° C, dt = 60 seconds [4].

• Reduced glutathione (GSH) - classical colorimetric method based on DTNB reaction in the presence of GSH in the environment using a spectrophotometer at 412 nm [7].

• Malonildialdeide (MDA) - conventional colorimetric method described by Drapper and Hadley, 1990 [8].

All of the reagents used for the completion of these experiments were purchased from Sigma-Aldrich (Steinheim, Germany). The data were statistically interpreted using statistical analysis Origin Pro75 software. The difference is considered statistically significant when $p \leq 0.05$.

3. RESULTS AND DISCUSSIONS

During the whole experimental period, also the test group – control group (CG) was affected by the ambient noise generated by the traffic in the harbour. The noise levels of the ambient noise are relatively constant, between 121 – 123 dB re 1μPa (Figure 5.).

The ten days of captivity with a moderate underwater noise have led to the installation of oxidative stress expressed by the accentuated increase of concentration of the antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT)) and also of reduced glutathione (GSH), compared with the values obtained after the analyzes performed on animals collected directly from the sea. This is not associated with membrane lipid peroxidation, the parameter value that indicates the degree of lipid peroxidation, respectively malonildialdehide (MDA), which remained almost unchanged in the first period as compared with the test organisms sacrificed at the beginning of the experiment (Table 1).

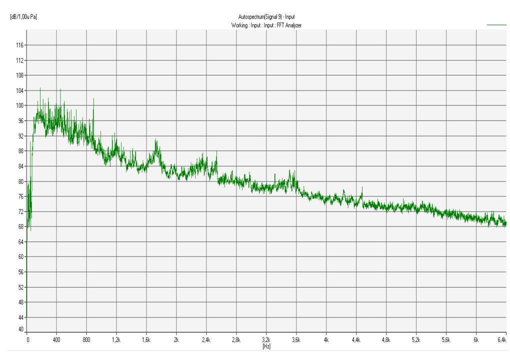


Figure 5. Spectrogram of ambient underwater noise in the control group area

Table 1 Mean values of superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) and of malonildialdehide (MDA) in the liver after 10 days of exposure of Round gobies to vibrations of 121 – 123 dB re 1μPa

Experi-mental group	Statis-tics index	SOD	CAT	GSH	MDA
		EU•mg of proteins^{-1}		mcg• mg of prote-ins^{-1}	nmol• mg of prote-ins^{-1}
test group (05.10. 2010)	X±ES	4.99± 0.52	2.01± 0.33	6.51± 0.47	0.67± 0.06
	n	5	6	6	5
control group (08.10. 2010)	X±ES	0.70± 0.007	0.31± 0.007	1.49± 0.23	0.72± 0.07
	n	6	6	6	5
	t	8.04	5.09	9.48	0.48
	p≤	0.001	0.001	0.001	NS >0.05
	+/- M%	-85.97	-84.57	-77.1	+6.94
control group (15.10. 2010)	X±ES	4.25± 0.17	1.66± 0.12	2.25± 0.16	0.48± 0.05
	n	5	6	6	6
	t	1.33	1.00	8.46	2.42
	p≤	NS > 0.05	NS >0.05	0.001	0.04
	+/- M%	-14.82	-17.41	-65.43	-28.35
control group (18.10. 2010)	X±ES	2.37± 0.57	0.99± 0.10	1.56± 0.06	1.02± 0.10
	n	6	5	6	5
	t	3.35	2.91	10.29	7.24
	p≤	0.01	0.01	0.001	0.001
	+/- M%	-52.50	-103.0	-76.03	+52.2

LEGEND: X ± ES - arithmetic mean ± standard error, n= the number of individual values which lead to the average, t = test 't' of Student, p ≤ threshold of statistical significance, NS = statistically insignificant.

Between 10th and 12th October, the experimental groups of gobies were exposed to the noise from the source (the hydro-pneumatic mechanism) with a rhythm of one hour vibrations – two hours of silence. The noise levels were in the range from 157 dB re 1μPa to 163 dB re 1μPa.

After the first 72 hours period of exposure to vibrations, the superoxide dismutase (SOD) activity decreased as a result of increased concentration of oxygen free radicals in the experimental groups held near the noise source (EG 2) (- 30, 46% vs. M, $p \leq 0.05$) and at the bow (EG 1) (-56.91% vs. M, $p \leq 0.001$). Catalase (CAT) acts on the substrate generated by superoxide dismutase; therefore it is a latency period between the moment of the activation of the superoxide dismutase and those of the catalase values confirmed by the scientific literature [2], [12] (Table 2).

Table 2 Mean values of superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) and of malonildialdehide (MAD) in the liver after a rhythmical exposure of Round gobies to noises ranging between 157 dB re 1μPa and 163 dB re 1μPa during a 72 hours period

Experi-mental group	Statis-tics index	SOD	CAT	GSH	MDA
		EU•mg of proteins^{-1}		mcg• mg of	nmol• mg of

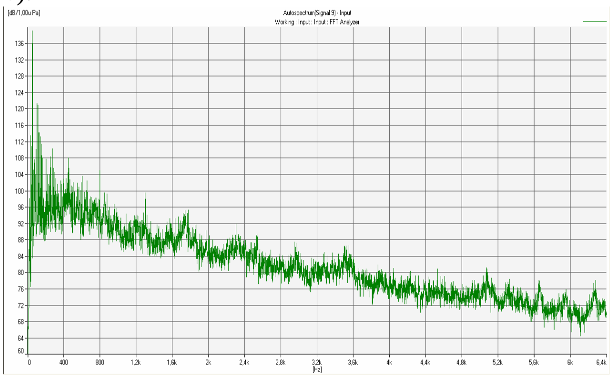
				prote-ins^{-1}	prote-ins^{-1}
control group (15.10. 2010)	X±ES	4.25± 0.17	1.66± 0.12	2.25± 0.15	0.48± 0.05
	n	5	6	6	5
EG – 1 (15.10. 2010)	X±ES	2.15± 0.32	0.93± 0.12	3.21± 0.19	0.83± 0.03
	n	6	6	6	6
	t	5.10	6.67	5.79	4.13
	p≤	0.001	0.001	0.01	0.05
	+/- M%	-56.91	-53.73	-50.69	+23.8
EG – 2 (15.10. 2010)	X±ES	3.27± 0.34	1.56± 0.17	2.73± 0.20	0.78± 0.01
	n	6	6	6	6
	t	2.38	1.55	2.51	3.75
	p≤	0.05	NS >0.05	0.05	0.05
	+/- M%	-30.46	-22.38	58.06	+16.4 1
EG – 3 (15.10. 2010)	X±ES	4.79± 0.20	1.78± 0.18	2.62± 0.28	0.80± 0.05
	n	6	6	6	6
	t	1.76	2.09	3.57	8.58
	p≤	NS >0.05	NS >0.05	0.05	0.01
	+/- M%	-2.00	-11,44	-59.75	+19.4

The catalase (CAT) activity in our experimental model is reduced only at the experimental group 1 (EG - 3), (- 53, 73% vs. M, $p \leq 0.001$). Reduced glutathione (GSH) level is dependent on the concentration of oxygen free radicals, so when there is a high concentration of oxygen free radicals, the GSH level decreases. In our experimental model, the level of GSH decreases as a response to changes in normal concentrations of ROS , as presented in EG - 2 (- 58, 06% vs. M, $p \leq 0.05$), EG – 3 (- 59.75 % vs. M, $p \leq 0.05$) and EG - 1 (- 50.69% vs. M, $p \leq 0.01$).

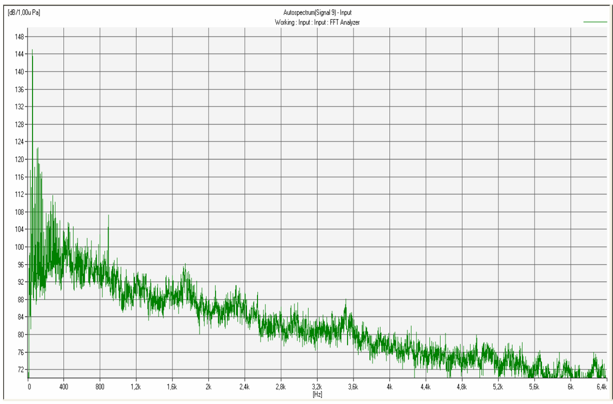
The malonildialdehide is an indicator of membrane lipid peroxidation, its levels increase only if the cell membrane suffers changes[16], [17]. It should be noted that our experimental model for all three experimental groups recorded increases in the level of the malonildialdehide, especially at the EG -1 (table 2).

Summarizing, the exposure of goby fishes at vibrations ranged between 157 dB re 1μPa and 163 dB re1μPa during one hour, followed by two hours of silence, rhythm reiterated within a three day period, was harmful for the fishes in the proximity of the noise source; the oxidative stress was observed especially in EG – 1, the very the next day, when all specimens from the cage were dead.

Between 13th – 15th October (the last 72 hour period), the rhythm of exposure of fishes at vibration was modified. The Diesel generators of the ship were used as noise producing sources. On 14th, after measuring the ambient noise, one Diesel generator was turned on and ran for approximately 25 minutes. Then, the second Diesel generator was turned on and we recorded the noise for another 25 minutes. After a period of 3 hours of silence, the noise source was turned on. After 10 minutes the first generator was powered and after another 10 minutes, the second one. With one Diesel generator the noise level was 139 dB, with two Diesel generators -145 dB and with both generators and the noise source the noise increased at 159 dB (Figure 6).



a



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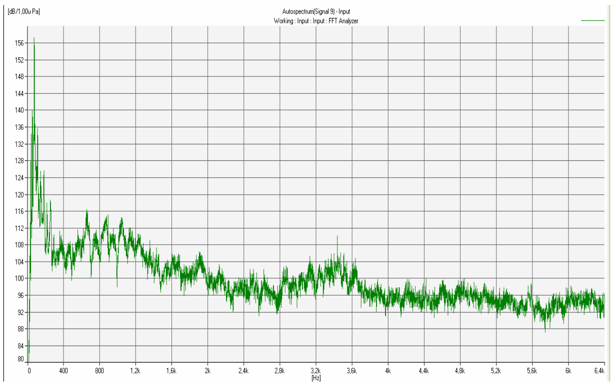

c

Figure 6 Spectrogram of the measurement of noise : a= with one generator -139 dB re 1μPa; b=with two generators - 145 dB re 1μPa; c=with two generators and the noise source (159 dB re 1μPa)

During the last 48 hours, the noise source was set to generate noise increasingly. Also, an underwater video camera was placed in front of the cage with the experimental group 2 (EG – 2). The movement of the gobies was recorded during those trials. The levels were also from 156 dB re 1μPa to 167 dB re 1μPa.

The superoxide dismutase (SOD) activity decreased significantly in both experimental groups (EG – 2 and EG – 3) (table 3). This suggests that the level of oxygen free radicals concentration exceeded the reference value and the cellular enzyme was consumed in the process of annihilation of chemical invasive species. Catalase (CAT) uses the hydrogen peroxide resulted during the biochemical processes induced by stress, reactions catalyzed by SOD [4].

In the last 72 hours of intermittent exposure to gradual vibrations, the catalase (CAT) activity decreased significantly in both remaining experimental groups: EG – 2 (- 53.73% vs. M, $p \leq 0.001$) and EG - 3 (- 23.31% vs. M, $p \leq 0.05$) (Table 3).

Table 3 Mean values of superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) and malonildialdehide (MAD) in the liver of Round gobies exposed to short intervals of variable intensity noise (139 dB re 1μPa, 145 dB re 1μPa and 159 dB re 1μPa) during a 72 hours period

Experi-mental group	Statis-tics index	SOD	CAT	GSH	MDA
		EU•mg of proteins^{-1}		mcg• mg of prote-ins^{-1}	nmol• mg of prote-ins^{-1}
control group (18.10. 2010)	X±ES	2.37± 0.57	0.99± 0.10	1.56± 0.06	1.02± 0.10
	n	6	5	6	5
EG – 2 (18.10. 2010)	X±ES	2.76± 0.16	0.93± 0.15	2.04± 0.19	1.96± 0.17
	n	6	6	6	5
	t	5.52	5.90	6.72	5.73
	p≤	0.01	0.001	0.001	0.01
	+/- M%	-44.68	-53.73	-68.66	+192.53
EG – 3 (18.10. 2010)	X±ES	2.65± 0.19	1.63± 0.03	1.76± 0.15	1.34± 0.13
	n	6	5	6	6
	t	6.12	4.56	8.43	7.34
	p≤	0.001	0.05	0.001	0.01
	+/- M%	-46.89	-23.31	-72.96	+100.00

This suggests the following issue: in the two experimental groups, hydrogen peroxide radical concentration increased beyond the endurance of the enzyme and it is clearly outdated and no longer able to manifest its biochemical role which will ultimately lead to the installation of the phenomenon of oxidative stress.

Regarding the level of reduced glutathione (GSH), in our experimental model it is a visible decrease of the mentioned bio-peptide in both experimental groups (EG – 2 and EG - 3) (Table 3). Reduced glutathione (GSH) is consumed in the process of annihilation of oxygen free radicals resulted from the cellular metabolic processes [12]. In this experimental model, the oxidative stress is expressed also by the increase of malonildialdehide (MDA), showing a biochemical and functional alteration of cell membranes (Table 3).

Round goby are free-swimming, and able to produce some sounds during reproductive season and are able to receive and to analyze sound with a frequency in a range of 100 to 600 Hz and an intensity varying between 120-180 dB re 1 Pa ([5] [6] [14] .

The quality of the sound produced either by the hydro-pneumatic mechanism, or by the Diesel generator(s) from the ship fits the parameters recommended by the scientifical papers. It is necessary to highlight that in our experimental model the stress generating factor is the resultant of two independent sources: captivity and noise.

4. CONCLUSIONS

The analysis of some biochemical indicators for the oxidative stress (superoxid dismutase, catalase, reduced glutathione and malonildialdehide) performed on liver tissue of Round goby from the Black Sea – *Apollonia* (*Neogobius*) *melanostomus* Pallas, 1814 exposed to different quality of noise makes evident the following conclusions:

- In Constanta harbour, ambient noise ranged between 121 and 123 dB re 1µPa and it had adverse effects on captive goby expressed by the values of biochemical indicators of the oxidative stress in liver tissue, except for the concentration of malonildialdehide, which did not occur in cellular splitting;
- The increase of vibration's intensity (157 to 163 dB re 1µPa) with a constant rhythm of exposure (one hour of activity of an hydro-pneumatic mechanism, two hours of pause) determined the installation of oxidative stress after 72 hours; this is held true by the decrease of concentration of superoxide dismutase, catalase, reduced glutathione as a result of increased concentration of oxygen free radicals generated by stress; some captive fishes situated in the proximity of the noise source died after an exposure of 72 hours (EG - 1).
- The exposure of Round gobies at increased and varying intensity of vibration (156 dB re 1µPa and 167 dB re 1µPa) for another period of 72 hours induced severe oxidative stress confirmed by values of specific biochemical indicators determined in the fish's liver, especially the concentration of malonildialdehide, which showed that cellular lysis also appeared.

5. REFERENCES

[1] Allen, R.G, Lamb, G.D, Westerblad, H., *Skeletal Muscle fatigue:cellular mechanisms*. Physiol. Rev. 88 : 287-332, as a pollution-mediated mechanism of toxicity in the common mussel, *Mytilus edulis* L. and other molluscs. *Funct. Ecol.* 4, 2008: 415–424

[2] Babich, H., Palace, M.R., Stern, A., *Oxidative Stress in Fish Cells;in Vitro Studies.* Arch. Environ. Contarn. Toxicol. 24, 1993: 173 –178

[3] Banarescu, P.,. *Pisces-Osteichthyes. Fauna R.P.R.* Editura Academiei RPR, București, 13, 1964: 998p

[4] Beers, R.F, and Sizer, I.W,. *A Spectrophotometric Method for Measuring the Breakdown of H_2O_2 by catalase*. J. Biol. Chem. 195, 1952:133-140

[5] Belange, A. J., Bobeica, I., Higgs, D. M., *The effect of stimulus type and background noise on hearing abilities of the round goby Neogobius melanostomus* — Comp. Biochem. Phys. A 144**,** 2006: 196-202

[6] Belange, A. J., Higgs, D. M., *Hearing and the Round Goby: Understanding the Auditory System of the Round Goby (Neogobius melanostomus),* Acoustical Society of America Journal, 117*, 4,* 2005: 2467-2467

[7] Beutler, E., *Red Cell Metabolism In: A Manual of Biochemical Methods* 2, ed. Grune and Stratton publishers London, 1975

[8] Bîrcan, A., Sutcu, R., Gokirmak, M., Hiczlmaz, H., Akkaya, A., Ozturk, O., *Total Antioxidant Capacity and C-Reactive Protein Levels in Patients with Community – acquired Pneumonia*. *Turk. J. Med. Sci.* 38 : (6), 2008: 537 – 544

[9] Christopher, PI., Wenke, JC., Nofal, T., Armstrong R.B., *Adaptation to Lenghthening contraction-induced injury in mouse muscle.* J.*Appl.Physiol* 97, 2004: 1067-76

[10] Diplock AT., *Introduction: markers of oxidative damage and antioxidant modulation*. Free. Radic. Res. 33 Sppl, 2000: S21-S26

[11] Jones, D.P., *Redefining oxidative stress*. Antioxid. Redox.Signal. 8, 2006: 1865-1879

[12] Kappus. H., - *Lipid peroxidation: mechanisms, analysis, enzymology and biological relevance.* In: H. Sies, Editor, *Oxidative Stress*, Academic Press, London, 1985: 273–310

[13] Kastelein, R A ., Sander, H. , Verboom, W. C., Nancy J. C.,Veen, J., Haan, D., *Startle response of captive North Sea fish species to underwater* tones between 0.1 and 64 kHz. Marine Environmental Research 65, 2008: 369–377

[14] Higgs, M.H., - *Sensory ecology of communication in the round goby (Neogobius melanostomus*), Can. Field Nat. 122, 2005: 245-249

[15] Popper, A. N., HalvorsenM. B., Kane A., Miller D. L., Smith M. E., Song J., Stein P., and Wysocki L., *The effects of high-intensity, low-frequency active sonar on rainbow trout.* The Journal of the Acoustical Society of America 122, 2007

[16] Sies H., - *Oxidative stress*. London Academic,
Slater, T.F., 1984 - Free-radical mechanisms in tissue injury. Biochem. *J*. **222**, 1985: 1–15

[17] Winston, G.W., *Oxidants and antioxidants in aquatic animals*. Comp. Biochem. Physiol. C. **100,** 1991: 173–176

[18] Winston, G.W., Di Giulio, R.T., *Prooxidant and antioxidant mechanisms in aquatic organisms*. Aquat. Toxicol. **19,** 1991: 137–161

[19]Winterbourne, C.C., *Comparison of superoxide with other reducing agent in the biological production of hydroxyl radicals*. J. Biochem. **182,** 1979: 625-628

[20] Wysocki, L.E., Davidson III, J.W., Smith, M.E., Frankel, A.S., Ellison, W.T., Mazik, P.M., Popper, A.N., Bebak, J., - *Effects of Aquaculture Production Noise on Hearing, Growth, and Disease Resistance of Rainbow Trout Oncorhynchus mykiss*. Aquaculture 272, 2007: 687-697

***www.joie.ro/2010/07/gara-maritima-constanta/

CHEMICAL WATERPROOFING OF THE INTERIOR WALLS AND BUILDINGS FRONT SIDES

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ABSTRACT

Chemical waterproof presents an efficient solution and easy to apply. We can see specific consumptions of different waterproof agents, regarding of waterproof efficiency which is conditioned by products nature and chemical composition.

Keywords : *silicons, exterior insulation, R radical, waterproofing, film creating*

1. INTRODUCTION

As far as we know, water is an important aggressive agent with major negative effects over walls or construction elements, which comes in contact with. Porous construction materials (bricks, mortars, connection means of the walls) absorbs water.

In this way, moisture crumbles concrete and might ruin plaster. From moisture negative elements, most important are:

- reinforcing and concrete embedded pieces corrosion, fact which leads to reduction and even complete loss of mechanical characteristics of the elements;
- degradation caused by frost-defrost cycles;
- materials mechanical-physical characteristics changes;
- thermical capacities reduction;
- dampness appearance. Capillary attraction allows water flow in all directions, creating a blotter effect. Capillary attraction action depends of water superficial tension, construction material hydrophilic surface and porous material thickness. Beside water, water steams can also go through porous materials and diffusion. To eliminate moisture from buildings walls we use many methods, like : chemical methods, electro-osmotic methods and physical methods.

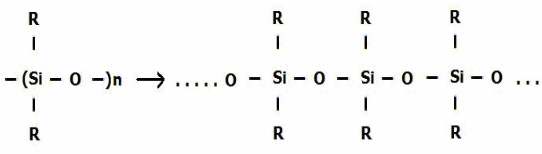
2. WATERPROOFING CHEMICAL WAYS OF INTERIOR WALLS AND BUILDINGS FRONT SIDES

Interior and exterior walls waterproofing problem is a different way to deal with. Exterior insulation is considered the best, but is restrictive. It is appreciated that 60% from insulations are made on the inside.

Generally, there are known four ways of chemical waterproofing of the inside walls by different chemical substances, as follows : a.with silicone hydrophobic substances; b.with limp substances (paraffin, resin); c.with sodium silicate; d.with a gel that occupies the capillarities (launched by REMMERS- Germany). Moving forward, we present some aspects of the chemical waterproofing at interior walls and buildings front sides.

3. SILICONS STRUCTURE AND PROPERTIES

Silicons are polymeric mixings, in which silicium atoms are connected with the help of interleaved oxygen atoms, and silicium valence untied by oxygen are saturated with at least an organic radical.



R radical is most of the times a methylic group (CH_3).

Organic substitutes number and nature related, we obtained liquid silicons, resin and rubber types. They are organic-silicon parameters, by their water hydrolysis. Silicons occupies an intermediary position between anorganic mixings and the organic ones, especially between silicates and organic polymers [3], [4]. Thermical stability related with other properties determines silicons using in a lot of domains. Film creating capacity, hydrophobia and separating effect are most interesting properties of silicons, which recommends them for waterproofing and paper/pasteboard enrichment.

Film creating capacity is explained by reduced superficial tension possessed by the silicons. Superficial film is created easier as the film generator and the sub-layer (construction material, paper etc.) are mutual related [5]. Silicons creates films easily on most of solid bodies, penetrating even the hardest accesible places, with narrow slits and pores. Hydrophobic behaviour is a general characteristic for all silicons. It has been realised that a water drop cannot expand on a silicon treated surface. Because of this, silicons are used especially at surfaces hydrophobia.

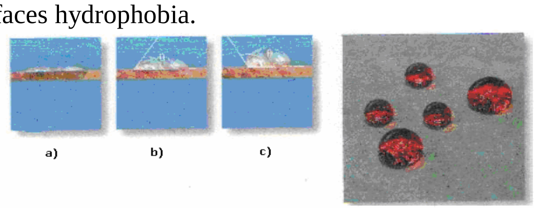


Figure 1 a) strong moistening; b) medium moistening; c) waterproofing

Hydrophobia effect depends also of the substitutes nature connected by silicium atom (Si-H connections silicons are most hydrophobe). Silicon resins are disloved in different organic solvents (methylic alcohol, xylen etc). or in water (preferably, for ecological reasons). There are lots of siliconic products with different comercial names, related with producer name (Baysilon – Bayer, Germany; Rhodorsil – Rhodia, France).

Table 1

Characteristics	Values
Dry substance contain, % Active substance, % 25^0C density, g/cm^3 pH Coagulation point, ^{0}C Thinner	approx. 47 approx. 28 1,34 approx. 13 < -20 water

First table presents Baysilon products for *Tab.1* hydrophobe construction materials conferring. Second table presents RHODORSIL SILICONATE 51 product characteristics, which is a watery solution with potassium methyl-silicone.

Table 2

Characteristics	**Values**
Dry substance contain, % Active substance, % 25^0C density, g/cm^3 pH Coagulation point, ^{0}C Thinner	approx. 47 approx. 28 1,34 approx. 13 < -20 water

Product role is construction material capillary reserve waterproof, fact realised by product polymerization in contact with present carbon dioxide. Reaction mechanism is shown in *figure 3.*

This way, inside the capillary reserve is created a hydrophobe poli-methyl-xilo-xanic resin, insoluble in water, which opposes water expand through capillarity. Reduced superficial tension of the silicons makes product penetration easier at capillary surface and has a good compatibility at construction material silicon reserve. High longevity of the treatment is favoured by forked structure of the resin and by high molecular weight favoured by alkalin pH of the environment. Fluorine-chemicals (polyflourine co-polymers) represents another product scale used for waterproofing. These products with an anionic character are, generally, miscible with water in any proportion, fireproof, with a dry substance contain which varies between 15 and 34%.

3.1. Waterproof tehnique for construction materials with silicon and fluorine chemicals

Regardless of interior or exterior walls waterproof the following actions are necessary:

a. Visual examination of building status (water existance, dampness affected areas identification(mold and and condensation);

b. Moisture measurements at front sides surface according to each cardinal point:

- Exterior side of building specific parameter measurement (air moisture and temperature, wind speed, sunny degree)
- Front side surface moisture measurement, starting from wall base and continuing with measurements made at each 10 cm until 100-220 cm.

c. Moisture measurements at inside walls:

Table 3 ZONYL product characteristics from Dupont

pH	-	-	4,5 - 5,0	4 - 5	7 - 9
Medium	Isopar H	Acetate butyl	water	Water/NNP	Water/IPA
Lighting point, ^{0}C	57	26	93	-	21
Dilusion environment	Cetone, Esters	Cetone, Esters	Water	Water	Water
	Support TYPE				
Concrete	••	••	•••	•••	••• *
INTERBLOKING PAVING STONES	••	••	•••	•••	•••
TERRACOTTA	•••	•••	•••	••	•••
GRAINED TERRACOTA	•••	•••	•••	••	•••
Marble	•••	•••	•••	••	•••

3.2. Interior walls waterproofing

The holes where we inject the product must be performed at 10 or 20 cm from the ground. Holes must have a 10 to 16 mm diameter (preferably 12 mm), and the distance between them must be from 10 to 20 mm (preferably 12 mm).

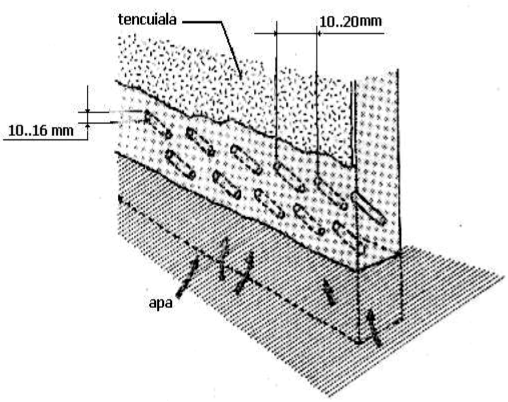


Figure 4 Interior walls waterproofing

Holes depth: 2/3 from wall thickness, and their angle must vary between 30 and 45^0. Waterproofing agent introduction can be made gravitationally (preferably) or by injection under low pressure (0,5-10 bars)and then holes must be closed up with a special prime. Injection is on until the support saturation, fact realized through waterproofing agent extrusion from support. Regarding wall thickness, waterproofing agent injection is made in a different way, as follows :

a. For 30 cm walls : one mark and depth injection;

b. For 40 cm walls : one mark injection, but at two depths (at 1/3 from wall thickness and at 2/3 from wall thickness);

c. For >40 cm walls : two marks injection with the method shown at 40 cm walls.

Regarding wall's structure and nature, silicon RHODORSIL consumption varies between 4 and 20 l of solution/ml.

Table 4 Fluorine-chemicals appliance mode (ZONYL products)

Assortment	**210**	**225**	**8740**	**321**	**9027**	**329**
Concentration,%	3-6	3-6	5-10	5-10	2-10	5-10

Applyance	Low porousity materials	Low porousity materials	Porous materials	Porous materials	Fresh concrete acid substratum	Porous materials
Consumption ,g/m^2	100-200	100-200	200-600	200-600	200-600	200-600

3.3 Chemical waterproofing of the front sides

Often the rain can penetrate the exterior walls. By front sides impregnation with silicon resins or fluorine-chemicals, this trouble can be easily fixed. Inestetic consequences of the dampness (like mold attacks) and severe cold damage can be, also, completely eliminated after front side impregnation with silicon resins or fluorine-chemicals.

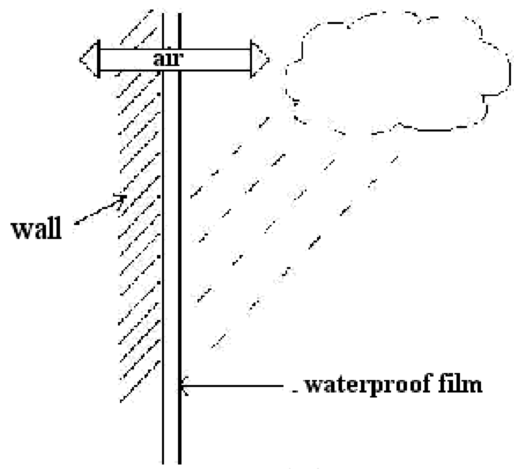


Figure 5 Chemical waterproofing of the front sides

Pores and construction materials capillaries are covered with thenwaterproofing agent, as an extremely refined film, almost invisible. This way we can keep intactair, gas and water steams penetration

Tables 5 Silicon agents appliance mode for front sides waterproofing

Assortment	**Baysilon S**	**Baysilon LN**
Thinner	Water	Gasoline or another hydrocarbon with boiling point at 140-150^0C
Dillution proportion	1:10 (Delivery shape :Thinner)	1:10;1:15 (Delivery shape : Thinner)

Applyable at:	Imbued content i n open colours (white, grey or beige)	For all natural and artificial constructions materials, strong or weak imbued, regardless of colour
Impregnation times	Can only be applied once	It can be applied once or twice on strong moist surfaces

Table 5 presents a series of application ways of waterproofing silicon agent, type Baysilon. Most adequate appliance of impregnation in solution can be made through intense spraying. Construction materials (like plating bricks) cannot be impregnated.

In case of PROTESIL silicon product, proper for natural rock waterproofing, plaster, apparent masonry and apparent concrete, his appliance being made by spraying or with brush or roller, in 1-2 layers. PROTESIL consumption is 0,2-0,4 l/m^2, regarding surface absorption. Another silicon product used for front sides waterproofing is DRYFILL, which applies without dilution in 2 layers and has a cover up capacity of 3-7 m^2/l, regarding surface quality. It is guaranteed a surface protection of 12-15 years. FUNOOSIL product is used for hydrophobic protection of the concrete in transports domain (streets, bridges, support and fonic protection walls, guide bars, bunk parkings, parking surfaces). For concrete, specific consumption is 0,3-0,5 l/m^2, and for fresh concrete is 1,0 l/m^2.

4. WATERPROOFING SILICON AGENTS USED AS PLASTER AND APPLICATIONS UNDER DISPERSION PAINTINGS

Pleasant aspect and durability of paintings made with dispersion paints can suffer heavily in case of a moist content. If fissures appeared, painted exterior wall can be degraded by atmospheric rainfalls. Same phenomenon can have place once with paintings antiquation. By water penetrating, bubbles will appear at the painting surface, because it will take its crust off or it will get covered with efflorescences. These early damages can be avoided if exterior walls are hydrophobic, before painting appliance, with a silicon waterproof agent. As hydrophobe dampness applied before painting with dispersion paints, is recommended especially Baysilon LN agent, the procedure being the same as in the case of exterior walls impregnation. Subsequent cover up with dispersion paints of silicon agents impregnation is not difficult if the first painting has been made with an undiluted paint. By water increase (one part water at 2-3 paint parts) we can obtain a faultless paint.

The painting applied on a hydrophobe content will mantain her adherence capacity many years, independent of atmospheric influences.

Also, we can notice resin silicon paintings appearance having the following advantages :

- Waterproof;
- Autocleaning capacity;
- Allows material breathing;
- Doesn't modify his colour during the rain like mineral paints.

5. WATERPROOF AGENTS FOR DAMPNESS AND MORTAR

Waterproof agents (for example, Baysilon F), added in dampness and mortar mixing, gives them hydrophobe properties. Dry waterproof agent is more homogenous at first with mortar and dampness components. After water adding and subsequent processing it results hydrophobe mortar and dampness layers on the entire thickness of their surface. Needed quantity of waterproof agents depends on the mixing nature and can be of 0,6 – 1,2 %, regarding of dampness and mortar dry components. In case of ADINOL-DM product, this will be added in mixing water at dampness preparation, in 1% proportion from binding materials (cement and lime), but is not recommended overdose, because in this case it will extent plug time and it will reduce the final resistances.

6. CONCLUSIONS

Interior walls and front sides waterproof problem is special and can be fixed with chemical method, electro-osmotic or physical. Silicon agents use in constructions is possible because there is chemical compatibility between the silicates from constructions materials and silicons. Chemical waterproof presents an efficient solution and easy to apply. We can see specific consumptions of different waterproof agents, regarding of waterproof efficiency which is conditioned by products nature and chemical composition.

7. REFERENCES

[1]CAMPIAN C., MOGA C., STREZA T., *"Constructions Magazine " nr.2 (68) /2005*

[2]NOLL W. *Chemie und Technologie der silicone, Second Edition Verlag Chemie, Weinheim, 1968*

[3]PROCA G., *Constructions silicons, Ed. Matrix Rom, Bucharest, 1999*

[4]Du Pont ZONYL – *Surface Protection Solution make, everyday easy*

[5]CHERCHES M, PUTINA P, *"Constructions Magazine" – nr 16 (68) 2006*

THE STUDY OF NAVAL POWER PLANT: EXPENSES INCURRED BY THE SHIP AFTER VOYAGES MADE

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ABSTRACT

This paper presents the analysis of transport costs for oil tanker at various operating regimes.
Are determined annual maintenance and exploitation for a ship.
During a voyage, the ship is navigational several situations and main engine and auxiliary machinery does not always work the same load.

Keywords: *engine power, oil-tanker, cost of transport, ballast, full load.*

1. INTRODUCTION

Current naval propulsion plants are composed of compression ignition engines.

Operating regimes of these power plants are quasi-stationary, given the static mechanical characteristics of the propulsion engine running, transmission power, consumer power and control the mechanisms of their positions.

Main engine of a ship is the main consumer of fuel and energy major manufacturer on board.

Economy in order to improve the installation of ship propulsion is used for marine main diesel engines of heavy fuel oil heavy fuel sulfur especially in slow diesel engines and semirapid diesel engines [2].

Ship's propulsion system must function safely with minimized expenses, so that the specific cost of transport to be as small.

To evaluate the the amount of these expenses must keep in mind that during a voyage, the ship is navigation a variety of situations and the main engine and auxiliary machinery does not work all the time on the same charge.

2. CASE STUDY

Petroleum is equipped with a propeller, the propulsion of the vessel being provided by a diesel engine MAN B & W & 6-cylinder, engine power: 9480 [kW], 127 [rpm]; deadweight in the sea water is 37000tdw [3].

The ship is equipped with three generators Diesel, 960 kW of power, speed 900 rpm. The crew consists of 31 persons.

Should be noted that after some time the ship hull navigation buildup leading to a propeller hydrodynamic heavy and extra power requires for ship propulsion [3].

Current marine engines with compression ignition regimes operate on variables of power and speed which entail changing parameters indicate effective that characterize the operating mode of the engine.

Mode of engine propulsion depends on: type of ship, navigational conditions, hull design, propeller type and mode of transmitting power from engine to engine.

Are analyzed nine operating modes for ship (ballast and full load).

✧ Specific cost of transport (annual) [1] :

$$CS_{T,\text{an}} = \frac{Ch_{\text{an,totale}}}{G \cdot 2R \cdot N_{\text{V}}} \text{ [€/tMm]} \qquad (1)$$

- $Ch_{\text{an,totale}}$ =f(v, $R_{t,}$) - maintenance and exploitation
- G [t] - quantity of products shipped per year
- R[Mm] - distance between extremes route
- N_V- number of annual trips
- N_V = f(v,R, G); N_v = f(v);

Minimum specific cost of transport CST.an = 0,002583 [€/tmM] mode resulted in the ship with v_b = 11 Nd speed, engine speed n_b = 80,865 [rpm] (ballast) and v_m = 14,87 Nd, n_m = 121,87 [rpm] (full load), making a total of 10,140 ship voyages year total cost of transport is $Ch_{\text{an,total}}$ = 8511407,357 [€/year] (figure 1).

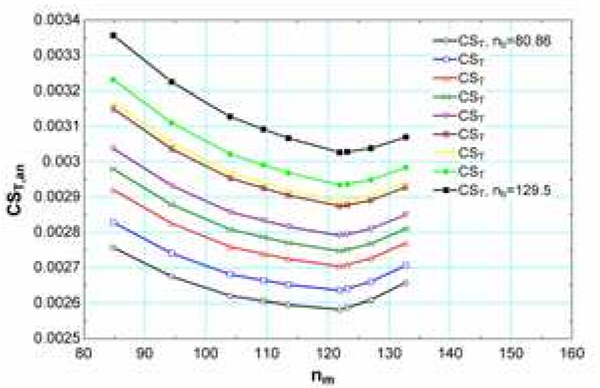

Figure 1 Specific annual transport cost

Figure 2 is the specific cost of transport (on travel and annually), total expenditure for maintenance and annual exploitation mode of ship speed v_b = 15 Nd, n_b = 119,5 [rpm] (ballast) and v_m = 15 Nd, n_m = 123,120 [rpm] (full load).

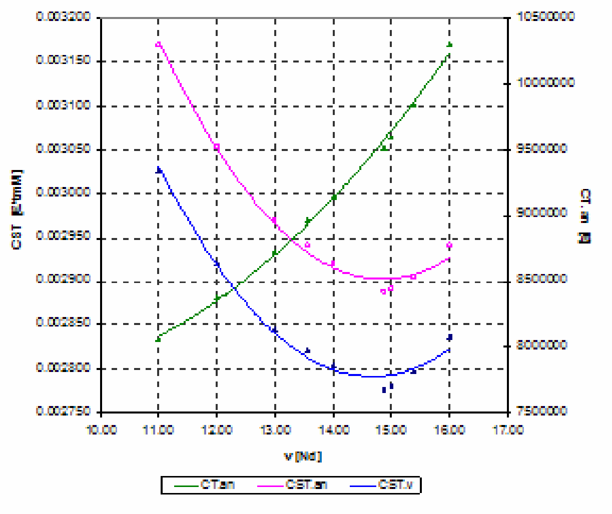

Figure 2 Specific variation in the cost of transport and total cost of annual maintenance and operation mode of the ship with speed v = 15 Nd

3. CONCLUSIONS

Annual operating and maintenance costs are : Ch_{sal} =8,27%; Ch_{CAS} =2,48%; Ch_{P_S} =0,12%; Ch_{amort}=18,80%; Ch_{rep} =7,05%; Ch_{apa} =0,01%; Ch_{Suez} =28,21%; Ch_{CL} =29,28%; Ch_{asig} =2,35%; Ch_{com} =0,109%; Ch_{div} =0,188%; Ch_{alte} =3,13%, of the cost of transportation.

Figure 3. are annual maintenance and operating costs.

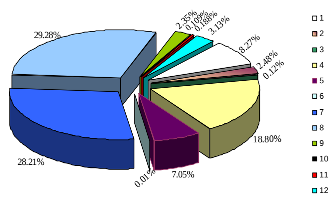

Figura 3 The share of costs

1- Ch_{sal}; 2- Ch_{CAS}; 3- Ch_{Ps}; 4-Ch_{amort}; 5-Ch_{rep}; 6-Ch_{water}; 7-Ch_{Suez}; 8-Ch_{CL}; 9-Ch_{asig}; 10-Ch_{com}; 11-Ch_{div}; 12-$Ch_{alte\ ch}$

Fuels and lubricants expenses represent the largest share (29,28%) of the total cost of transportation.

4. REFERENCES

[1] SIMIONOV, M., *Instalații de propulsie navala*, Galati University Press, 2009.

[2] LUPCHIAN MARIANA, *The profit made by a oil tanker after a voyage*, CIEI 2011, Proceedings of the International Conference On Industrial Power Engineering the 8-th Edition,, “VASILE ALECSANDRI” UNIVERSITY OF BACĂU, Alma Mater Publishing House, BACĂU – ROMÂNIA, aprilie 14-25, ISSN-L 2069-9905, Bacau 2011.

[3] LUPCHIAN MARIANA, *Determination of optimum operating regime for a naval power plant based on minimum fuel consumption*, Conference- New face of TMCR, Proceedings of 16th International Conference Modern Technologies, Quality and Innovation, volume I, ModTech Iaşi 2012.

[4] MAN B&W Diesel A/S, S50MC-C Project Guide, 6th Edition January 2009.

[5] MC Programme Engine Selection Guide MAN B&W Diesel A/S Two- stroke Engines 2nd Edition February 1992.

APPROXIMATIONS IN STRUCTURAL ANALYTICAL STUDIES

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ABSTRACT

The paper unveils the nature of the theoretical approaches, both analytic and numeric, which are based on hypotheses, which means accurate or less-accurate approximations. The study is structured on theory-level approximations, method-level approximation and ideas to improve the accuracy of the models. The conclusion is that the 'unity in diversity' principle applied for the scientific instruments, the difference between their natures, enriches the knowledge growth.

Keywords: *approximation, hypothesis, theory, method, accuracy improvements.*

1. INTRODUCTION

The problem of the approximations is inherent in any study and a high level of awareness in this matter is paramount for the accuracy of the results.

It is important to notice that a non-trivial approach of this problem should start by remarking the several levels which operate with concepts based on approximations. Let us consider three levels: philosophy, theory and method. Before considering the philosophical level which may be defined as the rational investigation of the truths and principles, it is easier to approach the levels of the theory and method. In this way, the results may be used to access a higher level of understanding and a possible generalization from a philosophical inter-domain standpoint.

The essay emphasizes some of the approximations employed in the theories and in the methods currently used in structural studies.

2. THEORY-LEVEL APPROXIMATIONS

The basic 'building blocks' of a theory are the hypotheses which state certain behaviour of a given aspect of the phenomena.

Let us analyse the way how the hypotheses influence the definition and computation of the strains in the Theory of Elasticity.

Functions of the displacement with respect to the axes of coordinates are:

$$\begin{aligned} u &= u(x,\, y,\, z) \\ v &= v(x,\, y,\, z) \\ w &= w(x,\, y,\, z) \end{aligned} \tag{1}$$

The definition of the linear strains is:

$$\begin{aligned} \varepsilon_x &= \frac{\partial u}{\partial x} + \frac{1}{2}\left[\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial x}\right)^2 + \left(\frac{\partial w}{\partial x}\right)^2\right] \\ \varepsilon_y &= \frac{\partial v}{\partial y} + \frac{1}{2}\left[\left(\frac{\partial u}{\partial y}\right)^2 + \left(\frac{\partial v}{\partial y}\right)^2 + \left(\frac{\partial w}{\partial y}\right)^2\right] \\ \varepsilon_z &= \frac{\partial w}{\partial z} + \frac{1}{2}\left[\left(\frac{\partial u}{\partial z}\right)^2 + \left(\frac{\partial v}{\partial z}\right)^2 + \left(\frac{\partial w}{\partial z}\right)^2\right] \end{aligned} \tag{2}$$

The definition of the angular strains is:

$$\begin{aligned} \gamma_{yz} &= \frac{\partial v}{\partial z} + \frac{\partial w}{\partial y} + \frac{\partial u}{\partial y}\frac{\partial u}{\partial z} + \frac{\partial v}{\partial y}\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\frac{\partial w}{\partial z} \\ \gamma_{zx} &= \frac{\partial w}{\partial x} + \frac{\partial u}{\partial z} + \frac{\partial u}{\partial z}\frac{\partial u}{\partial x} + \frac{\partial v}{\partial z}\frac{\partial v}{\partial x} + \frac{\partial w}{\partial z}\frac{\partial w}{\partial x} \\ \gamma_{xy} &= \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} + \frac{\partial u}{\partial x}\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\frac{\partial v}{\partial y} + \frac{\partial w}{\partial x}\frac{\partial w}{\partial y} \end{aligned} \tag{3}$$

By the use of the small deflections hypothesis, there may be neglected the nonlinear terms and the above definitions may be approximated as:

$$\varepsilon_x = \frac{\partial u}{\partial x};\ \varepsilon_y = \frac{\partial v}{\partial y};\ \varepsilon_x = \frac{\partial w}{\partial z}; \tag{4}$$

respectively

$$\gamma_{yz} = \frac{\partial v}{\partial z} + \frac{\partial w}{\partial y};\gamma_{zx} = \frac{\partial w}{\partial x} + \frac{\partial u}{\partial z};\gamma_{xy} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \tag{5}$$

Definitions (4) and (5) are widely used for most common problems, including in Strength of Materials. Even so, there are geometrical aspects regarding the definition of the strains, aspects which add more accuracy in this approach.

In order to evaluate the rationality of some approximations, there must be evaluated the values of the strains which will be used in the following proof.

According to Hooke’s law, we have

$$\begin{cases} \sigma = E \cdot \varepsilon \\ \tau = G \cdot \gamma \end{cases} \tag{6}$$

and the according strain is

$$\begin{cases} \varepsilon = \dfrac{\sigma}{E} \\ \gamma = \dfrac{\tau}{G} \end{cases} \tag{7}$$

By considering the maximum values of the allowable stresses and the minimum values of the according moduli of elasticity in their common ranges, one can calculate the maximum values of the strains. For the current materials the values of the strains are less than 0.004. For steel one can consider

$$\begin{cases} \varepsilon = \dfrac{250\ MPa}{2 \cdot 10^5\ MPa} = 1.25 \cdot 10^{-3} \\ \gamma = \dfrac{150\ MPa}{0.8 \cdot 10^5\ MPa} = 1.875 \cdot 10^{-3} \end{cases} \tag{8}$$

Let us consider the state of deflections presented in the figure above, which is employed to define the strains taking into consideration geometrical aspects.

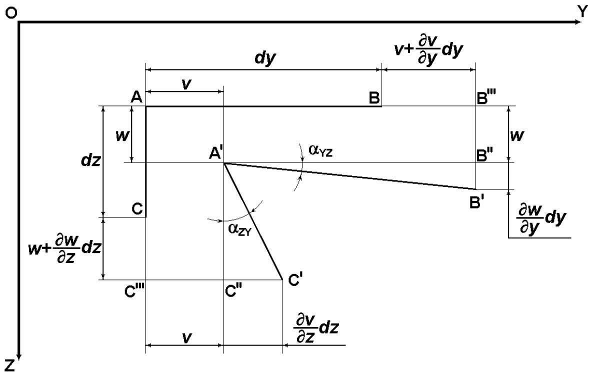

Figure 1 State of deflections

The shear strain is defined as

$$\gamma_{yz} = \alpha_{yz} + \alpha_{zy} \tag{9}$$

As it can be noticed from (8), α_{yz} and α_{zy} are even smaller than the maximum value of the angular strain γ_{yz}. This is why this small angle may be replaced either with its tangent, or with its sine.

It is interesting to evaluate how small may be the angle in order to have a relatively accurate approximation of the angle. Calculating the values of the sine and tangent functions, one can notice that the overall relative error is smaller than 1% if the angle is smaller than 10°, that is

$$\varepsilon_r < 1\% \;\Rightarrow\; \alpha \approx \sin(\alpha) \approx tg(\alpha),\ \forall\ \alpha < 10^\circ \tag{10}$$

Condition (10) is respected for the current vales of (8), this means for the fair conditions of the so called small deflections hypothesis.

The shear strain may be defined using the scheme presented in figure 1 and relation (9):

$$\begin{cases} \alpha_{yz} = B'\hat{A'}B'' \approx tg\left(B'\hat{A'}B''\right) = \dfrac{B'B''}{A'B''} \\ \alpha_{zy} = C'\hat{A'}C'' \approx tg\left(C'\hat{A'}C''\right) = \dfrac{C'C''}{A'C''} \end{cases} \tag{11}$$

Replacing $B'B''$, $A'B''$, $C'C''$ and $A'C''$ as they are expressed in figure 1, it results

$$\begin{cases} \alpha_{yz} = \dfrac{\dfrac{\partial w}{\partial y}d\,y}{d\,y + \dfrac{\partial v}{\partial y}d\,y} = \dfrac{\dfrac{\partial w}{\partial y}}{1+\dfrac{\partial v}{\partial y}} \\ \alpha_{zy} = \dfrac{\dfrac{\partial v}{\partial z}d\,z}{d\,z + \dfrac{\partial w}{\partial z}d\,z} = \dfrac{\dfrac{\partial v}{\partial z}}{1+\dfrac{\partial w}{\partial z}} \end{cases} . \tag{12}$$

In the expression above there may be identified the linear strains ε_y and ε_z, as they are presented in (4).

It results

$$\begin{cases} \alpha_{yz} = \dfrac{\dfrac{\partial w}{\partial y}}{1+\varepsilon_y} \\ \alpha_{zy} = \dfrac{\dfrac{\partial v}{\partial z}}{1+\varepsilon_z} \end{cases} \tag{13}$$

Taking into account (8) and (10), it results that ε_y and ε_z are smaller than 1, so they may be neglected in (13), and it results

$$\begin{cases} \alpha_{yz} \approx \dfrac{\dfrac{\partial w}{\partial y}}{1+0} = \dfrac{\partial w}{\partial y} \\ \alpha_{zy} \approx \dfrac{\dfrac{\partial v}{\partial z}}{1+0} = \dfrac{\partial v}{\partial z} \end{cases} . \tag{14}$$

The according shear strain is

$$\gamma_{yz} = \alpha_{yz} + \alpha_{zy} \approx \frac{\partial w}{\partial y} + \frac{\partial v}{\partial z}, \tag{15}$$

relation already presented in (5).

The only technical literature source where expression (13) was found is [6], without any discussion regarding the size of the linear strains ε_y and ε_z.

Apart of the definitions, let us consider the analytical relations employed to compute the strains for a rotated coordinate system.

Segment A'B', figure 2, is translated in order to have A≡A'. In order to define the components of the strain there must be done the additional constructions $BC\,||\,OY$, $B'C\,||\,OZ$, $AB \cap CB' = \{B''\}$, $CC' \perp AB'$, $BC'' \perp CC'$, $BD \perp AB'$. Components of the strain related to the B point are:

- with respect to the Y axis: BC,
- with respect to the Z axis: B'C.

where

$$BC = \frac{\partial v}{\partial y}d\,y + \frac{\partial v}{\partial z}d\,z \tag{16}$$

$$B'C = \frac{\partial w}{\partial y}d\,y + \frac{\partial w}{\partial z}d\,z \tag{17}$$

Component on AB' direction is

$$DB' = DC' + C'B' = BC'' + C'B' \tag{18}$$

From the BCC" right-angle triangle one can write

$$\cos(CBC'') = \cos(\alpha + \gamma_\alpha) = \frac{BC''}{BC} \tag{19}$$

and it results

$$BC'' = BC \cdot \cos(\alpha + \gamma_\alpha) \tag{20}$$

Again, because of (8) and (10), γ_α is very small in comparison with α and it can be used the fair approximation

$$\alpha + \gamma_\alpha \approx \alpha \tag{21}$$

It results

$$BC'' = BC \cdot \cos(\alpha) \tag{22}$$

Same, in the right-angle triangle B'CC' we have

$$\sin(C'CB') = \sin(\alpha + \gamma_\alpha) = \frac{C'B'}{CB'} \qquad (23)$$

and it results

$$C'B' = CB' \cdot \sin(\alpha + \gamma_\alpha) \qquad (24).$$

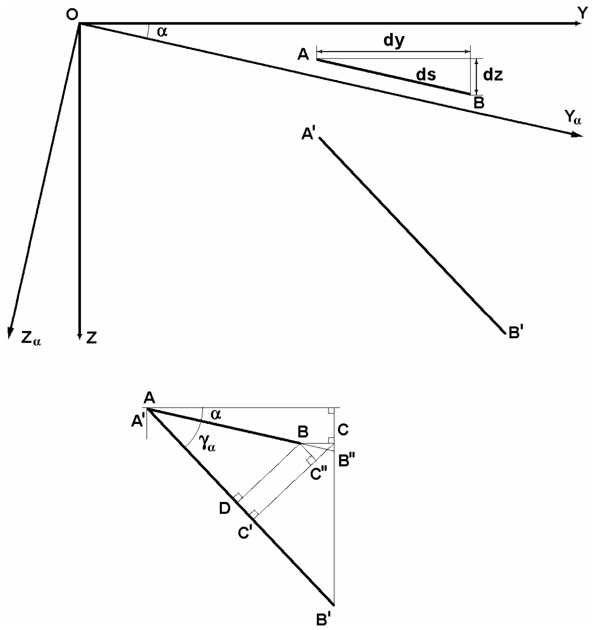

Figure 2 Rotated coordinate system

Using (21), it results

$$C'B' = CB' \cdot \sin(\alpha) \qquad (25)$$

So, the component on AB' direction is

$$DB' = BC \cdot \cos(\alpha) + B'C \cdot \sin(\alpha) \qquad (26)$$

Replacing (16) and (17) in (26) it results

$$\begin{aligned} DB' = &+\left(\frac{\partial v}{\partial y} d\, y + \frac{\partial v}{\partial z} d\, z\right) \cdot \cos(\alpha) + \\ &+\left(\frac{\partial w}{\partial y} d\, y + \frac{\partial w}{\partial z} d\, z\right) \cdot \sin(\alpha) \end{aligned} \qquad (27)$$

According to the definition of the linear strain

$$\varepsilon_\alpha = \frac{DB'}{AB} \qquad (28)$$

where

$$AB = ds \qquad (29)$$

$$d\, y = d\, s \cdot \cos(\alpha) \qquad (30)$$

$$d\, z = d\, s \cdot \sin(\alpha) \qquad (31)$$

It results

$$\begin{aligned} \varepsilon_\alpha = \frac{1}{d\, s}\Bigg[&+\left(\frac{\partial v}{\partial y} d\, s \cdot \cos(\alpha) + \right. \\ &\left. + \frac{\partial v}{\partial z} d\, s \cdot \sin(\alpha)\right) \cdot \cos(\alpha) + \\ &+\left(\frac{\partial w}{\partial y} d\, s \cdot \cos(\alpha) + \right. \\ &\left. + \frac{\partial w}{\partial z} d\, s \cdot \sin(\alpha)\right) \cdot \sin(\alpha) \Bigg] \end{aligned} \qquad (32)$$

After some transformations it results

$$\begin{aligned} \varepsilon_\alpha = &\underbrace{\frac{\partial v}{\partial y}}_{\varepsilon_y} \cdot \cos^2(\alpha) + \\ &+ \overbrace{\left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\right)}^{\gamma_{yz}} \cdot \sin(\alpha) \cdot \cos(\alpha) + \\ &+ \underbrace{\frac{\partial w}{\partial z}}_{\varepsilon_z} \cdot \sin^2(\alpha) \end{aligned} \qquad (33)$$

The final relation is

$$\begin{aligned} \varepsilon(\alpha) = &\frac{\varepsilon_y + \varepsilon_z}{2} + \frac{\varepsilon_y - \varepsilon_z}{2} \cdot \cos(2 \cdot \alpha) + \\ &+ \frac{\gamma_{yz}}{2} \cdot \sin(2 \cdot \alpha) \end{aligned} \qquad (34)$$

Similar relation may be derived for the shear stress variation with respect to a rotated coordinate system.

To conclude this paragraph regarding the theory, there can be noticed that both definitions and math relations are based on approximations which may be considered reliable for a certain class of problems.

These definitions and math relations are used in Strength of Materials without any proof, so the approximations are inherent to all the subsequent calculi. Similar approximations may be also found in the theory of the Strength of Materials.

3. METHOD-LEVEL APPROXIMATIONS

The term 'method' may be considered for applications in both Theory of Elasticity and Strength of Materials, as well as for methods originated in other sciences, such as mathematics, numerical methods, computer science and experimental methods.

Let us consider the model presented in figure 3, which represents an on-board crane employed to load or discharge the cargo on a ship. It is a statically indeterminate system which can be solved by the use of various methods. At a certain level all the solving methods must consider the compatibility of deformation. The geometrical solution is based on two hypotheses: infinite rigidity of the horizontal bar and parallelism of the vertical bars in the deflected position with respect to the initial position. Based on these hypotheses there may be written a relation between the sides of the similar triangles in figure 3. It results a relation between the deflections of the vertical flexible bars.

This is an example of using hypotheses, which means applying approximations, in the solution of a concrete problem. A more accurate approach should consider the influence of the so-called rigid horizontal bar onto the results of the study.

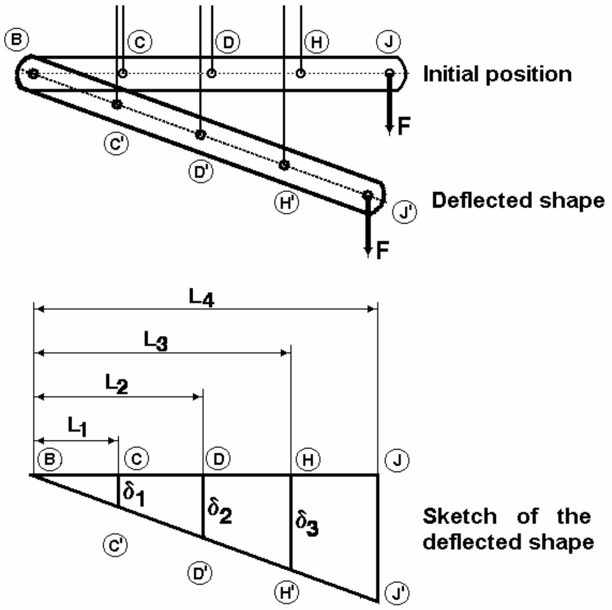

Figure 3 Model of a lifting system made of rigid and flexible bars

Theory of Elasticity offers a set of general equations and a portfolio of methods to solve the equations. These methods are synchronous with the technological level of the computing instrument in that age of science. In the class of the so-called 'computing instruments' there may be included: mathematical methods, numerical methods, computer algorithms. Some of the hypotheses were conceived especially to compensate the shortcomings of the computing instruments of a given technological level. An interesting aspect regarding the solving methods included in the theory of elasticity books is the presence of the experimental methods, [15].

A solution widely used in elasticity problems was to consider the Fourier and/or trigonometric series for the approximation of the notions. There was used the property of orthogonality of the functions, the final solution being expressed as a series of simple or double trigonometric functions. The concrete 'by hand' calculus uses, at most, the two first terms of the series. Approximation may be also found in this method, the computer based solution which considers several terms of the series requiring appropriate algorithms which must avoid inaccuracy and even run-time errors of that original software.

Beside its known weak points, Finite Difference Method, [10], is another important method which offers solutions to a wide class of problems: structural problems, heat transfer, computational fluid dynamics and others. It also uses approximations, starting with the expansion in series and followed by the size of the grid employed to solve the set of equations specific to that given phenomenon, size which may influence the convergence of the solution. It is a discrete method, so its approximations are added to the approximations of the basic theory of the model. It may be reliable if an original computer based solution is conceived and parameterized software is developed.

Finite Element Method is extensively used nowadays, important software applications being used by various people to solve specific problems. Beside its flexibility and simplicity in applying a certain software, a firmly theoretical level of the structural analyst is required in order to create an accurate model of the phenomena, using the facilities specific to this method. It is also a discrete method which has specific hypotheses, being a quintessence of general numerical methods: interpolation, calculus of integrals, solving systems of equations. It is a reliable nowadays instrument which is integrated in intelligent computer based systems of software applications, such as: CAD/CAE/CAM/PDF, for instance NX/FEMAP-NASTRAN/Teamcenter and others.

4. IDEAS REGARDING THE MEANS TO BE USED IN ORDER TO REACH A HIGHER ACCURACY

Each 'instrument', theory or method, is based on a set of hypotheses this means approximations. It is important to conceive a strategy which uses the strength of each such 'instrument' and compensates their weak points. This means to create a strategy of the research which is embedding several types of studies: analytic, numeric, experimental, the integration being done by the use of some original software applications.

A first example regards the way how the differential equation of the neutral fibre of a bar subjected to bending is deduced. The relation of the curvature is given by the differential geometry and it is

$$\frac{1}{\rho} = \frac{u''}{\left[1+(u')^2\right]^{\frac{3}{2}}}, \tag{35}$$

where u is the deflection and ρ is the curvature.

The rotation is defined by:

$$\varphi = \frac{du}{dx} = u' \tag{36}$$

and it is considered to be very small. Moreover, $(u')^2$ is even smaller. Consequently it is neglected in (35), which becomes

$$\frac{1}{\rho} = u'' = \frac{d^2 u}{dx^2}. \tag{37}$$

This differential equation may be easily integrated and it leads to the differential relation which may be integrated by the use of the method of initial parameters.

If $(u')^2$ is not neglected, other methods of integration should be used. Paper [11] presents an original computer based method and its limits with respect to the size of the cross-section of the bar subjected to bending. In this case it was imperative to use the numerical integration and an appropriate optimised algorithm. In this way the analytic and the numerical methods complete each other.

There are other cases where experimental and numerical studies complete each other, [13].

A computer based procedural model is presented in reference [9]. It uses experimental data acquired by the use of the strain gage technology. The algorithm is employed to compute the linear thermal expansion coefficient in those points where the temperature is measured. The large amount of experimental data offers statistical confirmability of the results. The same set of relations is used in a second stage to compute the temperature in those points where the temperature could not be measured by the use of a non-contact thermometer. Again, the results were confirmed by the statistic verifications.

Another idea is about the results of the fotoelasticimetery experimental investigation which may be processed using the finite difference method, [10], in order to compute the principal strains and stresses on the part.

Isoclinic fringes resulted from fotoelasticimetery experimental investigation may be processed using numerical interpolation methods in order to compute the position of the isostatics on the mechanical part.

Because theoretical studies use constants of the materials of the mechanical parts, it is advisable to measure the material constants in order to have accurate results which are used either for calibrating a numerical model, or to check the accuracy of the results, [7], [8].

These are just a few examples regarding the way how different types of methods may be used to solve a research problem.

Regarding the iterative numerical methods it is important to conceive the set of conditions which must indicate the convergence of the solution and the accuracy of the results. These conditions are based on the verification of either the error of the results of the calculus at successive iteration stages, or on the fulfilment of a general accuracy condition. According to the particular problem to be solved, customized conditions may be conceived.

In order to create an accurate model, the math relations used to define certain aspects of the model should be tested in order to verify if their hypotheses are in accord with the phenomenon and the values of their results are convergent with the results of other math relations. These are tests of the hypotheses which should be done in every model.

All the examples previously presented use the computer as the main tool of integration of the information produced by the different ‘branches’ of the study. There should be noticed that applied elasticity computer models are useful not only in research, but also in automatic design, [12], [19].

An important idea originated in the semi-numerical studies is to evaluate the sensitivity of the solution with respect to various factors which influence that given phenomenon, idea which may be applied in all the research studies.

Other aspects, such as: elasticity of the supports, material models and others, are not discussed in this essay. Regarding the materials’ behaviour, there should be added that there is no elasticity, but only allowable plasticity, idea which opens another direction of studies.

There also should be noticed that the modern software applications based on FEM offers advanced means of investigation to people with a low level of theoretical knowledge, who have no overview regarding the phenomena to be modelled. The according results, may wrongly consider the sub-models regarding the supports, loads, material, etc. This is why it is important to have alternate means to validate the results of the theoretical studies. And a firmly scientific background is a ‘must’, [20], [21].

5. CONCLUSIONS

Until now, based on an extensive analysis of the technical literature, [1], [2], [3], [4], [14], [15], [16], [17], [18], there could not be found a quantitative analysis of the notions on which the approximations are based in structural studies. This essay unveils the true nature of the theoretical models, especially of the analytic models which are all based on accurate or less-accurate approximations.

There are several levels where approximations are considered, starting with the basic definitions and math relations of the theory of elasticity, up to the solution of the concrete structural problems. The essay offers some suggestions and examples to be considered in order to create models with a higher degree of accuracy.

Coming back to the philosophic level mentioned at the beginning of the essay, Knuth, [5], quoted von Neumann who said “Anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin”. “Mutandis mutatis”, one can say “Anyone who considers standalone analytic instruments to model real systems is, of course, in a state of sin”.

A final conclusion is that the 'unity in diversity' principle applied for the scientific instruments, the difference between their natures, enriches the knowledge growth.

6. ACKNOWLEDGEMENT

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Ideas regarding the maritime structures are the result of the models developed in the framework of the scientific research study ‘Development of computer assisted marine structures’, Emil Oanta, Cornel Panait, Ghiorghe Batrinca, Alexandru Pescaru, Alexandra Nita, Feiza Memet, which is a component of the RoNoMar project, 2010.

7. REFERENCES

[1] BUZDUGAN, G. *Rezistența materialelor*, Editura Academiei RSR, Bucureşti, 1986

[2] FILONENCO-BORODICI, M.M. Teoria elasticitătii, Editura Tehnică, Bucure□ti, 1962

[3] GREEN A.E.; ZERNA W. Theoretical elasticity, Oxford at the Clarendon Press, 1968

[4] IE□AN, D. *Teoria termoelasticitătii*, Editura Academiei RSR, Bucure□ti, 1979

[5] KNUTH, D.E. The *Art of Computer Programming*, Vol. 2. 2 ed. Reading, MA: Addison-Wesley, 1981.

[6] MOCANU, D.R.; THEOCARIS, P.S.; ATANASIU, C.; BOLEANTU, L.; BUGA, M.; BURADA, C.; CONSTANTINESCU, I.; ILIESCU, N.; PASTRAV, I.; TEODORU, M *Analiza experimentală a tensiunilor, Volumul 1: Bazele teoretice ale metodelor tensometrice şi indicații practice privind utilizarea acestora*, Editura Tehnică, Bucureşti, 1976

[7] NITA, A.; BARSANESCU, P. *Impact of the finite element method for the measuring of the residual stress in molded polymeric parts*, 6th International Conference on the Management of Technological Changes, Date: SEP 03-05, 2009 Alexandroupolis GREECE Source: MANAGEMENT OF TECHNOLOGICAL CHANGES, VOL 1, pp.533-536, ISBN: 978-960-89832-7-4, IDS Number: BMO93

[8] NITA, A.; OPRAN C., *Testing Charpy impact strength of polymeric materials*, Annals of DAAAM for 2009 & Proceedings of 20th DAAAM International Symposium, 1529-1531, 25-28th November 2009, ISBN 978-3-901509-70-4, ISSN 1726-9679, pp 765, Editor Branko Katalinic, Published by DAAAM International, Vienna, Austria

[9] OANTA, E., TARAZA, D., *Experimental Investigation of the Strains and Stresses in the Cylinder Block of a Marine Diesel Engine*, Paper 2000-01-0520, SAE 2000 World Congress, Detroit, Michigan, March 6-9, 2000, ISSN 0148-7191

[10] OANTA, E Fundamente teoretice în programarea aplica□iilor de inginerie mecanică asistată de calculator, 294 pages, Editura Fundatiei "Andrei Saguna", Constanta, 2000, ISBN 973-8146-04-6, Preface by Aramă Constantin, member of the Romanian Science Academy

[11] OANTA, E.; NICOLESCU, B. *An original approach in the computer aided calculus of the large deflections*, Analele Universității Maritime Constanța, România, 2003, Year IV, Vol. 5, pag. 53-58, ISSN 1582-3601

[12] OANTA, E. *Applied Elasticity Computer Models in Automatic Design*, Proceedings of The 2nd International Multi-Conference on Engineering and Technological Innovation: IMETI2009, Section Mechanical Engineering including Industrial Engineering, Operations research, Aerospace, Marine and Agricultural Engineering, Mechatronics, Robotics, July 10th-13th, 2009, Orlando, Florida, USA, Organized by the International Institute of Informatics and Systemics, Collection: ISBN-10 1-934272-67-1, ISBN-13 978-1-934272-67-1, Volume: ISBN-10 1-934272-68-X, ISBN-13 978-1-934272-68-8, Edited by: Nagib Callaos, Hsing-Wei Chu, Yaroslava Yingling, C. Dale Zinn, pp. 270-275

[13] OANTA, E.; PANAIT, C.; SABAU, A.; BARHALESCU, M. L. & AXINTE, T. *Analytic Method to Compute the Isostatics using the Isoclinic Fringes*, Annals of DAAAM for 2012 & Proceedings of the 23rd International DAAAM Symposium, ISBN 978-3-901509-91-9, ISSN 2304-1382, pp 0493 - 0496, Editor Branko Katalinic, Published by DAAAM International, Vienna, Austria 2012

[14] POPA, B.; MADARASAN, T.; BATAGA, N; ADAMESTEANU, I. *Solicitări termice în construcția de maşini*, Editura Tehnică, Bucureşti, 1978

[15] SHAMES I.H.; COZZARELLI F.A. *Elastic and Inelastic Stress Analysis*, Taylor & Francis, 1997

[16] TEODORESCU, P.P. *Probleme plane în teoria elasticității*, Editura Academiei RPR, Bucureşti, 1961

[17] TEODORESCU, P.P.; Ille, V. *Teoria elasticitătii si introducere în mecanica solidelor deformabile*, Vol. I, Vol. II, Editura Dacia, Cluj-Napoca, 1976

[18] VOINEA, R.; VOICULESCU, D.; SIMION, F.P. *Introducere în mecanica solidului cu aplicații în inginerie*, Editura Academiei RSR, Bucureşti, 1980

[19] ZIDARU, N.; AXINTE, T. *Some Comments on standard calculation of compression helical springs and a proposal of optimal design, Constanta Maritime University Annals*, 2007, Year VIII, Vol. 10, pp. 225-228, ISSN 1582-3601

[20] ZIENKIEWICZ, O.C.; CHEUNG, Y.K. *The Finite Element Method in Structural and Cotinuum Mechanics*, McGraw-Hill Publishing Company Limited 1967

[21] ZIENKIEWICZ, O.C.; TAYLOR, R.L. *The Finite Element Method*, McGraw-Hill Book Company (UK) Limited, 1989

STUDY OF SOLAR ABSORPTION REFRIGERATION SYSTEM

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ABSTRACT

Solar energy is a relatively inexpensive source for freezing. We need cold even during periods when solar radiation is more intense. The purpose of the paper is to emphasize the importance of the solar energy used in absorption refrigerators installations.

Keywords: *Solar, installation, refrigeration, absorption, energy balance.*

1. INTRODUCTION

Solar energy is practically inexhaustible and clean.

The paper proposes a study of solar absorption refrigerating equipment. It can transform into other forms of energy.

The difficulties of using solar energy are:
- intermittent character;
- low density on surface;
- variation depending by season and climatic region;
- small storage possibilities for a longer period.

Powers achieved in Romania is about 600 W/m^2.

Advantages of absorption refrigeration systems:
- can use low-potential heat;
- long operating;
- do not use compressors;
- electricity consumption for pumps is low;
- good behavior at partial load;
- working solutions used will not damage the ozone layer.

2. SYSTEM DESCRIPTION

2.1. Solar absorption refrigeration scheme

This is shown in Figure 1.

The main parts are:

ST - storage tank;
A_b - absorber;
G - steam generator;
RS - regenerative heat excenger;
CS - solar panel;
P_1, P_2 - pumps;
C_d - condenser;
V - surface evaporation;
VL_1, VL_2 – expansion valves.

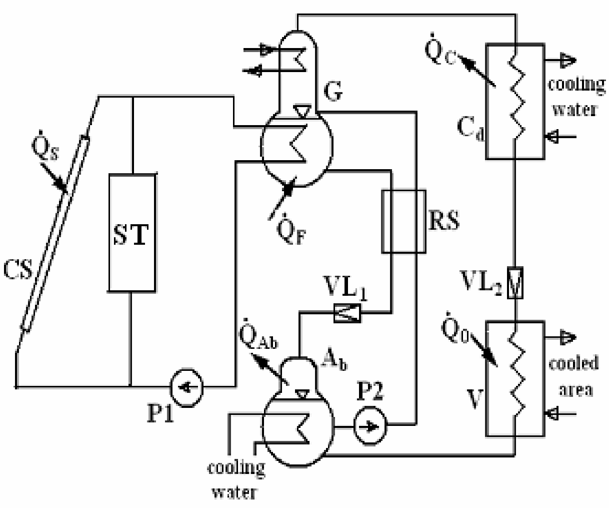

Figure 1 Absorption refrigeration scheme.

We will call below:
- thermochemical compressor (composed of: steam generator, absorber, heat regeneration and expansion valve 1);
- thermochemical expansion (composed of: condenser, expansion valve 2 and surface evaporation).

2.2. Solar panel

This is shown in figure 2.

The main parts are:

CS - solar panels
TI - thermometers
AV - automatic valves
FM - flowmeter
V - valves
ST - storage tank
SV - safety valve

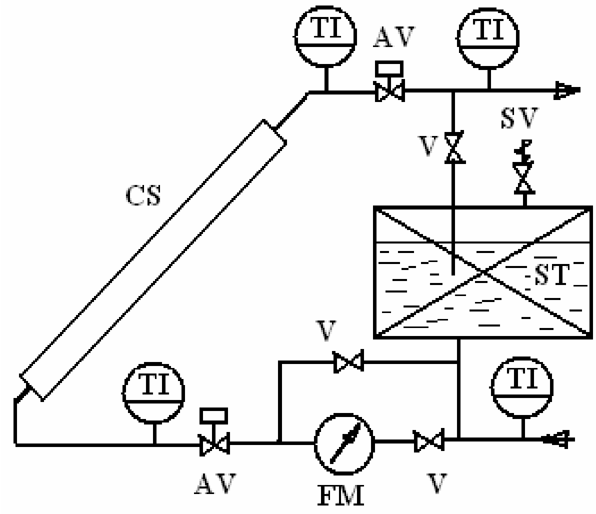

Fig. 2 Drawing of solar panel

The ε and η for solar panels are calculated as follows:

$$\varepsilon = \frac{(T_i + T_e) - 2T_a}{2I} \qquad (1)$$

$$\eta = \frac{G_e \cdot c_p \cdot \Delta T}{I} \cdot 100 \qquad (2)$$

Notations:

ε	-characteristic temperature	$\left[\frac{K \cdot m^2}{W}\right]$
η	-solar panel efficiency	$[\%]$
I	-solar radiation intensity	$\left[\frac{W}{m^2}\right]$
c_p	-specific heat	$\left[\frac{J}{Kg \cdot K}\right]$
G	-fluid flow per unit area	$\left[\frac{Kg}{m^2 \cdot s}\right]$

Efficiency variations depending by characteristic temperature is show in the next figure

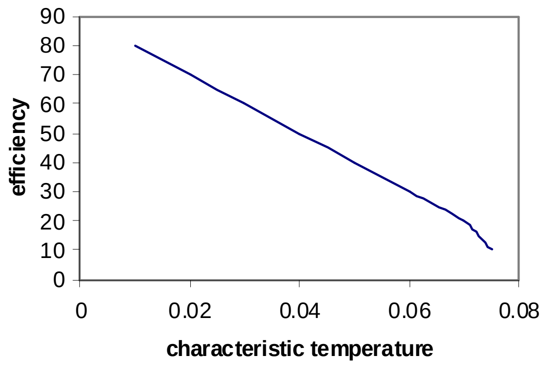

Figure 3 Efficiency variations depending by characteristic temperature

2.3. Exergetic flow diagram

This is shows in Figure 3.
In this diagram you can see two units:

- TC - thermochemical compressor;
- TE - thermochemical expansion.

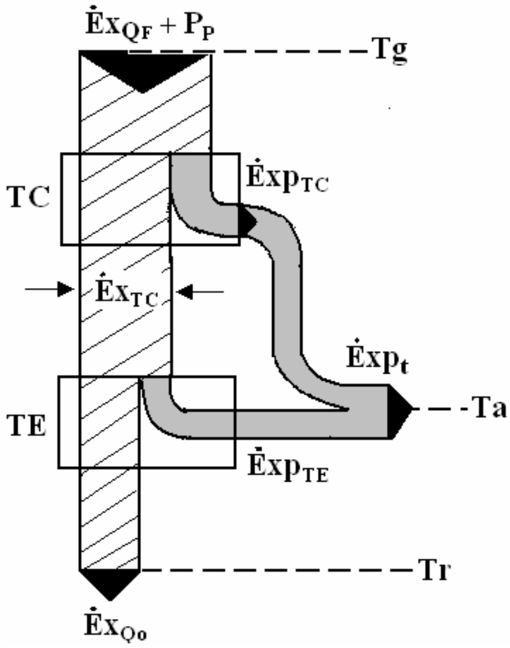

Figure 3 Exergetic flow diagram

Notations:

$\dot{E}x_{QF} + Pp$	- total exergetic flow introduced;
$\dot{E}xp_{TC}$	- exergue loss (in TC);
$\dot{E}x_{TC}$	- exergetic flow supplied by TC;
Q_0	- cooling power;
$\dot{E}x_{Qo}$	- exergetic flow;
$\dot{E}xp_{TE}$	- exergue loss (in TE);
$\dot{E}xp_t$	- total exergue loss.

3. EXERGETIC BALANCE EQUATION

Energy balance equation on the entire system:

$$\dot{E}x_{QF} + Pp = \left|\dot{E}x_{Qo}\right| + \dot{E}xp_{TC} + \dot{E}xp_{TE} \qquad (3)$$

$$\dot{E}x_{QF} = \left|\dot{E}x_{Qo}\right| + \dot{E}xp_{t} \qquad (4)$$

Performance coefficient for absorption refrigerating installation:

$$PC_{ARI} = \frac{Q_0}{Q_F + P_P} \qquad (5)$$

Exergetic efficiency is calculated as follows:

$$\eta_{exARI} = \frac{\left|\dot{E}x_{Qo}\right|}{\dot{E}x_{QF} + Pp} = 1 - \frac{\dot{E}xp_t}{\dot{E}x_{QF} + Pp} \qquad (6)$$

Also we can write relations:

$$\eta_{exTC} = \frac{\dot{E}x_{TC}}{\dot{E}x_{QF} + Pp} \qquad (7)$$

$$\eta_{exTE} = \frac{\left|\dot{E}x_{Qo}\right|}{\dot{E}x_{TC}} \qquad (8)$$

Result:

$$\eta_{exARI} = \eta_{exTC} \cdot \eta_{exTE} \qquad (9)$$

Energy needed is provided by the solar collector.

Storage tank provides the energy needed during the night. For this reason solar panels are dimensioned to ensure additional energy reserves.

4. CONCLUSIONS

1 - Energy losses due to efficiency may be compensated by increasing the solar surface.

2 - Exergetic efficiency depends by the two units: thermochemical expansion and thermochemical compressor.

3 - Can use an auxiliary heat source for not excessively oversized storage tank and solar panels.

4 - The regenerative heat excenger increase the exergetic efficiency of installation.

5 - Ship engine cooling water may be source of energy for absorption refrigeration installation.

5. REFERENCES

[1] Radcenco V., Porneala, S., Dobrovicescu, A., *Procese in instalatii frigorifice,* Editura didactica si pedagogica, Bucuresti, 1983.

[2] Danescu, Al. si col., *Utilizarea energiei solare*, Editura tehnica, Bucuresti, 1980.

[3] Porneala, S., Beju, C., *Reducerea pierderilor exergetice prin utilizarea regeneratorului de caldura intre solutii la instalatia frigorifica cu absorbtie*, Revista de termotehnica, anul V, nr. 1/2001.

[4]Nerescu, I., Radcenco, V., *Analiza exergetica a proceselor termice*, Editura tehnica, Bucuresti, 1970.

[5]Leca, A., Stan, M., *Transfer de caldura si masa*, Editura tehnica, Bucuresti, 1998.

[6]Bejan, A., *Termodinamica tehnica avansata*, Editura tehnica, Bucuresti, 1996.

DOMESTIC SOLAR WATER HEATING POTENTIAL IN THE SOUTH- EASTERN REGION OF ROMANIA

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ABSTRACT

One of the most effective methods to include ecological technology in a house is the use of solar systems for water heating. This paper determined solar water heating potential (SWH) for the South - Eastern region of Romania. It resulted that the use of solar energy covers approximately 35-50 % of the thermal energy needs for water heating from January to April and from October to December and 80-100 % from May to September.

This solar system reduces by up to two thirds the need to use traditional methods for water heating and minimizes costs for electricity or for fuel used in heating water, thus reducing the environmental impact.

Keywords: *solar water heating, solar radiation, energy consumption*

1. INTRODUCTION

The use of solar energy for domestic hot water supply proved to be a perfectly viable solution. The operating principle of the system of heating water with solar energy is simple, and the technology is already well known and reliable. Solar energy is non-polluting, inexhaustible, ecological and reliable. This facilitates energy savings, without producing waste or emitting polluting gases, such as carbon dioxide.

Above pollution problems and greenhouse gas impact, domestic hot water supply represents a considerable part of the buildings energy bills, which can be reduced by using solar energy.

2. SOLAR HEATING SYSTEMS

Solar systems for domestic hot water preparation are among the first uses of solar energy.

At present, they have acquired a considerable development because solar energy is a clean, non-polluting energy, whose use leads to the reduction of the emissions of greenhouse gases.

From the first attempts up to the present, the composition solutions, namely the functional - structural schemes have evolved greatly and are still developing.

Equipment manufacturers, stimulated by new standards related to low energy consumption of buildings or by those with positive energy, have developed a varied range of products for hot water preparation.

They can serve:

- individual or collective residential buildings;
- accommodation buildings;
- social and cultural buildings;
- swimming pools.

The functional - structural schemes are drawn up so as to best respond to a series of criteria, characteristics and users' requirements, to the buildings they serve, and location. Among these, the following are very important: hot water needs, location characteristics, the characteristics of climate calculation, solutions for heat supply for the buildings served, available control and adjustment equipment and systems, financial resources.

Due to the increased energy cost and the fact that fossil fuel resources are limited, the idea of recovery of solar energy as renewable energy source is increasingly popular around the world because mankind has realized the multiple benefits of solar heating.

A comparison between solar water heating systems and conventional systems is presented in Table 1.

Table 1. Comparison between solar water heating systems and conventional systems

	Solar Water Heater	Gas or Electric Water Heater
Initial Investment	€1650 - €2600	€200 - €400
Annual Operating Costs	€30 - €45	€350 - €470
Typical Lifetime	15 - 40 Years	8 - 20 Years
Lifetime Operating Cost	€400 to €1600	€3000 to €9500
Total Lifecycle Cost	€2100 - €4300	€2800 - €9800
Emissions	Zero	Fossil Fuel Emissions
Return on Investment	10 to 30%	None

3. SOLAR SYSTEM SELECTED TO COVER THE NEEDS OF HEAT

To ensure the needs of domestic hot water supply at a minimum temperature of 45ºC, it was chosen an installation using the solar collector Junkers FCB-1S. This type of installation contains a plane solar collector, a heat exchanger, a reservoir for hot water storage and preparation, two pumps and an electric resistance that keeps water in the storage at a minimum temperature of 60ºC tank throughout the year. Each pump is equipped with a temperature regulator which monitors water temperature difference in the heat exchanger (collector) and water temperature in the storage tank, determining, coupling / uncoupling of the water recirculation pumps through the collector, respectively a regulator that monitors water temperature difference in the storage tank and water temperature in the return system that serves homes. If water temperature in the solar collector increases by a specified value compared to the water in the storage tank (ordinarily, 4 – 11^{o}C), the temperature regulator will determine the start of the circulation pump. If solar collector temperature drops by 2 – 5^{o}C below water temperature in the tank, the regulator stops the pump. The solar collector captures solar energy and heats the water that circulates through it (figure 1.).

PS1 pump recirculates heat carrier through the solar collector circuit when heat carrier temperature in the return system of the collector (TC) is greater than water temperature in the hot water heater (TB1). Pump control is performed using the controller dT. The float sub on the solar collector circuit prevents water flowing by thermal syphoning from the heater to the collector, when temperature in the collector is below the temperature of water in the heater (for example, during the night). Each heater has such float sub on the input coil.

Table 2 Specific parameters for Junkers collector

Junkers FCB-1S	Azimuth-South position	Optical efficiency η_0=0.69	Tilting 30º
Dimensions:	Length 2,023 mm	Width 1,030 mm	Thickness 75 mm
Loss coefficient k_1=4, k_2=0.17 în W/m^{2}K	Tank volume 200 l	Tank surface 2.7m^2	Collector surface 2.08m^2
Inlet temperature - collector 15ºC	Outlet temperature 65ºC	External temperature 15ºC	Fluid flow 0.020kg/s per m^2

Number of collectors	3

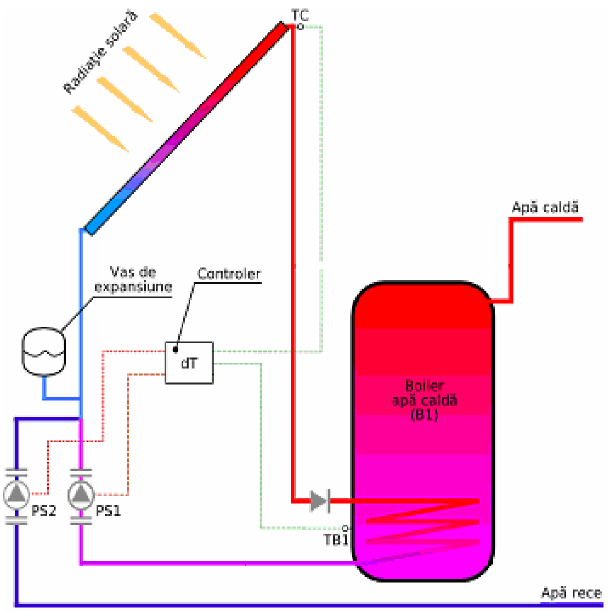

Figure 1 Solar system

The main characteristic parameters of the solar system are presented in table 2.

Calculations were made for a single family dwelling occupied by 4 persons whose total consumption of domestic hot water is 200 l/day with a specific consumption of q_s = 50l/ person per day.

The provisions of STAS 1343 and1478 were taken into account for water consumption.

The distribution of hot water consumption within 24 hours is shown in table 3.

Table 3 Distribution of hot water consumption within 24 hours

Time / hour		0	2	4	6	8	10	12	14	16	18	20	22	24	Total
V(t)	%	0	0	0	24.2	19.5	0	0	0	9.15	25.75	11.55	9.85	0	100
	l	0	0	0	55.4	39	0	0	0	11.3	51.5	23.1	19.7	0	200

We can note in table 6.11 that a high consumption of domestic hot water is between 18:00-22:00 o' clock.

The energy required to heat the water daily volume is calculated with the following relation:

$$E_{necesar} = V_t \cdot c_p \cdot (t_c - t_r) = 10.42 \text{ kWh} \qquad (6.25)$$

V_t – daily volume of water necessary for a house (200 l);

c_p – specific heat of water;

4. ENERGY ANALYSIS OF THE THERMAL SYSTEM

In order to determine the energy efficiency of the system a numerical program was developed in Matlab that calculated, based on the climatic data and energy consumption, monthly energy produced by solar panels and the auxiliary energy necessary to cover heat load in the months with a lower intensity of solar radiation.

Table 4 Energy analysis for the thermal system

Month	No. of days	Horizontal radiation	Inclined radiation	Energy produced	Energy consumed	Auxiliary energy
		kWh/m^2	kWh/m^2	kWh	kWh	kWh
Jan	31	46	74	100.56	277.62	177.06
Feb	28	65	92	118.89	236.43	117.53
Mar	31	107	130	170.58	253.83	83.24
Apr	30	148	160	205.73	230.29	24.56
May	31	184	179	229.23	218.13	0.00
June	30	200	188	239.98	207.26	0.00
July	31	203	194	252.96	206.23	0.00
Aug	31	178	185	245.28	198.30	0.00
Sep	30	136	160	224.20	214.17	0.00
Oct	31	92	124	180.99	237.96	56.97
Nov	30	49	79	111.04	245.64	134.60
Dec	31	37	64	89.54	261.76	172.21
Annual	365	1445.79	2747	2169	2787	766

Figure 2 shows variation in solar radiation in a year, falling on a horizontal surface and, respectively, on an inclined surface with an angle of 30 °.

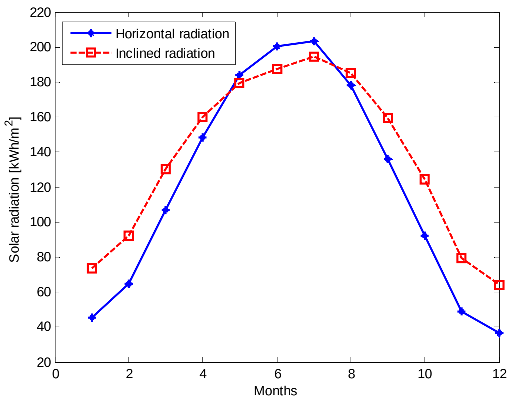

Figure 2 Variation in solar radiation in a year

Figure 3 represents the monthly variation of the energy produced by the solar thermal system and the monthly variation of energy consumption in order to ensure the heat demand of the house.

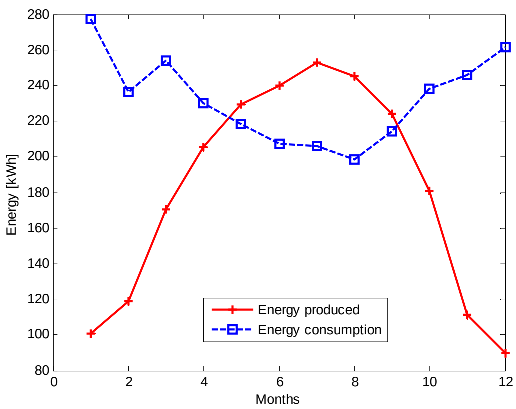

Figure 3 Monthly variation of the energy produced by the heating system and of the energy consumption in order to ensure the heat demand of the house

Figure 4 shows the monthly variation of thermal energy needs and the monthly variation of auxiliary consumption (from other sources) in order to ensure the heat demand of the house.

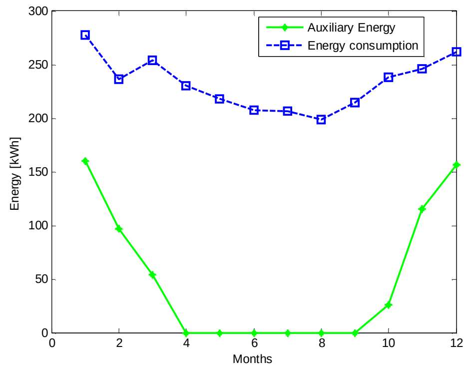

Figure 4 The monthly variation of thermal energy needs and of the auxiliary consumption (from other sources) in order to ensure the heat demand of the house

Figure 5 shows the monthly variation of the heat produced by the solar collectors compared with the monthly variation of auxiliary consumption so as to cover the heat demand of the house.

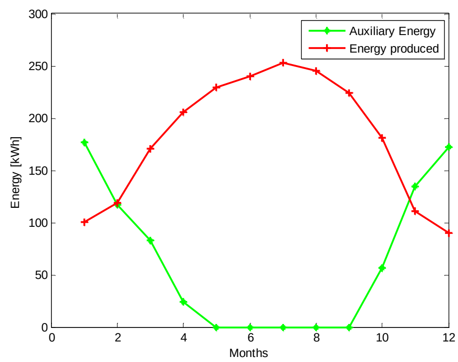

Figure 5 The monthly variation of the heat produced by the solar collectors and the monthly variation of auxiliary consumption so as to cover the heat demand of the house

Figure 6 shows the monthly variation of thermal energy needs compared with the monthly variation of the auxiliary consumption (from other sources) in order to ensure the heat demand of the house and monthly variation of the heat produced by the solar collectors.

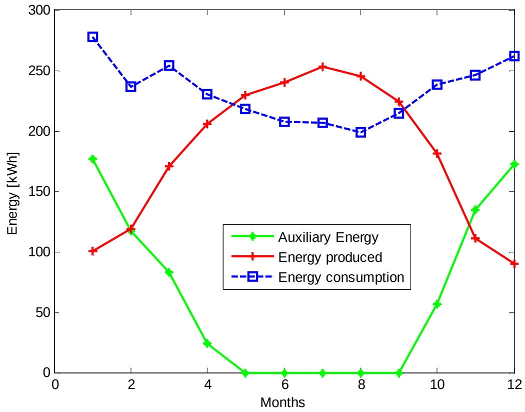

Figure 6 The monthly variation of thermal energy needs, auxiliary consumption and heat produced

5. CONCLUSIONS

The aim of this paper was to determine solar water heating potential (SWH) in the South- Eastern region of Romania for a single family dwelling occupied by 4 persons. After analyzing the system operation it resulted that the use of solar energy covers approximately 35-50 % of the thermal energy needs for water heating in from January to April and from October to December and approximately 70-100 % from May to September.

This solar system reduces by up to two thirds the need to use traditional methods for water heating and minimizes costs for electricity or for fuel used in heating water, thus reducing the environmental impact.

Initial costs for installing a solar water heating system vary between 1650 euro and 2600 euro for an active system, which will produce between 300 and 380 liters of hot water per day, respectively between 750 and 1500 euro for a passive solar system, with lower capacity. Since solar water heating systems lead to savings of over 50% in energy bills for hot water preparation, investment costs can be recovered within 10 years. Also, the state provides grants for the installation of solar systems.

The use of solar energy has a positive impact on the environment by reducing the use of non-renewable sources of energy to heat water, such as gas, coal, nuclear energy or black oil.

6. REFERENCES

[1] Cengel Y.A., (2003), *Heat Transfer: A Practical Approach*, 2nd Ed. McGraw-Hill.
[2] Hans Dieter B., Karl S., (2006), *Heat and Mass Transfer*. 2nd Ed. Springer.
[3] Holman J.P., (1997), *Heat Transfer*, New York, Mcgraw-Hill Inc., 459-472.
[4] Incropera F.P., DeWitt D.P., Bergman Th. L., Lavine A.S., (2007), *Fundamentals of Heat and Mass Transfer*, 6th Ed., John Wiley & Sons.
[5] John A. Duffie, William A. B., (1991), *Solar Engineering of Thermal Processes*, John Wiley & Sons, 331-376.
[6] Luminosu V.I., De Sabata T.C., De Sabata I.A., (2010), S*tudies on solar radiation and solar collectors*, Thermal Science, 14, 157-169.

ANALYSIS OF RESIDENTIAL PHOTOVOLTAIC ENERGY SYSTEMS

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ABSTRACT

Solar photovoltaic system is one of renewable energy system which uses PV modules to convert sunlight into electricity. Recent fossil fuel energy price escalation and likely future carbon dioxide emission cap-and-trade programs will substantially improved the cost-effectiveness of investment in energy conservation and renewable energy resources.

Solar PV system is very reliable and clean source of electricity that can suit a wide range of applications. In this paper, a technical study about implementation of photovoltaic (PV) module which can be installed on the rooftop of the house to be used as clean energy source was done. The system's mathematical model is developed in MATLAB.

Keywords: *photovoltaic system, solar radiation, energy demand.*

1. INTRODUCTION

At the start of this millennium the use of photovoltaic panels has increased in an accelerated rhythm. One reason for this growth is the improvement of solar cell manufacturing technology, followed by the fact that the price of photovoltaic panels decreased, and classic fuels become more expensive.

We do not have to pay any money for the sun's energy; still, we have to pay for energy capturing equipment. However, this cost has decreased lately and will decrease in the future and the price of oil and natural gas will grow as before. Photovoltaic panels consist of several photovoltaic cells connected in series and in parallel, so as to ensure the current and voltage for which they were designed. The efficiency with which monocrystalline photovoltaic cells (most commonly used) transform incident solar energy in electric energy is about 16-18%.

One of the earliest uses of solar photovoltaic energy was for remote applications. In the areas and residences which are too far to be viably connected to the electrical network, photovoltaic energy could be used for almost any need of electric energy of the house. Photovoltaic panels can provide home lighting, electric energy for appliances, televisions and household accessories.

There are two types of electrical installations with solar panels:

1. freestanding installations (isolated type) mainly used for power supply to consumers who do not have access to the power grid. They have generally low power, because the energy produced by panels is stored in electric batteries.

2. installations connected to the electrical network. In this case, power consumption is provided by solar panels, when they have conditions to produce it, or by the electrical network, when panels cannot produce power (for example, at night or when the sky is cloudy). When the current produced by the panels exceeds consumption needs, surplus power is delivered in the electrical network.

2. CLASSIC PHOTOVOLTAIC SYSTEM

A classic insular photovoltaic system (Stand Alone System) consists of the following components:

- photovoltaic panels,
- battery charge controller,
- group of batteries of 12, 24 or 48 V DC
- inverter, that transforms direct current DC in alternating current AC, necessary for domestic consumers.

The advantages of using photovoltaic panels are primarily represented by the possibility to ensure electricity in remote locations with no access to the electricity supply network. Such a system is easy to install, it does not require special knowledge in the energetic field, maintenance of panels is easy; also, panels only require cleaning of impurities deposited on their surface.

The most important advantages of photovoltaic - PV- systems:

1. Photovoltaic (PV) systems provide green, renewable power by exploiting solar energy.

2. Unlike wind turbines, Photovoltaic (PV) panels operate autonomous without any noise generation as they do not incorporate any moving mechanical parts.

3. With respect to operating costs and maintenance costs, Photovoltaic (PV) panels, unlike other renewable energy technologies, require minimum operating or maintenance costs; just performing some regular cleaning of the panel surface is adequate to keep them operating at highest efficiency levels as stated by manufacturers' specs.

Photovoltaic (PV) panels can be ideal for distributed power generation as they are highly suitable for remote applications.

Figure 1 shows a system of production and use of current by means of photovoltaic panels.

It can be noticed that photovoltaic panel is not the only component of the system. Since the moment when electric energy is needed is not the same as the moment when solar radiation is present, the electricity supplied by the panel is accumulated in one or more batteries to be used when needed. Between the photovoltaic panel and battery there is an interlaid load regulator because the parameters of electric current on the exit from the panel are variable, depending at least on the intensity of solar radiation, and the parameters of the electric current used to load the battery must be constant. The main role of the solar controller is to protect the battery. On the one hand, it limits the current and voltage delivered by the solar panel to maximum acceptable values for the battery, and on the other hand it limits the current absorbed by the rectifier, because solar batteries have different characteristics compared to car batteries and they must withstand many charge cycles - discharge during a period of 10 years.

Consumers supplied with direct current, are also connected to the outlet terminals of the controller, in order to be supplied with electric current with constant parameters.

We must mention the obligatory presence in such a system of an equipment called rectifier that transforms direct current into alternating current.

The rectifier takes over direct current from the solar controller and converts it into alternating current with a voltage of 220V and a frequency of 50 Hz. For such installations there are two types of rectifiers, with sinusoidal output (similar to the current provided by the network) and with quasi-sinusoidal output. The quasi-sinusoidal curve has some very steep slopes, which can affect the operation of sensitive equipment, such as laptop, TV set, radio, etc. Home appliances (fridge, vacuum cleaner) and lighting elements are generally not affected by a quasi-sinusoidal current.

The figure 1 shows the operation scheme for a solar photovoltaic system of isolated type.

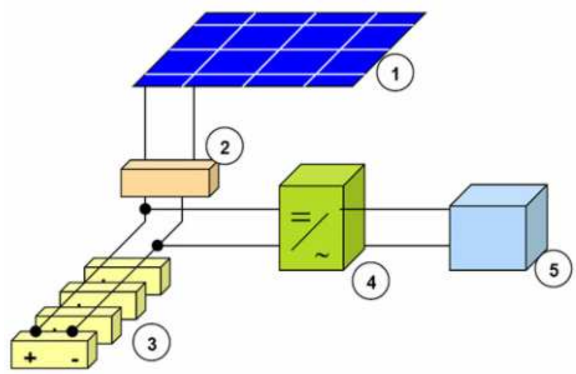

Figure 1 The operation scheme for a solar photovoltaic system of isolated type.
1 – PV generator; 2 – charge controller;
3 – batteries; 4 – DC/AC inverter; 5 - load

3. DIMENSIONING OF A PHOTOVOLTAIC SYSTEM

Photovoltaic systems have large fluctuations in production within one year: on a sunny day, in June they can produce a 5 times bigger amount than on a cloudy day in December. For this reason, production of systems is calculated for annual production, depending on the location, orientation and inclination of the panels.

Particularly for photovoltaic systems of isolated type (but not only), an essential principle is that of optimizing consumption: use of LED lighting, purchase of home appliances with reduced consumption, disconnecting electronic equipment from the plug when they are not in use. A single investment in this respect is less expensive than installing an oversized photovoltaic system.

During winter and summer, electric energy consumption varies depending on the day and time of the day. Electric energy consumption was determined for summer and winter.

For the house we have considered all home appliances which are necessary such as: fridge, TV set, computer, vacuum cleaner, iron, washing machine, air conditioning, microwave, etc.

The demands for the consumers chosen to determine electric energy consumption necessary for a house are 65.74 kWh per month, by the use of home appliances, with a capacity of 14330 W.

To ensure electricity needs of the house we chose ten solar panels, Siemens M75S, of monocrystalline silicon.

The electricity produced by the solar panel is stored in twelve accumulators grouped in sets of two. The system has an average operating autonomy during winter of 3 days and a cycle of unloading / loading of 80%. The internal resistance of the system is 1.11 mΩ and nominal voltage is 2V, with a nominal capacity of (C100) 295 Ah.

The main parameters specific to solar panels are presented in table 1.

Table 1 Parameters specific to Siemens M75S panel

Siemens M75S	Surface 0.63m2	Slope 36°C	Azimut-South
Max Voltage 17V	Max Current 4.4A	Rated capacity 74.8W	Cell resistance 308Ω
Number of modules			N=10

4. ENERGY ANALYSIS OF ELECTRIC SYSTEM

Table 2 shows the results of the energetic analysis, for the photovoltaic system consisting of ten panels.

Table 2 Energetic analysis of the photovoltaic system

Month	No. of days	E_S (solar radiation)	E_{PV} (PV)	E_E (excess)	E_A (auxiliary)	E_C (consumed)
		kWh	kWh	kWh	kWh	kWh
January	31	285	26	-	52	63
February	28	670	66	17	25	57
March	31	1282	125	64	22	63
April	30	1617	157	81	5	61
May	31	1865	177	101	6	63
June	30	2035	189	112	2	61
July	31	2321	210	130	5	63
August	31	2257	205	123	-	63
September	30	1612	150	81	12	61
October	31	952	91	32	23	63
November	30	409	39	2	41	61
December	31	236	21	-	58	63
Annual	365	15541	1456	743	245	741

Where:

• ES (solar radiation) – the intensity of solar radiation (monthly or annually) accumulated on photovoltaic panels, inclined at an angle of 36º;

• EPV (PV) – the energy produced (monthly or annually) by photovoltaic panels;

• EE (excess) – surplus of energy (monthly or annually) produced by solar panels;

• EA (auxiliary) – surplus of energy (monthly or annually) necessary to complete electric energy obtained from solar panels;

• EC (consumed) – the electricity required (monthly or annually) for a house.

Figure 2 shows monthly variation of electric energy produced by Siemens solar panels and monthly variation of electricity demand.

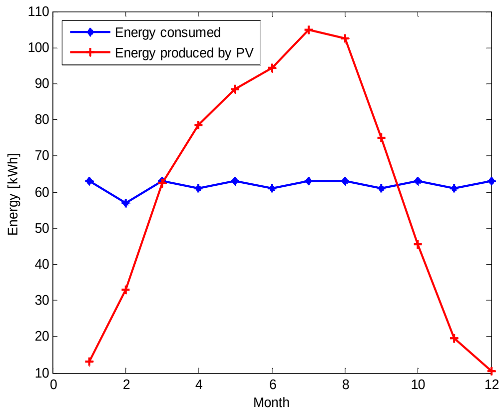

Figure 2 Electric energy produced by Siemens solar panels and monthly variation of electricity demand

In Figure 3 we can notice monthly variation of the need of electricity for a house and monthly variation of auxiliary consumption (from other sources) to ensure electrical needs of the house.

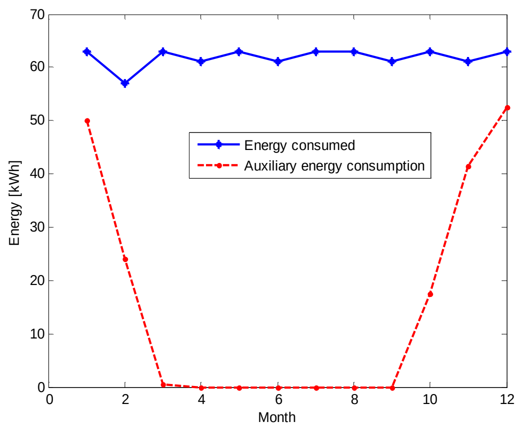

Figure 3 Variation of the need of electricity for a house and monthly variation of auxiliary consumption (from other sources)

Figure 4 shows monthly variation of electric energy produced by PV panels and monthly variation of auxiliary consumption (from other sources) to ensure electrical needs of the house.

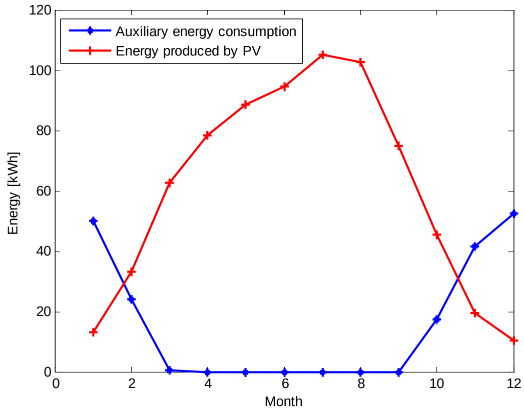

Figure 4 Monthly variation of energy produced and monthly variation of auxiliary consumption

Figure 5 shows the monthly variation of electric energy demand compared with the monthly variation of the auxiliary consumption (from other sources) in order to ensure the heat demand of the house and monthly variation of the electric energy produced by the PV panels.

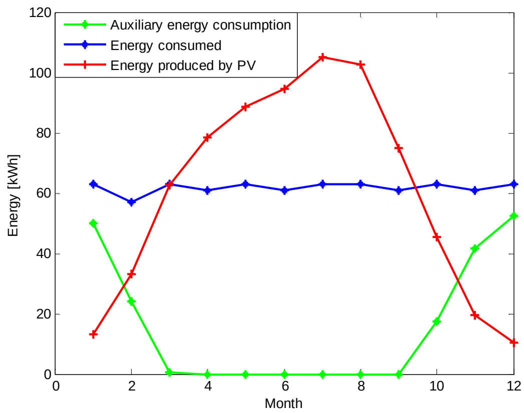

Figure 5 The monthly variation of electric energy demand, auxiliary consumption and electric energy produced

5. CONCLUSIONS

We can notice that the energy produced by PV panels in January, February, March, October, November and December is below the electricity demand for a house, and for the other months of the year this energy produced by the panels increases recording a surplus, reaching a maximum of 100 kWh. In this case, the solution can be represented by the conversion of excess electric energy into thermal energy. However, this transferred energy can cover thermal energy needs from April until September.

When installing a current source based on solar panels on an isolated house or on a chalet, it is recommended to pay attention especially to household appliances savings. It is recommended to use only saving lighting elements, which need only 20% of the energy necessary for classic bulbs. A laptop requires only 40-50 W, while a usual computer uses up 200-300W. A modern fridge that is very economical, of class A++ needs only half of the energy consumed by a fridge manufactured 10 years ago.

The average duration of use for these panels is of 20-25 years, the only component that requires more attention and whose life is shorter in the case of insular systems is represented by batteries. Another significant advantage of these systems is that they can expand in case of emergence of additional power consumers.

6. REFERENCES

[1] Yun GY, McEvoy M, Steemers K. *Design and overall energy performance of a ventilated photovoltaic façade.* Solar Energy 2007;81:383–94.

[2] Mei L, Infield D, Eicker U, Fux V. *Thermal modelling of a building with an integrated ventilated PV façade*. Energy Build 2003;35:605–17.

[3] Balocco Carla. *A simple model to study ventilated facedes energy performance.* Energy Build 2002; 34:469–75.

[4] Onar OC, Uzunoglu M, Alam MS. *Modeling, control and simulation of an autonomous wind turbine/photovoltaic/fuel cell/ultra-capacitor hybrid powersystem.* Journal of Power Sources 2008;185(2):1273–83.

[5] Reichling JP, Kulacki FA. *Utility scale hybrid wind-solar thermal electrical generation: a case study for Minnesota*. Energy 2008;33:626.

[6] Yang H, Zhou W, Lu L, Fang Z. *Optimal sizing method for stand-alone hybrid solar-wind system with LPSP technology by using genetic algorithm. Solar* Energy 2008;82:354

CONTRIBUTIONS TO KNOWING THE ZOOPLANKTON ON SEVERAL LAKES OF SOUTH-WEST DOBROGEA

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ABSTRACT

Zooplankton populations is considered an important compartment of aquatic ecosystems for the role in the trophic equilibrium and is considered a good indicator of changes in water quality because the community is strongly influenced and has a fast response to changes in environmental conditions.

The study presents the results of comparative analysis of zooplankton community in several lakes of south-west Dobrogea (Oltina, Bugeac şi Dunăreni) were was identified a number of 52 species and varieties. The numerical dominance is ensured by copepods and rotifers and the gravimetric dominance is ensured by cladocers.

Keywords: *zooplankton, lakes of south-west Dobrogea*

1. INTRODUCTION

The zooplankton from the Danube and the Danube Delta has been a constant concern, as object of detailed study, for many researchers, but that from the lakes of the flooded area became less important for the researchers remaining almost unknown. Regarding the river estuaries in the south-western Dobrogea, they have been studied too little or not at all from a hydro-biological point of view. The specialty literature is poor in data on the plankton composition from these aquatic ecosystems, only Enaceanu (1947) published an analysis of the plankton in the ponds of Oltina and in 1961 Popescu-Gorj and Costea published a wide analysis on the hydro-biological conditions still in the Oltina puddles (Iortmac, Ciamurlia and Oltina). Thus in August 2000 within the International project “Monitoring of the large European rivers basins” started studying the zooplankton populations from the river estuaries Oltina, Dunareni and Bugeac.

The three estuaries belong to the sector Ostrov-Cernavoda of the Danube flooded meadow, sector located in the hilly Danube Dobrogea subunit, in the south-west part of it, corresponding to the Levantine coastal platform. A feature of the Levantine platform is the depressions - bays in which there are stationed the river estuaries [12]. Thus, Oltina, Dunareni (Marleanu) and Bugeac are lake units formed on secondary valleys brought to the confluence area with the Danube and have the form of depressions with high and abrupt banks, flat bottoms and without accidents [8].

2. MATERIAL AND METHOD

In the period 2000-2004 there were collected every season, 71 quantitative zooplankton samples, but not in all the years we could get data from all seasons. The quantitative samples of zooplankton have been obtained by filtering 100 l water from the surface through a silk net with mesh size of 100 µm. The samples were preserved directly on a field with 4% formaldehyde solution. The zooplankton samples have been examined on a microscope and stereomicroscope. For the species identification we used mainly the prestigious identification guides published by the Romanian Academy in the series “Romanian Fauna” and other, well known, international books [2, 3, 4, 5, 10, 14, 16, 18]. Calculated analytical and synthetical indices were used to observe relationships characterising zooplanktonic taxa and the hierarchy established between them [9].

3. RESULTS AND DISCUSSIONS

The research made in the river estuaries, Oltina, Dunareni and Bugeac (*Figure 1*), in the period 2000-2004 reveals the existence of very low values of the specific diversity, together totalling 52 species and holoplanktonic varieties belonging to the Rotatoria groups (54%), Cladocera (27%) and Copepoda (Cyclopoida - 12% and Calanoida-5%).

From the taxonomic spectrum total of the three lake ecosystems, 86% fall within the primary consumers category (Cp) and 14% in secondary consumers category (Cs).

In the study period the zooplankton was represented by a small number of species, diversity and equity indices indicating specific features for each entity (*Table 1*).

Figure 1 Oltina, Dunareni and Bugeac lake’s

Table 1. General ecological data on the zooplankton populations from the river estuaries in the south-west Dobrogea in the period 2000-2004

Ecological atributes	Otina	Dunareni	Bugeac
Nsp	40	42	36
Primary consumers (Cp)	32	36	30
Secondary consumers(Cs)	9	8	8
D – ex.m^{-3}	5386420	5738040	4029730
B – g.m^{-3}	217,64	295,84	69,5
H_{max}	3,70	3,75	3,62
H_D	2,46	2,25	2,23
H_B	2,05	1,48	1,67
H_D/H_{max}	0,66	0,60	0,60
H_B/H_{max}	0,53	0,37	0,46

In terms of specific composition, all three aquatic ecosystems are dominated by rotifers, cladocera, their competitors to food and the water bodies most "energetic", being less represented. Comparing the resulted data with those obtained by Popescu-Gorj and Costea (1961), in Oltina there were identified with 70% fewer species namely 42 fewer species of rotifers, 14 species of cladocera and a species of calanoid copepods. The rest of the species reported by the authors mentioned above belong to other taxonomic groups, in this paper being presented only the main zooplankton groups (rotifers, cladocera and calanoid and cyclopoid copepods).

The analysis of the biotope preferences of zooplanktons revealed a mixture of planktonic typical forms (species of the genera *Brachionus*, *Keratella*, *Filinia passa*, *Polyarthra vulgaris*, *Synchaeta pectinata* among rotifers, *Bosmina longirostris*, the species of the genus *Daphnia*, *Moina micrura dubia* among cladocera, *Eudiaptomus gracilis*, *Cyclops vicinus vicinus* among copepods), phytophilous (*Euchlanis parva*, *Trichocerca similis*, *Testudinella patina* among rotifers, *Chydorus sphaericus*, nectobentonic (*Rotaria* sp. rotifer) and hyponeustonic (*Scapholeberis kingi* cladocer), the planktonic forms owning a predominant role.

Analyzing the qualitative composition of the zooplankton and in terms of nutritional preferences, the vast majority are primary consumers, sediment micro-filters (species of the genera *Brachionus*, *Keratella*, *Filinia*) and ineffective micro-filters (*Diaphanosoma orghidani*, *Bosmina longirostris*), that well exploits the particulated organic substance.

From a quantitative point of view the zooplankton from the river estuaries recorded an annual average the numerical abundance of 213439 ex•m-3 (*Annex 1*). The structure on taxonomic groups reveals the dominance cladocera with 54%, followed by rotifers with 35%, cyclopids, 8% and 0.007% calanoids. The numerical abundance of the primary consumers represent 70% of the total and that of the secondary consumer 30%.

At the systematic group level the numerical dominance is provided by rotifers (52%) in the case of the primary consumers, and by the cyclopid copepods (94%) for the secondary consumers. Among the rotifers primary consumers, the species that register the highest numerical abundance values are *Brachionus diversicornis*, *Brachionus calicyflorus* var. *amphiceros*, *Polyarthra vulgaris*, *Brachionus angularis* and among the cyclopids *Mesocyclops crassus*, *Acanthocyclops vernalis*, *Cyclops vicinus* (*Annex 1*).

The annual average of the ponderous abundance of zooplankton is at a relatively high rate, namely 8211.78 mg•m-3. At the systematic group level the ponderous dominance is ensured by cladocers, 93% of the total biomass, the rotifers represent only about 2% of the total biomass, and the biomass ponder of the other taxonomic groups was of 5% for cyclopids and well below 1% for calanoids.

The gravimetric ratio c1/c2 (15% / 85%) shows an increase in the contribution of the secondary consumers, compared to the situation shown in the case of the numerical abundance. This is due to the difference in size of the individuals of the two trophic levels, with significant plus in the case of the secondary consumers, especially of the *Leptodora kindti* species, responsible for high values of the biomass. The highest values of the ponderous abundance are due to the cladocers both in the case of the primary consumers (83%) and of the secondary ones (95%). Among the cladocers primary consumers, the species that register the highest gravimetric abundance values are *Diaphanosoma orghidani* (67%), *Daphnia galeata* (20%) and *Moina microria dubia* (10%). In the case of the secondary consumers, responsible for the high values recorded, is the cladocer *Leptodora kindti* (95%).

Between the three ponds, Oltina registers the highest value of the zooplankton medium density, for the entire period of study, namely 256496.2 ex•m-3. Unexpected is the value of the biomass of 10363.75 mg•m-3, the lowest between estuaries (*Annex 2*).

In the case of the numerical abundance, dominant are the ciclopids and the rotifers, and ponderously, dominate the cladocers (*Annex 2*). The relative numerical abundance of the primary consumers is 74% and 26% for the one of the secondary consumers. In the case of the biomass, the primary consumers represent 10% of the total biomass of the zooplankton communities, due to their small size, and the secondary ones of 90%.

The species responsible for the numerical density values are *Brachionus diversicornis*, a cosmopolitan species, with mass appearances during the summer and *Brachionus calicyflorus* var. *amphiceros*, among rotifers and the immature stages of cyclopids and the adults of the species *Mesocyclops crassus*, species characteristic to the plankton of the euthrophic waters and *Acanthocyclops vernalis vernalis* (*Figure 2*).

The biomass value is given by the cladocers *Leptodora kindti* and *Diaphanosoma orghidani*, thermophilic stenothermal species (have registered maximum densities in the warm months of the year), which prefer open water near the vegetation and which belong to different trophic levels. *Leptodora kindti*, responsible for achieving 87% of the biomass is an important predator on food chains that feeds rotifers, cladocers small filters and some species of copepods, being in its turn preferred by some species of fish (*Cyprinus carpio*, *Esox lucius*, *Abramis brama*). *Diaphanosoma orghidani*, primary consumer, filters fine debris, bacteria, flagellates and algae from the pelagial and is consumed by the carp (*Cyprinus carpio*), bream (*Abramis brama*), tench (*Tinca tinca*).

Along with the two cladocers, an important role in achieving the biomass, is detained by the rotifer *Brachionus diversicornis* and also by the cyclopis *Mesocyclops crassus* and *Acanthociclops vernalis* (*Figure 3*).

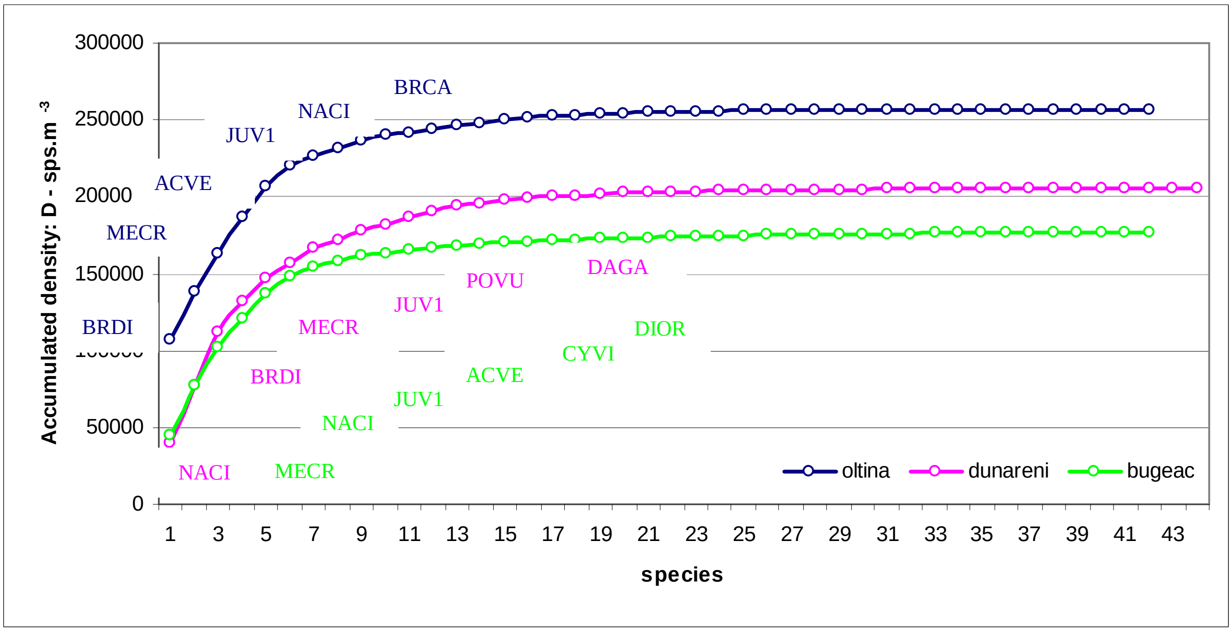

Figure 2 The accumulated zooplankton density from the river estuaries (2000-2004)

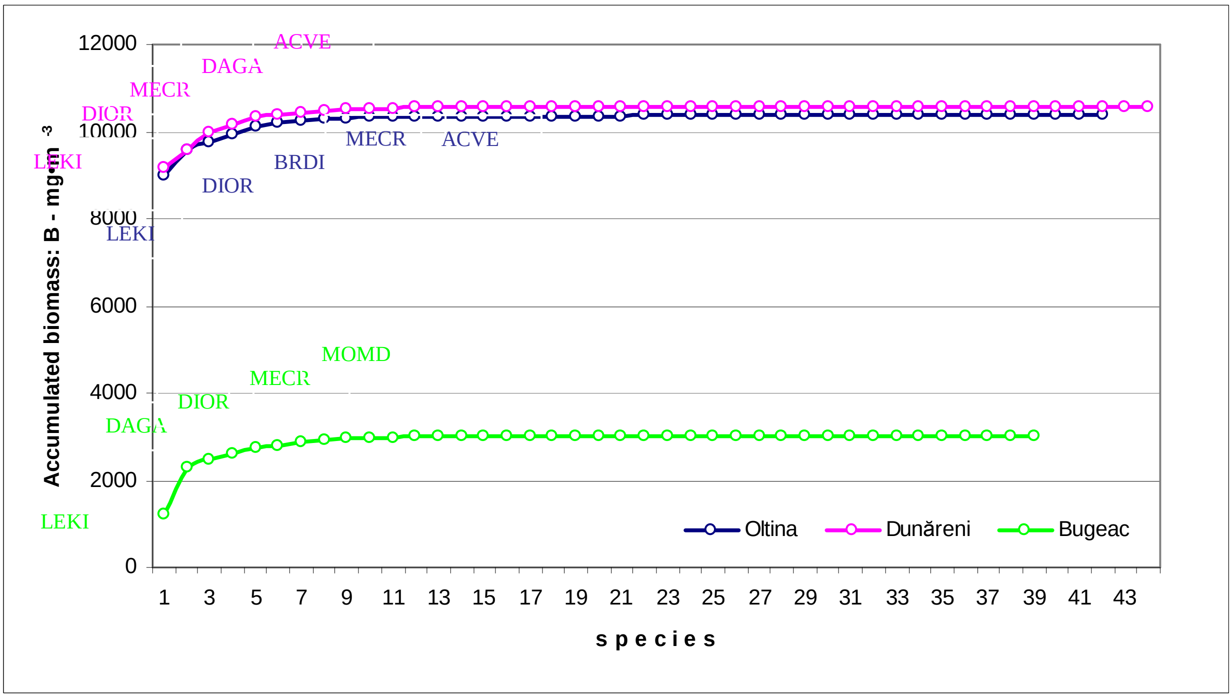

Figure 3 The accumulated zooplankton biomass from the river estuaries (2000-2004)

The Dunareni recorded an average of the abundance numerical of 204930 ex•m-3 and gravimetric of 10565.59 mg•m-3 (*Annex 2*). Numerically dominant are the cyclopids (50%) and gravimetrically the cladocers (96%), although as numerical abundance the represent only 10%. The c1/c2 ratio in what concerns the numerical abundance enhances the dominance of the primary consumers (77%) compared to the secondary ones (23%) and in the case of the biomass, the secondary consumers (89%) are eight times more abundant than the primary ones. To making the numerical density significantly participate the nauplial and juvenile forms of cyclopids, the adults of *Mesocyclops crassus*, with the rotifers *Brachionus diversicornis* and *Polyarthra* *vulgaris* and with the cladocer *Daphnia galeata*, species that grow particularly in the eutrophic waters (*Figure 2*). The biomass is provided in 87% by *Leptodora kindti*. A low intake is brought by the cladocers *Daphnia galeata* and *Diaphanosoma orghidani* among the primary consumers and the cyclopid *Mesocyclops crassus* among the secondary ones, the rest of the species having an insignificant participation to achieving the biomass (*Figure 3*).

In Bugeac the medium value of the numerical abundance is of 183170 ex•m^{-3} (*Annex 2*), and the numerically dominant taxonomic group is represented by ciclopids (78%). In the case of this lake, the secondary consumers (54%) are those that contribute to the achievement of the numerical density. The species that significantly contribute to achieving the numerical density are from among the cyclopids, namely the nauplial and juvenile stages (primary consumers), *Mesocyclops crassus*, *Acanthocyclops vernalis*, *Cyclops vicinus* (secondary consumers), plus the cladocer *Diaphanosoma orghidani* (primary consumer) (*Figure 2*).

The average of the gravimetric abundance is of 3.3 times lower than in Oltina and Dunareni (*Annex 2*). The cause is the lower value of the numerical abundance, especially of the cladocer *Leptodora kindti*, species responsible for the high values of the biomass from Oltina and Dunareni. The analysis on systematic groups shows the dominance of cladocers with 84% (*Annex 2*). The ratio c1 / c2 (48% / 52%) shows a balance between the two groups of consumers. The accumulated density shows also in the case of this lake, the importance of the species *Leptodora kindti* to achieve the biomass together with the cladocers, primary consumers, *Diaphanosoma orghidani* and *Daphnia galeata* and the cyclopid secondary consumer, *Mesocyclops crassus* (*Figure 3*).

The species responsible for making the numerical density and the biomass change from year to year, or change their position in the hierarchy established by density or biomass, which shows the temporal variability of these populations. This variability is dictated by the changes caused by the human impact, by the external environmental factors such as floods, temperature, concentrations of the suspended mineral matter, the oxidation-reduction potential values and by the biotic factors such as intra- and inter-specific competition.

To evaluate the differences between the three aquatic ecosystems, the results have been compared using the ANOVA test (*Table 2*). The obtained F value (0.1580) is lower than the tablular F (3.0716) [7], which leads to the conclusion that it is to be rejected the null hypothesis indicating that there is no significant difference between the densities of the three river estuaries.

Table 2 Variance analysis

Simple Anova				
Grup	*Count*	*Sum*	*Average*	*Variance*
Oltina	5	1897970	379594	3,75E+11
Dunareni	5	1846649	369329,9	1,23E+11
Bugeac	5	1215504	243100,8	5,03E+10

ANOVA

Dispersion	*SS*	*df*	*MS*	*F*
Inter-group	5,78E+10	2	2,89E+10	0,158086
Intra-group	2,19E+12	12	1,83E+11	
Total	2,25E+12	14		

The first 10 species with the highest ecological significance (*Annex 1*), ordered by density, have a high frequency (generally over 50%) and a dominance that summed represents over 60% of the entire population, and by biomass, although they do not have a high frequency, except the nauplial and juvenile stages of copepods, they have a dominance that summed represents over 80% of the whole population.

Among the most important as density, particularly stand the rotifer species (*Brachionus diversicornis*, *Brachionus angularis*, *Brachionus calyciflorus* var. *amphiceros*, *Keratella cochlearis* var. *tecta*) and of the cyclopids, among the first places are the larval stages and the adults of *Acanthocyclops vernalis vernalis*, *Mesocyclops crassus* (*Annex 2*). However, among the most important species as biomass are particularly among cladocers namely *Leptodora kindti*, that ranks first as biomass in all three ecosystems studied, *Diaphanosoma orghidani*, *Moina micrura dubia*, but also among cyclopids such as *Acanthocyclops vernalis vernalis*, *Mesocyclops crassus* (*Annex 2*).

A series of recent studies provide information referring to the species indicating the trophic status of an aquatic ecosystem [13], [1], [15]. In general, good indicators of eutrophic waters are the rotifers such as the species of the genus *Brachionus*, *Anuraeopsis fissa*, *Keratella cochlearis*, *Keratella cochlearis* var. *tecta*, *Keratella quadrata*, *Trichocerca pusilla*, *Trichocerca cylindrica*, *Polyarthra euryptera*, *Pompholyx sulcata*, *Pompholyx complanata*, *Filinia longiseta* and crustaceans such as *Bosmina longirostris*, *Chydorus sphaericus*, *Mesocyclops crassus*.

Many of these species are found in the plankton of the river estuaries in south western Dobrogea and are even dominant, leading to the conclusion that these lakes are within the category of the eutrophic waters. To support this statement also come the physical-chemical parameter values of the water (*Annex 3*) that we determined during the study period and even the absence of the macrophyte vegetation. Also, Török and Dinu (2006) consider that the numerical abundance of the cyanobacteria exceeds the point of algal blooming. The recorded values for the physical parameters (depth, transparency, colour) and the water chemical parameters (pH, oxygen, nitrogen, nitrates, phosphates, calcium and magnesium content) fall, generally, those estuaries in the good environmental status and indicate a trend of evolution of these ecosystems to the eutrophic state, according to the norm on surface waters quality classification. They found, however, deviations from the accepted values, which is reflected in modifications of the structure of biocenosis from these ecosystems, as a consequence of the human activities (agriculture, deforestation). Thus, the heat exchange that occurs in the whole water mass (lacking the thermal stratification), frequently recording during the summer season, values from 25 to 28.7 °C.

It was also found that at values lower than 0.80 of the transparency index, there does not grow the submerged aquatic vegetation, which led to the disappearance of some habitats and implicitly of some biocoenoses. The water has a strong alkaline character, which indicates the high basic reserve of the environment. The values exceeding the maximum allowed limit were registered in the Dunareni lakes (9.70 - 10.01 in august 2003), Bugeac (9.28 - 9.40 in October 2002) and Oltina (9.38 in August 2004) and can be entirely attributed to the total consumption of the free carbon dioxide in the process of photosynthesis of phytoplankton, but also in the limestone and carbonate content in the soil (the estuaries being located on carbonate chernozem type soils). Among the biogenic substances, the values recorded for total phosphorus in many cases exceed the value of 0.10 mg P/l, these ecosystems being framed in the hypertrophic waters category.

As a conclusion in what concern the river estuaries, the highlighted correlation between the low taxonomic diversity and the high numerical and gravimetrical abundance reflect the existence of some particular ecological conditions, unfavourable for most structural elements, but accessible for a limited number of forms, characterized by large ecological spectres.

4. CONCLUSIONS

Based on the analysis made on 71 quantitative samples of zooplankton in the river estuaries Bugeac, Oltina, Dunareni on the information resulted from consulting the specialty literature one can draw the following conclusions:

1. the taxonomic spectrum of the zooplankton from the river estuaries sum, in the conditions of the years 2000-2004, a number of 52 species and varieties, a relatively low diversity compared with the literature data;

2. in terms of quantity, the zooplankton from the river estuaries Bugeac, Oltina, Dunareni records an annual average of the numerical abundance of 213439 ex•m-3;

3. the numerical dominance is ensured by copepods and rotifers;

4. the dominance of the species indicating the eutrophic water (rotifers as the species from the genus *Brachionus*, *Keratella cochlearis* and among crustaceans *Bosmina longirostris*, *Mesocyclops crassus*), correlated with the values of the physical-chemical parameters of the water and the absence of the macrophyte vegetation, frames the river estuaries into the category of eutrophic waters to the hypertrophic waters;

5. in conjunction with the numerical abundance, the zooplankton from the studied aquatic ecosystems is characterized by high values of the biomass, registering a multiannual average of 8211.78 mg•m-3, above the limit characteristic to the natural lake ecosystems of shallow depth from the temperate continental zone of Europe;

6. at systematic groups level the gravimetric dominance is ensured by cladocers;

7. the low taxonomic diversity and the high numerical and gravimetrical abundance of reflects the existence of some particular ecological conditions accessible for a limited number of forms, characterized by large ecological spectra.

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6. REFERENCES

[1] BERZINS, B., PEJLER, B, 1989 - Rotifer occurrence in relation to oxygen content, *Hydrobiol.*, **183**: 165-172.

[2] DAMIAN – GEORGESCU, Andriana, 1963 - Copepoda. Fam. Cyclopidae (forme de apă dulce), *Fauna R.P.R.*, Ed.Acad. R.P.R., **4** ,*6*, 204p.

[3] DAMIAN – GEORGESCU, Andriana, 1964 - Dinamica copepodelor în complexul de bălți Crapina-Jijila (zona inundabilă a Dunării), *Hidrobiologia*, **5**, Ed. Acad. R.P.R., Bucureşti: 105-122.

[4] DAMIAN – GEORGESCU, Andriana, 1966 – Copepoda. Calanoida – forme de apă dulce, *Fauna R.S.R.*, **4**, *8*, 130 p.

[5] DUSSART, B.H., DEFAYE, D., 1995 – *Copepoda. Introduction to the copepoda in Guides to the identification of the Microinvertebrates of the Continental Waters of the World*, cood, Ed.H.J.F.DUMONT, SPB Academic Publishing, bv.1995.

[6] ENĂCEANU, V., 1947 – Contribution a la connaissance du plancton des lacs Oltina, Ciamurlia et Iortmac (Roumanie), *Not. Biol*., **5**: 1-3.

[7] FOWLER, J., COHEN, L., JARVIS, Ph., 1998 – *Practical statistics for field biology*, John Wiley & Sons, 259 p.

[8] GÂŞTESCU, P., 1971 - *Lacurile din România, Limnologie generală*, Ed. Academiei R.S.R., Bucureşti: 40-48, 123-160.

[9] GOMOIU, M-T., SKOLKA, M., 2001 – *Ecologie, Metodologii pentru studii ecologice*, Ed.. Ovidius University Press, Constanța, 170p.

[10] HARDING, J.P., SMITH, W.A., 1974 – *A key to the British Fresh-water Cyclopid and Calanoid Copepodes,* Biol.Ass., Sc., Pub., **18.**

[12] IANA, Sofia, 1971 - *Dobrogea de sud-vest,* Rezumat teză de doctorat, Univesitatea Bucureşti: 13-15.

[13] KARABIN, A., 1985 **-** Pelagic zooplankton (Rotatoria + Crustacea) variation in the process of lake eutrophication. I. Structural and quantitative features. *Ekologia Polska* **33**, *4*: 576-616.

[14] KIEFER, Fr., 1960 – *Ruderfuss – Krebse (Copepoden).* Kosmos – Verlag Franckh – Stuttgart, 99p.

[15] MATVEEVA, L.K., 1991 **-** Can pelagic rotifers be used as indicators of lake trophic state? *Verh. Internat.Verein. Limnol*., **24**: 2761-2763.

[16] NEGREA, St., 1983 – Cladocera Crustacea, *Fauna R.S.R,* **IV**, *12,* Ed. Acad. R.S.R.

[17] POPESCU-GORJ, A., COSTEA, Elena, 1961, - Cercetări hidrobiologice şi piscicole în bălțile Oltinei (Lunca inundabilă a Dunării), *Hidrobiologia*, **II**, Ed. Acad. R.P.R., Bucureşti: 29-125.
[18] RUDESCU, L., 1960 – Trochelminthes.Rotaria, *Fauna R.P.R.*, **II**, *2*, Ed. Acad.R.P.R.
[19] TÖRÖK, Liliana, DINU, Cristina, 2006 - Evaluarea stării de calitate a apei din lacurile Oltina, Bugeac şi Dunăreni pe baza structurii populațiilor fitoplanctonice, *Delta Dunării*, **III**, Tulcea: 109-128.

Annex 1

General characteristics of the zooplankton populations from the river estuaries (2000-2004)

		Species	F%	D_{avg}	D_{eco}	D_D%	W_D	Rk D			D_B%	Rk B
				sps. m^{-3}								
ROT-CI	ASCO	*Ascomorpha* sp.	14	100,6	724,0	0,05	0,81	32	0,02	0,14	0,00	39
ROT-CI	BRAN	*Brachionus angularis*	78	4173,5	5365,9	1,98	12,41	9	2,09	2,68	0,03	14
ROT-CI	BRCA	*Br. calyciflorus* var. *amphiceros*	42	8011,4	19227,3	3,80	12,58	8	14,42	34,61	0,18	11
ROT-CI	BRCP	*Br. calyciflorus* var. *pala*	47	3027,4	6410,9	1,44	8,23	11	5,45	11,54	0,07	12
ROT-CI	BRDI	*Brachionus diversicornis*	54	47692,1	88046,9	22,62	35,01	2	85,85	158,48	1,06	8
ROT-CI	BRDH	*Br. div. var. homoceros*	1	83,3	6000,0	0,04	0,23	38	0,15	10,80	0,00	43
ROT-CI	BRFO	*Brachionus forficula*	17	213,2	1279,2	0,10	1,30	26	0,38	2,30	0,00	30
ROT-CI	BRQU	*Brachionus quadridentatus*	1	12,5	900,0	0,01	0,09	46	0,02	1,62	0,00	49
ROT-CI	BRQB	*Br. q.* var. *brevispinus*	40	263,6	654,5	0,13	2,24	22	0,47	1,18	0,01	25
ROT-CI	BRQC	*Br. q.* var. *cluniorbicularis*	40	1770,4	4395,5	0,84	5,82	15	3,19	7,91	0,04	15
ROT-CI	BRQM	*Br. q.* var. *melheni*	1	0,3	20,0	0,00	0,01	55	0,00	0,04	0,00	56
ROT-CI	BRQR	*Br. q.* var. *rhenanus*	4	28,9	693,3	0,01	0,24	37	0,05	1,25	0,00	42
ROT-CI	BRUR	*Brachionus urceolaris*	25	399,7	1598,9	0,19	2,18	24	0,72	2,88	0,01	26
ROT-CI	EPMA	*Epiphanes macrourus*	1	41,7	3000,0	0,02	0,17	41	0,10	6,90	0,00	45
ROT-CI	EUPA	*Euchlanis parva*	13	261,0	2087,8	0,12	1,24	29	0,47	3,76	0,01	32
ROT-CI	FIPA	*Filinia passa*	39	1363,8	3506,8	0,65	5,02	16	1,77	4,56	0,02	18
ROT-CI	KECO	*Keratella cochlearis*	35	585,6	1686,4	0,28	3,11	19	0,76	2,19	0,01	23
ROT-CI	KECT	*Keratella cochlearis* var. *tecta*	58	900,8	1544,3	0,43	4,99	17	1,17	2,01	0,01	19
ROT-CI	KEQU	*Keratella quadridentata*	15	1026,0	6715,5	0,49	2,73	20	1,33	8,73	0,02	24
ROT-CI	LELU	*Lecane luna*	8	13,9	166,7	0,01	0,23	39	0,03	0,38	0,00	40
ROT-CI	PHYL	*Phylodina* sp.	17	205,1	1230,8	0,10	1,27	27	3,49	20,92	0,04	20
ROT-CI	POVU	*Polyarthra vulgaris*	57	6347,4	11146,6	3,01	13,09	7	1,90	3,34	0,02	16
ROT-CI	POCO	*Pompholyx complanata*	18	183,1	1013,8	0,09	1,25	28	0,05	0,30	0,00	36
ROT-CI	ROTA	*Rotaria* sp.	8	5,8	70,0	0,00	0,15	45	0,10	1,19	0,00	37
ROT-CI	SYPE	*Synchaeta pectinata*	22	454,0	2043,1	0,22	2,19	23	0,59	2,66	0,01	27
ROT-CI	TEPA	*Testudinela patina*	13	8,3	66,7	0,00	0,22	40	0,01	0,09	0,00	44
ROT-CI	TRGR	*Trichocerca gracilis*	35	343,1	988,0	0,16	2,38	21	0,79	2,27	0,01	22
ROT-CI	TRSI	*Trichocerca similis*	3	2,8	100,0	0,00	0,06	48	0,01	0,23	0,00	51
ROT-CI	TRIC	*Trichocerca* sp.	3	2,1	75,0	0,00	0,05	50	0,00	0,17	0,00	53
CLA-CI	ALRC	*Alona rectangula coronata*	7	1,0	14,0	0,00	0,06	49	0,01	0,13	0,00	47
CLA-	ALNA	*Alonella nana*	1	0,4	30,0	0,00	0,02	54	0,00	0,27	0,00	54

CI												
CLA-CI	**BOLO**	*Bosmina longirostris*	22	56,4	253,8	0,03	0,77	34	0,51	2,28	0,01	28
CLA-CI	**CHSP**	*Chydorus sphaericus*	25	181,8	727,2	0,09	1,47	25	1,64	6,55	0,02	21
CLA-CI	**DACU**	*Daphnia cucullata*	1	41,7	3000,0	0,02	0,17	42	2,00	144,00	0,02	33
CLA-CI	**DAGA**	*Daphnia galeata*	29	4836,8	16583,3	2,29	8,18	12	198,61	680,96	2,45	**5**
CLA-CI	**DALO**	*Daphnia longispina*	3	559,7	20150,0	0,27	0,86	31	26,87	967,20	0,33	17
CLA-CI	**DIOR**	*Diaphanosoma orghidani*	26	6657,5	25228,4	3,16	9,13	**10**	665,54	2522,05	8,22	**2**
CLA-CI	**ILAG**	*Ilyochryptus agilis*	3	1,1	40,0	0,00	0,04	52	0,01	0,36	0,00	50
CLA-CI	**ILSO**	*Ilyochryptus sordidus*	4	0,4	10,0	0,00	0,03	53	0,00	0,09	0,00	52
CLA-CI	**MALA**	*Macrothrix laticornis*	4	1,3	30,0	0,00	0,05	51	0,01	0,27	0,00	48
CLA-CI	**MOMD**	*Moina micrura dubia*	50	2534,7	5069,4	1,20	7,75	13	100,12	200,24	1,24	**6**
CLA-CI	**SCMU**	*Scapholeberis mucronata*	3	463,9	16700,0	0,22	0,78	33	2,23	80,16	0,03	31
CLA-CI	**SCKI**	*Scapholeberis kingi*	11	210,8	1897,5	0,10	1,05	30	1,01	9,11	0,01	29
CYC-CI	**NACI**	Nauplii ciclopid	100	31895,8	31895,8	15,13	38,90	**1**	31,90	31,90	0,39	**9**
CYC-CI	**JUV1**	Juvenili - C1	99	22768,5	23089,2	10,80	32,63	**3**	50,09	50,80	0,62	**7**
CYC-CI	**NACA**	nauplii calanid	4	12,5	300,0	0,01	0,16	44	0,02	0,54	0,00	46
CYC-CI	**EUGR**	*Eudiaptomus gracilis*	6	1,9	35,0	0,00	0,07	47	0,07	1,18	0,00	38
CYC-CI	**CALA**	Calanoida sp.	1	0,1	10,0	0,00	0,01	56	0,00	0,15	0,00	55
ROT-CII	**ASHE**	*Asplanchna herricki*	53	2240,6	4245,3	1,06	7,49	14	3,81	7,22	0,05	13
CLA-CII	**LEKI**	*Leptodora kindti*	38	1060,6	2828,1	0,50	4,34	18	6578,3	17542,1	81,23	**1**
CYC-CII	**ACVE**	*Acanthocyclops vernalis ver.*	82	15218,1	18571,2	7,22	24,32	**5**	82,90	101,17	1,02	**4**
CYC-CII	**ACVI**	*Acanthocyclops viridis*	1	40,3	2900,0	0,02	0,16	43	0,16	11,78	0,00	41
CYC-CII	**CYSC**	*Cyclops scutifer*	3	105,6	3800,0	0,05	0,37	36	0,37	13,16	0,00	35
CYC-CII	**CYVI**	*Cyclops vicinus vicinus*	58	7400,4	12686,4	3,51	14,31	**6**	36,68	62,88	0,45	**10**
CYC-CII	**EUSE**	*Eucyclops serrulatus serrulatus*	4	184,7	4433,3	0,09	0,60	35	0,60	14,35	0,01	34
CYC-CII	**MECR**	*Mesocyclops crassus*	53	36817,9	69760,3	17,46	30,36	**4**	189,59	359,22	2,34	**3**
			Nsp	**D_{avg}**		**D_D%**			**B_{avg}**		**D_B%**	
		Rotatoria	30	79762		37,83			129,2		1,60	
		Cladocera	15	16608		7,88			7576,9		93,56	
		Cyclopoida	6	114431		54,28			392,3		4,84	
		Calanoida	2	15		0,01			0,1		0,00	
		Total	**53**	**210816**		**100**			**8098,4**		**100**	

Annex 2

General characteristics of the zooplankton populations from the Oltina, Dunareni and Bugeac lakes (2000-2004)

			Oltina							Dunareni							Bugeac						
		Speciile	F%	D_{avg} sps.m^{-3}	W_D	Rk_D	B_{avg} mg. m^{-3}	W_B	Rk_B	F%	D_{avg} sps.m-3	W_D	Rk_D	B_{avg} mg. m^{-3}	W_B	Rk_B	F%	D_{avg} sps.m-3	W_D	Rk_D	B_{avg} mg. m^{-3}	W_B	Rk_B
ROT-CI	ASCO	*Ascomorpha* sp.	10	23,8	0,3	32	0,0	0,0	41	29	240,7	1,8	24	0,0	0,11	34							
ROT-CI	BRAN	*Brachionus angularis*	86	4940,0	12,8	7	2,5	1,4	13	82	5900,4	15,4	6	3,0	1,51	14	64	1371,3	7,1	11	0,7	1,22	16
ROT-CI	BRCA	*Br. calyc. var. amphiceros*	57	13467,6	17,3	6	24,2	3,7	9	46	9148,2	14,4	7	16,5	2,69	10	18	1645,7	4,5	14	3,0	1,46	15
ROT-CI	BRCP	*Brachionus calyc. var. pala*	29	2079,0	4,8	14	3,7	1,0	16	54	5529,6	12,0	9	10,0	2,25	11	55	847,0	5,2	13	1,5	1,69	13
ROT-CI	BRDI	*Brachionus diversicornis*	52	107147,1	46,8	1	192,9	9,9	3	61	37017,5	33,1	3	66,6	6,19	7	45	6402,2	13,2	7	11,5	4,27	10
ROT-CI	BRDH	*Br. div. var. homoceros*															5	260,9	0,8	31	0,5	0,26	34
ROT-CI	BRFO	*Brachionus forficula*	24	600,0	2,4	20	1,1	0,5	20	25	98,2	1,1	29	0,2	0,20	28							
ROT-CI	BRQU	*Brachionus quadridentatus*								4	32,1	0,2	35	0,1	0,04	37							
ROT-CI	BRQB	*Br. q. var. brevispinus*	19	304,8	1,5	22	0,5	0,3	25	50	336,4	2,9	22	0,6	0,54	20	45	137,4	1,9	24	0,2	0,63	26
ROT-CI	BRQC	*Br. q. var. cluniorbicularis*	19	388,1	1,7	21	0,7	0,4	21	46	1008,2	4,8	17	1,8	0,89	17	50	3960,4	10,8	8	7,1	3,51	11
ROT-CI	BRQM	*Br. q. var. melheni*								4	0,7	0,0	44	0,0	0,01	44							
ROT-CI	BRQR	*Br. q. var. rhenanus*	5	95,2	0,4	30	0,2	0,1	31								9	3,5	0,1	39	0,0	0,04	39
ROT-CI	BRUR	*Brachionus urceolaris*	14	11,9	0,3	34	0,0	0,1	33	43	874,6	4,3	18	1,6	0,80	18	14	175,7	1,1	29	0,3	0,37	30
ROT-CI	EPMA	*Epiphanes macrourus*	5	142,9	0,5	29	0,3	0,1	29														
ROT-CI	EUPA	*Euchlanis parva*	10	2,9	0,1	38	0,0	0,0	40	14	237,5	1,3	26	0,4	0,24	25	14	525,2	2,0	23	0,9	0,64	25
ROT-CI	FIPA	*Filinia passa*	48	1768,1	5,7	11	2,3	1,0	15	43	1569,6	5,7	14	2,0	0,91	16	23	743,9	3,3	16	1,0	0,91	22
ROT-CI	KECO	*Keratella cochlearis*	38	1388,1	4,5	15	1,8	0,8	18	32	385,0	2,5	23	0,5	0,39	24	32	97,0	1,4	27	0,1	0,38	29
ROT-CI	KECT	*Keratella cochl. var. tecta*	67	1925,7	7,1	10	2,5	1,3	14	46	447,5	3,2	19	0,6	0,51	21	64	517,0	4,4	15	0,7	1,20	17
ROT-CI	KEQU	*Keratella quadridentata*	19	3310,5	5,0	13	4,3	0,9	17	18	148,2	1,1	28	0,2	0,18	29	5	8,7	0,2	38	0,0	0,06	38
ROT-CI	LELU	*Lecane luna*	5	9,5	0,1	35	0,0	0,0	39	18	28,6	0,5	32	0,1	0,11	35							
ROT-CI	PHYL	*Phylodina* sp.	14	200,0	1,1	26	3,4	0,7	19	7	19,6	0,3	34	0,3	0,15	30	32	435,7	2,7	18	7,4	2,73	12
ROT-CI	POVU	*Polyarthra vulgaris*	52	737,1	3,9	17	0,2	0,3	23	64	14456,1	21,3	5	4,3	1,62	13	50	1598,3	6,9	12	0,5	0,91	23
ROT-CI	POCO	*Pompholyx complanata*								18	291,8	1,6	25	0,1	0,12	32	32	217,8	2,1	21	0,1	0,27	33
ROT-CI	ROTA	*Rotaria* sp.								11	9,3	0,2	36	0,2	0,13	31	9	7,0	0,2	37	0,1	0,23	35
ROT-CI	SYPE	*Synchaeta pectinata*	29	32,9	0,6	28	0,0	0,1	30	21	867,9	3,0	21	1,1	0,48	22	14	334,8	1,8	26	0,4	0,50	28
ROT-CI	TEPA	*Testudinela patina*	24	16,7	0,4	31	0,0	0,1	32	4	1,8	0,1	42	0,0	0,01	43	9	8,7	0,3	35	0,0	0,07	37
ROT-CI	TRGR	*Trichocerca gracilis*	14	223,8	1,1	25	0,5	0,3	27	39	501,8	3,1	20	1,2	0,66	19	45	258,7	2,6	19	0,6	0,97	20
ROT-CI	TRSI	*Trichocerca similis*								7	7,1	0,2	37	0,0	0,03	39							
ROT-CI	TRIC	*Trichocerca* sp.								7	5,4	0,1	38	0,0	0,03	41							
CLA-CI	ALRC	*Alona rectangula coronata*	14	1,4	0,1	39	0,0	0,0	36	7	1,4	0,1	41	0,0	0,03	40							
CLA-CI	ALNA	*Alonella nana*								4	1,1	0,0	43	0,0	0,02	42							
CLA-CI	BOLO	*Bosmina longirostris*	24	9,5	0,3	33	0,1	0,1	28	25	26,1	0,6	31	0,2	0,24	26	14	136,1	1,2	28	1,2	0,84	24
CLA-CI	CHSP	*Chydorus sphaericus*	29	41,9	0,7	27	0,4	0,3	24	29	93,2	1,1	27	0,8	0,48	23	18	417,4	2,0	22	3,8	1,47	14
CLA-CI	DACU	*Daphnia cucullata*															5	130,4	0,6	33	6,3	0,95	21
CLA-CI	DAGA	*Daphnia galeata*	5	0,5	0,0	41	0,0	0,0	38	32	10113,9	12,6	8	399,2	11,0	2	50	2828,3	8,8	9	135,8	14,6	5
CLA-CI	DALO	*Daphnia longispina*	10	1919,0	2,7	18	92,1	2,9	10														
CLA-CI	DIOR	*Diaphanosoma orghidani*	14	5761,9	5,7	12	576,2	8,9	4	21	3896,8	6,4	13	389,7	8,89	5	45	10836,1	16,3	6	1083,0	39,4	2
CLA-CI	ILAG	*Ilyochryptus agilis*								7	2,9	0,1	40	0,0	0,04	38							
CLA-CI	ILSO	*Ilyochryptus sordidus*	14	1,4	0,1	40	0,0	0,0	37														
CLA-CI	MALA	*Macrothrix laticornis*								11	3,2	0,1	39	0,0	0,05	36							
CLA-CI	MOMD	*Moina micrura dubia*	48	366,2	2,6	19	14,6	2,6	11	54	4553,9	10,9	11	182,2	9,61	4	45	2056,5	7,5	10	78,3	11,1	8
CLA-CI	SCMU	*Scapholeberis mucronata*	5	9,5	0,1	36	0,0	0,0	34								5	1443,5	1,9	25	6,9	1,00	19
CLA-CI	SCKI	*Scapholeberis kingi*	19	2,4	0,1	37	0,0	0,0	35	11	108,2	0,8	30	0,5	0,23	27	5	526,1	1,1	30	2,5	0,60	27
CYC-CI	NACI	Nauplii ciclopid	100	19921,4	27,9	4	19,9	4,4	8	100	39769,6	44,1	1	39,8	6,14	8	100	33243,5	43,4	1	33,2	10,5	9
CYC-CI	JUV1	Juvenili - C1	95	24151,4	29,9	3	53,1	7,0	6	100	20550,0	31,7	4	45,2	6,54	6	100	24206,5	37,1	2	53,3	13,3	7
CAL-CI	NACA	nauplii calanid															14	39,1	0,5	34	0,1	0,17	36
CAL-CI	EUGR	*Eudiaptomus gracilis*															18	6,1	0,2	36	0,2	0,34	32
CAL-CI	CALA	Calanoida sp.	5	0,5	0,0	42	0,0	0,0	42														
ROT-CII	ASHE	*Asplanchna herricki*	71	1929,0	7,3	9	3,3	1,5	12	57	3800,0	10,3	12	6,5	1,87	12	27	626,5	3,3	17	1,1	1,03	18
CLA-CII	LEKI	*Leptodora kindti*	29	1476,2	4,1	16	8997,6	49,8	1	36	1422,9	5,0	16	9175,4	55,7	1	50	240,0	2,6	20	1207,6	43,7	1
CYC-CII	ACVE	*Acanthocyclops vernalis ver.*	100	25320,5	31,4	2	151,4	12,1	2	68	4224,3	11,8	10	20,7	3,64	9	82	19377,8	30,1	4	96,1	16,2	4
CYC-CII	ACVI	*Acanthocyclops viridis*								4	103,6	0,4	33	0,4	0,12	33							
CYC-CII	CYSC	*Cyclops scutifer*	10	361,9	1,2	24	1,3	0,3	22														
CYC-CII	CYVI	*Cyclops vicinus vicinus*	76	5246,7	12,5	8	27,4	4,5	7	32	1920,0	5,5	15	5,9	1,34	15	73	16038,7	25,9	5	82,6	14,2	6
CYC-CII	EUSE	*Eucyclops serrulatus serr.*	10	442,9	1,3	23	1,1	0,3	26								5	173,9	0,7	32	0,9	0,36	31
CYC-CII	MECR	*Mesocyclops crassus*	43	30716,2	22,7	5	183,9	8,7	5	68	35175,0	34,1	2	187,7	11,0	3	41	44389,1	33,1	3	197,1	16,8	3
			Nsp	D_{avg}			B_{avg}			Nsp	D_{avg}			B_{avg}			Nsp	D_{avg}			B_{avg}		
		Rotatoria	23	140744,8			244,6			27	82963,9			117,8			22	20183,0			37,8		
		Cladocera	11	9590,0			9681,1			11	20223,6			10148,1			9	18614,3			2525,3		
		Cyclopida	7	106161,0			438,0			6	101742,5			299,7			4	137429,6			463,2		
		Calanoida	1	0,5			0,01			0	0,0			0,0			1	45,2			0,3		
		Total	**42**	**256496,2**			**10363,8**			**44**	**204930,0**			**10565,6**			**36**	**176272,2**			**3026,6**		

Annex 3

Physical and chemical characteristics of the lakes (2001-2004)

Aquatic ecosistems	**Data**	**Physical characteristics**			**Chemical characteristics**						
		Water depth cm	Secchi depth (cm); **T/A**	T^0C	pH	O_2 mg/l	PO_4**;** **P tot** mg/l	NO_3- mg/l	NO_2- mg/l	NH_4- mg/l	Ca/Mg mg/l
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Bugeac	17.07.01	155	20; **0,12**	28,3	8,46	6,56	0,52; **0,16**	0,95	0,155	0,998	128/97
		100	15; **0,15**	28,2	8,89	7,01					
		170	25; **0,14**	28,3	8,39	6,85					
		155	23; **0,14**	28,7	8,35	6,96					
Oltina	18.07.01	145	18; **0,12**	25,8	8,80	3,93	0,49; **0,15**	1,30	0,082	0,175	115/93
		155	25; **0,16**	26,1	8,73	4,25					
		150	24; **0,16**	26,2	8,80	4,02					
Dunareni	18.07.01	100	46; **0,46**	28,7	8,86	8,13	0,80; **0,28**	1,27	0,046	0,082	148/117
		120	30; **0,25**	28,6	8,82	7,80					
		95	40; **0,42**	28,4	8,85	8,10					
		50	50; **1,00**	23,9	7,60	2,28					
		100	100; **1,0**	25,9	8,65	3,93					
		100	100; **1,0**	25,3	8,41	7,32					
Bugeac	12.09.01	40	12; **0,3**	17,6	8,31	9,30	0,81; **0,27**	1,40	0,16	0,307	95/72
		105	9; **0,08**	16,7	8,44	8,89					
Oltina	11.09.01	90	13; **0,14**	19,1	8,56	10,15	0,75; **0,24**	1,70	0,020	0,476	115/101
		100	15; **0,15**	19,5	8,62	9,50					
Dunareni	12.09.01	65	6; **0,09**	19	8,42	12,80	0,21; **0,06**	1,80	0,057	0,126	107/83
		60	8; **0,13**	19,1	8,52	12,40					
		45	5; **0,11**	20,3	8,56	13,25					
		100	100; **1,00**	17,4	8,11	6,34					
		95	85; **0,89**	17,3	8,17	5,89					
Bugeac	21.03.02	100	13; **0,13**	9,6	8,77	11,77	0,13; **0,04**	0,9	0,078	0,22	109/70
		105	12; **0,11**	8,5	8,76	11,33					
		50	20; **0,50**	8,9	8,80	10,89					
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Dunareni	22.03.02	95	77; **0,81**	11,3	8,49	9,41	0,02; **0,006**	0,4	0,021	0,132	108/74
		55	55; **1,00**	12,1	8,35	8,65					

		65	45; **0,69**	11, 6	8,45	9,36					
Bugeac	27.06.02	80	11; **0,13**	23	9,16	13,76	0,67; **0,21**	0,8	0,122	0,132	117/91
		120	12; **0,10**	23,2	9,02	13,70					
		95	10; **0,10**	22,9	8,95	10,86					
Dunareni	26.06.02	80	20; **0,25**	22,7	8,32	5,57	0,83; **0,27**	2,3	0,157	0,675	145/112
		55	8; **0,14**	22,4	8,45	6,44					
		70	12; **0,17**	22,8	8,36	6,25					
		70	70; **1,00**	27	9,20	8,52					
		110	110; **1,0**	27,3	8,07	7,17					
Bugeac	03.10.02	60	5; **0,08**	17,9	9,40	14,50	0,32; **0,10**	3,5	0,069	0,249	98/84
		80	4; **0,05**	18,1	9,35	13,70					
		60	4; **0,06**	17,3	9,28	13,41					
Oltina	03.10.02	60	0	13,5	8,85	11,45	0,53; **0,17**	3,9	0,077	0,144	126/106
		115	0	14,7	8,74	11,40					
		115	0	15,2	8,77	10,40					
Dunareni	04.10.02	80	20; **0,25**	15,1	8,91	14,60	0,37; **0,12**	2,4	0,078	0,276	119/95
		100	15; **0,15**	15	8,80	12,95					
		95	15; **0,15**	14,9	8,76	12,94					
		80	80; **1,00**	16,8	7,49	6,25					
		100	75; **0,75**	17,2	7,43	6,70					
Oltina	23.04.03	120	21; **0,17**	10,9	8,55	11,06	0,09; **0,02**	0,13	0,05	0,130	109/72
		155	27; **0,17**	11,4	8,86	11,37					
		155	25; **0,16**	11,2	8,87	11,40					
		120	35; **0,29**	11,2	8,78	12,19					
Dunareni	24.04.03	95	32; **0,33**	13,06	8,64	11,23	0,23; **0,07**	0,80	0,102	0,193	128/94
		105	32; **0,30**	14,4	8,57	10,94					
		95	20; **0,21**	14,4	8,53	10,80					
		80	34; **0,42**	13,6	8,45	10,52					
Dunareni	08.08.2003	60	3; **0,05**	26,3	9,70	13,35	0,83; **0,27**	1,35	0,159	0,077	147/114
		55	3; **0,05**	27,1	9,94	13,72					
		50	6; **0,12**	28,4	10,01	12,20					
		45	8; **0,17**	28,5	9,98	15,26					
Bugeac	05.08.04	150	18; **0,12**	22,7	8,60	5,56	0,45; **0,14**	1,27	0,125	0,032	115/88
		165	20; **0,12**	23,6	8,80	7,24					
		170	22;**0,129**	23	8,72	6,86					

		160	25; 0,15	23,8	8,82	7,80					
Oltina	05.08.04	125	24; **0,19**	24,5	9,38	11,27	0,72; **0,22**	1,94	0,087	0,145	116/90
		160	24; **0,15**	25,2	9,32	10,64					
		160	24; **0,15**	25,8	9,31	10,63					
Dunareni	04.08.04	90	20; **0,22**	25,9	9,00	11,31	0,80; **0,26**	1,52	0,153	0,084	132/109
		100	18; **0,18**	26	8,80	11,23					
		80	30; **0,37**	26,3	8,97	9,08					
		85	18; **0,21**	25,00	8,77	7,09					
Bugeac	04.11.04	140	24; **0,17**	13,4	8,94	10,50	0,11; **0,03**	0,50	0,040	0,134	193/150
		165	24; **0,14**	13,3	8,80	11,20					
		140	27; **0,19**	13,3	8,82	11,18					
		160	28; **0,17**	13,4	8,83	10,89					
Oltina	05.11.04	100	23; **0,23**	13	9,22	12,03	0,12; **0,03**	0,30	0,049	0,078	218/181
		150	27; **0,18**	13	9,13	11,70					
		155	23; **0,14**	13,5	9,06	11,40					
		115	31; **0,26**	13,3	8,63	12,25					
		110	34; **0,30**	13,3	8,77	12,95					

NEW APPROACHES FOR THE MATHEMATICAL MODEL OF INJECTION TECHNOLOGY PROCESSES

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ABSTRACT

This paper proposes a preliminary study of the governing equations of the injection molding. A challenge is to optimize the mold design which leads to the most homogeneous filling. In addition to these three conservation equations, there may also be one or more constitutive equations that describe material properties, shear thinning behavior. Since these equations may also be coupled together, temperature dependent viscosity, the solution can become even more complex. The goal of the modeler is to take a physical problem, apply these mathematical equations and solve them to predict the flow phenomena.

Keywords: *mathematical model, injection molding, polymeric material.*

1. INTRODUCTION

One of the most important polymer processing operations is the injection molding. This process involves the following sequence of steps: (a) heating and melting the polymer, (b) pumping the polymer to the shaping unit, (c) forming the melt into the required shape and dimensions, (d) cooling and solidification [1].

Thermoplastics are usually processed in the molten state. Molten polymers have very high viscosity values and exhibit shear thinning behaviour. As the rate of shearing increases, the viscosity decreases, due to alignments and disentanglements of the long molecular chains.

The viscosity also decreases with increasing temperature. In addition to the viscous behaviour, molten polymers exhibit elasticity. These include stress relaxation and normal stress differences. Slow stress relaxation is responsible for frozen in stresses in injection molded and extruded products. The normal stress differences are responsible for some flow instabilities during processing.

A challenge is to optimize the mold design which leads to the most homogeneous filling. In order to be able to predict and model complex polymer flows, one must first have a basic understanding of the mathematics that govern the flow: the conservation of mass, the conservation of momentum, and the conservation of energy.

2. THE MATHEMATICAL MODEL SOLUTION

The injection molding process is a very complex process and it must satisfy certain physical laws. So first, we must have a basic understanding of the mathematics equations that govern the flow. We express these laws in mathematical terms as the conservation of mass, the conservation of momentum, and the conservation of energy. In addition to these three conservation equations, there may also be one or more constitutive equations that describe material properties.

Solutions of the equations present several practical problems. Due to the characteristic thin wall of molded components, it is possible to make some reasonable assumptions that lead to a simplification of the governing equations. These simplified equations describe what is called Hele Shaw flow and may be readily solved in complex geometries. These simplified equations that are used in commercial plastics CAE analysis software [2].

Although analytical solutions to the conservation equations for some simple two-dimensional shapes are available, when more complex two-dimensional problems or three-dimensional analysis are required, numerical methods are required, like you see in figure 1.

2.1 Conservation of mass:

The flow of a viscous fluid in the mold is mathematically described by the governing equations of conservation of mass, momentum and energy. For a material with density ρ, specific heat at constant pressure C_p in most general form these equations can be written as follows [2, 3 and 4]:

Conservation of mass is:

$$\frac{D\rho}{Dt} + \rho(\nabla \cdot \bar{v}) = 0 \tag{1}$$

Where notation:

$$\frac{D}{Dt} = \frac{\partial}{\partial t} + \bar{v} \cdot \nabla \tag{2}$$

means material derivative, which is a particular kind of time derivative, in which the material point is held constant.

2.2 Conservation of momentum:

Conservation of momentum is described through next equation:

$$\frac{\rho D\bar{v}}{Dt} = -\left[\nabla \cdot \bar{\bar{\tau}}\right] - [\nabla p] + \rho \bar{g} \qquad (3)$$

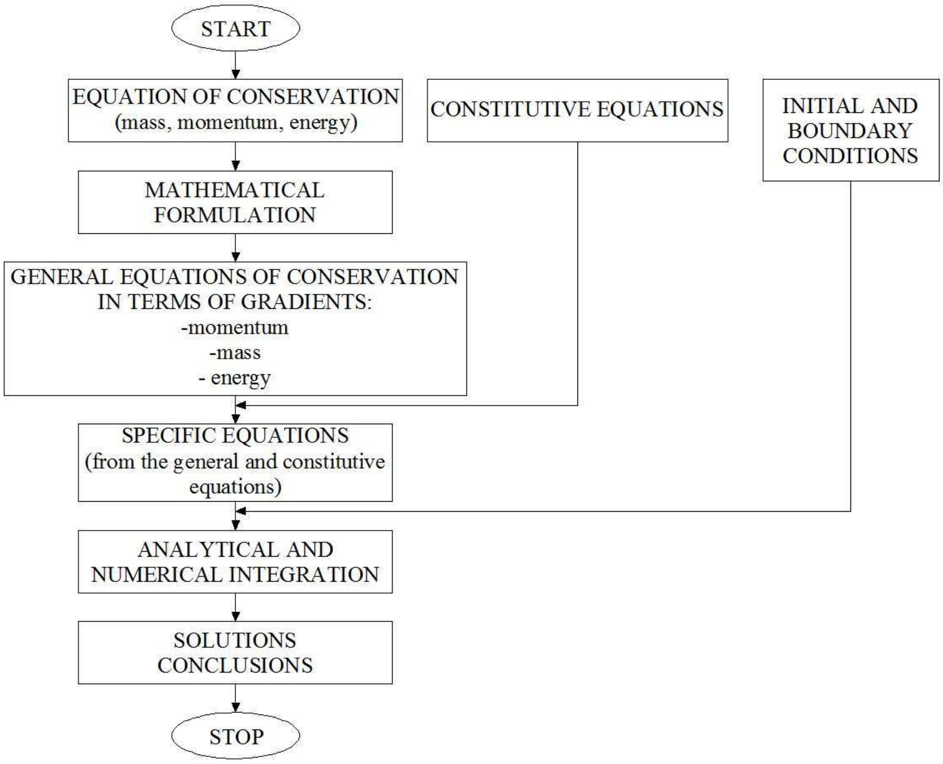

Figure 1 The mathematical model solution for the couple mold injection – polymeric material

When considering theory that governs plastic injection molding, we might begin by looking at fluid flow through the mold.

One of the most general laws governing fluid flow is the Navier-Stokes Equation (3). In these equations $\bar{v}$ is the velocity vector, p is the pressure, $\bar{\bar{\tau}}$ is the stress tensor and $\bar{g}$ is the vector of the body force per unit mass acting on the fluid.

Equations (1) and (3) are sufficient to describe the fluid flow. But there is no method to solve them analytically in such general form. For practical needs these equations are simplified. Typical simplifications are based on the assumptions that allow excluding less important terms from the equations.

Usually, isotropic material and symmetric stress tensor are assumed. If material density is assumed to be constant $\rho = const.$, for the incompressible fluid the equation (1) reduces to:

$$\left(\nabla \cdot \bar{v}\right) = 0 \qquad (4)$$

One should take into account that simplified equation (4) holds only for materials, which are not only incompressible but also have low thermal heat expansion coefficient, their density does not change much with temperature [5].

Assumption of constant material density during the injection molding filling stage does not introduce big error because most of fluids are practically incompressible at the pressures encountered at the filling stage.

2.3 Conservation of energy:

If the material has constant density and constant thermal conductivity, $k = const.$, equation (5) describe the conservation of energy, where C_p specific heat at constant pressure:

$$\rho C_p \left(\frac{DT}{Dt}\right) = k\nabla T - \left(\{\nabla \bar{v}\} : \bar{\bar{\tau}}\right) \qquad (5)$$

2.4 Constitutive equations

The general form for the constituent equations for incompressible non-Newtonian fluid is:

$$\bar{\bar{\tau}} = \eta \bar{\bar{\Delta}}, \qquad (6)$$

where $\bar{\bar{\tau}}$ is the viscous stress tensor, $\bar{\bar{\Delta}}$ is the velocity of deformation tensor and η is the fluid viscosity.

The viscosity of a Newtonian fluid η is independent on shear rate. Most of polymers are non-Newtonian fluids.

Fluids for which equation (6) holds are called generalized Newtonian fluids. Term "Generalized

Newtonian Fluid” sometimes is confusing, because it is used for actual non-Newtonian fluids.

The function $\eta\left(\dot{\gamma}\right)$ is called non-Newtonian viscosity, where $\dot{\gamma}$ is the shear velocity, so for a simple shear flow equation (6) becomes:

$$\tau = \eta\left(\dot{\gamma}\right)\dot{\gamma}. \tag{7}$$

Type of the viscosity function depends on the material properties. If the curve at the viscosity versus shear rate plot turns downward with the increase of shear rate, then the fluid is called shear thinning or pseudo plastic. Most of polymers exhibit this type of non-Newtonian behavior. Polymer injection molding feedstock’s, as materials based on polymer binders, have the same type of viscosity.

Since the pioneering work of Hieber and Shen, the Hele-Shaw model has been constantly adopted to simulate two-dimensional injection molding. This model approximates 3D polymer melt flows between two flat plates assuming that the gap thickness is much smaller than the channel or cavity characteristic length. This strategy can be measured by the number of works available in the literature and by its use in commercial packages as Moldflow and C-mold [6 and 7].

A more realistic formulation would require a viscosity description consistent with the rheological model and a point-wise evaluation of the shear strain rate and temperature over the gap thickness. The shear-thinning regime can be described by a number of empirical, semi empirical or theoretical functions.

3. THE CONSTITUTIVE MODEL FOR THE COUPLE MOLD – POLYMERIC MATERIAL

In injection molding fluid is flowing through a relatively small gap. If we apply this assumption, as well as others related to plastic injection molding we choose the Ostwald de Waele model (figure 2) [4].

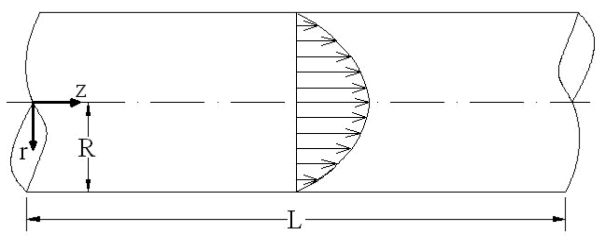

Figure 2 Flow geometry through a cylindrical canal

For the unidirectional flow in cylindrical coordinates the constitutive equation will be:

$$\tau_{rz} = m\left(-\frac{dv_z}{dr}\right)^n, \tag{8}$$

where m is the index of consistence $\left[\frac{N}{m^2}\cdot s^n\right]$ and n is the index of flow.

The injection moulding process is broadly divided into three phases:

- filling,
- holding (or packing) and
- cooling.

In recent researches, the pressure at the impression has been considered the most important parameter to establish a correlation with the dimensions and weight of the molded part and it is considered a finger print of the process. The figure 3 shows a typical pressure evolution inside the mold impression and its main features.

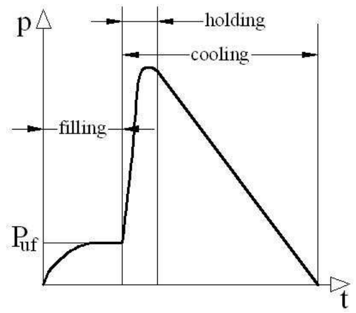

Figure 3 Molding phases

Mold cavity filling is characterized by the fountain effect, in which elements of the molten polymeric fluid undergo complex shear and stretching motions as they catch up to the free flow front and then move outwards to the cold walls. This phenomenon can impart considerable orientation to the resulting injection molded part.

While molecular orientation is used in extrusion to improve the mechanical properties, in injection molding orientation is generally a nuisance. The orientation is further exacerbated during the packing stage. The consequent frozen in stresses can cause parts to become distorted, especially at elevated temperatures. Figure 4 shows streamlines and fluid element deformation in fountain flow.

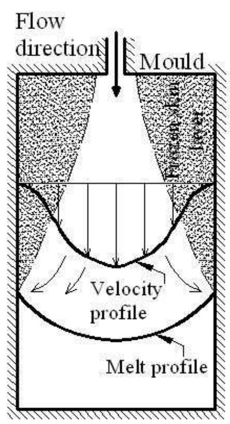

Figure 4 Fountain flow

We consider that the fill of the molds is done isothermal and the packing phase begins after the fill was finished.

In the packing phase the mold cavity is essentially filled up by the polymer melt. More melt are forced by the plunger to fill the cavity in order to compensate the thermal shrinkage after the part is injected and cooled.

The orientation of the molecules is further exacerbated during the packing stage. The consequent frozen in stresses can cause parts to become distorted, especially at elevated temperatures. Figure 5 shows streamlines and fluid element deformation in fountain flow.

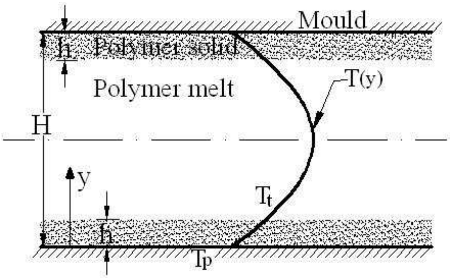

Figure 5 Frozen skin layer in the mold

During the molding cooling process, a three-dimensional, cyclic, transient heat conduction problem with convective boundary conditions on the cooling channel and mold base surfaces is involved.

The mold temperature is fluctuated periodically with time, what we cared is not the actual mold temperature but the effect of the mold temperature on heat transfer of molded part.

The role of the fountain effect at the free-flow front is responsible for complex shear and stretching motions that result in fluid element deformations and molecular orientation phenomena.

The filling stage of injection molding, which might be typically about 1 second in duration, is followed by a very short packing stage (0.1 second) necessary to pack more polymers in the mold to offset the shrinkage after cooling. During the packing stage, there is no net fluid flow but motions due to density differences that require pVT behavior analysis. Very high shear rates arise in injection molding operations, and as such to limit temperature increases from viscous heating and also to facilitate easy filling, low viscosity thermoplastic polymer grades are used.

4. CONCLUSIONS

To obtain the mathematical models it's necessary to combine: 1. physical laws (conservation of mass, momentum and energy); 2. material response models (constitutive equations for viscosity and/or viscoelaticity, pVT behaviour); 3. information about the process (geometry and processing variables).

The injected parts are real bodies with a high viscosity behaviour. In the thermoplastics processing, concerning the injection process, the deformation is accompanied by structural changes and rheological variation properties, the melt having a non-Newtonian behaviour. The rheological parameters and physical properties of polymers melt depend on the thermodynamics parameters. The mold injection includes: flow, heat transfer and knowledge dependence about pressure-volume-temperature for the thermoplastic material processed.

The production of injection molded parts is a complex process where, without the right combination of material, part and mold design and processing parameters, a multitude of manufacturing defects can occur, thus incurring in high costs. Computer aided engineering tools can be used to simulate a wide variety of phenomena such as mold injection. The simulation results can be used to correct the defects on the final part, for example by adjusting process settings or modifying the mold design, so it's necessary to use CAE tools to predict and solve potential problems before they occur.

5. REFERENCES

[1] SERES, I.: *Mold Injection*, (In Romanian Language). West Printing House, Oradea, 1999, pp.347. ISBN 973-9329-48-9

[2] BILOVOL, V. V.: *Mould filling simulations during powder injection moulding*, 2003, pp.136, ISBN 90-806734-4-7

[3] MIHAIL R., STEFAN: *The simulation of the polymers processes*, (In Romanian Language). Technical Printing House, Bucharest, 1989, pp. 368, ISBN 973-31-0102-8

[4] NIȚĂ (RAICU), A: *Researches and contributions regarding the optimization of the mold injection process to increase the quality for some components and accessories of polymeric materials*, Ph.D. thesis Constanta Maritime University, 2010

[5] OANTA, E.; PANAIT, C.; MARINA, V.; MARINA, V.; LEPADATU, L.; CONSTANTINESCU, E.; BARHALESCU, M. L.; SABAU, A. & DUMITRACHE, C. L.: *Mathematical Composite Models, a Path to Solve Research Complex Problems*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISBN 978-3-901509-83-4, ISSN 1726-9679, pp 0501-0502, Editor Branko Katalinic, Published by DAAAM International, Vienna, Austria 2011

[6] RAICU G., STANCA C, *Advanced concepts in nanomanipulations*, Advanced Topics in Optoelectronics, Microelectronics, and Nanotechnologies IV, Proceedings SPIE Vol. 7297, 72971Z, Jan. 7 2009

[7] OANȚĂ E., BĂRHĂLESCU M., SABĂU A., *Management of Change Based on Creative Inter-Domain Syntheses*, Proceedings of the 7th International Conference on Management of Technological Changes, September 1st-3rd, 2011, Alexandroupolis, Greece, Editor: Costache Rusu, Vol II, ISBN (Vol. II) 978-960-99486-3-0, ISBN 978-960-99486-1-6, Democritus University of Thrace, pp. 589-592

STATIC ANALYSIS OF CYLINDER LINERS FROM DIESEL ENEGINES USING FEM

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ABSTRACT

Current compression ignition engines are characterized by increasing level of demand based on increase boost pressure and speed, reducing mass and gauges [6].

Because of this, certain organs, such as the cylinder liners because of the intense damage washed cooling water and the inner surface in contact with the piston and combustion gases lead to the removal MAC of cylinder liner wear running outside cause its replacement before eating life, established mainly in relation to inner wear [1].

It is very important to know which is the optimal composition of the material, how different concentrations affect constituents and how is the optimal degree of participation in alloys used in the manufacture of cylinder liners from internal combustion engines.

Mechanical vibrations that occur in the motor mechanism, especially in the cylinder liners, is a principal factor of wear with implications for the functioning of the various components of internal combustion engines used in motor, rail and marine transport. Therefore, to design engines it is necessary to perform a static analysis for cylinder liners to see what is the degree of deformation, so that does not result displacements and mechanical vibrations. These values must be correlated with nodal displacements of the allowed values of engine construction standards or naval classification registry.

Internal tension state has an important influence on the wear behavior of cylinder liners. This tension state is generated by mechanical vibrations which cylinder liners is subjected and cavitation bubbles collapse and through its surface [2].

This paper presents an exemple for the static finite element analysis performed using the FEMAP software for cylinder liners made of two materials most commonly used in their construction and for four thicknesses.

Keywords: *finite element analysis, static analysis, deplacement, damages, wear, vibration, diesel engine, cylinder liner.*

1. INTRODUCTION

An intermediate steel has properties that characterize ferrite and cementite properties. Compared with ferrite, is harder and less plastic, but not so hard and brittle that cementite. Hardness, tensile strength, plasticity, of steel depends primarily on the ratio of the concentrations of ferrite and cementite. Dependencies of hardness, tensile strength, toughness, elongation at break according to carbon content are shown in figure 1 [3].

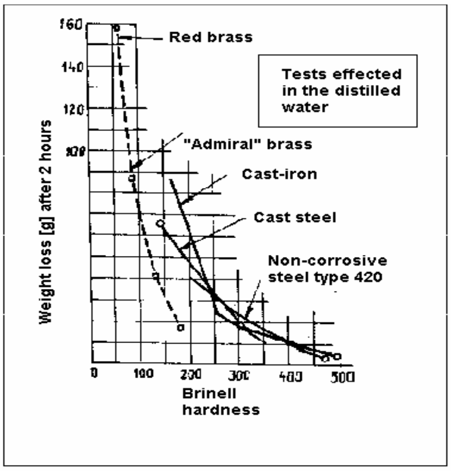

Figure 1 Variation of mechanical characteristics of carbon steels [5].

Characteristics of steel are strongly influenced by the presence in their structure of alloying elements. The main alloying elements of the steel used to build the cylinder liners are chromium and nickel [4].

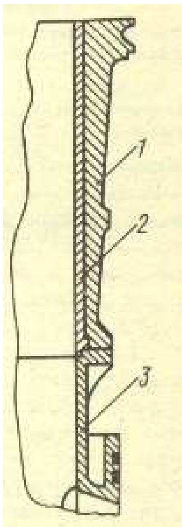

Figure 2 Construction cylinder liner in two layers [5]: 1 – Upper part; 2 – Insertion of iron; 3 – Lower part.

Chromium, carburigen element, shows very favorable influences on resilience and increase corrosion resistance steels, both at room temperature and also at high temperatures. Corrosion resistance of chromium steels is even higher as the chromium content is higher [3].

Nickel is one of the elements that increase corrosion resistant steels in air, seawater, acidic environments. Pearlitic steels are preferred which, along with nickel, contain other elements of the forming carbides such as chromium [3].

Cylinder liners destinated for small and medium internal combustion engines are made almost exclusively of cast iron as best meet the main requirements: - high resistance to abrasive wear, high corrosion properties, satisfying resistance to mechanical stress, easy pouring. The most used are cast iron with lamellar graphite or nodular fine [4].

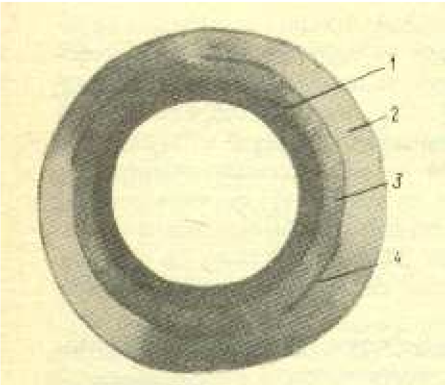

Figure 3 Macrostructure of bimetallic cylinder liner steel - iron [5]: 1 - graphite, 2 - layer steel, 3 - layer of iron; 4 - transition zone

Cast iron with lamellar graphite type A shows a basic structure predominantly pearlitic and gives higher strength properties (Fc250 - Fc4OO or Fcx2OO - Fcx350 brands). Nodular cast iron are strongly influenced by the structure of the mechanical properties (modulus of elasticity of cast iron with nodular graphite is between 16,500 and 18,500 daN/mm^2, fatigue strength is superior cast iron with lamellar graphite, with values between 12 and 18 daN/mm^2, and vibration damping capacity lower than those with lamellar graphite). The cast iron alloy with Ni, Cr, Mo, Cu, and Ti greatly improved properties are obtained [3].

The construction of engines usually use alloys Al - Si. They contain, usually from 2% to 14% Si and various impurities: Fe up to 1.4%, Mg up to about 0.15%, Cu max. 0.6%... Improved mechanical and technological characteristics of these alloys can be made by alloying with Mg, Mn, Cu, and Ni... The alloys used are [3]:

1) Al - Si - Mg (Si 2 - 14%, Mg 2% and additions of iron, manganese, titanium);

2) Al - Si - Cu (Si 5 - 12%, with max. 5% and small additions of manganese, iron ...).

These alloys, besides the aforementioned properties, have a good weldability and can be subjected to heat treatment for hardening and aging.

Pimosenko [5] developed a method for obtaining bimetal cylinders cast iron - steel overlapping process with a process of saturation of the carbon released. Between the two layers is a transition zone, which produces smooth change of carbon concentration from 2.14% to strength steel layer. Transition zone thickness is 1 to 2 mm (figure 2 and figure 3).

2. STRUCTURE MODEL

Cylinder liners by FEM calculation was performed using FEMAP software. To do this, we took into account a cylinder liner with geometrical dimensions corresponding to the Diesel engine D 103.

The structure model of the cylinder liner is shown in figure 4:

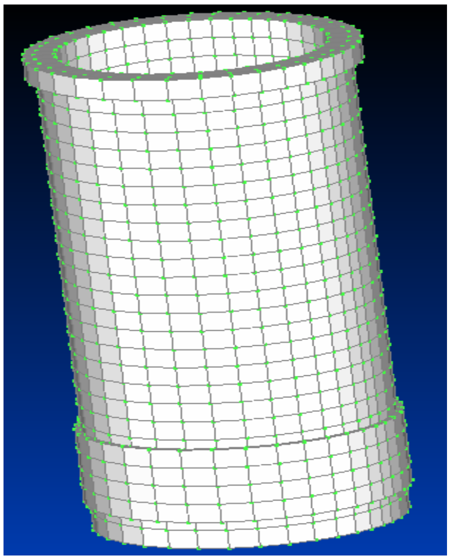

Figure 4 Discretized calculation model.

The model considered consists of 3575 nodes and 3985 solid elements (brick8).

For calculations were considered two cylinder liners made of steel and cast iron (2 mm, 4 mm, 6 mm and 8 mm thickness).

3. THE CYLINDER LINER LOAD

Figure 5 shows the variation of forces acting on the motor mechanism D - 103, at speeds taken into account in theoretical and experimental calculations: 1320, 1500, 1620, 1755 and 1830 $\left[\frac{\text{rot}}{\text{min}}\right]$ ([7], [8]).

In this paper, the FEM calculation was performed for speed n = 1755 $\left[\frac{\text{rot}}{\text{min}}\right]$. Corresponding to this speed, the normal force, which is exerted on the cylinder liner will be $F_N = 6825$ N.

The distribution of normal force in FEM model was made on cylinder liner generatirx of the Diesel engine. Thus, the normal force was divided into five nodes cylinder liner.

4. CONSTRAINT CONDITIONS

For this structure, the cylinder liner areas used to fix into cylinder block of the Diesel engine are considered fixed at both the top and the bottom.

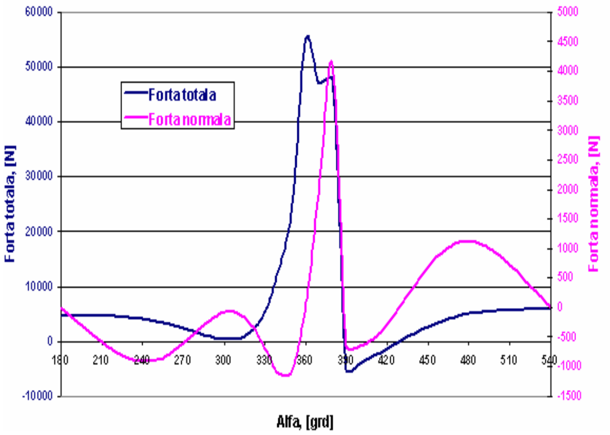

Figure 5 Total force and normal force variation in the motor mechanism D – 103 [7].

5. RESULTS OBTAINS BY THE STATIC ANALYSIS

Nodal displacements obtained from static analysis reveals that the maximum values are obtained in the motion plane of the connecting rod, the driving side of the piston from top dead center to bottom dead center.

Displacement values of the cylinder liner generatrix made of cast iron are shown in table nr. 1 and figure 6.

Table 1. Displacement values for the cylinder liner made of cast iron.

Thickness Distance [mm]	2 [mm]	4 [mm]	6 [mm]	8 [mm]
239	0.000	0.000	0.000	0.000
230	0.160782	0.036784	0.015506	0.008339
220	0.212691	0.050691	0.022154	0.012594
210	0.258464	0.062635	0.027618	0.015448
200	0.284983	0.067362	0.030147	0.017460
190	0.321032	0.072299	0.032103	0.018176
180	0.320120	0.070638	0.031355	0.018147
170	0.244519	0.067771	0.029724	0.016774
160	0.187564	0.054977	0.024338	0.014101
150	0.155447	0.042481	0.018933	0.010981
140	0.128731	0.034277	0.015207	0.008859
130	0.104871	0.027946	0.012328	0.007159
120	0.083721	0.022691	0.010020	0.005813
110	0.065307	0.018001	0.008016	0.004655
100	0.049236	0.013833	0.006226	0.003628
90	0.035444	0.010159	0.004603	0.002683
80	0.023978	0.006913	0.003116	0.001808
70	0.014241	0.003948	0.001745	0.001004
55	0.000	0.000	0.000	0.000

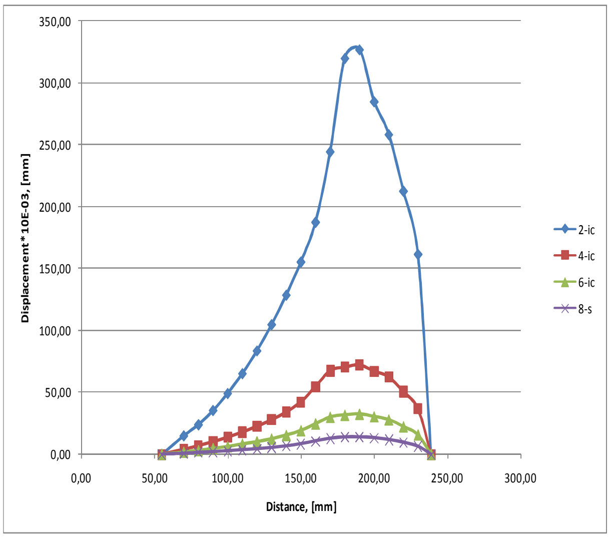

Figure 6 The variation of nodal displacements of cylinder liner generatrix made of cast iron for four thicknesses.

In figure 7 is presented a distorted cylinder liner made of cast iron with 4 mm in thickness (distorted amplification factor is presented to highlight displacement nodes).

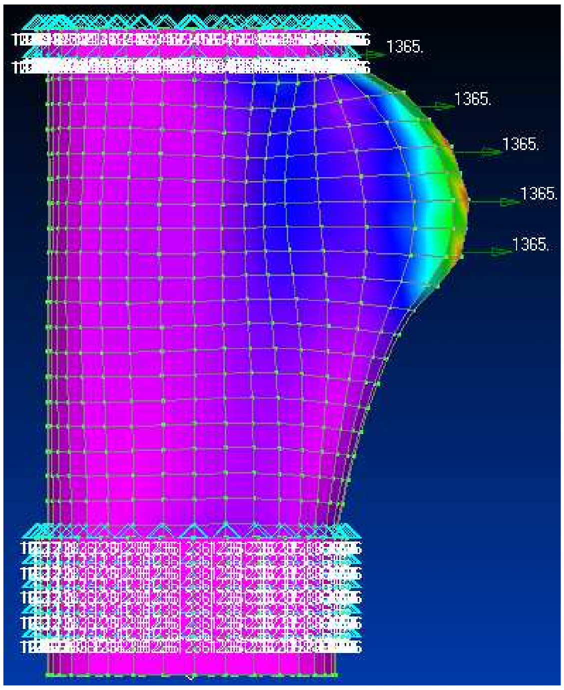

Figure 7 Distorted cylinder liner made of cast iron with 4 mm in thickness

Displacement values of the cylinder liner generatrix made of steel are shown in table 2 and figure 8.

Table 2. Displacement values of the cylinder liner generatrix made of steel

Thickness Distance [mm]	2 [mm]	4 [mm]	6 [mm]	8 [mm]
239	0.000	0.000	0.000	0.000

230	0.122066	0.027926	0.011786	0.006349
220	0.161183	0.038412	0.016791	0.009549
210	0.195775	0.047384	0.020958	0.011729
200	0.215662	0.051055	0.022842	0.013232
190	0.247414	0.054775	0.024349	0.013793
180	0.242131	0.053459	0.023751	0.013749
170	0.185017	0.051332	0.022544	0.012730
160	0.141990	0.041626	0.018445	0.010688
150	0.117692	0.032195	0.014362	0.008329
140	0.097523	0.025989	0.011544	0.006724
130	0.079511	0.021202	0.009365	0.005437
120	0.063531	0.017230	0.007619	0.004418
110	0.049611	0.013686	0.006103	0.003544
100	0.037408	0.010536	0.004749	0.002765
90	0.027038	0.007759	0.003519	0.002049
80	018380	0.005300	0.002390	0.001385
70	0.011004	0.003043	0.001345	0.000726
55	0.000	0.0000.	0.000	0.000

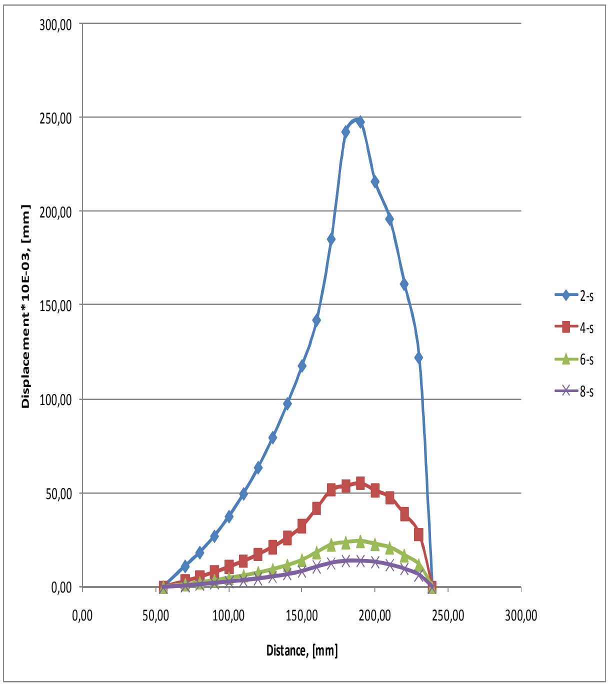

Figure 8 Variation of nodal displacements of cylinder liner generatrix made of steel for four thicknesses.

For cylinder liners made of cast iron and steel, a comparison of nodal displacements shown in figures 9-12.

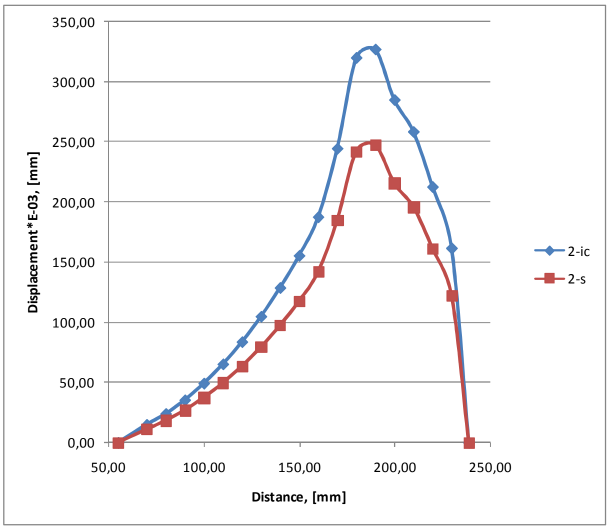

Figure 9 Variation of nodal displacements for cylinder liners with 2 mm in thickness made of cast iron and steel

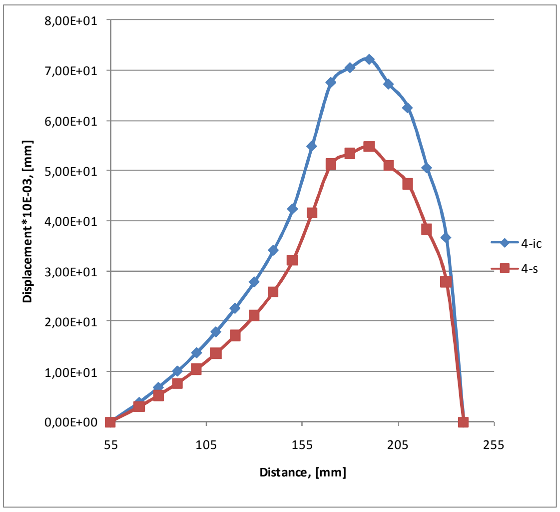

Figure 10 Variation of nodal displacements for cylinder liners with 4 mm in thickness made of cast iron and steel.

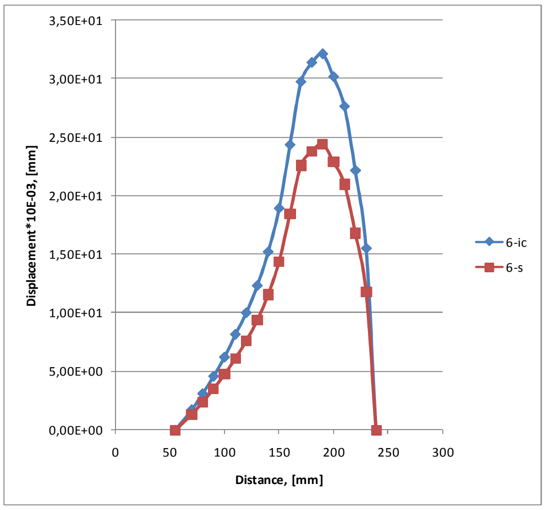

Figure 11 Variation of nodal displacements for cylinder liners with 6 mm in thickness made of cast iron and steel.

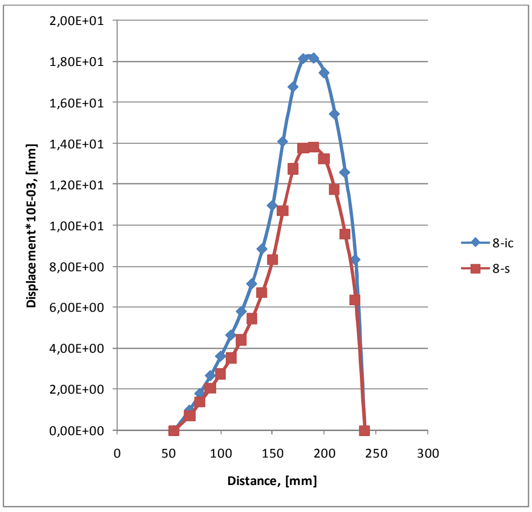

Figure 12 Variation of nodal displacements for cylinder liners with 8 mm in thickness made of cast iron and steel.

6. CONCLUSIONS

Results obtained from the FEM static analysis of cylinder liners made of cast iron and steel, for the four thickness variants leads to the following conclusions:

a) Nodal displacement amplitudes for cylinder liner made of cast iron are greater than those of steel (because the difference between the modules of elasticity of the two materials used);
b) With decreasing thickness of cylinder liner, nodal displacement values increase;
c) For the cylinder liners with thicknesses over 2 mm, the variation of nodal displacement values is not significant when the thickness increases;
d) As seen from the data presented, the maximum dispacements are obtained near the top dead center, after piston change the support surface, the race of piston is to bottom dead center as regard measurements of the diffraction line width and the density dislocation [2]. From evolutions of crystalline grid dislocation density, it follows that if cylinder liners with thickness of 4 mm, the destruction process not begins by agglomeration of dislocations in areas where there were obstacles for moving dislocations, such as dissolved atoms, impurities, other dislocations ...,but through a process of fatigue crystalline grid, described the evolution of the amplitude jumps high internal stresses second order in the mass impact excitation. In the case of cylinder liner with the thickness more 6 mm, it is found that the density of dislocations in different points of the circumference varies both jumps with different amplitudes and periods as low monotone. Evolution dislocations density, correlated with the second order internal stresses lead to the conclusion that the destruction process begins due to congestion and blocking dislocations in various obstacles and destruction process is more likely to occur in the area of the cylinder liner situated near the areas with maximum vibration (0^o and 180^o).

7. REFERENCES

[1] Bortevskii I.T., Mirosnicenko A.F., Pogodaev L.I., *"Porîsnie kavitationnoi stoikosti dvigatelei vnutrennego sgorania"*, Kiev, 1980.
[2] CRUDU I., SIMIONOV M., GHEORGHIES C., *The Tension State in the Superficial Layer in the Vibration Cavitation Case*, 8th International Conference on Tribology NORDTRIB'98, Ebeltoft, Denmark, 1998
[3] Geru N., s.a., *"Materiale metalice. Structura proprietati, utilizari"*, Editura Tehnica, Bucuresti, 1985.
[4] Grünwald V.,*"Teoria, calculul si constructia motoarelor pentru autovehicule rutiere"*, Editura Didactica si Pedagogica, Bucuresti, 1984.
[5] PIMOSENKO A.P., *Zasita sudovîh dizelei ot kavitationîh rezrusenii*, "Sudostroenie", Leningrad, 1983.
[6] Pogodaev L.I., Sevcenko P.A., *"Ghidroabrazinîi I kavitationnîi irnos sudovogo oborudovania"*, Sudostroenie, Leningrad, 1984.
[7] SIMIONOV M., *The Studies and the Researches Concerning the Cavitation Destruction of theCylinder Liners from the Diesel Engine* (in Romanian), Ph.D. Thesis, University *"DUNAREA DEJOS"* of Galati, Romania, 1997
[8] SIMIONOV M., *The cavitation of the cylinder liners from the Diesel engines*, Mongabit Printing Galati Press, Galati, 2000.

SECTION III

ELECTRONICS, ELECTRONICAL ENGINEERING AND COMPUTER SCIENCE

AN APPROACH TO EVALUATE THE OPERATIONAL STATUS OF A TECHNICAL SYSTEM

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ABSTRACT

The operational capability-the functionality- represent the definning feature of an instalation.The goal of this subject is to establish a manner of evaluating from a quality and quantity perspective the operational status of a technical equipment under exploitment.The quantification of this size consists on one hand to estimate the functionality status of a system based on the estimations of a group of experts and on the other hand, to associate to these opinions a probability related to the operational status of the technical equipment.Thereby, it is obtained an conjunctiv couple of operational status „AND" reliability, intended to offer to the manager a more reliable image concerning the level of the operational performances of the equipment subject to technical investigations..

Keywords: *Fuzzy scale, Fuzzy operators, Ranks correlation factors, Experton, Mathematical expectation of the experton, Hamming distance, Ranks correlation factor, Logical conjuctions and disjunctions.*

1. INTRODUCTION

The functionality of a technical equipment is defines by the following concepts:

-the operational status which includes basic parameters and the dynamic disruptive phenomena (vibrations, axial displacements, heat, noise) whose admissible values are given in the technical datasheets for various exploitation conditions. The operational status is given as nonnumeric (linguistic) estimations using a hierarchical scale arbitrarily established by the assessor;

- operational safety given by the functioning probability (the reliability of the technical equipment).

2. THE ESTIMATION OF THE OPERATIONAL STATUS OF A TECHNICAL SYSTEM

Let there be an estimation scale made up of a pre-establishe number of levels, congrous to an accepted semantics of that particular scale. For the presented case it was preferred an septenary scale consisting in seven levels-Figure1, where α_k is level of nonlinear scale and n_t the index of the level, the graph of the nonlinear scale and the graph of the linear scale. In the following we propose a septenary non-linear scale, depicted using two parabolically shaped rings; the allure of the convex-concave graph, „S" letter-shaped and asymetrical is specific to the logostic function. In order to build a non-linear scale we use fuzzy logic operators, frequently as [1]: concentrative (α^2) and dilator ($\alpha^{1/2}$), α is a certain level of the linear scale. In the following, considering the nature of the graph associated to a slow convex-fast concave phenomenological type of evolution, of the size under analysis- The operational

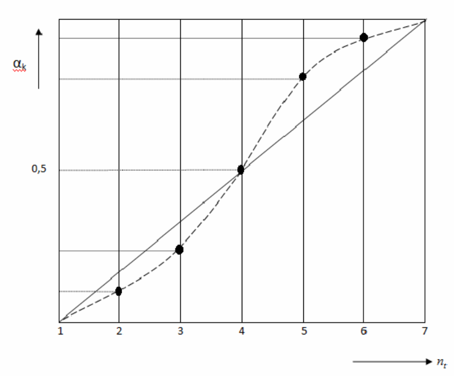


Figure 1 Septenary scale

status of a tehnical system. We propose the following mathematical relations [2]: for the „concentrative" operator, the case of the levels α_2 and α_3 we have $\alpha_{2nl} = \alpha_2^l$, $\alpha_{3nl} = \alpha_3^l$; for the „dilator" operator, the case of the levels α_5 and α_6 we have $\alpha_{5nl} = \alpha_5^l$, $\alpha_{6nl} = \alpha_6^l$, where α_2, α_3, α_5, α_6, α_{2nl}, α_{3nl}, α_{5nl}, α_{6nl} are the levels of the scale in its linear/ non-linear version, ℓ –the „golden number" from Fibonnacci string: $\ell = \lim_{n\to\infty} \frac{a_n}{a_{n-1}} \Rightarrow \ell \cong 1{,}618034$, a_n, a_{n-1} are consecutive numbers in Fibonnacci string, *e*- the base of the natural logarithms: e = 2,71828. We find the presence of the inflection point of the graph: $M\ (n = 4; \alpha = 0{,}5)$. Because it is required to asses sizes of great impact as the operational status and/or the reliability of a technical system, evolutions like $\alpha_C^{\ell} - \alpha_D^{1/e}$ shapes these phenomena with a degree of likehood superior to cases where it is used α^2 (concentrative), frequently encountered. It is clear that the decider is the one that- accordingly to the problem-can establish the representatives of the two logical operators, concentrative and dilator.

In table 1, α_k^l, $\Delta\alpha_k^l$, α_k^{nl}, $\Delta\alpha_k^{nl}$, represent the level, respectively the step-size, between the two versions: linear and non-linear ($\Delta\alpha_k^l = \frac{1}{6}(0.1666...)$, $\Delta\alpha_k^{nl} = \alpha_k^{nl} - \alpha_{k-1}^{nl}$, $k \neq 1$). The experton represents a statiscal edifice presented like a table with two columns where are reg istered the relative cumulated frequency given like an interval, associated to the levels of the scale: $f_c^r(\alpha_k) = \left[f_c^{r,\inf}(\alpha_k); f_c^{r,\sup}(\alpha_k)\right]$, where $f_c^r(\alpha_k)$ represents the relative cummulated frequency with the inferior/superior boundaries corresponding to the scale levels. The defining size of an experton is the mathematical expectation also given as an interval: $E(Ex(Z)) = \left[E^{\inf}(Ex(Z)); E^{\sup}(Ex(Z))\right]$ where $Ex(Z)$ is a certain Z experton.

Table 1

k	Semantics	Linear version		Non-linear version	
		α_k^l	$\Delta\alpha_k^l$	α_k^{nl}	$\Delta\alpha_k^{nl}$
1	Unsatisfactory	0	0	0	0
2	Almost unsatisfactory	0,167	0,167	0,055	0,055
3	Less satisfactory	0,333	0,167	0,169	0,114
4	Satisfactory	0,5	0,167	0,5	0,331
5	Good	0,667	0,167	0,861	0,361
6	Almost very good	0,833	0,167	0,935	0,074
7	Very good	1	0,167	1	0,065

For the calculations of this size we use:

a) for the linear scale,

$$E^{\inf/\sup}(Ex(Z)) = \frac{1}{n-1}\sum_k f_c^{r,\inf/\sup}(\alpha_k) \qquad (1)$$

b) for the nonlinear scale,

$$E^{\inf/\sup}(Ex(Z)) = \sum_k f_c^{r,\inf/\sup}(\alpha_k)\cdot\Delta\alpha_k \qquad (2)$$

both $f_r^c(\alpha_k)$ relations expressing the relative cumulated frequency.

The mathematical expectation of an experton is the average value $m(Z)$ of the associated intervals of the estimations regarding the operational status, given accordingly to the scale in use:

$$E(Ex(Z)) = m(Z) \qquad (3)$$

where:

$$m(Z) = \left[\frac{\sum_j a_j^{\inf}}{m}; \frac{\sum_j a_j^{\sup}}{m}\right],\ j = \overline{1;\ m} \qquad (4)$$

$a_j^{\inf//\sup}$ represent the inferior/superior limit of the interval associated to the j experton estimation, and m is the number of experts. Between the left/right elements, a_k^s, a_k^d of the two columns of the experton we mention $a_k^s \leq a_k^d$. Sometimes, in the case of fuzzy operators, concentrative/ dilators , rises the need to completely or partially change the initial semantics of that scale. For instance, in the case of the non-linear septenary scale propose by this „case study", the linguistics of the levels 1, 2, 3, 4, 5, 6, 7 can be maintained like originally proposed for the linear version; but in the case of the 5th evel, to which we associated the word „good", respectively the linear level $\alpha_5 = 0{,}667$, in the non-linear version , using the „dilatation" method, this level has been considerably modified compared to the previous level (from $\alpha_{5l} = 0{,}667$ to $\alpha_{5nl} = 0{,}861$ an augmentation of aproximately 29%); consequently, in the following, this level will be called „more than better", symbolized by MTB**.** These simple, formal considerations do not affect the calculus. However, it is noticeable that if the number of the levels of a scale rises, than, the likelihood of the estimation drops.

Using a scale with eleven levels the step-size $\Delta\alpha = 0{,}1$, makes the semantic hierarchisation of the levels to become more difficult. The option for a certain scale, however, is the choise of the analyst. The building operation of expertons in the case of the logical conjunction or logical disjunction uses logical operators[3]: $\wedge$, means „AND"; also means minimum; $\vee$ represents the word „OR"; has the meaning of maximum. For the relations between entities or sentences we use the logical symbols: Δ-considered ‚AND', ∇ -considered "OR".

3. CASE STUDY

3.1. The operational status of the technical system.

Let there be a segment of a hydraulic grid regarding the deliver of heat to some consumers-Figure 2

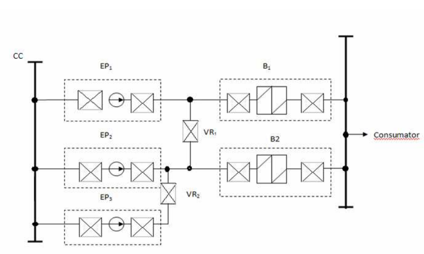


Figure 2 Schematics of the hydraulic grid

Where: CA**-** is accumulating pipeline; EP1, EP2- electropumps**;** VR1, VR2**-** adjustment valve and B1, B2 -boilers, heater used when overload. Thermal agent is steam taken using an adjustable outlet of a heating turbine. Heat is delivered to the consumer in two ways:

a^0 - version number 1, any of the EP_1 and EP_2 electropumps are working at full capacity (100%) or EP_3 is working at partial load (50%);

b^0 - version number 2, both EP_1 and EP_2 electropumps are working simultaneously or EP_3 is working at full capacity (100%).

The last version fits to termic overload conditions (specific to the cold season). In this scenario two actions are considered, concerning the information necessary for the calculations: first expertise and second expertise. This last operation is intended to validate the first expertise or to dismiss it if the information privided by the second expertise are sensibly different compared to those obtained within the first action. The two actions are conducted in identical technical and organizing conditions, at rigorously established moments, however:

- the group of experts that conduct the first expertise, e_j ,must be completely different from the group of the experts that conduct the second expertise, e_j^*;

- the size of the group may or may not be identical.

Actually, we are measuring the similarity of the opinions of the two groups of experts e_j and e_j^*. We will use the following „tools": Hamming distance and ranks correlation factor.

The data FIRST EXPERTISE and SECOND EXPERTISE are given in tables 2 and 3; these include the assesments of the first/second group of experts, the associated fuzzy intervals, also their locations-ranks, corresponding to the preferential hierarchy. The Hamming distances [4] concerning the first expertise and the second expertise are given using the mathematical relations (for the subsystem SS_1 and SS_2):

$$d^H_{SS_1-SS_1^*} = \frac{\left|m(SS_1) - m\left(SS_1^*\right)\right|}{2} \quad (3)$$

$$d^H_{SS_2-SS_2^*} = \frac{\left|m(SS_2) - m\left(SS_2^*\right)\right|}{2} \quad (3')$$

After replacement we optain: $d^H_{SS_1-SS_1^*} = 0{,}0148$;

So, both Hamming distances are significantly lower then the critical level, $\alpha^* = 10\%$, set accordingly to [4]: $\%\, d^H_{SS_1-SS_1^*} > \%\, d^H_{SS_2-SS_2^*} << \alpha^*$. It can be conclude that the second expertise validates the first expertise. This conclusion is also confirmed by the Spearman ranks correlation factor [5]: $\eta = 1 - \frac{6\sum d_j^2}{m\left(m^2-1\right)}$, where η is the ranks correlation factor, d_j - the difference between two location and m-number of experts. Based on the calculations data-locations- within the second and the third tabel, the fourt table is built. Ranks correlation factor is used to analyze links defined on qualitative features. After replacing we obtain: $\eta_1 = 0{,}80$; $\eta_2 = 0{,}90$. Accordingly to [5], the values obtained define a „strong link": $\eta = \{0{,}80; 0{,}90\} \in [0{,}75; 0{,}95)$.

Table 5 presents the experton resulted from the logical disjunction- consequence of the two actions, first and second expertise; and the mathematical expectation of this experton $E\left(Ex\left(S\nabla S^*\right)\right)$ is:

$$E\left(Ex\left(S\nabla S^*\right)\right) = 0{,}8906;\ 0{,}9332 .$$

The expertons of the systems in (S) first-expertise version, respectively the second-expertise (S^*) version and also those of subsystems SS_1, SS_2, SS_1^*, SS_2^* make up table 6.

Table 2 First expertise

SS_q	SS_1 subsystem electropumps		SS_2 subsystem heaters-valves		Locations	
e_j	A_{1j}	I_{1j}	A_{2j}	I_{2j}	L_{1j}	L_{2j}
e_1	MTB	0,861	AVG	0,935	5	2
e_2	AVG	0,935	MTB; AVG	0,861; 0,935	2,5	4
e_3	MDG; AVG	0,861; 0,935	MDG; AVG	0,861; 0,935	4	4
e_4	AFB; FB	0,935; 1	AFB; FB	0,935; 1	1	1
e_5	AVG	0,935	MTG; AVG	0,861; 0,935	2,5	4
$m\left(E_q\right)$	*	0,9054; 0,9332	*	0,8906; 0,9480	*	*

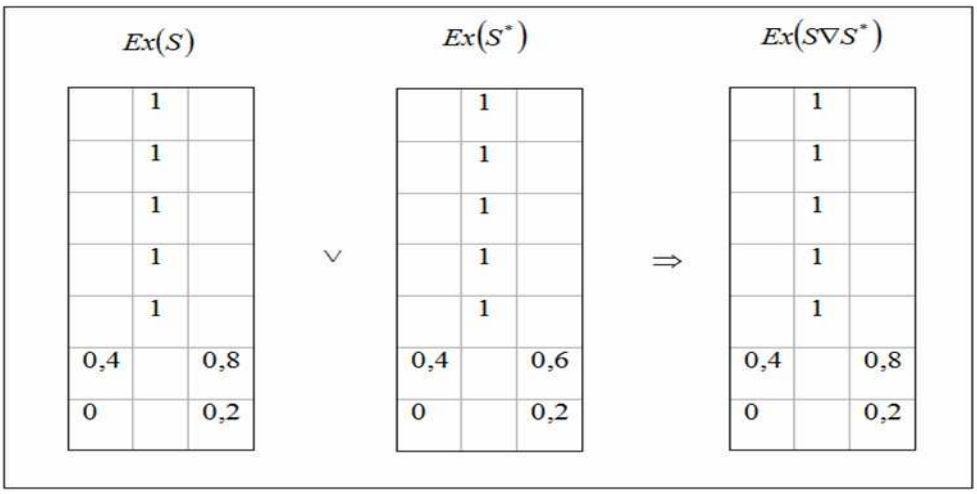
Table 3. Second expertise

SS_q	SS_1 subsystem electropumps		SS_2 subsystem heaters-valves		Locations	
e_j	A^*_{1j}	I^*_{1j}	A^*_{2j}	I^*_{2j}	L^*_{1j}	L^*_{2j}
e^*_1	MDG	0,861	AVG; VG	0,935; 1	4,5	1,5
e^*_2	AVG; VG	0,935; 1	AVG	0,935	1	3
e^8_3	MTB	0,861	MDG	0,861	4,5	4,5
e^*_4	AVG	0,935	AVG; VG	0,935; 1	2	1,5
e^*_5	MTB; AVG	0,861; 0,935	MDG	0,861	3	4,5
$m^*(E_q)$	*	0,8906; 0,9184	*	0,9054; 0,9314	*	*

Table 4

e_j	e^*_j	L_{1j}	L^*_{1j}	L_{2j}	L^*_{2j}	d_{1j}	d_{2j}	d^2_{ij}	d^2_{2j}
e_1	e^*_1	5	4,5	2	1,5	+0.5	+0.5	0,25	0,25
e_2	e^*_2	2,5	1	4	3	+1,5	+1	2,25	1
e_3	e^*_3	4	4,5	4	4,5	-0.5	-0,5	0,25	0,25
e_4	e^*_4	1	2	1	1,5	-1	-0,5	1	0,25
e_5	e^*_5	2,5	3	4	4,5	-0,5	-0,5	0,25	0,25
$\sum_j$								4	2

Table 5



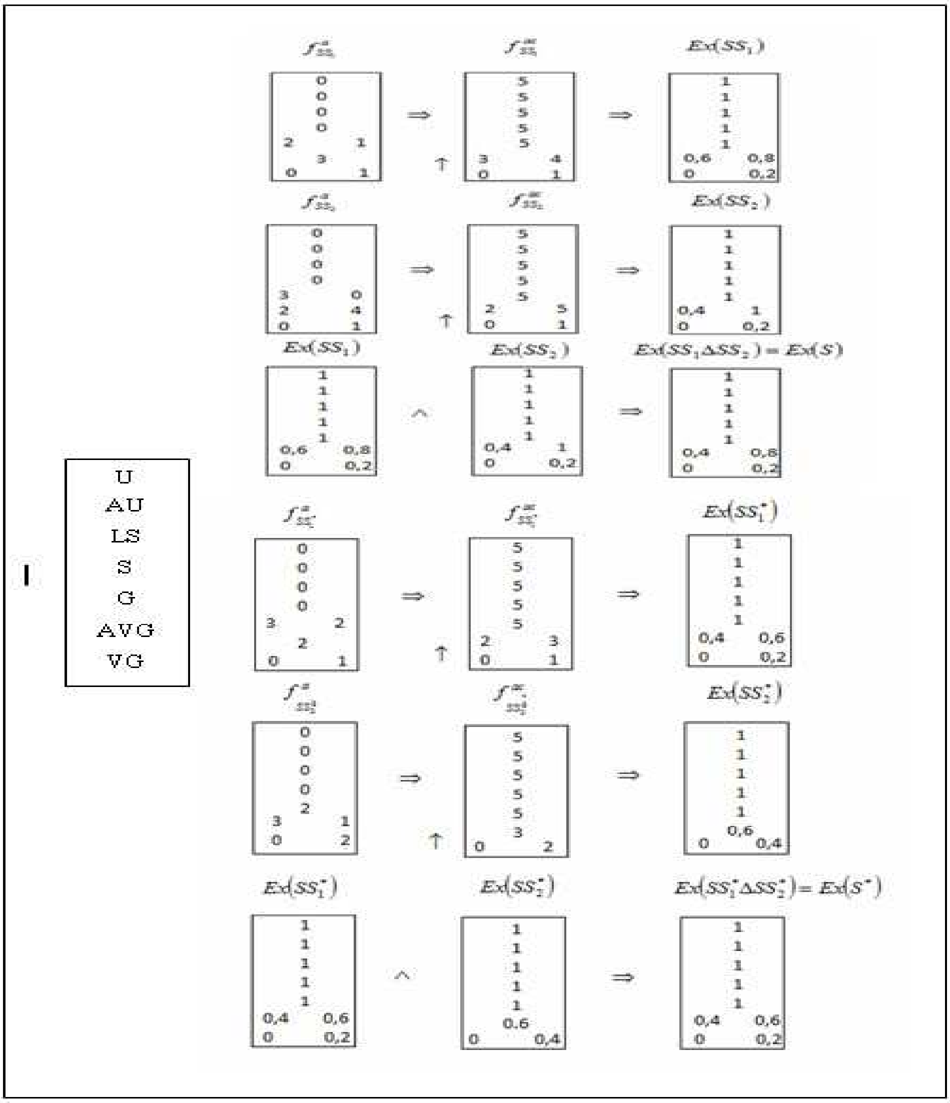
$Ex(S)$ $\vee$ $Ex(S^*)$ $\Rightarrow$ $Ex(S \nabla S^*)$

$Ex(S)$		
	1	
	1	
	1	
	1	
	1	
0,4		0,8
0		0,2

$Ex(S^*)$		
	1	
	1	
	1	
	1	
	1	
0,4		0,6
0		0,2

$Ex(S \nabla S^*)$		
	1	
	1	
	1	
	1	
	1	
0,4		0,8
0		0,2

Table 6 The expertons of the system



Note: The symbol (*) is related to the second-expertise information. The size of the group of experts that conducted the first and, respectivly the second expertise is the same, but the persons are different.

Table 7 presents the mathematical expectations of the expertons $Ex(SS_1)$, $Ex(SS_2)$, $Ex(SS_1^*)$, $Ex(SS_2^*)$, obtained according to (3). The relation (4) is checked.

Table 7. Mathematical expectations of the expertons

$m(SS_1)$	0,9054; 0,9332	$Ex(SS_1)$	0,9054; 0,9332
$m(SS_2)$	0,8906; 0,9480	$Ex(SS_2)$	0,8906; 0,9480
$m(SS_1^*)$	0,8906; 0,9184	$Ex(SS_1^*)$	0,8906; 0,9184
$m(SS_2^*)$	0,9054; 0,9314	$Ex(SS_2^*)$	0,9054; 0,9314

3.2. The reliability of the tehnical system

It resulting from the schematics presented in figure 3 (reliability schematics for operational version nomber one)- for the first operational version.

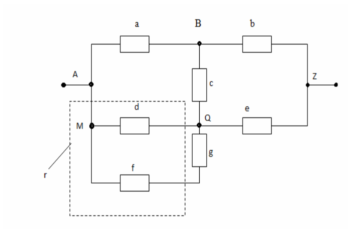


Figure 3

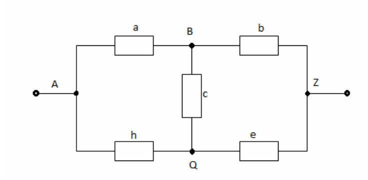


Figure 4

In this schematics *a,d,f* are the three electropumps , *b,e* are the two heaters, *c* and *g* are the adjustement valves. Scheme given above may appear as in figure 4 (bridge type reliability schematics). The reliability levels of the components of this schematics are as follows: R_a = 0,95; R_b = 0,97; R_c = 0,98; R_d = 0,96; R_e = 0,97; R_f = 0,96; R_q = 0,98. Regarding the reliability of the cumulative element, *h*, its level of reliability is given by: $R_h = R_d + R_f \cdot R_q - R_d \cdot R_f \cdot R_q$. By replacing the before-shown data we obtain: R_h = 0,99763. For the determination of the reliability of the schematics presented in figure 4 we will use the following methods:

A. the method “decomposition of the schematics”;

B. the method of “ the structure function”;

the method of the”transfiguration “triangle-star””.

A. According to this method, the reliability of the system results out of the sum of the reliabilities of the following schematics: Figure 5 and Figure 6.

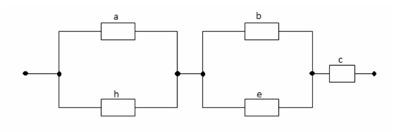


Figure 5

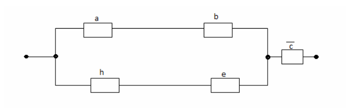


Figure 6

It is concludable that:

$R(S) = (R_a + R_h - R_a \cdot R_h)\,(R_b + R_e - R_b \cdot R_e)\,R_c + (R_aR_b + R_e{\cdot}R_h - R_aR_b\,R_eR_h) \cdot (1 - R_c)$ (4)

By replacing the values of the reliability of the elements a,b,c,e,h the reliability of the system is obtained as: R(S) = 0,99894929.

B. The method is based on the F(S) structure function of the system, size defined by the logical sum of the minimal pathways of the reliability schematics presented in figure 4. A simple evaluation of this schematics highlights the following minimal pathways: *ab, he, ace, hcb*. Therefore, the structure function is a logical sum of products (the structure function is SOP type-sum of products [6], [7]): $F(S) = ab + he + ace + hcb$. The calculation of this type of sum-transition from logical sum to algebric sum- is done according to: $X + Y = X + Y - XY$. Congrous to this relation, we obtain :

$$F(S) = ab + eh + ace + bch - abce - abch - aceh - bceh + abceh \quad (5)$$

The expression of the reliability of the system is:

$R(S) = R_aR_b + R_eR_h + R_aR_cR_e + R_bR_cR_h - (R_aR_bR_cR_e + R_aR_bR_cR_h + R_aR_cR_eR_h + R_bR_cR_eR_h) + R_aR_bR_cR_eR_h$

eplacing the reliabilities of the elements of the mentioned schematics, the reliability of of the system can be deduced: *R(S)* = 0,99891. The method of the structure function becomes more difficult when the number of minimal pathway rises. For example, if their number is N=6, the number of the factors of the xpression of reliability ν is 63: $\nu = 2^N - 1$. Usually, during the calculations, a considerable amount of factor reduce.

C. The method is advisable to determine the reliability of undecomposable systems. Let there be the segment from schematics 4- the *ABQA* perimeter-figure 7. Using the triangle-star transfiguration (Δ- *Y),* the transfigurated schematics is obtained in Figure 8:

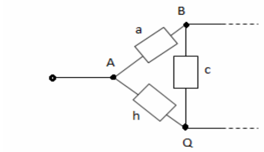


Figure 7 Segment of the scheme presented in figure 4

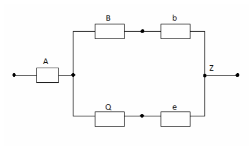


Figure 8. The reliability schematics

By this manner, a serial-parallel schematics was obtained. In this new schematics of reliabilities of “elements” resulted after the transfiguration, [7] and [8] will be established: $R_A = 1-(1-R_a)(1-R_h)$; $R_B = 1-(1-R_c)(1-R_a)$; $R_Q = 1-(1-R_h)(1-R_c)$. Therefore: $R_A = 0{,}9998815$; $R_B = 0{,}9990000$; $R_Q = 0{,}9999526$. The reliability of the system, according to the schematics from figure 6 is: $R(S) = R_A\,(R_BR_b + R_QR_e - R_B{\cdot}R_b{\cdot}R_Q{\cdot}R_e)$. It can easily be deduced that: *R(S) =0,99895*.

By comparing these three methods, we can conclude that the error is unsignificant: $R(S)_{a)}$ = *0,99894;* $R(S)_{b)}$ = *0,99891;* $R(S)_{c)}$ = 0,99895.

Operational scenario number two. The EP1 and EP2 electropumps are working simultaneously or only the EP3 electropumps is working (at full capacity). Any heater can provide the demand overload conditions. The realiability schematics, according to these conditions is given in Figure 9:

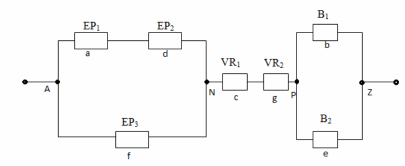


Figure 9 Reliability schematics, operational version two

The expression of the reliability of the system in this version is: $R(S) = (R_a{\cdot}R_d + R_f - R_a{\cdot}R_d{\cdot}R_f)\cdot R_c{\cdot}R_g{\cdot}(R_b + R_c - R_b{\cdot}R_e)$, where: $R_a = 0{,}95$; $R_b = 0{,}97$; $R_c = 0{,}98$; $R_d = 0{,}96$; $R_e = 0{,}97$; $R_f = 0{,}96$; $R_g = 0{,}98$. It is obtained that: $R(S)_{V_2}$ = *0,95644*. This represents a diminishment of approximately 4,5% compared to the operational status of version number one.

3.3. The operational potential of the system

The performance function [9] of the system $\phi(S)$- in the analysed case- is defined by the superior limit of the mathematical expectation of the experton obtained from the logical disjunction generated by the two actions- first and second expertise: $E\left(Ex\left(S\nabla S^*\right)\right)=0{,}8906;0{,}9332$. So $\phi(S)=0{,}9332$. The product, $\phi(S),R(S)$ defines the probable operational status of the system or the operational potential, **PO ,** of the system. The following values are obtained: $PO_{version\ 1} = 0{,}9332 \cdot 0{,}99893 \Rightarrow 0{,}93220$; $PO_{version\ 2} = 0{,}9332 \cdot 0{,}95644 \Rightarrow 0{,}89255$.

4. CONCLUSIONS

The estimations of the groups of experts, obtained from both investigation actions, first and second expertise, offers to the decider a sufficiently real image regarding the operational capacity of the installation under analysis. The likelihood augments when the two operations validate the corectness of the points of vue of the group of experts.

The used fuzzy scale must be sufficiently "covering" in modelling/interpreting as reliable as possible, the concluusions provided by the experts in situations when this type of opinions are interpreted relatively ambigous. The estimation and the reliability are able to offer to the decider optimum solutions concerning the implementation of an adequat management for exploiting a technical equipment at a performant operational level.

For high values of the reliability of a system, its operational potential is determined by the performance function. This size, OP=0,932- version number 1- represent 99,7% of the second-to-last level of the scale, which, by "defuzzyfication", represents "almost very good"; also, version number 2 reports a factor of 95,3% compared to the same performance level.

5. REFERENCES

[1] ŞOFRAN E., BIZON N., IONI□Ă S., RĂDUCU R., "*Sisteme de control fuzzy*" (Fuzzy control systems). Editura All Educa□ional, Bucureşti,1998.

[2] CÂRLAN M., COROIU N., DEMENI I., "*A decisional Fuzzy Model on neliniar Subintervals of maximum Presumption*". The Sixth Energy Sistem Conference, Torino, Italy, 2006.

[3] MURGAN A. D.**,** "*Principiile teoriei informației în ingineria informației şi a comunicațiilor*"(*Principles of information theory in information and communications engineering*), Editura Academiei Române, Bucureşti, 1998.

[4] KAUFMANN A., ALUJA I. G., "*Tehnici pentru gestiunea prin experți*"(*Techniques for managing by experts*). Editura Expert, Bucureşti, 1995.

[5] BARON T., BIJI E., TOVISSI L., WAGNER P., ISAIC-MANIU A., KORKA M., POROJAN D., "*Statistica teoretică şi economică*" (*Theoretical and economical statistics*). Editura Didactică şi Pedagogică, Bucureşti, 1996.

[6] CĂTUNEANU V. M., MIHALACHE A., "*Bazele teoretice ale fiabilității*" (*Theoretical fundamentals of reliability*). Editura Academiei Române, Bucureşti,1983.

[7] CÂRLAN M., "*Probleme de optimum în ingineria sistemelor tehnice*"(*Optimunm problems in technical systems engineering*). Editura Academiei Române, Bucureşti,1994.

[8] CĂTUNEANU V. M., BACIVAROF I. C. , "*Fiabilitatea sistemelor de telecomunicații*" (*Reliability of communications systems).* Editura Militară, Bucureşti, 1985.

[9] TÂRCOLEA C., FILIPOIU A., BONTA□ S., "*Tehnici actuale în teoria fiabilității*"(*Modern techniques in theory of reliability*). Editura Ştiințifică şi Enciclopedică, Bucureşti, 1989.

CVT ELECTRICAL CHARACTERISTICS DURING LINEAR AND NONLINEAR LOADING

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ABSTRACT

The objective of this application was to characterize the CVT as a load while the CVT supplied a simple linear load and while it supplied a complex nonlinear load [11]. In the following tests, the CVT was connected first to a simple linear load and then to a complex nonlinear load. An electric-service supply source with an average total harmonic distortion in the voltage of 3% supplied power to the CVT during all tests.

Keywords: *resistive linear load, nonlinear load, power factor.*

1. INTRODUCTION

The paper analyses the CVT electrical characteristics during linear and nonlinear loading. The application showed that one of the main drawbacks of using a CVT is its inability to protect the equipment from voltage interruptions. Therefore, an application was conducted to find out if the RTT (ride-through-transformer) prototype can perform like a typical CVT, while protecting the equipment from voltage sags and interruptions.

2. PERFORMANCE: LINE CURRENT DISTORTION

A resistive linear load consisting of incandescent lamps was connected to the output of the CVT. The load was increased in ten equal increments from 0 to 8.3 A (output current rating of the CVT). Next, a bridge rectifier (such as the type that might be used in electric-vehicle battery chargers) was connected to the CVT. The rectifier and its resistive load (incandescent lamps) were the complex nonlinear load of the CVT. By adding lamps, this complex load was increased in ten equal increments from approximately 0.4 A (rectifier with no lamps connected) to 8.3 A. Figure 1 and Figure 2 show the line-current distortion during these tests compared with the line-current distortion for the same loads connected directly to the electric-service supply. At no load, the power consumption of the CVT was approximately 120 W (core losses only). With the full linear load, total losses increased to approximately 134 W (core losses plus load losses); with the full nonlinear load, total losses dropped to approximately 110 W.

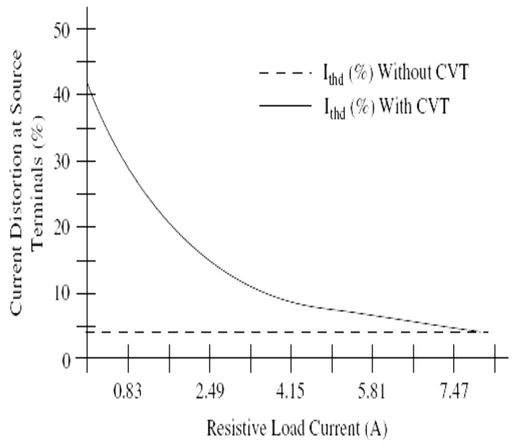


Figure 1 Line-current distortions for a linear load

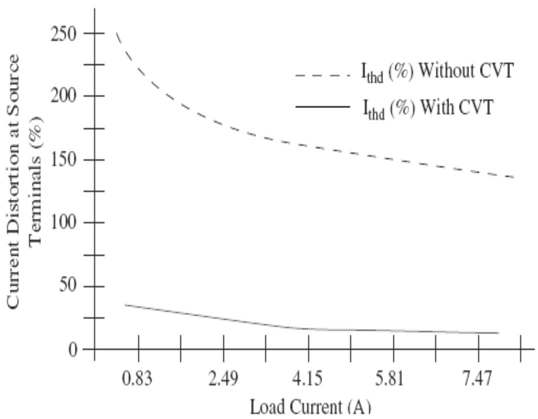


Figure 2 Line-current distortions for a nonlinear load

Notice in Figure 1 and Figure 2 that, while the y-axis current-distortion magnitudes are significantly different, the absolute current-distortion values of the CVT's input current with either linear or nonlinear load is nearly identical. Current distortion at the CVT's input terminals was practically independent of the type of load connected to the output (approximately 40% at no loading to approximately 5% at full loading). When a linear, low-distortion load was connected to the CVT output, the CVT contributed to the current distortion at its input terminals from the electric-service power source, particularly during low loading. When a nonlinear, high-distortion load was connected, the CVT substantially reduced load-current distortion. When fully loaded, the CVT had relatively small power consumption and an efficiency of 85% to 90%. As opposed to most voltage regulators, the losses of the CVT decreased as the nonlinear load increased. The CVT also significantly affected the power factor of the load.

3. PERFORMANCE: POWER FACTOR

For both linear and nonlinear loads, the size of the load affected the input power factor of the CVT. While the CVT was loaded at less than 40% of its output power rating (approximately 3.3 A), the power factor ranged from 0.65 to 0.95. While the CVT was loaded at greater than 40%, the power factor was greater than 0.95 for the linear load and greater than 0.90 for the nonlinear load. For the linear load, the power factor crossed from lagging to leading at approximately 60% load (approximately 5 A). Figure 3 and

Figure 4 show the power factors for the linear and nonlinear load (without and with the CVT), respectively.

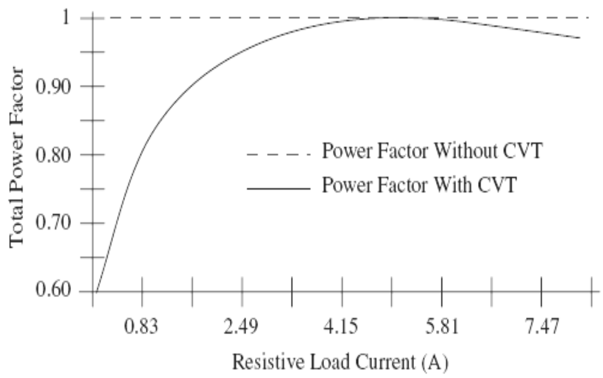


Figure 3 Power factor for a linear load

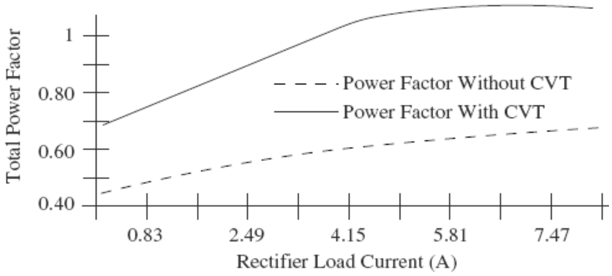


Figure 4 Power factor for a nonlinear load

The CVT significantly affected the power factor of the load. At low loading, the nonlinear load without the CVT had a power factor as low as 0.44. With the CVT, the total power factor of the nonlinear load ranged from 0.61 to near unity. However, when loaded at less than 50%, the CVT significantly reduced the power factor for the linear, resistive load, which normally has a unity power factor.

Note that in most CVT applications, the aggregate facility loading is significantly small, so it would not be prudent to attempt any power-factor correction at individual CVT operating loads. Power-factor correction initiatives should be accomplished at the electric service meter of the facility.

4. APPLICATION CONSIDERATIONS - USING THREE-PHASE INPUT

One of the drawbacks of using a CVT is its inability to protect equipment from voltage interruptions. A traditional CVT can protect equipment down to approximately 40% of nominal voltage. A company has introduced a prototype CVT that protects equipment from deep voltage sags and brief power interruptions.

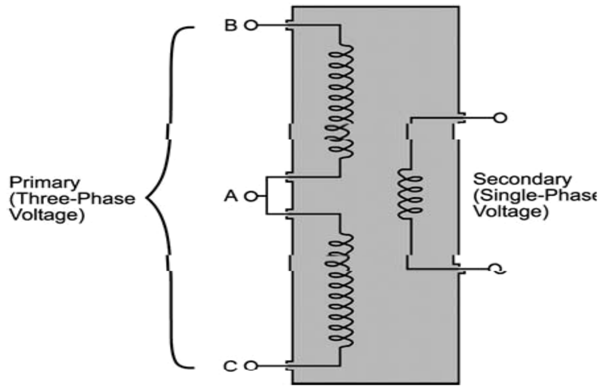
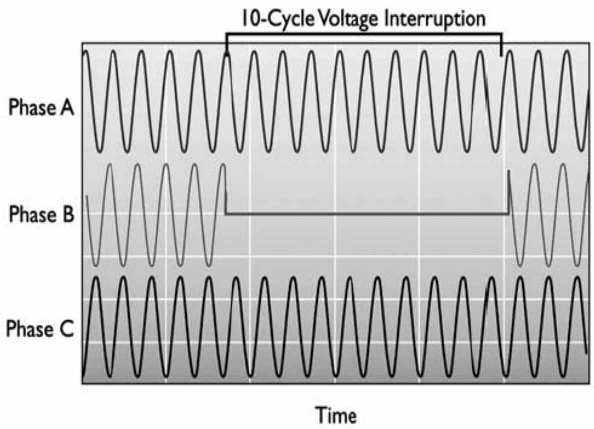


Figure 5 Schematic of a ride-through transformer

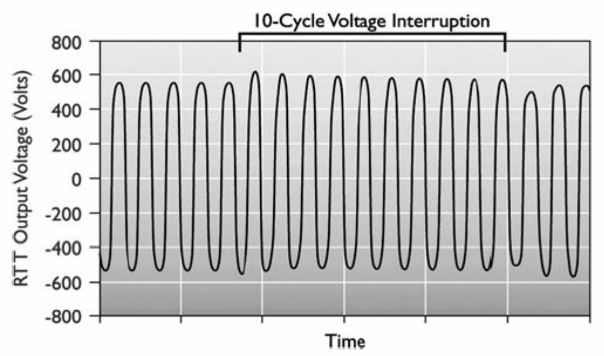
As shown in Figure 5 the ride-through transformer (RTT) is designed to protect single-phase process controls. Unlike traditional CVTs, the RTT uses all three phases of supply voltage as its input. This enables the RTT to access energy in unsagged phases of the supply voltage during one- or two-phase voltage sags and interruptions.

EPRI PEAC tested the prototype, 1-kV, 480-V RTT [12] to determine its ability to protect process controls during single-phase, two-phase, and three-phase voltage sags and interruptions. The particular prototype acquired for testing was connected to a load bank that consisted of a mixture of 12 industrial control components: ice-cube relays, motor starters, contactors, a programmable logic controller, a linear dc power supply, and a switch-mode power supply.

Figure 6a and Figure 6b show the response of an RTT to phase-to-neutral and phase-to-phase sags.



a



b

Figure 6 a/b.

Performance of a ride-through transformer (RTT) during a ten-cycle voltage interruption and voltage sag. Voltage regulation of an RTT during a single-phase voltage interruption (top: input; bottom: output)

To get the most out of a CVT with a three-phase input, the most trouble-free voltage phases of the electric-service supply will have to be determined. For example, if most voltage sags occur on phase A or B, then the center tap on the transformer primary should be connected to phase C. Although this prototype transformer promises to retail at a price substantially higher than the price of a traditional, single-phase CVT, the price differential can be greatly reduced by a reduction in size. Because the performance of a traditional CVT greatly depends upon loading, CVTs are often oversized for the connected load. A smaller but more loaded RTT should be able to perform as well as the derated, traditional CVT.

5. CONCLUSIONS

The test results revealed that the prototype RTT protected the connected process controls from most of the applied voltage sags and interruptions. Besides, it was observed that RTT performance greatly depended on the phase configuration (that is, single-, two-, or three-phase) of the voltage sags or interruption and, to a much lesser extent, on the loading of the RTT output. It was observed that the RTT performed like a typical CVT during three-phase voltage sags.

6. REFERENCES

[1]. Sola/Hevi-Duty Corp., About Sola/Hevi-Duty, www.sola-hevi-duty.com/about/solahist.html, October 18, 2009.

[2]. Advance Galatrek, CVT Background Data, http://www.aelgroup.co.uk/hb/hb003.htm, October 18, 2008.

[3]. EPRI, System Compatibility Projects to Characterize Electronic Equipment Performance under Varying Electric Service Supply Conditions, EPRI PEAC, Knoxville, TN, May 2003.

[4]. Godfrey, S., Ferroresonance, http://www.physics.carleton.ca/courses/75.364/mp1html/node7.html,October 18, 2002.

[5]. Cadicorp, Ferro-Resonance, Technical Bulletin 004a, www.cadicorp.com, October 18, 2002.

[6]. Groupe Schneider, Ferroresonance, No. 190, www.schneiderelectric.com, October 19, 2002.

[7]. IEEE, Standard for Ferroresonant Voltage Regulators, IEEE Std. 449-1998, Institute of Electrical and Electronics Engineers, Piscataway, NJ, 1998.

[8]. EPRI, Sizing Constant-Voltage Transformers to Maximize Voltage Regulation for Process Control Devices, PQTN Application No. 10, EPRI PEAC, Knoxville, TN, October 1997.

[9]. EPRI, Ferro-Resonant Transformer Output Performance under Varying Supply Conditions, PQTN Brief No. 13, EPRI PEAC, Knoxville, TN, May 1993.

[10]. EPRI, Ferro-Resonant Transformer Output Performance under Dynamic Supply Conditions, PQTN Brief No. 14, EPRI PEAC, Knoxville, TN, January 1994.

[11]. EPRI, Ferro-Resonant Transformer Input Electrical Characteristics during Linear and Nonlinear Loading, PQTN Brief No. 16, EPRI PEAC, Knoxville, TN, February 1994.

[12]. EPRI, Testing a Prototype Ferro-Resonant Transformer, EPRI PEAC, Knoxville, TN, unpublished.

APPLICATIONS OF MONOLITHIC BRIDGE DRIVERS

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ABSTRACT

High power monolithic bridge drivers are for discrete transistors and half bridges in applications such as DC motor or stepper motor driving. The device contains four push-pull power drivers which can be used independently or as two full bridges. The driver is controlled by a TTL-level logic input and the drivers are equipped with an enable input which controls a whole bridge. Short circuits to ground can be protected against by the circuit and the upper transistor of the output stage is thus turned off, interrupting the short circuit current. When the short is removed the circuit recovers automatically.

For DC Motor Driving in application where rotation is always in the same sense a single driver can be used to drive a small DC motor. The motor may be connected either to supply or to ground.

Keywords: *current flow, DC motor, bridge, dynamically during, the motors rotational.*

1. INTRODUCTION

In general monolithic bridge drives are an attractive replacement for discrete transistors in applications such as DC motor or stepper motor driving.

The monolithic bridge drive may be controlled by a logic input and each pair a bridge may be controlled by an enable input. They can be used independently or as two full bridges.

The monolithic bridge drives are used for short circuit protection or for DC motor driving.

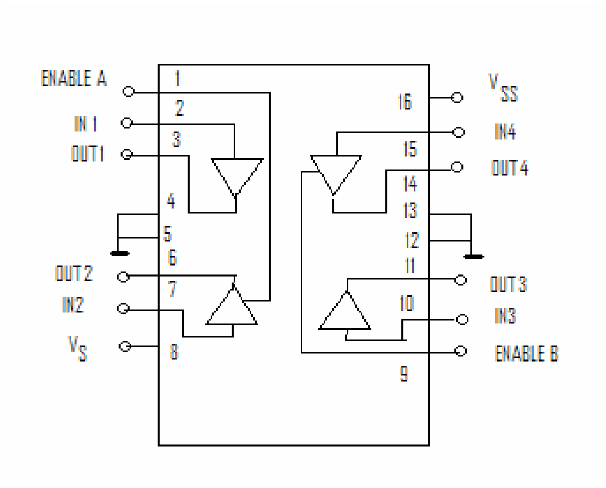


Figure 1 Internal structure

The internal structure of device is represented as four push pull drives and it does not have external emitter connections.

2. SHORT CIRCUITS PROTECTION

The monolithic bridge drive can be damaged by shorts circuits from the output to ground or to the supply. Short circuits can be protected against by the circuit shown in figure 2 which have a resistor, a capacitor and a transistor. When the output is short circuited the input is pulled low after a delay of roughly 10µs. This period of time is determined by the RC time constant. The upper transistor of the output stage is thus turned off, interrupting the short circuit current. When the short is removed the circuit recovers automatically. The waveforms are shown in figure 3. If the short circuit is removed while V1 is high the output stays low because the capacitor C is charged to V_{IH}. The system is reset by the falling edge of V1, which discharges C.

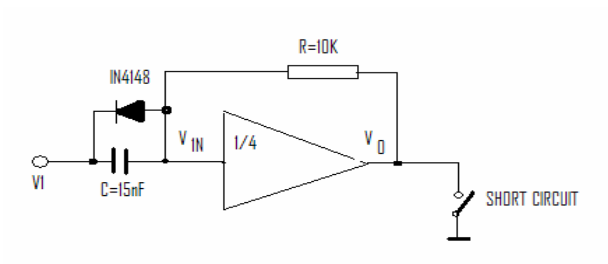


Figure 2 This circuit protects a driver from output short circuits to ground

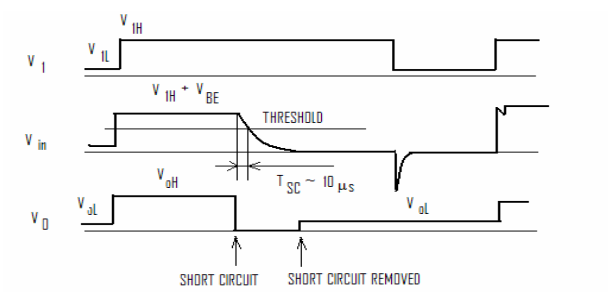


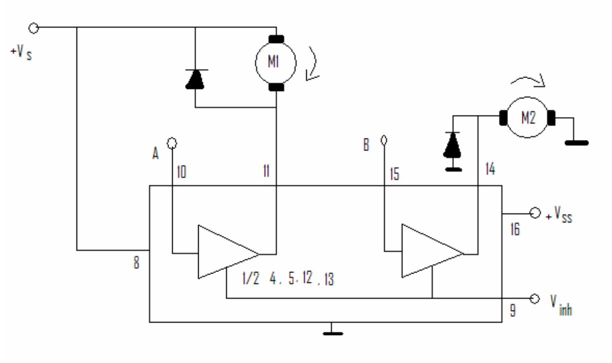
Figure 3 Waveforms illustrating the short circuit protection provided by the circuit of figure 2

3. DC MOTOR DRIVING

It may be used to drive a small DC motor. The motor may be connected either to supply or to ground as in fig. 4.

The control logic may be inverted. The maximum motor current is 1A. Care should be taken to avoid exceeding the maximum power dissipation of the package. Each motor in this configuration is controlled by its own logic input which gives two alternatives: run and fast stop. The enable/inhibit inputs also allow a free running motor stop by turning off both transistors of the driver. These inputs are common and two channels by one bridge can be used when both channels are disabled together.

For the driver DC motors in both directions may be used the logic inputs of two channels and the motor can be made to run clockwise, run counter clockwise or stop rapidly.



V_{inh}	+A	+M1	+B	+M2
H	H	Fast Motor Stop	H	Run
H	L	Run	L	Fast Motor Stop
L	X	Free Running Motor Stop	X	Free Running Motor Stop

Note:
L=low;
H=high;
X=Don't Care

The enable/inhibit input is used for a free running stop - it turns off four transistors of the bridge when low. By reversing the current may be achieved a very rapid stop. There are necessary a tachometer dynamo and closed loop control. This configuration is suitable for motors with currents up to 1A. The motor speed can be controlled by switching the drivers with pulse width modulated square waves. The PWM control signal can be applied to either the channel input or the appropriate enable input. The recirculation path is through the suppression diode and motor, giving a fairly slow decay. A control the channel input may be that the circuit responses faster. Each channel has an independent input and this is very convenient.

4. CONCLUSIONS

When Vs is relatively low it may be sufficient to control the differential voltage drop by just limiting the over voltage with the power supply capacitor and not having to use the schottky diodes. The feasibility of this solution should nevertheless be verified experimentally in the specific application.

5. REFERENCES

[1] GLUCK,H – *Fahrdynamische Gesichtspunckte zur automatischen fahr*
[2] JAVORSKI, I. - *Wirtschaftlinchkeeitsgrenzen zwischen Diesel*
[3] DEKKER, A.J. – *Electrical Engineering Materials*, PrenticeHall inc. , New York, 1967
[4] SOLYMAR, L., WALSH, D. - *Lectures on the Electrical Properties*, University press, Oxford, 1990
[5] GUILLEMIN, P., SABY, B., 3-*phase motor driving using the ST9 multi-functional timer and DMA*, SGS - THOMSON, 1992
[6] BOURGEOIS, J.M., MAURICE, B., SABY, B., - *Versatile and cost effective induction motor drive with digital three phase generation*, SGS-THOMSON, 1992

HARMONIC DISTORTION OF 6 AND 12 PULSES CONVERTERS

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ABSTRACT

The harmonic distortion level may be significant in electric propulsion systems, as the main loads usually are variable speed propulsion/thruster drives with frequency converters.

It is therefore necessary to be able to predict harmonic distortion, evaluate the effects, and perform the proper means to manage the voltage distortion, without functional faults over the life time of the installation.

Keywords: *harmonic distortion, periodic waveform, current converters, voltage converters.*

1. INTRODUCTION

A non-linear load connected to a network will distort the sinusoidal voltages. This deviation from a sinusoidal voltage or current wave form is named *harmonic distortion*.

The distorted waveform may cause electromagnetic interference or erroneous measurement signals. It is particularly necessary that measurement systems of monitoring and protection devices are made for true RMS measurements in order to function properly.

The harmonic distortion level may be significant in electric propulsion systems, as the main loads usually are variable speed propulsion/thruster drives with frequency converters.

Rules and regulations normally give guidelines or requirements that limit the harmonic distortion in a ship network. However, these limitations are not a guarantee for proper functionality.

It is therefore necessary to be able to predict harmonic distortion, evaluate the effects, and perform the proper means to manage the voltage distortion, without functional faults over the life time of the installation.

Distortion of currents and supply voltage waveforms may lead to:

- Accelerated aging of insulation material.

Increased power dissipation (losses) in equipment connected to the network, such as generators, motors, transformers, cables etc, from the harmonic currents, may cause overheating and deterioration of the insulation and reduced life time of the equipment.

- Overloading of electronic equipment.

Increased load current of electronic equipment that has been designed for sinusoidal voltage supply, may cause overheating and malfunction of this equipment.

2. HARMONICS OF *VOLTAGE SUPPLY* CONVERTERS

A Fourier series, i.e. the infinite series of sinusoidal components and a DC term, can in general express any periodic waveform:

$$u(t) = u_{cc} + u_1 \sin(\omega_1 t) + u_2 \sin(2\omega_1 t + \varphi_2) + u_3 \sin(3\omega_1 t + \varphi_3) + ... + u_h \sin(h\omega_1 t + \varphi_h) + ...$$

Some of the terms can be zero, such as the DC terms in most AC applications and the triple harmonics in symmetric three-phase systems which are isolated from ground.

The frequency converters are inherently non-linear and the currents to a motor drive are not sinusoidal but distorted by harmonic components of generally any order, but as we will see, most of the frequency components are zero under ideal conditions.

When analyzing the harmonic distortion of the network supply, one can normally, at least initially, disregard the motor side behaviour, by assuming ideal de-coupling between the network and motor sides by the DC link. In Figure 1, a VS converter with diode rectifier and smoothing DC inductor and capacitor has been shown, in a 6-pulse configuration. If the smoothing DC components are large, the current waveforms will approach the ideal shapes.

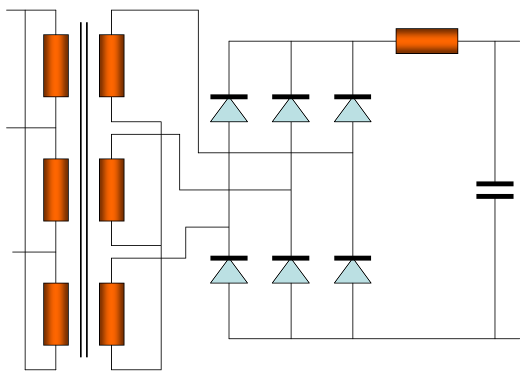

Figure1 6 pulses converter

By observation, one can see that the current into the 12 pulse rectifier (fig.2) is equal to the 6 pulse rectifier, but the phase shift of the Y-connected transformer secondary will shift all voltages and currents by 30 degrees, compared to the D-connected secondary.

Assuming that converter and transformer are symmetrically designed and output stage of converter is assumed to be de-coupled from rectifier current, only the *characteristic* harmonic components are present in the input currents to the line supply of the frequency converter.

For a 6-pulse converter these components are:

$$h = 6xn \pm 1, \quad h = 5, 7, 11, 13, 23, 25\ldots$$

In a 12-pulse converter (fig.2), multiples of sixth (+/-1) harmonics, which are present in the secondary and tertiary windings of the feeding transformer, will due to the 30-degree shift be cancelled in the primary windings and thus the remaining harmonic current components will be of order:

$$h = 12xn \pm 1, \quad h = 11, 13, 23, 25\ldots$$

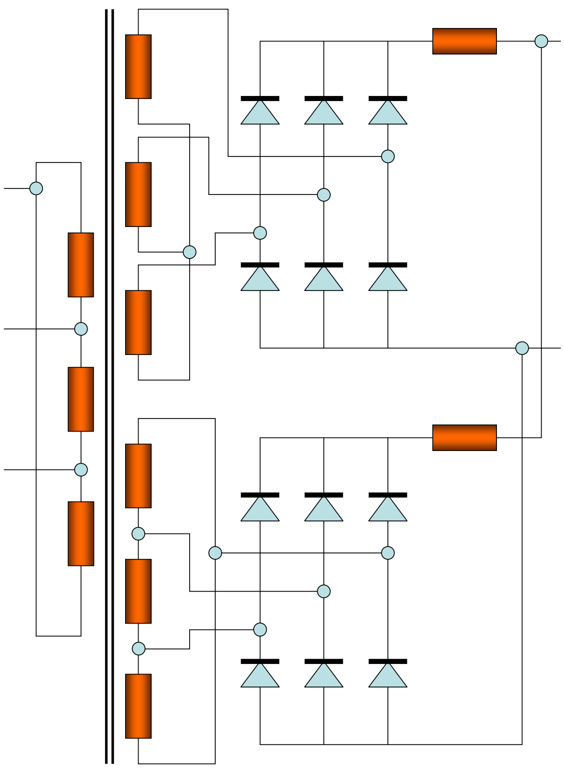

Figure 2 12 pulses converter

The Total Harmonic Distortion (*THD*) is a measure of the total content of harmonic components in a measured current, *THD(i)*, or voltage, *THD(u)*:

$$THD(i) = 100\% \times \frac{\sqrt{\sum_{h=2}^{\infty} i_{(h)}^2}}{i_{(1)}}$$

$$THD(u) = 100\% \times \frac{\sqrt{\sum_{h=2}^{\infty} u_{(h)}^2}}{u_{(1)}}$$

where $u_{(1)}$, $i_{(1)}$ are the fundamental RMS value of the voltage and current, and $u_{(i)}$, $i_{(i)}$ are the RMS value of the i^{th} harmonic of the voltage (or current).

Normally, one will only regard harmonics up to and including the 50th harmonic order.

3. HARMONICS OF *CURRENT SUPPLY* CONVERTERS

For a CS converter, the characteristic harmonics will be similar to a VS converter. However, the de-coupling between the line supply and the motor sides are not as ideal as for the VS, and the harmonics of the line side currents are strongly influenced by the motor side harmonics. In addition to the pure harmonics, a CS drive also generates non-integer harmonics to the power network. Non-integer harmonics are interfering components at frequencies that are not exact multiples of the system frequency. In a CS drive these non-integer harmonics are due to the DC pulsation frequencies caused by the machine converter and are therefore synchronous with the motor frequency according to the following formula:

$$f_i = h \cdot f_N \pm p \cdot f_M$$

where:

f_i Non-integer harmonic component

h Characteristic harmonic component from drives (1, 5, 7, 11, 13 etc)

f_N Network frequency

p Pulse-number of the drive

f_M Machine frequency.

The amplitude of the non-integer harmonic components are mainly determined by the size of the DC inductor, i.e. the larger inductor the lower amplitudes. Secondly, the amplitudes are in general much smaller than the integer harmonic components.

4. HARMONICS OF IDEAL 6 and 12 PULSES CURRENT WAVEFORMS

For the idealized current waveforms, one can establish the harmonic spectrum by the following relation (since the wave-form is an odd function with average zero):

$$i_h = \frac{2}{T}\int_{-T/2}^{T/2} i(t)\sin\left(\frac{2h\pi}{T}t\right)dt$$

Using this relation, one can find the following spectrum, where $\hat{I}$ is the amplitude of the current:

$i_1 = \hat{I}$
$i_2 = i_3 = i_4 = 0$
$i_5 = i_1 / 5$

$i_6 = 0$
$i_7 = i_1 / 7$
$i_8 = i_9 = i_{10} = 0$
$i_{11} = i_1 / 11$
$i_{12} = 0$
$i_{13} = i_1 /13$
…
i.e.:

$$i(t) = \hat{I}\sum_h \frac{1}{h}, h = n \cdot 6 \pm 1, n = 1,2,3,4,...$$

Fig. 3 shows the result of this series, where the terms up to 37th harmonics are included, showing how the resulting waveform converges towards the original six-pulse shape.

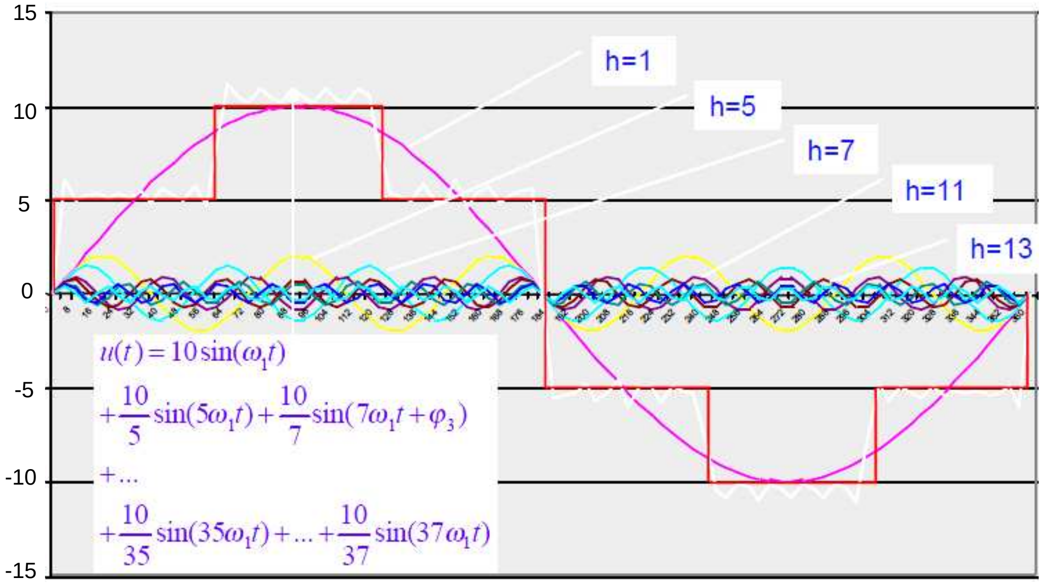

Figure 3 Harmonics up to 37th of a six-pulse current waveform
(missing our selves' measurements, will have to bring as true the ones performed by Alf Kåre Ådnanes)

In the 12 pulse current waveform, the harmonics of order 5, 7, 17, 19 etc, are cancelled due to the 30 degree phase shift of the three-winding transformer. These harmonics will flow in the transformer windings, but with opposite phase, in the secondary windings of the transformer, and by the summing, they will circulate inside the transformer only, and not flow into the network.

The total harmonic distortion of these current wave forms can be found by the relation

$$THD(i) = 100\% \times \frac{\sqrt{\sum_{h=2}^{\infty} {i_{(h)}}^2}}{i_{(1)}}$$

The corresponding harmonic spectrums that can be measured in a typical installation with VS converters are shown in Figure 4.

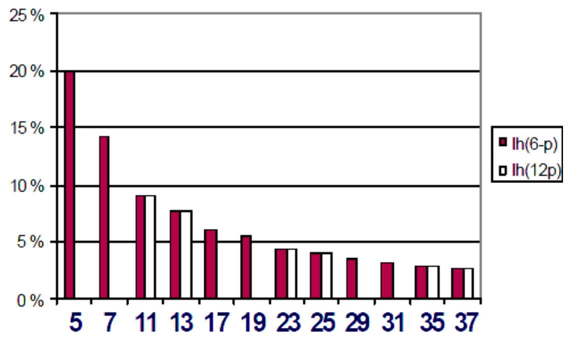

Figure 4 Characteristic harmonics of a six and twelve pulse current wave-form.

These are ideal current waveforms. In practice, impedance due to inductance, resistance, and capacitance alters the current shape (fig.5).

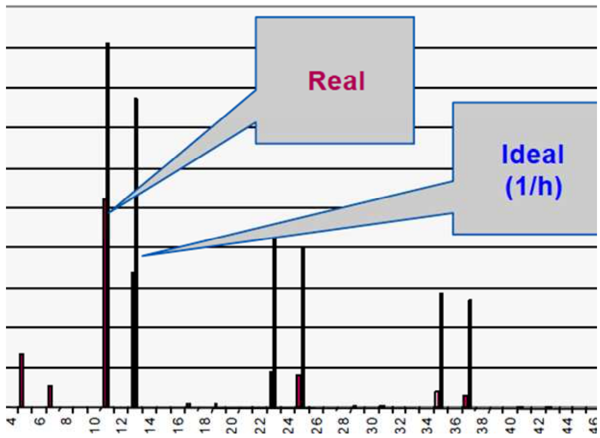

Figure 5 Characteristic harmonics of a 12 pulse current waveform, comparing the real values of a practical installation with the ideal amplitudes

5. CONCLUSIONS

The total harmonic distortion of the current yields THD(i) about 30% for the 6-pulse current, and 15% for the 12-pulse current.

6. REFERENCES

[1] **Dordea, Şt**., **Zburlea**, **E**., *Active steering by 4 electric thrusters*, Constanta Maritime University Annals, Year XII, 15th issue, Constanta, 2011, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[2] **Dordea, Şt**., **Zburlea**, **E**., *Electric propulsion with turbo generators*, Constanta Maritime University Annals, Year XII, 15th issue, Constanta, 2011, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[3] **Dordea, Şt**., **Zburlea**, **E**., *Active steering – Electric thrusters*, Constanta Maritime University Annals, Year XI, 14th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[4] **Dordea, Şt**., **Zburlea**, **E**., *Electric drives for azimuth propulsors*, Constanta Maritime University Annals, Year XI, 14th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[5] **Dordea, Şt**., **Zburlea**, **E**., *Proportional steering system*, Constanta Maritime University Annals, Year XI, 13th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[6] **Dordea, Şt**., **Zburlea**, **E**., *Anti-hunt control system*, Constanta Maritime University Annals, Year XI, 13th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[7] **Dordea, Şt.,** *Acționări electrice cu undă sintetică*, autor unic, Ed. Muntenia, ISBN (10) 973-692-153-0, ISBN (13) 978-973-692-153-7, 155 pag, Constanta, 2006.

[8] **Dordea, Şt.,** *Repartiția secvențială a sarcinii în acționarea electronică a motoarelor asincrone trifazate*, A IX-a Sesiune de comunicări ştiințifice cu participare internațională „Ştiința şi învățământul, fundamente ale secolului al XXI-lea", Ştiințe tehnice, vol.I, ISBN 973 – 7809 – 04 – 1, ISBN 973 – 7809 – 03 – 3, Academia Forțelor Terestre „Nicolae Bălcescu", pp. 49 – 53, 5 pg, Sibiu, 2004.

[9] **Dordea, Şt**., *Transferul de energie în sistemele electrohidraulice de guvernare navale*, Teză de doctorat, Universitatea „Dunărea de Jos" din Galați, 2002

[10] **Dordea, Şt.**, *Sisteme de guvernare cu acțiune continuă şi comandă digitală* - Referat doctorat, Universitatea "Dunărea de Jos", Galați, 1998

[11] **Dordea, Şt.**, *Contribuții la transferul de energie în sistemele electrohidraulice de Guvernare Navale* – Referat doctorat, Universitatea "Dunărea de Jos", Galați, 1998

[12] **Dordea, Şt.**, *Stadiul actual în domeniul sistemelor de guvernare navale* – Referat doctorat, Universitatea "Dunărea de Jos", Galați, 1997

[13] **Dordea, Şt.,** *Steering Controls*, TCW Report, Anschutz, Kiel, 1989.

QUANTIFYING HARMONIC DISTORTION

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ABSTRACT

It is *necessary to be able in predicting harmonic distortion*, evaluate the effects, and perform the proper means to manage the voltage distortion, without functional faults over the life time of the installation.

There are two types of simulation tools available: time domain simulation and the more commonly applied, which calculates in frequency domain. The benefit of the frequency domain calculation tools is that the time and work for modeling and calculation of large systems is much shorter than for a time domain simulation. However, the accuracy will normally be lower, since one has to decide the harmonic content of the load current, which in reality is dependent on the network configuration and can only be determined by time domain simulation or by equivalent figures from similar systems. Special considerations should be made for PWM type of controllers and use of passive filters, where time domain simulations are strongly recommended in order to obtain results that are necessary for correct design and dimensioning

Keywords: *harmonic distortion, periodic waveform.*

1. INTRODUCTION

The harmonic currents drawn by a non-linear load from the network will be distributed in the network and flow through the other equipment in the power network. If regarded to be a current source of harmonic current components, it is obvious that the harmonic currents will flow through the paths with lowest impedance for the harmonics. These are normally the running generators, large motors, or large distribution transformers to other (higher or lower) voltage levels.

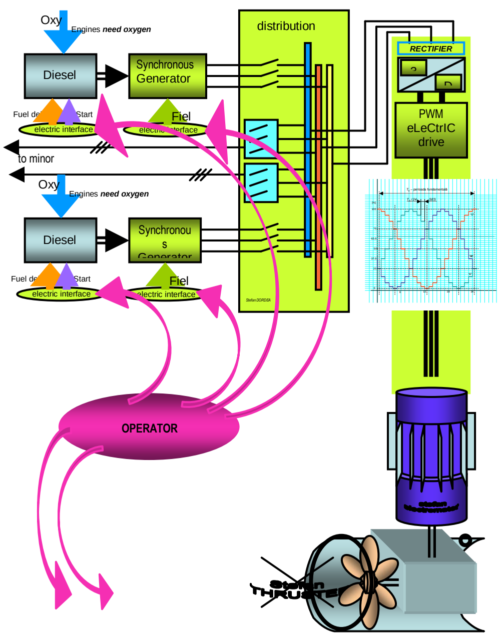

Figure1 *by Stefan Dordea* Thruster drives with diode bridge and drilling drives with thyristor bridge are running simultaneous

There are two types of simulation tools available: time domain simulation and the more commonly applied, which calculates in frequency domain. The benefit of the frequency domain calculation tools is that the time and work for modeling and calculation of large systems is much shorter than for a time domain simulation. However, the accuracy will normally be lower, since one has to decide the harmonic content of the load current, which in reality is dependent on the network configuration and can only be determined by time domain simulation or by equivalent figures from similar systems.

Special considerations should be made for PWM type of controllers (Fig.1&2) and use of passive filters, where time domain simulations are strongly recommended in order to obtain results that are necessary for correct design and dimensioning.

2. FREQUENCY DOMAIN – HARMONIC INJECTION

In this method, the nonlinear load is represented by a harmonic current source, injecting harmonic currents to the network. The network in terms are modeled as a system where its various parts, generator, cable, transformer, motors, etc., are modeled with an appropriate impedance model, representing the impedance for the harmonic frequency currents injected by the harmonic current source.

An example of a such model is shown in Fig.3, with a harmonic current source representing the frequency converter, and impedance models for generator, cable, transformers, and loads, e.g. motors.

By calculating the resulting voltages from the harmonic currents, the harmonic voltages are found in the branches or points of interest. Summing up these, the harmonic voltage distortion is finally found.

There are several calculation software programs assisting in building up and calculation of harmonic distortion in the frequency domain. Building up large networks is quite simple by library models, and calculation times are short.

The main challenge is to find a good harmonic representation of the converter, especially when using converter types where the harmonic spectrum is highly dependent on the network, such as with VS Converters. Library models are not always to be trusted.

The simulation circuits can normally be assumed ideal, with symmetric supply and neglected impedance in switchboards and cables.

In practice transformers and converters are not ideally symmetrical, nor is the network impedance. Further, there must be expected that highly dependent on the network, such as with VS Converters. Library models are not always to be trusted.

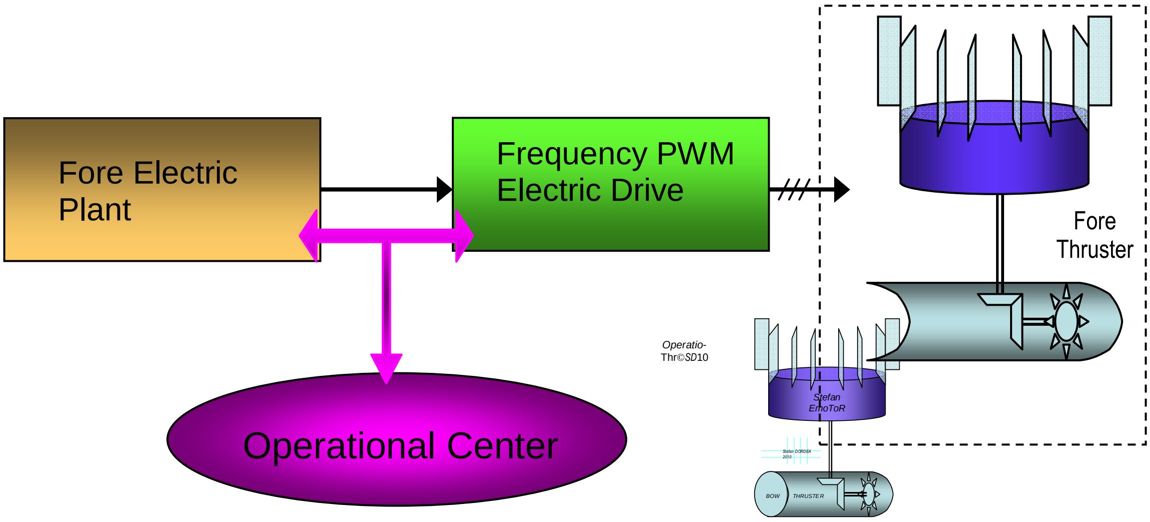

Figure2 *by Stefan Dordea* Frequency converter inside a thruster

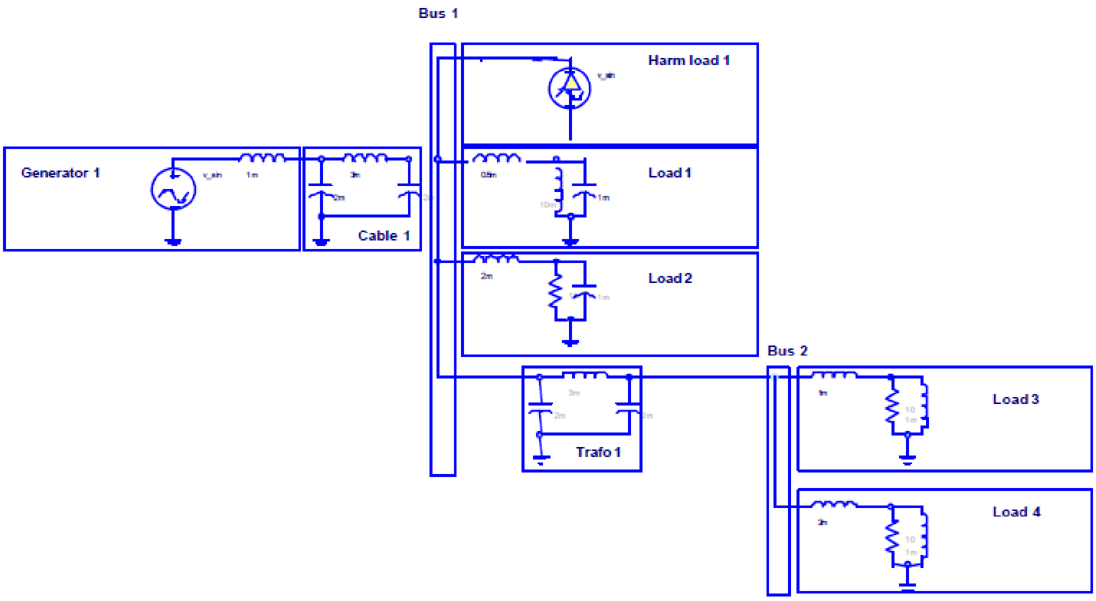

Figure 3 Model of a network used in frequency domain

3. TIME DOMAIN – NETWORK SIMULATION

By building up a circuit model of the network, with discrete impedance models, one can perform a time domain simulation of the system. Initial values of voltages and currents are chosen and after some simulation time, the system has stabilized sufficiently to represent stationary conditions.

By taking one fundamental period of the voltage or current waveform of interest, one can then perform a Fourier transformation and find the harmonic spectrum at any point or branch of the system.

A simplified circuit model for the same system as in Figure 3 is depicted in Figure 4.

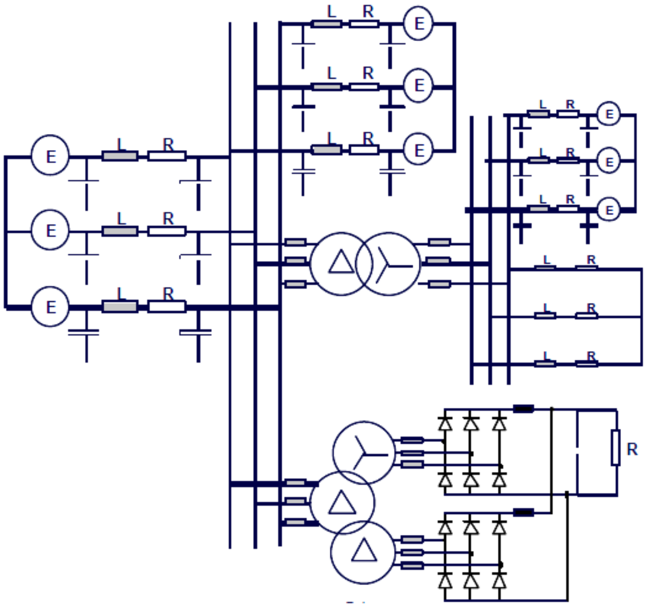

Figure 4 Model of a frequency domain

It is quite obvious that a complex network is cumbersome to model and time consuming to simulate. Time step in the simulation must also be relatively short in order to give accurate results.

The great benefit is that this model gives an accurate calculation of the voltages and currents, and also the harmonic spectrum of the nonlinear loads.

In network with high voltage distortion one should avoid the use of tube lighting with capacitive compensators.

An example of waveforms of switchboard voltage and currents to the thruster is calculated by the time domain analysis program KREAN and shown in the four figures below.

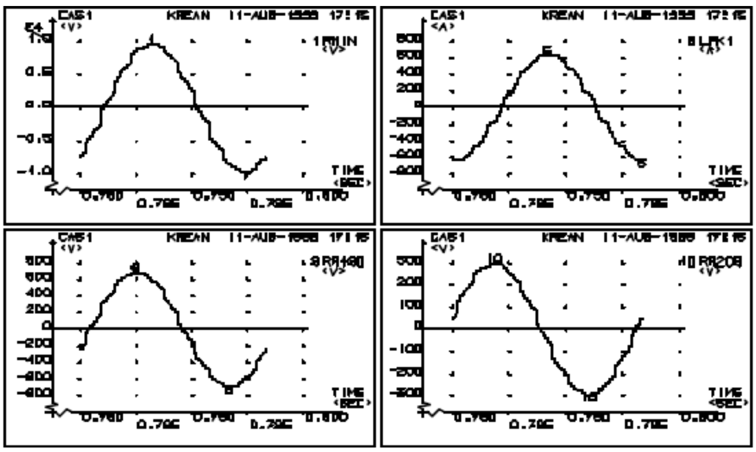

Figure 5 shows a simulation with PWM thruster drive

4. CONCLUSIONS

Frequency domain calculations are widely used because of the simple modeling and short calculation times. If the harmonic representation of the converter currents is accurate, the results are also accurate. It is not always straightforward to find the harmonic representation, which may strongly be influenced by the network characteristics.

Then, a time domain simulation can be used, either for a complete calculation, or for a part of the system that is representative enough to give a good harmonic model of the converter, and feed these results into a frequency domain calculation for the complete system.

To illustrate the potential faults, if comparing the results of the time domain simulation with a corresponding frequency domain calculation of the same system with the ideal harmonic currents of a 12-pulse rectifier, the real voltage distortion gives THD=8%, while the frequency domain calculation with ideal current waveforms results in 20%. This difference is of course so large that the result from the latter calculation is use-less for any engineering aspect.

5. REFERENCES

[1] **Dordea, Şt**., **Zburlea**, **E**., *Active steering by 4 electric thrusters*, Constanta Maritime University Annals, Year XII, 15th issue, Constanta, 2011, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[2] **Dordea, Şt**., **Zburlea**, **E**., *Electric propulsion with turbo generators*, Constanta Maritime University Annals, Year XII, 15th issue, Constanta, 2011, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[3] **Dordea, Şt**., **Zburlea**, **E**., *Active steering – Electric thrusters*, Constanta Maritime University Annals, Year XI, 14th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[4] **Dordea, Şt**., **Zburlea**, **E**., *Electric drives for azimuth propulsors*, Constanta Maritime University Annals, Year XI, 14th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[5] **Dordea, Şt**., **Zburlea**, **E**., *Proportional steering system*, Constanta Maritime University Annals, Year XI, 13th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[6] **Dordea, Şt**., **Zburlea**, **E**., *Anti-hunt control system*, Constanta Maritime University Annals, Year XI, 13th issue, Constanta, 2010, Editura Nautica, ISSN 1582 - 3601 (cotat *B+* în sistemul CNCSS)

[7] **Dordea, Şt.,** *Acționări electrice cu undă sintetică*, autor unic, Ed. Muntenia, ISBN (10) 973-692-153-0, ISBN (13) 978-973-692-153-7, 155 pag, Constanta, 2006.

[8] **Dordea, Şt.,** *Repartiția secvențială a sarcinii în acționarea electronică a motoarelor asincrone trifazate*, A IX-a Sesiune de comunicări ştiințifice cu participare internațională „Știința şi învățământul, fundamente ale secolului al XXI-lea”, Științe tehnice, vol.I, ISBN 973 – 7809 – 04 – 1, ISBN 973 – 7809 – 03 – 3, Academia Forțelor Terestre „Nicolae Bălcescu”, pp. 49 – 53, 5 pg, Sibiu, 2004.

[9] **Dordea, Şt**., *Transferul de energie în sistemele electrohidraulice de guvernare navale*, Teză de doctorat, Universitatea „Dunărea de Jos” din Galați, 2002

[10] **Dordea, Şt.**, *Sisteme de guvernare cu acțiune continuă şi comandă digitală* - Referat doctorat, Universitatea “Dunărea de Jos”, Galați, 1998

[11] **Dordea, Şt.**, *Contribuții la transferul de energie în sistemele electrohidraulice de Guvernare Navale* – Referat doctorat, Universitatea “Dunărea de Jos”, Galați, 1998

[12] **Dordea, Şt.**, *Stadiul actual în domeniul sistemelor de guvernare navale* – Referat doctorat, Universitatea “Dunărea de Jos”, Galați, 1997

[13] **Dordea, Şt.,** *Steering Controls*, TCW Report, Anschutz, Kiel, 1989.

THE SPECTRUM OF THE IMPULSE SIGNAL

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ABSTRACT

The paper proposes another point of view on problems regarding the spectrum of the impulse signal or a dissidence among signals. The numerical calculation, applied in an absolutely identical manner and with positive results to any other kind of signal known under the form of discrete numerical function $f_i(t_i), i = 1,2,3\cdots$, for which $\delta t = t_i \quad t_{i\ 1}$, regardless of the fact that it may have discontinuities here and there, cannot be applied to the impulse signal. This has determined me to change, only now, and in a radical manner, the software processing the signals, which included the impulse type signals.

Keywords: *Dirac function, periodic signal, Fourier transform, spectrum.*

1. INTRODUCTION

Throughout the paper I will be using for the impulse signal an expression which is quite similar to the Dirac function δ(t) that is written as follows

$$\delta(t) = \begin{matrix} 0\,, & t \neq t_0 \\ \infty\,, & t = t_0 \end{matrix} \quad \text{and} \quad \int_{t_0\ \varepsilon|_{\varepsilon\to 0}}^{t_0+\varepsilon|_{\varepsilon\to 0}} \delta(t)dt = 1 \qquad (1)$$

It is easily seen that the Dirac function has no definite form, but rather proprieties. The impulse signal I will be working with will have a rectangular shape, with parallel flanks, but it could be defined with other shapes too, triangular, parabolic, etc., on condition the properties are respected (1). The shape of the signal is shown in figure 1 and in order for it to be even closer to a Dirac function, it will also follow the rule

$$A \cdot dt|_{dt\to 0} = 1 \qquad (2)$$

so as to enable, for values $dt \to 0$, the value of the funtion to tend to infinite, $A|_{dt\to 0} \to \infty$.

The impulse signal may also be practically realised as a periodic signal with the period T_0. In this case the t_0 moment at which the signal is defined has the role of a phase and it will thus be called t_0 in applications.

2. THE TERMS OF THE FOURIER SERIES (THE HARMONIC COMPONENTS)

Considering the impulse signal as a periodic signal with the pulsation $\omega_0 = \frac{2\pi}{T_0}$ the terms of the Fourier series will be as follows:

2.1 The a_0 *term(movement on the horizontal axis)*

Taking into account (2) we arrive at

$$a_0 = \frac{1}{T_0}\int_0^{T_0}\delta(t)dt = \frac{A}{T_0}\int_{t_0}^{t_0+dt}dt = $$
$$= \frac{A\cdot dt}{T_0} = \frac{1}{T_0} \qquad (3)$$

From (3) it is concluded that an unperiodic signal (with the period $T_0 \to \infty$) has zero movement. The shorter the period is, the more noticeable the movement of the signal will be (the constant component will have a bigger value).

2.2 The harmonic components of i order

We will subsequently take into account (2) and the properties of the trigonometrical functions when they have as an argument small infinites, according to which $\sin(\alpha)|_{\alpha\to 0} = \alpha$ şi $\cos(\alpha)|_{\alpha\to 0} = 1$.

$$a_i = \frac{2}{T_0}\int_0^{T_0}\delta(t)\cos(i\omega_0 t)dt = \frac{2}{T_0}\int_{t_0}^{t_0+dt}A\cos(i\omega_0 t)dt =$$
$$= \frac{2A}{i\omega_0 T_0}\sin(i\omega_0 t)\Big|_{t_0}^{t_0+dt} = \frac{2A}{i\omega_0 T_0}\cdot$$
$$[\sin(i\omega_0 t_0)\cos(i\omega_0 dt) + + \sin(i\omega_0 dt)\cos(i\omega_0 t_0)$$
$$-\sin(i\omega_0 t_0)] = \frac{2A}{i\omega_0 T_0}[\sin(i\omega_0 t_0)\cdot 1 +$$
$$+ i\omega_0 dt\cos(i\omega_0 t_0) - \sin(i\omega_0 t_0)]$$

$$a_i = \frac{2}{T_0}\cos(i\omega_0 t_0), \quad i = 1,2,3,\cdots \qquad (4)$$

$$b_i = \frac{2}{T_0}\int_0^{T_0}\delta(t)\sin(i\omega_0 t)dt =$$
$$= \frac{2}{T_0}\int_{t_0}^{t_0+dt} A\sin(i\omega_0 t)dt =$$
$$= \frac{-2A}{i\omega_0 T_0}\cos(i\omega_0 t)\Big|_{t_0}^{t_0+dt} =$$
$$\frac{-2A}{i\omega_0 T_0}\left[-i\omega_0 dt\sin(i\omega_0 t_0)\right]$$
$$b_i = \frac{2}{T_0}\sin(i\omega_0 t_0),\quad i = 1,2,3,\cdots \tag{5}$$

The amplitude of the harmonic component of i order is

$$A_i = \sqrt{a_i^2 + b_i^2} = \frac{2}{T_0} \tag{6}$$

and the phase

$$\varphi_i = \arctan\left[\frac{\cos(i\omega_0 t_0)}{\sin(i\omega_0 t_0)}\right] \tag{7}$$

From (6) and (7) it can be seen that for an impulse signal all the harmonic components have a constant value aacording to (6). If the impulse is defined in the origin ($t_0 = 0$ or $t_0 = T_0$), the phase is of $\frac{\pi}{2}$. For the impulse signanls defined anywhere on the interval of a period, the phase of harmonic components varies with the order of the harmonic function. The important thing is that up to $i = \infty$ all the harmonic functions have a constant amplitude. The larger the frequency of the impulse signals is, the proportionally larger the amplitude of the harmonics is, according to (6), which can be also written as

$$A_i = 2\cdot\nu_0 \tag{8}$$

where ν_0 is the frequency of the impulses.

3. THE FOURIER TRANSFORM AND THE SPECTRAL FUNCTION

We know the transformation formula of a time function $f(t)$ into a function of complex variable $F(j\omega)$, where ω is the pulsation.

$$F(j\omega) = \int_{\infty}^{+\infty} f(t)e^{\ j\omega t}dt \tag{9}$$

called Fourier transform. The (9) relationship can be written using Euler's relations

$$F(j\omega) = \int_{\infty}^{+\infty} f(t)\cos(\omega t)dt - j\int_{\infty}^{+\infty} f(t)\sin(\omega t)dt = \tag{10}$$
$$= \mathrm{Re}(\omega) + j\,\mathrm{Im}(\omega)$$

In (10) the function $f(t)$ is replaced with the impulse function described above, with the following additions:

- the inferior limit at integration will be 0 because the signal is defined on positive time intervals;
- the superior limit at integration will be an integer multiple n of T_0 period, respectively, the duration of the periodic signal;

We, thus, obtain:

$$\mathrm{Re}(\omega) = \int_0^{nT_0} A\cos(\omega t)dt = A\int_{t_0}^{t_0+dt}\cos(\omega t)dt +$$
$$A\int_{T+t_0}^{T+t_0+dt}\cos(\omega t)dt + A\int_{2T+t_0}^{2T+t_0+dt}\cos(\omega t)dt + \cdots$$
$$+ A\int_{(n\ 1)T+t_0}^{(n\ 1)T+t_0+dt}\cos(\omega t)dt = \frac{A}{\omega}\sin(\omega t)\Big|_{t_0}^{t_0+dt} +$$
$$+ \frac{A}{\omega}\sin(\omega t)\Big|_{T+t_0}^{T+t_0+dt} + \frac{A}{\omega}\sin(\omega t)\Big|_{2T+t_0}^{2T+t_0+dt} + \cdots$$
$$+ \frac{A}{\omega}\sin(\omega t)\Big|_{(n-1)T+t_0}^{(n-1)T+t_0+dt}$$

$$\mathrm{Re}(\omega) = \sum_{i=1}^{n}\cos\{\omega[(i-1)T + t_0]\} \tag{11}$$

$$\mathrm{Im}(\omega) = \int_0^{nT_0} A\ \sin(\omega t)dt = A\int_{t_0}^{t_0+dt}\sin(\omega t)dt +$$
$$A\int_{T+t_0}^{T+t_0+dt}\sin(\omega t)dt + A\int_{2T+t_0}^{2T+t_0+dt}\sin(\omega t)dt + \cdots + A\int_{(n\ 1)T+t_0}^{(n\ 1)T+t_0+dt}\sin(\omega t)dt =$$
$$-\frac{A}{\omega}\cos(\omega t)\Big|_{t_0}^{t_0+dt} - \frac{A}{\omega}\cos(\omega t)\Big|_{T+t_0}^{T+t_0+dt} -$$
$$-\frac{A}{\omega}\cos(\omega t)\Big|_{2T+t_0}^{2T+t_0+dt} - \cdots - \frac{A}{\omega}\cos(\omega t)\Big|_{(n-1)T+t_0}^{(n-1)T+t_0+dt}$$

$$\mathrm{Im}(\omega) = \sum_{i=1}^{n}\sin\{\omega[(i\ \ 1)T + t_0]\} \tag{12}$$

The module of the Fourier transform is called a spectral function $S(\omega)$ and has the expression

$$S(\omega) = \sqrt{\mathrm{Re}^2(\omega) + \mathrm{Im}^2(\omega)} \tag{13}$$

representing the spectrum on the continuous domain of signal pulsation. It can be seen from the above that the

functions of the spectral function, including its extremes, depend on the length (duration) of the impulse signal, respectively on n. The maxims of this function are to be found from the condition that $\frac{dS}{d\omega} = 0$, condition which can be applied directly to the quantity under the radical from (13), respectively $\frac{d\left[\mathrm{Re}^2(\omega) + \mathrm{Im}^2(\omega)\right]}{d\omega} = 0$.
Thus,we have

$$
\begin{aligned}
&\sum_{i=1}^{n} \cos\left\{\omega\left[(i-1)T_0 + t_0\right]\right\} \bullet \\
&\sum_{i=1}^{n} \left[(i-1)T_0 + t_0\right] \sin\left\{\omega\left[(i-1)T_0 + t_0\right]\right\} = \\
= &\sum_{i=1}^{n} \sin\left\{\omega\left[(i-1)T_0 + t_0\right]\right\} \bullet \\
&\sum_{i=1}^{n} \left[(i-1)T_0 + t_0\right] \cos\left\{\omega\left[(i-1)T_0 + t_0\right]\right\}
\end{aligned}
\tag{14}
$$

by whose solving we find out for which ω values the extremes appear and from (13) which the values of these extremes are. To simplify the calculations, since the allure of the spectral function does not depend on the phase of the t_0 signal, in (14) we can adopt $t_0 = 0$. Due to the complexity of the (14) equation the analytical solving can be easily done for concrete values of n. As a result of the calculations we get:
- for n=1, $\omega = \forall, \omega \geq 0$ and $S(\omega) = 1$, namely, a continuous and constant spectrum, of value 1;
- for n=2, $\omega = k\frac{2\pi}{T_0} = k\omega_0, k = 0,1,2,3\cdots$ and $s(\omega) = 2$, namely, a periodic variable spectrum, reaching maximums at pulsations which are multiples of the fundamental pulsation of the signal; for the values $\omega = k\frac{\pi}{T_0} = \frac{k}{2}\omega_0, k = 1,3,5\cdots$ the spectral function has null values;
- for n>2 we preferred the numeric solving, which also confirms the cases n=1 or n=2 and which shows that the maxims are equal to the n duration of the signal, occurring for the fundamental pulsation's multiples.

4. CONCLUSIONS

The numerical solving of the above raises a rarely encountered problem which is difficult to deal with. Normally, the differentiation operator $dt \to 0$ from the analytical calculation of the integrals, becomes, when numerically solving, a simple finite number $\delta t \to$ howeversmallbutnotnull. Depending on the concrete value of δt, not null, are the solving precision and the calculations' duration. For the impulse signal, whose duration is $dt \to 0$, solving through numerical methods triggers integrating on the interval $t_0,\ t_0 + dt$ that becomes the interval $t_0,\ t_0 + \delta t$, which has to be divided into subintervals with small-finite value, under the value of δt. This means integrating with two different norms regarding the division of intervals (namely, the differentiation operator), one of them marked dt for the interval $\infty, +\infty$ (respectively $0,\ nT_0$ in finite duration signals) and another one, smaller than dt, of the form d(dt), for the interval $t_0,\ t_0 + d\,t$, which is not correct, the basic (9) formula starts from an integration with a unique norm of this operator. This is why the numerical calculation, applied in an absolutely identical manner and with positive results to any other kind of signal known under the form of discrete numerical function $f_i(t_i), i = 1,2,3\cdots$, for which $\delta t = t_i \quad t_{i\ 1}$, regardless of the fact that it may have discontinuities here and there, cannot be applied to the impulse signal.

5. REFERENCES

[1]. CARTIANU, Gh. ş.a. *Signals, circuits and systems*, Editura Didactică şi Pedagogică, Bucureşti, 1980.
[2]. MATEESCU, A. *Signals, circuits and systems*, Editura Didactică şi Pedagogică, Bucureşti, 1984.
[3]. Mateescu, A., Dumitru, N., Stanciu, L. *Signals and systems*, Editura Teora, Bucuresti, 2001.
[4]. NAFORNIŢĂ, M., Isar, A. *Time representations - frequency*, Editura Politehnica Timişoara, 1998.
[5]. OPPENHEIM, A.V., Schafer, R.W. *Discrete-Time Signal Processing*, Prentice-Hall, 1989.
[6]. SĂVESCU, M. *Signals, circuits and systems-Problems*, Editura Didactică şi Pedagogică, Bucureşti, 1982.
[7]. STANOMIR, D., Stănăşilă, O. *Mathematical methods in signal theory*, Editura Tehnică, Bucureşti, 1980.
[8]. TEOLIS, A. *Computational signal processing with wavelets*, McGraw-Hill, 1999.

TELEMEDICINE AND ETHICS

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ABSTRACT

The technological insertion in medicine in the last past years dramatically changed the medical practice. Based on the medical team reaction time optimization need and on the request for better medical information management, under continuous expansion with the technological advance, the telemedicine concept is taken into account and implemented more and more. The obvious advantages such as the power of patient and illness management, availability at any time and scalability of the information and better access to medical care, lower medical services cost, are balanced by side effects such as the vulnerability of the confidentiality concept, additional harm put on the patient and even the health services quality, the doctor patient relationship. The question we are asking here is if the side effects such as the mentioned ones should worry us. In this paper we address this question, underlining the ethical aspects related to the implementation of the telemedicine in the current medical practice.

Keywords: *telemedicine, patient, bioethics.*

1. INTRODUCTION

About, more or less, 10-20 years ago, the majority would have been considered the bioethics unrelated to the technology. The need for better diagnostics, the increase in quantity and quality of the information, the medical treatment optimization and the wish for better quality of life, asked for technological applications in medicine. Thus, the technology to medicine insertion evolved more and more. Combined with the popularization of the abuse cases in medical research (abuses happened since the beginning of the 20th century), such was the Tuskegee experiment or even the Nazi experiments, this connection won a very important place and has been getting stronger and stronger. Today it is actually is actually really necessary for better understanding of the moral effects. The moral effects are referenced to some ethical principles on medical researches on human subjects, extended to post-research period, in long term usage. The most important four bioethical principles are the principle of justice, the principle of autonomy, the principle of non-maleficence and the principle of benefits. They were defined and framed into documents and guides for medical research on humans. The already mentioned Tuskegee case (following up the untreated syphilis for about 40 years) or the Nazi experiments (for instance, humans were placed in cold, frozen water, half dressed, to check out the human body limits, in order to improve the pilots protection equipments in case of plain failure) defined the well known Nuremberg code and the Declaration of Helsinki.

The medical technology allowed the rise of new medical sub-domains. The current interest, the current focus is on the telemedicine, as the totality of the technologies that provide remote investigations. From this moment further even the patient doctor relationship knew variants, moving from the master face in face one to the one technologically mediated.

2. WHAT IS THE TELEMEDICINE

The telemedicine became already not only a very used term in the current medical practice, based on technology, but also a concept that is evolving every day, a trend. Even Romania knew it since several years ago, in various applications from medical training to remote assisted surgery. Even if the standard definition is not completely applied, there are certain specific elements that are used, both in medical follow up for long term surveillance of chronically diseased patients and in acute cases, post surgery. In this last case the patient carry on monitoring equipment, for the clinical, vital signs recording. Later, after a period decided together with the physician, either the data are uploaded from home by the patient himself on the health care central server (using the Internet) or the patient bring the device in person to the doctor office, where the data is downloaded locally and read by the physician. Either way the final is the same, the physician read the information and presents the results to the patient together with the further therapy suggestions.

There are cases the chronic ill patients are carrying out the equipment all the time, without on line connection and in case of any emergency, a panic button will activate a tracking GPS system from the health care center that optimize the intervention time on the patient.

The telemedicine is a technology used for health care services delivery especially when the distance to the health care provider is a critical item. The currently used type of telemedicine systems is the communication between hospitals, between hospitals and primary health care providers and between physicians in general medicine and specialists in various medical fields. It can be seen as an example of "telematics applied in health care services", with wide application range because it includes informatics or information technology, with the aim of increasing health care providing efficiency or better health care system management. It intends to increase the society general health status (comfort and prevention). By the telemedicine, the remote health care services are provided to those that are living far away from the health care services provider, not necessary ill or wounded, but already in good medical status, healthy, and want to institute precaution measures in order to avoid the potential illnesses or to those that need permanent surveillance. The monitoring is done in real time, continuously or upon patient request [1, 2].

The tele-monitoring includes various types of medical surveillance such as:

- Tele-alarm – when the critical vital signal cross over a certain threshold, an alarm flag out to the medical team that its expertise is requested into an emergency set up;
- Tele-assistance – confirm to the patient different decision he/she is going to take on various treatment Do not use bolded characters in the text body;
- Tele-re-education – used especially the same way with the prosthesis. The patient is getting re-skilled in the tasks he lost after a medical circumstance Do not use other headers or footers;
- Tele-surveillance – the patient is shadowed by the technology on running the daily tasks and in case of continuously failure, the trained team will provide assistance on the matter of interest

All just mentioned focus on the chronic ill patients that requests such assistance. The surveillance protocol is shaped both on the patient and the treatment pattern. The main aim is to prevent (is cheaper to prevent than to treat).

The tele-surveillance can be performed either through “intelligent apartments”, at the patient location, at work, in the office, on the street etc. The surveillance outside the “intelligent apartments” is partially done because is performed with only a certain amount of pieces parts of the whole system. An example on this respect is the information about cardiac rhythm and body temperature delivered through the cell phone. This kind of medical surveillance replaces the long time patient hospitalization and in the same time informs the doctor in case the normal threshold is crossed [11], [12], [13]. There were settled several assisted health care services:

Level 0 – the therapy and the diagnosis are done without continuous assistance (minimal technology)

- The diagnosis is based on the direct medical team investigation;
- The treatment is suggested directly by the physician (face in face)

Level 1 – assistance technology for the diagnosis and the therapy

- The technology assists the medical team on establishing the diagnosis
- The therapy and the treatment are still provided face in face by the physician

Level 2 – the diagnosis and the therapy are based on technological assistance

- The diagnosis is based on the technology that assist the medical team
- The medical team use the processed information (decision making support and expert system) to settle diagnosis and suggest treatment;
- Technology assisted treatment

Level 3 – integrated technology based diagnostics

- Advanced technology – the diagnostic system is fed with data for analysis. The treatment and the therapy are automatically defined and processed. The system is autonomous.

The telemedicine intend to create an interconnected network of all hospitals in the country, a network linking different types of hospitals to a primary health care center (PHC). Another intention is to establish a partnership between the private hospitals and public ones. The medical research centers are under discussion as well.

3. DISCUSSIONS

The bioethics discourse definitely supposes balancing the advantages, the benefits and the side effects the technologies rises. The main interest is on the way this technology improves the patients quality of life on one side and on the other side the side effects the users could potentially face. Among the advantages we mention:

- the emergency intervention time optimization, in case the patient faces a medical condition requesting such
- the possibility for continuous patient surveillance inside and outside the hospital
- keeping the daily set up by setting up and personalizing the system at home or based on the user preferences. This is the scalability option available
- the possibility to share the medical decisions, thoughts among various other practitioners on different sites
- the data from the patients has high level of accuracy by the consistent length of the medical status and vital signs period surveillance.

The disadvantages are more related to the moral aspects than to the technical issues, as follows:

- Sometimes the cost is prohibiting the patient to get access to this technology. The justice principle is this way somehow broken. Not all the patients would afford it.
- Limited amount of equipments available at a moment, at once. The increased number of persons in need produces a limitation of the technical supplies the health care providers can share. It is such the problem of justice, of resource allocation. As average, in case of theoretical approach of each person paying the same money to the medical system, how and who decide which patient will be the first, how the priority list would be filled up? The principle of justice is however under breaching risk.
- Patient marginalization by social isolation and the lack of the social contact. This issue is a big problem especially in the case of patients mentally ill, with medical prescription of social contact. A secondary issue is that the telemedicine system cut out the human feelings the physician could get from the real life.
- The patient should have technical skills prior to using the system or even should get by the time is supposed to use the telemedicine resources is a real barrier for many users. The learning curve is quite large as long as the patient’s average age is bigger. As the

humans are different, the adaptation time dramatically differ based on each particular case

- The distance to the patient is in certain cases an important issue in case of emergency. If the system does not predict a fatal issue or the medical problem occurs suddenly, the patient life is jeopardized and the remote medical team is only watching the patient collapsing
- In spite of all those many applications on the market, the technology is still young, is still under testing. It is never too safe when comes about human life. The age around 20-30 years is not a warrant of the safety, is not a proficiency of safe technology
- One of the biggest issues is the principle of confidentiality that in case of information technology is under the risk of getting cracked, pirated, and broken. The problem here is that if the patient records becomes public, depending on what kind of medical condition exists, the patient could experience social stigma (think about AIDS or Parkinson even if the second one is not contagious ill but the latest year's studies revealed mental problems. If the others learn about such condition, the patient is isolated by the general misconception the mental ill is dangerous. A step further, the employers avoid hiring or keeping hired persons with certain conditions) on one side or could have uninsured medical conditions if the risk is documented during analysis for different other risks. Such kind of issues apply not only on the currently recorder, confirmed patients but also on the healthy individuals that are running periodically analysis. The electronic files are of a big interest for the insurance companies. If, for instance, a healthy person has an increased level of glucose in blood, we can talk about a quite important risk of diabetics. This information would be used by the insurance company to avoid insuring this condition or increasing the level of insurance the person should pay. Fortunately, the data confidentiality can be preserved. At the moment, there are both hardware and software solutions to protect the patient medical records. These solutions protect against both the electronic crimes, information theft and against the abuse from the users allowed to access medical data and sharing with third parties. Another bioethical issue in the case of the confidentiality breaching is who should be charged for this if happens? The medical practitioners that handled the data and introduced it into the system, the system designer because the system was not safe enough, can we talk about a shared guilty? Though question
- The "big brother" abuse risk. The communication channel is under risk of getting used by third parties that are getting access to the patient real time recordings. They can either share the information with the others or can add wrong data into the channel, producing false positive replies from the system side. Subsequently, this produces final wrong patient medical status and treatment.

Based on the double effect principle, one thing is good as long as it does not harm. For instance, think about the case of morphine in cases of the edge. Up to a certain point the morphine is a painkiller while for long term cases it produces addiction, subsequently body adapting to this medication, subsequently request additional doses and at the end it could produce patient death by slowing down the vital signs behind a supportable limit. We could say it is the overdose case. It is very difficult to separate the treatment from the overdose since every single patient reacts different to the stimulus. The bioethics aim is to underline the fact that each of us must be considered as unique case, separated from the whole group. The procedure unification must be avoided in order to avoid the double effect. Equal treatment does not mean right treatment for different patients.

Another major issue is the infrastructure handling. The doctor must get skilled on informatics that is splitting a bit the current focus on the medical issue to the technical aspects as well. The doctor must be multivalent, multidisciplinary trained too. On the other side such technologies are designed as tools for the current practice and, as the doctor got used with the stethoscope, a blood pressure scale, he/she should get used with minimal level of using modern technologies.

From the four bioethical principles mentioned above, we can synthesize the telemedicine usage issues. From the autonomy perspective, a telemedicine set up answers faster to the patient needs, it answers when asked, increasing the patient autonomy, translated on the increase on the someone ability to take decisions. The decisions taken by a telemedicine system are for the straight patient benefit, reducing to zero the dependency on the medical team that has a limited replying time comparing with a sensor system, designed to produce answers in real time. From the principle of justice perspective, it is quite difficult to manage the resources to fit all individual needs so a priority list is requested. From the principle of beneficence, the decisions made through a telemedicine system theoretically are designed for the patient benefit. This assumption must be taken or the discussion is closed before opening. Since the decision time is optimized by reducing the human dependency based on the sensor system that is taking deciding in real time, the benefit level is supposed to increase. Nevertheless, from the justice principle perspective is difficult to provide the same treatment to every single individual in the society. The resource management principle is either replacing or coming along it. There is the social duty to involve in to the therapy procedure all the resources that do not jeopardize the other's resources. This utilitarianism principle has an old history on the last decades and statutes that the greatest good must be provided to the greatest number of persons. The last bioethics principle claims the treatment must, before all, do not harm. The telemedicine systems risks are related not only to the chance the information to be ripped off, breaching the confidentiality, but also to false positive diagnostics, therefore false decisions. For instance, a long period a patient lays down can raise a flag on the health care center that something would be wrong. The lack of human brain analyzing various other events and signs (the posture or the attitude), provide such risks.

One other very important aspect is the patient doctor relationship technically linked. On a long, interpersonal communication issues from the patient side could arose. The patient gets unhappy, attitude strongly related to the communication and affects the health status at end. The standard procedure is agreed by the patient and the doctor as well since either one has the chance to study the pair, to get the feeling on him/her. From such kind of meetings the patient doctor relationship is getting stronger, the patient trusts the doctor. The treatment or even only the technologically assisted surveillance does not have the same effect as in the case of face in face investigation. The remote monitoring has a big side effect, the impersonal addressing. Both the patient and the doctor are talking to an object (microphone, monitor etc.) that are further broadcasting the thoughts. Even more, the patient must trust that no one else is involved into the meeting either in the doctor room or in different site, unless he prior consented on this.

The technologies will never broadcast the emotions, the feelings the same way in the real life, the pain, the discomfort. Everything becomes numbers that cannot count the empathy [6]. The emotional level is damaged and that is an important barrier to the positive treatment result.

An old Latin quote says “mens sana in corpora sano”. There are two important elements here, closely related: the mind and the body. The aim is to have both of them healthy. Most of the time unhealthy mind determines body issues.

In order to address all ethical issues, behind any definitions sometimes opposed, we have to consider some real references such as the science aim, the science sense, the humanity defining. The science tendency is to help the humans to better integrate to the nature, to work together with the nature. That is why only the information is not enough. It must be mapped on humanity and processed and controlled by the moral values that are above any value. This is how the bioethics became a topic of the last period interest. The whole society is interested on this subject and the bioethical discourse is shaped by the moral experts and the civil society.

4. CONCLUSIONS

Our intention on this paper is only to inform both the doctors and patients, and even those designing such kind of technologies, on the related issues. The main risks associated to this technology are the autonomy and confidentiality breach, to the informed consent from the patient side and to the human to human relationship damage.

The telemedicine has a great health care providing potential especially on the inaccessible on a daily basis areas. It provides virtual clinics but it does not exclude the face to face meeting, in order to better get the feeling on the patient medical status, thoughts about the treatment, the procedures. This is indeed important for those patients without family support, living alone.

In spite of the general idea that the bioethics is delaying many times the technological process that is however getting ahead, its aim is only on informing on any possible way about both the good and the bad effects.

Around the world, the data confidentiality is a concept currently quite well controlled by hiring contracts, professional ethical codes, administrative laws and the Human Rights Act (1998) and either other documents and laws. In order to avoid bioethical principle breach, through the health care providing process, especially when comes about the telemedicine, where the patient doctor relationship is basically remote based, the responsibilities must be clearly underlined. Proactive attitude must be added from the health care providers. Currently, most of the health care organizations are reactive. They are running procedures after the events happened, instead of taking prevention attitude.

5. REFERENCES

[1] KLEMENS, J., *Ethical considerations of privacy and cyber-medical information*, Legal: Cyber Law, april 2, 2008

[2] NORMANDIN, S., R., *An international quality care solution,* Patient Safety & Quality Healthcare, January/February, 2008

[3] KARANTH, G., K., Patient, doctor and telemedicine. Some ethical issues, http://nbc.ijme.in/nbcpdfs/KaranthGK.pdf

[4] SILVERMAN, R., D., *Current legal and ethical concerns in telemedicine and e-medicine*, Journal of Telemedicine and Telecare, 2003; 9: S1

[5] MADDOX, P., J., *Ethics and the brave new world of e-health*, Online Journal of Issues in Nursing, 2002; 8

[6] YADAV, H., LIN, W., Y., *Patient confidentiality, ethics and licensing in telemedicine*, Asian Pacific Journal of Public Health, 2002; 13: S

[7] YEO, C., J., J., *Ethical Dilemmas of the Practice of Medicine in the Information Technology Age*, Singapore Med J 2003 Vol 44(3): 141-144

[8] BEAUCHAMP, T., L, CHILDRESS J., F., *Principles of Biomedical Ethics*, 4th ed. New York: Oxford University Press; 1994

[9] STRODE, S., W, GUSTKE, S,, ALLEN, A., *Technical and Clinical Progress in Telemedicine*, JAMA 1999; 281:1066-8

[10] PERRY, J., BEYER, S., FRANCIS, J., HOLMES, P., *Ethical issues in the use of telecare*, ADULTS' SERVICES report 30, Great Britain, May 2010

[11] OGAWA, M., Togawa, T., *Monitoring Daily Activities and Behaviors at Home by Using Brief Sensor*, 1st Annual International IEEE - EMBS Special Topic Conference on Microtechnology in Medicine&Biology, Lyon, France, 2000

[12] DAVID, P., L. *Assessing technological barriers to telemedicine: technology-management implications*, IEEE Transactions on engineering management, vol. 46, nr. 3, august, 1999

[13] PENDERS, J., *Privacy in (mobile) telecommunications services*, Ethics and Information Technology, nr. 6, pg. 247-260, 2004

[14] ROSS, E., *Smart Home, Managing Care Through the Air*, IEEE Spectrum, decembrie, pg. 14-19, 2004

[15] STANBERRY, B., *Telemedicine: barriers and opportunities in the 21th century*, Journal of Internal Medicine, nr. 247, pg. 615-628, 2000

IMPROVEMENTS OF THE DIRECT TORQUE CONTROLLED INDUCTION MOTOR DRIVES

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ABSTRACT

This paper presents two methods for reducing the torque ripple of the conventional Direct Torque Control (DTC) of induction motor drives. The methods were implemented on a Digital Signal Controller, their effectiveness was evaluated for a set of motor operating points and the experimental results are comparatively presented.

Keywords: *Direct torque control, torque ripple, pulse width modulation, space vector modulation.*

1. INTRODUCTION

Direct Torque Control (DTC) is a high performance control strategy for induction motor drives fed by Voltage Source Inverters (VSI) [1]. The main advantages of DTC are the simple control scheme, a very good torque dynamic response, absence of the inner current loops and rotor position/speed measurement. These advantages make DTC an attractive option for applications that require a very fast torque response, torque reference input (no speed control, but torque control only) and improved reliability in harsh environments (dust, vibrations conditions), due to the absence of the rotor position transducer.

However, the main drawback of the conventional DTC is the high torque ripple generated in steady state operation.

In conventional DTC, the voltage vector selection is based on the torque and flux errors, but small and large errors are not differentiated by the hysteresis controllers. The voltage vectors are applied for the entire sample period, even for small errors, resulting large torque overshoots in steady-state regime.

One approach to reduce the ripple is to increase the number of voltage vectors applied in a sampling period, using some sorts of pulse-width modulation (PWM). Among the possible choices, a simpler one is to use two voltage vectors: a nonzero one, applied for a fraction of the sampling period, and the null vector for the rest. The duty ratio must be calculated each sample period, and by varying it between its extreme values, it is possible to apply more voltage levels to the motor, according to the desired torque variation. In [2], an analytical online algorithm calculates the optimum duty ratio each sampling period, by using a torque ripple minimization condition, which is based on ripple equations. However, this algorithm requires high computational effort and additional motor parameters to be known. In [3] the duty ratio value is provided by a new fuzzy logic module, whose inputs are the stator flux position, the electromagnetic torque and an input defining the motor operating point, given by the speed and the torque values. This algorithm involves expert knowledge and needs the rotor speed.

To overcome this problem, the authors proposed two modified DTC schemes, which are based on the idea of increasing the number of voltage vectors applied in a sample period. This makes it possible to obtain more voltage levels at the inverter output, in accordance to the desired torque and flux variations.

The proposed schemes were experimentally tested for a set of motor operating points. Their effectiveness was evaluated by calculating the root mean square (RMS) deviation of the instant torque values with respect to the load torque, in steady state regime.

The paper presents the DTC principle, the proposed schemes, graphical and numerical experimental results of the tests that were conducted to evaluate the effectiveness of the proposed control schemes, and the conclusions.

2. DIRECT TORQUE CONTROL PRINCIPLE

The basic model of the classical DTC induction motor scheme is shown in figure 1. It consists of torque and stator flux estimators, torque and flux hysteresis comparators, a switching table and a VSI. The basic idea of DTC is to choose the optimum inverter voltage vector in order to control both stator flux and electromagnetic torque of machine simultaneously [1].

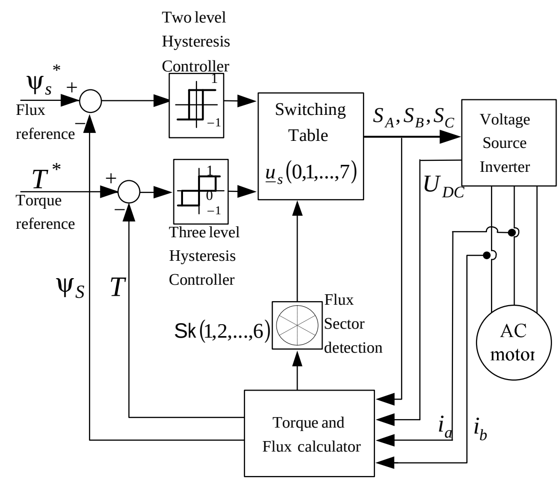

Figure 1 Block diagram of the conventional DTC

The stator flux space vector, $\underline{\psi}_s$, is calculated in the stationary reference frame $(\alpha-\beta)$ using the stator voltage equations [5]. The circular trajectory of stator flux is divided into six symmetrical sectors referred to inverter voltage vectors. The $\alpha-\beta$ components of the stator flux are used to determine the sector in which the flux vector is located. The calculated magnitude of stator flux and electromagnetic torque are compared with their reference values in their corresponding hysteresis comparators. Finally, the outputs of the comparators and the number of sector at which the stator flux space vector is located are fed to a switching table to select an appropriate inverter voltage vector [4].

2. THE PROPOSED DTC METHODS FOR TORQUE RIPPLE REDUCTION

In conventional DTC, a single stator voltage vector of the inverter standard topology is selected during every control sampling period, and it is maintained constant for the whole period. By this switching technique, based on hysteresis, large and small torque and flux errors are not differentiated, which causes an extra torque ripple in motor steady state operation.

The both proposed methods are based on the idea of increasing the number of voltage vectors applied in a sample period. Their principles are differentiated by the voltage vector calculation criteria and mode of applying this vector to the inverter.

2.1. DTC with the variable amplitude of the inverter basic space phasors

This first method consists in the modulation of the nonzero voltage vector duration over a sampling period, according to the torque and stator flux errors, using symmetric PWM. The nonzero voltage vectors are selected using a switching table, like in classical DTC. The null vectors are automatically inserted by using PWM, so they are no more needed in the switching table. Consequently, in the proposed control scheme, shown in figure 2, simple comparators, with no hysteresis, are used. A duty ratio calculator and a PWM block have been added to the classical scheme.

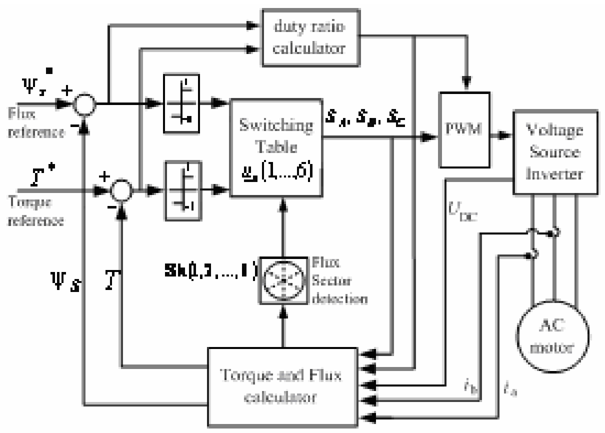

Figure 2 Block diagram of the first proposed method

Every sample time, one of the six nonzero voltage vectors are selected from the switching table, and it is applied to the inverter using symmetric PWM switching strategy. The PWM period is considered equal to the control sample period.

To apply to the inverter the selected voltage vector (denoting the corresponding inverter switching states S_i, $i = A, B, C$), with a given duty ratio, it was adopted the following method: for $S_i = 0$, the pulse duty ratio of the corresponding inverter leg takes zero value, otherwise it takes the calculated value.

The calculation procedure of the duty ratio is presented below.

In order to preserve the very good dynamic response of the classical DTC, the voltage duty ratio is modified only when the actual torque value is located in a ”proximity” zone, around the reference value, otherwise it is kept at 100%. This zone, whose width is denoted by Z_T, is similar to the torque hysteresis band of the classical DTC torque comparator.

The duty ratio, as a function of the torque and flux error, is calculated as in (1), so that to be a fractional value.

$$\delta = \left|\frac{\varepsilon_T}{Z_T}\right| + \left|\frac{\varepsilon_F}{Z_F}\right|\left(1 - \left|\frac{\varepsilon_T}{Z_T}\right|\right) \leq 1 \qquad (1)$$

where: ε_T and ε_F are the torque error and respectively the flux error;

Z_T and Z_F are the corresponding base values used for normalization.

The second term in (1) was introduced in order to avoid the flux decrease at low frequencies, due to the stator ohmic drops, which can occur when the torque error becomes too small. This term takes into account the flux error, which is normalized in the same manner as the torque error.

The duty ratio δ is limited to a minimum value, δ_{min}, in order to consider the maximum switching frequency of the inverter.

Considering the voltage duty ratio, the line voltage at the inverter output is given by (2).

$$U_l = \delta \cdot U_{DC} \qquad (2)$$

where: U_l is the line voltage at the inverter output,

U_{DC} is the DC link voltage.

At current sample time, the (α,β) components of the stator voltage are calculated using (3) and (4).

$$u_{s\alpha} = \frac{2}{3}\delta U_{DC}\left(S_A - \frac{S_B - S_C}{2}\right) \qquad (3)$$

$$u_{s\beta} = \frac{2}{3}\delta U_{DC}\frac{S_B - S_C}{\sqrt{3}}, \qquad (4)$$

where δ is the duty ratio calculated at previous sample time.

2.1.2. DTC using Space Vector Modulation

In this second method, a reference stator voltage space vector is calculated, in terms of magnitude and phase, using the instant values of torque and stator flux errors, and the flux position.

A normalized value of the reference voltage magnitude was calculated using equation (5). The right side of the equation is the same as that utilized for the duty ratio calculation in the previous scheme.

$$m = \left|\frac{\varepsilon_T}{Z_T}\right| + \left|\frac{\varepsilon_F}{Z_F}\right|\left(1 - \left|\frac{\varepsilon_T}{Z_T}\right|\right) \le 1 \qquad (5)$$

For torque and flux errors situated in these zones, m is calculated using the expression (5), otherwise m equals unity [9].

As regarding the voltage vector phase, its calculation is based on the conventional DTC principle. As presented in Section 2, the main idea of DTC is to choose the optimum voltage vector in order to achieve a simultaneous and decoupled control of the stator flux and electromagnetic torque. Every control sample time, one of the inverter voltage vectors is selected according to the torque and flux errors and the sector in which the actual flux vector is situated. The phase difference, $\Delta\theta$, between the selected voltage vector and the middle of the flux sector, is $k \cdot \pi / 3$, where $k \in \{-2, -1, 1, 2\}$. It can be proved that for a given voltage vector and a flux sector, the torque slope depends on the flux vector phase angle.

This determines a irregular torque ripple in steady state operation, especially when the sector changes. In order to obtain a uniform torque ripple, the above mentioned dependency can be eliminated by considering a voltage vector which is phase shifted with $\Delta\theta$ relatively to the flux vector phase angle (θ), instead of the middle of the sector like in the conventional DTC. For simplicity, there were preserved the phase difference quantities. The phase of the reference voltage vector is calculated by adding to the flux phase angle the phase difference $\Delta\theta$, whose value is simply derived from the sign of the torque and flux errors, like in equation (6).

$$\Delta\theta = \mathrm{sign}(\varepsilon_T) \cdot \frac{\pi}{6}\left(3 - \mathrm{sign}(\varepsilon_F)\right) \qquad (6)$$

$$\alpha = \theta + \Delta\theta \qquad (7)$$

The reference voltage vector, with the calculated magnitude, m, and phase θ, is applied to the inverter using Space Vector Modulation. In the linear region, the voltage vector at the inverter output is:

$$\underline{U}_{ref} = m \cdot \frac{\sqrt{3}}{2}\left|\underline{u}_i\right| \cdot e^{j\alpha} \qquad (13)$$

where: $\left|\underline{u}_i\right|$ is the modulus of the inverter basic space vectors.

$m = \dfrac{\left|\underline{U}\right|_{ref}}{\left|\underline{U}\right|_{max}}$ is the normalized value of the reference voltage vector magnitude;

$\left|\underline{U}\right|_{ref}$ is the magnitude of the reference voltage.

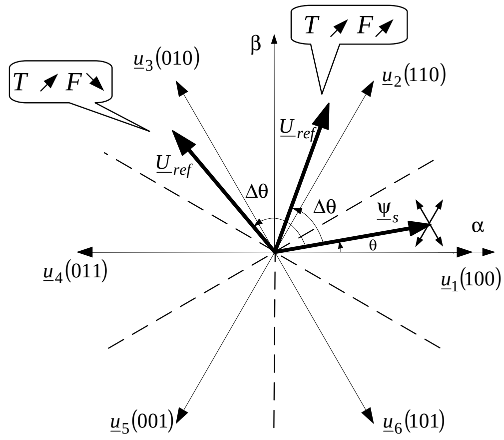

Figure 3 The voltage space phasor angle for two cases of torque and flux commands

The principle of the presented method is illustrated in figure 3, for two cases of torque and flux commands.

In figure 4 it is presented the block diagram of the proposed DTC-SVM scheme [5].

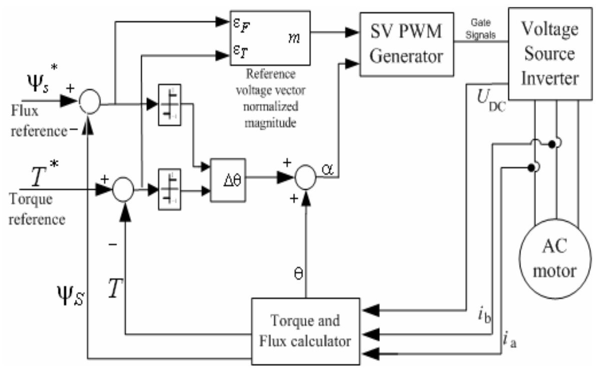

Figure 4 Block diagram of the second proposed method

3. EXPERIMENTAL RESULTS

The proposed methods, along with the conventional DTC, were implemented on a Digital Signal Controller, and tested for a series of motor operating points, given by torque and speed. The results obtained for an induction motor drive by using the conventional DTC and DTC with the proposed methods of torque ripple reduction are comparatively presented in this section.

In figure 5 it is presented the experimental set-up.

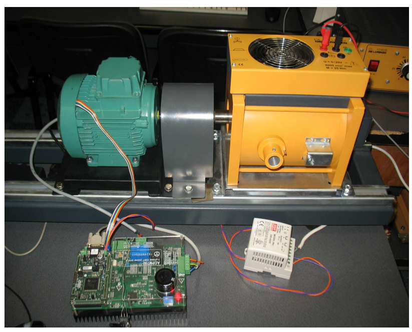

Figure 5 Picture of the experimental set-up

The experimental scheme used for the tests is shown in Figure 6.

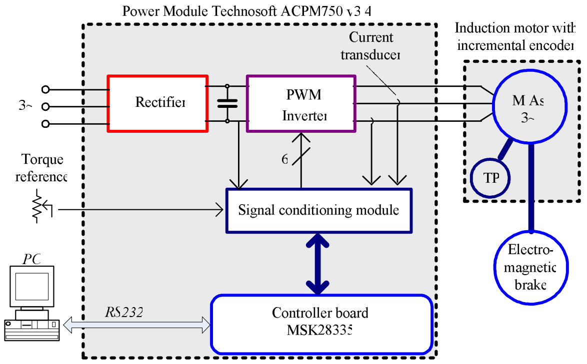

Figure 6 The scheme of the experimental set-up

The components of the experimental set-up are:

- 3-Phase IGBT Power Module, 750W, Technosoft ACPM 750 v3.4;
- Controller board MSK28335, with TMS320F28335 Digital Signal Controller, floating point, 150 MHz;
- Induction motor Sieber, 370 W, with incremental encoder;
- Electromagnetic brake, with magnetic powder, DeLorenzo DL1019P, capable of maintaining constant torque regardless the operating speed;
- Software development tool Technosoft DMC28x Developer Pro, used for application development, reference input and data logging;
- PC with RS232 communication.

The motor parameters are:

$P_n = 370\,W;\ n_n = 1390\,rpm;\ T_n = 5{,}15\,Nm$

$I_n = 2{,}1\,A\,(Y);\ R_s = 10\ \Omega;$

The control sampling period was set to 0.1 *ms* for all three control schemes, and in both proposed control schemes the PWM period was set to 10 kHz.

The tests were conducted so that to emphasize:

- the torque time response, as compared to the conventional DTC.
- the effectiveness of the proposed methods of torque ripple reduction, at different speeds and loads.

All the subsequent tests graphical results are expressed in relative units.

In order to correctly evaluate the torque transient response provided by the proposed methods, there was performed a prime test in which the torque reference was directly imposed, with no outer speed loop. The reference was prior programmed using the reference generator built into the DMC tool in the following sequence: at t = 0 s, $T_{ref} = 2T_n$, followed by $T_{ref} = T_n$ at t = 0.2 s and $T_{ref} = 0$ at t = 0.4 s.

The results, comparatively presented in figure 7, for conventional DTC and the two proposed DTC methods, show that the fast torque response of the conventional DTC was preserved, with an insignificant delay. Moreover, the steady state error of the torque, which is inherent in conventional DTC [9], is eliminated by the proposed schemes, due to the torque reference correction [8]

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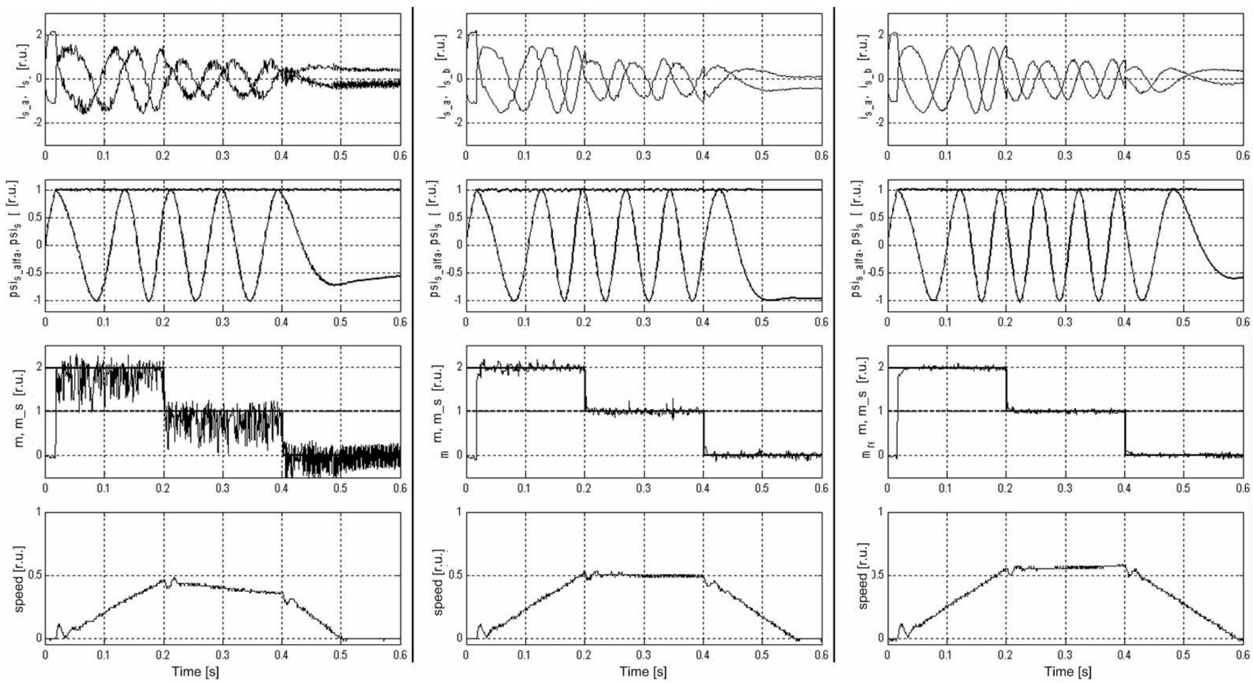

Figure 7 Comparative results from the first experimental test, emphasizing the torque response in the case of conventional DTC (a), and DTC with the first and second proposed methods (b) and (c) respectively. The quantities represented, up to down, are: two stator phase currents, estimated stator flux module and the flux component on phase alpha, torque reference and estimated torque, measured speed.

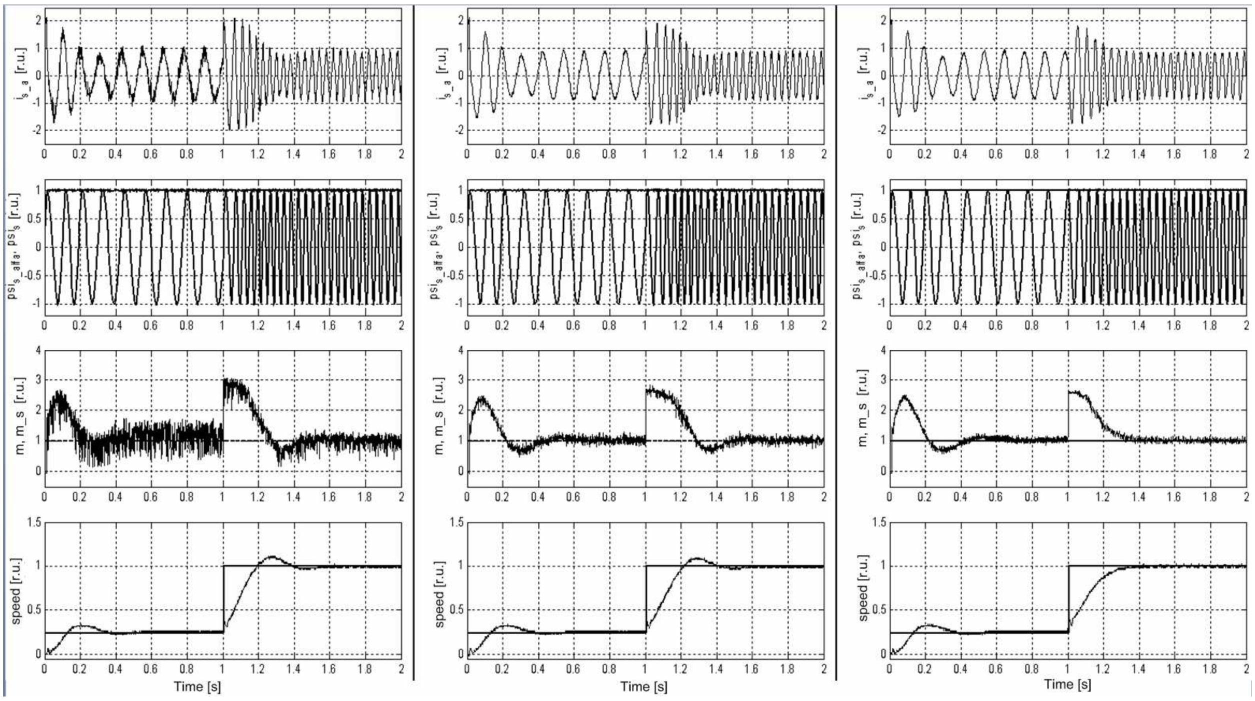

Figure 8 Comparative results from the second experimental test, emphasizing the torque ripple reduction, as compared to conventional DTC (a), achieved by the first and second proposed methods (b) and (c) respectively. The quantities represented, up to down, are: two stator phase currents, estimated stator flux module and the flux component on phase alpha, torque reference and estimated torque, measured speed.

The second test was conducted to evaluate the effectiveness of the proposed methods of torque ripple reduction, at different values of speed and load torque. For this purpose, an external speed loop was added to the control scheme, so that the torque behavior can be clearly observed at constant speed.

Note that the speed transient response is not relevant in this case, since the test was focused on the steady state behavior.

The test consists in running the motor at low and high speeds, for different loads, in the cases of conventional DTC and respectively the two proposed methods of torque ripple reduction.

The test revealed that the torque ripple is significantly reduced by using the proposed methods, for both low and rated speed operation. Sample results of the performed tests are comparatively presented in figure 8, for the case of load equal to the rated torque, and two speed levels of 25% and 100% of the rated speed. The quantities represented are: two stator phase currents, estimated stator flux module and the flux component on phase alpha, torque reference and estimated torque, measured speed. All quantities are expressed in relative units, with respect to the corresponding rated values.

For a quantitative evaluation of the proposed methods effectiveness, in table 1 it is presented the root mean square (RMS) deviation of the developed torque, with respect to the load torque. The presented values are calculated for a set of operating points, defined by speed and load torque, in steady state regime.

For better readability, the speed and torque are expressed in percent of the corresponding rated values, and the torque standard deviation is expressed in percent of the rated torque.

Table 1. Root mean square (RMS) deviation of the instant torque values from the load torque

		RMS of the torque deviation in percent of T_N, $\sigma_M^{(pc)}$ [%]		
speed [%]	torque [%]	Conventional DTC	DTC with variable duty ratio	DTC using SVM
25	25	34	8.3	5.3
	100	23	8	5.7
100	25	33.5	9.9	6.4
	100	17.3	8.5	5.8

5. CONCLUSIONS

The paper presented two methods of torque ripple reduction, for the DTC.

In order to test the proposed methods, and to compare the resulted motor behavior, all the methods were implemented on a Digital Signal Controller and tested on a 3-phased voltage inverter drive.

The first proposed method has the advantage of preserving the structural simplicity of the conventional DTC, while adding very little computation effort.

In the second method, the torque ripple is reduced in a significant larger amount, but in the expense of an increased complexity, which is inherently added by the

SVM technique. However, SVM offers a better utilization of the inverter switching capability.

The experimental results proved the effectiveness of both proposed methods. Moreover, the corresponding control algorithms are simple and allow easy tuning.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] I. TAKAHASHI, T. NOGUCHI, *A new quick-response and high efficiency control strategy of an induction motor*, IEEE Trans. Ind. Applicat., IA, *22*, 1986.

[2] J. KANG, S. SUL, *New direct torque control of induction motor for minimum torque ripple and constant switching frequency*, IEEE Trans. Ind. Applicat., vol. 35, 1999.

[3] L. ROMERAL, A. ARIAS, E. ALDABAS AND M. G. JAYNE, *Novel Direct Torque Control Scheme With Fuzzy Adaptive Torque-Ripple Reduction*, IEEE Trans. Ind. Applicat., vol. 50, June 2003.

[4] P. VAS, *Sensorless Vector and Direct Torque Control*. New York: Oxford University Press, 1998.

[5] S. V. PATURCA, M. COVRIG, C. CEPISCA, G. SERITAN, *Proposed Schemes for Improving the Steady State Behaviour of Direct Torque Controlled Induction Motor*, Proceedings of the 7th WSEAS International Conference on POWER SYSTEMS (PE'07), Beijing, China, 2007

[6] S.V. PAȚURCĂ, M.COVRIG, *Direct Torque Control with Variable Voltage Duty Ratio for Inverter Fed Induction Motor Drives*, Proceedings of the 10th WSEAS International Conference on Automatic Control, Modelling & Simulation (ACMOS'08), Turkey, 2008

[7] S.V. PAȚURCĂ *Comenzi moderne în sisteme de acționări*, Bucuresti, Ed. Matrix Rom, 2011

[8] S.V. PAȚURCĂ, *Contribuții la comanda numerică cu controlere industriale, a acționărilor electrice*, Ph.D. thesis, University "Politehnica" of Bucharest, 2010

[9] L. ROMERAL, A. ARIAS, E. ALDABAS AND M. G. JAYNE, *Novel Direct Torque Control (DTC) Scheme With Fuzzy Adaptive Torque-Ripple Reduction*, IEEE Trans. Ind. Applicat., vol. 50, 2003.

[10] S.V. PATURCA, A. SARCA, M. COVRIG, *A Simple Method Torque Ripple reduction for Direct Torque Control of PWM Inverter-Fed Induction Machines Drives*, 8th International Conference on Applied Electricity, ICATE 2006.

CLOUD CONTENT DISTRIBUTION NETWORKS FOR DVB APPLICATIONS

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ABSTRACT

In this paper we present the integration of Digital Video Broadcasting (DVB) applications and Cloud Content Delivery Networks (CDN). DVB works reasonably well in the sens that the system is very scalable and can sustain very high request rates. But it also has its limitations and lack of geographic replication is one of them in the context of CDN use. So offering a true solution to getting video and audio web content rapidly to browsers across the world is most welcome. With SlapOS, the proposed open source distributed cloud system, we implement a testbed for content distribution service that caches content at different locations based on the access patterns of the individual users. We demonstrate that by using distributed cloud computing our platform is more scalable and resilient than many other DVB to IP gateway systems, and much easier to handle when it comes to offering access to different types of fixed and mobile IP terminals.

Keywords: *DVB, cloud computing, DTT, broadcasting, content delivery network.*

1. INTRODUCTION

Internet users are increasingly adding video content to existing online services and applications, therefore having the effect that the number of people viewing videos online has grown over the past year and the time spent per viewer has increased accordingly. Google sites, including YouTube, continue to be the most watched online video sites with more than 35.4 million Google sites visitors watching YouTube [1].

We will focus in this paper on using existing DVB platforms and adding cloud technology for improving content distribution to IP interconnected devices. We will introduce also SlapOS [2], the first open source operating system for Distributed Cloud Computing. SlapOS is based on a grid computing daemon called slapgrid which is capable of installing any software on a PC and instantiate any number of processes of potentially infinite duration of any installed software [3]. Slapgrid daemon receives requests from a central scheduler the SlapOS Master which collects back accounting information from each process. SlapOS Master follows an Enterprise Resource Planning (ERP) model to handle at the same time process allocation optimization and billing. SLAP stands for “Simple Language for Accounting and Provisioning”.

This structure has been implemented for cloud-based automation of ERP and CRM software for small businesses and aspects are under development under the framework of the European research project “Cloud Consulting” [4]. The goal of Cloud Consulting is to create new technologies which automate the configuration of ERP and Customer Relationship Management software for the benefit of SMBs.

DVB consists of a transmitting system for compressed digital signals over the available channel's frequencies that makes possible to broadcast more channels with better-quality pictures and sound than traditional analogue television. In its recent research of television policy, the Romanian Government called for the development of digital terrestrial television (DTT) to optimize the shortage of the broadcast spectrum for regular television broadcasting [5].

The objectives of our work are to demonstrate that cloud computing is a well-developed and mature technology that can be used to improve the scalability of DVB content distribution applications over IP networks and to offer full access to video programs to all IP based terminals such as set-tops, TV, smart phones and multimedia PCs.

The paper is structured as follows. Section II describes a distributed architecture for cloud platforms and identifies common functions. Section III presents an example to design and implement an open source test platform for cloud content delivery network. Section IV describes an approach to test different DVB to IP cloud solutions and an example of testbed using SlapOS. The conclusion summarizes the contributions.

2. ARCHITECTURE DESCRIPTION

2.1 Cloud Architecture

SlapOS is an open source Cloud Operating system which was inspired by recent research in Grid Computing and in particular by BonjourGrid [6] a meta Desktop Grid middleware for the coordination of multiple instances of Desktop Grid middleware. It is based on the motto that ”everything is a process”.

SlapOS is based on a Master and Slave design. In this chapter we are going to provide an overview of SlapOS architecture and are going in particular to explain the role of Master node and Slave nodes, as well as the software components which they rely on to operate a distributed cloud for telemetry applications.

Slave nodes request to Master nodes which software they should install, which software they show run and report to Master node how much resources each running software has been using for a certain period of time. Master nodes keep track of available slave node capacity and available software. Master node also acts as a Web portal and Web service so that end users and software bots can request software instances which are instantiated and run on Slave nodes. Master nodes are stateful. Slave nodes are stateless. More precisely, all information required to rebuild a Slave node is stored in the Master node. This may include the URL of a backup service which keeps a online copy of data so that in case of failure of a Slave node, a replacement Slave node can be rebuilt with the same data.

It is thus very important to make sure that the state data present in Master node is well protected. This could be implemented by hosting Master node on a trusted Infrastrucure as a Service (IaaS) infrastructure with redundant resource. Or - better - by hosting multiple Master nodes on a many Slave nodes located in different regions of the world thanks to appropriate data redundancy heuristic. We are touching here the first reflexive nature of SlapOS. A SlapOS master is normally a running instance of SlapOS Master software instantiated on a collection of Slave nodes which, together, form a trusted hosting infrastructure. In other terms, SlapOS is self-hosted, as shown in Figure 1.

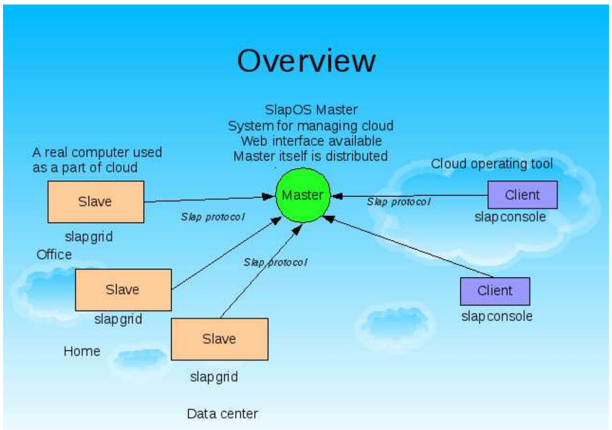

Figure 1 Example of master-slave architecture [2]

2.2 *Cloud Kernel*

SlapOS relies on mature software: buildout and supervisord. Both software are controlled by SLAPGrid, the only original software of SlapOS. SLAPGrid acts as a glue between SlapOS Master node (ERP5) and both buildout and supervisord, as shown in Figure 2. SLAPGrid requests to SlapOS Master Node which software should be installed and executed. SLAPGrid uses buildout to install software and supervisord to start and stop software processes. SLAPGrid also collects accounting data produced by each running software and sends it back to SlapOS Master.

SlapOS master nodes keep track of the identity of all parties which are involved in the process of requesting Cloud resources, accounting Cloud resources and billing Cloud resources. This includes end users (Person) and their company (Organisation). It includes suppliers of cloud resources as well as consumers of cloud resources. It also includes so-called computer partitions which may run a software robot to request Cloud resources without human intervention. It also includes Slave nodes which need to request to SlapOS master which resources should be allocated.

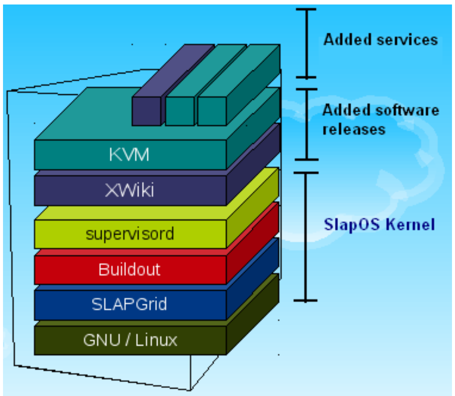

Figure 2 SlapOS Kernel and User Software example [2]

Any user, software or slave node with an X509 certificate may request resources to SlapOS Master node. SlapOS Master node plays here the same role as the back office of a marketplace. Each allocation request is recorded in SlapOS Master node as if it were a resource trading contract in which a resource consumer requests a given resource under certain conditions. The resource can be a NoSQL storage, a virtual machine, an ERP, etc. The conditions can include price, region (ex. China) or specific hardware (ex. 64 bit CPU). Conditions are somehow called Service Level Agreements (SLA) in other architectures but they are considered here rather as trading specifications that guarantees. It is even possible to specify a given computer rather than relying on the automated marketplace logic of SlapOS Master [7].

2.3 *State-of-the-art and comparison with other cloud approaches*

Many real-world systems involve large numbers of highly interconnected over Internet heterogeneous components. The Cloud is among one of the more promising system that will be deployed at a large scale in the near future because the field counts yet on many success stories: Amazon EC2, Windows Azure or Google App Engine [4].

The architecture used in our approach is a distributed cloud environment that is deployed on “volunteer PCs” at home, office or in small data centers and run SlapOS [2] open source cloud provisioning system, either standalone or in combination with existing virtualization technologies (OpenStack, OpenNebula, Eucalyptus, OCCI [8], VMWare, etc.).

Recent research on Cloud Computing has focused on the implementation of Service Level Agreements (SLA) and operation of large Data Centers. However, in case of Force Majeure such as natural disaster, strike, terrorism, unpreventable accident, etc., SLA no longer apply. Rather than centralizing Cloud Computing resources in large data centers, Distributed Cloud Computing resources are aggregated from a grid of standard PCs hosted in homes, offices and small data centers.

Based on the implemented scenario, several question rise regarding its performances and efficiency.

SlapOS nodes report on resources used and trusting client to report billing values is a well-known security issue. The security mechanisms included in SlapOS are setup to prevent a node from cheating on billing values reported. However traffic on unencrypted links could be intercepted and it is possible for a node to join the cloud and start sniffing sensitive data.

SlapOS uses buildout and a single URL to describe how to build and install software. This approach could be extended in different ways. Ideally, it should be possible to install software using other build systems or even by using packages (DEB, RPM). Also issues arise regarding Quality of Experience (QoE) during transcoding and multimedia mixing for offering video connectivity between mobile devices, tablets, PCs and set-top-boxes [9]

Nevertheless development is still needed for Slaprunner, the SlapOS buildout web based runner so that software profiles and release versions can be better managed and many other web-based applications added to the software release directory.

3. IMPLEMENTATION DETAILS

We will use the SlapOS platform implemented during the “Cloud Consulting” project [4] hosted on several servers running Ubuntu Linux – Apache – MySQL template with current software release.

SlapOS Master runs ERP5 Cloud Engine, a version of ERP5 open source ERP capable of allocating processes in relation with accounting and billing rules. Initial versions of SlapOS Master were installed and configured by human. Newer versions of SlapOS Master are implemented themselves as SlapOS Nodes, in a completely reflexive ways. A SlapOS Master can thus allocate a SlapOS Master which in turn can allocate another SlapOS Master, etc.

By default, SlapOS Master acts as an automatic marketplace. Requests are processed by trying to find a Slave node which meets all conditions which were specified. SlapOS thus needs to know which resources are available at a given time, at which price and under which characteristics. Last, SlapOS Master also needs to know which software can be installed on which Slave node and under which conditions

SlapOS Slave nodes are relatively simple compared to the Master node. Every slave node needs to run software requested by the Master node. It is thus on the Slave nodes that software is installed. To save disk space, Slave nodes only install the software which they really need.

Each slave node is divided into a certain number of so-called computer partitions. One may view a computer partition as a lightweight secure container, based on UNIX users and directories rather than on virtualization. A typical barebone PC can easily provide 100 computer partitions and can thus run 100 wordpress blogs or 100 e-commerce sites, each of which with its own independent database. A larger server can contain 200 to 500 computer partitions.

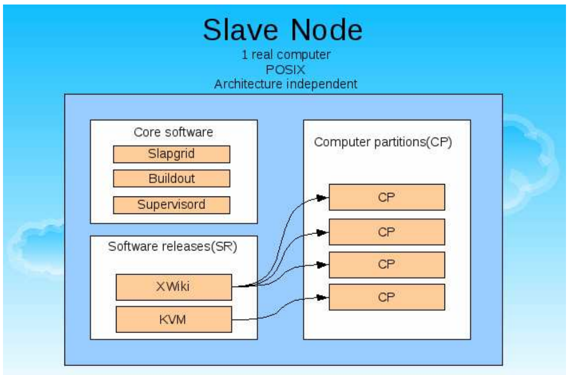

Figure 3 SlapOS Slave implementation [2]

SlapOS approach of computer partitions was designed to reduce costs drastically compared to approaches based on a disk images and virtualization. As presented in Figure 3, our current implementation does not prevent from running virtualization software inside a computer partition, which makes SlapOS at the same time cost efficient and compatible with legacy software

SlapOS Slave software consists of a POSIX operating system, SlapGRID, supervisord and buildout. SlapOS is designed to run on any operating system which supports GNU's glibc and supervisord. Such operating systems include for example GNU/Linux, FreeBSD, MacOS/X, Solaris, AIX, etc.

4. CLOUD DVB TEST PLATFORM

By using virtual servers running on a cloud-based platform it is simple to deploy new servers with specific roles configured in a single file and boot them on demand. The applications running on the cloud service provider test platform are presented in Figure 4.

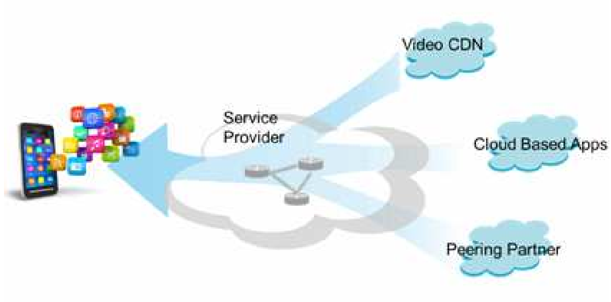

Figure 4 Cloud service provider platform for DVB applications

Example of cloud based apps tested are cloud based program recommendation systems for digital TV that enhances the traditional electronic program guides (EPG) by offering suggestions based on statistics obtained from data mining on large data sets and possibility of searching for TV shows based on popular keywords.

Our test platform is designed for a DVB to IP cloud content distribution network by using current DVB-T software releases and we intend to develop configuration templates also for DVB-T2 and future versions.

We implemented an automation mechanism which allows automatic movement of running virtual servers based on Python scripts, scheduling rules and load balancing algorithms, as well as start-up and shut down. This allows a cloud-based application to be resilient as well as energy efficient and to automatically start additional servers when the load increases. This approach is used widely by Amazon as it scales its active servers to follow the current demand for its services [10].

As standard servers are becoming more powerful and affordable, many of the broadcasting tasks, which historically have been handled by dedicated proprietary DSPs, are able now to be carried out, using software processing, on standard IT servers with cloud virtualization. When analyzing the broadcast workflow - ingest, transmission and uplink - of a typical publisher-broadcaster, we will find IT servers running applications at every stage. Even the complex functionality of a traditional broadcast chain - including the video server, presentation, logo generation, and graphics - can be replicated exactly using software running on a generic x86 server in the cloud [11].

Baseband video was first considered to be a problem for a cloud-based platform. The challenge was that the cloud based platform uses standardized interfaces such as Cat 5/6 and IPv4 or IPv6, and not broadcast-specific standards such as coaxial cables and DVB-T/S. In a cloud-based application, the essence of a broadcast transaction will remain the same, but the interface is likely to change. Its foundations will still be based on broadcast standards which cover the interface for transmission of 3G digital video signals over a single coaxial cable with BNC connectors.

The cloud infrastructure transports the real-time MPEG-2 or MPEG-4 encoded DVB-compliant stream via RTP/UDP over IP. By extending this type of routed infrastructure and stream-based workflow, the uplink site itself is effectively in the cloud and can receive DVB streams sent via IP for re-multiplexing or uplink directly to the DTT sites.

The advantage of cloud connected uplink sites is the possibility to apply routing to two geographically separate uplink sites. The digital media packets could be provided by cloud nodes hosted in cloud domains that might be physically on different continents and the masters always synchronized. The broadcaster service is therefore resilient, even in the event of total loss of a primary site.

5. CONCLUSIONS

SlapOS is capable of allocating resources for content distribution networks beyond the borders of traditional Cloud Computing by providing an ecosystem of virtual machines, application servers and databases for delivery of next generation IP services. That said, SlapOS can be used to operate Smart TV, Video on Demand and IPTV applications more efficiently.

The Cloud CDN has the potential to enhance the broadcast technology by enabling the provision of additional services quicker and at a lower cost than at any time in the past. To take advantage of these technologies, however, a next generation of systems integration is required, as well at the network and at the software interface level.

In the event of a force majeure, TV operators would only need Internet access to continue their streaming operations. Cloud-based broadcast operations could be running in a disaster recovery scenario, like recently in Japan, from small remote locations with broadband connectivity located on different continents.

As future work we envision an approach focused on the role of network management security in balancing the benefits and tradeoffs of digital video broadcast in the cloud.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] A. Sutherland, “The Story of Google”, The Rosen Publishing Group, 2012
[2] http://www.slapos.org (October 2012)
[3] The Free Cloud Alliance (FCA) Blueprint, http://www.freecloudalliance.org (October 2012)
[4] G. Suciu, O. Fratu, S. Halunga, C. G. Cernat, V. A. Poenaru, and V. Suciu, “Cloud Consulting: ERP and Communication Application Integration in Open Source Cloud Systems,” 19th Telecommunications Forum - TELFOR 2011, IEEE Communications Society, 2011
[5] “Politics and strategy for the transition from analog terrestrial television to digital terrestrial broadcasting and implementation of digital multimedia services at national level,”http://ec.europa.eu/information_society/policy/ecomm/doc/current/broadcasting/switchover/ro_2009_switchover.pdf (October 2012)
[6] H. Abbes, C. Cerin, and M. Jemni, “A decentralized and fault-tolerant Desktop Grid system for distributed applications,” Concurrency and Computation: Practice and Experience, vol. 22, no. 03, 2010
[7] http://www.osoe-project.org (October 2012)
[8] http://occi-wg.org/ (October 2012)
[9] D. Strohmeier, S. Jumisko-Pyykko, K. Kunze, and M. O. Bici, “The Extended-OPQMethod for User-Centered Quality of Experience Evaluation: A Study forMobile 3D Video Broadcasting over DVB-H,” Hindawi Publishing Corporation, EURASIP Journal on Image and Video Processing, 2011.
[10] T. Ng, G. Wang, "The impact of virtualization on network performance of Amazon EC2 data center," IEEE INFOCOM 2010 - 29th IEEE International Conference on Computer Communications, vol. 29, no. 01, 2010.
[11] A. Davies, “Using the cloud,” Broadcast Engineering, vol. 54, 2012.

FUZZY CONTROL OF A NONLINEAR PROCESS BELONGING TO THE NUCLEAR POWER PLANT WITH A CANDU 600 REACTOR

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ABSTRACT

The present paper is set on presenting a highly intelligent configuration, capable of controlling, without the need of the human factor, a complete nuclear power plant type of system, giving it the status of an autonomous system. The urge for such a controlling system is justified by the amount of drawbacks that appear in real life as disadvantages, loses and sometimes even inefficiency in the current controlling and comanding systems of the nuclear reactors. The application stands in the comand sent from the auxiliary feedwater flow control valves to the steam generators.

As an environment fit for development I chose Matlab Simulink to simulate the behaviour of the process and the adjusted system. Comparing the results obtained after the fuzzy regulation with those obtained after the classical regulation, we can demonstrate the necessity of implementing artificial intelligence techniques in nuclear power plants and we can agree to the advantages of being able to control everything automatically.

Keywords: *Distributed Control System (DCS), smart control, simulation, artificial intelligence, fuzzy controller*

1. INTRODUCTION

The multilateral evolution of human society, determined by the expansion of the technical progress, is required to meet growing needs, both in terms of quality and quantity. In order to manufacture certain products or to conduct certain processes, experts had to build and put into operation large industrial plants and complexes, which they considered to be complex systems. [1]

It can be said that a nuclear unit (NU), regardless of the chain reactor embedded, is indisputably a complex system.

The unit consists of several main systems:

Primary Heat Transport System (primary)

The Turbine-Generator System (secondary)

The Steam Boiler System, considered to be the interface between the first two systems.

All three systems contain more than 100 technological subsystems placed in different hierachical structures. For instance, the water supply system (second tier) of the steam generator (first tier) brings together many subordinate systems (third tier):

The Adjusting of Feedwater Flow

The Boiler Feed Pumps

The Auxiliary Pump Subsystem

The Condenser System

The structure of these systems/ subsystems is made up of thousand of components of different sizes and with different destinations.

Due to the uniqueness of the technological process (nuclear processes), this domain is highly prone to hazardous events. Specific data have shown that the complex system called ‘nuclear power plant’ must reach a global optimum in relation to three criteria:

-system efficiency

-system cost

-operational security

Besides the specific attributes of any complex system, the NPP domain highlights a number of technological features that are worth mentioning: the increased complexity which, among other things, implies the following demands:

to organize and execute all maintainance activities at a high professional level;

to ensure a far greater use to the appliances;

to ensure efficient management.

The high degree of risk asociated to some activities is the third criteria of performance (operational security). Among these activities, the following stand out:

the development of safety standards, included in policies and laws, that form the target of nuclear safety;

the implementation of security systems meant to ensure obedience when it comes to these norms.

As it is known, security systems are waiting systems: they need to keep their intervention capacity unaltered, to preserve it, although no need for such intervention is very much desired.

Security analysis is a means of confirming (or denying) this preservation and the efficiency of these systems comes out after the risk analysis.

2. SMART CONTROL WITH A HIGH DEGREE OF AUTONOMY FOR THE NPP THAT CONTAINS A CANDU 600 TYPE REACTOR

The smart autonomous command and control system (SIACC) for the NPP with a CANDU600 type of reactor, that is described in this paper, can be used for any sort of nuclear reactor due to a property through which the system can access auto-renewal. Automatic renewal is necessary in order for the system to make the proper decission when dealing with a multitude of dangerous situations in a NPP.

SIACC will have a hierarchical architecture, qualifying itself for the standards of the autonomous smart systems, as shown in [2].

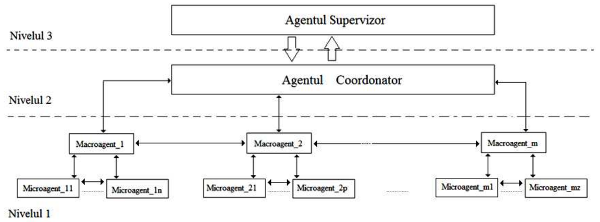

Figure 1 The architecture of the smart control solution with a high degree of autonomy for NPP

On the first level of the hierarchy we can find the micro-agents, coordinated by the macro-agents. On the second level we have the agent of coordination and on the last level the supervisor. The supervisor has the role of maintaining the smooth functioning of the entire NPP system. He is the only one that can give the order for it to shut down. The agent coordination manages communication between macro-agents, giving them priority in communication and negotiating communication channels between them. They also interpret the commands given by the supervisor and sends those commands to the macro-agents.

The macro-agents control the component systems of CNE, while the micro-agents deals with the functional units of the system.

The macro-agents control the component systems of CNE, while the micro-agents deals with the functional units of the system.

Micro-agents are responsible for the subsystems within the major systems of the reactor. They are design to retrieve and monitor field parameters. Monitoring also includes framing values in the allowable variation domains that are characteristic to each of them, also setting off proper alarms when it comes to exceeding thresholds.

In the system described here, there is no need for old-fashioned setting; we can simply use the smart tecniques, namely those based on fuzzy logic.

The degree of intelligence that the macro-agents posses is superior to that of the micro-agents. Micro-agents are implemented using small-dimensional systems, based on knowledge capable of understanding and interpreting information received from a higher level as well as a lower level (two different languages).

An important factor in demonstrating the high-degree level of intellingence is, as mentioned before, the capacity of macro-agents to auto-renew their systematic parameters that can allow optimal system operation. This demonstrates their usefulness and efficiency in commanding systems other than those destined for NPP with reactors of the CANDU type.

On the next hierarchical level there is the agent coordination which has the role of ensuring communication between the supervisor and the macro-agents. The coordinator takes some crisp values of the parameters that have an essential role in the dinamics of the plant and processes them, turning them into linguistic indicators of the system's well-functioning. These indicators are transmitted to the supervisor in order to be used as parameters of functions performed by it.

As the supervisor is meant to replace the human operator, it uses methods of processing which mimic brain functioning. This involves replacing crisp values with linguistic values or values based on knowledge and association. It is for these reasons that the information coming from the supervisor needs processing, so that it can be sent back by the macro-agents.

At this hierarchic level, the integrated techniques are mainly smart. The degree of precission will lower as they will climb up the scale.

The supervisor monitors the well functioning of the entire NPP system and, based on the linguistic indicators received from the immediate inferior rank, it will elaborate the law of auto-renewal in case the indicators point out a change in the system's dynamics.

This level is a hybrid system that combines all the techniques of the artificial intelligence. Fuzzy systems have the task of achieving a 'communication protocol' with the coordinator. Once the linguistic indicators are received, they are processed in genetic algorithms that determine normal plant behaviour in perspective. This means that the system is evolving, if it manages to maintain the current parameter values in the range of variation. Thus, predictively, a behavioral type of control is performed, capable of preventing any future abnormality and capable of ensuring a high degree of autonomy and efficiency. In the case in which, as a result of processing, appears the need for initializing the configuration of the distributed control system, the same genetic algorithms mentioned earlier tell us about the parameters used by the neural networks in developing new managerial policies.

The supervisor is the agent that controls the whole NPP. At this level (the last of the hierarchy) the degree of precission is zero, while the degree of intelligence is at maximum.

We can conclude that in the fundamental structuring of the system, the degree of intelligence goes higher when the degree of precission lowers along the three hierarchic levels. The following principle emerges: the way intelligence goes up and the way precission goes down the scale and vice versa if we are dealing with a case of a three level structuring [2].

3. THE FUZZY CONTROL OVER AN NONLINEAR PROCESS BELONGING TO THE NUCLEAR POWER PLANT WITH A CANDU 600 REACTOR

In the following we suggest a smart control solution at a reduced scale, more precisely a fuzzy controller to control the flow control valve of the nuclear power plant at Cernavoda. Starting from the mathematical model a valve system, the transfer function is calculated based on simulating the behaviour of a valve without in absence of a smart control.

Using open-loop system response, we will pinpoint the performance of the system and we will set new performance in order to build a smart controller.

Thus, we have watched a demonstration of how superior the adjusting solutions based on techniques of artificial intelligence. The classic techniques are losing points when it comes to the simplicity of determining the the law of adjustment which, in the case of nonlinear processes, is very hard to explain, because it involves complicated mathematical calculations.

The adjusting techniques that use smart controllers are capable of automatic renewal, being able to adjust any type of system, regardless of the complexity of its mathematical model.

The water supply system of a CANDU nuclear power plant can ensure ongoing flow from the condensor to the steam generators. Controlling the flow is very important for the proper functioning of the nuclear power plant. The subsystem that adjusts that control is a flow valve (feedwater control valve FCV119), one of the final elements of the plant distributed control system.

Dynamic performance operation also depends on the law of control used and it mainly refers to stabilize and reduce transient processes derived from various operating conditions of the water supply subsystem.

In these paper we will propose synthesis solutions on how control can make the process more efficient.

3.1 Valve FCV119 must respond for the way the operating system is characterized

The basic function of the feedwater system (FWS) is the control over the feedwater flow that heads to the steam generators.

FWS main operating parameters are presented in Table 1:

Table 1 Nominal feedwater parameters

Parameter	Value
Temperature at the entrance of SG	187 °C
Pressure at the entrance of SG	48, 26 bar (a)
Debit entry in SG	3510, 732 t/h

The time of closing/opening for the flow control valves,as well as for the motorized valves for flow isolation, is of ≥20 s. The adjustment of a larger reinforcing can sometimes cause the system to remain stuck on a closed position, while the adjustment of a smaller reinforcing causes failure on an open position.

The thermal-hydraulic parameters of the water supply for the steam generators at different power levels of the reactor have their values given in Table 2.

3.2 The mathematical model

The constitutive assumptions of the simplified linear mathematical model of the motion of subsystem FCV 119 are the following:

a) the actuator has equal active surfaces of the piston
b) dead zone thresholds of the controller are neglected
c) the pressure and control of flow characteristics of the controller and of the amplifier output is considered to be liniar (proportional to a current and, of couse, proportional to a control pressure).
d) in the case of linearity, we take into account the hypothesis of small variable variations close to a position of equilibrium
e) dynamic phenomena in the upstream and downstream hydraulic piping system of the FCV119 control valve are neglected
f) stationary and transient hydrodynamic forces on the piston actuator are neglected
g) the stabilizing effect introduced by the amplifier with a bypass flow throttle is neglected.

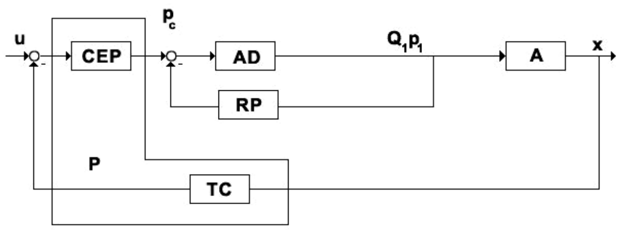

Figure 2 Block diagram of FCV 119 system

Given these conditions, the mathematical model of the valve actuator piston movement is defined by the following system of equations:

$$\begin{aligned} &m\ddot{x} + f\dot{x} = S(p_1 - p_2) \\ &S\dot{x} + \frac{V_1}{B}\dot{p}_1 = k'_{Qp}[k_{pu}(u - k_x x) - p_1] \\ &-S\dot{x} + \frac{V_2}{B}\dot{p}_2 = k''_{Qp}[-k_{pu}(u - k_x x) - p_2] \end{aligned} \quad (1)$$

where:
x is the output variable – varying variable of the valve actuator [cm]
p1 – pressure variation in the upper chamber of the actuator (held upright) [daN / cm 2]
p2 - pressure variation in the lower chamber of the actuator [daN / cm 2]
u is the control signal [mA]
m – mass of the moving part of the valve (including the piston actuator) [daN / cm 2]
f - coefficient of viscous friction piston-cylinder actuator [daN s / cm]
S - active surface of the piston actuator [cm2]
V1, V2 - volume actuator cylinder chambers for the initial position of the piston when the valve is fully open (piston is in its upper position) [cm3 / s]
B - module compressibility of air [daN / cm 2]
k'Qp, k 'Qp - flow-pressure coefficients of the amplifier output that gain control; they are considered to be distinct on supply and on exhaust[cm5/daNxs]
kpu – pressure-current coefficient of the positioner [daN/(cm2xmA)]

kx - positive reaction amplification coefficient of the positioner [mA / cm]

3.3 The transfer function of the system and open loop system response

Assuming zero initial conditions for the system, we apply the Laplace transform in order to obtain the transfer function of the system x / u:

$$L\left\{\frac{x(t)}{u(t)}\right\}=\frac{X(s)}{U(s)} \qquad (2)$$

This corresponds to a third order system (given the difference in degree between denominator and numerator) without special problems of stability, simplification of poles and zeros etc. Numerical simulations will attest this assumption. After laborious mathematical calculations, the transfer function of the valve system will be obtained:

$$H(s)=\frac{28.3778s+21.2444}{0.00508s^4+0.08401s^3+17.759s^2+36.3864s+16.7194}$$

A first simulation of this system will result in open loop system response (without adjusting fuzzy). Reference signal will be a signal level of 20.32. This signal is the output value of the variable x for which the valve is fully closed. As we mentioned earlier on, the situation that we wish to create for this regulation is failure; the FCV119 valve should close, thus obtaining zero flux.

In the present application we will not portray the feature of the output flow because it is a function of x.

The representation of the system response (time variation of piston valve position) is sufficient to establish the correctness of the fuzzy control law and of the control solution presented in the paper.

To achieve the simulation we used Matlab Simulink simulation environment. Thus, we built the system in open loop diagram (Figure 3).

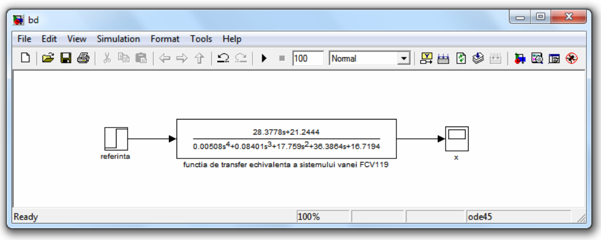

Figure 3 Open circuit diagram valve system

Open loop system response was obtained simulating the above scheme for a period of 100 seconds (Figure 4):

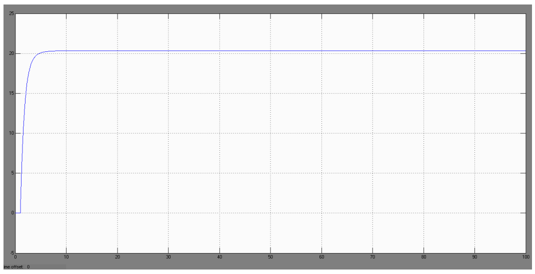

Figure 4 Open loop system response

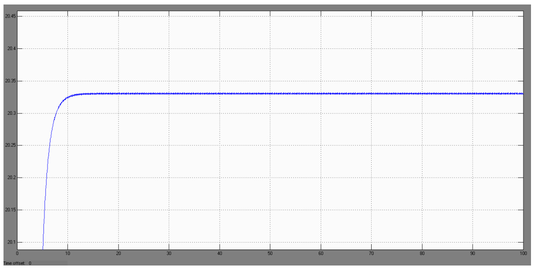

Figure 5 Open loop system response highlighting transitional time

In Figure 5 (in which transient time is highlighted) we can see that the transient time of the system is approximately equal to the 10s. That fact shows us that in an emergency situation the valve will not close immediately the water supply and that incidents might happen.

Notice that the system is stabilized at the value xst = 20.32cm, which means that the valve will close completely (x = 0 - fully open valve, x = 20.32 - valve fully closed).

The fuzzy controller will now have the duty of cutting off some of the transient time, thus obtaining an appropriate response to the requirements of the system.

3.4 Designing the fuzzy controller

Fuzzy controller must ensure a minimalization of the transitional flow when it comes to the control valve of the water supply system. The water supply must circulate towards the steam generators at a certain reference level without affecting output in steady value.

A control system with a fuzzy controller on a direct path has the following structure:

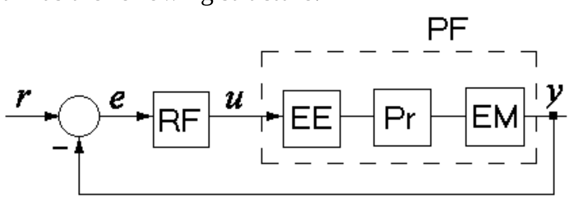

Figure 6 Control scheme with fuzzy controller.

The fuzzy controller receives from the beginning an error signal – a crisp constant (e) and provides at the end a control constant (u), that is also a crisp constant. In this case, the fixed part (PF in Figure 6) is the nonlinear process- flow control valve of the water supply that runs through the circuit up to the steam generators.

The basic structure of a fuzzy controller is shown in Figure 7:

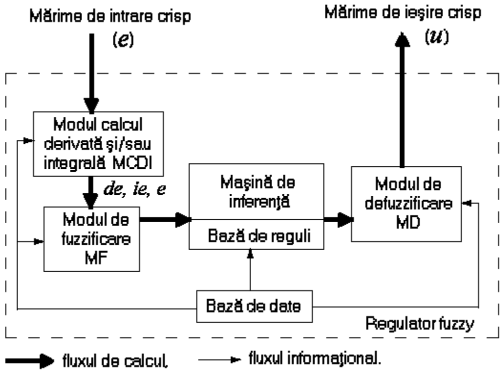

Figure 7 Basic structure of a fuzzy controller

The calculation of derivative and/or integral module (MCDI) is determined by some input values regarding numerical differentiation and/or numerical integration.

The numerical differentiation of the crisp input value e(k) is calculated in the following manner:

$$de(k) = e(k) - e(k-1) \tag{3}$$

where e(k) is the current crisp input value (the error) and e(k-1) is the value from the previous step.

The numerical integration can be determined by summing up the crisp values of the error with the formula:

$$ie(k) = \sum_{i=0}^{k} e(i) = ie(k-1) + e(k) \tag{4}$$

Notice: From all the above, we can see that a fuzzy regulator has, unlike a conventional controller, multiple input values. The fuzzy controller inputs are the linguistic variables from the prerequisite rules. In this case the fuzzy controller input will have two values:
error calculated with the formula:

$$e(k) = r(k) - y(k) \tag{5}$$

and the standard deviation:

$$de(k) = e(k) - e(k-1) \tag{6}$$

MF fuzzification module performs the following functions:
a) turn (scales) crisp input value into a normal, ferm value. Optional calculation is required here, mainly because of the numerical processing
b) converts crisp values of the input value into a fuzzy list

3.5 Building the controller in Matlab

After the controller has been designed (after the linguistic variables and membership functions were set, the inputs and outputs of the system were chosen and the inference table was built), we must then build it in Matlab and use it in the FCV119 valve adjustment scheme.

In order to implement the controller in Matlab, we used the fuzzy toolbox from the command window. The graphic interface helped us with:
a) the number of inputs and outputs, the names and their range of variation (Figure 8)
b) the number of linguistic variables and the membership functions belonging to them (Figure 9)
c) the rule base that allows the controller to give orders to the system (Figure 10)

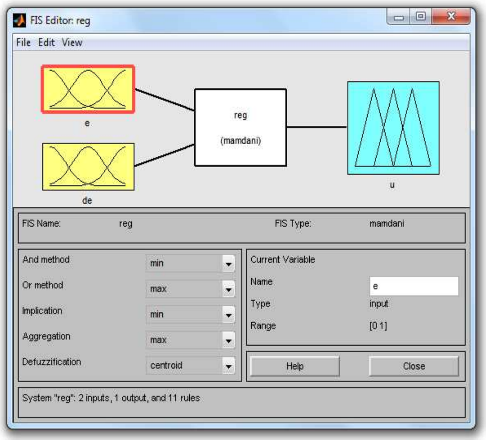

Figure 8. Fuzzy controller inputs and outputs

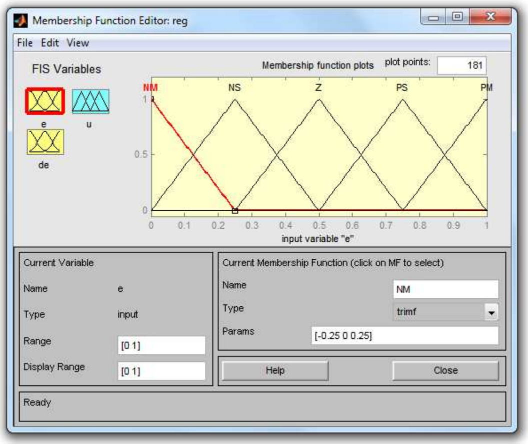

Figure 9 Establishing linguistic variables and membership functions

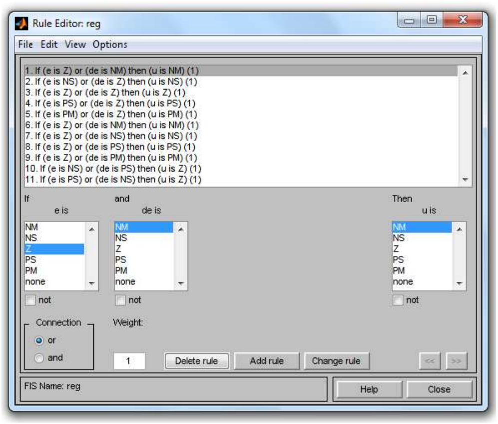

Figure 10. Construction of the fuzzy controller rule base

The Matlab Simulink diagram on how to simulate the system is shown in Figure 11:

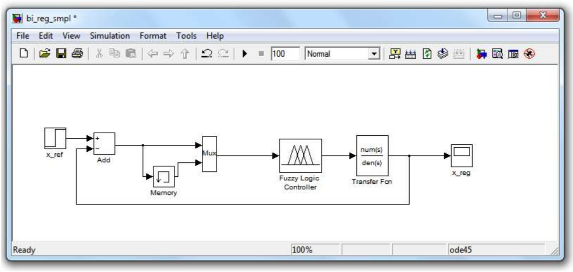

Figure 11 Diagram that explains how to adjust using a fuzzy controller

Controlled system response is shown in Figures 12 and 13:

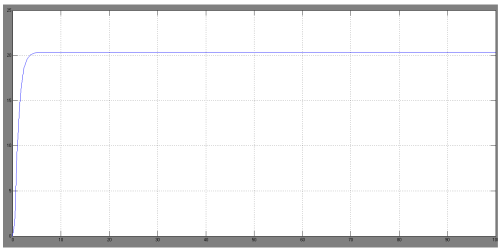

Figure 12. Response of the controlled system

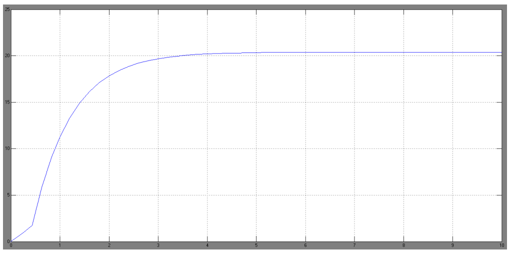

Figure 13. Response of the controlled system – emphasing transitional time

We can see that in Figure 13. the fuzzy controller genuinely decreased the transient time, bringing it to a value of 3.5s. It decreased by 65%, demonstrating how efficienct smart controll is in industrial processes.

4. CONCLUSIONS

In this paper we thought of an smart control solution at a reduced scale, more specifically, we have proposed a fuzzy controller to control a flow control valve in a system at the Cernavoda NPP.

With this purpose in mind, we started out with the mathematical model of the valve system, we calculated the transfer function based on which we have simulated a valve behaviour in absence of smart control. Using open loop system response, we have emphasized performance and we have set a new system performance, so that we may build the smart controller. Thus, we witnessed superiority of those adjusting solutions, based on artificial intelligence techniques, over the classical ones. The latter have also lost ground in simplicity of determining the law of adjustment. In nonlinear processes, the law of adjustment, can be difficult to explain and it involves very complicated mathematical calculations. In contrast to the above facts presented, the adjustment techniques using smart controllers are capable of auto-renewal; they can adjust any system, regardless of the complexity of that system’s mathematical model.

The classical (conventional) synthesis of the control law is dependent on the mathematical model taken into account for the physical system. In the unconventional synthesis, with the use of some artificial intelligence (fuzzy logic and neural networks), we can obtain control laws that do not depend much on the mathematical model (they can even be independent). In other words, we can obtain robust control laws. Obviously, a control law can have results if it is tested on a physical object, but equally important are the various mathematical models of the physical system on which this law can obtain validation.

The robustness of the control law can also be tested through the dynamic performance obtained after the experiment made on mathematical models or online operation, on the physical object.

Other variants for the synthesis are possible and desirable (eg. neuro-fuzzy synthesis), but it is considered that a simple fuzzy controller can provide good results even at on-line tests.

Initially, in the plant design, the control valve could only be controled manually, with the use of the contour.

The current control loop consists of: controller, equipped with an indicator for prescribed value, electro-pneumatic converter and flow measurement loop. The control function happens with the help of the DCS (Distributed Control System), that collects input data (flow, manual prescription of reference) and sends output values (the value prescribed and the controller command) to the pointing device and the electropneumatic converter. Upstream pressure values of the control valve are stored in the DCS from the loops of differential pressure measurement. The adjustment function for this control valve is ‘summoned’ oftenly (at a cyclic period) by the sequencer programs of the DCS.

If we want this project to be considered a valid solution for control, monitoring and command over the entire NPP, we need applications that will widen our way of seeing how to apply smart control. Also, we must deepen our search by consulting works that speak about how to validate the software that we are about to develop. In order to validate the proposed solution in this paper, we can make practice of Unit’s 1 simulator from Cernavoda, currently used for training and testing human operators.

The research done in this area may have a positive impact on the instrumentation, maintenance and control system upgrades of Units 1 and 2 and it can also represent the basis for smart control system development of future NPP. Having this purpose, the system must have the capacity of auto-renewal, an essential characteristic in the control of the nuclear power plants.

5. REFERENCES

[1]. *Controlul si comanda centralelor nuclearoelectrice*, Stefanescu P.

[2]. *Ingineria reglarii automate*, Dumitrache I.

PARAMETERS THAT INFLUENCE THE TRANSMISSION IN DVB-T2

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ABSTRACT

This paper proposes to analyze the opportunity of introducing Digital Terrestrial Television (DTT) in Romania by using directly the DVB-T2 standard instead of DVB-T. To this end we propose a testbed for performing measurements related to the functioning of the DVB-T, DVB-T2 and DVB-H networks. We also try to search for an appropriate configuration for sending video or data streams from a DVB-T2 transmitter equipment to a receiver. And for this the parameters at the transmission will be modified to simulate the “in-field” requirements. Results show that no configuration is better than another because in different environments we may have different error sources or different conditions that may need special tuning of each and every parameter of the transmitter.

Keywords: *Digital TV, Digital video broadcasting, Test equipment, Modulation, Code Rate.*

1. INTRODUCTION

In Romania, as well as other countries, demand for the release of broadcast spectrum for non-broadcast applications (e.g. mobile cellular communication) has increased as well as the demand for broadcasting frequency spectrum. This makes the maximization of spectrum efficiency a necessity

Romania does not yet have an approved plan for transition to digital television, but initially the country had committed itself to the European Commission to complete the transition to digital and stop analog transmission until the end of 2012. The National Authority for Management and Regulation in Communications in Romania (ANCOM), in collaboration with the Romanian Ministry of Communications and Information Society (MCSI) had produced a draft strategy in early 2010, but the plans were abandoned and, at the moment, an implementation strategy is not yet completed.

The Digital Video Broadcasting (DVB) Project is a worldwide alliance of companies in the video broadcasting, corresponding to the equipment manufacture or broadcasting network operating domain. For wireless terrestrial video broadcasting, there are two main standards developed under the DVB Project: DVB-T (finalized in 1997) and DVB-T2 (2009). Both of them offer also a large versatility in implementation by choosing proper parameters of the transmitted signal in order to optimize the overall performances according to the desired requirements.

The DVB-T2 Standard is based on the same principles as DVB-T, offering a high flexibility for the transmitting modes. DVB-T2 offers a high transfer rate for the information or a signal more shielded from errors. The high transfer rate along with MPEG 4 encoding means that there can be sent more than 2 HD channels on the same multiplex [1].

The rest of the paper is organized as follows. Section 2 gives some insight into the current state of digital terrestrial television implementation in Romania; Section 3 gives some scenarios and issues regarding how the implementation of DTT in Romania should be handled, while Section 4 describes a testbed un UPB premises for carrying different experiments for analyzing different aspects of DVB-T, DVB-T2 and DVB-H networks. Section 5 highlights some basic measurements available on the UPB’s DVB-T2 testbed, while sections 6-10 present some measurements carried out on the same testbed to evaluate the performances of DVB-T2 systems for various parameter settings. Finally, Section 11 draws the conclusions.

2. STATE OF DIGITAL TERESTRIAL TELEVISION TRANSITION IN ROMANIA

The transition from analog to digital television is in progress around the world, but Europe is the most advanced continent in this regard. The European Commission has launched a series of actions for spectrum release and establishing a plan for its future use, so that EU citizens enjoy all the benefits of digitization. It is expected that all EU countries migrate to digital transmission (the so-called digital switchover) until 2015, if not earlier. The European Commission had initially recommended to member states that this process be completed by the end of 2012, but some countries have delayed the analog switch-off. Terrestrial digital broadcasting has already been introduced in 21 EU Member States and cover different geographical areas. Analog transmissions have already been completely stopped in 17 European countries [1].

At the moment in Romania digital terrestrial television (DTT) is only broadcast in the cities of Bucharest (2 locations) and Sibiu (2 locations) using the DVB-T standard. The signal, however, can be received on a fairly large distance around the cities, reaching up to about 60 km [2]. These are part of the pilot DTT program that was implemented by the Romanian Society of Radio-communications (RADIOCOM), which deployed the first digital television transmitters, the one in Bucharest in March 2006 and the one in Sibiu in November 2006. The multiplexes are broadcast on channels 54 (738 MHz – 3 SD programs and 1 HD program) and 59 (778 MHz – 7 SD programs). The two multiplexes use 64QAM modulation and FEC code rates

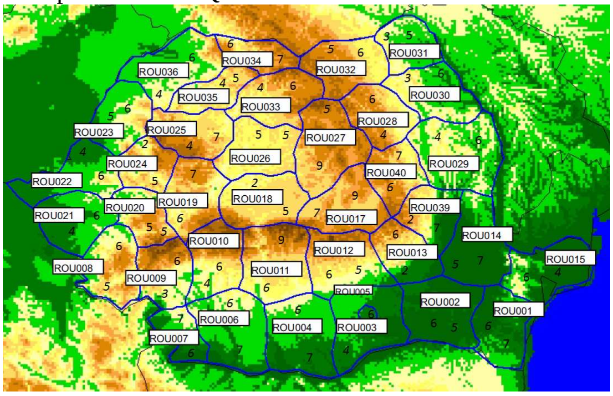

Figure 1 Romanian Allotment in the UHF band and number of channels planned per allotment before (normal) and after (italic) DD2

of 2/3 and 3/4. There is also a Single-Frequency Network made up of transmitters in 3 locations in Bucharest operated by a private broadcaster which broadcasts on channel 30 (546 MHz – 2 HD programs) with the same modulation parameters as the ones operated by RADIOCOM.

At the Geneva Regional Radiocommunication Conference 2006 (RRC-06), a plan for digital television was adopted, and at the World Radiocommunication Conference 2007 (WRC-07) the decision was made to allocate the 790-862 MHz band (channels 61-69) for mobile services. According to the final acts [3] of the RRC-06, Romania has a total of 36 allotments in the UHF band, with each allotment having a number of channels that can be used in the future for the DTT network. The Romanian Authorities have produced a draft strategy [4] for implementing DTT in Romania that was later abandoned. It stated that there were two free-to-air multiplexes (1 and 2) which would carry national television and some other programs of public interest and another 4 multiplexes (3 to 6) that would carry commercial TV programs. Under this strategy, each allotment contains mainly 5, 6 or 7 channels in the UHF band, with the exception being the zones in the middle of the country with 9 channels (Fig. 1).

The recent decision by World Radio Conference (WRC-12) in Geneva to allocate the 694-790 MHz band for mobile services [5, 6] (the so-called “second digital dividend” or DD2) puts more pressure on the broadcasting spectrum allocation in Romania, and it is highly unlikely that there will be more than 4 national multiplexes in the UHF band (channels 21-48). So, there is a need for rethinking the frequency assignments for these national multiplexes. The new number of channels per allotment is given in Fig. 1.

Regarding the total closure of analog services, the Romanian Government has changed the initial date of 01.01.2012, moving the final date for ending analog broadcasting to 17.06.2015 in line with the ITU Geneva 2006 (GE06) agreement on analog switch-off date.

3. TRANSITION SCENARIOS AND ISSUES

Some of the issues that have to be taken into account when moving from analog to digital TV broadcasts are [6]:

- The transition period is as lengthier and more difficult as the percentage of viewers that depend on the terrestrial platform is higher;
- There will be the need of simulcasting for a certain period;
- There may be a need for additional spectrum to accomplish the transition;
- There will be a need for incentives for viewers in order to accept the transition to newer techniques because this implies an upgrading of equipment, which will have to be paid for;

Since Romania has not yet started the transition to operational DTT, only as a limited number of pilot / experimental DVB-T transmitters, it may be suitable to introduce DVB-T2 as the DTT standard. This is driven by several factors:

- The advantages of DVB-T2 over DVB-T (outlined in Section III)
- The recent decision of a mobile allocation in the 694-790 MHz band (the so-called “second digital dividend”)
- A national DVB-T network has yet to be implemented, which means that a strong argument against implementing DVB-T2 (the fact that DVB-T2 is not backward compatible with DVB-T) is not an issue.

Some of the existing infrastructure from analog TV can be re-used (antennas, amplifiers, repeaters etc.), when implementing a DVB-T2 network. Apart from that, there will be a need for modulators, gateways, MIP Inserters for SFNs, monitoring equipment, and possibly filters. Also, on the receiving side, there will be a need for new DVB-T2 capable TV sets or DVB-T2 set-top boxes. There will, of course, be a simulcast period required, and its length will largely depend on the penetration rate of the existing analog television services. It is estimated that around 20% (about 1.4 million) households in Romania receive terrestrial analog television [7]. With such a relatively small percentage of population, there is only a need for a short simulcast period. It is also possible to take the approach that Germany has, where a region-wise transition was preferred, in order to avoid abrupt changes across the country. Also, the simulcast situation is virtually straightforward, since DVB-T2 can carry more programs in a multiplex than analog TV and there is only need for a small number of multiplexes, which is in line with the second digital dividend. To this end, some administrative measures should be taken especially by the authorities:

- Before the start of the transition, and also, during the simulcast period, there has to be an information campaign so the users understand the differences between analog and digital TV and also the advantages of the latter;
- Since there is a need for new TV sets or set-top boxes, there will be a need of investment from the consumer in this new receiving equipment. The authorities should take into consideration subsidizing this equipment, especially for low-income families

which are more likely to use terrestrial reception anyway, since mid and high-income families are already subscribed to cable, DTH or IPTV. Equipment's could be subsidized also in rural areas where penetration rate of cable, DTH, or IPTV is relatively low;

- A set of parameters to be fulfilled by receiving equipment should be defined by the National Regulatory Authority and made sure they are respected. To this end, receiving equipment suppliers should have to be approved by the authorities, in order to sell this kind of equipment;
- Conducting further market studies in order to see what possibilities for new services there exist. In particular, the feasibility of implementing a DVB-H network could be studied, since Romania is a country with a high smartphone penetration rate;
- A decision has to be made if all the antennas for different multiplexes will be collocated into an area (using communication towers) or not. The advantage is that the receiving antenna can be a directional one, not an omnidirectional one, increasing the transmission efficiency. Unfortunately, in areas with major radio wave reflections or in the case of SFN usage this solution will not be applicable.

4. PROPOSED TESTBED

Figure 2 shows a proposed testbed for analyzing different aspects of DVB-T, DVB-T2 and DVB-H networks. It comprises two main parts: Transmission and Reception for each of the three technologies. Each of them is constructed of equipment that may or may not be common to one or more of the three chains. Details of the equipment are given below.

Transmission. Common to all three chains is a Windows 7-based laptop running different streaming server software that comes bundled with the corresponding equipment it is connected to. Details are given next for every technology:

DVB-T. The laptop is connected via an USB/ASI adapter described in [8] which can generate an MPEG-2 or uncompressed transport stream to a DVB-T modulator [9]. The Modulator outputs DVB-T compliant signals via an indoor antenna with a low RF signal, suitable for laboratory tests.

DVB-T2. The laptop is connected directly via USB with a DVB-T2 lab modulator [10]. This Modulator also transmits DVB-T2 signals via a low power indoor antenna with an RF level of max 2 dBm with the purpose of laboratory testing.

DVB-H. The laptop is connected to an Electronic Service Guide (ESG) Server [11] which is connected to a DVB-H IP encapsulator [12]. The encapsulator performs MultiProtocol Encapsulation (MPE) of the video stream and FEC coding and outputs an ASI signal which is carried over 75-ohm coaxial cable to a DVB-H modulator.

Reception.

DVB-T and DVB-T2. Both DVB-T and T2 reception is made via a measurement receiver [13] compatible with both DVB-T and T2 standards, which is connected to another Windows 7-based laptop running DiviCatch analyzer software.

DVB-H. Reception is made on a Nokia N96 handset which is equipped with a DVB-H receiver and a video player. There is also a DVB-T/H Analyzer available from [14] in order to evaluate RF signal properties like Signal Strength, Signal-to-Noise Ratio, Modulation Error Rate, Bit Error Rate at various points in the demodulation chain (pre-RS, pre-Viterbi, post-Viterbi etc.), as well as jitter, time slicing etc.

5. INITIAL MEASUREMENTS

For the experimental measurements, the equipment is composed of the LabMod DVB-T2 Modulator and the

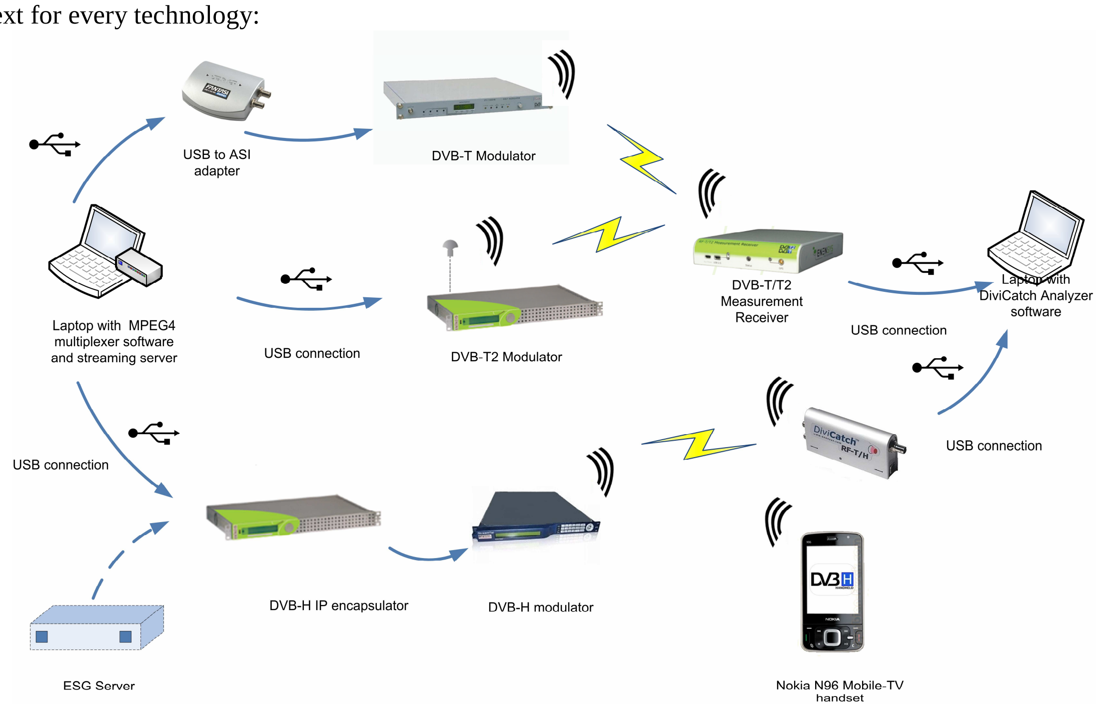

Figure 2 Proposed DVB testbed

ReFeree T2, and two computers, one for sending the data stream and one for processing the received information. This corresponds to the center section of the transmitting chain depicted in Figure 2.

The software used for the measurements was the one offered by the equipment providers. For the transmitter, the console was accessible using a web browser and from there we adjusted all the parameters for the transmission (Constellation, Code rate, Bandwidth). In order to transmit the data string, DiviSuite 1.0 software was used.

At the receiver, the signal was analyzed using ReFeree v1.0 software and after each transmission was ended, it delivered reports so the data could be properly analyzed.

The initial settings for the transmitter were used: Bandwidth of 8MHz; FFT Mode of 32k normal; Guard Interval of 1/128; Constellation chosen 64QAM with a code Rate 2/3.

Figure 3 illustrate the SNR and BER variations when trying to properly calibrate the equipment (i.e. place it where received DVB-T2 signal could be decoded and the stream could be played). The fluctuations of the signal are caused by different distances between the receiver's antenna and the transmitter.

The final distance at which we finally placed the antenna is of 1 m and all the other tests were done with the system in this position.

6. CHANGING THE OUTPUT PARAMETERS

After positioning the antenna in such a way that the signal was properly received, the next step was to tune the parameters and observe the results at the receiver. In order to see those changes, modifications were done to the following parameters: guard interval, modulation, code rate, constellation rotation.

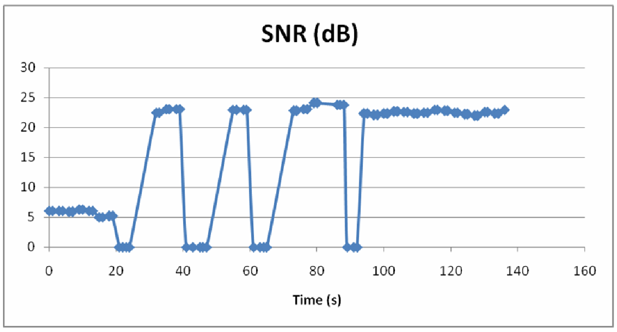

Figure 3 SNR variation for initial calibration

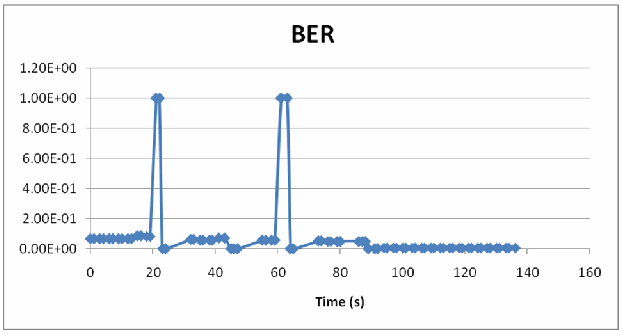

Figure 4 BER variation for initial calibration

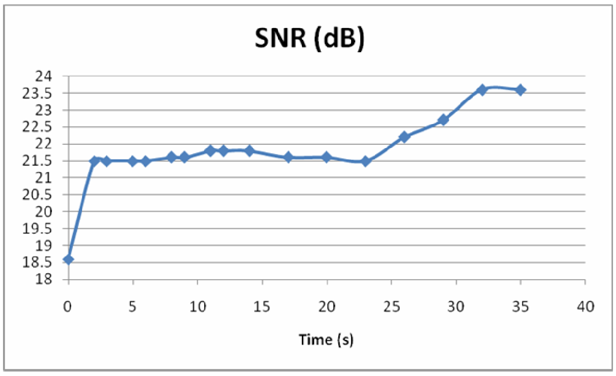

Figure 5 SNR variation with initial settings

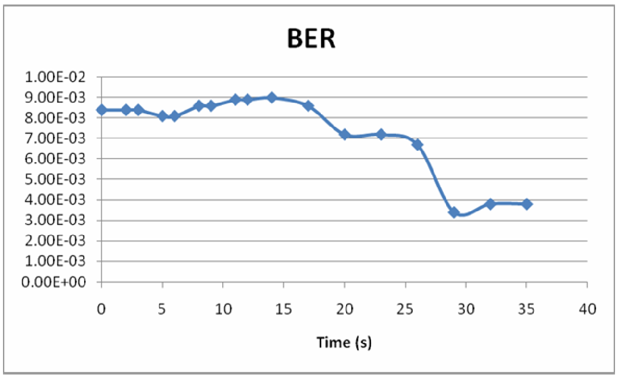

Figure 6 SNR variation with initial settings

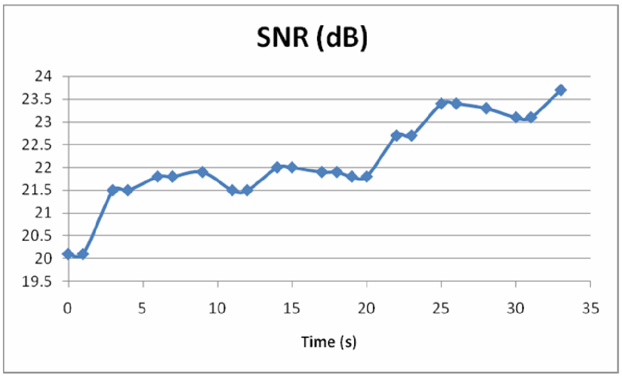

Figure 7 SNR variation when changing modulation scheme

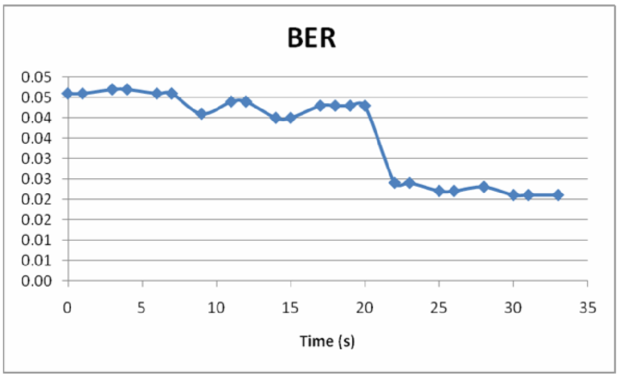

Figure 8 BER variation when changing modulation scheme

Table 1 Measurements from the receiver for GI of 19/256

Time (sec)	Quality measurements		
	Signal Level	***SNR***	***BER***
0	-69.7	18.6	8.40E-03
2	-69.9	21.5	8.40E-03
3	-69.9	21.5	8.40E-03
5	-69.7	21.5	8.10E-03
6	-69.7	21.5	8.10E-03
8	-69.7	21.6	8.60E-03
9	-69.7	21.6	8.60E-03
11	-69.8	21.8	8.90E-03
12	-69.8	21.8	8.90E-03
14	-69.9	21.8	9.00E-03
17	-69.9	21.6	8.60E-03
20	-69.7	21.6	7.20E-03
23	-69.7	21.5	7.20E-03
26	-69.6	22.2	6.70E-03
29	-69.7	22.7	3.40E-03
32	-70	23.6	3.80E-03
35	-70	23.6	3.80E-03

Related to the configuration used in Section 5, only the guard interval was changed from 1/128 to 19/256.

The report from the receiver contains the signal level, SNR and BER of the received signal. The output is summarized in Table 1. Figures 5 and 6 represent the curves obtained based on the information provided by the receiver, since such a representation is more intuitive and can be easily interpreted by the user.

7. CHANGE IN MODULATION SCHEME FROM 64-QAM TO 256-QAM

For a change in constellation from 64 QAM to 256 QAM the Signal to Noise Ratio (SNR) and the Bit Error Rate (BER) curves are the ones depicted in Figures 7 and 8. It can be seen that the signal gets stabile and as the SNR rises, the BER values drop.

8. CHANGE OF CODE RATE FROM 1/2 to 5/6

For a Code Rate of 5/6 the received signal parameters analyzed by the receiver are showed in Figures 9 and 10. Comparing this to the response we get when the Code Rate is set to 1/2, we can see in Figure 11 that the Signal to Noise Ratio has a better value and has a more linear shape:

Figure 13 shows that the signal received is of a better quality for this configuration than for the previous one.

9. CHANGE IN CONSTELLATION FROM ROTATED TO NORMAL (FOR 64 QAM)

For this test the settings chosen were the following: Bandwidth of 8MHz; FFT Mode of 32k; Guard Interval of 19/256; Pilot Patterns selected as PP8; Normal 64 QAM Modulation; Code Rate of 5/6.

According to Table 2 and to Figures 13 and 14 that interpret the data gathered in the table, the signal is weaker than in the previous case but it is strong enough to cover the noise and to offer us a good Signal to Noise Ratio. Also from the BER graph we can deduce that there are some errors that the equipment tries to correct but still the values of the graph are smaller than in the previous cases.

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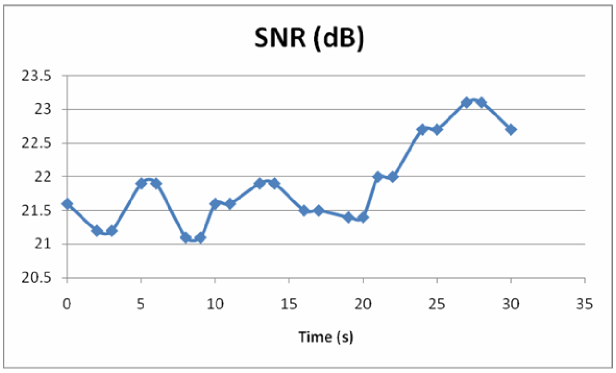

Figure 9 SNR variation for a Code Rate of 5/6

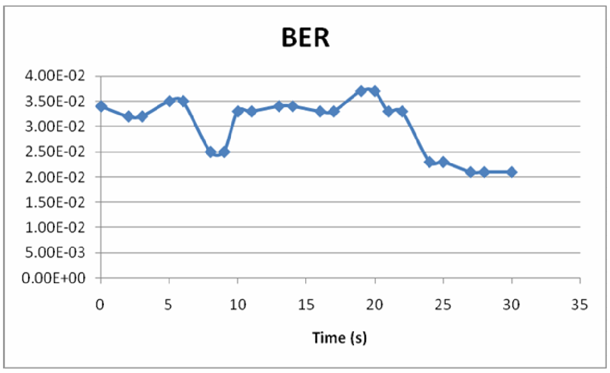

Figure 10 BER variation for a Code Rate of 5/6

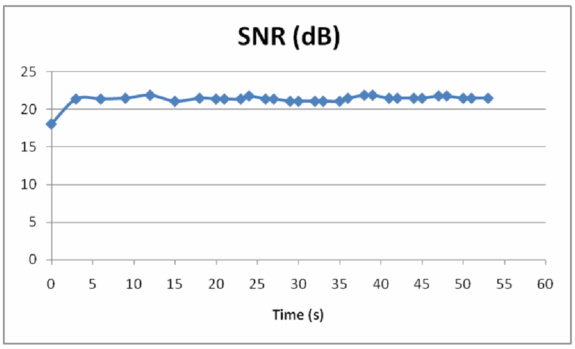

Figure 11 SNR variation when the Code Rate is changed from 5/6 to 1/2

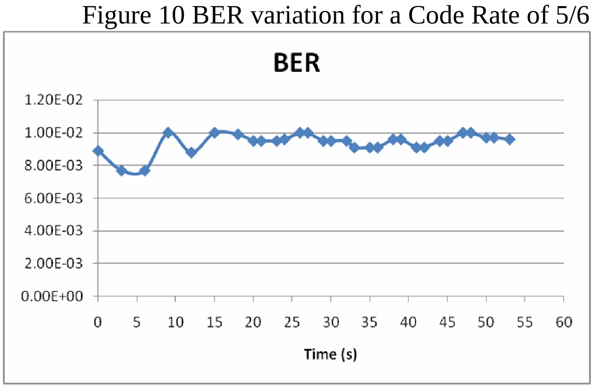

Figure 12 BER variation when the Code Rate is changed from 5/6 to 1/2

Table 2 Measurements from the receiver for 64-QAM

Time (s)	Signal level (dBm)	SNR (dB)	MER (dB)	Pre LDPC BER
0	-69.9	18.1	19.9	8.90E-03
1	-69.9	18.1	19.9	8.90E-03
3	-70.1	21.1	20	9.20E-03
4	-70.1	21.1	20	9.20E-03
6	-70.4	21.5	19.9	1.00E-02
9	-70.4	21.9	19.9	9.90E-03
12	-70.4	21.2	19.9	9.50E-03
15	-70.3	22	19.9	8.70E-03
18	-70.3	21.5	20	1.20E-02
21	-70.3	21.6	20.1	9.20E-03
24	-70.3	22.4	20.6	4.60E-03
26	-70.2	23.1	21.2	4.60E-03
27	-70.2	23.1	21.2	4.60E-03
29	-70.2	23.1	21.2	4.60E-03

10. CHANGE IN CONSTELLATION- FROM ROTATED TO NORMAL (FOR 256 QAM)

For the last test done, the idea was to keep the normal constellation but to change its type from 64-QAM to 256-QAM Table 3 offers the information about the data received.

After this, in Figures 15 and 16 are depicted the interpretations of each column from Table 3.

The last picture (Figure 17) is the monitoring window from the receiver. And it illustrates the variations of the overall bit rate and net bit rate.

If we compare the values of the signal level in Table 3 with the one from the previous test in Table 1, we can see that the values indicate a weaker signal in the case of the 64 QAM configuration, even if for the 64 QAM configuration, the values seem to fluctuate more.

Also, another remark that can be made concerning the graph of the SNR. For 256-QAM it is a more stable variation without significant jumps between values as it can be observed in the 64 QAM case (Figure 13).

Table 3 Measurements from the receiver for 256-QAM

Time (s)	Signal level (dBm)	SNR (dB)	MER (dB)	Pre LDPC BER
0	-70	20.2	21.3	4.60E-02
4	-70.2	21.6	21.1	4.50E-02
7	-70.1	21.9	21.1	4.20E-02
9	-70.3	21.8	20.8	4.30E-02
10	-70.3	21.8	20.8	4.30E-02
12	-70.3	21.8	20.8	4.30E-02
13	-70.4	21.8	20.3	4.30E-02
15	-70	21.6	20.1	4.50E-02
18	-70.2	22.1	20.1	4.40E-02
21	-70.2	22.1	20.1	4.40E-02
23	-70.1	21.8	20.1	4.30E-02
24	-70.1	21.8	20.1	4.30E-02
26	-70	21.8	20.1	4.40E-02
29	-69.9	21.1	20	4.20E-02
32	-69.8	21.6	19.8	4.50E-02
34	-69.8	21.9	19.9	4.40E-02

In the case of the bit error rate, we can also see a difference between the two cases, Figure 14 compared to Figure 16.

In Figure 16 there is a smoother variation indicating there are no severe errors to be corrected by the system, whereas in Figure 14 the fluctuations of the graph and the small values at its end indicate a rather high level of errors that the system needs to manage.

11. CONCLUSIONS

The equipment used is able to verify the fluctuations that appear for the following parameters: Signal level, SNR, Pre LDPC BER, Post LDPC BER, Post BCH FER and also can depict the curves for the Overall and Net Bitrate. With these experiments we tried

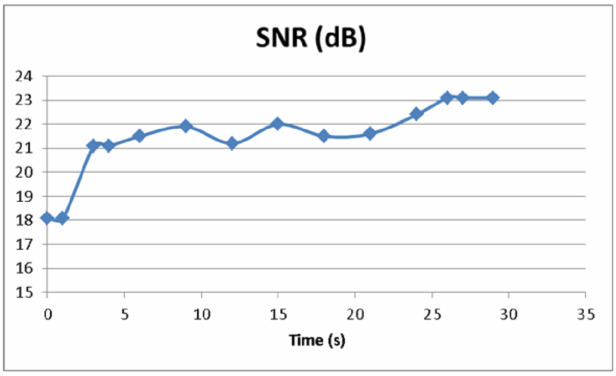

Figure 13 SNR variation for 64-QAM

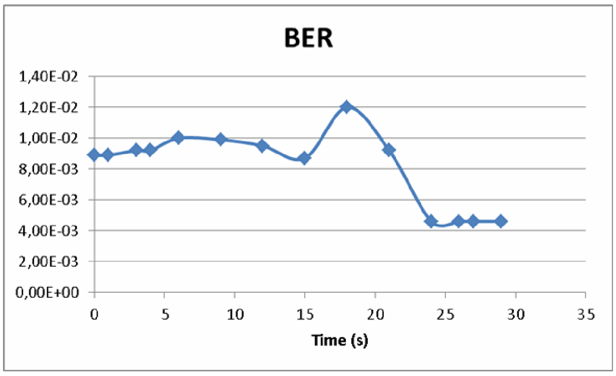

Figure 14 BER variation for 64-QAM

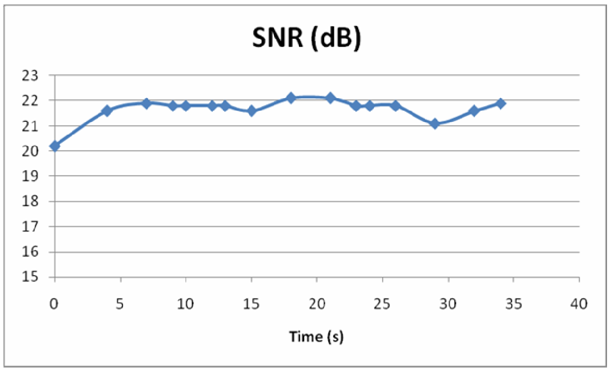

Figure 15 SNR variation for 64-QAM

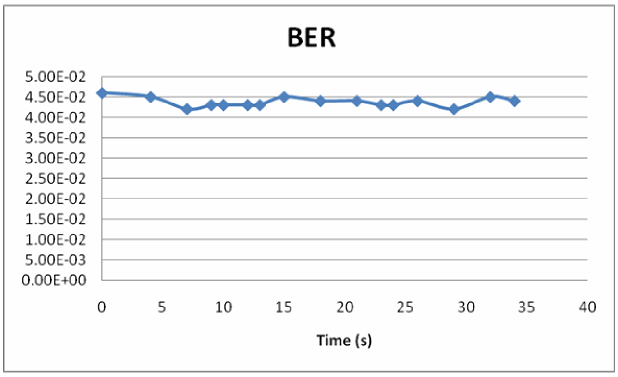

Figure 16 BER variation for 64-QAM

Figure 17 GUI illustration of the receiver measurements for 256-QAM

to show the way in which the parameters that we set at the transceiver can alter the parameters of the received signal and bitrate of the stream for a given distance between the transmitter and receiver. By changing the parameters and by analyzing the measurement graphs we can optimize the parameters of a real network to fit the given conditions.

We cannot declare that one configuration is better than another because in different environments we may have different error sources or different conditions that may need special tuning of each and every parameter of the transmitter.

12. ACKNOWLEDGMENTS

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13. REFERENCES

[1] (2012, May) DigiTAG - Digital Terrestrial Television Action Group. [Online]. Available: http://www.digitag.org

[2] (2012, Jun.) DVBT.ro - All you want to know about DVB-T. [Online]. Available: http://www.dvbt.ro/lista-canale-dvb-t-romania/

[3] (2012, Apr.) FINAL ACTS of the RRC-06. [Online]. Available: http://www.ancom.org.ro/uploads /links_files/ActeleFinale_GE-06.pdf

[4] (2012, Mar.) Romanian strategy regarding the transition to DTT. [Online]. Available: http://ec.europa.eu/information_society/policy/ecomm/doc/current/broadcasting/switchover/ro_2009_switchover.pdf

[5] (2012, Jun.) Second digital dividend will release 694-790MHz band for mobile services in 2015. [Online]. Available: http://www.wireless-mag.com/News/14085 /Second_digital_dividend_will_release_694-790MHz_band_for_mobile_services_in_2015.aspx

[6] "Frequency and Network Planning Aspects of DVB-T2," EBU, Tech. Rep., May 2012. [Online]. Available: http://tech.ebu.ch/docs/tech/tech3348.pdf

[7] "National Authority for Management and Regulation in Communications in Romania (ANCOM) 2011 Annual Report," ANCOM, Tech. Rep., Dec. 2011. [Online]. Available: http://www.ancom.org.ro/uploads /links_files/Raport_Anual_ANCOM_2011.pdf

[8] (2012, Jun.) DTU-205 FantASI USB-2 ASI/SDI Output Adapter Product Page. [Online]. Available: http://www.dektec.com/products/USB2/DTU-205/ index.asp

[9] (2012, Jun.) DVB-T and DVB-H Modulator ETL1100DVB Main Features. [Online]. Available: http://www.eurotel.it/download/brochures/eurotel_dvb-t_and_dvb-h_modulator.pdf

[10] (2012) DVB-T2 Lab Modulator Product Page. [Online]. Available: http://www.enensys.com/products/test-and-monitoring-:-modulators/dvb-t2-lab-modulator.html

[11] (2012, Jun.) JADE Mobile TV Electronic Service Guide Server Product Data Sheet. [Online]. Available: http://www.thomson-networks.com/system/files/ Products/CDT-5007D-5_JadeMobileTV.pdf

[12] (2012, Jun.) DVB-H IP encapsulator Product Page. [Online]. Available: http://www.enensys.com/products/ip-encapsulator.html

[13] (2012, Jun.) DVB-T DVB-T2 Measurement Receiver ReFeree-T2 Product Detail. [Online]. Available: http://www.enensystest.com/products/ product-detail/product/dvb-t2-measurement-receiver.htm

[14] (2012, Jun.) DVB-T DVB-H Professional RF Analyzer DiviCatch RF-T/H Product Detail. [Online]. Available: http://www.enensystest.com/products/ product-detail/product/dvb-t-dvb-h-professional-rf-analyzer.html

SEASONAL VARIATIONS OF THE TRANSMISSION LOSS AT THE MOUTH OF THE DANUBE DELTA

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ABSTRACT

Underwater communication devices, such as underwater acoustic modems (UAM) are designed using the passive sonar equation. At the beginning of the design phase we must know very well the parameters that compose this equation, if we want the modem operation to depend as little as possible on the variability of the transmission channel.

The only parameter that is not known a priori is the transmission loss (TL). The measurement of this parameter is fairly expensive because it involves at least one marine research platform, trained personnel and numerous devices. Therefore we need to estimate this parameter and an inexpensive solution is to simulate the underwater acoustic channel (UAC) in the region where we want to deploy the underwater acoustic modem.

Using conductivity, temperature and depth (CTD) information taken from the NOOA's database, information about the wind speed at the surface and information about the geoacustical properties of the sea floor, we modeled the underwater acoustic channel at the mouth of the Danube Delta. With the help of the AcTUP simulation software we were able to estimate the seasonal variations of the transmission loss in the region of interest using a frequency dependent simulation method. These results will be used later to adapt the underwater acoustic modem to the transmission channel.

Keywords: *Transmission loss, passive sonar equation, underwater acoustic channel, underwater acoustic modem, frequency dependent simulation, channel modeling, channel simulation.*

1. INTRODUCTION

An underwater acoustic modem is a comunication device designed to transmit to the surface the data acquired by sensors. Multiple underwater acoustic modems compose an underwater wireless sensor network (UWSN). These communication equipments transmit information wirelessly using acoustic waves with a projector and receive the information with a hydrophone. Usually an UWSN is placed on the seafloor with the purpose of monitoring chemical and biological phenomena of interest [1].

An UAM is designed using the passive sonar equation. At the beginning of the design phase we must know very well all the parameters that compose this equation, if we want the modem to operate correctly in an underwater transmission channel whose parameters vary with temperature, salinity, depth, wind speed at the sea surface and geoacustical properties of the seafloor.

The only parameter that is not known a priori is the transmission loss. The measurement of this parameter is fairly expensive because it involves at least one marine research platform, trained personnel and numerous devices. Therefore we need to estimate this parameter and an inexpensive solution is to simulate the underwater acoustic channel (UAC) in the region where we want to deploy the underwater acoustic modem [2].

Using information obtained from the National Oceanic and Atmospheric Administration's (NOOA) database [3], information about the wind speed at the surface and information about the geoacustical properties of the seafloor we modeled the underwater acoustic channel at the mouth of the Danube Delta. Using Acoustic Toolbox User-interface and Post-processor (AcTUP) simulation software we were able to estimate the seasonal variations of the transmission loss in the region of interest using a frequency dependent simulation method. These results will be used later to adapt the underwater acoustic modem to the transmission channel.

In the next section we will present the proposed underwater acoustic channel model and the method with which the transmission loss was computed. In section 3 we present the seasonal variations of the transmission loss obtained by simulating the propagation of the underwater acoustic waves in the considered transmission channel. In the final section we present the conclusions of this article and future work.

2. UNDERWATER ACOUSTIC CHANNEL MODELLING

The region of interest is shown in Figure 1. It is geographically located on 45.3 N and 29.8 E latitude and longitude respectively. At this location were recorded 465 CTD data between 1986 and 1991. These data have been introduced in equation 1 to compute the sound speed profile (SSP).

$$\begin{aligned} c(T,S,z) = {} & 1449.2 + 4.6\cdot T - 0.055\cdot T^2 \\ & + 0.00029\cdot T^3 \\ & + (1.34 - 0.01\cdot T)\cdot(S-35) \\ & + 0.016\cdot z \end{aligned} \qquad (1)$$

where c is the speed of sound in m/s, T is the temperature in degrees Celsius, S is salinity in parts per thousand (ppt) and z is the depth measured in meters [4]. This equation is valid for

$$0 \le T \le 35^{\circ}\ C$$

$$0 \le S \le 45\ ppt$$

$$0 \leq z \leq 1000 \text{ m}$$

The depth of our location is 20 m. It will be assumed that near this location the depth will be constant.

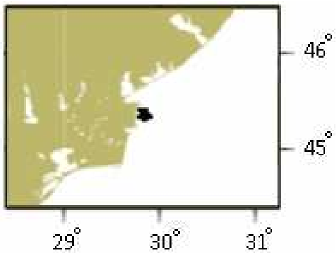
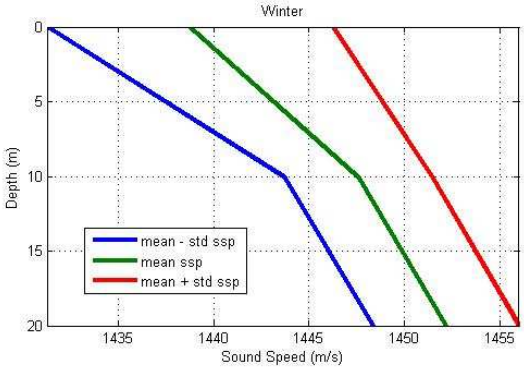


Figure 1 The region at the mouth of the Danube Delta

2.1 Seasonal variations of the sound speed profile

The mean sound speed profile was computed for each season using the data obtained from NOAA. Also we computed the standard deviation (std) of the SSP. These data were used to define two new sound speed profiles. One was obtained by adding the std data to the mean sound speed profile and the other one was obtained by subtracting the std data from the mean SSP. These profiles are shown in Figure 2.



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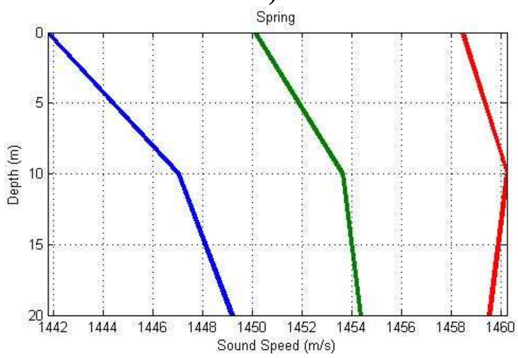

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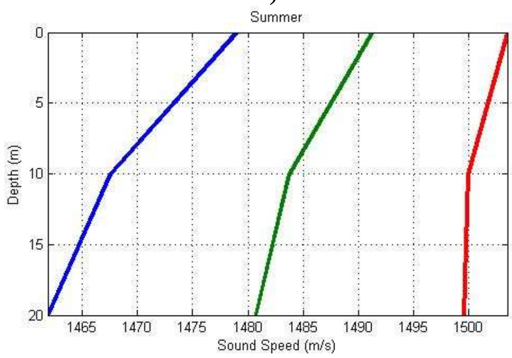

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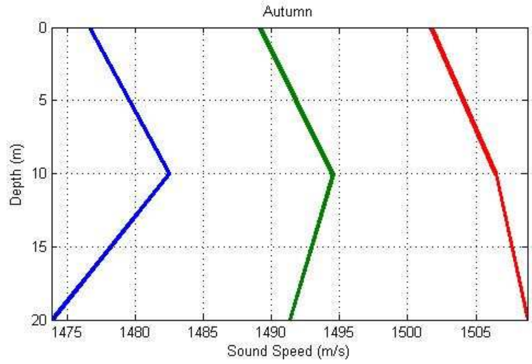


d)

Figure 2 Seasonal variation of the sound speed profile at the mouth of the Danube Delta

In Figure 2 we observe a large variation of the sound speed. This variation is between 1430 and 1510 m/s. In winter and spring we have the smallest sound speeds which are due to low temperatures. The highest sound speeds are observed during summer and autumn. Also we observe that the sound speeds in the mean SSP, the green trace, are less than 1500 m/s (the average value of the underwater sound speed on the globe). This is due to the fact that the average salinity at the mouth of the Danube Delta, 17 ppt, is much smaller than the average salinity, 35 ppt. The low salinity is due to the fresh water brought by the Danube into the Black Sea.

Referring to the mean SSP we observe in Figure 2 a) a positive sound speed gradient. This is called the mixed layer and is due to the harsh conditions in the winter. The bad meteorological conditions determine the mixing of layers with different temperatures resulting in a layer with a constant temperature for the entire water column.

In Figure 2 b) in the mean sound speed profile we observe again the mixed layer. Also in Figure 2 d) between 0 and 10 m the mixed layer is present. Between 10 and 20 m we notice a negative sound speed gradient. This is called the thermocline. Also during summer, Figure 2 c), because of the calm and sunny conditions we notice the thermocline. This is represented by a decrease in temperature with increasing the water column depth.

2.2 Seafloor sound speed profile and geophysical properties

The seafloor consists of three sedimentary layers. The first layer is composed of silty-clay or mud. This is a dynamic layer which consists of river deposits continuously brought by the Danube. The second layer consists of silt and the third layer is made of sand.

Table 1 Geophysical properties of the seafloor sediments

Properties	Silty-Clay	Silt	Sand
Depth (m)	0.15	0.05	> 1
Sound speed (m/s)	1491	1575	1650
Density (kg/m3)	1480	1700	1900
Attenuation (dB/λ)	0.15	1	0.8

The sound speed profile of these layers is shown in figure 3 and in Table 1 we present the geophysical properties for each layer [5], [6].

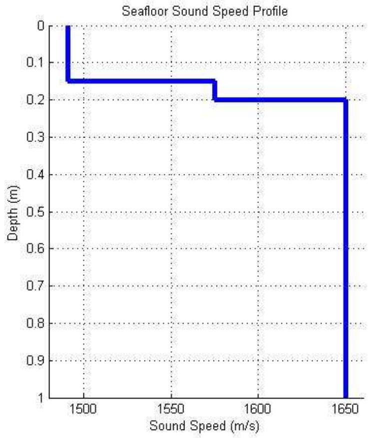


Figure 3 Seafloor sound speed profile. The third sedimentary layer is deeper than 1 m.

2.3 Underwater acoustic channel modeling

We envisioned an underwater wireless sensor network at the mouth of the Danube Delta, consisting of two modems, placed just above the seafloor, which can communicate horizontally. Using the data presented in sub-sections 2.1 and 2.2, we created in AcTUP simulation software [7], which is a MATLAB plug-in, 12 underwater acoustic environments, one for each sound speed profile.

In figure 4 we present the proposed underwater acoustic channel. The sea surface was considered a reflector with 1.75 m rms roughness. The bottom was modeled as a flat reflector and attenuator. The sea depth is considered to be 20 m. The transmitter and receiver were placed at 50 cm above the seafloor in a horizontal configuration. The transmission distance between them is considered to be 500 m.

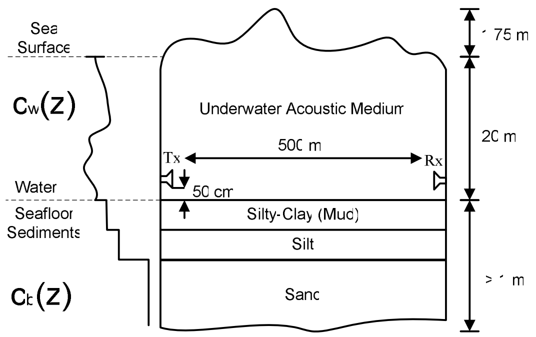


Figure 4 Underwater acoustic channel model at the mouth of the Danube Delta. The sea depth, z, is measured in meters, $c_w(z)$ represents the water sound speed profile and $c_b(z)$ the seafloor SSP.

2.4 Transmission loss computation

The method used to compute the transmission loss is described in detail in [8]. We briefly present the most important steps that were performed to compute the transmission loss at the mouth of the Danube Delta.

Using the UAC model presented in figure 4 we performed a frequency dependent simulation in AcTUP.

The simulation results were obtained using the Bounce-Bellhop algorithm [9]-[11]. This is a ray tracing algorithm that simulates the propagation of acoustic waves in the marine medium. The algorithm records his simulation results as channel complex impulse responses.

We simulated our underwater acoustic channel in the frequency range 1-99 kHz with a step of 1 kHz and we obtained 99 simulation files. We used the results from these files and the equation 2 to compute the frequency response of the UAC for the considered transmission distance and for the 12 underwater acoustic environments.

$$H(l,f) = \sum_{k=1}^{n} A_{k,l} \cdot e^{j\theta_{k,l}} \cdot e^{-j2\pi f t_{k,l}} \quad (2)$$

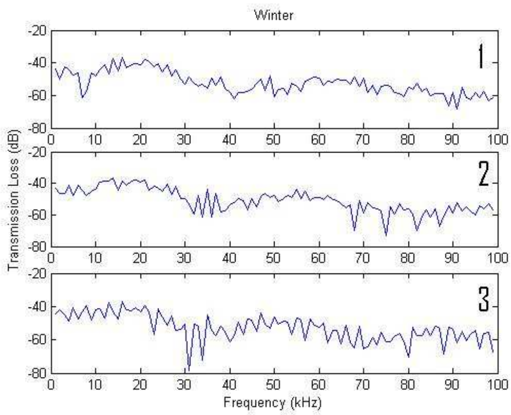
In equation 2 $A_{k,l}$ is the amplitude and $\theta_{k,l}$ is the phase of the impulse response. The delay of each impulse or the time of arrival relative to the first impulse is represented by $t_{k,l}$, H is the frequency response, l is the transmission distance and f is the transmission frequency. The transmission loss was computed using equation 3 and the frequency response from equation 2.

$$TL = 10 \log_{10}|H(f)|^2 \quad (3)$$

We must emphasize that the presented method has several advantages over the experimental one. A first advantage is that it is less expensive than the experimental one because it requires the simulation of a mathematical model with real input data. The simulation results will be satisfactory if the underwater acoustic channel will be modelled more realistically. Another advantage of this method is that we can simulate the transmission losses for a wide range of frequencies. A third advantage is that we can change at any time the current simulation model.

3. SEASONAL VARIATIONS OF THE TRANSMISSION LOSS

The simulation results are shown in Figure 5 for each season and for each sound speed profile. In each sub-figure the upper plot, 1, is characterized by the mean minus one std sound speed profile. The middle plot, 2, is determined by the mean SSP and the lower plot, 3, is characterized by the mean plus one std SSP.



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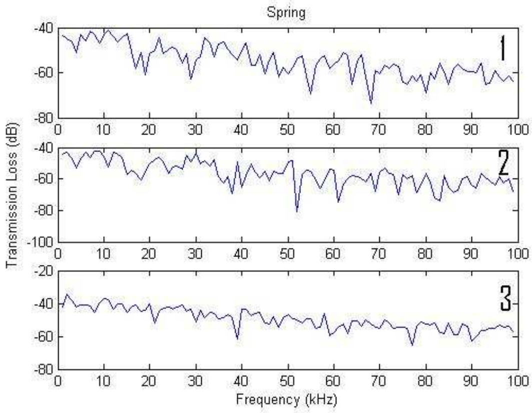

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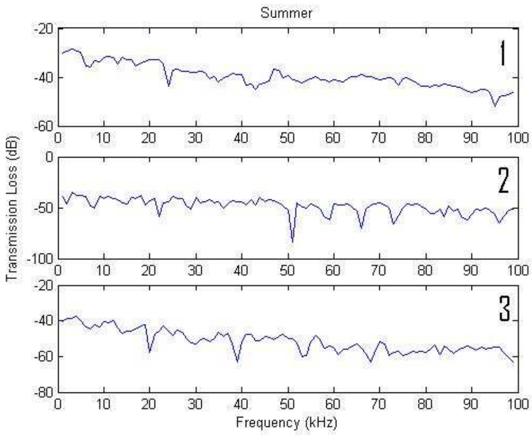

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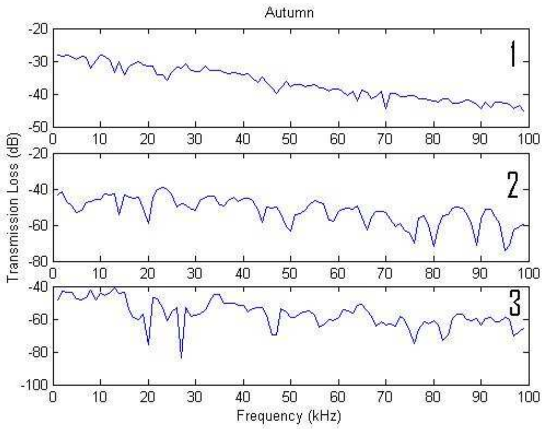

d)

Figure 5 Seasonal variations of the transmission loss.

We observe in Figure 5 a.1 three pronounced notches around 8, 40 and 90 kHz. As the sound speed increases we notice in a.2 that these notches are smaller, but others appear around 70 and 80 kHz. In a.3 we see the appearance of a notch around 22 kHz and two pronounced notches around 32 kHz. The one at 8 kHz disappeared and that at 40 kHz is still present. The notches around 70 and 80 kHz have moved 10 kHz away.

We see that the frequency selectivity in figure 5 b.1 and b.2 is much larger than that in Figure 5 a). A quasi-linear decay is observed in b.3 were the notches are very small.

The same linear decay is observed in Figure 5 c.1 but the transmission loss level is 10 dB higher than that in b.3. In c.2 we observe a quasi-constant TL level with a pronounced notch around 50 kHz and three smaller notches around 65, 70 and 75 kHz. In c.3 we observe that the linear decay is somehow restored, with notches around 20, 40, 50 and 70 kHz.

Again the same linear decay is observed in d.1. This pattern is transformed in a random patter in Figure 5 d.2 and d.3 where an increase in frequency selectivity is observed.

In conclusion we can say that if the transmission losses in Figure 5 would have been determined by temporal variations in the SSP we have been noticed a time varying frequency selective fading.

4. CONCLUSIONS

In this article we present the variations of the transmission loss at the mouth of the Danube Delta in response to changes from the mean sound speed profile. We also show these changes for each season. We modeled the underwater acoustic channel using real data and AcTUP simulation software. We used the simulation results to compute the changes in the transmission loss for each season.

These results will be used in designing an underwater acoustic modem. In the near future we want to install in the considered region an underwater wireless sensor network consisting of two modems placed on the bottom in a horizontal link.

5. REFERENCES

[1] Akyildiz, I., Pompili D. and Melodia, T., *Underwater acoustic sensor networks: research challenges*, Ad Hoc Networks 3 (3), pp. 257-279, 2005.

[2] Etter, C. P., *Underwater Acoustic Modeling and simulation*, 3rd ed., Spon Press, 2003.

[3] National Oceanic and Atmospheric Administration, NOAA, http://www.noaa.gov/, 2012.

[4] Brekhovskikh, L. M., *Fundamentals of Ocean Acoustics*, 3rd edition, Springer, 2003.

[5] Oaie, Ghe., Secrieru, D., *Black Sea Basin: Sediment Types and Distribution, Sedimentation processes*, Proceedings of Euro-EcoGeoCentre Romania, 2004.

[6] Jensen, F. B., *Computational Ocean Acoustics*, 2nd edition, Springer, 2011.

[7] Maggi, A. M., *AcTUP v 2.2, Acoustic Toolbox User-interface and Post-processor, Installation and User Guide*, 2010.

[8] Xiao, Y., *Underwater acoustic sensor networks*, CRC Press, Boca Raton, 2010.

[9] Porter, M. B., *The Bellhop Manual and User's Guide*, 2011.

[10] Porter, M. B. and Liu, Y. C., *Finite-Element Ray Tracing*, Theoretical and Computational Acoustics 2, 947-956, 1994.

[11] A. J. Duncan, A. L. Maggi, A Consistent, *User Friendly Interface for Running a Variety of Underwater Acoustic Propagation Codes*, Proceedings of ACOUSTICS 2006, pp. 471-477, 2006.

ENERGY-EFFICIENT TRANSMISSION METHOD FOR UNDERWATER ACOUSTIC MODEMS

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ABSTRACT

In this article we present a transmission method that minimizes the energy used by an underwater acoustic modem (UAM) to send the acquired data from the environment to another UAM or to the surface. This underwater communication device could be placed on the seafloor to monitor the aquatic environment. The energy used to transmit the acquired data is finite because the modem is powered by batteries. Using this finite energy-efficient will enable the modem to monitor a longer time.

If the method described in this article will be used to design an underwater acoustic modem, it can reduce the energy used for transmission and the modem will be adapted to the underwater acoustic channel. Another advantage of this method is that the design and technical maintenance cost will be reduced which will determine a reduction in the total production cost of an UAM.

Keywords: *transmission method, underwater acoustic modem, passive sonar equation.*

1. INTRODUCTION

The ocean acoustic engineers have designed and implemented two types of underwater modems: cabled and acoustic.

A cabled modem transmits the acquired information, to a data center placed near shore, through a fiber optic placed on the ocean or sea floor [1]. Also through this cable the modem is powered and can function a very long time, virtually unlimited. We must emphasis that this method of monitoring has a high cost of implementation and maintenance because a cable is very long and expensive and must be placed on the ocean floor. Furthermore it is not a reliable monitoring method because the cable can break at any time when the weather is bad.

An acoustic modem is an underwater communication device used to acquire scientific data from the marine environment through the use of a sensor module and to transmit acoustically the data to another modem or to the surface. Afterwards the data are saved on a server placed near shore for immediate or later processing [2]. We must emphasize that a big shortcoming of this monitoring method is that the modem will operate a short period of time because it is powered by batteries.

Even if this is an important disadvantage at the present time the underwater acoustic modems are widely used due to the fact that they have smaller manufacturing cost than cabled modems, but the costs are still high [3].

A big advantage is that an acoustic modem can be recovered easily. It is provided with an acoustic release, which can be operated remotely. The acoustic release opens and the modem comes to the surface. Afterwards the communication device is recovered, fixed and placed in the water again [4].

Although this operation is quite fast, it is expensive because it involves at least one marine research platform, trained personnel and numerous sophisticated devices. It can be repeated several times in a year because most of the time the energy from the batteries is depleted quite fast. This is due to the fact that the modem uses a lot of power to transmit the data at shorter or medium distances. Efficient use of this energy, for data transmission, will increase the life of the underwater acoustic modem.

This will be possible if we adapt the modem to the transmission channel. It means that we have to know the variations of the underwater acoustic channel ahead of time or to estimate them [5].

The energy-efficient transmission method described in this article is based on the idea of estimating the variations of the underwater acoustic channel in a particular region. The area of interest is located in the north-western part of the Black Sea belonging to Romania. We split this area in two important regions. In figure 1 we highlight the Danube Delta region and in figure 2 we show Constanta region.

If the method described in this article will be used to design an underwater acoustic modem, it can reduce the energy used for transmission and the modem will be adapted to the underwater acoustic channel. Another advantage of this method is that the design and technical maintenance cost will be reduced which will determine a reduction in the total production cost of an UAM.

In the next section we will present the energy-efficient transmission method and we will highlight its use and performance with an example. In section 3 we will present the results obtained using this method for the variations of the underwater channel in the considered regions. In section 4 we present the conclusions of this article.

2. ENERGY-EFFICIENT TRANSMISSION METHOD

The method presented in this article is based on the passive sonar equation which is shown in equation 1.

$$SNR = SL - TL - NL \tag{1}$$

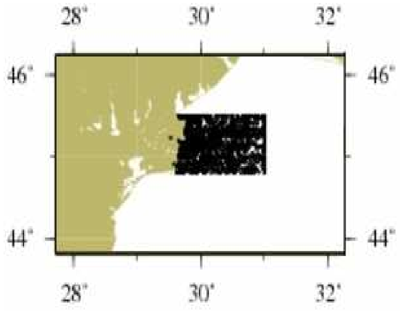


Figure 1 Danube Delta region

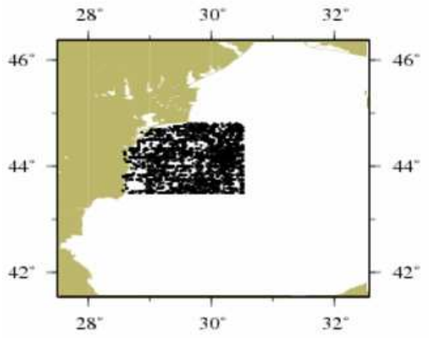


Figure 2 Constanta region

where SNR is the expected signal-to-noise ratio at the receiver, SL is the source level of the projector, TL is the transmission loss experienced by an underwater sound wave when travels from the transmitter to the receiver, NL is the noise level in the underwater acoustic channel produced by various sources. These four parameters are expressed in decibels relative to the intensity of a plane wave of rms pressure 1μPa and are functions of frequency.

We must emphasize that the parameters of the left side of equation 1 are characterized by positive values only.

The single parameter in equation 1 that can be modeled by an underwater modem designer is the SL. The parameters TL and NL depend on the specific characteristics of the underwater acoustic environment and can only be measured or estimated.

The transmission loss will be estimated for each link configuration in the underwater acoustic channel. The noise level is presented in equation 2 for the frequency range 0.1-100 kHz

$$NL = 50 + 7.5w^{0.5} + 20\log_{10}(f) - 40\log_{10}(f+0.4) \quad (2)$$

where w is the wind speed in m/s.

Next we define the parameter total frequency response (TFR) that is shown in equation 3 and represents the cumulative effect of transmission loss and ambient noise.

$$TFR = TL + NL \quad (3)$$

We will use the above notation and rewrite equation 1. This is highlighted in equation 4.

$$SNR = SL - TFR \quad (4)$$

The relationship that defines the parameter SL is shown in equation 5

$$SL = TVR + 20\log_{10}(k) \quad (5)$$

where TVR is the transmitting voltage response and k is the amplification. We must emphasize that the TVR is defined as the output sound intensity level generated at 1 m range by a transducer for an input voltage of 1 V. The TVR profile for various transducers could be obtained from different manufacturers [6]-[8].

In equation 6 we show the new form of the passive sonar equation.

$$SNR = TVR + 20\log_{10}(k) - TFR \quad (6)$$

From equation 6 we observe that for a given SNR at the receiver we could find the optimum amplification k. Then for this amplification we can find the optimum transmission frequency. This method will offer good results if one could estimate accurately the transmission loss in the region of interest [9].

The amplification k, as a function of frequency, can be computed using the equation 7.

$$k = 10^{((SNR-TVR+TFR)/20)} \quad (7)$$

Next for a given transmission bandwidth (ΔB) around the optimum frequency we can find the amplification that will ensure the chosen SNR for the entire band of frequencies.

2.1 UAM design example

We propose to ensure at the receiver a SNR equal to 60 dB re 1μPa. In figure 3 we present an estimate of the parameter TL for the frequency range 0.1-100 kHz that was computed for a specific Tx-Rx configuration with real acoustic data acquired in the region of Constanta.

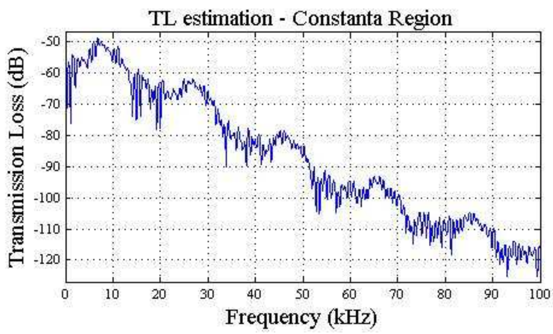


Figure 3 Transmission loss estimated using real acoustic data acquired in the Constanta region.

For the estimation of the parameter TL was used an underwater acoustic propagation modelling software named AcTUP (Acoustic Toolbox User interface and Post processor) [10]. This software runs under Matlab and is a guide user interface written by Amos Maggi and Alec Duncan which facilitates the rapid application of different acoustic propagation codes from Acoustic Toolbox which was written by Mike Porter [11].

In figure 4 we present the parameter total frequency response and in figure 5 we show the TVR of an underwater transducer. This profile was obtained from [6].

Using the equation 7 and the information described above we computed the amplification in the frequency range 0.1-100 kHz. The amplification in the region of the optimum frequency is shown in figure 6.

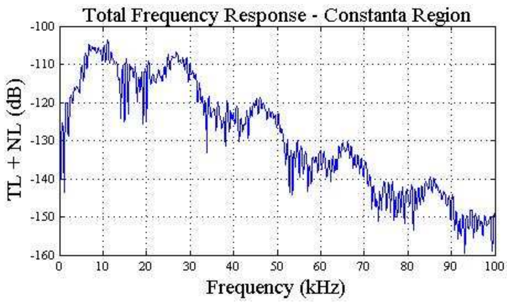


Figure 4 Total frequency response for Constanta region

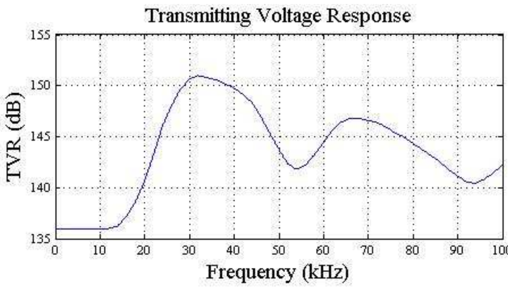


Figure 5 Transmitting voltage response

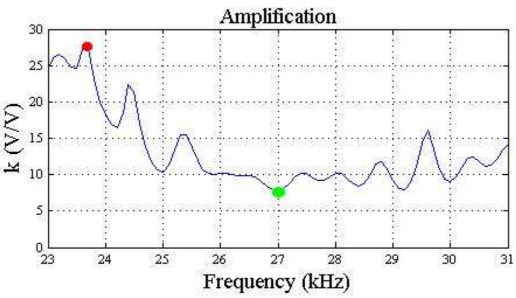


Figure 6 The amplification in the region of the optimum frequency for a given transmission bandwidth

We obtained an amplification of 27 V/V (red dot) for an 8 kHz transmission bandwidth. The optimum transmission frequency is 27 kHz (light green dot).

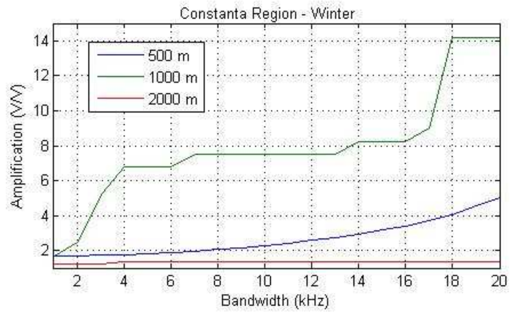
3. TRANSMISSION METHOD RESULTS

In this section we present the results obtained using the transmission method described in section 2. We computed the amplification for transmission bandwidths between 1 kHz and 20 kHz. In figure 7 we show the results for the region of Constanta and in figure 8 we show the results for the Danube Delta region.

For the computation of optimum amplification we used the transmission voltage response shown in figure 5, the noise level described mathematically in equation 2 and estimated transmission losses from the considered regions.

The parameter TL was estimated for three transmission distances, 500, 1000, 2000 meters and for the four seasons of the year using the AcTUP simulation software. In this software we introduced information about the seasonal mean sound speed profile (SSP), mean bathymetry profile, sedimentary composition and speed profile and wind speed at the sea surface.

The underwater speed in the SSP was computed using the sound speed formula obtained from [12] using conductivity, temperature and depth (CTD) information obtained from National Oceanic and Atmospheric Administration (NOAA) [13]. We must emphasize that the CTD data were recorded in a period between February 1890 and September 1998. Information about the sedimentary composition was obtained from [14].



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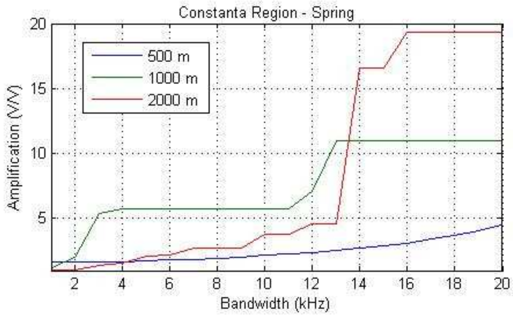

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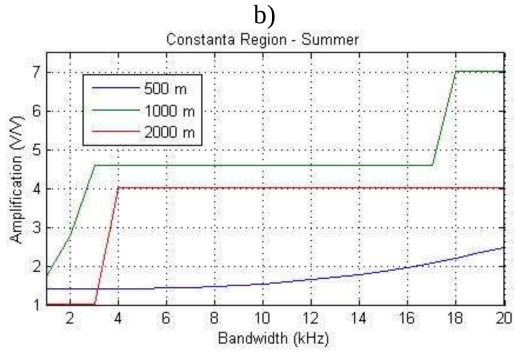

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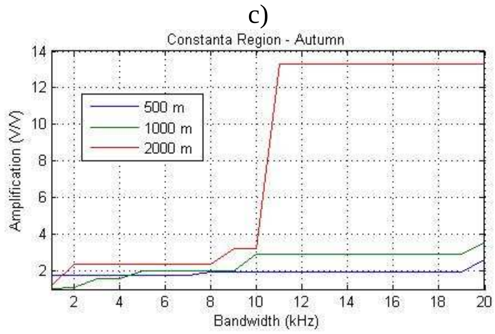
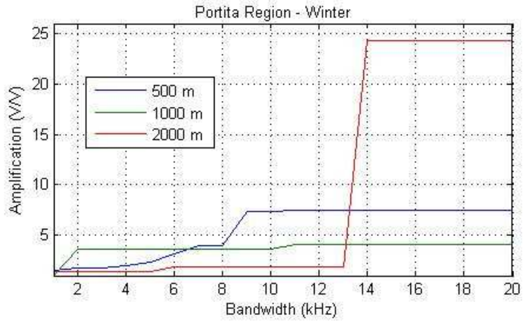


d)

Figure 7 Transmitter amplification as a function of transmission bandwidth in the region of Constanta



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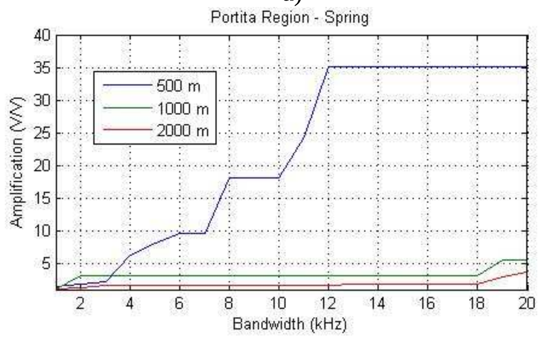

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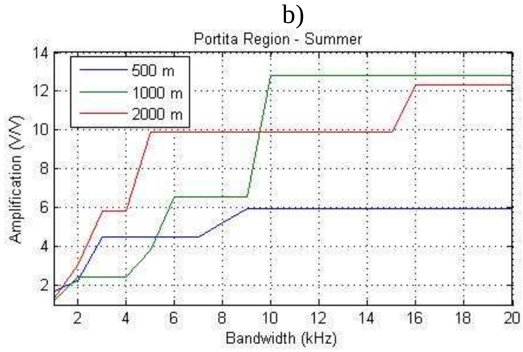

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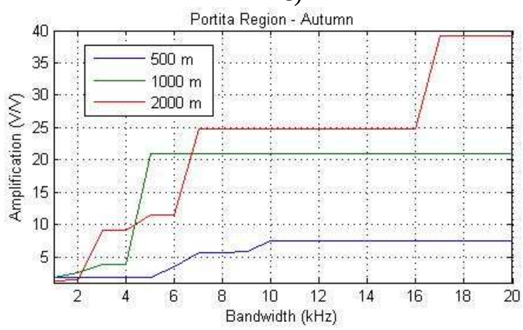

d)

Figure 8 Transmitter amplification as a function of transmission bandwidth in the Danube Delta region

We wish to specify that these amplifications were computed for a minimum SNR for which the amplification was greater than 1.

We observe in both figures for all the transmission distances that the smallest amplification is obtained in summer. In figure 7 a-c we observe that for a transmission distance of 500 m the amplification increases exponentially with bandwidth, but this growth is slow. In figure 7 d between 1-10 kHz we notice an amplification smaller than 4. For distances 500 and 1000 m this amplification is maintained but for distance 2000 m the amplification is approximately 4 times greater. In figure 8 a, b and d we observe high amplifications. This is due to the fact that the seabed in the Danube Delta region absorbs very well the transmitted underwater signals. In figure 8 b, for the transmission distance 500 m, we notice a rapid increase in amplification, because the values of the estimated transmission loss are smaller. For this region the smallest amplification is obtained in spring for the transmission distances 1000 and 2000 m.

4. CONCLUSIONS

In this article we present an energy-efficient transmission method that could be used by an ocean acoustic engineer in designing an underwater acoustic modem.

This method described in section 2 can reduce the energy used for transmission and we could say that the modem will be adapted to the underwater acoustic channel. This method will offer good results if one could estimate accurately the transmission loss in the region of interest. For the results presented in section 3 we used transmission loss estimates based on acoustic data recorded for 108 years. Another advantage of this method is that the design and technical maintenance cost will be reduced which will determine a reduction in the total production cost of an UAM.

5. REFERENCES

[1] Maffei, A.R., et. al., *NEPTUNE Gigabit Ethernet submarine cable system*, Proceedings. IEEE Oceans, 2001.

[2] Akyildiz, I., Pompili D. and Melodia, T., *Underwater acoustic sensor networks: research challenges*, Ad Hoc Networks, 2005.

[3] Benson, B., et. al., *Design of a low-cost underwater acoustic modem*, IEEE Embedded Systems Letters, 2010.

[4] Teledyne Benthos, Inc., *Acoustic Releases*, http://www.teledyne.com, 2012.

[5] Zărnescu, G., *Low cost adaptive underwater acoustic modem for the Black Sea environment*, Advanced topics on optoelectronics, microtehnologies and nanotechnologies, 2012.

[6] Benthos, Inc., *Underwater transducers*, http://www.benthos.com, 2012.

[7] EvoLogics GmbH, *Underwater transducers*, http://www.evologics.de, 2012.

[8] LinkQuest, Inc., *Underwater transducers*, http://www.link-quest.com, 2012.

[9] Xiao, Y., *Underwater acoustic sensor networks*, CRC Press, Boca Raton, 2010.

[10] Duncan, A., Maggi, A., *Underwater acoustic propagation modelling software – AcTUP v2.2l*, http://cmst.curtin.edu.au.

[11] Porter, M., *The Bellhop manual and user's guide*, http://oalib.hlsresearch.com, 2011.

[12] Brekhovskikh, L. M., *Fundamentals of Ocean Acoustics*, 3rd edition, Springer, 2003.

[13] National Oceanic and Atmospheric Administration, *NOOA*, http://www.noaa.gov/, 2012.

[14] Oaie, Ghe., Secrieru, D., *Black Sea Basin: Sediment Types and Distribution, Sedimentation processes*, Proceedings of Euro-EcoGeoCentre Romania, 2004.

SECTION IV
MATHEMATICAL SCIENCES AND PHYSICS

ADAPTIVE CONTROL OF HYPER-CHAOTIC YUJUN SYSTEM

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ABSTRACT

This paper deals with the adaptive control of the uncertain hyper-chaotic Yujun system with unknown parameters. We determine adaptive control laws to stabilize the Yujun system to one of its unstable equilibrium points and we derived update laws for the estimation of system parameters. To validate and demonstrate the effectiveness of the adaptive control scheme derived in the paper numerical simulations are presented.

Keywords: *Adaptive control, hyper-chaos, stabilization.*

1. INTRODUCTION

The control of chaotic systems means to design state feedback control laws that stabilize the chaotic systems around the unstable equilibrium points. It is presently a topic of interest research due to its potential applications in many fields including chemical reactions [1], electrical systems [2], meteorology [3], nonlinear aero-elasticity [4], control of unstable modes in multi-modes lasers [5], ship capsize problem [6], etc.

Since the seminal work by Ott et al [7], a variety of linear and non-linear techniques have been proposed for control of chaotic systems. They can be categorized based on different points of view [8]. One of the most important categories is the adaptive control methods. When a dynamical has some unknown parameters in its describing equations usually an identification algorithm is coupled with the control algorithm to provide an adaptive control system. In such a technique, parameter estimation and control are performed simultaneously. Adaptive control has been used widely for controlling chaos in many discrete and continuous time systems [9-13]. The main objective of this paper is to apply the adaptive control method for the stabilization of an uncertain hyper-chaotic Yujun system with unknown parameters to one of its unstable equilibria.

The paper is organized as follows. The system description is given in Section 2. The determination of the adaptive control functions and of the update laws for the estimation of the system parameters are presented in Section 3. The simulation examples to demonstrate the performances of the proposed method are provided in Section 4. We close with a short summary and conclusions in Section 5.

2. SYSTEM DESCRIPTION

In 2010, Yujun et al [14-15] reported a new hyper-chaotic system which was obtained by adding a nonlinear controller to a known three-dimensional autonomous chaotic system. The generated system undergoes hyper-chaos, chaos and some different periodic orbits with control parameters changed. It is described by

$$\begin{aligned} \dot{x} &= a\left(y-x\right)+y\,z \\ \dot{y} &= c\,x-y-x\,z+w \\ \dot{z} &= x\,y-b\,z \\ \dot{w} &= -x\,z+d\,w \end{aligned} \qquad (1)$$

where x, y, z and w are state variables, while a, b, c and d are real constants.

When parameters $a = 35$, $b = 8/3, c = 55$ and $d = 1.5$ are considered, the system (1) shows hyper-chaotic behaviour. Indeed, it has two positive Lyapunov exponents, $\lambda_1 = 1.4944$ and $\lambda_2 = 0.5012$. The others are $\lambda_3 = 0$ and $\lambda_4 = -38.9264$. The above system was simulated using a fourth order Runge-Kutta integration algorithm of MatLab with the initial conditions $x(0) = 5$, $y(0) = 22$, $z(0) = -10$, $w(0) = -12$. Figure 1 presents the phase planes of the hyper-chaotic Yujun system.

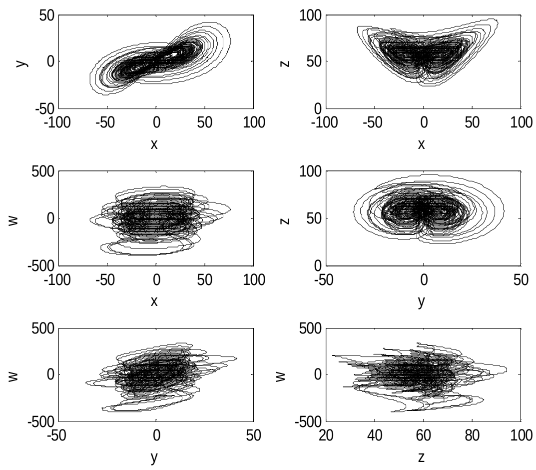

Figure 1 The phase planes of the Yujun system (1) with $a = 35$, $b = 8/3, c = 55$ and $d = 1.5$

The equilibria of the system (1) are obtained by setting $\dot{x} = \dot{y} = \dot{z} = \dot{w} = 0$. After some algebra we get the following bi-quadratic equation in y:

$$d y^4 + ab(ad - a + cd - 2d) y^2 + a^2 b^2 d (1-c) = 0 \quad (2)$$

The other unknowns are given by

$$x = \frac{aby}{ab - y^2},\ z = \frac{xy}{b},\ w = y + xz - cx \quad (3)$$

For a = 35, $b = 8/3, c = 55$ and $d = 1.5$ the system (1) has the following equilibrium points

$E_0: (0, 0, 0, 0)$, $E_1: (49.9962, 8.7725, 164.4719, 5482)$,
$E_2: (-49.9962, -8.7725, 164.4719, -5482)$

All these equilibria are unstable. To see this, we calculate the Jacobian

$$J = \begin{pmatrix} -a & a+z & y & 0 \\ c-z & -1 & -x & 1 \\ y & x & -b & 0 \\ -z & 0 & -x & d \end{pmatrix} \quad (4)$$

and evaluate it at the three equilibria. For the trivial equilibrium E_0 the Jacobian has eigenvalues $\{-65.0532; 29.0532; -2.667; 1.5\}$. For the equilibria $E_{1,2}$ the Jacobian has eigenvalues $\{-0.1276 \pm 1.5452i; -0.1195; 0.003\}$.

3. ADAPTIVE CONTROL OF AN UNCERTAIN HYPER-CHAOTIC YUJUN SYSTEM

In this section, adaptive control is applied to control the equilibria E_0 and E_1. In order to achieve this we start by considering the change of variables

$$x = x_0 + \tilde{x},\ y = y_0 + \tilde{y},\ z = z_0 + \tilde{z},\ w = w_0 + \tilde{w} \quad (5)$$

with (x_0, y_0, z_0, w_0) one of the equilibrium points mentioned above. Doing this, the system (1) becomes

$$\begin{aligned} \dot{\tilde{x}} &= a(\tilde{y} - \tilde{x}) + \tilde{y}\tilde{z} + y_0 \tilde{z} + z_0 \tilde{y} \\ \dot{\tilde{y}} &= c\tilde{x} - \tilde{y} - \tilde{x}\tilde{z} + \tilde{w} - x_0 \tilde{z} - z_0 \tilde{x} \\ \dot{\tilde{z}} &= \tilde{x}\tilde{y} - b\tilde{z} + x_0 \tilde{y} + y_0 \tilde{x} \\ \dot{\tilde{w}} &= -\tilde{x}\tilde{z} + d\tilde{w} - x_0 \tilde{z} - z_0 \tilde{x} \end{aligned} \quad (6)$$

The controlled system of the system (6) is described as follows:

$$\begin{aligned} \dot{x}_c &= a(y_c - x_c) + y_c z_c + y_0 z_c + z_0 y_c + u_1 \\ \dot{y}_c &= c x_c - y_c - x_c z_c + w_c - x_0 z_c - z_0 x_c + u_2 \\ \dot{z}_c &= x_c y_c - b z_c + x_0 y_c + y_0 x_c + u_3 \\ \dot{w}_c &= -x_c z_c + d w_c - x_0 z_c - z_0 x_c + u_4 \end{aligned} \quad (7)$$

where u_1, u_2, u_3 and u_4 are four controllers to be designed. Choosing the controllers as

$$\begin{aligned} u_1 &= -\tilde{a}(y_c - x_c) - y_c z_c - y_0 z_c - z_0 y_c - k_1 x_c \\ u_2 &= -\tilde{c} x_c + y_c + x_c z_c - w_c + x_0 z_c + z_0 x_c - k_2 y_c \\ u_3 &= -x_c y_c + \tilde{b} z_c - x_0 y_c - y_0 x_c - k_3 z_c \\ u_4 &= x_c z_c - \tilde{d} w_c + x_0 z_c + z_0 x_c - k_4 w_c \end{aligned} \quad (8)$$

the equations (7) can be written as

$$\begin{aligned} \dot{x}_c &= e_a(y_c - x_c) - k_1 x_c \\ \dot{y}_c &= e_c x_c - k_2 y_c \\ \dot{z}_c &= -e_b z_c - k_3 z_c \\ \dot{w}_c &= e_d w_c - k_4 w_c \end{aligned} \quad (9)$$

where k_1, k_2, k_3 and k_4 are positive constants. We denote by $\tilde{a}, \tilde{b}, \tilde{c}$ and $\tilde{d}$ the estimate values of the unknown constants a, b, c and d, respectively, and by

$$e_a = a - \tilde{a},\ e_b = b - \tilde{b},\ e_c = c - \tilde{c},\ e_d = d - \tilde{d} \quad (10)$$

the parameter estimation error. Additionally, note that

$$\dot{e}_a = -\dot{\tilde{a}},\ \dot{e}_b = -\dot{\tilde{b}},\ \dot{e}_c = -\dot{\tilde{c}},\ \dot{e}_d = -\dot{\tilde{d}} \quad (11)$$

Now, we pick up a Lyapunov function

$$V = \frac{1}{2}\left(x_c^2 + y_c^2 + z_c^2 + w_c^2 + e_a^2 + e_b^2 + e_c^2 + e_d^2\right) \quad (12)$$

Its derivative along the system (9) is

$$\begin{aligned} \dot{V} &= x_c \dot{x}_c + y_c \dot{y}_c + z_c \dot{z}_c + w_c \dot{w}_c + e_a \dot{e}_a + e_b \dot{e}_b + \\ &+ e_c \dot{e}_c + e_d \dot{e}_d = -k_1 x_c^2 - k_2 y_c^2 - k_3 z_c^2 - k_4 w_4^2 + \\ &+ e_a\left(y_c x_c - x_c^2 - \dot{\tilde{a}}\right) + e_b\left(-z_c^2 - \dot{\tilde{b}}\right) + e_c\left(x_c y_c - \dot{\tilde{c}}\right) + \\ &+ e_d\left(w_c^2 - \dot{\tilde{d}}\right) \end{aligned}$$

By choosing the parameter update laws as

$$\begin{aligned} \dot{\tilde{a}} &= y_c x_c - x_c^2 + k_5 e_a \\ \dot{\tilde{b}} &= -z_c^2 + k_6 e_b \\ \dot{\tilde{c}} &= x_c y_c + k_7 e_c \\ \dot{\tilde{d}} &= w_c^2 + k_8 e_d \end{aligned} \quad (13)$$

where k_1, k_2, k_3 and k_4 are positive constants we obtain

$$\begin{aligned} \dot{V} &= -k_1 x_c^2 - k_2 y_c^2 - k_3 z_c^2 - k_4 w_c^2 - k_5 e_a^2 - k_6 e_b^2 - \\ &- k_7 e_c^2 - k_8 e_d^2 < 0 \end{aligned} \quad (14)$$

Since **V** is a positive definite functional on R^8 and $d\mathbf{V}/dt$ is a negative definite functional, than the equilibrium point $\mathbf{e}=(x_c, y_c, z_c, w_c, e_a, e_b, e_c, e_d)=\mathbf{0}$ of the systems (9) and (13) is uniformly asymptotically stable, hence the controlled Yujun system converges to the equilibrium $(0,0,0,0)$ exponentially and the parameters estimation errors e_a, e_b, e_c, e_d decay to zero exponentially with time.

3. NUMERICAL SIMULATION

3.1 Stabilization to the equilibrium point E_0

This case corresponds to $x_0 = y_0 = z_0 = w_0 = 0$. The calculations were carried out using the MatLab solver ODE23s and selecting the parameters of Yujun system (1) as $a = 35$, $b = 8/3, c = 55$ and $d = 1.5$. Initial value $(x_c(0), y_c(0), z_c(0), w_c(0)) = (5, -9, 2, 7)$ and $(e_a(0), e_b(0), e_c(0), e_d(0)) = (10, -1/3, 10, 23/6)$ were chosen as examples. When the control is activated and the constants $k_i, i = 1, 2, ..., 8$ are settled to be equal with 2, the controlled Yujun system (1) converges to the equilibrium point E_0 exponentially as shown in Figure 2. Figure 3 delineates the estimation of the uncertainties. We may note that the control is rapidly achieved and the unknown uncertainties are quickly estimated to the right values.

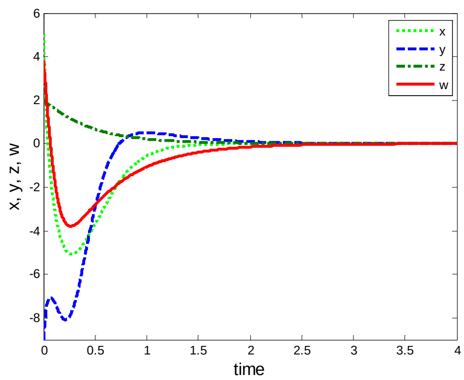

Figure 2 Time responses of the controlled Yujun system

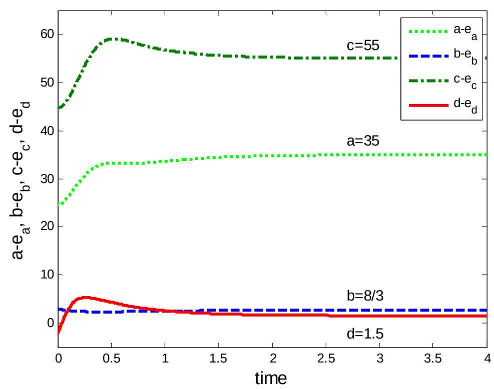

Figure 3 Parameters estimates $\tilde{a}(t), \tilde{b}(t), \tilde{c}(t), \tilde{d}(t)$

3.2 Stabilization to the equilibrium point E_1

We consider now $x_0 = 49.9962, y_0 = 8.7725$, $z_0 = 164.4719, w_0 = 5482$, $k_i = 2, i = 1, 2, ..., 8$, and initial values $(x_c(0), y_c(0), z_c(0), w_c(0)) = (20, 10, 30, 50)$ and $(e_a(0), e_b(0), e_c(0), e_d(0)) = (8, -1, 5, 6)$. When the adaptive laws (8) are applied, the controlled Yujun system (1) converges to the equilibrium E_1 exponentially as indicated in Figure 4.

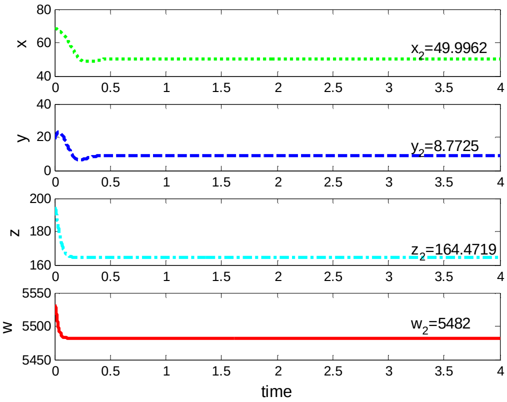

Figure 4 Time responses of the controlled Yujun system

3.3 Stabilization time

Here we restrict attention to the influence of the positive constants $k_i, i = 1, 2, ..., 8$, on the stabilization process. To this purpose, we fix $k_1 = k_2 = ... = k_8$ in the remainder of this subsection. It seems obvious that high values of k_i will lead to small values of the stabilization time. To verify this assumption, we performed a set of numerical experiments where the outputs were the stabilization time t_s to equilibrium point E_0 and the time t_u required for the uncertainties to be estimated to the right values. The absolute error used in the simulations was fixed at 0.0001. Our findings are presented in Table 1. As we shall see, both t_s and t_u converge to zero while k_i approaches infinity. An interesting situation occurs when k_i tends to zero. As expected, t_u begins greater and greater but t_s, after a normal increase, has a maximum at $k_i \cong 0.4$, and then begins to decrease. We plan to address this behaviour in a future paper.

Table 1 Dependence of t_s and t_u with k_i

k_i	t_s	t_u	k_i	t_s	t_u
0.05	5.907	237.899	2.00	5.431	5.824
0.10	6.832	117.673	3.00	3.805	3.954
0.20	9.928	59.136	5.00	2.358	2.273
0.30	13.753	39.406	8.00	1.424	1.424
0.40	14.202	30.299	12.00	0.975	0.975
0.50	13.365	23.561	15.00	0.761	0.791
0.75	10.742	15.956	20.00	0.571	0.594
1.00	8.734	12.141	50.00	0.227	0.236

4. CONCLUSIONS

In this paper we proved that using the adaptive control method we can simultaneously obtain the control of a chaotic system to one of its unstable equilibrium and estimation of its constant unknown parameters.

We investigated two problems. In Section 2 we derived adaptive control scheme and update laws for the estimation of system parameters for the hyper-chaotic Yujun system with unknown parameters. In Subsection 3.3 we presented a short study about the influence of some constants involved in the adaptive control scheme on the stabilization time. The numerical simulations presented in the paper allow us to reliably suggest that the adaptive control method is very effective and convenient to achieve chaos control of hyper-chaotic systems.

5. REFERENCES

[1] SCHWARTZ, I.B., TRIADOF, I., *Controlling unstable Stratesin reaction-diffusion systems modelled by time series*, Physical Review E 50(4), p. 2548-2552, 1994

[2] GE, S.S., WANG, C., *Adaptive control of uncertain Chua's circuit,* IEEE Transactions on circuits and systems, 47(9), p. 1397-1402, 2000

[3] LIAO, T.L., LINI, S.H., *Adaptive control and synchronization of Lorentz system*, Journal of the Franklin Institute, 336, p. 925-937, 2007

[4] VIRGIL, L.N., DOWELL, L.H., *Nonlinear aero-elasticity and chaos*, Computational nonlinear mechanics in aerospace engineering, 146, p. 531-546, AIAA, Washington DC., 1992

[5] COLET, P., ROY, R., WIESENFELD, K., *Controlling hyper-chaos in a multimode laser model*, Physical Review E, 50, p. 3453-3457, 1994

[6] VIRGIN, L.N., *The nonlinear rolling response of a vessel including chaotic motions leading to capsize in regular seas,* Applied ocean research, 9, p. 89-94, 1987

[7] OTT, E., GREBOGI, C., YORKE, J.A., *Controlling chaos,* Physics Review Letters, 64, p. 1196-1199, 1990

[8] SALARIEH, H., SHAHROKHI, M., *Adaptive control of chaos,* www. Intechopen.com

[9] FENG, G., CHEN, G., *Adaptive control of discrete time chaotic systems: a fuzzy control approach,* Chaos, Solitons and Fractals, 23, p. 459-467, 2005

[10] HUA, C., GUAN, X., *Adaptive control for chaotic systems*, Chaos, Solitons and Fractals, 22, p. 55-60, 2004

[11] MERAT, K., SALARIEH, H., ALASTY, A., *Implementation of dynamic programming for chaos control in discrete systems*, Journal of Computational and Applied Mathematics, 232, p. 531-544, 2009

[12] PYRAGAS, K., PYRAGAS, V., KISS, I.Z., HUDSON, J.L., *Adaptive control of unknown unstable steady states of dynamical systems,* Physical Review E 70, p. 1-12, 2004

[13] YASSEN, M.T., *Adaptive control and synchronization of a modified Chua's circuit system,* Applied Mathematics and Computation, 135, p. 113-128, 2003

[14] VAIDYANATHAN, S., *Sliding controller design for the global synchronization of identical hyper-chaotic Yujun systems,* International Journal of Advanced Information Technology, 2, p. 13-26, 2012

[15] YUJUN, N., XINGYUAN, W., MINGJUAN, W., HUANUANG, Z., *A new hyper-chaotic system and its circuit implementation,* Communications in Nonlinear Science and Numerical simulation, 15, p. 3518-3524, 2010.

THE EVALUATION OF GRAVITATIONAL PERTURBATION CCELERATION ACTIONS ON GPS SATELLITES

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ABSTRACT

The precision to determine various points on the Earth's surface, on sea or in the air using GPS receivers suffers not only due to the precision of determining the satellite position on it's orbit but also to the technique that measures the distance between the satellite and the receiver. The orbital errors of the satellites are caused mainly by the gravitational and non-gravitational perturbations of satellites. This article proposes to evaluate the main gravitational perturbations that act upon a GPS satellites.

Keywords: *GPS satellite, kepler orbit, Runge-Kuta method, gravitational perturbation.*

1. INTRODUCTION

There are two methods we can use to calculate GPS satellites orbit. The first method is based on the analytical solutions of Lagranage's planetary equations, expressed in Keplers orbital element terms. The second method is based on the numerical solution of the 2nd order diferential equation of perturbed relative motion:

$$\ddot{r} = -\frac{\mu}{r^3} r + \frac{\partial \Re}{\partial r} \tag{1}$$

expressed in Cartesian coordinates, from an inertial rectangular geocentric equatorial reference system (with the axis Ox facing the true vernal point at J_{2000} epoch), [3], where:

μ - the Earth's gravitational parameter,

$\Re$ - is the sum of all perturbation accelerations that act on the GPS satellite.

2. THE ANALYTICAL SOLUTION

The analytical solution used in the precise calculus of short GPS orbit arcs represents an extension of the 1st order perturbation theory. Generally speaking, the linear solution offers a precision of 2m in the geocentric radius vector, for all the perturbation forces of the satellites, except the predominant effect of the 2nd harmonic zone (of coefficient C_{20} or J_2). For this harmonic it is necessary to include the 2nd order perturbations; in principle, it requires the 2nd solution of Lagranage's planetary equations, using the 1st order (linear) solution to evaluate the right member of this equation.

The comparative analysis of the 1st order analytical solution with the numerical solution applied to GPS satellites, shows the fact that the 2nd order perturbations generally have magnitudes of the order 30, mainly in the direction tangent to the orbit.

The 2nd order effects are included in the analytical solution, using Taylor series. For example, for an Keplerian element q_i, its derivative in relation with time can be written as follows:

$$\frac{dq_i}{dt} = \frac{dq_i}{dt}(\underline{q_0}) + \sum_{j=1}^{6} \frac{\partial q_i}{\partial q_j}(q_j - q_j^0) + ... \tag{2}$$

where q_0 is a reference Keplerian orbit used in the 1st order linear solution, having the role of a Taylor series node. The 2nd order derivative of the orbital element q_i in relation with time will be the sum of the 1st order derivatives and the 2nd order solutions:

$$\frac{dq_i}{dt} = \frac{d\Delta_1 q_i}{dt} + \frac{d\Delta_2 q_i}{dt} \tag{3}$$

The 2nd order perturbations will be calculated with the following relation:

$$\Delta_2 q_i = \int \left[\sum_{j=1}^{6} \frac{\partial \dot{q}_i}{\partial q_j} \Delta_1 q_j \right] dt \tag{4}$$

Replacing (2) and (3) in (4), $\Delta_1 q_i$ are the solutions of integrated Newton-Euler equations. The perturbation force function $\Re$ has the following form [12]:

$$\Re = \frac{\mu}{a}\left(\frac{a_e}{a}\right)^{\ell} \sum_{m=0}^{\ell}\sum_{p=0}^{\ell}\sum_{q=-\infty}^{\infty} F_{\ell mp}(i) G_{\ell pq}(e) S_{\ell mpq}(\omega, \Omega, M, \theta) \tag{5}$$

For GPS satellites the following observations are available:

- for simplicity, Newton-Euler equations are integrated using only one term in (5);
- the 2nd order perturbations are necessary only for e, ω, M;
- the sum with *j* index in equation (4) only requires including the 1st order solutions for e, ω, M;
- only two terms of the developing perturbatory force function are necessary for each Δq_j.

The 2nd order solution is obtained by isolating the most important 2nd order terms and is consistent with the numerical solution, the only disadvantage being the length of the calculus [11]. The maximum errors per revolution reach the order of 1m. For the same period, the mean square error has the value of 0,6m.

A much more efficient 2nd order solution is that of Asknes and Kinoshita, based on a transformation of the differential equation system in a canonical form. More precisely, Asknes used Hill's variables, while Kinoshita adopted a modified form of Delauney's variables. In both cases, the 2nd order perturbations reach the order of 1m or smaller for GPS satellite orbits.

Removing the singularity effect in the Keplerian orbital elements, the differences between the analytical method and the numerical mehod are eliminated. In order to obtain a precision of 1m in the calculation of the satellite's geocentric position, we will incorporate the 2nd order development in the final solution. Taking into consideration the time allocated for calculation of the numerical solutions, the introduction of the 2nd order solution has a very small effect thus this cannot represent a semnificative criteria in the tie of solutions.

2. THE NUMERICAL SOLUTION

The numerical solution of GPS satelites orbit is based on direct numerical integration of 2nd order diferential equations of perturbed relative motion, in Cartesian coordinates. This method, also known as Cowell's method has the advantaje of a simple formulation for movement equations.

In Cartesian coordinates, it has the following form:

$$\ddot{x}_i = -\frac{\mu}{r^2}\cdot\frac{x_i}{r} + \frac{\partial\Re}{\partial x_i} \quad \text{for } i = 1, 2, 3 \tag{6}$$

where r is the geocentric radius vector, $\frac{\partial\Re}{\partial x_i}$ is the sum of perturbed accelerations caused by the non-centred terrestrial gravitational field, the Moon-Sun gravitational attraction and the relativist effects and x_i coordinates are defined in an inertial geocentric equatorial reference system.

The movement equations are complete when each perturbation acceleration is evaluated and transformed in this reference system.

The transformation of (6) relation from CTS (Conventional Terrestrial System) in CIS (Conventional Inertial System) is made with the help of the 4 rotation matrices, based on the relation:

$$x_i'\left[CTS\right] = R^M \cdot R^S \cdot R^N \cdot R^P \cdot x_i\left[CIS\right] \tag{7}$$

where: $\boldsymbol{R}^P$ - the rotation matrix for precessional motion

$\boldsymbol{R}^N$ - the rotation matrix for nutation

$\boldsymbol{R}^S$ - the rotation matrix for sidereal time

$\boldsymbol{R}^M$ - the rotation matrix for the pole's movement.

The arguments of R matrices are based on the new definitions adopted for the reference epoch J_{2000} (J = 2451545.0). The accelerations due to Moon-Sun gravitational attractions can be expressed directly in the adopted reference system. The caused acceleration is proportional with the Moon-Sun gravitational attraction on the GPS satellite minus the geocenter acceleration caused by the the same perturbation force.

In this conditions, equation (6) becomes:

$$\ddot{x}_i = -\frac{\mu}{r^3}\cdot x_i + \left[\frac{\partial V}{\partial x_i} + \ddot{x}_i^L + \ddot{x}_i^P\right] \tag{8}$$

where the terms in brackets are expressed in CIS.

The integration of the 2nd order diferential equation of relative perturbed movements of the GPS satellite (9) can be made using the 4th order Runge-Kutta algoritm.

RUNGE KUTTA METHOD

In principle, with the defined initial condition (the position x_0 and the speed $\dot{x}_0$ at t_0 launching epoch), the equations (6) can be integrated numerically. As a reference we will introduce the keplerian orbit. Thus, only the small differences between the total acceleration and the central acceleration have to be integrated. The integration will have as a result the increase (incrementially) dx which will give the right position. The 2nd order differential equations will be transformed in a system of two 1st order equations as follows:

$$\underline{\dot{x}}(t) = \underline{\dot{x}}(t_0) + \int_{t_0}^{t}\left[d\underline{\ddot{x}}(t_0) - \frac{\mu}{r^3(t_0)}\underline{x}(t_0)\right]dt \tag{9}$$

$$\underline{x}(t) = \underline{x}(t_0) + \int_{t_0}^{t}\underline{\dot{x}}(t_0)dt \tag{10}$$

The numerical integration of this system is realised applying a 4th order Runge-Kutta algoritm [2].

This method can be applied also for integrating the Newton-Euler equation system, these having the advantage of being 1st order equations.

Consider the Newton-Euler equations as follows:

$$\dot{q}_i = \dot{q}_i\left[q_j, t\right] \equiv \dot{q}_i\left\{a, e, i, \omega, \Omega, M\right\} \tag{11}$$

where q_i is any of the satellites keplerian elements. The integration of the system (11) is made on a constant step of time Δt (small enough), thus:

$$\begin{aligned} w_i &= \dot{q}_i\left[q_j(t), t\right]\cdot\Delta t \\ x_i &= \dot{q}_i\left[q_j(t) + \frac{w_j}{2}, t + \frac{\Delta t}{2}\right]\cdot\Delta t \\ y_i &= \dot{q}_i\left[q_j(t) + \frac{x_j}{2}, t + \frac{\Delta t}{2}\right]\cdot\Delta t \\ z_i &= \dot{q}_i\left[q_j(t) + \frac{y_j}{2}, t + \frac{\Delta t}{2}\right]\cdot\Delta t \\ q_i(t+\Delta t) &= q_i(t) + \frac{w_i}{6} + \frac{x_i}{3} + \frac{y_i}{3} + \frac{z_i}{6} \end{aligned} \tag{12}$$

3. THE EVALUATION OF GRAVITATIONAL PERTURBATION ACCELERATIONS

Consider the satellite S, and its position defined by the geocentric radius vector $\vec{r}^{\,S}$.

The coordinates $\vec{r}_{SCI}^{\,S}$ (for J_{2000} epoch) are known and we need to find out the $\vec{r}_{SCT}^{\,S}$ coordinates (for the t epoch of observation).

We considered an keplerian orbit (unperturbed) with the initial conditions on the date 10.02.2011, 00:00:00 UT: xai, yai, zai, vxai, vyai and vzai.

The 4th order Runge-Kutta algoritm was applied for the integration of unperturbed movement equation (1.1).

The soft determines the values of the radius vector and speed, for the selected period and for each integration step it wrote them in a text file.

The satellite movement was considered to be gradually perturbed by only one perturbation: the zonal harmonics J_2, J_3, J_4, J_5, J_6, the gravitational attraction of the Sun and Moon, and also the relativistic effects. Runge-Kutta method was applied for the integration of the unperturbed movement.

The integration of the satellite's orbit was realised using the 4^{th} order Runge-Kutta method for an orbital period (12 hours) and 1,2 days (50 hours) and the action of the main gravitational perturbation accelerations was illustrated both numerically and graphically.

Table 1 Values of the action of the main gravitational perturbation accelerations

Parameter	**GPS satellite**	**Formula** [Km/s^2]
Semi-major axis	26 500 km	
Inclination	55^0	
Central acceleration	5,6 * 10^{-4}	$\frac{\mu}{r^2}$
Perturbation	**Produced acceleration** [Km/s^2]	**Formula**
J_2 Harmonic	2 x 10^{-7}	$3 \cdot \frac{\mu}{r^2} \cdot \frac{a_{ec}^2}{r^2} J_2$
J_3 Harmonic	2,3 x 10^{-11}	$4 \cdot \frac{\mu}{r^2} \cdot \frac{a_{ec}^3}{r^3} J_3$
J_4 Harmonic	2,5 x 10^{-11}	$5 \cdot \frac{\mu}{r^2} \cdot \frac{a_{ec}^4}{r^4} J_4$
J_5 Harmonic	1,1 x 10^{-12}	$6 \cdot \frac{\mu}{r^2} \cdot \frac{a_{ec}^5}{r^5} J_5$
J_6 Harmonic	5,6 x 10^{-13}	$7 \cdot \frac{\mu}{r^2} \cdot \frac{a_{ec}^6}{r^6} J_6$
Sun's gravitational attraction	2,95 x 10^{-8}	$\mu_{3c}\left(\frac{\vec{r}_{3c}-\vec{r}}{\left(r_{3c}-r\right)^3}-\frac{\vec{r}_{3c}}{r_{3c}^3}\right)$
Moon's gravitational attraction	1,95 x 10^{-8}	
Relativistic effects	3,4 x 10^{-12}	$\frac{3\mu^2 \cdot a\left(1-e^2\right)}{c^2 \cdot r^4}$

where:
r – the geocentric vector radius of the GPS satellite;
a_{ec} – the Earth's semi-major axis;
e - the GPS's satellite orbit eccentricity;
c – the speed of light.

Keplerian orbit

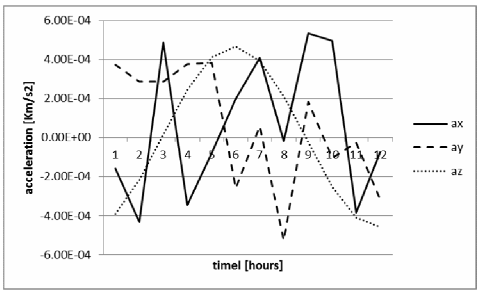

Figure 1 The variation of acceleration components

The perturbation accelerations of the zonal harmonics J2, J3, J4, J5 and J6

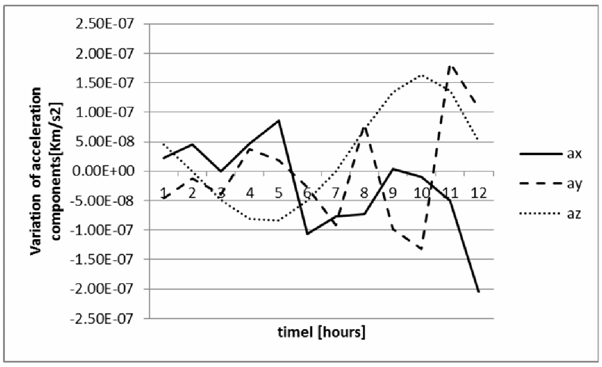

Figure 2 The variation of acceleration's components due to J2 perturbation

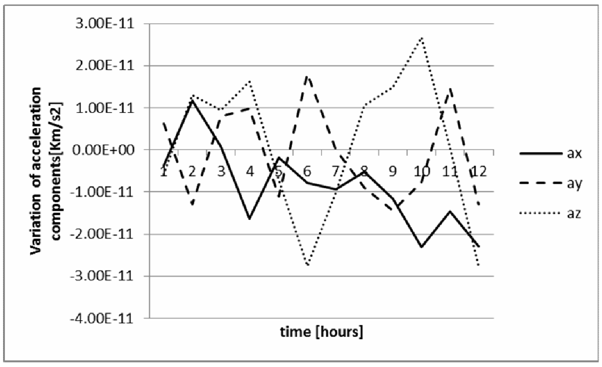

Figure 3 The variation of acceleration's components due to J3 perturbation

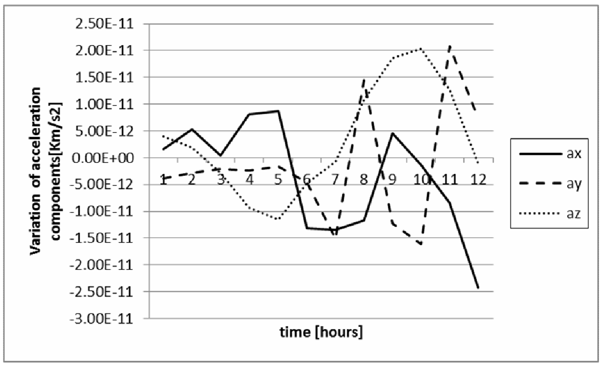

Figure 4 The variation of acceleration's components due to J4 perturbation

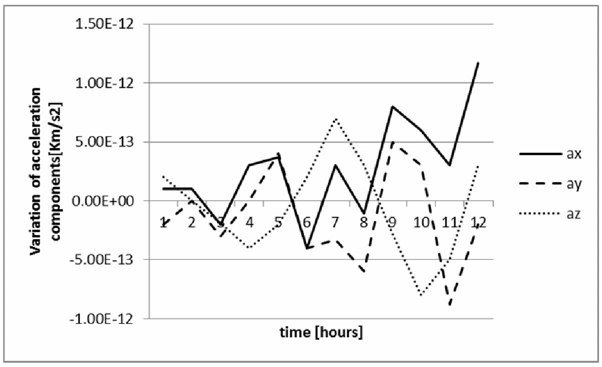

Figure 5 The variation of acceleration's components due to J5 perturbation

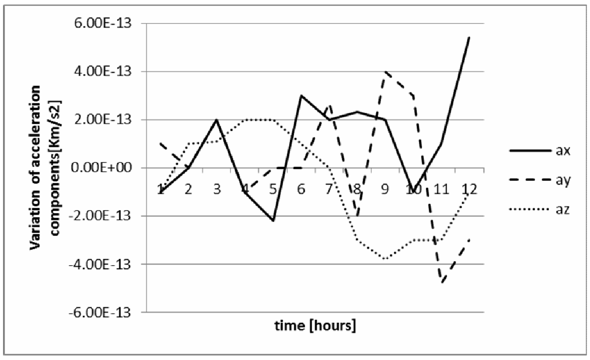

Figure 6 The variation of acceleration's components due to J6 perturbation

Perturbation accelerations due to Sun and Moon gravitational attraction

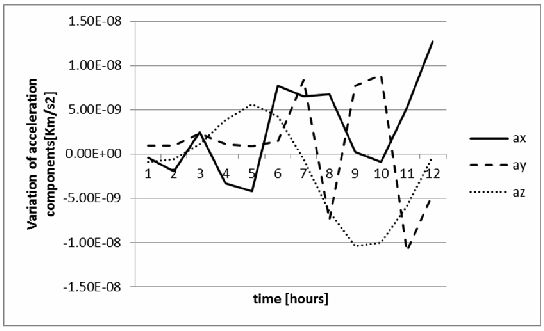

Figure 7 The variation of acceleration's component s due to Sun's gravitational attraction

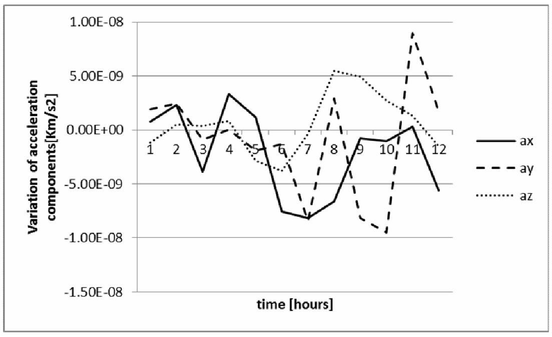

Figure 8 The variation of acceleration's components due to Moon's gravitational attraction

Perturbation acceleration due to relativistic effects

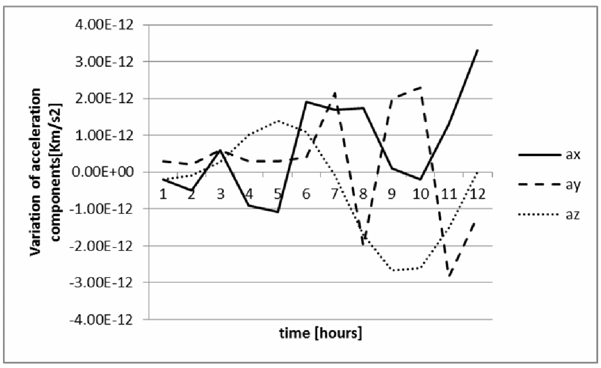

Figure 9 The variation of acceleration components due to relativistic perturbation effects

5. CONCLUSIONS

Out of all gravitational perturbations that act upon a GPS satellite, the non-centered gravitational terestrial field has the most significant effect. The odd zonal harmonics produce a very small perturbation effect. The reason is that the potential perturbator contain *sinφ* term inside Legendre polynomials. The J2 zonal harmonic has it's order at least 3 times bigger than the other zonal harmonics.

Sun's and Moon's attraction represents the second important category of gravitational type influences upon a satellite movement. The perturbation acceleration induced by the relativity effect is a consequence of the fact that artificial satellites are moving in Earth's gravitational field.

From the variation of the perturbation acceleration graphs the secular effect can be observed (added in time), long periodic, short periodic (the variation period is smaller than the orbital theriod of 12 hours) or mixed of the accelerations upon GPS satellites.

6. REFERENCES

[1] Arnold V., Kozlov V., Neishtadt A., "*Mathematical aspects of classical and celestial mechanics*", Springer, Germania, 2006

[2] Beutler G (2005) *Methods of Celestial Mechanics I & II*. Springer, Germany, 2005

[3] Brouwer, D., Clemence, G.M., "*Methods of Celestial Mechanics*", *Academic Press,* New York and London 1961, p 11.

[4] Claessens, S.J., Featherstone, W.E., „*Computation of geopotential coefficients from gravity anomalies on the ellipsoid*", Western Australian Centre for Geodesy, 2004

[5] Cojocaru, S., „*Tratat de navigație maritimă – Metodele moderne ale navigație maritime*", Ed. Ars Academica, Bucureşti, 2008

[6] Collins G., „The foundations of Celestial Mechanics", SUA, 2004

[7] Hofmann-Wellenhof, B. et al, „*GPS - Theory and Practice*", New York 1993.

[8] Lupu S. „*Elemente de dinamica sistemului global de pozitionare NAVSTAR - GPS*", Ed. Academiei Navale "Mircea cel Bătrân", Constanta 2011

[9] Mathuna D., „*Integrable systems in celestial mechanics*", Springer, SUA, 2008

[10] Montenbruck O, Gill E *Satellite Orbits: Models, Methods and Applications*. Springer, Germany, 2000

[11] Nakiboglu, S.M., and al. *A multistation, multi-pass approach to Global Positioning System improvement and precise positioning*. Geodetic Survey of Canada, Rep. 85-003, Ottawa 1985.

[12] Seeber, G.,. *Satellite geodesy*, Walter de Gruyter, 2003

[13] Su, H., "*Precise orbit determination of global navigation satellite system of second generation*", Germania, 2000

[14] Taylor F W (2005) *Elementary Climate Physics*. Oxford University Press, United Kingdom.

THE EFFECTS CAUSED BY NON-GRAVITATIONAL PERTURBATIONS: THE ANISOTROPIC THERMAL EMISSION AND ANTENNAS EMISSION ON GPS SATELLITES

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ABSTRACT

From the non-gravitational perturbations category acting on Earth's artificial satellites, the most important is the solar radiation pressure. The mode of action of these perturbations is performed directly and indirectly. The indirect mode of action of solar radiation pressure is manifested by the albedo phenomenon, anisotropic thermal emission, antennas emission and eclipses. This article proposes to evaluate the orbital errors causes by the indirect effects of the solar radiation pressure: anisotropic thermal emission and antennas emission acting on the GPS satellites.

Keywords: *GPS satellites, indirect solar radiation pressure, orbital elements.*

1. INTRODUCTION

Taking into consideration the perturbation accelerations acting in the way of the satellite deviation from the keplerian movement, the 2nd order inhomogeneous differential equation of the satellite's perturbed motion, as a vector, has the following form [4], [12]:

$$\frac{d^2\vec{r}}{dt^2} = -\mu\frac{\vec{r}}{r^3} + \frac{\partial\Re}{\partial r} \qquad (1)$$

Of all non-gravitational perturbations, the most important is the solar radiation pressure. Its mode of acting on an artificial satellite of Earth is directly and indirectly. Among the indirect effects of the solar radiation pressure there is the anisotropic thermal emission and the antennas emission. These produce a very little effect compared to the central acceleration.

Starting from the initial conditions (position and velocity) of a GPS satellite, the 4th order Runge – Kutta algorithm was applied for the integration of the unperturbed equation motion [3], [9]. The soft determined the values of the range vector and velocity, for the selected period, and for each step of integration, it wrote the values in a text file. The soft also solved Laplace's problem and determined the keplerian elements ($a,\ e,\ i,\ \omega,\ \Omega,\ M$) [5], [10].

where:

a - the semi-major axis

e - the eccentricity

i - the inclination

ω - the mean anomaly

Ω - the perigee argument

M - the longitude of the ascending node

The parameters of the keplerian elliptical orbit define the position of the orbit in the inertial space (*i, Ω*), the orientation of the orbit in its plane (*ω*), the shape of the orbit (*a, e*) and the satellite's position on the orbit (*M*). The only orbital parameter that depends on time is the mean anomaly.

2. ANISOTROPIC THERMAL EMISSION

An indirect effect of the interaction between the solar radiation and the artificial satellite is due to the fact that the equilibrium of temperature distribution on the satellite becomes uneven, due to different orientation related to the solar heating of different satellite parts. This leads to a new force since the thermal photons emitted by the hot surface areas have more kinetic energy than those from colder areas.

For a spinning satellite there will be two asymmetries in the distribution of temperature [11].

For a nearly spherical body that rotates with high velocity the absorbed flow of energy by the satellite's surface elements has the following form:

$$\alpha \Phi_e\, n \cdot S \qquad (2),$$

where:

α - is the absorption coefficient,

Φ_e - is the solar constant ($\approx 1.38 \times 10^6 \mathrm{erg} \cdot \mathrm{cm}^{-2} \cdot \mathrm{s}^{-1}$)

n and S vectors specify the orthogonal directions (outside) on the surface element and respectively oriented to the Sun.

The energy emitted per area unit has the form:

$$\varepsilon\sigma T^4 \qquad (3),$$

where:

$\sigma = 5.67 \times 10^{-5}\ \mathrm{erg/cm^2} \cdot s \cdot K$ - is the Stephan–Boltzmann constant,

T – surface's temperature,

ε - the emission coefficient, ($\varepsilon = 1$ for a black body).

The anisotropic thermal acceleration has a linear variation depending on the temperature variation of two body parts of the satellite and the ratio of the effective section area and the satellite's mass.

When it is known that for a satellite there is a "typical" temperature difference between two parts of its body, the size order of the corresponding perturbation acceleration can be evaluated from the expression:

$$A_w \cong \nu\alpha\frac{A}{M}\cdot\frac{\Phi_e}{c}\frac{\Delta T}{T_0} \qquad (4),$$

where A/M, represents the mean value of the satellite area-mass ratio, and *v* is a coefficient that replaces the factor 4/9 deduced for spherical satellite.

The acceleration value due to anisotropic thermal acceleration for a "diurnal" temperature difference has the order of 10^{-13} Km/s^2.

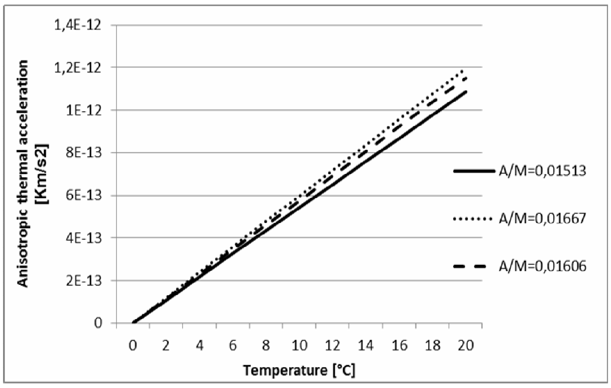

Figure 1 Perturbing acceleration variation based on area-mass ratio

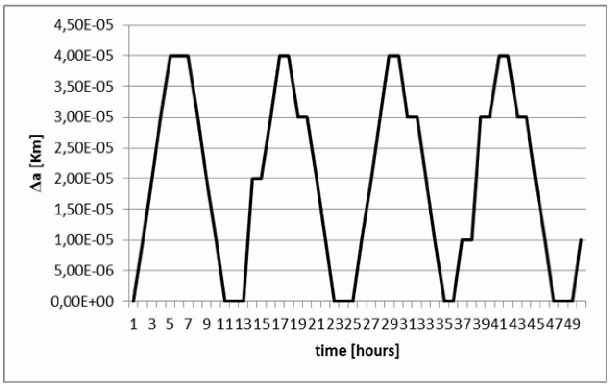

Figure 2 Semi-major axis variation due to anisotropic thermal emission

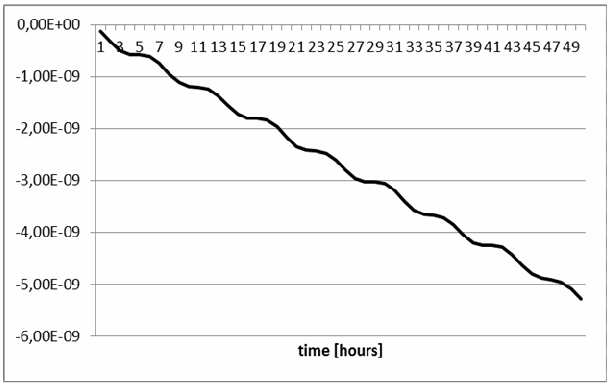

Figure 3 Eccentricity variation due to anisotropic thermal emission

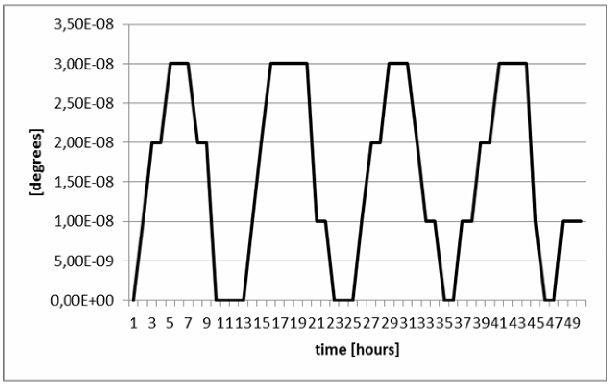

Figure 4 Inclination variation due to anisotropic thermal emission

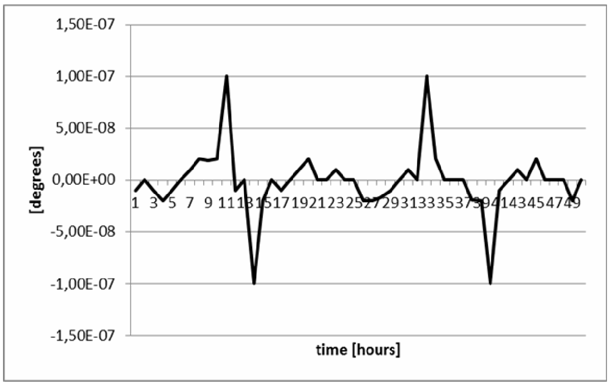

Figure 5. The ascendent node longitude variation due to anisotropic thermal emission

The semi-major axis suffers short periodic perturbations equal to an orbital period and with an amplitude of $4 \cdot 10^{-5}$ kilometers.

The eccentricity suffers a short periodic perturbation equal to 6 hours and with an amplitude of $6 \cdot 10^{-10}$ superimposed over a secular perturbation.

The orbit's inclination suffers a short period perturbation equal to an orbital period and with an amplitude of $3 \cdot 10^{-8}$

The longitude of the ascending node suffers a mixed periodic perturbation:

- short periodic perturbations with a period of 3 hours and an amplitude of $1 \cdot 10^{-7}$ degrees.
- long periodic perturbations with a period of 24 hours.

3. ACCELERATION PRODUCED BY ANTENNAS EMISSION

The emission of GPS satellites navigation antennas produce a constant radial acceleration and as a consequence there is a change in the acceleration in this direction.

GPS satellites continuously emit with a power between 70 and 80 watts in the antenna's direction in the transmission of the two fundamental frequencies L1 and L2.

The force expressed in newtons due to the absoption of photons from the incident radiation flux (*E*) is given by the formula:

$$F = \frac{E}{c} \tag{5}$$

where:
E – is expressed in W/m^2
c – the speed of light in vacuum expressed in m/s.

Thus, according to Newton's third law when a power signal (W) is emitted, there is an equal and opposite reactive force acting in the opposite direction[17].
The resulting acceleration is given by:

$$Fr = \frac{W}{Mc} \tag{6}$$

Considering antennas power of emission of 80 watts the resulting acceleration on different GPS satellites is [17]:

Table 1 The acceleration produced by GPS satellites

GPS satellite type	Acceleration [m/s^2]
Block I	5.3×10^{-10}
Block II	3.0×10^{-10}
Block IIR	2.4×10^{-10}

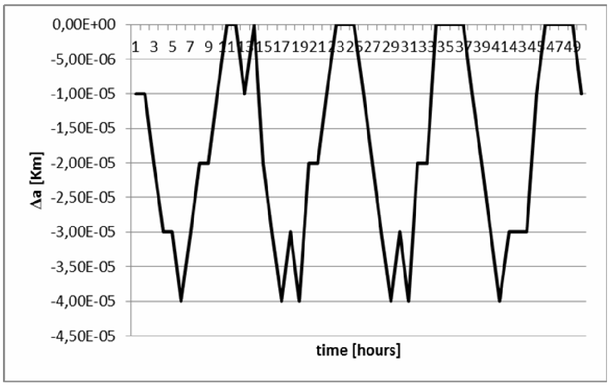

Figure 6 Semi-major axis variation due to antennas emission

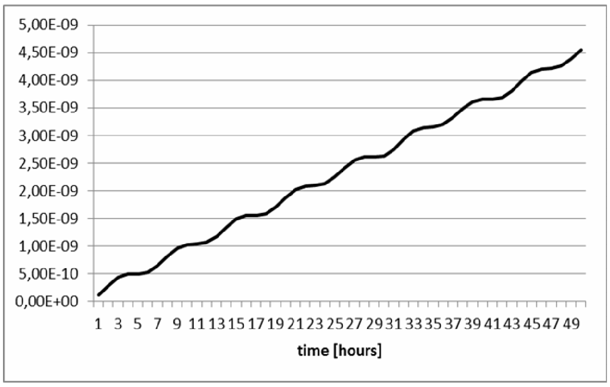

Figure 7 Eccentricity variation due to anisotropic thermal emission

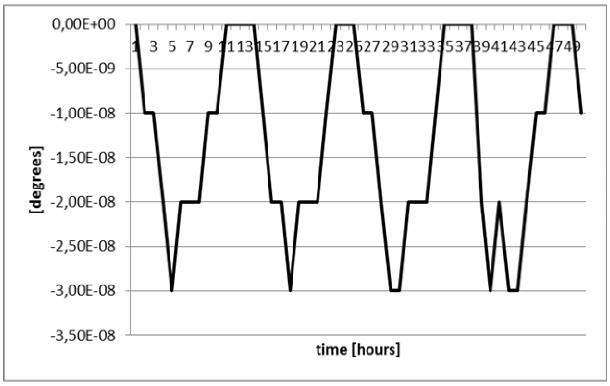

Figure 8 Inclination variation due to antennas emission

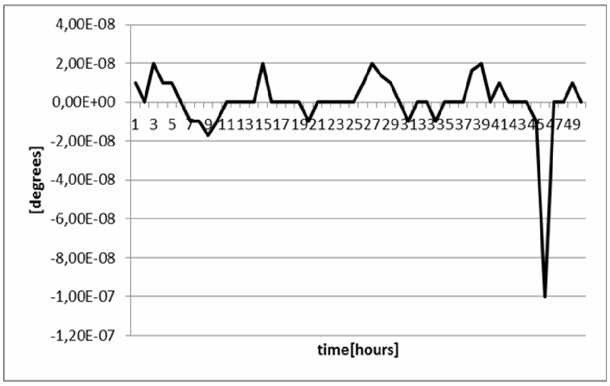

Figure 9 The right ascension variationof the ascendent node due to antennas emission

The semi-major axis suffers many short period perturbations:
- a short period perturbation equal to an orbital period and an amplitude of $4 \cdot 10^{-5}$ kilometers.
- a short period perturbation with a period of 3 hours and an amplitude of $1 \cdot 10^{-5}$ kilometers.

The eccentricity suffers a short period perturbation with a period of 3 hours and an amplitude of $2 \cdot 10^{-10}$ superimposed over a secular perturbation.

The pitch suffers many periodic perturbations:
- a short period perturbation equal to the orbital period and an amplitude of $3 \cdot 10^{-8}$ degrees.
- a mixed periodic perturbation superimposed over the short periodic perturbation.

The perturbations that act upon the longitude of the ascending node are mixed periodic with periods of 3, 6, 18 and 48 hours and with amplitudes of $2 \cdot 10^{-8}$ and $1{,}2 \cdot 10^{-7}$ degrees.

5. CONCLUSIONS

Anisotropic thermal emission does not produce long term effects or secular effects on the semi-major axis, but only 1st order effects in eccentricity, upon the longitude of the satellites ascending node and the inclination.

The emission of GPS satellite's radio waves to Earth will produces a "recoil" of the solar radiation pressure.

The long term effects appear only in the case of eccentricity. The other orbital elements suffer only short periodic perturbation of different periods.

The size order of the action by this perturbation is given by the fractional efficiency of the satellite by converting solar energy into radio waves.

7. REFERENCES

[1] Barkstrom BR (1984) The Earth Radiation Budget Experiment. Bulletin of the American Meteorological Society 65(11): 1170-1185

[2] Bar-Server Y, Kuang D (2004) Improved Solar-Radiation Pressure Models for GPS Satellites. NASA Tech Briefs (NPO-41395)

[3] Beutler G (2005) Methods of Celestial Mechanics I & II. Springer, Germany

[4] Brouwer, D., Clemence, G.M., ′Methods of Celestial Mechanics′, *Academic Press,* New York and London 1961, p 11.

[5] Cojocaru, S., „*Tratat de navigație maritimă – Metodele moderne ale navigație maritime*”, Ed. Ars Academica, Bucureşti, 2008

[6] Fliegel H, Gallini T, Swift E (1992) Global Positioning System Radiation Force Model for Geodetic Applications. Journal of Geophysical Research 97(B1): 559-568

[7] Fliegel H, Gallini T (1996) Solar Force Modelling of Block IIR Global Positioning System satellites. Journal of Spacecraft and Rockets 33(6): 863-866

[8] Frolich, C. & Lean, J. 1998, "The Sun's Total Irradiance: Cycles, Trends and Related Climate Change Uncertainties since 1976", *Geophysical Research Letters*, vol. 25, no. No. 23, pp. 4377-4380.

[9] Hofmann-Wellenhof, B. et al, „*GPS - Theory and Practice*”, New York 1993.

[10] Lupu S. „*Elemente de dinamica sistemului global de pozi□ionare NAVSTAR - GPS*”, Ed. Academiei Navale “Mircea cel Bătrân”, Constan□a 2011

[11] Milani, A., Nobili, A. M., & Farinella, P. 1987, *Non-graviational Perturbations and Satellite Geodesy* Adam Hilger.

[12] Munyamba, N. “*Derivation of a Solar Radiation Pressure Model of the latest GLONASS Spacecraft*”, 2010

[13] Rodrigues-Solano, C. Master Thesis: „*Impact of albedo modelling on GPS orbits*”, 2009

[14] Seeber, G., 2003. *Satellite geodesy*, Walter de Gruyter.

[15] Taylor F W (2005) Elementary Climate Physics. Oxford University Press, United Kingdom

[16] Ziebart, M., 2001. *High Precision Analytical Solar Radiation Pressure Modelling for GNSS Spacecraft, PHd Thesis*. United Kingdom: University of East London.

[17] Ziebart M, Edwards S, Adhya S, Sibthorpe A, Arrowsmith P, Cross P (2004) High Precision GPS IIR Orbit Prediction using Analytical Non-conservative Force Models. Proceedings of ION GNSS 2004: 1764-1770

SECTION V

ENGLISH FOR SPECIFIC PURPOSES

WHEN NEW TEACHING METHODS MEET THE OLD ONES

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ABSTRACT

It is well known that the new generation of "digital natives" needs new teaching-learning strategies complementary or opposed to the old/traditional ones that permit learners to communicate and collaborate, and even switch the role with their teacher, sometimes. E-learning is the common frame of this new type of transmitting-acquiring information, providing an open and transparent environment for learners, ensuring also an authentic audience when they are to display the results of their work. Web-based learning and computer-learning showed that new technologies make a difference in education when properly used.

Keywords: *e-learning, speaking skill, web site, informative speech, essay, writing skill.*

1. INTRODUCTION

Some years ago I had the opportunity to attend a course in the USA, in the Defence Language Institute, a place considered by teachers of EFL working for the military the heart of teaching and sharing knowledge. My course was called Materials Development Seminar, and I did not know what to expect from a course that stated it could improve my personal way of developing teaching materials. My personal experience in teaching based on my own teaching materials was pretty large- I had had 12 years of teaching at that moment (4 in the primary school, 3 in the secondary school and high school, and 5 in the University) and I was over confident on my skills. The course was given to us by two of the best English teachers I have ever had the opportunity to work with, and it was based on using the internet for developing our own teaching materials. At the end of the course I had the feeling that my teaching career was going to change as a result of my new approach towards teaching and learning. And it changed, and it is continuously changing because my courses and seminars are constantly changing- improving I may add- becoming more personalized, trying to individually respond to my students individual needs in improving their skills.

2. MATERIAL DEVELOPMENT

As an example of how web-based learning can be sustained, I developed some activities answering ESP requests for my military students. The topic is TERRORISM, a subject that is present in our lives more than we would want because of the rise of terrorist attacks nowadays. I have chosen to develop my students *speaking skill* knowing that it is the second most difficult skill to develop in English after writing, but also the most needed by anyone who has to communicate in English.

2.1 Pre-Speaking Activity.

I considered that a pre-speaking activity based on listening would introduce the students better in the topic and would be a good way of introducing/ clarifying information about The Informative Speech.

Go to the following web page:
http://www.americanrhetoric.com/rhetoricofterrorism.htm
Click on the President's Address to the nation 9-11-01
Click on the MP3 play button.
Listen to the entire speech.

2.2 Speaking Activity.

After listening to the speech, the students could be given the general information about WHEN, HOW, and WHY this kind of speech is delivered.

THE INFORMATIVE SPEECH

There are some features you should take into consideration when referring to an informative speech:

- the occasion the speech is delivered,
- the construction of the speech,
- the function of this kind of speech.

In addition to the already given information, I considered helpful for the students to read and discuss on a given chart about the construction of the informative speech.

THE CONSTRUCTION OF THE INFORMATIVE SPEECH

1. INTRODUCTION	
1.Salutation	-The speaker greets the audience
2.Background Information	-The speaker provides the audience with some general information about the topic of the speech
3.Topic Sentence	-The speaker introduces the main idea of the speech
2. BODY	
1.First Argument	-The speaker presents the first main point of his speech
2.Second Argument	-The speaker discusses the second main point of his

	speech. Some introductory phrases could be used: secondly, immediately following, to continue with…
3.Third Argument	-The speaker presents the third main point of his speech. Note the introductory phrases: third, my third point is …
4.Fourth Argument (Rarely Found In A Speech)	-The speaker presents the fourth main point of his speech. Note the introductory phrases: my fourth point is, then …
3. CONCLUSION	
1.Restatement of Topic Sentence	-The speaker reminds the main point of his speech
2.Concluding Statement	-The speech is concluded with a memorable statement, and the speaker thanks the audience for their participation

A second listening would help the students identify the three parts of the speech and its topic.

Listen again to President Bush's address to the American people from the Oval Office on 9/11/01.While you are listening, mark the different parts of the speech on the given transcript. Underline the topic sentence from the Introduction.

To expand the area concerning the informative speech additional reading could be given:

Go to the web address:
http://writing.colostate.edu/references/speaking/infomod/index.cfm

Read about purpose of informative speeches, major types of informative speeches, structuring, outlining and delivering informative speeches.

After having so much information, each student must be able to start the construction of his informative speech. To help them I considered useful giving some roles and situations they might choose from in order to deliver their speeches:

1. You are the U.S. Secretary of Defense and you have to inform the public opinion about a car-bombing attack in Philadelphia.

2. You are the U.K. Prime Minister and you have to inform the public opinion about the capture of the man who was responsible with the London terrorist attacks.

3. You are the U.S. President and you have a press conference on the capture of Osama bin Laden.

4. You are the Egyptian President and you inform the press about the investigation of the terrorist attacks in Sharm el Sheik.

5. You are the U.S. Vice-president and you inform the chiefs of the secret agencies about the steps to be followed after a terrorist attack.

6. You are the French President and you have a press conference about a terrorist attack on Tour Eiffel.

7. You are the wing commander and you inform your pilots about an attack on a resistance nest in El Salvador.

8. You are the captain of a frigate and you inform your crew about a rescue mission.

Students are also given a time limit:

Your speech has to be up to 15 minutes.

A final look into the speech features could be useful before students start their work:

When preparing the speech, keep in mind the following features:

1. Clarity
2. Organization
3. Choose words carefully.
4. Don't try to cover too many points
5. Use words like "First", "Second", "Furthermore", etc.
6. Keep the speech moving forward according to a well-developed plan.
7. Use precise vocabulary without being too technical for the audience.
8. Simplify whenever possible.
9. Use reiteration, but avoid repeating with exactly the same words.
10. Coherence
11. Use motivational appeals, interesting intros, etc., to keep audience interested.

2.3. Post- Speaking Activity.

After listening and discussing all speeches, for expanding the students view on other types of speeches, additional sites are brought to their attention:

For more speeches (informative, persuasive, etc) go to the following addresses:
http://www.americanrhetoric.com/MovieSpeeches/moviespeechcrimsontide.html
http://www.americanrhetoric.com/MovieSpeeches/moviespeechreturnoftheking.html
http://www.whitehouse.gov/vicepresident/news-speeches/

3. CONCLUSIONS

Teaching English for Special Purposes had appeared an impossible mission for me years ago, but thanks to continuous learning, asiduous work, and training courses, like the one mentioned in the beginning of the paper, ESP – military branch - has given the most fulfilling satisfaction.

4. REFERENCES

[1] http://www.americanrhetoric.com/MovieSpeeches/moviespeechcrimsontide.html
[2] http://www.americanrhetoric.com/MovieSpeeches/moviespeechreturnoftheking.html
[3] http://www.americanrhetoric.com/rhetoricofterrorism.htm
[4] http://www.whitehouse.gov/vicepresident/news-speeches/
[5] http://writing.colostate.edu/references/speaking/infomod/index.cfm

THE INTERVIEW - A COMMUNICATIVE TESTING TECHNIQUE

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ABSTRACT

The present paper is focused on the importance of applying the appropriate evaluating approach to a rather relative human interaction. As in the case of many controversial matters, theoreticians have attempted to set some guidelines, weigh the pros and cons of a communication interview while establishing the boundaries of language skills, competences and abilities.

Keywords: *interview, testing, teaching methods, competences*

1. INTRODUCTION

In the years since the emphasis in the language classroom began to move from the classical approaches to the communicative one, we – as classroom teachers and researchers - have bravely addressed the accompanying problem of how to measure our students' success in a way appropriate to this new type of language teaching. The older established methods of teaching have been used with various degrees of success, but rarely with a confidence that we were measuring exactly what we intended to teach and certainly with strong reservations that the result would tell us what we wanted to know.

2. TEST RELIABILITY

So overly concerned with test reliability were we that we often overlooked the compromise we were making with evaluating student competences in potentially real situations. The obvious flaw was that we simply were not measuring enough of what we were aiming to have the student acquire. "*Tests play a fundamental and controversial role in allowing access to the limited resources and opportunities that our world provides. The importance of understanding what we test, how we test, and the impact that the use of tests has on individuals and societies cannot be understated. Testing is more than a technical activity; it is also an ethical enterprise.*"(Fulcher 2010)

The idea is generally shared that the most important implication of the concept of communicative competence is undoubtedly the need for tests that measure an ability to use language effectively to attain communicative goals.

It would appear that communicative competence cannot be successfully tested with the normal procedures of classical test methodology when the student is mostly involved in classroom activities.

Such competences had better be evaluated in a more tolerant atmosphere suggestive of real life situations, which would seem to indicate an interview event.

It has been estimated that nonverbal and paralinguistic communicative systems might account for as much as 65 per cent of the actual meaning in a spoken message (Littlejohn & Foss 2005). Nevertheless, we still believe that the interview is the method with the greatest potential for measuring communicative abilities. However, the interview must take on as much of non-classroom real-life atmosphere as possible; it must be conversational in tone, with less of the searching aspects so often associated with other language interviews. That is to say, the students must be judged on their ability to communicate, not on the grammar or structures they do not know or seemingly cannot use. They must be allowed to direct the conversation according to their level of competence, avoiding whatever is difficult for them and using the schemes and clues they have at their disposal. The teacher will judge how well all of these aspects come together to produce effective communication, which is the "bottom line" in a true, non-classroom situation.

Once the interview/conversation has taken place, the teacher faces a problem long associated with testing communicative abilities. While a discussion with each student would be ideal, time does not usually permit such initiatives. The use of a universal rating scale is good on condition that it follows the same philosophy as the interview. A scale that judges the grammatical components of the conversation as more important than continuity or comprehension and response does little to encourage the skills we are trying to enhance. Furthermore, the former approach does not adhere to the spirit and intent of the interview.

We are using the scale to describe the levels of communication which require some degree of grammatical competence that is, more than elementary knowledge of sentence level grammar. The scale shall describe the requirements of conversational communication, which must be presented in a language tailored to the students' comprehension ability.

Teaching English in a communicative style has the clear advantage of bringing the trainees much closer to active communication which is not restricted to a particular issue. In this way, the trainers will understand the need of changing the language-learning approach from studying a subject to that of learning a skill. This requires new methods of evaluation. We can no longer test material as subject matter which is not being taught as such. A method of interview/ conversation is geared to the non-discreet parameters of the acquiring of communicative language. The interview is open-ended and a teacher has every opportunity to lead the conversation towards the students'strong points, and to use other skills of communication that can lead to an easy-flowing and productive conversation.

In summarizing some viewpoints at a national conference, Helt (1982), states as a particular area of skepticism, "the absence of an instructional environment which is supportive of the attempt to develop communication skills" (Helt 1982). On the same line of thought, the testing or evaluative environment in our classroom today must also aim at improving communicative language skills.

3. TEST RATING

Considering the above views, the interview is one method that evaluates what a communicative teacher is trying to achieve: competence in a real communicative situation. This method of evaluating the performance in the interview is a scale that has been designed to be personal and encouraging as much as evaluative.

If the students are to learn anything from their ratings, these should be presented in a user friendly way.

The ratings are often presented in a manner that shows their subjectivity as shown by Professor Herb Marsh in his study "Making Students' Evaluations of Teaching Effectiveness Effective: The Critical Issues of Validity, Bias, and Utility" published in the American Psychologist, in 1997.

Furthermore, conversation between two people is prone to misunderstanding on either side and the students are helped to understand that a problem arising from faulty communication is not necessarily one-sided.

Topics that are introduced within the interpretative framework of personal usage cannot effectively be tested with the memory-oriented structures of conventional testing procedures. We consider that interviewing procedures have the potential to allow students to choose more creatively the communicative techniques at their disposal and to show their true skill in a certain language used for communication.

There is no task inherent in the interview/ conversation except that of communication. However, even interviews can be non-communicative if they are too rigidly structured. This is the result of an interviewer taking the leading part all the time and when the rating scale is not geared towards evaluating total communication. As regards other assessment techniques, there is always a serious risk that learners will adapt their learning behavior to the test.

4. CONCLUSIONS

No matter how valuable, a single short interview can cover only some elements of a communicative situation. There is a need to develop more innovative procedures that shall measure only clear and accurate communication.

Thus, taped or recorded interviews are sometimes used in order to better understand the approach trainers should adopt while assessing the knowledge of their trainees. Researchers such as Allan Pease and Barbara Pease, in *The Definitive Book of Body Language*, New York, Bantam, 2004 have even included the impact of body-language or even some psychological profiling in the interview ratings. They claim that no-verbal cues are layered on and contribute a great deal to the linguistic impact of the communicative act.

To conclude, we must once again stress the fact that a new approach is needed in interviewing as a testing technique since it is definitely a complex process which brings together language practice, theory, ethics, and personality.

5. REFERENCES

[1] Helt, R, *Developing communicative competences: A Practical model*, Modern Language Journal, 1982

[2] Savignon, S, *Communicative competence. Theory and Classroom Practice*, Ed. Addison, Wesley, 1983

[3] Littlejohn, S.W. and K. A. Foss, *Theories of Human Communication*, Ed. Belmont California, 2005

[4] Marsh, H. W., & Roche, L. A, *Making students' evaluations of teaching effectiveness effective*, American Psychologist, issue no. 52, 1997

[5] Fulcher, G. *Practical Language Testing*, London, Hodder Education, 2010

TEACHING ELEMENTS OF COMMUNICATION FOR BUSINESS ENGLISH

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ABSTRACT

If tackling Business English vocabulary and various corresponding grammar structures is often discussed within the epistemic community, the particularities of teaching specific communicational elements to students in economics tend to be less presented. This study undertakes to bring up the matter regarding conversational structures as quite straightforward and unproblematic and to emphasize the need of attentive consideration to the approaches of teaching such material so that quality education can be provided.

Keywords: *Business English, elements of communication, teaching language, didactic method.*

1. INTRODUCTION

The standard phrases involved in communication prove to be much less debated in the specialty literature than other aspects of teaching a language for specific purposes, i.e. Business English, such as the introduction of lexical elements or the basic grammar involved. An explanation may lie in the general impression that communication structures are too explicit and direct to create any problems in learning. Though a good point indeed, this does not mean that proper teaching of such material is useless or too easy and straightforward to consider. On the contrary, it implies that the approaches to introducing such ready-made elements to students can be rather dull or uninspired and in many situations it boils down to the rather non-didactic instruction to learn by heart the given formulas. Mundane and boring activities have to be avoided (Hogan 2003: 18). Instead, some interactive activities, which are both efficient and appealing, can be devised. Thus, the result will be much more rewarding for trainer and trainee as well.

2. DIDACTIC APPROACH TO THE ELEMENTS OF COMMUNICATION

2.1 Context issue

Standard phrases that are useful in making a presentation (Sweeney 1997: 50-54), in a negotiation of contractual terms, in a problem solving session or an ordinary meeting (Goodale 1987:119-123) are obviously context bound and make plenary sense only in the authentic context.

Elements of standard conversation, business communicational structures and economic vocabulary ancillary to the processes involving human interactions and transactions represent bases of the business activities. Such elements are rather hard to teach in context as that is neither easy to render by means of didactic creation of text nor are such communicational contexts available for didactic purposes.

Thus, just a few exemplifications of partial contexts will have to suffice and teachers will need to do without the authentic text that represents for instance a basic tool for the introduction of BE vocabulary.

2.2 Usefulness of creative methods

When approaching communication structures, teachers of English who work with Economics students shall have to resort to distinct methods, creating activities that can assure introduction of such material in a pleasant and effective manner.

By solving a puzzle, by playing a word game, several elements of communication can well be introduced and then reinforced so that the students shall not simply learn the useful phrases by heart, which is a much inefficient and resented approach.

It is nevertheless true that, more often than not, the use of only a few interactive drills will not do. They cannot, in themselves, be sufficient as such for assuring assimilation of material which will be further used in communicational circumstances. However, this will constitute a good beginning and can provide an appealing atmosphere – a status so necessary for getting down to work.

There shall, of course, follow other exercises on the same phrases, to reinforce that material. Then other similarly interactive activities shall be introduced. They are meant to produce synapses that will allow effective mental storage and will later assure the ability of reproducing the communicational standard phrases together with the usage of connections, in any given communicative environment, which should sound as natural as their own language (Cartwright 2002: 48).

3. USE OF INTERACTIVE DRILLS AND VISUAL AIDS

3.1 A strong 'mnemotechnique' mix

The mixture of colours, shapes and attractive activities to perform during classroom activities should prove very effective.

Categorising, classifying and introducing structures in table cells to easily create visual elements that provide better memorising, i.e. the use of various forms, shapes, shades and strategic positioning, are indeed good methods for an overview of the elements. However, the introduction of drills such as gap filling or matching shall be more appropriate, assuring focus on the matter in order to solve the task and thus, creating a proper ground for passive learning. For instance, if instead of placing the structures in some tables by category we ask students to match some standard phrases to their usage as given by the headline this activity shall induce a deductive approach and more successful results in assimilating the structures discussed. Thus, a matching drill like the one in Figure 1 below, can be a good way of tackling several structures belonging to the field of conducting a meeting (Sweeney 1997: 81). Students shall be asked to draw a connecting line from each of the headlines enumerated in the big circle in the middle, to the arrow indicating the corresponding phrase.

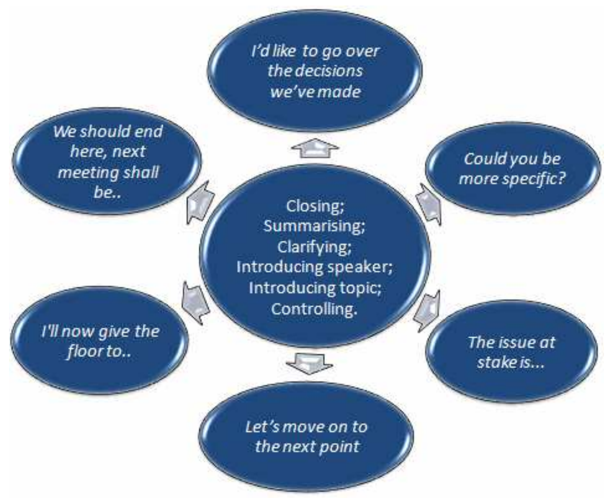

Figure 1 Conducting a meeting

Then, other examples of phrases will be given and students will have to add them to the one of the previously discussed categories that they consider to be suitable. Being given an image containing several communication structures, students are asked to name the category represented. In the situation provided in figure 2, they are to recognise the category of 'controlling' [2 pp.118-120].

Figure 2. Other standard phrases used in controlling a meeting

Such visual aids prove extremely efficient with students of all ages. Using diverse shapes and figures, colours and highlights, a series of categories can be covered through conceptually similar exercises.

Assignments of producing didactic material on elements of distinct categories can be fun and yet surprisingly effective: objects with witty, symbolic names can be added to the students portfolio and it is pretty sure they will not forget the phrases they will use in the production of objects such as: 'the controlling box' (a cube having imprinted, in vivid colours, on each face, a standard phrase of the category), or 'an introduction fan' (made of about 5, 6 blades, each containing a phrase or an example of introducing the topic, on one side, and of introducing the speaker, on the other), etc.

3.2 Playing with words

Various exercises of matching, synonymic or antonymic pairs, crosswords and word-search games often prove quite appealing when having to introduce notions used in communicational processes and this occurs in some stages of making presentations. For instance, according to Sweeney (1997: 53), when describing diagrams and graphs, several specific terms shall be used as those given in Table 1.

Table 1. Vocabulary of describing graphs

Action	Counteraction
increase/ climb/ rise/ grow/ go up	*decrease/ fall/ go down*
recover/ improve/ get better	*decline/ get worse*
reach a peak/ reach a maximum	*hit bottom/ reach a low point*
stabilize/ level out	*undulate/ fluctuate*
stay the same	*change status/ trend*

Such lexical units are fundamental for the communication process specific to the business activity, and studying them is of utmost importance.

Other means of stressing the importance of vocabulary acquisition are the crossword puzzles. Thus, they can be produced, by using actions – across - and counteractions – down, as exemplified in Figure 3:

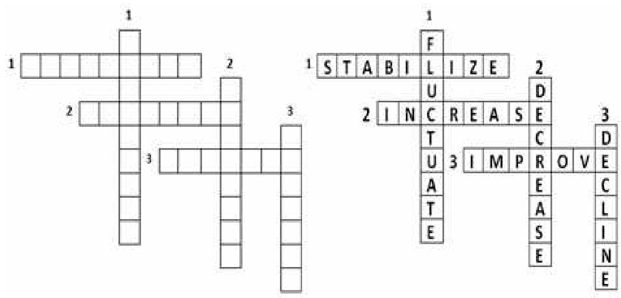

Figure 3. Action/Counteraction puzzle and solution

Much in the same way, word search games can be created, with actions vertically and counteractions horizontally (see Figure 4).

R	C	D	G	O	D	O	W	N	I
E	L	F	E	H	A	L	O	M	U
A	I	V	T	I	D	E	A	C	M
C	M	B	B	O	E	A	I	O	N
H	B	G	E	T	W	O	R	S	E
A	H	I	T	B	O	T	T	O	M
P	R	N	T	G	Y	N	B	E	E
E	A	M	E	O	W	A	S	D	O
A	R	K	R	U	F	A	L	L	Z
K	E	L	A	P	T	R	E	L	V

R	C	D	G	O	D	O	W	N	I
E	L	F	E	H	A	L	O	M	U
A	I	V	T	I	D	E	A	C	M
C	M	B	B	O	E	A	I	O	N
H	B	G	E	T	W	O	R	S	E
A	H	I	T	B	O	T	T	O	M
P	R	N	T	G	Y	N	B	E	E
E	A	M	E	O	W	A	S	D	O
A	R	K	R	U	F	A	L	L	Z
K	E	L	A	P	T	R	E	L	V

Figure 4. Word search game and solution

In the former case, that is the example in Figure 3, even definitions are unnecessary, if given the specification that each number has across and down one descriptor, respectively its opposite.

As for the latter, much in the same way, the indication to find antonymic pairs, vertically and horizontally, may be added on condition that students are told that the parts of a phrase can be found linked together. Depending on the students' level of language knowledge, distinct degrees of difficulty can be introduced by using more or less words, sometimes with letters switched around, etc.

Furthermore, antonymic pair matching drills can be also given, or students can be required to identify synonymic structures in a certain word group.

3.3 Enjoying the acquisition of phrases

To make the activities even more pleasant by their playful sophistication, or simply for later reinforcement, a real puzzle game can be imagined: a sheet of paper should be given, split into, 4 or 6 rectangular parts, each bearing a certain name – of an aspect, a phase, a step of one activity involving business communication.

To exemplify we can consider 4 stages in a business negotiation and the base of the game – the paper aforementioned – would look like in figure 5.

bidding	bargaining
summarising	accepting / refusing

Figure 5 Negotiation puzzle - Base

Then, the students are given several cards (i.e. six for each rectangle, so twenty four, for our example) each containing one standard phrase involved in the activities specified. The cards are to be shaped and cut such way that they represent the puzzle piece which shall fit in the rectangles. The students will be required to sort the cards according to the stages of negotiation that the phrases belong to and then solve the puzzle (Sweeney 1997: 111), as given in Figure 6.

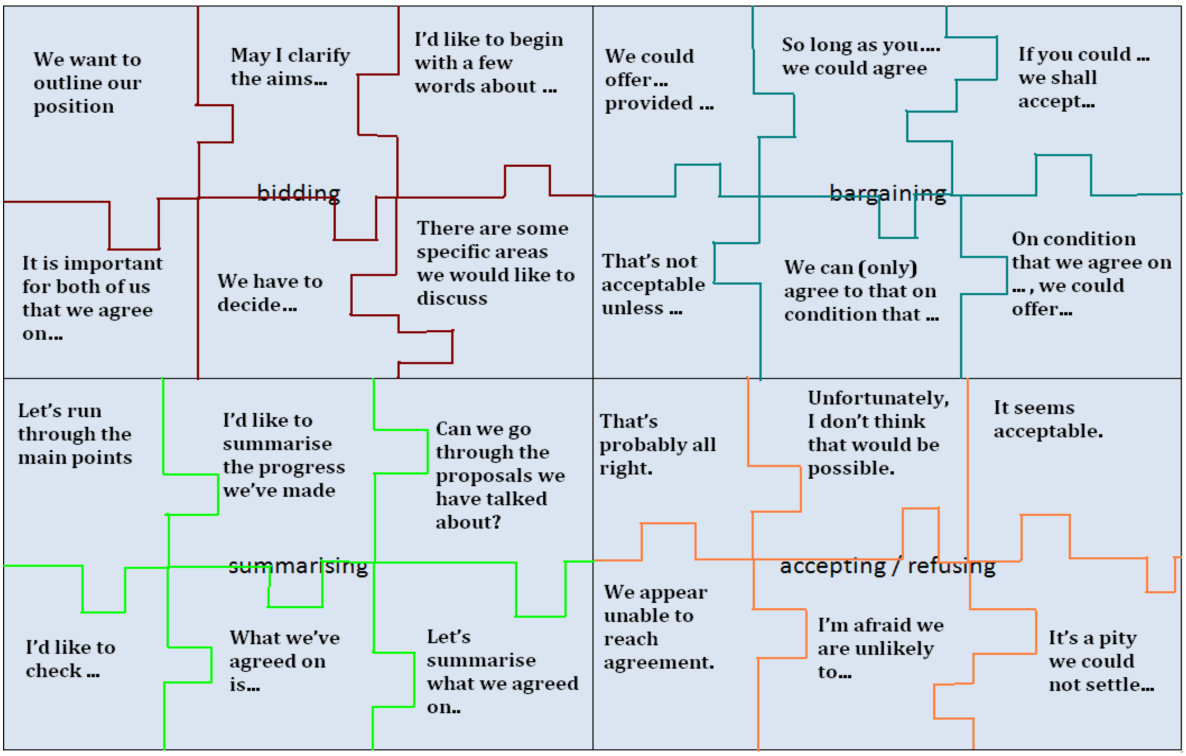

Figure 6. Negotiation puzzle - Solution

All in all, the standard phrases involved in business communication are inherent elements of Business English teaching and approaches that can be most appropriate for providing proper instruction are worth considering and discussing. As providers of education, the teachers of English for specific purposes (i.e. Economics) shall find the best methods to ensure effective assimilation and further good use of linguistic resources. As McKenna (1998: 15) believes, "[I]n all communication, the key to success is knowledge".

However, the more straightforward the object of teaching, the more demanding it shall turn out to be in terms of finding a good way to tackle it, of choosing the best method of transmitting it to the students. “Without good oral communication everyday business [...] would slow down [...]. Everything from questioning fellow workers, to making presentations, handling customer inquiries and complaints, giving directions, and evaluating performance would become completely cumbersome and inefficient” (Picardi 20001: 21). Since the teachers' role is to facilitate knowledge acquisition, we cannot simply rely on the traditional approach of requiring plain learning by memorising from direct reading of didactic material.

5. CONCLUSIONS

As educators we should elaborate such activities that the students will feel attracted to – from the otherwise blunt material – where even a passive learning is possible.

Nowadays didactic methodology is based more and more on interactive activities and presentation of material so that learning is primarily ensured by cognitive processes other than reading–reproducing repeatedly, prior to memorising (Jensen 1998: 99-101).

As a consequence, information is no longer served plain but is intervened upon and filtered, rearranged and rebuilt in numerous forms of presentation, as appealing as possible. This happens when indirect and passive learning is assured by awakening psychological triggers such as the cognitive – affective processes. They link knowledge to emotion and further the reinforcement of the former is provided subliminally and unconsciously.

Therefore, activities that arouse interest and appeal to the emotional side are regarded as pleasant, attractive and seemingly not demanding a big intellectual effort, though straining the intellect in a disguised form. These activities are thus, best means for introducing blank information like many of the standard communicational structures in English. Sensorial and ludic approaches are the most successful as they meet the basic needs of the human nature and offer patterns of tracks of thinking and processing that lead to the expected result, i.e. the assimilation of the material presented in classroom. This is why visual aids and games are so helpful in the teaching act. Taking advantage of the psychological aspect and resorting to such methods in tackling even direct didactic material, the classes are not only more pleasant but also more useful for the learners.

6. REFERENCES

[1] CARTWRIGHT, Roger, *Communication*, Oxford, Capstone Publishing, 2002

[2] *Communication Skills*, 2nd edition, Careers Skills Library, New York, Ferguson, Facts on File, 2004.

[3] GOODALE, Malcolm, The Language of Meetings, Thomson Language Teaching Publications, Geneva, 1987.

[4] HOGAN, Kevin; Stubbs, Ron, *Can’t Get Through: 8 Barriers to Communication*, Pelican Publishing Company, 2003.

[5] JENSEN, Eric, *Teaching with the brain in mind*, Association for Supervision and Curriculum Development, Alexandria, Virginia USA, 1998.

[6] McKENNA, Colleen, *Powerful Communication Skills*, Career Press, 1998.

[7] PICARDI, Richard P., *Skills of Workplace Communication: a Handbook for T&D Specialists and their Organizations*, Westport, Quorum Books, 2001.

[8] SWEENEY, Simon, *English for Business Communication*, Student’s Book, Cambridge University Press, 1997.

MARITIME ENGLISH PRACTICE ON SIMULATORS

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ABSTRACT

Maritime universities all over the world consider future Deck Officers' training to be a sensible issue. Since the International Maritime Organization (IMO) introduced training on simulators as an integrated educational part for future seafarers, training future Deck Officers on simulators became a very important component of the maritime education process. Over the past decades, the education of professional officers has undergone many evolutions. Today's maritime universities, academies and faculties using advanced methods of teaching, modern simulators with communication in Maritime English and other sophisticated equipment have not to forget that practical training on board a ship still plays an invaluable role in officers' education. Still, it must be acknowledged that a proper training on simulators is a good start for a theoretical training that could eventually be used onboard. In this paper we are trying to point out the fact that without the use of simulators combined with a proper knowledge of Maritime English, University graduates would face real troubles when trying to apply for a job at the crewing and shipping companies.

Keywords: *Deck Officer, simulator, university, training, maritime education*

1. INTRODUCTION

Simulator classes provided inside maritime universities offer a proper training programme for future officers by making Maritime English the main language used in specialized communication. This happens because it has been proven that Maritime English represents an important part of a future navigating officer's training and it will still gain in importance as long as the shipping industry is in progress. Young seafarers are provided with all the necessary conditions to get acquainted with Maritime English during the university years. Therefore it's only up to them if they reach a certain level of knowledge necessary for a proper watch keeping. They should always be aware of the fact that their lives, other crew members' lives and the ship's integrity might depend on this particular aspect.

2. MARITIME ENGLISH THEORETICAL TRAINING

Decades ago, America and Britain were the world's greatest sea-going nations. Eighty percent of crews were native English speakers. By the end of the nineteen seventies the situation was the opposite. Eighty percent of crews did *not* speak English as a first language. It was clear that in order to keep the seas safe the shipping industry would have to find new ways of passing information through the radio.

A new way of speaking resulted after a period of time when experts in language worked closely with experts in shipping in order to reach a convenient agreement for both parties regarding communication at sea. The new language was called Seaspeak. The International Maritime Organization made Seaspeak the official language of the seas in nineteen eighty-eight. Seaspeak defined the rules of how to talk on the radio between ships.

The official book of Seaspeak says that messages between ships should be of direct interest to the crew. Messages should be short and clear. Such messages should be in words simple enough for a non-native speaker of English to understand.

Therefore Seaspeak contains a list of about five thousand words. The main focus of the content is on words which are specific for ships and the sea and the rest of the words are in general use by all English speakers. But there is another very important thing about Seaspeak. It uses seven really important words, called 'message markers'. A message marker is meant to tell the listener what kind of message is going to be transmitted. Message markers are words such as: Question, Warning, and Information.

Ships fully manned with one nationality were common during the eighties and nineties to find, with only Pilipino, Russian, Indian, Romanian, Bulgarian etc. nationalities on board – with no reason for those seafarers to speak any other language than the native one. The Master may have had to know a smattering of essential sentences like "pleeese, where be I", or "big ship, big ship, get out the way" but the engineer down in the engine room had no need for English – very useful ignorance when port state control started snooping around or the superintendent visited. For the most part, the working language of many ships was whatever the predominant language was on board. Deck officers simply memorized some essential sentences in English that enabled the ship to get into and out of some foreign port and when the COLREG Regulations had to apply in the open sea and communication ship-to-ship was needed in order to avoid maritime accidents they simply preferred to avoid talking in the VHF.

Nowadays, many ships are manned from top to bottom with officers and crews of varying origin working side by side over failing engines. Most of them are able to talk to each other better than any British seafarer ever could and up on the Bridge the Master is speaking the Queen's English over the radio to some Welsh harbour Master who nobody can understand outside of Wales.

Today it is quite normal for ships around the world to sail with a compliment of twelve fine and able crew members. It is also possible for this very same vessel to sail around with twelve completely different nationalities, all speaking English daily, all communicating, socializing and swearing in that one common language. All of them have learnt and maybe most of them are still learning to use English on a daily basis at work and as the communication language.

In any type of maritime communication, it is well known inside the shipping industry that Maritime English is the main and only language that should be used. Still, more and more people have trouble understanding the importance of speaking English, especially students of Maritime Universities from countries where a different language is used for teaching. Therefore, maritime universities use the most updated simulators where the communication is performed only in Maritime English in order to help students understand the importance of learning Maritime English during the university years.

Due to the fact that English is the international language that is used worldwide the shipping industry accepted it as the main language on board ships and in communications ship-to-ship and ship-to-coast. The future Deck Officers wishing to go on board merchant ships cannot afford to be left out for not mastering English especially in this era of globalisation. This is the main reason why teachers in maritime universities should try to explain to their students the importance of knowing Maritime English. It does not matter the subject that the teacher has to teach during his/her classes as long as the specific maritime courses would have the key words attached in English.

Therefore new learners (in this case, students from maritime universities) of a language (English) really do need to build up a solid foundation of knowledge. In this case it is extremely useful for them that all of their teachers know and control Maritime English and in this way it should become really easy for them to use some important maritime terms used daily on board ships and in any type of communications.

As previously stated future Deck Officers have no choice but to gain the appropriate skills and knowledge to communicate effectively and efficiently in English. Communication is an essential part of their daily activity onboard merchant ships and also of human interaction. The benefits of an effective communication are many and obvious as they enhance all aspects of our personal and professional lives. Ineffective or misunderstood communications in our personal lives may give rise to problems or embarrassment but in one’s professional lives the results of misunderstandings may have much more serious results. Effective communication ship-to-ship and ship-to-coast is vitally important in the world of international shipping, with seafarers from many countries sailing on ships all over the world, and in this way it can be emphasized the importance of Maritime English.

The legislation nowadays emphasizes the importance of the English language proficiency in relation to safety at sea because most maritime accidents are caused by human error, notably breakdowns in communication or cooperation. Instruction and practice of maritime English for communication and cooperation is an important element in maritime education.

IMO Standard Marine Communication Phrases are mainly the basis for the study of Maritime English, which builds on a basic knowledge of English and has been drafted in a simplified version of Maritime English. It includes phrases for use in routine situations such as berthing as well as standard phrases and responses to be used in emergency situations. The ability to understand and use the SMCP is required for the certification of officers in charge of a navigational watch on ships of 500 gross tonnage or above under the STCW 1978, as amended.

Another important issue to be taken into account is the multicultural crew that is met almost onboard every merchant ship. This is due to the fact that nowadays, the shipping industry is a multinational one. Interaction and collaboration between people from different countries and cultures represents the focus of all activities in this industry. Due to company necessity in having offices placed in different countries according to business interests in an international company these details are common. But these aspects become more complex when we refer to onboard ship activities. For this reason it is necessary to observe and study the kind of compatibilities or non-compatibilities that exist between seamen from different countries in order to create a proper working environment on board the ship.

Facing multicultural working environment, many seafarers have accommodation problems, difficulties in working relationships onboard and the biggest problem has been created by the use of a foreign language, mostly Maritime English, in the daily duties communication.

It is a fact that the language barrier onboard ship can be overtaken only if students really master Maritime English, so it is important for them to use as much Maritime English as they can during the university years in order to get used to speaking in a different language other than their mother tongue.

3. MARITIME ENGLISH PRACTICAL TRAINING ON SIMULATORS

The appearance of an important system inside Maritime Education and Training has been noticed during the last years, and that is training the Deck Apprentices by using the simulators. It has been generally agreed that the graduates of a Maritime University need a proper training regarding Maritime English during the study years by using simulators in order to keep up with the changes that occur on board a merchant ship due to: advances made in Maritime Education and Training as a direct result of equipment development, smaller crews that can operate ships exactly in the same way and at the same level of professionalism as the larger crews used until recently, reduced time spent in ports for ship’s operations and so on.

A proper knowledge of Maritime English is needed by the modern Deck Officer in order to understand the basic concepts of the navigation systems used nowadays and in order to evaluate their output’s accuracy and finally getting the right possible navigational decisions. For a new Deck Apprentice embarked onboard a merchant ship for the first time it is important to know an adequate Maritime English and this can be obtained only by a proper training including training on simulators .

An integrated bridge simulation system is primarily designed and introduced to train and develop potential cadets and officers with the necessary knowledge and skills in properly and correctly handling and managing a vessel. Whereas a new and alternative use of the integrated bridge simulation system has been discussed and proven to be suitable and effective in training and assessing communication skills, especially in contextualizing the practice of the mandatory part of the IMO SMCP, reinforcing the trainees to play different roles in a realistic atmosphere and environment. It has been decided that most of the scenarios and contents in SMCP can be flexibly designed or tailored and properly practiced in an integrated bridge simulation system based environment. The key task then is how to organize and implement the syllabus of Maritime English teaching and learning via this effective learning by pedagogic methodology.

An attempt to approach the training and testing the proficiency of Maritime English that meets the international standards pointed out in STCW has been the subject of many discussions in the past years. Using integrated bridge simulation system in a bridge activities context seems to be one of the most effective experiential learning and training methods, which will allow the future Deck Officers to get accustomed to a workplace environment and to expand their practice little by little, so that they may communicate and pass messages with confidence when taking up their future jobs onboard.

It can be concluded that affirmativeness in multiple possibilities is obvious when taking into account many discussions regarding the use of integrated bridge simulation system in Maritime English practice. However, solutions in combining this technology with operational teaching and assessing maritime communications especially with coursework design has not much been referred to. Using the integrated bridge simulation system can assist Maritime English teaching, training and assessing. Collaborated operation of the system can be of benefit in facilitating communication and Maritime English training and practice, as well as enhancing mutual understanding of the navigation customs and cultural background among cadets and seafarers from different countries.

Maritime Universities all over the world are training future Deck Officers in accordance with their national standards and to the international standards elaborated by IMO (International Maritime Organisation). Apart from the evaluations made by the national agencies, the university’s curricula are assessed and approved by the naval authorities considering the legislation and recommendations of the International Maritime Organisation, and of the European Agency for Maritime Safety and thus, the certificate of competency has international recognition.

In Constanta Maritime University, for example, the Bachelor of Science degree graduates have the advantage of a double certification. They get:

- Engineer diploma in the Naval Engineering and Navigation field (the European equivalent of Bachelor of Science diploma);
- Officer in Charge of a Navigational Watch Certificate.

Constanta Maritime University is fitted with simulators and laboratories with software for each specialty discipline thus every student gets the best theoretical training before going on board merchant ships as Apprentices. On these specific simulators, all the instructors are trying to use as much Maritime English as possible during the communication situations that appear inside the scenarios performed and in this way making students understand the importance of using a proper Maritime English that could eventually help them in their future career. Constanta Maritime University applies communication in Maritime English for future Deck Officers by using the following simulators: Simulator for Navigation and Ship’s Manoeuvre TRANSAS NT Pro 4000, GMDSS Simulator – Global Maritime Distress and Safety System and the Simulator for Handling Bulk Liquid Cargo, certified by Det Norske Veritas, Class A, B, C – Cargo Handling.

During the simulator classes the instructors use different scenarios where a proper Maritime English should be used. The instructor who supervises the scenarios will initially allow students to familiarise with the instruments and controls found on the bridge of a merchant ship. The student will be able to locate and use the bridge equipment in normal operating conditions.

The exercises get more and more difficult and students get accustomed with the procedures used for turning on the navigation equipment. Every exercise is preceded by a briefing and followed by a group discussion - debriefing, in which the actions and decisions taken by the student are analysed and it is important to mention that these discussions are performed in English.

During exercises, every student will play different roles within the bridge team and will have the possibility of taking part in all the operations done during the watch, covering all the steps in the chain of command of the navigational bridge and in this way also getting acquainted with all the aspects of a proper communication performed in Maritime English on the bridge and during a navigational watch. The purpose of these exercises is to achieve the following goals:

- Familiarisation with the use of instruments and controls from the navigational bridge;
- The ability of making decisions;
- Organising the bridge/engine team;
- Understanding the individual role in the chain of command while working in a team;
- Understanding the specific tasks according to certain situations;
- Understanding the necessity of a good planning, following step by step the check lists, and the scheduling of each specific procedure;
- Good understanding of the watchkeeping procedures;

- Getting the expertise in identifying the operational problems and solving them;
- Familiarizing with communication in Maritime English.

Global Maritime Distress and Safety System Long Range Operator's Certificate Course -GMDSS LRC is another course provided by Constanta Maritime University and consists of the students' familiarisation with the issues considering the fundamental theoretical concepts about: maritime radio - communications and satellite equipment and systems (SMM - Maritime Mobile Service and SMMS - Satellite Mobile Maritime Service), communication techniques used in GMDSS, radio frequencies, GMDSS functions, and communication procedures etc., all of them performed in Maritime English.

4. CONCLUSIONS

A safe shipping environment means that all seafarers across the world should reach high standards of competence and professionalism in the duties they perform onboard. The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended in 1995 (STCW-95), has the role of setting these standards, governing the awarding of certificates and controlling watchkeeping arrangements. Its provisions not only apply to seafarers, but also to ship-owners, training establishments such as maritime universities and national maritime administrations.

Therefore, all affiliations and member qualities of a maritime university along with the fact that maritime universities are evaluated every year by naval authorities are solid proofs of a proper implementation of the 1995 STCW Convention in these institutions. All training programmes and assessments in maritime universities are provided in connection with the STCW-95 certificate and comply with STCW-95 standards, being approved national and international maritime authorities.

Maritime education and training institutes all over the world have installed integrated bridge simulation systems, based on which maritime teaching and training have been designed and experimented. In response to these changes, course and syllabus design and organization as well as instruction and evaluation have thus undergone reforms since the attention has been particularly drawn to simulator training. Physically within language skills targeted integrated bridge simulation system training, all means of lingual communication devices employed in real ship operation should be properly fixed to simulate navigational and safety communications from ship to shore and vice versa, from ship to ship, as well as onboard ship.

Maritime English course design and organization is critically important throughout the whole training program. It ought to take into account the emphasis IMO guidelines on ship management lays in the need for good communication. The major concepts and skills with this aspect are: Understanding culture differences; Situational awareness; Close loop communication; Briefing and Debriefing; and Communication procedures. Effective communications represent an essential ingredient to safe and efficient ship operations.

Therefore, the international community has chosen the English language as the medium for that communication and IMO has developed a standard vocabulary and the training tools to deliver it. This is the main reason why teachers of Maritime English but not only them, instil in future Deck Officers the appropriate skills and knowledge to ensure that failures of communication are no longer a major cause for maritime accidents.

5. REFERENCES

[1] BARSAN, E., HANZU-PAZARA, R., ARSENIE, P. and GROSAN, N., *The Impact of Technology on Human Resources in Maritime Industry*, 6th International Conference of Management of Technological Changes, Alexandropolis, Greece, Publisher: Democritus University of Thrace, pp 641 – 644, 2009

[2] BATRINCA, G., VARSAMI, A. and POPESCU, C., *The Sustainability of Maritime Education and Training On Board Training Ships in the Present Economic Conditions*, 6th International Seminar on the Quality Management in Higher Education, Tulcea, Romania, Vol. 1, pp 35 – 38, 2010

[3] BELEV, B., *Information Capabilities of Integrated Bridge Systems*, The Journal of Navigation 57, p. 145-151, 2004

[4] BELEV, B., GECHEVSKI, P., DUNDOV, N., *Using Simulators for Education and Training – Condition, Necessity, Development*, Proceedings of BulMet 2005, Varna, p. 39-44, 2005

[5] BUTMAN, B. S., *STCW and Beyond: Minimal Requirements and Additional Knowledge for Marine Engineers*, 8th IAMU Annual General Assembly, Odessa, Ukraine, Edited by Dmitriy Zhukov, Odessa National Maritime Academy, pp 57 – 67, 2007

[6] HANZU-PAZARA, R., *The shipping companies' role in increasing onboard personnel competencies*, Marine Transport & Navigation Journal, Vol. 1, No. 1, pp 111-116, 2009

[7] HANZU-PAZARA, R., STAN, L., GROSAN, N. and VARSAMI, A., *Particularities of cadets practice inside of a multinational crew*, 10th General Assembly of International Association of Maritime Universities, St. Petersburg, Russia, published in MET trends in the XXI century, pp 99 – 105, 2009

CREATIVE THINKING ACTIVITIES IN FOREIGN LANGUAGE TEACHING

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ABSTRACT

The purpose of this paper is to suggest activities through which teachers can help students bridge the gap between the mastery of linguistic structures and the use of language to communicate meanings in real situations. Classroom activities pave the way to communication in the foreign language through various types of communicative activities and exercises. The value of the activities described in this paper resides in the opportunity to analyze the students' performance and to explain deficiencies and suggest improvements in their use of the language, meant to contribute to their communicative skills

Keywords: *creative thinking, foreign language classes, communicative activities, oral communication*

1. INTRODUCTION

Knowing a language implies not only awareness and mastery of that language, i.e. of grammar and lexis, it also means "being able to use it effectively in social situations, selecting the appropriate style, matching language to context, perceiving the speaker's intention, and performing speech acts." (Cunningsworth 1983:8).

Teachers have become more and more aware of the necessity of providing opportunities for spontaneous discussion and for impromptu activities that stimulate actual situations in which students might find themselves in the foreign culture. As a result, writers of teaching materials are concentrating on producing dialogues containing useful patterns that students may adapt in order to express their meaning in their own way.

Consequently, more emphasis should be placed on state of the art exercises and activities in order to encourage student creativity. Despite inherent difficulties in daily classroom situations, encouragement must be given to students to perform as naturally as possible in practice sessions. Therefore, a range of creative exercises may be proposed allowing students of varying levels to achieve success along these lines.

2. STUDENT-TAILORED EXERCISES

Initially, the teacher may request restricted answers to simple questions containing the essence of the response desired: the elementary comprehension exercises in which the students are able to extract the answers and produce them on the basis of minimal changes in the original material. The comprehension technique allows for a wide range of difficulty levels and can be used by teachers according to the needs and levels of their students. Comprehension exercises should be aided by means of thoroughly selected reading activities.

Thus, students may take in information and discourse analysis expressed in the appropriate registers of the target language. These reading activities are aimed at activating the students' recognition capacity for appropriate forms of expression while also being based on the field of interest of the students and the goal of the specific training. As the students' mastery of the course material develops, they will be able to improve the precision of their semantic control of the language.

Likewise, paraphrasing exercises prove to be useful. Their aim is to rephrase the content in different words while keeping the meaning of the new sentence/text as close to the original as possible. Subsequent analysis of the student's version provides a good opportunity for discussion of the nuances of meaning, emphasis, tonality or levels of formality. The tremendous impact of tonality is shown in the table below conceived by Carpenter in *Principles of Management*, online version 2010:303.

Placement of the emphasis	What it means
I did not tell John you were late.	Someone else told John you were late.
I did **not** tell John you were late.	This did not happen.
I did not **tell** John you were late.	I may have implied it.
I did not tell **John** you were late.	But maybe I told Sharon and José.
I did not tell John **you** were late.	I was talking about someone else.
I did not tell John you **were** late.	I told him you still are late.
I did not tell John you were **late**.	I told him you were attending another meeting.

Textual commentary can also serve a similar end – students may be asked to analyze the language used by the writer, explaining the intended aim of the material under discussion along with the level of formality and the linguistic expression of the concepts presented.

In addition, short exercises based on dialogue creation can come in handy. In a gap filling type of exercise, the student plays the part of one speaker and is required to match his responses to the context and the meaning of the other person's utterances. Despite a slight element of contrast in this type of exercise, students still enjoy considerable creative freedom in their role, for instance:

1st engineer: Hi, I'm sorry I'm late!

Chief Engineer: …

1st engineer: I was in a hurry, so I left the documents in the cabin, I'm sorry! I decided to go back for them.

Chief Engineer: …

1st engineer: Because I knew you were already too busy to take my call.

A more unrestricted form of this type of exercises is the one in which only a context or a single line of dialogue is provided, while students need to come up with the rest of the dialogue.

Moving on to more extended discourse, teachers may make use of a series of exercises based on reporting. Reported dialogues give excellent occasions for rephrasing of ideas in new linguistic forms – change of grammatical person and syntactic structures alongside tense manipulation.

Example: Task: Put the following dialogue in the reported speech:

1st Engineer Paul Smith arrives at St James Hospital and asks for Dr. Jefferson.

Dr. Jefferson: Hello, sir. What seems to be the problem? *(Dr. Jefferson asked …)*

Paul Smith: I have been experiencing stomachaches for two days. *(Paul replied that ...)*

Paul Smith: There's nothing wrong with my regular meals. *(Paul claimed that ...)*

Paul Smith: Ok, then, I shall take the prescribed medicine and come back in two days. *(Paul concluded that ...)*

3. CREATIVE THINKING ACTIVITIES

Among creative thinking activities, oral composition, though quite demanding, can be used in classes for advanced students. This type of activity may be structured as an interview or a dialogue with someone in the appropriate field of study as well as a short dissertation on a topic of significance such as *"At the crewing office"*, *"At the customs office"* etc.

This gives students the opportunity to create by means of their own resources an imaginative and extended discourse which can provide a good use of language in its fullest sense. These exercises need to be prepared carefully in advance, making sure that students have a good knowledge of the linguistic items, structural and lexical, adequate to the task chosen, together with all the necessary skills to be applied in the oral composition.

However, while the above suggested activities encourage a progress from the relatively constrained forms of simple answers to the creative freedom of oral composition, they lack the essential feedback of a communicative situation, in which flexibility of response is related to the personal, social objectives both of the speaker and of his dialogue partner, which in turn make students respond appropriately to other people's trains of thought and objectives in a natural manner.

Further on, we should consider the purpose and benefits of communicative language teaching which are beautifully and explicitly stated by Jack C. Richards:

"One of the goals of CLT is to develop fluency in language use. Fluency is natural language use occurring when a speaker engages in meaningful interaction and maintains comprehensible and ongoing communication despite limitations in his or her communicative competence. Fluency is developed by creating classroom activities in which students must negotiate meaning, use communication strategies, correct misunderstandings, and work to avoid communication breakdowns." (Richards, J. C., 2006:118)

It is by now common knowledge that a foreign language can only be learned by speaking as it was proved by the successful practical application of the Callan method invented in 1960. The techniques used by this method are basically repetition, speed, and question and answer format. (Callan, 1995) This is why teachers do their best to maximize speaking time for students by introducing speaking exercises and activities. In this respect, role-playing is an excellent way to improve one's skills of verbal expression in a range of simulated situations. Whereas students should be cognitively equipped to play the roles assigned, they should also have the basic command of the linguistic tools to express themselves in their roles. If teachers ignore these simple prerequisites, students might experience a feeling of embarrassment and frustration.

Hence, efforts should be made to try to devise exercises which practice more than one side of fluency in the foreign language at a time. In terms of fluency great help is provided by question starting in *which, do* or *what does… mean?*

4. CONCLUSIONS

The basis of knowing a foreign language is the ability of the speakers to produce, in an appropriate and flexible manner, many statements based on a limited experience and by means of a specific corpus of language. This ability derives from the capacity to learn the rules of a language and to apply them correctly under various circumstances. Consequently, knowledge of a foreign language implies not only being familiar with its vocabulary and grammar but also a good understanding of other factors that influence the students' choice of verbal expressions considering "appropriateness" criteria. Such factors might include noise, seating arrangements, relationships, space, and even ventilation.

The value of the activities described in this paper resides in the opportunity to analyze the students' performance and to explain deficiencies and suggest improvements in their use of the language, meant to contribute to their communicative skills.

5. REFERENCES

[1] CUNNINGSWORTH, A., *English Teaching Forum,* issue no. 4, October, 1983

[2] RICHARDS, J. C., *Communicative language teaching today,* Cambridge University Press, 2006

[3] CALLAN R., *Callan Method: Teacher's handbook,* 3rd edition, Granchester, Orchard Publishing Ltd., 1995

[4] CARPENTER, M. *Principles of Management,* Barnes and Noble, online edition 2010

TRANSLATING MARITIME IDIOMS

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ABSTRACT

The historical significance of the sea cannot be left behind by a translator working into a foreign language like English. The translator may come across a myriad of nautical words and expressions that must be carefully handled in translation. As it is generally known, English and Romanian use different linguistic forms and these forms represent only one of the aspects of the difference between the two language systems. The most challenging are the cultural meanings that are intricately woven into the texture of the language, and it is the translator's task to catch and render them appropriately. Thus, the differences between the source language culture (SLC) and the target language culture (TLC) make the translating process in general and the translation of maritime idioms in particular, a real challenge. In this case, translation strategies and techniques are of paramount importance. Since maritime idioms represent the special cultural image, the translator should ideally be bilingual, and most importantly, bicultural.

Keywords: *maritime idioms, translation strategy, equivalence*

1. INTRODUCTION

Both English and Romanian are permeated with phrases and expressions which originated at sea, deriving from the customs and traditions of seafarers who spent more time on board ship than on land, and therefore carrying with them a large amount of cultural information. Thus, the unique talk of sailors has found its way into the lands' speech which got beautifully coloured and gained metaphorical significance.

Considerable work on idioms has been done by several linguists (Lipka 1991, Cruse 1986, Carter 1987), and researchers into vocabulary and language teaching (Carter & McCarthy 1988, Nattinger & DeCarrico 1992). There are innumerable, intricate definitions of the term 'idiom' in the literature, but this study will adopt the one provided by the *Webster's Encyclopedic Unabridged Dictionary of the English Language* where an idiom is understood as "a construction or expression of one language whose parts correspond to elements in another language but whose total structure or meaning is not matched in the same way in the second language" (1997: 707). In terms of their translatability, idioms are considered as one of the most complicated elements of language. Since English has its own ways of expressing certain things, corresponding expressions may not be found in Romanian. This language-fixity makes the translation of maritime idioms rather problematic and thus, it is important to take a closer look at their possible translation strategies as well.

2. MARITIME IDIOMS

Maritime idioms are very elusive, and the difficulty of exactly characterizing them is perhaps one of the reasons why relatively little attention has traditionally been accorded to these expressions, in spite of their unquestionable relevance. In my opinion, maritime idioms constitute a real challenge to compositional models of language comprehension due to their widespread use in the language and their property of carrying a metaphorical sense that makes their understanding difficult.

Irrespective of the idiom type, translators need to have a well-developed phraseological competence (Croitoru & Dumitraşcu 2006, Heltai 2001). They have to know the ready made phrases used in the nautical register in the language cultures bought into contact, namely, English and Romanian, as well as to match and evaluate them from a sociolinguistic perspective.

Sometimes the meaning of maritime idioms cannot be predicted from the meaning of their constituent parts, i.e. *cut a dido→ a face o manevră complicată; on the dags → în concediu (despre un marinar); dress a ship overall → a ridica marele pavoaz; make a heavy weather → a suporta un balans puternic; ship a heavy sea → a lua apa cu bordul; keep full for stays → a pregăti volta în vânt.* Thus, idioms are said to be non-compositional because their meanings are not the sum of the meanings of their parts (Cruse 1986, 2000, Nattinger & DeCarrico 1992). However, it could be argued that other multi-word units are also non-compositional (of course, in effect) and yet are not generally considered idioms. The verb and noun in the idiom *sling the cat*, for example, have at least two meanings: their default context-free literal meanings, and the meanings that are induced by the idiom context. In non-idiomatic contexts, the verb *sling* will have the meaning "to throw or drop something" and the word *cat* the meaning "a small animal with fur, four legs, a tail and claws." In the idiom context, these words have a dual meaning, retaining their literal meanings but also acquiring the idiomatic meanings of "empty" and "the contents of the stomach." Popa (1992: 224) gives the following Romanian equivalents *a da la peşte, a avea rău de mare*.

Another maritime idiom which is worth mentioning is *high and dry*. This idiom refers to a vessel aground above high water mark (Royce 1993: 221). According to Huff (2004: 61), this phrase refers to a person left without support or resources, but it was originally used for a vessel left high upon the shore and dry by an ebbing tide. Lindquist (2009: 94) labels this idiom as 'opaque' (i.e. opaque idioms are the full idioms whose meaning cannot be derived from the meanings of the component words) in spite of the fact that it consists of common words combined by simple grammar. He also remarks that the figurative meaning of this idiom is based on the nautical meaning of being stranded. Thus, *high and dry* translates into Romanian as *părăsit, izolat, pe linie moartă*. In *Dicționar Maritim Englez-Român* (DMER 1982: 246), Anton Beziris et. al., provide the following Romanian equivalents: *high and dry eşuat (despre navă); (meteo) fără vânt, calm*.

In the maritime context, the phrasal verb *keel over* refers to a situation when a strong gust of wind causes a vessel to capsize with her keel pointed upward (Huff 2004: 68) and its Romanian variant is *a se răsturna cu chila în sus* (DMER 1982: 276). In informal English the idiom *keel over* stands for collapse in faint and translates into Romanian as *a-şi pierde cunostiința temporar, a vedea negru în fața ochilor, a leşina*.

An interesting idiom belonging to the sailors' talk is *to shoot Charlie Noble*. Etimologically, this idiom is explained as "to clean the galley smoke pipe of soot and dirt by firing a pistol therein" (Connel and Mack 2004: 287). Charlie Noble was a British merchant service captain who required a high polish on the galley funnel. This idea is also shared by Ford (2008: 91) who considers that the eponym *Charlie Noble* "[...] has its origin in maritime fire prevention" and was used on board in order "[...] to reduce fire hazard". Thus, the idiomatic expression *to shoot Charlie Noble* is specific only to the maritime jargon and since it has not soaked into the land's speech, it is unfamiliar to the landsman. *Dicționar Maritim Englez-Român* (DMER 1982) does not record such entry, whereas Popa (1992: 223) registers the following translation variants: "*a lua un relevment, a face o observație (pentru determinarea punctului)*". However, this interpretation is not satisfactory, since a booklet published recently by the Texas Maritime Academy records the figurative meaning of this idiom as "doing all the things necessary to keep a ship and all the persons on board safe"(Charlie Noble Booklet 2012: 50).

The idiomatic expression *make a heavy weather* which in common core English means *find something hard to do* and translates into Romanian as *a face ceva cu mare chin* is of nautical origin. In maritime English *make a heavy weather* refers to the vessel's capacity to experience a strong motion or labour, and the Romanian counterpart is *a înfrunta o furtună, a suporta un balans puternic* (DMER 1982: 314). The expression *to cross someone's bows* which means to annoy, displease, or offend someone translates into Romanian as *a scoate pe cineva din sărite / pepeni, a călca pe cineva pe coadă / bătătura*. This expression has nautical origins. When one ship passes in front of another, crossing her path, the first is said to cross the bows of the second. Such a move is considered dangerous and a breach of the rules of the road. Both the nautical and figurative meanings are in use today. Other idiomatic expressions commonly used in both Maritime English and Standard English are the following: i.e. ME: *be bilged → to take in water at the bilge or to damage (a vessel) in the bilge, causing it to leak → a avea gaură de apă (la santină);* SE : *be bilged → to fail an exam → a pica la examen*; ME*:be at sea → be in the voyage → a fi (plecat) pe mare, a fi în larg;* SE: *be at sea → to be completely confused → a fi nesigur;* ME: *give a wide berth → adequate distance from sea vessels or other objects to ensure safety and maneuverability →a se tine la distanță/ departe de;* SE: *wide berth → a considerable or comfortable distance from a person or object, especially for safety or deliberate avoidance → a ocoli/evita pe cineva*, etc. In what follows, I will deal with some translation strategies which I regard as applicable and important to translating maritime idioms.

3. TRANSLATION STRATEGIES

The term 'strategy' is used in different ways in translation studies, and a variety of other terms can be used to mean the same thing: 'procedures', 'techniques of adjustment', 'transformations', 'transfer operations' etc. Superceanu (2006: 259) defines translation strategies as "[...] individual cognitive procedures operating on a large or small scale. They are used consciously or unconsciously for the solution of a translation problem, for example, search, checking, monitoring, inferring, and correlating" (Superceanu 2006: 259). Translation methods, translation techniques and translation strategies are all goal-oriented, however, only translation strategies are problem oriented and they are used when the translator realizes that the usual procedure is not sufficient for reaching a certain goal.

Löscher (1991: 76) defines translation strategy as "a potentially conscious procedure for the solution of a problem which an individual is faced with when translating a text segment from one language to another". In our view translation strategies of maritime idioms are applied when a translation difficulty occurs and the translator wishes to solve the problem and produce a good translation. We shall also understand a strategy for translating idioms according to Leppihalme's view on strategies which he considers to be "means which the translator, within the confines of his/her existing knowledge, considers to be the best in order to reach the goals set by the translation task." (Leppihalme 1997: 28).

There are some arguable points regarding idioms. Dollerup (2006) brings these issues into discussion when he states that "[...] notably literal translation of idiomatic expressions is one of the most quoted types of error in translation" (Dollerup 2006: 36).

Thus, a straightforward word for word substitution in what maritime idioms are concerned cannot be allowed for. Regarding idioms, Baker (1992) suggests some translation strategies whose acceptability or non-acceptability depends on the context in which a certain idiom is translated.

3.1. Translation by an idiom with similar meaning and form

This translation strategy involves the use of an idiom in the TL which conveys the same meaning as that of the SL idiom and consists of equivalent lexical items.
In order to exemplify we shall use maritime English idioms together with their meaning and translation into Romanian: *to execute antics → to make tactical*

manoeuvres → a executa manevre tactice; to stand chine to chine → a staţiona bord la bord; kill the way → a anula inerţia (navei); a fair-weather sailor → an inexperienced navigator → marinar neexperimentat; gaw –gaw sailor → a clumsy navigator → nepriceput.

3.2. Translation by an idiom with similar meaning and dissimilar form

As idiomatic expressions are notoriously difficult to translate, Duff (1990:137) suggests that as a rule, if a suitable idiom in one's own language does not readily spring to mind one should give a straight forward translation of meaning. Baker (1992) believes that the basic problems that idiomatic expressions pose in translation are related to two main areas: the ability to recognize and interpret an idiom correctly and the difficulties involved in rendering the various aspects of meaning that an idiom conveys to the TL.

Therefore, the more difficult an expression is to understand, the less sense it makes, i.e. *keep full for stays → a pregăti volta în vânt; dog the watches – to shift the watches at 1800 → a schimba carturile la ora 1800; drop the killick → let go the anchor → a fundarisi ancora; crawl in front of the head cook → to behave well with the chief cook → a se purta frumos în faţa bucătarului şef.*

It is often possible to find an idiom in the TL which has a similar meaning to that of the source idiom but which consists of different lexical items. This idea is reflected in the idiomatic expression: *tread the deck* which means *do the daily duty on board* and translates into maritime Romanian as *a face cartul pe navă*. Other examples would include: *turn up the hands → to call for the crew on the bridge → a aduna echipajul pe punte; to take a trick at the wheel → to be on watch at the wheel → a sta de cart la timonă.*

3.3. Translation by paraphrase

Paraphrase is one of the most common strategies in the translation of idioms. This translation strategy is very productive when translating idioms and a match cannot be found in the TL or when it seems inappropriate to use idiomatic language in the TL because of stylistic differences. Newmark (1988: 109) refers to this strategy as 'reducing metaphor to sense'. The following maritime English idioms can be translated into Romanian by means of paraphrase: *cut a dido → make a difficult manoeuvre for anchorage → a face o manevră complicată pentru ancorare; do sweety Fanny Adams → do nothing onboard → a nu face nimic la bord; bring down by the head → employ too many sailors → a angaja prea mulţi marinari*; *dress a ship overall → a ridica marele pavoaz, bury her head → enter a wave with the bow → a intra cu prova în val; be at full bore → operating at the highest speed or power → a avea toată viteza/ a se deplasa cu toată viteza; be a good ship → a ţine bine marea; to give her the gun → to make an engine run faster → a pune maşina la viteză maximă*; *to bury in the deep → to submerse → a intra în imersiune; keep the land aboard → to sail along the coast → a naviga de-a lungul coastei; to come on squally → to blow in gusts → a bate în rafale; to bury a vessel's bow → to submerge the vessel's bow → a intra cu prova în apă*; *to carry a bunting talk → to transmit messages using the code flags → a transmite message folosind codul de pavilioane; administer the Bible → to apply the onboard regulations → a aplica regulamentul de la bordul navei;*. Mention must be made that most of the above expressions are also used in the navy.

Other idiomatic expressions translated by means of a paraphrase are the ones that take the verb *be* as their constituent element. They bear the following patterns: to be + prepositional phrase, be + adverbial phrase, be + adjective + prepositional phrase: *be by the bows/head → a fi aprovat; be by the stern → a fi apupat; be down by the bows → a fi aprovat; be down by the stern → a fi apupat; be in nice trim → a a fi cu asietă dreaptă; be laden by the head → a a fi aprovat(ă); be on her beam ends → a fi canarist(ă) neredresabil*; *be on the dags →to be on leave → a fi în concediu (despre un marinar); be at the paddle → to proceed at slow speed → a se deplasa cu viteza redusă; be flat aback/aft → have the sheets too tightly backed up → a fi cu şcotele recuperate strâns.* As it can be noticed, some of these expressions are synonymous. However, the use of this strategy involves the disadvantages of loosing quality and stylistic flavour. Newmark (1988: 109) considers that while using this strategy not only components of sense will be missing or added, but the emotive or pragmatic impact will be reduced or lost. Still, paraphrase is usually descriptive and explanatory; sometimes it preserves the style of the original idiom as well.

3.4. Translation by a non-idiom into an idiom

By translating some Maritime Romanian non-idioms with Maritime English idioms, the translator can maintain the style of the original text. In my view this is an important strategy in compensating for all the 'lost' idioms as well as preserving the linguistic and stylistic spirit of the original text.

For instance, the Romanian verb *a aprova* has a multitude of idiomatic equivalents in maritime English: *bring down by the head; to bridge by the head; pitch forward* or *weigh the bow down* (Popa 1993: 38). The Romanian expression *a lua apă cu prova* can be translated into English by means of the idiomatic expression *be wet forward* or by the pharsal verb *plow in*. Similarly, the Romanian *navă ieşită din uz* can be translated with the expression *be up Blackstakes*, which means *out of service*. The Romanian syntagm *marinar nepriceput* can be rendered into English with the idiom *a King's hard bargin* which stands for an *unskilful navigator*. This is a near synonym of the expression *a gaw –gaw sailor → a clumsy navigator → marinar bun la nimic*.

4. CONCLUSIONS

Not only does maritime language encode particular meanings, but by virtue of these meanings and the forms employed to symbolise these meanings which constitute part of shared knowledge within a particular maritime speech community, it can serve an interactive function, facilitating and enriching communication in a number of ways. There are maritime English idioms which, translated into maritime Romanian will not be able to render exactly the initial context, even though there may be a dictionary equivalent. Under these circumstances the maritime translator has to resort to a combination of units in order to find an adequate equivalent that performs the exact function of meaning in the sentence as its original counterpart and preserves as much as possible invariant information with respect to a system of reference (Baker 1992).

The general conclusion of the study can be drawn that idiomatic expressions are translatable by some means, but depending on a special situation each demands a particular strategy. Since the majority of the idiomatic expressions in one language do not usually have corresponding idioms in another language, there does not seem to be one 'best' strategy. On the other hand, literal translation without considering its restrictions may lead to an awkward and unnatural translation. Then, the strategy of translating an idiom with a normal, non- idiomatic expression can be appropriate when there is no corresponding target language idiom which conveys the meaning of the original expression. However, during the process of translating idiomatic expressions, translators should always be aware of cultural and lexical diversities.

In my view specialized professional users (i.e. translators) working in the field of maritime navigation and transport require an updated terminological resource acting as a support for the definition and translation (English-Romanian/ Romanian-English) of terms belonging to this domain. Therefore, the terminological lexicon should be mostly rich in technical terms, but it should also contain idiomatic expressions and sayings originating from the maritime domain, which is a cultural environment affecting from a lexical point of view, our everyday life. In this way, the lexical coverage of the terminological resource shall be increased with concepts connected to navigation and belonging to a cultural linguistic heritage shared by Romanian and English.

5. REFERENCES

[1] BAKER, M., *In Other Words.* London: Routledge, 1992

[2] BEZIRIS, A., POPA, C., SCURTU, G., BANTAŞ, A., *Dicționar Maritim Român-Englez.* Bucureşti: Editura Tehnică, 1982

[3] CARTER, R., *Vocabulary. Applied Linguistic Perspectives*, London: Allen & Unwin, 1987

[4] CARTER, R., McCARTHY, M., J., *Vocabulary and Language Teaching*, London: Longman, 1988

[5] CROITORU, E., DUMITRAŞCU, A., *Collocations and Colligations in Specialized Texts*. In “Specialized Discourse: Theory and Practice, Galați: Europlus Publishing House, 2006, pp 103-113

[6] CRUSE, D., A., *Lexical Semantics*. Cambridge: Cambridge University Press, 1986

[7] CRUSE, D., A., *Meaning in language: An introduction to Semantics and Pragmatics*. Oxford: Oxford University Press, 2000

[8] CONNEL, R., W., MACK, W., P., *Naval Ceremonies, Customs and Traditions, 6th Edition.* United States of America: Naval Institute Press, 2004

[9] DOLLERUP, C., *Basics of Translation Studies,* Iaşi: Institutul European

[10] DUFF, A., *Translation. Resource Book for Teachers*. Oxford: Oxford University Press, 1990

[11] FORD, C., W., *Boat Green: 50 Steps Boaters can take to save our Waters.* Canada: New Society Publishers, 2008

[12] HUFF, R., P., *Captain Bucko’s Nauti-Words Handbook: Fascinating facts and fables about the origins of hundreds of nautical terms and expressions.* United States of America: Write Aweigh, 2004

[13] HELTAI, P., *Ready-made language and translation*. In Hansen, G., Malmkjær, K., Gile, D. (eds.), *Claims, changes and challenges in translation studies: selected contributions from EST Congress, Copenhagen, 2001*. Amsterdam / Philadelphia: John Benjamins, 2004

[14] LEPPIHALME, R., *Culture bumps: an empirical approach to the translation of allusions*. Clevedon: Multilingual Matters, 1997

[15] LINDQUIST, H., *Corpus Linguistics and the Description of English.* Edinburgh: Edinburgh University Press, 2009

[16] LIPKA, L., An Outline of English Lexicology. Tübingen: Max Nyemeyer Verlag, 1991

[17] LÖSCHER, W., *Translation performance, translation process and translation strategies.* Tübingen: Guten Narr, 1991

[18] NATTINGER, J.R., DE CARRICO, J.S., *Lexical Phrases and Language Teaching*. Oxford: Oxford University Press, 1992

[19] NEWMARK, P., *Approaches to Translation*, Hertfordshire: Prentice Hall, 1988

[20] POPA, C., I., *Expresii marinăreşti în limbile engleză şi română*, Bucureşti: Editura Militară, 1992

[21] POPA, C., I., *Romanian - English Dictionary: Maritime Terminology*, Constanta: Poligraf, 1993

[22] ROYCE, P., M. , *Royce’s Sailing Illustrated Vol I. The Sailor Bible since 1956*. available from http://books.google.ro/books?id=CStSBHWsHsgC&printsec=frontcover&hl=ro&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

[23] SUPERCEANU, R., *Evaluation and Revision Procedures used in Translation*. In Luminita Frențiu (ed.) *Romanian Journal of English Studies,* Editura Universității de Vest, Timişoara, 2006 pp. 257-263

[24] ****Webster Encyclopedic Unabridged Dictionary of the English Language*, New York: Gramercy Books, 1996

[25] ****Charlie Noble Booklet*, Texas Maritime Academy, Texas A& M University at Galveston, August 2012, available from http://www.tamug.edu/corps/images/Charlie_Noble_Booklet_Fall_2012

SECTION VI
TRANSPORT ECONOMICS

INDICATORS FOR THE PERFORMANCE AND FOR THE EFFORT IN TRANSPORT

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ABSTRACT

The cooperation and integration of several types of transport need special and dedicated indicators. If their definition surprises the specificity of the transport, they could be used for the benchmark of different systems of transport and also for the measurement of their relative influence into the market. Same of specific indicators for informational concepts are transformed and adapted for transport activities. This paper presents a way to generate better and more adequate indicators for getting a representation of the transport activities.

Keywords: *inter-modality, multimodality, entropic level, equivocation, trans-information, informational factor.*

1. INTRODUCTION

We will consider the transport as a system included into the logistic. The sub-systems of the transport system are the means of transport: by road, by sea, by railroad or on air Multimodal transport is not only the reunion of several types of transportation. The management of multimodal transportation involves the entire transport infrastructure: terminals, consolidation warehouses, ports, airports or something else, which requires the highest extent of coordination from all of those involved in the logistics process.

The cooperation and integration of several types of transport need special and dedicated indicators. If their definition surprises the specificity of the transport, they could be used for comparison of different systems of transport and for the measurement of their relative influence into the market.

2. INTER-MODALITY AND MULTIMODALITY

The term of inter-modality was used for a system of transport which consists of modules of transport more different than similar. The method involves the transportation of freight in an inter-modal vehicle or container, using multiple modes of transportation (rail, ship, and truck), without any handling. This reduces cargo handling, and so improves security, reduces damages and loss, and allows freight to be transported faster. As a consequence, each mode of transport will have its own development and the differences between them will increase.

They are two different approaches of the inter-modality:

- the inter-modal system consists of hubs (ports, airports, terminals, warehouses) and the network or
- the inter-modal system consists of hubs (ports, airports, terminals, warehouses) only.

It is obvious that nothing exists completely independent; anything is included in the wholeness.

Multimodal transport means the simultaneous or alternative use of the different ways of the transport. It solves a big part of cargo mobility problems. The multimodal transport refers to a transport system usually operated by one carrier with more than one mode of transport under control or ownership of one operator. It involves the use of more than one means of transport such as a combination of truck, railcar, railways, aeroplane or ship in succession. The most important advantages of multimodal transport could be considered the followings: coordinated and planned as a single operation, minimized the loss of time and risk of loss, pilferage and damage to the cargo at trans-shipment points. The markets is psychically reduced by faster transit of goods, the distance between origin or source materials and customers is getting to be insignificant.

2.1 Inter and multimodal characterisation of a system of transport

A system of transport could be in one of the 'm' states.

Shannon [3] characterised the multimodal diversity of such a system by its entropic level:

$$H = -\sum_{i=1}^{m} p_i \lg p_i \tag{1}$$

This formula is not related to the tendency of the system to change its state from the state i to the state j, where i, j $\in$ { 1,2,…m}. For this reason, the average entropy H_m of the system under a transitory matrix is

$$H_M = \sum_{i=1}^{m} p_i H_i \tag{2}$$

where
$$H_i = -\sum_{j=1}^{m} p_{ij} \lg p_{ij} \tag{3}$$

and
$$H_{M\max} = \lg m \tag{4}$$

If the system laid in the state i it could pass to any state j. The entropy H_i only considers the incertitude of the change of the state without a suggestion about its nature.

Let T_{ij} be the transition of the system to a state j with a certain level of efficiency (done by the indicators e_{ij}).

$$E_i : \begin{pmatrix} T_{i1}........T_{im} \\ p_{i1}........p_{im} \\ e_{i1}.........e_{m1} \\ \end{pmatrix}, \quad e_{ij} \geq e_{i,j+1}, \ j=1,2,\ldots m \qquad (5)$$

Let consider now the transitions are in the decreasing order of the level of efficiency.

Let E_i denote the fact that the system is in the state i and is doing the transition T_{ij} with the probability p_{ij}. If E will normally unfold, the outcome will be the transition T_{ij} to the state with the maximum of efficiency (j=1).

The level of inefficiency is done by the non dimensional indicator

$h_{ij} = (e_{i1}-e_{ij})/e$, where $e = (|e_{i1}|,\ldots,|e_{im}|)$.

If $h_{ij} = \lg w_{ij}$, we arise to the weighted entropy

$$H_i^{\ p} = -\sum_{j=1}^{m} p_{ij} \lg \frac{w_{ij}}{p_{ij}} \qquad (6)$$

or

$$H_i^{\ p} = \alpha \sum_{j=1}^{m} p_{ij} h_{ij} + H_i \qquad (7)$$

introduced by Theiler, Tovissi [4].

For the usual entropy, if $p_{ij}=1$ (doubtless transition) $H_i=0$ (the disorder is at minimum, for any j).

For the weighted entropy, if there exists doubtless transition ($p_{ij}=1$), there $H_i^{\ p} = \lg w_{ij} = h_{ij}$ or the minimum disorder is expressed by the inefficiency h_{ij} of the transition from i to j, or the disorder is at minimum if the transition h_{ij} is inefficiency.

The maximum value is :

$$H_{i\max}^{\ p} = \lg \sum_{j=1}^{m} \lg w_{ij} \text{ and is fulfilled for} \qquad (8)$$

$$p_{ij} = \frac{w_{ij}}{\sum_{i=1}^{m} w_{ij}}, \ j=1,2,\ldots m$$

The weighted entropy for the entire system [2] is:

$$H_M^{\ p} = \sum_{i=1}^{m} p_i H_i^{\ p}$$

and

$$H_{M\max}^{\ p} = H_{i\max}^{\ p} \qquad (9)$$

In the case of a transhipment platform for goods, we could consider the following three different possible situations [5]:

1. containerised
2. united (i.e. palletised goods)
3. bulk.

The transitions between this could be described as follows: a part of the bulk merchandise should be united and going from the state 3 to the state 2, the units could pass into a container (from the state 2 to the state 1) and so on. It is possible to define the matrix of these passages.

In the inter-modal freight transport, the goods lie into a state *i* and could pass into a state j with the probability p_{ij}, where j=1, 2, 3. The entropy H_i for each state *i* give us the possibility to understand the incertitude of transition from *i* to *j*.

The margin between the real values and the maximum value of the entropy shows if there still exist possibilities of improvement of the activities of the transhipment platform for goods.

2.2 The characterisation of a inter-modal system of transport in uncertainty conditions

Let M be the matrix and its elements p (x_i, y_j) representing the probability of transmission of signals from the entry $i \in X$ to the exit $j \in J$.

Using the following:

- $p(x_i)$ as the probability the signal x_i come in the system and

$p(y_j)$ as the probability the signal y_j come out from the system, then:

A. the entropy of the entering field will be:

$$H(X) = -\sum_{i=1}^{m} p(x_i) \lg p(x_i) \qquad (10)$$

B. the entropy of the going out field will be:

$$H(Y) = -\sum_{j=1}^{n} p(y_i) \lg p(y_i) \qquad (11)$$

C. the entropy of the total field will be:

$$H(X,Y) = -\sum_{i=1}^{m} \sum_{j=1}^{n} p(x_i, y_j) \lg p(x_i, y_j) \qquad (12)$$

and trans-information in absolute value T and relative value T_r is:

$$T = H(X) + H(Y) - H(X,Y) \qquad (13)$$

$$T_r = \frac{T}{H(X)} \qquad (14)$$

Let we consider now the equivocation

$$H(X/Y) = H(X,Y) - H(Y) \qquad (15)$$

as a measure of the equivoque on the come in field X when is known the come out field Y. In dynamic interpretation this represents the equivoque of the passed modal distribution starting from the present modal distribution. A static interpretation is that H represents the equivoque of the traffic generators distribution starting from the present modal distribution off the traffic.

Let we consider now the average error

$$H(X/Y) = H(X,Y) - H(X) \qquad (16)$$

as a measure of incertitude of the come out field Y, when is known the come in field X. . In dynamic interpretation this represents the incertitude of the future modal distribution knowing the initial present modal distribution. A static interpretation is that H represents the incertitude of the future modal distribution as a result of the initial known distribution of the traffic generators.

Trans-information T is also equalled to:

$$T = H(X) - H(X/Y) = H(Y) - H(Y/X) \quad (17)$$

and represents the average value of the mutual information related to the field X obtained from the field Y, or the average of the information passing throw the system.

Based on the trans-information, the systems could be in the following situations:

1. There exists a one-to-one function between X and Y, there isn't equivoque on the come in signals and there isn't error on the come out signals, T_r=1. The traffic on each transport mode is provided by only one traffic generators or sender.
2. For any signal from Y corresponds only one signal in X, so there no exists equivoque on the signal x_i come into the system when is known the signal y_j to the exit.

At the same time, for the same signal x_i entered into the system they are generated many signals y_j at the exit and this facilitate the genesis of some errors during the process.

For the transport, this is the situation of a dispatch started by car, divided into many pieces and some of them will continue the way by another mod of transport.

3. A signal entered into the system generates only on signal to the exit, so there is no error. But, if the signal from the exit is known there exists equivoque on the entering signal:

$$T_r = H(Y)/H(X) \quad (18)$$

4. There exists an equivoque related to the entered signals and error on the exit signals. This created an uncertin situation about the work inside the system and:

$$T_r = H(X) + H(Y) - H(X,Y)/H(X) \quad (19)$$

5. If all the signals: entered, leaved or the reunion of them have the same probability in their category

$$p(x_i, y_j) = \frac{1}{mn} \quad \text{and}$$

$$p(x_i) = \frac{1}{m},\ p(y_j) = \frac{1}{n}, i = 1...m,\ j = 1...n \quad (20)$$

then the entropies will have the maximum values and it results the followings:

$$H(X) = \lg m,\quad H(Y) = \lg n, \quad (21)$$

$$H(X,Y) = \lg mn = H(X) + H(Y) \quad T_r = 0,$$

The significance of this situation is the possible connexion of each entered signal to any signal arrived to the exit, so the uncertainty is dominant.

The relative trans-information could define the quality of the connexions entrance-exit through the system as follows:

$T_r = 0$ maximum complexity

$T_r = 1$ correspondence on-to-one between entrance and exit,

$T_r \neq 0, T_r \neq 1$ random connexion between entrance and exit.

Into an intermodal terminal, during an interval of time come in a number of transport units from different modes of transport x_i. The same units will go out from the terminal using the vehicles y_j of other types of transport. Immediately could be know H(X), H(Y), H(X,Y), T_r. If the relative trans-information has a small value, the conclusion is that the change of the mode of transport is very complex and it requires a lot of diver logistic and multimodal operations.

Relative trans-information represents an indicator of the degree of specialisation of freight in relation with the modes of transport served by the terminal and allows a comparison between transport terminals. In the same time the trans-information could be used for define the optimal solution for the classical problem of transport in Operational Research, where x_i represents the supplier and y_j represent the consumer.

3. INDICATORS FOR THE PERFORMANCE AND FOR THE EFFORT IN TRANSPORT

The classical indicators are not very adequate to the complexity and the real value of the performance into transport. For example, if the route between the expedition points x_i i=1…m and final point y_j is denoted by TK_{ij} (tkm)

$$TK = \sum_{i=1}^{m} \sum_{j=1}^{n} TK_{ij} \quad (22)$$

do not indicate the real effort for the transport.

This effort is bigger if:

- the number of the sender/ reception points is bigger
- the weight of the dispatch points done by their probabilities p_i (dispatched tones from x_i / dispatch tones from all points) is more uniform and the same for the receiving points.
- there exists a large diversity of goods
- the complexity of the connexions is important, so that the matrix of the connexions has a lot of positive elements.

The first two features are reflected into the entropy H(X) of the dispatch/receive points, related to the maximum value $H(X)_{max}$=lg m.

For he third feature will proceed by analogy related to the weight of each category of goods in the total displacement.

The fourth feature could use the new concept of trans-information introduced by Cuncev…as follows:

Let consider now the stochastic matrix Z=(z_{ij}) i=1,2…n, j=1,2…n of the probabilities to have a transfer of goods between the points x_i and y_j:

$Z_{ij} = TK_{ij} / TK$

The probability to arrive same goods in y_j could be expressed by

$$q_j = \sum_{i=1}^{m} p_i z_{ij} \quad (23)$$

The average value of the mutual transferred into the information system is the trans-information T

$$T = H(X) + H(Y) - H(X,Y) = H(X) - H(X/Y) \quad (24)$$

where H(X,Y) means the entropy of the reunite in/out field.

Considering the relative trans-information Tr = T/H(X) as a characterisation of the complexity of the connexions (i, j) we get:

$T_r = 0$ maximum complexity
$T_r = 1$ correspondence on-to-one sender-receiver
and $T_r \neq 0$, $T_r \neq 1$ for a random correspondence .

We introduce now a new concept, the informational factor $C(T_r)$, for the complexity of factors that are influencing the effort of transport.
Using this new concept, the total transport activity could be expressed by:

$$CTK = TK \cdot C(T_r). \tag{25}$$

The evaluation of this factor $C(T_r)$ is very difficult to be done. In order to have a method to calculate it, I propose the following algorithm:
Step 1: the identification of all factors that are influencing the effort of transport;
Step 2: to establish the empirical probability of involvement of each of the previous factors;
Step 3: to allocate to each factor a measurable magnitude of its involvement;
Step 4: to build the synthesis function of all this factors.

It is a similarity between this operation and the building of the synthesis function for the multi-criteria optimisations problems [1], in linear programming.

In a similar way a lot of specific indicators for informational concepts could be transformed and adapted for transport activities. This way will allow to have a better and more aquarate representation of the transport activities.

4. THE OPTIMAL DECISION UNDER RISK CONDITIONS

Let we consider that the decision maker will adopt a strategy i if he knows the complete field of probability related to the behaviour of the concurrent:

$$(A, J, p_{ij}), p_{ij} \geq o, \sum_{i,j=1}^{m} p_{ij} = 1 \tag{26}$$

where p_{ij} represents the probability that the concurrent will adopt the alternative j when the decision maker will choose the variant i. The problem is to determine the optimal strategy for the decision maker such as he will obtain at least the utility U_{ij} .

Usually for this problem is used the method of the minimisation of the lost. But this method applied for the criteria of the minimisation of the average lost U

$$U = \sum_{i,j=1}^{m} U_{ij} p_{ij} \tag{27}$$

do not take into consideration the unpleasant surprise generated by the concurrent who could choose an unfavourable variant for the decision maker, with a great probability.

The distribution of the probability of loss takes into consideration the surprise effect. If the homogeneity of the distribution increases the predictability of the events decrease.

For such a situation, taking into consideration the well-balanced entropy

$$H_G = -\sum_{i=1}^{m} U_{ij} p_{ij} \lg p_{ij} \tag{28}$$

it will be considered also the unpleasant surprise generated by the concurrent who could choose an unfavourable variant for the decision maker with a great probability.

5. CONCLUSIONS

The movements of goods from supplier to receiver imply the change of different modes of transport and a lot of inter-modal and logistic operations. The complexity of the transport activities is well to be measured using different indicators.

The indicators are also necessary for ranking the different systems of transport, for characterize the informational and operational connexions in the hubs and in junction's points.

There is not only one possible system of indicators.

The proposed indicators do not completely cover the multimodal transport problems, but each of them clarifies same important and new aspects.

The suggested algorithm achieves a connexion from the multimodal transport problems and the multi-criteria linear optimisation problems.

6. REFERENCES

[1] CARP D. *Noduri şi rețele de transport*, Editura Didactică şi Pedagogică, ISBN 978-973-30-2539-9 Bucuresti 2009
[2] CUNCEV I. *Analiza entropica a sistemelor din transporturi*, Revista transporturilor si telecomunicațiilor, nr.1 1978
[3] SHANNON C.E. *A mathematical Theory of Communication,* Bell Technical Journal, nr.27
[4] THEILER G., TOVISSIL. *Măsuri informaționale care țin seama de nivelul de eficiență al fiecărei stări*, ,Revista de statistică, nr.3, 1977
[5] European Intermodal Association (2005). *Intermodal Transport in Europe*. EIA, Brussels, ISBN 90-901991-3-6, 2005

MEASURING MARKET CONCENTRATION ACCORDING TO EUROPEAN COMPETITION POLICY

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ABSTRACT

For European Commission, the measurement of market concentration is important because it lies at the heart of decisions about whether to approve mergers and acquisitions that might pose a potentially harmful impact on consumers. The most commonly utilized measure of market concentration is the Herfindahl Hirschman Index (HHI), and the change in the HHI from pre-merger to post-merger ("delta").

In first part of the paper I focused on the definition of concentration as it appears in European legislation and on the relevant market by identifying those substitute products or services which provide an effective constraint on the competitive behavior of the products or services being offered in the market by the parties under investigation.

In the second part of the paper, I took an example using the HHI index to see how a merger affects the degree of market concentration. Further, I brought to light several issues regarding the measurement of market concentration and analysis of results as they are addressed by the european competition policy. As a result of this paper, I reached the conclusion that HHI index is more complete and elaborate than other market indicators and I find that a concentration operation (acquisition or merger) between two companies may have an important impact on the degree of market concentration and can lead to anti-competitive effects, requiring detailed analysis of the European Commission.

Keywords: *Herfindahl Hirschman Index; mergers; market concentration; market share*

1. INTRODUCTION

Economic theory indicates that concentration is an important determinant of market behavior and market results. Monopolistic practices are more likely where a small number of the leading firms account for the bulk of an industry's output than where even the largest firms are of relatively small importance. Therefore, in the explanation of business policy, the characteristics of an industry stated in the concentration index are likely to play an important part. This relation to the degree of monopoly has motivated most of the empirical studies involving the measurement of concentration.

Concerns and general suspicion about market concentration have a long history in the United States, dating back to the earliest days of the new republic. That economic and political liberties were seen as inextricably linked fostered the sentiment that the concentration of economic power invariably leads to the concentration of political power. As Dirlam and Kahn (1954, p. 17) observe: „*Clearly we are not devoted to a competitive system only for "economic" reasons. It is also associated with such social and political ideals as the diffusion of private power and maximum opportunities for individual selfexpression. If the economy will run itself, government interference in our daily life is held to a minimum*".

Market concentration is useful as an economic tool because it points the degree of competition in the market. In this regard, Tirole (1988, p. 247) notes that: "*Bain's (1956) original concern with market concentration was based on an intuitive relationship between high concentration and collusion.*"

There are game theoretic models of market interaction that anticipate a future growth in market concentration that will result in higher prices and lower consumer welfare even when collusion in the sense of cartelization (i.e. explicit collusion) is absent. Such examples are Cournot oligopoly and Bertrand oligopoly for differentiated products.

Empirical studies that are projected to test the relationship between market concentration and prices are jointly known as price-concentration studies).

Any study that claims to examin the relationship between price and the level of market concentration is also testing whether the market definition (according to which market concentration is being calculated) is relevant; that is, whether the boundaries of each market is not being determined either too narrowly or too broadly so as to make the defined "market" meaningless from the point of the competitive interactions of the firms that it includes (or is made of).

As a matter of public policy, the measurement of market concentration is important and lies at the heart of decisions about whether to approve mergers and acquisitions that might pose a potentially harmful impact on consumers in terms of both prices and the availability of goods and services. „*These issues have been addressed by antitrust laws in the U.S. dating to the Sherman Antitrust Act in 1890"* [Hays and Ward 2011]. Unlike, it was not until 1989 that EU Policy makers realized the „*usefulness and the necessity of a common merger regulatory framework*" [Lipczynski and Wilson, 2001], and responded with the European Council Merger Regulation (ECMR) on the control of concentrations, „*forced by the increased cross-border activities of European firms in the second half of the 1980*s" [Jacobson and Andréosso-O'Callaghan, 1996].

2. CONCENTRATION IN COMPETITION POLICY

A *concentration* between an incumbent and a potential entrant can raise significant competitive concerns. According european competition policy, „*a concentration shall be deemed to arise where a change of control on a lasting basis results from: (a) the merger of two or more previously independent undertakings or parts of undertakings, or (b) the acquisition, by one or more persons already controlling at least one undertaking, or by one or more undertakings, whether by purchase of securities or assets, by contract or by any other means, of direct or indirect control of the whole or parts of one or more other undertakings. The creation of a joint venture performing on a lasting basis all the functions of an autonomous economic entity shall constitute a concentration*" [Council Regulation (EC) No 139/2004, art. 3].

Control shall be constituted by rights, contracts or any other means which, either separately or in combination and having regard to the considerations of fact or law involved, confer the possibility of exercising decisive influence on an undertaking, in particular by: ownership or the right to use all or part of the assets of an undertaking; rights or contracts which confer decisive influence on the composition, voting or decisions of the organs of an undertaking. Control is acquired by persons or undertakings which: (a) are holders of the rights or entitled to rights under the contracts concerned; or (b) while not being holders of such rights or entitled to rights under such contracts, have the power to exercise the rights deriving therefrom.

Concentrations with a Community dimension must be notified to the Commission prior to their implementation. Where a concentration raises serious doubts as to its compatibility with the market, the Commission can carry out detailed on-the-spot investigations.

The competition authorities may measure market concentration using the number of pregnant competitors in the market. This measure is most useful when there is a gap in market share between significant competitors and smaller rivals or when it is difficult to measure revenues in the relevant market. The competition authorities also may consider the combined market share of the merging firms as an indicator of the extent to which others in the market may not be able readily to substitute competition between the merging firms that is lost through the merger.

Three proxies have received attention in the literature for determining whether a firm (or group of firms) has the ability and incentive to raise or maintain prices above competitive levels (or achieve other anticompetitive effects): (1) the Lerner Index; (2) market shares and (3) the Herfindahl-Hirschman Index ("HHI"), which turns market shares into a measure of market concentration.

Using the *Lerner Index* as measure of market power is difficult because there are both theoretical and practical problems. The main theoretical difficulty is that "the *Lerner Index does not offer a competitive benchmark except in perfectly competitive markets, where the Lerner Index should be zero"* [Elzinga, 1989]. The most remarkable practical obstacle to broader application of the Lerner Index is determining the firm's marginal cost of production at any given point in time. Without a measurement or reasonable estimate of marginal cost, the ratio is incalculable. Furthermore, exogenous economic factors, such as shifts in consumer demand or the cost of inputs, could result in spectacular and misleading changes.

A *market share* is the fraction or percentage of a relevant market controlled by a specific market participant. Market shares can calculated based on: sales revenues; capacity and units. Therefore, "*market share calculations permit courts and agencies to determine how many sales the defendant will lose if it raises prices*" [Hay, 1992]. The greater the firm's market share, the less likely that other firms will be able to enlarge production to defeat the unilateral price increase.

But market share analysis has attracted its share of criticism. Some critics contend that because market share calculations require product and geographic market definitions, they can become complex and expensive undertakings.

Other critics accuse that market share analysis may not create accurate insights into market power. If product and geographic markets are defined too broadly, market shares will underestimate the firm's ability to raise or maintain prices above competitive levels in the relevant market. Because market shares are based upon historical data, some argue that they may be less useful in analyzing potential competitive effects in volatile or dynamic markets. Others argue that historical market share data may not reflect the ability of existent and potential competitors to modify production in the relevant market through expansion or entry.

The definitions of *relevant market* represents an intermediate step in the investigation. The European Commission made precisely this point in its Notice on the Definition of Relevant Market for the Purposes of Community Competition Law published in December 1997. In para. 2, the Notice states that: "*Market definition is a tool whose purpose is to identify in a systematic way the competitive constraints that the undertakings involved face. The objective of defining a market in both its product and geographic dimension is to identify those actual competitors of the undertakings involved that are capable of constraining their behavior and of preventing them from behaving independently of any effective competitive pressure*."

The Commission Notice on the definition of the relevant market refers to three competitive constraints which can act on the undertakings: demand substitutability, supply substitutability and potential competition.

The concept of substitutability is the key of the relevant market definition. Products that should be included in the relevant market and the geographical area of the market are determined by the extent to which consumers can easily choose between substitutable products (demand substitutability), or by the extent to which undertakings can easily shift their production to obtain such substitutable products (supply substitutability). Demand substitutability has the most important role in defining the relevant market, being an efficient and direct force of constraint. Supply substitutability influences the relevant market only when it has effects similar to those of demand substitutability, namely effectiveness and direct character. The potential competition, the third form of competitive constraint, is usually analysed in a stage following market definition, generally when the position of the undertakings within the relevant market has already been established.

The relevant market has two components: the product market and the geographic market. Defining the relevant market consists in combining the product market and the geographic market, after they have been defined previously. Most of the time, we start by defining the product market and then we continue with geographic market definition.

The relevant product market comprises all the products and/or services which are regarded as interchangeable or substitutable by the consumer, by reason of the products' characteristics, their prices and their intended use. The products do not have to be identical to be considered substituble and therefore to be included in the same market and also their prices do not have to be identical. „*The relevant geographic market comprises the area in which the undertakings concerned are involved in the supply and demand of products or services, in which the conditions of competition are sufficiently homogeneous and which can be distinguished from neighbouring areas because the conditions of competition are appreciably different in those area. The geographic market can be identified at local or regional level, at national or international level"*. [Bozian L., 2009].

There is a test for the relevant market which is now used in both the US and EU, and increasingly elsewhere as well. This test is called variously the hypothetical monopolist test, the *SSNIP test* or the 5–10% test. The test is consistent with the principles that we have outlined above for relevant market definition. In particular, it asks a specific form of the question "Is this a market worth monopolizing?" The starting point for the test is the narrowest set of products that could plausibly be considered a separate market. The "Small but Significant and Nontransitory Increase in Price" (SSNIP) is usually taken to be either 5% or 10%.

The European Commission has adopted this test. The Market Definition Notice paragrf 17 provides that: „*The question to be answered is whether the parties' customers would switch to readily available substitutes or to suppliers located elsewhere in response to a hypothetical small (in the range 5% to 10%) but permanent relative price increase in the products and areas being considered. If substitution were enough to make the price increase unprofitable because of the resulting loss of sales, additional substitutes and areas are included in the relevant market. This would be done until the set of products and geographical areas is such that small, permanent increases in relative prices would be profitable*".

3. HERFINDAHL-HIRSCHMAN INDEX (HHI) METHODOLOGY

The index was originally proposed and used in the field of industrial economics by Herfindahl (1950) and Hirschman (1964) independently of each other.

For the first time, in 1982, the Department of Justice in US replaced the standard four firm concentration index (C4) with the Herfindahl-Hirschman index (HHI) as its. Since then, the HHI has been used in the analysis of horizontal mergers in which parties combine their productive capacities in a relevant market to operate as a single firm. Whereas C4 adds up the market shares of the top four firms to calculate industry concentration, "*HHI is more complete and elaborate in that it uses a weighted average of market shares of all firms*" [Anbarci and Katzman, 2005].

Concentration ratios have two significant deficiencies as proxies for the effectiveness of competition in an industry. First, they do not take account of the relative sizes of the leading companies. For example, a market which has four firms each with a 20% market share will have the same C4 ratio as a market in which the leading four firms have market shares of 55%, 20%, 3% and 2%. But it is probable that the competitiveness of the two markets will differ. For instance, in the latter case there is a clear potential "leader" for the other firms to follow, whereas in the former case their might be fierce competition to become the largest firm (particularly if there are significant economies of scale in production). The second problem stems from taking into account neither the total number of firms in the market nor the market shares of smaller companies.

Unlike the N-firm concentration ratio:

1. The HHI reflects the degree of market share inequality across the spectrum of firms that participate in a market. The influence of smaller firms is lessened. The influence of larger firms is emphasized.
2. Thus, higher values of the HHI reflect the combined influences of both unequal firm sizes and the concentration of activity among a few large firms.

It consists of the sum of squares of firm sizes, all measured as percentages of total industry size.

$$HHI = \Sigma(S)_i^2$$

where S is the proportion of market share for the i^{th} firm. Scale goes from zero to 10.000, with 10.000 indicating that a single company controls 100% of the market share in a given industry.

Although it is best to include all firms in the calculation, lack of information about very small firms may not be important because such firms do not affect the HHI significantly. While the absolute level of the HHI can give an initial indication of the competitive pressure in the market post-merger, the change in the HHI (known as the 'delta') is a useful proxy for the change in concentration directly brought about by the merger.

One can show that the post-merger change in the HHI caused by the merger of any two market participants will always equal 2 times the product of the merging firms' market shares. For any two firms, A and B, with market shares a and b respectively, A and B's pre-merger contribution to the market HHI is $a^2 + b^2$. If firms A and B merge, their combined contribution to the post-merger HHI is $(a + b)^2$. Basic algebra shows that $(a + b)^2 = a^2 + 2ab + b^2$. The difference between the post-merger HHI and the pre-merger HHI is, therefore, $(a + b)^2 – (a^2 + b^2) = 2ab$.

We will take an example of measuring market concentration to see what implications has a merger between two companies upon the HHI. Suppose that the market shares of the 7 firms participating in a relevant market are 25, 20, 15, 15, 10, 10, and 5. The HHI for this market will be:

Table 1

Firm	Market share %	Squared market share
1	25	625
2	20	400
3	15	225
4	15	225
5	10	100
6	10	100
7	5	25
Total	100	HHI = 1.700

Own calculations using random date

HHI can be calculated using data from the table: HHI $= 25^2 + 20^2 + 15^2 + 15^2 + 10^2 + 10^2 + 5^2 = 1.700$

From the example, if the second and third largest firms in the market were to merge, what will happen with the HHI index? To archive the result, we have to calculate the new HHI index under existing market shares after merger:

Table 2

Firm	Market share %	Squared market share
1	25	625
2 and 3 merge	25 + 10 = 35	1225
4	15	225
5	10	100
6	10	100
7	5	25
Total	100	HHI = 2.300

Own calculations using random date

We seen in the table that after the merger of firms 1 and 2 square of market share is much higher than the sum of squares of individual shares before concentration. The merger increases HHI from 1.700 points to 2.300 points. The difference between the post-merger HHI and the pre-merger HHI (delta) is 2.300 - 1.700 = 600 points.

To interpret this result, first we must see which are the thresholds taken into account by European merger policy when a merger is subject to review.

4. EU GUIDELINES ON THE ASSESSEMENT OF MERGERS

Market shares and concentration levels provide useful first indications of the market structure and of the competitive importance of both the merging parties and their competitors.

Normally, the Commission uses current market shares in its competitive analysis. The European Commission has traditionally become concerned about the market power of firms when their market share is above 40%. The UK domestic competition authorities have traditionally seen 25% as a threshold figure for significant market power. However, current market shares may be adjusted to reflect reasonably certain future changes, for instance in the light of exit, entry or expansion (Case COMP/M.1806 — Astra Zeneca/Novartis, points 150 and 415). Post-merger market shares are calculated on the assumption that the post-merger combined market share of the merging parties is the sum of their pre-merger market shares. Certain mergers, by reason of the limited market share of the companies concerned, are not likely to significantly impede effective competition. An indication to this effect exists, in particular, where the combined market share of the merging firms does not exceed 25%. This indication derives from Recital 32 of the EC Merger Regulation. However, it does not apply to cases where the proposed merger is likely to give rise to co-ordinated effects.

To complement the above indicia, the Guidelines also apply the Herfindahl-Hirschman Index ("HHI"), and the change in the HHI from pre-merger to post-merger ("delta") as first indications of the change in competitive pressure in the market following the merger. It should estimate of the market share in value (and where appropriate volume) of all competitors (including importers) having at least 5 % of the geographic market under consideration. On this basis, provide an estimate of the HHI index pre- and postmerger, and the difference between the two (the delta). After this, it must be indicated the proportion of market shares used as a basis to calculate the HHI and the sources used to calculate these market shares and provide documents where available to confirm the calculation.

The Guidelines indicate that the Commission is unlikely to identify competition concerns in a market with a post-merger HHI below 1.000, and that such cases normally do not require extensive analysis.

The Commission is also unlikely to identify competition concerns in a merger:

- with a post-merger HHI between 1.000 and 2.000 and a delta below 250,
- with a post-merger HHI above 2.000 and a delta below 150 except where some special circumstances are present,

which somehow invalidate the HHI as a useful proxy for the change in competitive conditions. This may relate, by way of example, to the following instances: (a) a merger involves a potential entrant, or a recent entrant with a small market share; (b) one or more merging parties are important innovators in ways not reflected in market shares; (c) there are significant cross-shareholdings among the market participants; (d) one of the merging firms is a maverick firm with a high likelihood of disrupting coordinated conduct; (e) indications of past or ongoing coordination, or facilitating practices, are present; (f) one of the merging parties has a pre-merger market share of 50% or more (V. Verouden, 2004).

5. CONCLUSIONS

Merger policy is seen as preventing excessive market concentration and monopoly power. The concern is that excessive concentration may cause a substantial lessening of competition or the creation of a dominant position, which may increase prices and reduce consumer welfare. The lessening of competition resulting from a concentration is more likely to be substantial, the larger is the market share of the incumbent, the greater is the competitive significance of the potential entrant, and the greater is the competitive threat posed by this potential entrant relative to others.

In the analysis undertaken, the HHI index is 2.300 and the delta is 600. According to Commission Guidelines "*is also unlikely to identify competition concerns in a merger: with a post-merger HHI above 2.000 and a delta below 150*". But HHI post merger and delta in our analysis exceeds the thresholds, therefore we are in front of an anticompetitive mergers (in practice of Europe Union, high post-merger HHIs and large changes in HHIs tend to be associated with anticompetitive mergers). But, not all mergers with these characteristics create or enhance market power. In markets with highly differentiated products, mergers may allow for unilateral price increases irrespective of market shares or HHI calculations.

In my opinion, HHI is more complete and elaborate than other market indicators like concentration rate or market share, because it is a weighted average of market shares of all firms. Concentration ratios do not take account of the relative sizes of the leading companies. For example, a market which has four firms each with a 20% market share will have the same C4 ratio as a market in which the leading four firms have market shares of 55%, 20%, 3% and 2%. But it is very probable that the competitiveness of the two markets will differ. For instance, in the latter case there is a clear potential "leader" for the other firms to follow, whereas in the former case their might be fierce competition to become the largest firm (particularly if there are significant economies of scale in production).

Further, the HHI reflects the degree of market share inequality across the spectrum of firms that participate in a market. The influence of smaller firms is lessened and the influence of larger firms is emphasized. Thus, higher values of the HHI reflect the combined influences of both unequal firm sizes and the concentration of activity among a few large firms.

Also, special attention should be paid to markets with many players and low concentration which can sometimes be cartelized markets, whilst highly concentrated markets can be characterized by fierce competition when, for instance, entry into and exit from the market are very easy. So that a detailed investigation should be initiated by European Commission after the measuring the concentration.

6. REFERENCES

[1] DIRLAM J., KAHN A., *Fair competition: The Law and Economics of Antitrust Policy*, Cornell University Press,1954

[2] TIROLE, J. *The Theory of Industrial Organization*, MIT Press1988

[3] HAYS F., WARD S.G., *Understanding market concentration: internet-based applications from the banking industry*, Journal of Instructional Pedagogies , 2011

[4] LIPCZYNSKI J., WILSON J., *Industrial Organisation. An Analysis of Competitive Markets,* London: Financial Times–Prentice Hall, 2001

[5] JACOBSON D., ANDRÉOSSO-O'CALLAGHAN B., *Industrial Economics and Organization: a European Perspective*, Maidenhead: McGraw–Hill, 1996

[6] Council Regulation (EC) No 139/2004, art. 3

[7] ELZINGA K., *Unmasking Monopoly: Four Types of Economic Evidence*, in R. Larner and J Meehan, Economics and antitrust policy,1989

[8] HAY G. A., *Market Power in Antitrust*, 60 Antitrust L.J. 807-808, 1992

[9] European Commission. *Notice on the Definition of the Relevant Market for the Purposes of Community Competition Law.* Official Journal C 372. December 1997

[10] BOZIAN L., *The Relevant Market Concept and the Hypothetical Monopolist Test,* in „Profil Concurența, no. 1, 2009

[11] European Commission, *Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings* (2004/C 31/03) Official Journal of the European Union

QUALITY STRATEGIES IN THE MARKET PROCESS

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ABSTRACT

In order to resist the competitive environment in the market or to consolidate its leading position in the field, organizations are increasingly interested in implementing a quality management system and adopt quality-oriented strategies of the market processes. Also, in order to increase customer satisfaction, organization management is always interested in improving the effectiveness and efficiency of processes, products and services, through the implementation of continuous improvement programs, including preventive and corrective actions that are necessary. In this article, we try to plead for the necessity of adopting quality improvement strategies with direct impact on the market performance of the organization.

Keywords: *quality improvement, competitivity*

1. INTRODUCTION

The term quality management has a specific meaning within many business sectors. This specific definition, which does not aim to assure 'good quality' by the more general definition, but rather to ensure that an organization or product is consistent, can be considered to have four main components: quality planning, quality control, quality assurance and quality improvement. Quality management is focused not only on product/service quality, but also the means to achieve it. Quality management therefore uses quality assurance and control of processes as well as products to achieve more consistent quality.

1.1. Short history on quality

The concept of quality as we think of it now first emerged out of the Industrial Revolution. Previously goods had been made from start to finish by the same person or team of people, with handcrafting and tweaking the product to meet 'quality criteria'. Mass production brought huge teams of people together to work on specific stages of production where one person would not necessarily complete a product from start to finish. In the late 19th century pioneers such as Frederick Winslow Taylor and Henry Ford recognized the limitations of the methods being used in mass production at the time and the subsequent varying quality of output. Birland established Quality Departments to oversee the quality of production and rectifying of errors, and Ford emphasized standardization of design and component standards to ensure a standard product was produced. Management of quality was the responsibility of the Quality department and was implemented by Inspection of product output to 'catch' defects.

Application of statistical control came later as a result of World War production methods, and were advanced by the work done of W. Edwards Deming, a statistician, after whom the Deming Prize for quality is named. Joseph M. Juran focused more on managing for quality. The first edition of Juran's Quality Control Handbook was published in 1951. He also developed the "Juran's trilogy," an approach to cross-functional management that is composed of three managerial processes: quality planning, quality control and quality improvement. These functions all play a vital role when evaluating quality.

Quality, as a profession and the managerial process associated with the quality function, was introduced during the second-half of the 20th century, and has evolved since then. Over this period, few other disciplines have seen as many changes as the quality profession.

The quality profession grew from simple control, to engineering, to systems engineering. Quality control activities were predominant in the 1940s, 1950s, and 1960s. The 1970s were an era of quality engineering and the 1990s saw quality systems as an emerging field. Like medicine, accounting, and engineering, quality has achieved status as a recognized profession.

2. QUALITY – INDISPENSABLE TOOL TO SURVIVE IN A COMPETITIVE ENVIRONMENT

When we discuss about our country we can observe a particularity that is becoming more and more obvious in our business environment is the awareness of the quality importance in all organizational processes, customer relationships both internal (employees) and external customer (consumers, investors, suppliers, partners, etc.). In order to resist the competitive environment in the market, more and more organizations in Romania have implemented and certified a quality management system in accordance with standard SR EN ISO 9001:2008.

On the other hand, to maintain its market leadership, organizations implement an integrated management systems concerning Quality, Environment, Safety and Ethics or they adopt different strategies for continuous quality improvement of its internal and external processes, including processes of market.

In this sense, organizations define their own quality policy and objectives, document the organization quality management system and work toward promoting at least the following basic principles related to quality assurance processes:

- client orientation, concerning especially understanding and satisfying customer need and expectations , respecting in the same time any legal and regulatory requirements, providing motivation and responsibility of each employee;
- continuous improving the effectiveness and efficiency of the quality management system through procedural approach in which quality chains includes all organizational entities, activities and organizational resources;
- setting quality objectives at the strategic, tactical and operational on an informational database, enabling analysis and makeing the best decisions on continuous improvement of the quality product.

3. WAYS OF DEALING WITH QUALITY IN THE MARKET PROCESSES

In order to increase customers satifaction, the organization management is always interested in improving the effectiveness and efficiency of processes, activities and products. Organizations choose between two strategies on continuous quality improvement processes, namely:

- INNOVATION – a strategy that refers to radical improvements of projects, or reviewing and improveing existing processes;
- KAIZEN – a strategi that follows slower improvemt activities, developed by emplyees that work on the existing procesess

Radical improvement projects involve significant redesign of existing processes and include: defining objectives and presenting process improvements, implementation of improvement actions, checking the improved process, evaluations on improvements.

In the second case, improvements are made in small steps, and the best source of ideas is represented by the emplyees of the organisation. When it comes to elaborate an improvement project, interests of all parties are taken into account.

Whichever method is selected improvement process should include the following components:

- Evaluation on existing situation
- Identification of possible risks
- Effect evaluation
- The implementation of the new solution
- Evaluation on efficiency concerning the process.

4. CUSTOMER FOCUS

Organizations depend on their customers and therefore should understand current and future customer needs, should meet customer requirements and strive to exceed customer expectations.

- **Key benefits:**

• increased revenue and market share obtained through flexible and fast responses to market opportunities;
• increased effectiveness in the use of the organization's resources to enhance customer satisfaction;
• improved customer loyalty leading to repeat business;
• researching and understanding customer needs and expectations;
• ensuring that the objectives of the organization are linked to customer needs and expectations;
• communicating customer needs and expectations throughout the organization;
• measuring customer satisfaction and acting on the results;
• systematically managing customer relationships;
• ensuring a balanced approach between satisfying customers and other interested parties (such as owners, employees, suppliers, financiers, local communities and society as a whole).

5. LEADERSHIP

Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.

Applying the principle of leadership typically leads to:
• people will understand and be motivated towards the organization's goals and objectives;
• activities are evaluated, aligned and implemented in a unified way;
• miscommunication between levels of an organization will be minimized;
• considering the needs of all interested parties including customers, owners, employees, suppliers, financiers, local communities and society as a whole;
• establishing a clear vision of the organization's future;
• setting challenging goals and targets;
• creating and sustaining shared values, fairness and ethical role models at all levels of the organization;
• establishing trust and eliminating fear;
• providing people with the required resources, training and freedom to act with responsibility and accountability;
• inspiring, encouraging and recognizing people's contributions.

6. INVOLVMENT OF PEOPLE

People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.

Applying the principle of involvement of people typically leads to:
• motivated, committed and involved people within the organization;
• innovation and creativity in furthering the organization's objectives;
• people being accountable for their own performance;
• people eager to participate in and contribute to continual improvement;
• people understanding the importance of their contribution and role in the organization;
• people identifying constraints to their performance;
• people accepting ownership of problems and their responsibility for solving them;
• people evaluating their performance against their personal goals and objectives;

• people actively seeking opportunities to enhance their competence, knowledge and experience;
• people freely sharing knowledge and experience;
• people openly discussing problems and issues.

7. PROCESS APPROACH

A desired result is achieved more efficiently when activities and related resources are managed as a process.

Applying the principle of process approach typically leads to:
• lower costs and shorter cycle times through effective use of resources;
• improved, consistent and predictable results;
• focused and prioritized improvement opportunities;
• systematically defining the activities necessary to obtain a desired result;
• establishing clear responsibility and accountability for managing key activities;
• analysing and measuring of the capability of key activities;
• identifying the interfaces of key activities within and between the functions of the organization;
• focusing on the factors – such as resources, methods, and materials – that will improve key activities of the organization;
• evaluating risks, consequences and impacts of activities on customers, suppliers and other interested parties.

8. SYSTEM APPROACH TO MANAGEMENT

Identifying, understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its objectives.

Applying the principle of system approach to management leads to:
• integration and alignment of the processes that will best achieve the desired results;
• ability to focus effort on the key processes;
• providing confidence to interested parties as to the consistency, effectiveness and efficiency of the organization;
• structuring a system to achieve the organization's objectives in the most effective and efficient way;
• understanding the interdependencies between the processes of the system;
• structured approaches that harmonize and integrate processes;
• providing a better understanding of the roles and responsibilities necessary for achieving common objectives and thereby reducing cross-functional barriers;
• understanding organizational capabilities and establishing resource constraints prior to action;
• targeting and defining how specific activities within a system should operate;
• continually improving the system through measurement and evaluation.

9. REFERENCES

[1] IORDACHESCU, M., SCUTARU, E., IORDACHESCU D., STANCA, C., *Concepte în managementul calității totale*, Editura Fundației Universitare „Dunărea de Jos“, Galați, 2004

[2] KAPLAINS, S., TALABA, D., NANOUSSI, D., *Measuring Quality and Improvement: Quality Indicators*, în „Proceedings of QUEST International Conference”, Patras, Grecia, 9-12 martie 2000

[3] KELADA, J., *La gestion integralé de la qualité. Pour une qualité totale*, Edition Quafec, Quebéc, 1990

[4] KELADA, J., *Qualité totale et gestion par extraversion*, "Gestion", 1991

[5] KNIGHT, J., *Monitoring Quality and Progress of Internationalization*, în „Jurnal of Studies in International Education”, vol.5, nr.3, Sage Publications, 2001

[6] Lupan, R., Kobi, A., Robledo, C., Bacivarov, I., *The ISO 9000:2000 Quality System Improvement Using the Six Sigma Methodology*, în „Management of the Technological Changes”, Technical University of Crete, Chania, Grecia, 2003

[7] LUPU, M.L., NEGURICI, O., *Auditing the Quality of the Informational System – Elaboration and Applicati*on în „Management of the Technological Changes”, Technical University of Crete, Chania, Grecia, 2003

[8] MOLDOVEANU, G., DOBRIN, C., *Managementul calității în sectorul public*, Editura A.S.E., 2007

[9] OLARU M., *Managementul calității*, Ediția a II-a revizuită şi adăugită, Editura Economică, 1999

[10] OLARU, M., ISAIC-MANIU, A., LEFTER, V., POP, N. A., POPESCU, S, DR[GULĂNESCU, N., RONCEA, L. şi RONCEA C., *Tehnici şi instrumente utilizate în managementul calității*, Editura Economică, Bucureşti, 2000

[11] OLARU, M., *Modele de evaluare a performanțelor obținute prin TQM*, în „Marketing-Management”, nr.5-6, 1997

[12] OLARU, M., *Politica şi obiectivele organizației referitoare la calitate*, în „Q-Media”, nr.3, 1999

[13] Oprean, C., *Documentele sistemului de management al calității*, în „Ghidul calității în învățământul superior”, Proiectul Calisro, Editura Universității din Bucureşti, 2004

[14] PERIGORD, M., *Etapele calității. Demersuri şi instrumente*, Editura Tehnică, Bucureşti, 1997

[15] PETRE, V., SÂRBULESCU, I., *Protecția consumatorilor – Drepturile fundamentale ale consumatorilor*, Editura TipoRadical, Drobeta Turnu Severin, 2004

[16] PEYRAT, O., *New ISO 9000 standards: generic, attractive, but not as simple as they look*, în “ISO Management Systems”, October 2001

[17] PLEGUEZUELOS, C.,T., *Calidad total en la administracion publica*, 1999

[18] POLLITT, C., BOUCKAERT, G., *Public Management Reform – A comparative Analysis*, Ediția a II-a, Oxford Univeristy Press, New York, 2004

[19] ROBLEDO, C., LUPAN, R., *Measuring the Sharesholder value after the ISO 9000 Quality System Certification*, în „Management of the Technological

Changes", Technical University of Crete, Chania, Grecia, 2003

[20] RONCEA, C., *Auditul sistemului calității*, Ghid practic, Editura CLASS, Bucureşti, 1998

[21] RUSU, B., *Managementul calității totale în firmele mici şi mijlocii*, Editura Economică, Bucureşti, 2001

[22] SADGROVE, K., *Managementul calității totale în acțiune* (traducere), Editura Rentrop& Straton, Bucureşti, 1999

[23] SANDERS, D., ROSS, B., COLEMAN, J., *The Process Map*, în „Quality Engineering" 11(4) 555-561, SUA, 1999

[24] STANCA, C., *Approaches on European Quality Assurance Evaluation of Higher Education Institutions*,QIEI 2008, Sibiu 18-20 septembrie 2008, în revista „Calitatea – Acces la succes", anul 9, nr. 93/2008

[25] STANCA, C., *Aspects on Revision of Quality Management Standard ISO 9001 in 2008*, Constantza Maritime University Annals, Year X, 12th Issue, Editura Nautica, Constanta, 2009

[26] STANCA, C., *Interpretarea unor termeni prin prisma aplicării managementului calității în educație*, Lucrările simpozionului Calitate şi dezvoltare durabilă din perspectiva integrării în Uniunea Europeană, Editura ASE, Bucureşti, 24 mai 2002

[27] STANCA, C., *Managementul calității în transporturi*, Editura Nautica, Constanța 2012

[28] STANCIU, I., *Managementul calității totale*, Editura Cartea Universitară, Bucureşti, 2003

[29] STANCIU, I., *Managementul calității totale*, Editura Metropol, 1999

[30] SUCIU, C., *Serviciile publice dedicate cetățenilor din Uniunea Europeană în societatea bazată pe cunoaştere*, Academia de Studii Economice, Centrul Internațional pentru Management Public, în "International Conference and Workshop", 10 aprilie 2008, www.cicmp.ase.ro

[31] TEODORU, T., *Auditul sistemelor de management*, Editura Conteca '94, Bucureşti, 2005

MANAGEMENT FUNCTION CONCERNING RISK MANAGEMENT IN PUBLIC ORGANIZATOINS

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ABSTRACT

Handling the risk management helps fulfilling the basic objectives of an organization by implementing strategies, policies and specific methodologies that were developed to keep under control the risk limit that a public entity can bear.

Keywords: *risk management, public organizations*

1. INTRODUCTION

The need o f creating a department concerning risk management is given by the following reasons:

- the changes that took place in the public organizations leadership management;
- we must facilitate efficient and effective achievements of the organization goals based on risk management;
- we have to ensure the basic conditions for organizing a proper internal control system;
- an annual review and elaboration of plans are required for managing risks concerning developed activities, in order to limit the lost that risk involves, naming the employees responsible for implementing those plans;
- identification of inherent risks associated with any actions or inactions that can lead to unfulfilling organizations objectives;
- implementing an efficient internal control system that can lead to standardization of risk management in public organization;
- elimination inappropriate, ineffective managerial act and also removing overly inefficient centralized management systems that may affect reaching achievement.

2. RISK MANAGEMENT - DEFINITION

Risk management is the process of identification, analysis and either acceptance or mitigation of uncertainty in investment decision-making. Essentially, risk management occurs anytime an investor or fund manager analyzes and attempts to quantify the potential for losses in an investment and then takes the appropriate action (or inaction) given their investment objectives and risk tolerance. Inadequate risk management can result in severe consequences for companies as well as individuals.

For example, the recession that began in 2008 was largely caused by the loose credit risk management of financial firms. Simply put, risk management is a two-step process - determining what risks exist in an investment and then handling those risks in a way best-suited to your investment objectives. Risk management occurs everywhere in the financial world. It occurs when an investor buys low-risk government bonds over more risky corporate debt, when a fund manager hedges their currency exposure with currency derivatives and when a bank performs a credit check on an individual before issuing them a personal line of credit.

3. OBJECTIVES OF RISK MANAGEMENT FUNCTION

The objective of risk management is to identify potential problems before they occur so that risk-handling activities may be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.

On short notice this is what management risk employees should:

- identify and prioritise potential risk events;
- help develop risk management strategies and risk management plans;
- use established risk management methods, tools and techniques to assist in the analysis and reporting of identified risk events;
- find ways to identify and evaluate risks;
- develop strategies and plans for lasting risk management strategies.

4. ANALISYS OF RISK MANAGEMENT MODEL

a. *Management strategies*

The success in applying good risk management strategies in the organization is determined by:

- planning the actions that must be done in order to achieve the proposed objectives;
- planning the internal control actions that are required in order to manage risk properly;
- planning the strategy that must be implemented in case risks are being materialized.

b. Risk analysis

Risk analysis is a technique to identify and assess factors that may jeopardize the success of a project or

achieving a goal. This technique also helps to define preventive measures to reduce the probability of these factors from occurring and identify countermeasures to successfully deal with these constraints when they develop to avert possible negative effects on the competitiveness of the organisation.
Risk analysis stages are:

1. *Identifying internal risks*

The risk in an organization activity it refers to not reaching the objectives established in terms of performance (not reaching the quality standards), timelines and costs (budget overrun)

A risk element is any factor that has a measurable probability to deviate from the plan. This of course requires the existence of a plan. The strategies, plans and the programs of an organisation are elements that allow reality prefiguration and then makes possible the confruntation between actual achievements and the expected ones. In order to attain the objectives is required the development of a activities set.

In the identification faze of risk the potential hazards are evaluated, the effects and the probabilities of those to occur, in order to decide which of those risks can be avoided.

1. *Risk evaluation and quantification*

There are three important principles in risk evaluation:

- to ensure that there is a clearly structured process in which to be taken into account both the probability and impact of each risk;
- registration of risk assessment in a way that can facilitate monitoring and identifying priority of risks
- to understand very clearly the difference between inherent and residual risk.

Evaluation should be based, as much as possible, on independent and impartial evidence. It also must be taken into account all factors affected by this risk and to avoid confusions between risk evaluation and the apreciation on acceptable character of the risk.

2. *Risks prioritization*

Once the risks were evaluated, the organization priorities concerning risks will come out. If a risk represents a great exposure, then that risk will beome a priority. The major risks should be always taken into account by the permanent council of the organization.
Specific activities that must be implemented:

- **Determining risk exposure**

A problem when you have a number of possible risks is that it can be difficult to decide which risks are worth putting effort into addressing. Risk Exposure is a simple calculation that gives a numeric value to a risk, enabling different risks to be compared.

- **Risk tolerance evaluation**

Risk tolerance represents the ,,quantity” of risk that an organization is prepared to accept, or on which it can be exposed at a certain time. Risk concept has different semnification depending on the risk nature, that can be an opportunity or a threat for the organization. Risk exposure (as a combination between probability and impact), determined by evaluation methods, makes sense only reported to risk tolerance level.
If the exposure of inherent risk (the risk before the implementation of the intern control measurements of the risks) is lower or equal with the risk tolerance defined by managers, the control risk measurements are not required, which means that the risks are accepted.
Otherwise, control measurements are required, so that the exposure to residual risk (the risk that remains after the measurements concerning risk control are applied) must be within the limits of risk tolerance established.

3. *Application of specific control on residual risks that are evaluated, quantified and prioritized.*

The problem of controlled or uncontrolled risks can be discussed depending on risk tolerance. In this context the subjects are the uncontrolled risks or partially controlled risks.

Alternative strategies adopted for risk control

❖ **Acceptance – risks tolerance**

In such a situation, no measurement has to be taken, even if permanent monitoring of risk is necessary in order to find out if the exposure level is increased.

❖ **Risks transfer**

Is the possibility of transferring the risk to a destination outside the organization by signing an insurance policy.

❖ **Risk mitigation**

It involves risk control system appropriate application for reducing the identified inherent risk at a minimum level.

❖ **Risk avoidance**

This strategy consists in eliminating activities that generate risks. We must mention the fact that the option of avoiding risks is limited in the public sector compared to the private one.

❖ **Ending risks**

Is achieved by stopping the activity that is generating the risk but it can affect the objectives achievement.

❖ **Handling difficult situations**

Risk response is the action phase of the risk management cycle, in which it aims: elimination of risks, risks mitigation or to split risks. Handling difficult situations consists in a plan elaboration that aims the impact reduction of risks that can not be avoided.

Concluding what was presented above, we can deduct tha handling risks means control them using internal measures.

4. *Monitoring, reviewing and reporting risks*

   A. *Monitoring risks*

Risk monitoring and control continues on though an organisation until the objective is reached. Risk monitoring and control is the process of identifying and analyzing new risk, keeping track of these new risks and forming contingency plans in case they arise. It ensures that the resources that the company puts aside for a project is operating properly.

B. Reviewing and reporting risks

Reviewing and reporting risks is demanded by two facts:

- monitoring changes in risk profiles as a result of implementing the internal control instruments and because of modified circumstances that are in favour of risk occurrence;
- obtaining assurance concerning efficiency in risk management and identifying the need of future measurements.

Characteristics of reviewing activities:

- offering assurance that all the aspects of risk management are reviewed at least once a year;
- offering assurance that risks are under review with an appropriate frequency, that they are stable compared to the mobility of the circumstances and nature of internal control tools that will be implemented;
- establishing a mechanisms for alerting top management levels about new risks or changes in risks already identified, so that these changes could be addressed properly.

5. Completing the management risk process by developing the risk register

The managing function of managing risks ends with the development of a Risk Register for each department.

In order to prepare the Risk Register we must follow the next steps:

- develop an operational working procedure;
- establish the main general and specific objectives of each department;
- identify risks associated with department activities;
- evaluation and quantification of inherent risk in order to determine its exposure;
- preparation of Risk Register which will contain inherent risks and residual risks after applying control strategies;
- monitor the process of risk management that keeps under control residual risk exposures in order to maintain it within normal tolerability limits;
- develop an action plan in which there will be mentioned:

The strategy adopted for the specific risk:

- actions that will be taken by implementing the most appropriate forms and instruments of control to minimize risk

Risk register development will be made in accordance with the model given by legal framework.

5. REFERENCES

[1] KAPLAINS, S., TALABA, D., NANOUSSI, D., *Measuring Quality and Improvement: Quality Indicators*, în „Proceedings of QUEST International Conference”, Patras, Grecia, 9-12 martie 2000

[2] KELADA, J., *La gestion integralé de la qualité. Pour une qualité totale*, Edition Quafec, Quebéc, 1990

[3] KELADA, J., *Qualité totale et gestion par extraversion*, "Gestion", 1991

[4] KNIGHT, J., *Monitoring Quality and Progress of Internationalization*, în „Jurnal of Studies in International Education”, vol.5, nr.3, Sage Publications, 2001

[5] Lupan, R., Kobi, A., Robledo, C., Bacivarov, I., *The ISO 9000:2000 Quality System Improvement Using the Six Sigma Methodology*, în „Management of the Technological Changes”, Technical University of Crete, Chania, Grecia, 2003

[6] LUPU, M.L., NEGURICI, O., *Auditing the Quality of the Informational System – Elaboration and Applicati*on în „Management of the Technological Changes”, Technical University of Crete, Chania, Grecia, 2003

[7] MOLDOVEANU, G., DOBRIN, C., *Managementul calității în sectorul public*, Editura A.S.E., 2007

[8] OLARU M., *Managementul calității*, Ediția a II-a revizuită şi adăugită, Editura Economică, 1999

[9] OLARU, M., ISAIC-MANIU, A., LEFTER, V., POP, N. A., POPESCU, S, DR[GULĂNESCU, N., RONCEA, L. şi RONCEA C., *Tehnici şi instrumente utilizate în managementul calității*, Editura Economică, Bucureşti, 2000

[10] OLARU, M., *Modele de evaluare a performanțelor obținute prin TQM*, în „Marketing-Management”, nr.5-6, 1997

[11] OLARU, M., *Politica şi obiectivele organizației referitoare la calitate*, în „Q-Media”, nr.3, 1999

[12] Oprean, C., *Documentele sistemului de management al calității*, în „Ghidul calității în învățământul superior”, Proiectul Calisro, Editura Universității din Bucureşti, 2004

[13] PETRE, V., SÂRBULESCU, I., *Protecția consumatorilor – Drepturile fundamentale ale consumatorilor*, Editura TipoRadical, Drobeta Turnu Severin, 2004

[14] PEYRAT, O., *New ISO 9000 standards: generic, attractive, but not as simple as they look*, în “ISO Management Systems”, October 2001

[15] PLEGUEZUELOS, C.,T., *Calidad total en la administracion publica*, 1999

[16] POLLITT, C., BOUCKAERT, G., *Public Management Reform – A comparative Analysis*, Ediția a II-a, Oxford Univeristy Press, New York, 2004

[17] ROBLEDO, C., LUPAN, R., *Measuring the Sharesholder value after the ISO 9000 Quality System Certification*, în „Management of the Technological Changes”, Technical University of Crete, Chania, Grecia, 2003

[18] RONCEA, C., *Auditul sistemului calității*, Ghid practic, Editura CLASS, Bucureşti, 1998

[19] RUSU, B., *Managementul calității totale în firmele mici şi mijlocii*, Editura Economică, Bucureşti, 2001

[20] SADGROVE, K., *Managementul calității totale în acțiune* (traducere), Editura Rentrop& Straton, Bucureşti, 1999

[21] SANDERS, D., ROSS, B., COLEMAN, J., *The Process Map*, în „Quality Engineering” 11(4) 555-561, SUA, 1999

[22] STANCA, C., *Approaches on European Quality Assurance Evaluation of Higher Education Institutions,*QIEI 2008, Sibiu 18-20 septembrie 2008, în revista „Calitatea – Acces la succes", anul 9, nr. 93/2008
[23] STANCA, C., *Aspects on Revision of Quality Management Standard ISO 9001 in 2008*, Constantza Maritime University Annals, Year X, 12th Issue, Editura Nautica, Constanta, 2009
[24] Europeană, Editura ASE, Bucureşti, 24 mai 2002
[25] STANCA, C., *Managementul calității în transporturi*, Editura Nautica, Constanța 2012

[29]

[26] STANCIU, I., *Managementul calității totale*, Editura Cartea Universitară, Bucureşti, 2003
[27] SUCIU, C., *Serviciile publice dedicate cetățenilor din Uniunea Europeană în societatea bazată pe cunoaştere*, Academia de Studii Economice, Centrul Internațional pentru Management Public, în "International Conference and Workshop", 10 aprilie 2008, www.cicmp.ase.ro
[28] VASILCOVSCHI, N., GEORGESCU, Ş., *Transformatinal Leadership in the Economic Competitiviness in Shipping Industry Today*, Constantza Maritime University's Annals, Year XIII, 17t^{h} Issue.

IMPLEMENTING LEAN IN A HIGHER EDUCATION UNIVERSITY

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ABSTRACT

Lean means creating more value for customers with fewer resources, by minimizing waste. Although traditionally this concept is applied in manufacturing, the Lean management improvement principles can be also applied in the case of educational institutions. This paper presents three case studies of implementing Lean in UK and USA universities that can be useful examples for implementing Lean in any university environment.

Keywords: *Lean, Lean management, Lean thinking*

1. INTRODUCTION

Lean thinking is a new paradigm that has become the foundation for continuous process improvement and excellence in manufacturing and service organizations around the world. Lean is focused on creating value through relentless elimination of waste [1].

A lean organization understands customer value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.

To accomplish this, lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services through entire value streams that flow horizontally across technologies, assets, and departments to customers.

Eliminating waste along entire value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to make products and services at far less costs and with much fewer defects, compared with traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Also, information management becomes much simpler and more accurate.

A popular misconception is that lean is suited only for manufacturing. Lean applies in every business and every process, and in this paper we will reffer to lean applied in the academia. It is not a tactic or a cost reduction program, but a way of thinking and acting for an entire organization.Businesses in all industries and services, including healthcare and governments, are using lean principles as the way they think and do [2].

In any business there are three types of activities:

1. activities that add value, are those activities which, from the point of view of the customer, make a product or service more valuable;
2. necessary activities that do not add value. In terms of the customer, such activities don’t make a product or service more valuable, but from the point of view of the supplier such activities can not be eliminated;
3. unnecessary activities that do not add value are those activities that can be eliminated.

Lean concept refers to the effective management of an organization’s production processes by eliminating waste, ie processes that do not add value and are not required.

The focus of Lean based management is on value, customer, efficiency and effectiveness, as well as savings, sustainability and increasing performance.

There are more steps to implement Lean in an organization including creating Value Stream Maps. Firstly, a current Value Stream Map is identified. That means designing a chart that includes all the necessary steps to go from receiving an order from a customer to the delivery of the required product. After that is drawn a future Value Stream Map, including opportunities for improvement identified through analysis of the current map. This step of implementing Lean, among other steps, is referred to in the following case-studies.

Lean reference list consist in works of James P. Womack and Daniel T. Jones (Lean Thinking), which is one of the earliest books describing Lean philosophy, Taiichi Ohno (The Toyota Production System: Beyond Large-Scale Production), Jefrey Liker (The Toyota Way), Mike Rother and John Shook (Learning to See - Value Stream Mapping to Add Value and Eliminate Muda) and others like Don Tapping, Tom Luyster and Tom Shuker, Kevin J. Duggan or Kenneth Dailey.

Lean thinking is a relatively new concept in Romanian management literature, though there are several national authors that offer a personal perspective on Lean[3].

2. MODELS OF LEAN IMPLEMENTATION IN A HIGHER EDUCATION ORGANISATION

The following case study presents how Lean, a technique traditionally used only in the manufacturing business, is tailored to the particularities of the higher education processes and is implemented in an USA university.

2.1 The four-step model of Lean implementation at University of Central Oklahoma

The University of Central Oklahoma, located in Edmond, Oklahoma, has embraced the concept of Lean Thinking and was transformed in a Lean University due to several reasons: budget reduction, insufficient funding to cover mandatory cost increases, outdated administrative process, employee job dissatisfaction and low productivity levels. Lean Thinking was initially focusing on Administration processes but later expanded to other divisions. The primary focus of Lean implementation was to identify and eliminate waste from the product or service provided. Lean Thinking methodology was introduced through a comprehensive employee training program.

Before implementing Lean, the university had overworked limited staff with deteriorating morale. The administrative process was not customer service focused. In order to analyze the situation, the surveys made on focus groups concluded that the majority of issues were complaints based on non-value-added activities.

Training was provided to all administrative staff to create both a common understanding and cooperation for the Lean effort. Each administrative staff member attended a one-day introductory Lean class.

The model used to implement the Lean University™ at the University of Central Oklahoma is a 4-step model that has been proven effective in other types of organizations

Step 1: Identify the Opportunities - Complete an organization-wide diagnostic search for issues, problems and opportunities.

Step 2: Solution Design - Create a draft for success that involves all employees: training, mapping, and planning.

Step 3: Implementation – Use kaizen events, core teams, and metrics to implement and illustrate change.

Step 4: Continuous Improvement – Monitor performance after projects are completed.

For the first processes, the University outsourced the facilitator role to a Lean specialized consultation company. A Process Improvement office with a manager overseeing Lean processes has been added, which provided closer oversight of past Lean processes and the scheduling of future Lean initiatives.

Implementation of Lean started in holding informational meetings attended by all administrative support staff to provide a brief overview of Lean advantages and to explain the steps required to achieve the cultural change.

In step one was established a priority list based on the campus-wide surveys, acknowledging issues, opportunities and areas where immediate action was necessary to improve customer service.

In step two was offered Lean training and a Value Stream Mapping workshop to all administrative support staff. The training was focused on how can Lean be used in administrative, service and support type processes and at the workshop participants created a current state map and a future state map with priority changes, in order to visually illustrate the process.

In step three departments implemented changes in their process based on the maps made at step two. As the changes were implemented, the employees within the process were explained those changes and the changes' effects.

Step four is still running and consists in looking for continuous ways to improve the work process and eliminate waste.

The overall impact of implementing Lean at the University of Central Oklahoma was the cultural concept that positive change can and does occur. Employees have realized that they have been empowered to make improvements that help the financial position of the university and that reduced their frustration and increased their productivity. Beside this benefit, though the effort was focused on improving customer service, there have been multiple instances of cost savings through project work (e.g. reduce annual paper costs). The activity of Purchasing Department was streamlined by changing the flow of processing purchase orders from a batch and queue methodology to synchronous flow. Also was improved student satisfaction regarding the improved services offered [4].

2.2 Analysis of Lean implementation in UK business schools and universities

The second case study presents the analysis of Lean implementation in UK business schools and universities made by AtoZ Business Consultancy [5]. The study included a combination of Russell Group and non Russell Group research and teaching intensive organisations. The Russell Group represents an association of 24 major research-intensive universities of the UK. In 2010-2011, the Russell Group universities accounted for 72% of UK universities' research grant and contract income and 61% of all doctorates awarded in the UK [6].

The context of Lean implementation in the studied educational organisations consisted in government budget cuts and increased student fees. Implementing Lean had significant impacts like improving the culture of change, revising processes and practices and staff improvements concerning their work. Some of the main conclusions of the study are the following:

- Lean implementation in Higher Education is at a beginning stage and there is place for improvements;
- There are no "outsanding" examples of Lean implementation, but there are cases of good examples to follow;
- Limited understanding of Lean key principles
- Focus on project based activities around few processes which are redesigned and then not always re-visited or monitored;
- Revised processes were one of the key successes of the Lean programmes, which would be sustained even if the Lean programme ended;
- There is the need to better understand customers and processes, in order to sustain Lean improvements over the longer term;
- There is scope for a better understanding of end-to-end processes to ensure that Lean was not seen only in terms of process-focused change but more in terms of a culture change in behaviours and attitudes;
- All organisations should consider developing internal capability in order to create

sustainability;

-Managers should learn how how to challenge positively to further support a culture of continuous improvement.

2.3. Implementing Lean at the University of Minnesota

At University of Minnesota from the United States a five-step Lean implementation methodology was addopted.

Step one consisted in finding early adopters from nonacademic departments who have an initial interest or need to improve their processes.

Step two refered to establishing training materials that internalize lean principles to enable the organization better understanding Lean without defensiveness. Training materials included examples of lean applications in a university environment.

In step three was created a central improvement office that supports departmental leaders in their efforts to launch continuous improvement activities. The office has a strategic role in fostering replication throughout the university.

In step four were established three demonstration events scheduled six weeks apart. It was used a seasoned lean facilitator experienced in transactional process improvement for the initial demonstration events. The department head has to assign a continuous improvement (CI) coordinator to work with the seasoned lean facilitator, in order to assure that the event logistics run smoothly and all pre-event and post-event activities are completed.

Step five consisted in extending the effort of Lean implementation to other university areas after the first event was successfully completed and after were identified additional university departments that showed an interest in starting a lean initiative.

Once the early Lean adopters from the Minnesota university were identified and trained it is critical to monitor current implementation plans and encourage the next wave to learn the benefits of participating in these type of events.

The first and most important method is to communicate the results far and wide to many departments.

The University of Minnesota has an office of service and continuous improvement (OSCI), which operates as an internal consulting group to enhance service, value and efficiency at the university. OSCI has put together a lean user group that meets monthly on campus. This has provided a valuable way for people to come together and learn and share their experiences. OSCI also publish a quarterly newsletter to highlight the good work being done and the publication is disseminated to a large number individuals throughout the university.

Also, the university organize an annual quality fair useful for knowledge sharing and cross-unit collaboration that features more than 35 posters and breakouts sessions and attracts more than 1,000 attendees from across the university system. Staff and students from the universities, public sector and private enterprise are invited to attend this event of networking, poster sessions and collaboration in an effort to discover ways to innovate and improve [7].

3. ANALYSIS OF THE PRESENTED CASE-STUDIES AND CONCLUSIONS

In this paper were presented three case studies of implementing Lean in UK and USA higher education universities. Going through these case-studies are identified several particularities for Lean implementation in the educational environment.

First of all, the common driver for implementing Lean is the moment when a crisis or an event that change the normal order of things occurs. In two of the case-studies presented, the crisis moment started once with the budget reduction. From this point of view, Lean implementation can be perceived as a attitude of response for the current crisis. But there should be taken into account that people have a natural attitude of people of resistance at change and this situation must be treated with great care. Leaders of departments must understand very well the benefits of Lean implementation and the steps of the implementation process in order to further communicate them to their subordinates.

Lean is a long-term customer oriented initiative of improvement and improvement ways must be found continuously.

A facilitator is needed to assure the right implementation of Lean. The facilitator can be a Lean consulting company, like in the case of Oklahoma University or a leader with experience in implementing Lean in other universities or similar organisations.

Revised processes are one of the key successes of Lean implementation and should be sustained even if the Lean programme ends.

An office of Process Improvement (Oklahoma case) or an Office of Service and Continuous Improvement (Minnesota case**)** must be added, with a manager overseeing Lean processes and responsible persons who analyze the completed Lean processes and who check up and observe the running Lean improvements. Such office should play the role of catalyst for Lean implementation and sustainable improvement and also should collaborate with other universities or similar organisations units to identify sustainable improvements examples.

The good examples with results of implementing Lean, along with Lean benefits must be communicated to all departments of the university.

In conclusion, there are many improvement opportunities that justify Lean implementation in universities. Problems may appear in understanding the need of Lean, as humans in general are reluctant to change, but good follow-up examples like the ones provided above help in establishing an adequate strategy that can contribute to the success of Lean implementation.

4. REFERENCES

[1] http://www.csom.umn.edu/executive-education/lean-toolkit-A3.html

[2] http://www.lean.org/whatslean/

[3] STANCA, C., *Implementation of Quality Management Systems in Romanian Maritime Education and Training*, Third General Assembly of The International Association of Maritime Universities, September 23-26, Rockport, Maine, United States of America, 2002

[4] MOORE, M., NASH, M., HENDERSON, K., *Becoming a Lean University*, University of Central Oklahoma, 2007, available at http://www.sacubo.org/docs/bestpractices/2007/UnivofCentralOkla-LeanUniversity.pdf, accessed at 10.12.2012

[5] RADNOR, Z, BUCCI, G., *Analysis of Lean Implementation in UK Business Schools and Universities*, AtoZ Business Consultancy, 2011

[6] http://www.russellgroup.ac.uk/home/

[7] SALEWSKI, A., KLEIN, V., *How to Launch Lean in a University*, 2009 available at http://asq.org/edu/2009/06/baldrige-national-quality-program/how-to-launch-lean-in-a-university.pdf accessed at 12.12.2012

THE IMPORTANCE OF RELATIONS BETWEEN GEORGIA AND ROMANIA FOR THE PROGRESS OF ENERGY PROJECTS

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ABSTRACT

Romania and Georgia have developed close relations during the past two decades. They have excellent bilateral relations, collaborating in a wide range of fields. Georgia is an important partner of Romania in the wider Black Sea area, while Romania is the most active European partner of Georgia, one of the strongest supporters of Georgia's Euro-Atlantic integration. As part of the Southern Energy Corridor, both countries are very interested in the delivery of Caspian energy resources to Europe through projects that include them as transit countries. Although Nabucco has been for a long time the most important project for them, now-a-days, the realization of AGRI became the most important goal. The relations between these two countries are thus vital for the development of this energetic project.

Keywords: *energy project, hydrocarbons, energy corridor, Nabucco, AGRI, South Stream, North Stream, liquefied petroleum gas, Southern Caucasus*

1. INTRODUCTION

During the two decades since the establishment of diplomatic relations between Romania and Georgia, these two countries and their relations have evolved considerably in all areas. Currently, the partnership between Bucharest and Tbilisi has new insights to deepen, strongly supported by the interests of each of these two countries as well as by the interests of the world powers as EU and NATO.

Firstly, Georgia wants to integrate itself into Euro-Atlantic structures, and Romania, as a member of NATO and the EU, supports democratic developments and European and Euro-Atlantic aspirations of Georgia and is open to share its experience in the preparation for accession.

Also, Georgia is interested to confirm its position at regional level of transit country for energy resources from Southern Caucasus and Central Asia, strongly supporting energy projects in the region, a very important project being currently the Interconnector of liquefied natural gas Azerbaijan-Georgia-Romania-Hungary (AGRI), in which Romania and Georgia are partners.

Regarding Romania, its interests are both those of a member of Euro-Atlantic structures for solving conflicts in the region, fight against terrorism and energy security, and those, personal ones, of safety in the Black Sea region and access to Caspian hydrocarbons by positioning Romania on energy routes from the Southern Caucasus and Central Asia to European markets. In an interview in 2005, Romanian President Traian Basescu explained why the importance of relations with Georgia, given the fact that it can provide contact with the "wider Black Sea area, providing 50% of energy required in EU.That is why our interests are major ones".

As can be seen, both parties are equally interested in securing a transit role in regional energy projects, such projects having both economic and geostrategic value for the two states. Although over the years many variations of these projects were circulated, of major importance for Romania and Georgia are pipelines Nabucco and AGRI, designed to supply Europe with Caspian natural gas, avoiding transit through Russia.

Implementation of these projects remains uncertain for the moment, everything depending on the development of relations between participants, both regional and global, in this "Caspian game". However, the existence of cooperation relations between Romania and Georgia means a small but important step in achieving them.

1. EVOLUTION OF RELATIONS BETWEEN GEORGIA ANS ROMANIA AND THEIR BACKGROUND

Shortly after World War I, when the Russian Empire was dismantled, Romania recognized on 18 February 1921 the independence of the Democratic Republic of Georgia. Also, after the dissolution of the USSR, on 27 august 1991, the Romanian Government welcomed the "Declaration of the Parliament of Georgia on the restoration of state independence" and expressed willingness to develop friendly relations and cooperation with Georgia, based on the UN Charter and principles of international law, Romania being the first state to recognize the restoration of Georgia's independence [9].
Diplomatic relations between the two countries were established on 25 June 1992, and the Romanian Embassy in Tbilisi was inaugurated on 25February 1998. Beginning with the visit of President of Georgia, Eduard Sheverdnadze, in Bucharest on 30 June 1995 at the meeting of BSEC [9], reciprocal official visits of leaders of the two countries have been conducted periodically and Romanian-Georgian relations constantly improved.
For example, after Romania joined the EU in 2007, Georgia became a priority state for development assistance under EU and international principles. Since that year, the Ministry of Foreign Affairs of Romania financed development projects in Georgia worth about 2 million euros in areas of common interest such as

economic development and social justice, human rights, education and support to civil society.

Romania also became involved in the process of resolving frozen conflicts between Georgia, Abkhazia and South Ossetia. In 2005, together with the Czech Republic, Lithuania, Latvia, Estonia, Bulgaria, Sweden and Slovakia, Romania formed the New Group of Georgia's Friends to support the state of Georgia in the process of integration into Euro-Atlantic structures and of solving conflicts in Abkhazia and South Ossetia [3]. Moreover, after the conflict between Georgia and Russia in August 2008, President Basescu said that Romania will be further involved in stabilizing the region even if not expressing a firm condemnation of Moscow's military intervention on Georgian territory, as some of the "Friends of Georgia", namely Baltic States, Sweden and Poland. The fact that Romania chose to align EU and NATO position, according to MEP Adrian Severin was the right attitude, because "as the West needs Russia more than Georgia, so Romania needs more to spare relations with Moscow than to strengthen relations with Georgia ".

However, after about a month after these unfortunate events, the Romanian government sent observers to the EU Civil Monitoring Mission in Georgia (EUMM Georgia) aimed mainly to observe the situation on the ground after the war in the summer of 2008. By this action, the EU has shown interest in the Eastern neighborhood and its role as an international player in the field of security, while Romania, through participation, has shown interest in stabilizing the Black Sea region and the fact that it is a responsible regional player [5], the Romanian team of EUMM being the largest of the participating EU Member States.

In addition, regarding the issue of Georgia's accession to NATO, Romanian officials have expressed their support for the state of Georgia to join Alliance structures, position confirmed at the Bucharest Summit in 2008 and maintained at the summit in Lisbon in 2010 and Berlin in 2011. Romanian President Traian Basescu believes that Georgia should be granted MAP status, even under current conditions, and thus to have a timetable for NATO accession .

Even in the most recent meeting of the Foreign Minister of Romania with his Georgian counterpart on 3 September 2012, the two discussed the stage of approach of Georgia to Euro-Atlantic structures. Romanian Minister highlighted the substantial contribution of Georgia to NATO operations and ensured Romania's commitment to support the realization, in the near future, of the European and Euro-Atlantic aspirations of Georgia. He also appreciated the good progress of Georgia made in relation to the Union, in particular through the effective use of the opportunities offered by the Eastern Partnership.

Moreover, in the press conference made at this meeting, the Romanian minister said that "economic relations must be the measure of excellent political relations between our countries. Under this point of view the volume of trade has already registered a positive trend. Georgia is a direct neighbor of Romania, separated only by the Black Sea. We agreed that in order to restore and revitalize the relationship between Romania and Georgia there are required more active steps. We could attract flows of goods and Constanta could become an important hub of transportation in the area. Our common energy project involves establishing a direct link to transport gas directly to Romania, through Constanta. We study the feasibility of this project".

Black Sea transportation problem was also discussed in 2010 by Georgian President Mikhail Saakashvili and Prime Minister of Romania at the time, Emil Boc, who agreed that the economic potential of both countries allow an increase in trade, and evoked the possibility of resuming bilateral scheduled ferry lines between Romania and Georgia, from Constanta to Batumi. Black Sea transport is closely related to one of the priorities of the two countries, namely the implementation of joint energy project AGRI, to ensure the transit of natural gas from the Caspian Sea to Europe via the Black Sea, through the use of liquefied natural gas technology. At the last meeting, the two Ministers reiterated their commitment to this project and expressed confidence about its favorable development once the feasibility study is completed, which is expected to take place in late September this year.

The reasons underlying the existence of these close relations between Romania and Georgia are varied, relying in particular on the different needs of the two countries.

Firstly, Georgia's interests are mainly political. Although economic relations with Romania are not to be neglected, trade volume exceeding, in 2011, 200 million Euro, with an increase of 26.4% over the previous year [12], the Southern Caucasian state is particularly interested in joining the Euro-Atlantic structures that can reduce high vulnerability in front of the Russian Federation. Romania's support, as a member of both structures, as well as its development assistance it is very important for Georgia.

Romania also wants to ensure the stability and security of the Black Sea region by preventing this from becoming again a big Russian lake and therefore strongly supports the independence and sovereignty of the seaside states (Ukraine, Georgia).

Also, in terms of strategy, Romania's interest in the area aimed to open this region, which is on the main axis of the 21st century, as drawn by military experts of the Great Powers: Gulf of Aden, Persian Gulf, Shanghai. One should not ignore the economic interests of Romania, which is related to the exploitation of its own energy resources, as well as of the Caspian Basin resources.

Finally, the EU supports cooperation between the two countries, because the AGRI project, the Union could reduce dependence on Russian gas sooner and easier than expected.

3. ROLE OF GEORGIA AND ROMANIA IN ENERGY PROJECTS

Statistics show that currently the natural gas dependence of the EU-27 is of 58%, while that of Romania is 42%. According to the Romanian Center for European Policies, EU import dependency on gas will increase to 84% by 2030. Moreover, for the moment, natural gas imports from Russia represents 33% of EU consumption and 40% of the gas consumed by households and businesses. In Central and Eastern Europe, Russian gas covers 87% of total imports and 60% of consumption.

Statistics concerning dependence of European countries on energy imports shows that 26 of the 27 EU countries are net importers of energy, with one exception: Denmark.

For this reason, a major issue dominates political agendas of key European leaders namely reducing dependence on Russian energy sources and energy diversification. European policymakers have understood the potential of renewable energy is huge and could provide a way to mitigate the monopoly position of the Russian Federation, but the potential of solar and wind is a long term process that can not prevent dependence on Russian imports in the coming years .

Thus, the most viable short term proved to be diversifying sources and routes of energy transportation, European plans aiming to strengthen relations with the Southern Caucasus, Central Asia and Middle East, which are possible future EU energy partners. An European Commission report stated that: "A southern corridor to be opened to transport gas from the Caspian region could meet the future energy needs of the EU".

BTE gas pipeline (Baku-Tbilisi-Erzurum) which was completed in May 2006 showed that it can carry Caspian gas to Europe without crossing Russia. This result gave European leaders more confidence in such projects, especially in the Nabucco gas pipeline, the largest project that does not include Russia as a supplier or as a transit country. Pipeline route is likely to begin at the borders of Georgia-Turkey and Iraq-Turkey, passing through Turkey, Bulgaria, Romania, Hungary and ending in Austria (Baumgarten). Hydrocarbons to be delivered to European markets will come from the Caucasus, the Middle East and Egypt. Nabucco is designed with a maximum capacity of 31 billion cubic meters per year, but the actual volume will depend on market needs.

Nabucco could thus provide up to 45% of total gas demand of the European Union, which would mean that Russian monopoly should end.

Although Nabucco talks started in 2002 and in 2004 was founded the company Nabucco Gas Pipeline International GmbH, the beginning of work was delayed many times and is not yet clear when it will start.

One reason for this delay is Russia's opposition. Russia vehemently opposed since the launch of Nabucco project, not willing to lose the status of Europe's energy supplier, which gives a great power in dealing with it.

A first step made in this direction was to come up with counter-offers, namely North Stream and South Stream. The first, North Stream, is a two pipelines system crossing the Baltic Sea from Vyborg in Russia, to Lubmin near Greifswald, in Germany. From Germany, the gas can move forward to Belgium, Denmark, France, Holland, England and other countries. It is expected that at the end of 2012 will be functional, each pipeline with a capacity of approximately 27.5 billion cubic meters per year.

The second is a more obvious candidate for Nabucco. South Stream is a project of Gazprom (Russia), Eni (Italy) and EDF (France), designed partly offshore and partly onshore. Until now, it was established as the first choice for offshore portion to cross the Black Sea, connecting Russia with Bulgaria, passing only through the territorial waters of Russia, Turkey and Bulgaria. The onshore has currently two types of routes. Northwestern route is intended to Slovenia and Austria through Bulgaria, Serbia and Hungary, and on the south-western to Greece-Italy route. Croatia and Macedonia will be also supplied by pipeline route adjacent to the main onshore section. The project is likely to have a maximum capacity of 63 billion cubic meters per year [8]. The works seem to start in 2013 and the supply itself is scheduled to begin in 2015.

By comparing the three projects, one thing is clear. While Russian projects deadlines are clear, for Nabucco was only stated that since the completion of the procedure for obtaining necessary documentation and feasibility testing, the actual work will take 4-5 years. Therefore, it is uncertain when this will happen and if it will happen.

Of course, the fact that Russia has come up with counter-offers which can be considered as using the so-called "soft power" was not the only factor behind the delay in Nabucco. Rather the "hard power" applied in the August 2008 war with Georgia showed to the Union that Russia is not willing to lose its local hegemony and monopoly power in the European market. Launching of Nabucco project could not be considered a sufficient reason for the use of "hard power" of Russia, so that a more serious challenge was needed, and that came in the NATO Summit in April 2008 Bucharest by announcing intentions of world leaders to grant MAP status to Georgia.

On this occasion, Vladimir Putin warned that Russia will take radical measures if Georgia receives an invitation to sign the NATO Membership Action Plan, including the recognition of independence for separatist provinces Abkhazia and South Ossetia. Although Georgia has not received MAP, Russia has the justification needed to implement threats and as a result of the war in august 2008, recognized the independence of these regions, installing military troops within these provinces.

The war in Georgia has highlighted the region's vulnerability to Russia and also how vulnerable it would be a major energy transport route that would transit the country as Nabucco. This new reality has removed many European leaders from the Nabucco project idea and redirected them to Russian variants, the Russian method of "divide and rule" being proved successful.

Georgia and Romania's role in energy projects in the region is the fact that both are part of the Nabucco project as transit countries. Both are closer to Euro-Atlantic alliance than to Russia, Romania is already a member of both NATO and the EU and Georgia aspiring to membership in these structures. With NATO and the EU, relations between Romania and Russia have cooled significantly, and subsequently to the announced install of missile shield in Romania, it became evident that there is now no possibility of reconciliation. Romania also took part of Georgia in the war with Russia and is interested in developing new energy transit routes to avoid transiting Russia. Of course Georgia's position is clear, as the most open country to the West in the Southern Caucasus, and the conflict with Russia makes it extremely interested in establishing closer political and economic relations with the Western countries in order to assure their support in the future.

However, by their opening to the Black Sea, both countries are positioned on the east-west axis, Romania being the most important gateway to Central and Western Europe of Caucasus and Central Asia through the port of Constanta, and Georgia the gateway to the East of the West, thus avoiding two major regional powers, Russia and Turkey.

Georgia and Romania interest for energy projects is both economically and strategically. Both as transit countries would benefit economically because their country is crossed by the pipeline. Also, they can ensure their own energy security by obtaining natural gas imports needed. And, from a strategic perspective, through participation in these projects of energy supply to Europe, the two countries would ensure their own protection of the Euro-Atlantic powers in case of conflicts in the region, the latter not wanting to jeopardize the energy transport routes to European markets.

Therefore becomes legitimate the interest in these two countries for Nabucco, both as importers and as transit countries, and the possibility of its failure is a concern. Seeing the uncertainty of the future Nabucco, Romania came up with another energy project through which the Caucasian gas to reach Europe, creating its own Nabucco by an agreement signed in 2010 with Azerbaijan and Georgia, subsequently joined by Hungary, under the name of Azerbaijan-Georgia-Romania Interconnector (AGRI).

4. IMPORTANCE OF COLLABORATION BETWEEN ROMANIA AND GEORGIA: THE AGRI ENERGY

Romania, over the past two decades, managed to establish important political and economic relations with the countries of the Southern Caucasus, being the only EU country that has signed a strategic partnership with a countriy in the region, namely Azerbaijan. Romania also was among the first countries to recognize the independence of Azerbaijan and Georgia after the collapse of the USSR and remains a strong supporter of their integration into Euro-Atlantic formations. Thus, having a good relationship of cooperation with both Southern Caucasian states, and all three being interested in reducing Russian monopoly in the region, they decided to launch an energy project of lesser amplitude than Nabucco or South Stream, but with more chances of achievement. So appeared AGRI.

For all three, and later for Hungary too, the project implementation is a priority. Within all meetings of officials of countries involved in this project, since signing the agreement on the establishment of AGRI, this is the most debated subject. For example, information on official visit to Tbilisi of the President of the Chamber of Deputies of Romania from 24-26 October 2011 states that an important theme addressed during that visit was energy security, in connection with the implementation of AGRI and Nabucco projects, shaping as significant contributors to economic and political stability, not only for Romania and Georgia, but throughout Europe. AGRI is defined as „a tangible result of the cooperation potential between Romania, Georgia, being complementary to Nabucco, within the Southern Corridor". Also, at the recent meeting of the Foreign Minister of Romania, Titus Corlățean, with his Georgian counterpart Grigol Vashadze, held on 3 September 2012, the two countries reiterated their commitment both on the implementation of energy project, and expressed confidence about its outlook after the completion of the feasibility study in progress.

AGRI project involves transporting Azerbaijani gas from Shah Deniz deposit in Azerbaijan through the Baku-Tbilisi pipeline to Georgia, where it will be liquefied so that it can be transported by heavy ships to the port of Constanta. Here will be build a regasification terminal and gas will be transported by pipelines to the West through Hungary and to the South through Bulgaria. Romania expects to be able to supply gas in the EU over the next three years, at the end of September 2012 feasibility studies being expected to be done, and so AGRI could compete with Russian supplier Gazprom, which could lose by this a part of its western consumers.

Moreover, research conducted recently in Romania led to the discovery of significant reserves of natural gas in its continental shelf of the Black Sea, that can infuence the entire Euro-Caspian energy system, from Central Asia to Central Europe. This discovery leads to remaking of calculations around Southern Gas Corridor of EU, providing new energy sources for South Eastern Europe. In this new context, Romania is no longer only a transit country but also a production one, and its role in energy projects becomes more important. In this regard, President Traian Basescu said: „Operation of deposits may begin after doing all prospects (...) there is a matter expected, approximately, on the horizon of 2015-2016. In this horizon, 2015-2016, Romania will be be fully independent of energy „.

This new reality can increase the interest of the Union for Romania as a supplier, but also for projects that involve it, like AGRI. However, the attractiveness of the project is given also by other factors such as the much lesser time for realization that of Nabucco or South Stream, low production costs and the chosen route, avoiding both Russia and Turkey.

On the other hand, even this competitive advantage given by the fact that does not include Russia and Turkey as transit countries can bring problems to the AGRI project. Analysts at Stratfor believes that the AGRI project worries both Russia and Turkey. Russia does not like the closer relations of Romania with the South Caucasus states and is clearly dissatisfied in regard to the new energy route involving Georgia and Azerbaijan. Eugene Chausovsky from Stratfor notes that participating AGRI states have serious problems with Russia: on Georgia's territory there are two separatist Russified provinces, South Ossetia and Abkhazia; Azerbaijan, although it strives to have a pragmatic policy, had in time disagreements with Russia, who supported and funded the Armenians in Nagorno-Karabakh, and Romania's relations with the Kremlin are cold due to Republic of Moldova, which tends to come from the influence of Russia into Western sphere. Poor relations with Russia of the parties could make the AGRI project vulnerable, especially as the pipeline through which Azerbaijani gas comes to Georgia passes through the vicinity of Abkhazia, the separatist republic controlled by Russia.

The project is also not seen with good eyes by Turkey, especially because it wanted to be necessary in all energy projects in the region to negotiate from a position of advantage.

However, since AGRI is not at the same level as major projects such as Nabucco or South Stream, not being able to be a competitor for them, there is a chance that, like BTE pipeline, AGRI to be allowed to supply Azerbaijani gas to Europe.

5. CONCLUSIONS

Caspian game, in the last two decades, has become increasingly complicated. Interests are great for all parties, consumers, carriers and suppliers. It is about geopolitics, money, power, energy. The European Union wants to diversify energy sources and routes to reduce Russian monopoly, a direction supported by the U.S. However, uncertainty about future energy projects that avoid Russia make the UE to hesitate when it comes to confronting this local hegemon. On the other hand, Russia is not willing to lose the status of Europe's energy supplier and control of the "near abroad". For this reason, it strongly opposes any energy project which do not include Russia and any state from its former sphere of influence approaches of the Euro-Atlantic structures. In addition to these great powers, other countries involved in Caspian game adopt each a position found to be the most advantageous in that context.

In this paper we have discussed the importance of relations between Romania and Georgia to the great Caspian game. These two Black Sea littoral states have an important role as transit countries in energy projects that could bypass Russia. Both have cold relations with Russia, especially Georgia. Romania and Russia have different approaches to problems in Republic of Moldova and Transnistria and look in opposite directions, Romania being in good relations with the EU and NATO, with which Russia has many misunderstandings. Regarding Georgia, the situation is more than clear. Georgia wants sovereignty and independence towards Russia, hoping he can get them through the accession to Euro-Atlantic structures, while Russia is not willing to give up the power on Caspian region.

Pro-western perspective of both countries make them closer and encouraged them to move towards liberalization under Russian monopoly, at least in energy terms. Thus, the two showed their willingness to participate in Nabucco, the first large-scale project that does not include Russia, or as supplier or as a transit country. But since this project is delayed, Romania took the initiative and proposed the AGRI project, much smaller, but also more feasible.

Even in this context, Russia does not seem to be happy, considering that Romania has overextended its military influence and power in the Black Sea. Romania's energy ambitions are thus perceived as movements that undermine Russian projects, if only through the AGRI project. However, until now, the AGRI project remained standing, all partners being interested in its realization, but his future is still uncertain because of Russian opposition.

6. REFERENCES

[1] Chamber of Deputies, 2011. Information on official visit to Tbilisi of Ms. Roberta Alma Anastase, President of the Chamber of Deputies, the head of a parliamentary delegation, www.cdep.ro

[2] [*Ministry of Foreign Affairs Bilateral relations: Georgia*, www.mae.ro

[3] Ciubotaru, R. 2008. Romania-Georgia relations, foreign policy litmus, www.cotidianul.ro

[4] Cristescu, A. 2011. *Romania under the burden of energy dependence? Top European states by dependence on imported energy*, www.econtext.ro

[5] Drăgan, C., *Competitivity aspects on Romanian maritime transports*, Constanta Maritime University's Annals, Year XIII, 17th Issue

[6] Drăgan, C., *Developments of maritime transport economy in Europe*, Constanta Maritime University's Annals, Year XIII, 17th Issue

[7] *EU does not want to depend on Russian gas*, www.evz.ro

[8] Fati, S. 2011. *Why fear Russia and Turkey to Romania*, Romania Libera, www.romanialibera.ro

[9] http://south-stream.info

[10] *Line ferry to Batumi, between Romania and Georgia, could be reactivated soon*, www.b1.ro

[11] Ministry of Foreign Affairs, 2012. Press Release: *Celebration of 20 years of diplomatic relations between Romania and Georgia*, www.mae.ro

[12] Ministry of Foreign Affairs, 2012. Press Release: Consultation of Foreign Minister of Romania, Titus Corlățean, with his Georgian counterpart Grigol Vashadze, www.mae.ro

[13] Ministry of Foreign Affairs, 2012. Press Release: NGO Forum Romania - Georgia www.mae.ro

[14] National Foundation for Romanians Abroad, 2012. EUMM Georgia, www.romanii.ro

[15] Necula, F. 2012. *Romania, a new power in the gas league - Asia Times*, www.ziare.com

[16] Petrescu, A. 2012. Corlățean: *We want to implement joint energy projects of Azerbaijan-Georgia-Romania-Hungary Interconnector*, Epoch Times http://epochtimes-romania.com

[17] Prompt Media, 2010. *Ferry lines between Romania and Georgia, from Constanta to Batumi, will be restarted*, www.romedia.gr

[18] Racheru, I.M. 2009. *Romanian foreign policy issues. Romania-Georgia bilateral relationship* (2004-2009), Sfera Politicii, No. 139, www.sferapoliticii.ro
[19] Wall street.ro, 2010. *Net energy imports decreased by 41% since 1990*, www.wall-street.ro
[20] *We insist that Georgia is given MAP*, www.financiarul.ro
[21] www.nabucco-pipeline.com

POSITIONS OF THE STATES INVOLVED IN ENERGY PROJECTS IN THE SOUTH CAUCASUS

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ABSTRACT

South Caucasus (also referred to as Transcaucasus), is a region situated to the south of the Greater Caucasus Mountain Range, composed of Georgia, Azerbaijan and Armenia. Due to the rich oil reserves of the Caspian Sea basin and geostrategic importance of the Caucasus as a crossroad between Europe and Asia, this region has always constituted a pole of attraction for the great powers of the world after the collapse of USSR. Not only neighboring countries like Russia, Iran, Turkey and Central Asian states (Kazakhstan and Turkmenistan), but also the United States, European Union and China are becoming actively involved in this region.

Thus, while Armenia has been allied with Russia and Iran, considering these two powers as a counterweight to Turkey - its main enemy in the region, Azerbaijan and Georgia have developed geostrategic alliance with Turkey, and the United States by promoting cooperation with NATO member countries. Moreover, the conflict in Nagorno-Karabakh had deprived Armenia of the possibility of cooperation with other South Caucasian states. Armenia, which bases itself mainly on the relationship with Russia, believes that maintaining good relations with Iran is vital in terms of its national security, therefore, Armenia encourages active presence of Iran in the region. Meanwhile, Azerbaijan and Georgia, which have developed geo-economic relations between them in course of time and expanded strategic partnership with Western democracies, particularly through the NATO alliance, put forth their best efforts in order to leave the sphere of influence of Russia.

Keywords: *South Caucasus, energy project, energy corridor, Caspian Sea, strategic interests, economic interests, Caspian energy, oil, energy security*

1. INTRODUCTION

According to the Statistical Review of World Energy of British Petroleum (BP) in 2012, global energy consumption has increased again in 2011, with a growth rate of 2.5%, a value near the average for the last ten years. Consumption growth is attributable especially to emerging economies, because in OECD countries (Organisation for Economic Cooperation and Development) demand fell in 2011 for the third time in four years. Fossil fuels continue to dominate the energy market, with a market share of 87% of the mix of hydrocarbons, the oil being the leader on the market (33.1%). Even if renewable energy is becoming increasingly used, it represents currently only 2% of global consumption. Research in recent years has shown that there are sufficient sources of hydrocarbons to meet demand growth, as evidenced each year by BP in its statistics on proven reserves, but problems accessing these resources in some regions and transportation to consumers create challenges in trying to secure an offer at reasonable prices to demand [BP, 2012].

For this reason, a significant part of foreign policy is concerned with the availability of pipelines and terminals, of future pipeline routes, partnerships, etc. [Dolghin, 2004], or, in short, with the energy security.To ensure the energy security in the last two decades, after the dissolution of the Union of Soviet Socialist Republics (USSR) in December 1991, the European Union (EU) and United States (U.S.) have tried to develop relations with the three countries of the South Caucasus (Azerbaijan, Georgia and Armenia), in order to gain access through these countries to the rich energy resources of the Caspian basin.

Caspian Sea region (South Caucasus and Central Asia) has aproximmately three to four percent of global oil reserves and four to six percent of global natural gas reserves [BP, 2012]. The proportion of Caspian hydrocarbon reserves of the world total is not significant, but given the uncertainty of oil supply from the Persian Gulf to international markets, and the possibility for Russia to use its energy supplier status as a tool for local hegemony, energy transport in the South Caucasus and Central Asia (Kazakhstan and Turkmenistan) to the Western countries through the Caucasus has become important for the EU and the U.S. [de Haas, 2006].

But not only the EU and U.S. have energy interests in the Caspian Sea, but also other players like Russia, Iran, Turkey, China and neighboring countries in Central Asia, which would like to get control of oil and gas production or of pipes through which the hydrocarbons will be transported to world markets [Neguț et. Al., 2008]. U.S. wants to diversify energy routes in the South Caucasus to international markets, especially to Europe, to avoid Russian monopoly and strengthen the independence of states in the region, while Russia is keen to maintain its local hegemony. For Turkey and EU, South Caucasus is a bridge to the Caspian and Central Asia hydrocarbons, while Iran and the Central Asian states see the South Caucasus as route of transport for energy resources to the West [Mehtiyev, 2004]. China's role in this discussion is given by the fact that as the second largest energy consumer in the world, after the United States, the country imports large quantities of Caspian hydrocarbons from Kazakhstan and hence has a real interest in region's security, but also, given the constant growth in consumption, China may be interested in finding other importers from the Caspian region since already has a pipeline that goes from the Caspian Sea shore in Kazakhstan. This contemporary struggle for energy resources and routes of hydrocarbons from the Caspian basin is thus a complex of economic, geopolitical and security variables [Nuriyev, 2001].

2. RUSSIA

Even after more than twenty years after the collapse of the USSR, Russia continues to regard South Caucasus states as part of its legitimate sphere of influence and try to restore traditional geopolitical hegemony in the region, actively fighting, but also subtle, for dominance over its neighbors in the "near proximity" [Nuriyev, 2001]. In addition to these geopolitical interests, Russia has economic grievances to the abundant energy resources in the Caspian Sea, wishing that the new republics of the South Caucasus to export most of these resources through pipelines that cross Russia to the Western countries. Thus, Russia would be the intersection of energy routes to Europe, EU becoming increasingly dependent on the Kremlin leadership. In addition, Russia has lately focused primarily on the ex-Soviet states of South Caucasus because the good relations between Georgia and Azerbaijan which are being closer than ever to NATO and the EU, could reduce Russian sphere of influence and bring security problems for a long term. Sunny (2010), like Nuriyev (2001), feels that the main goal of Russia in the South Caucasus is to restore its local hegemony in the "near proximity", as opposed to U.S. ambitions to achieve global hegemony.

In this region, Russia is able to demonstrate the European Union and NATO that is not willing to cede power over the ex-Soviet states, South Caucasus and Central Asia being the most vulnerable from the former Soviet Union to the influence of great Western powers. If, by 2008, Russia used "soft power" to try preventing the increase of American and European influence in the region, in august 2008 Russia demonstrated by Russo-Georgian war that can appeal to "hard power" if competitors exceeds the limits imposed by Kremlin. Through these events, Russia has shown that if its interests in the region are neglected, both Azerbaijan and Georgia, the two South Caucasus countries open to the West, will suffer serious consequences since Russia has the capability to handle frozen ethnic conflicts from these two countries to restart wars in Nagorno-Karabakh or Abkhazia.

Georgian control is essential for the "energy game" played by Russia, as Moscow considers energy as the key to return to the world stage. Since Georgia is the only alternative for transport of hydrocarbons in the South Caucasus and Central Asia to Europe by avoiding Russia, removing this alternative would be a great step in regaining the title of world power and energy control over European neighbors. The most vulnerable point is Georgia's Black Sea coast, Georgia being the only one of the three South Caucasus countries with access to the Black Sea, poorly protected for a sea invasion, a fact that could be in the benefit of both Russia and Abkhazia. It is hard to imagine that Russia's armed forces have not a plan for a possible sea attack on Georgia, given the fact that there are antecedents, and the strained relations between Russia and Georgia seem not to improve in the near future. Moreover, Russia has provided weapons to Abkhazia over time for using this region as an intimidation factor against the ambitions of the South Caucasus states to have independent foreign and defense policy [Tchantouridze, 2008]. In this context, Georgia is urged to assert sovereignty and independence from Russia by establishing alliances with Western organizations and states.

In addition, Tchantouridze (2008) explains that from the threat of Russia is not exempted Azerbaijan, which, having a border adjacent to that of Russia to the Caspian Sea, has a higher risk for a Russian invasion. Against Georgia, which could find support in other littoral states to maintain its sovereignty, defense of Azerbaijan in the Caspian Sea is affected by the lack of support of others, for example Iran continuing to deny legal status of the Caspian Sea and holding by Azerbaijan of offshore oil reserves, while Turkmenistan is standing to Russia and does not want to damage the relationship with it by supporting Azerbaijan. Moreover, like the conflict in Abkhazia with Georgia, Russia could get involved in the conflict in Karabakh for supporting Armenia and Karabakh, and even to form an alliance with them against Azerbaijan in order to gain control of its rich resources of hydrocarbons. However, Azerbaijan has not shown a position so strongly against Russia as Georgia, but has a quite clear pro-Western trend. Of the three South Caucasus countries, the only standing to Russia is Armenia that, not being sure of the NATO and EU support against Russian oppression that would arise if they show a desire for integration into these formations, preferred not to take the risk and keep relations with Russia on the level of cooperation.Thus, we can conclude that in terms of Russia's interests in the South Caucasus, they are related by hydrocarbons in the region as if the South Caucasus states remain dependent on Russian energy imports and Russia's pipeline system, they remain within its sphere of influence and within the influence of Russian energy companies.

3. UNITED STATES

The three small states of the South Caucasus have gained each more attention from the United States than expected. Explanation is given by the Azerbaijani oil, strong international Armenian diaspora and the pro-Western standing of Georgia [Olcott Brill, 2002]. U.S. involvement in the region is manifested by a desire to achieve and ensure the area stability by solving frozen conflicts and to ensure the exploitation and transportation of Caspian oil to international markets by removing Russian monopoly.

As noted in the previous section, Russia, since the collapse of the USSR in 1991, has expressed a desire to control the ex-Soviet states, a fact disliked by the world powers, including the U.S.. The latter was attracted by Azerbaijan's oil reserves, and many U.S. oil companies such as Chevron, ExxonMobil, Unocal and Amerada

Hess, are involved in oil extraction projects in Azerbaijan [Olcott Brill, 2002]. For this reason, Caspian security problems have become very important for the U.S., who have started dialogue on security issues in Azerbaijan since 1997, and since 1999 have provided the South Caucasus state arms and patrol vessels in the Caspian Sea [Mehtiyev, 2004]. Bilateral relations between the two countries have improved significantly since the events of September 11, 2001, when, with the onset of military action in Afghanistan, Georgia and Azerbaijan, Azerbaijan has proven to be a trustful ally in the fight against terrorism, together with Central Asian countries such as Turkmenistan, Kazakhstan, Uzbekistan and Kyrgyzstan, giving U.S. the right to land, refuel and transit through their territories [Cornell, 2005]. Instead, the United States offered to modernize air defense system and military airports in Azerbaijan and established a department of defense cooperation with the U.S. embassy in Baku to strengthen military cooperation between the two nations. Moreover, the crisis in Iraq and support of Azerbaijan in American military action in Iraq in 2003, increased opportunities for establishing long-term alliances in the region.

Both great importance of oil reserves in the South Caucasus and geopolitical considerations determined U.S. to consider relocating some of its military forces from Western Europe to the Caucasus and Caspian Basin [Mehtiyev, 2004]. Also in 2005, the United States expressed their intention to build two radar systems in Azerbaijan, one on the border with Iran and other on the border with Russia, which will be linked to the proposed missile systems to be installed in Central Europe in order to achieve a protective umbrella against Iran from the Caspian Sea to the Balkans [Baban & Shiriyev, 2010]. But reactions were immediate. Both neighbors of Azerbaijan, Iran and Russia, as U.S. rivals, criticized military cooperation between U.S. and Azerbaijan and possible military presence in the South Caucasus which are not to be willing to accept.

However, the U.S. intervention in Azerbaijan proved to be beneficial for the latter because, otherwise, would have been much harder to exploit its own oil and gas reserves, and also for Turkmenistan, who would have been totally dependent on Russia for transporting hydrocarbons to world markets. Exactly this dependence feared U.S., since the price structure of oil, in respect of gas, is given by world markets, transit countries having great discretionary power. Therefore, in order to avoid transiting Russia, the Clinton administration strongly supported the project of transporting oil from Azerbaijan through Turkey, on the route Baku - Tbilisi - Ceyhan (BTC pipeline) instead of the version through Russian port Novorossisk [Olcott Brill, 2002].

Regarding natural gas, since May 2006 when BTE gas pipeline (Baku - Tbilisi - Erzurum) became operational, several projects such as Nabucco, ITGI (Interconnector Turkey Greece Italy), TAP (Trans Atlantic Pipeline) AGRI (Azerbaijan Georgia Romania Interconnector), White Stream and others, have been completed, are under construction or in the planning phase, all having in common that they do not include Russia as a transit country. For this reason, as was shown in the previous section, Russia, seeing the more active presence of U.S. and EU in its sphere of influence, is trying to keep active "frozen conflicts" in the region, with the hope that this will slow their investments in energy projects in the Caspian region and prevent loss of control over the South Caucasus. Thus, until a consensus is reached between these three major global players, the Western powers decided to provide energy security in the South Caucasus. Both Western and Russian sources reported that miliary officers in Turkey, together with their colleagues from Azerbaijan and Georgia have simulated exercises over time to protect the BTC and BTE pipelines in case of armed attack, and support the possibility of understanding with the U.S. and NATO to secure them. But NATO, U.S., Georgian and Azerbaijani officials deny involvement of U.S. and NATO in security projects in Georgia and Azerbaijan, arguing that both countries do not benefit from foreign aid to protect pipelines, position that is contrary to claims of NATO representatives who showed an interest in the South Caucasus and particularly in its energy resources [de Haas, 2006].

Lacking oil and gas reserves of Azerbaijan, Georgia is vulnerable to Russian pressures, the Kremlin being always ready to use "hard power" in Georgia, as shown in 2008. Because of threats from Russia, Georgia became the most open to the West of all three South Caucasus states, aiming to find sources of funding and support for security and independence of state. Thus, the transport of Caspian oil has become crucial for Georgia since it represents a source of income that ensures its existence and even if the Georgian government has assumed the responsibility to protect existing and future oil and gas pipelines across the country, that relies on the fact that the EU and U.S. will not allow alternative routes of transport of hydrocarbons to fall under Russian control [Olcott Brill, 2002], this assumption giving hope that in case of a possible future conflict Georgia benefit from external support. In fact, it has already happened, Georgia being considered by the U.S. as part of Caspian energy corridor and an ally in the war against terrorism. The first step in this direction was the launch of the "Train and equip" operation in February 2002, when the Bush administration announced its decision to send 150 military trainers and 10 military transport helicopters to Georgia, a help the Georgians had asked since 1997, but the Clinton administration was reluctant to offer it. Bilateral military assistance from the U.S. offered to Georgia was also steadily increasing since that time, funds provided aimed to ensure both border security and providing training and military education.

Of the three South Caucasus states, Armenia is the only one who has a close partnership with Russia, seen as a protector against Turkey. The fact that the latter is a NATO member, and close to EU - U.S., leds Armenia since 1991 to preserve the traditional alliance with Russia and later to become strictly dependent on it to survive. However, after the events of September 11, the possibilities offered by the U.S. and Europe have made Yerevan to consider implementing a new foreign and security policy after a multi-vector model which requires, while preserving the partnership with Russia, an improved relation with other world powers like the U.S. or France. In January 2005, Armenia has supported the U.S. in Iraq, and in 2007 began the debate in Congress on the adoption of a resolution on the recognition of the "Armenian Genocide" approach postponed due to opposition of Turkey [Priego, 2008]. Noting the slight opening of Armenia, the United States tried its involvement in energy as a transit corridor to transport Azerbaijani hydrocarbons to Europe, U.S., as a mediator in the Nagorno-Karabakh conflict, considering that such a project could also lead to solving issues between the two countries. Armenia's refusal to waive the close relationship with Russia, led to the elimination of this variant and to reorientation of deicison-makers to Georgia, who is willing to reduce Russian power in the region and to join Euro-Atlantic structures [Sabanadze, 2002].

4. EUROPEAN UNION

Although directly interested in the Caspian riches, as the largest global oil consumer and the main recipient of an East-West energy corridor, until the early 2000s, the EU has preferred to leave the initiative in regard to action in Caspian region to NATO, U.S. and their regional allies (Turkey), desiring not to worsen relations with Russia, the main supplier of energy in Europe. Initially, immediately after the collapse of the USSR, the EU has shown interest in the Caspian region as a potential supplier of oil, taking advantage of the chaos of the Russian Federation beginnings. In this respect, the EU launched major energy projects as TRACECA (Transport Corridor Europe-Caucasus-Central Asia) and INOGATE (International Oil and Gas Transport to Europe) that would have to link Europe to the Caspian region, but regional escalation of conflicts and Russia's return to power on the European energy market has led to stagnation of these projects. The EU also decided not to get involved in solving frozen conflicts in the Caucasus, leaving this task to others international organizations [Aldea, 2008]. Lately, however, EU enlargement to Eastern Europe, by the accession of Bulgaria and Romania in 2007, brought the EU to the border with the South Caucasus, which has increased the Union's interests for the region. In this context, European strategies regarding the Caspian area were reviewed and coordinated with the U.S. and NATO efforts. EU decided to become more active in the Caspian region, both as a mediator of conflicts, but also by reconsidering energy projects in the region, seeking to ensure energy security by diversifying energy sources. The latter can not be obtained without solving serious security problems of Caspian region both internally, given the political tensions and separatist conflicts, and externally, being influenced by geopolitical rivalries of regional actors.

In fact, the South Caucasus states are also interested in developing relations with the West, which are solid security guarantees from major world powers such as the EU or NATO, needed to secure their political independence and economic viability [Cornell et. al., 2005]. The inclusion of the South Caucasus in the European Neighbourhood Policy in 2004 was a small step in this direction since announcing intensification of cooperation between the EU and South Caucasus countries, but what particularly expect Georgia and Azerbaijan is an guarantee of long-term security, which can be obtained at the earliest by joining NATO umbrella.

Of the three South Caucasus states, as for the relationship with NATO, Georgia has most clearly expressed its willingness to join the EU, which is predictable given its vehement opposition from Russia. Moreover, Azerbaijan is open to cooperation and interested in EU membership, but do not neglect relations with Russia, while Armenia, as shown in previous sections, being very close to Russia, does not consider membership in Euro-Atlantic organizations while working with several western states. Openness to West of Georgia and Azerbaijan also involves high risk for their safety, Russia suggesting again that is willing to intervene military in the region, repeating events of 2008, if Georgia joins NATO, a threat that wants to show that the Kremlin is not willing to accept the presence of NATO or EU in its sphere of influence, given that both parties are interested in destroying Russian energy monopoly.

Despite the obvious EU energy interests in the Caspian region, European efforts over the past two decades were much lower than those of the U.S. and U.S. policy continues to be the best representation of Western position for the South Caucasus in terms of ensuring security, strengthening the rule of law and promotion of energy projects. Indeed, among the main priorities of EU energy development policy are included avoiding strategic dependence given that some EU countries are already strategically dependent on Russian gas, especially countries in Central, Eastern and South-Eastern Europe, where there is a dependence of almost one hundred percent of Gazprom, a Russian monopoly gas supplier. Even France and Germany are increasingly dependent on Russian gas and natural gas demand in Europe is expected to increase substantially in the future, Russia is prepared to fill this gap with its own gas, or gas from Turkmenistan and Kazakhstan, and if they do not have alternative delivery options at the time, Russia will control the transport route of these hydrocarbons [Cornell et. al., 2005].

The first alternative to this version proved to be a natural gas pipeline from the Caspian Sea transiting Azerbaijan, Georgia and Turkey, which helped to diversify energy supply for Europe and of course reduce dependence on Russian monopoly. This is known as the Baku - Tbilisi - Erzurum (BTE often abbreviated) which transports natural gas from Sangachal terminal to Erzurum in Turkey and became operational in 2006. In parallel with BTE pipeline there is the Baku-Tbilisi-Ceyhan (BTC) oil pipeline from Azeri-Chirag- Guneshli oil field in the Caspian Sea to the Turkish port of Ceyhan on the Mediterranean Sea.

Of course, there is no way to eliminate, by means of these two projects, the Western countries' dependence on oil from the Middle East and on Russian gas, the above named projects managing to cover only a very small percentage of overall demand. However, these two pipelines diversify global oil supply and secure it against problems that might occur elsewhere. This creates a competitive market that is the long-term interests of

Europe, of the U.S. and of the monopolists themselves because it forces them to reform the system.

However, once the Azerbaijani hydrocarbons will reach European markets, any supply disruption could have an immediate impact on European consumers as fungible the markets might be. Faced with the real threat of disruption of energy supply, the EU should feel the need to invest in the political and economic security of the South Caucasus, namely to revive TRACECA, with a serious political and financial commitment; to speed up the South Caucasus states integration in transatlantic partnerships and NATO, to facilitate the internationalization of processes of conflict resolution in the South Caucasus, which are currently monopolized by Russia, and provide further strong support for the development of energy projects [Cornell et. al., 2005].

Thus it can be concluded that EU Member States and Georgia and Azerbaijan need that the Union to become more consistent in implementing its policy instruments and much more related to activities in the region of EU Member States. However, as seen on the international political scene so far, the EU maintains a position of neutrality in the Caspian region [Nuriyev, 2007]. Most likely the reason is that the EU wants at all costs to avoid a direct conflict with Moscow, although its interest in Caspian energy sources and projects in the region is growing.

5. TURKEY

Turkey is the second most important regional player, after Russia, bordering all three South Caucasus states, being related to the region in historical, cultural and linguistic terms. South Caucasus in the last two decades has gained strategic importance for Turkey, especially for two reasons. The first is the need for stability regions after the collapse of the USSR, for the Turkish state own security. The second reason is economic growth given by Turkey's participation in energy projects in the region as a transit country for natural gas and oil pipelines leaving from the Caucasus and Central Asia to international markets [Szymanski, 2009]. Thus, we can conclude that Turkey shares common interests of the U.S. and the EU to ensure the stability and security of the South Caucasus through peaceful resolution of frozen conflicts in the region and achieving energy projects in the southern corridor to avoid transiting Russia.

For the South Caucasus states, several features of Turkey make it to be regarded as an indispensable partner in the region. Among these important values is that Turkey is a NATO member and EU close with a traditional alliance with the Western democracies. Also, Turkey's position in the heart of Eurasia, at the intersection of Asia, the Middle East and Europe, gives it a strategic geopolitical importance as a transit country. Moreover, embrace of democracy and open market economy makes Turkey a model for the Caucasian countries and an attractive partner for cooperation and investment.

However, Turkey has differentiated strategy in relations with the South Caucasus states. It considers Georgia and Azerbaijan as natural allies in the South Caucasus [Nuriyev, 2001], supporting Azerbaijan in any field and having good cooperation with Georgia, who shares the role of a transit country for Caspian hydrocarbons. Regarding relations with Armenia, Turkey leads a policy of isolation [Asatryan, 2002], taking part of Azerbaijan in the Nagorno-Karabakh conflict, and any improvement in the relations between Turkey and Armenia would mean losing alliance with Azerbaijan. Thus, the peaceful resolution of the Nagorno-Karabakh is currently the only way to engage in a relationship these three states.

Ankara has shown over recent years interest in the South Caucasus, although its influence in the region is limited by the instability of Turkish society and its domestic problems. These realities are that, despite of its strong cultural and linguistic links with the South Caucasus, Turkey to have among the main regional actors the least impact on the region. But the great advantage that Turkey has, over these big regional powers, is given by its geopolitical position that facilitates involvement in all energy projects designed to supply Europe with Caspian hydrocarbons [Nuriyev, 2001]. The first attempts, namely oil BTC pipeline and gas pipeline ETC showed that it is possible a diversification of energy sources and routes ensuring Europe's energy needs with options that bypass Russia, and more ambitious projects such as Nabucco are expected to be implemented in the near future, Turkey receiving, through its role as a transit country in all these projects, incentives to imply more in the region.

6. IRAN

Iran is also an important geopolitical actor in "The Great Caspian Game", being in the vicinity of the South Caucasus and with historical, economic, cultural and ideological interests in the region. With the collapse of the USSR, Iran hoped to be able to restore its historical influence on South Caucasus states [Nuriyev, 2001] categorically opposing the involvement of the Western powers in the South Caucasus and Caspian Sea region.

Noting the opening of Azerbaijan and Georgia to cooperation with the West, including with Turkey, seen as a rival in the region, Iran has decided to ally with Armenia, supporting it at the beginning of the conflict of the Nagorno-Karabakh. Moreover, the assistance offered to Armenia helped to improve the relations between Iran and Russia, the two countries having common interests in the Caucasus, and subsequently led to the establishment of the axis Russia - Armenia - Iran [Sadegh-Zadeh, 2008].

Over the years, Yerevan and Tehran have built strong relationships, especially regarding the energetic cooperation, a first gas pipeline connecting the two countries being already operational. However, Iran's position regarding the conflict between Azerbaijan and Armenia is not the same as before, Tehran moving to certain neutrality and becoming interested in its diplomatic solution. Its northern border instability and possible involvement of third parties in the renewal of hostilities is a source of concern for Iran.

Like Russia, Iran is very interested in what happens in Azerbaijan, especially in the Caspian Sea. The fact that Azerbaijan has strengthened its cooperation with the

West by developing relations with Turkey, NATO, the United States and Israel, offers, according to the Iranian analysts, the possibility to Azerbaijan to become a powerful oil-producing country that Iran can no longer influence [Nuriyev, 2001]. For this reason, Tehran is trying to make felt the threat of Russian-Iranian alliance to the territorial integrity and sovereignty of Azerbaijan, in order that Azerbaijan, aware of the dangers occured if pro-western policy would end relations with Russia and Iran, to maintain cooperation with these two countries.

Divergences in the Caspian Sea, the BTC pipeline construction and exclusion of Iran from the "Contract of the Century" on the understanding of oil exploration in 1995, have deteriorated over the past two decades relations between Iran and Azerbaijan [Sadegh-Zadeh, 2008]. Among these problems, the most important is of the status of Caspian Sea and its division of resources. The five states with access to the sea - Iran, Russia, Kazakhstan, Turkmenistan and Azerbaijan - have different views on the definition of the Caspian as sea or lake, and depending on their position these states fail to agreement regarding its division. Iran demands an equally divided sea, each country receiving 20 percent, without specifying whether 20 percent refers to reserves or sea surface. On the other hand, Russia has decided to split the area based on each country border the sea, Kazakhstan and Azerbaijan agreed with this approach since their independence in the early '90s. Even if in this division Russia can not take advantage of the great reserves thus assigned to Azerbaijan and Kazakhstan, it still has important deposits in the north of the sea and is based on the fact that it will benefit anyway from transportation and processing of hydrocarbons of other neighboring countries. Thus, the only obstacle in clarifying the Caspian Sea status is represented by Iran, the main dispute being between it and Azerbaijan. The conflict escalated in 2001 when Iran has threatened to use military force to avoid exploring the region by fleet owned by BP, which led Azerbaijan to postpone exploring that area to settlement of conflict [Cornell et. al., 2005]. Moreover, disagreements exist between Azerbaijan and Turkmenistan, and solving the problem of territorial delimitation of southern Caspian Sea is an impediment to development projects in the region, which affects not only the Caspian Sea littoral states, but also all other actors involved in " The Great Caspian Game".

However, until recently, relations between Azerbaijan and Iran appeared to be improved, going to greater cooperation in the political and economic field. In terms of political field, Azerbaijan expressed its refusal to join an anti-Iranian coalition, considering the problem of using nuclear technology should be solved diplomatically. In addition, the two countries had signed an agreement to prevent the attack of one against the other. Economically, Azerbaijan and Iran had signed various agreements for energy projects, and even negotiations on dividing the Caspian Sea seemed to have entered the right track [Sadegh-Zadeh, 2008].

But although since last year Azerbaijan leadership suspected that behind a growing number of protests in the country is Iran as instigator [Stratfor, 2011], at the beginning of the year Azerbaijani authorities have clear evidence in this regard, arresting 22 people who are believed to have planned an attack against local Israeli and American targets, ordered by Iran. Following these events, Wafa Guluzade, a political commentator seen very close to Azerbaijani President Ilham Aliyev, warned Iran that "planning the murder of prominent foreign citizens in Azerbaijan by a band of terrorists, one of whom living in Iran, is considered as a 'hostile activity' against this country "and that such actions will not influence the socio-political situation of Azerbaijan, but continuing in this direction will receive a response from Azerbaijan and its Western allies [Shvidler, 2012]. Relations deteriorated further due to Azerbaijan Eurovision festival organization, Iranian media strongly criticizing the show that was ranked as un-Islamic and very scandalous. Consequently, Iran withdrew its ambassador in Baku in May 2012 to protest against "insults to the holy" [Ştefanescu, 2012].

Even if it does not have a border with Iran, diplomatic relations between Georgia and Iran have developed quite a lot lately, especially because of the conflict between the South Caucasus state and Russia. Georgia seek ways to eliminate economic and energy dependence on Russia, and Iran, which has significant natural gas reserves, is willing to export oil to this new client and to develop economic relations with Tbilisi. However, Iran's cooperation with Georgia could bother Russia, and so Iran may be forced to stop engaging in relations with Georgia if it wants to retain political and military cooperation with Moscow. Also, as it did in the past with Azerbaijan, U.S. could ask Georgia to break ties with Iran [Sadegh-Zadeh, 2008]. Thus, the development of relations between Iran and the South Caucasus still remains uncertain.

7. CENTRAL ASIA

Even though after 1990 Caspian basin became an important element in international geopolitical discourse because of its potential energy, the term "Caspian", besides to define the sea with same name and the depression in which it is, never meant an entity, either culturally or politically. Besides that was along time space for which control rivaled the Russian Empire and Iran, the two regions east and west of the Caspian Sea are relatively foreign to each other. The reason is that, in the past, ties between Europe and Asia were made either through the south axis Iran-Turkey to the Mediterranean or through the north by Russia [Peyrouse, 2009].

However, with the implosion of the USSR, the countries of South Caucasus and Central Asia have tried to regain role as intermediaries between Europe and Asia because, by developing bilateral relationships, these states can be opened to new markets, those in Central Asia being interested in Turkish and Iranian markets, and those in South Caucasus in Chinese and South-Asia markets. Peyrouse (2009) argues that interests are both economic and strategic, most of these countries wanting to reduce Russian dominance in the region, and being, in fact, influenced by major world powers, the United States trying to achieve an east - west axis instead the traditional north - south axis, and China trying to gain access to Iranian and Turkish markets, and Europe hoping to develop TRACECA project.

Even if there is a high potential for developing relations between the two regions, trade is still limited, the most significant exchanges taking place between Azerbaijan and Kazakhstan, in particular in energy field. Considering that hydrocarbons transport from Caspian basin to international markets would drive the development of relations between South Caucasus and Central Asia, Russia's active involvement in the region, not to lose control over transportation and processing of these resources, is an obstacle also for other products trade.

Moreover, proximity to Russia or to West divides the group of South Caucasus and Central Asian states in two. The most important oil-producing countries in the Caspian region, Azerbaijan and Kazakhstan, and Georgia as a transit country, hope that by supporting multiple pipelines routes may limit Russia's ability to use economic mechanisms to influence. Meanwhile, they try to resist the economic pressures of Russia in the hope that these routes will be constructed. Azerbaijan and Georgia, as well as Uzbekistan, producer of gas, and Kyrgyzstan, poor in resources, are also confident that the political, military and economic relations with other countries will help to resist Russian pressure. Kyrgyzstan, with less to offer in economic or military terms, is more willing to accept Russian influence than Uzbekistan. On the other hand, Turkmenistan, the largest gas exporter in the region, most shipped to destinations in Russia, sought to reduce the vulnerability to Russia doing a policy of more and more increased political, economic and social isolation. Finally, Armenia and Tajikistan are dependent on Russia for their security needs, and therefore maintain close relations with Moscow [Oliker, 2002].

Opening the West of most Caspian states and realization of the first southern caucasian energy project that avoids Russia through the BTC pipeline, completed in 2005, gave courage to Central Asian states to engage in such projects. For example, since 2006, Kazakhstan has committed to export oil through BTC. Moreover, discussions on the implementation of the Trans-Caspian Pipeline (TCP) from Turkmenistan to Azerbaijan, an undersea pipeline to carry gas from Central Asia to the EU [Mitan, 2011], started in 1999, but concerns over Caspian status yet raises obstacles to its construction. Therefore, so far transporting Kazakh oil through Azerbaijan to European markets was made by rail and sea.

The situation is similar for exports of natural gas, the BTE project being expected to expand further eastwards to include Turkmenistan and Kazakhstan. Both countries have shown interest in the European project Nabucco, but no concrete measure has been taken so far [Peyrouse, 2009].

Thus, we can conclude that relations between states in the South Caucasus and Central Asia are limited and will likely continue as long as countries in the region do not share common interests and strategies. In addition, the situation is aggravated by the involvement of major world powers like China, Russia, Iran and the U.S., who also have different approaches to the problem. Therefore, the chances for cooperation or competition in the region appear to be equal at the moment, only the global political elite ability to promote partnership instead of competition being able to bring relations between these countries on track.

8. CHINA

In 2011, China recorded the largest increase in consumption of oil and gas worldwide, being the second largest energy consumer globally after the U.S. [BP, 2012]. Thus, with continued growth in consumption, China is looking for new energy sources and routes of transportation of hydrocarbons.

Therefore, even if, so far, China has not shown a special interest in energy projects in the South Caucasus, this could occur in the near future. It is known that Iran, Kazakhstan and Russia already exports oil to China, between Kazakhstan and China being in operation a pipeline that starts near the Caspian Sea. Thus, the development of the submarine trans-caspian project could also facilitate exports of Azerbaijani hydrocarbons to the East.

Steps in this direction have already been taken by China, which over recent years has significantly improved relations with the South Caucasus states. In addition, China has expressed a desire to ensure stability in the region, this being necessary to develop energy transport on the East-West axis. It can therefore be concluded that although still far from maturity, relations between the Caucasus and China will grow in importance in the near future, given the growing presence of China in the region, aimed to find new markets for its products and energy resources, but also of transport corridors to Europe.

9. CONCLUSIONS

Its geostrategic position and rich energy reserves turned Caucasus from an area unknown to the West in the new "star" of the world stage. Interest of the main powers of the world, highly industrialized and energy consumers, in an era where energy consumption is growing faster than the discovery of new resources, was attracted immediately after the collapse of the USSR to this newly independent region, each of them trying to secure benefit from it.

As emphasized throughout this paper, Russia has the highest authority in the development projects in the region, not only being able to use "soft power" and "hard power" to impose its position. This regional actor can be stopped by a more active EU or U.S. presence. Up to date EU has not imposed sufficiently strong position in the region in order to avoid a conflict with Russia, and U.S. is not so much interested in the Caspian region to be more involved.

Thus, the South Caucasus countries, still feeling the threat of Russia, and without strong international support, have the power to solve ethnic conflict and to secure peace and stability that investors expect to start valuable energy projects.

Uncertainty and unpredictability that dominate this region make unknown the direction in which the three

South Caucasus states are going, the effects of negative developments certainly going to be felt widely. Thus, it is expected to reach a consensus of major powers to help these new states to exceed the period of transition from the former Soviet republics to independent and sovereign states. In addition, their support for stability and regional security could have beneficial effects on international routes and diversifying energy sources.

10. REFERENCES

[1] Aldea, P. 2008. Geopolitica, *Dimensiunea Geopolitică a Caucazului şi petrolului caspian* [Geopolitics, Geopolitics size of Caucasus and Caspian oil], www.vamist.ro

[2] Asatryan, G.S. 2002. *Armenia and Security Issues in the South Caucasus*, The Quarterly Journal, 3/September 2002

[3] Baban, I., Shiriyev, Z. 2010. *The U.S. South Caucasus Strategy and Azerbaijan*. Turkish Policy

[4] BP, 2012. *Statistical Review of World Energy 2012*

[5] Cornell, S.E. 2005. *US engagement in the Caucasus*. Helsinki Monitor

[6] Cornell, S.E., Tsereteli, M., Socor, V. 2005. *Geostrategic Implications of the Baku - Tbilisi - Ceyhan Pipeline*. In: Cornell, S.E., Starr, S.F., ed. 2005.

[7] Dolghin, N. 2004. Geopolitica. *Dependenţele de resursele energetice*

[8] de Haas, M. 2006. *Current Geostrategy in the South Caucasus, Power and Interest News Report*

[9] Drăgan, C., *Competitivity aspects on Romanian maritime transports*, Constanta Maritime University's Annals, Year XIII, 17th Issue

[10] Drăgan, C., *Developments of maritime transport economy in Europe*, Constanta Maritime University's Annals, Year XIII, 17th Issue

[11] Mehtiyev, E. 2004. *Perspectives of Security Development in the South Caucasus, Baku: Peace and Conflict Resolution Center*

[12] Mitan, M. 2011. *Miros de razboi in Marea Caspica* , www.ziare.com

[13] Neguţ, S., Leca, A., Papatulică, M., Vlad, L.B., Neacşu, M.C. 2008. Project SPOS 2008 – *Studii de strategie şi politici, Studiul nr. 2 – Orientări privind securitatea energetică a României*, Institutul European din România

[14] Nuriyev, E. 2007. EU *Policy in the South Caucasus - A view from Azerbaijan*, CEPS Working Document, 272/July 2007

[15] Nuriyev, E. 2001. *Geopolitical Breakthrough and Emerging Challenges: The Case of the South Caucasus*, Journal of International Affaires, vol. VI (2)

[16] Olcott Brill, M. U.S. 2002. *Policy in the South Caucasus*, The Quarterly Journal, 3/september 2002

[17] Oliker, O. 2002. *Conflict in Central Asia and South Caucasus: Implications of Foreign Interests and Involvement*. In: Oliker, O., Szayna, T.S., ed. 2002. Faulties of Conflict in Central Asia and the South Caucasus. Implications for the U.S. Army, Santa Monica: Rand

[18] Peyrouse, S. 2009. *Is there any unity to the Trans - Caspian Region? The economic relations between Central Asia and the Caucasus*, Asia Europe Journal

[19] Priego, A. 2008. *NATO Cooperation towards South Caucasus*, CRIA, vol. 2 (1)

[20] Sabanadze, N. 2002. *International Involvement in the South Caucasus*, ECMI Working Paper

[21] Sadegh-Zadeh, K. 2008. *Iran's Strategy in the South Caucasus*, Caucasian Review of International Affairs, vol. 2 (1)

[22] Shvidler, E. 2012, *Azerbaijan thwarts terror attack against Israeli*, Jewish targets, Haaretz

[23] Sunny, R.G. 2010, *The pawn of great powers: The East-West competition for Caucasia*. Journal of Eurasian Studies, vol. 1 (1)

[24] Ştefănescu, B. 2012, *Tensiuni în creştere între Iran şi Azerbaidjan din cauza atitudinii pro-occidentale*

[25] Stratfor, 2011, *Tensions Growing Between Azerbaijan and Iran?*, eurasianet.org

[26] Szymanski, A., 2009, *South Caucasus - the Case for Joint Commitment of Turkey and the E*U, PISM Strategic Files

[27] Tchantouridze, L. 2008. *The Three Colors of War: Russian, Turkish, and Iranian Military Threat to the South Caucasus*, Caucasian Review of International Affairs, vol. 2 (1)

MARKETING INTELIGENCE SYSTEM A “SMART TOOL” FOR THE CAMPANIES

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ABSTRACT

Marketing Intelligence Systems are tools that allow organizations to conduct a new business, a new integrative vision that includes the customers’ needs, requirements and desires. The activity of the organization should focus on achieving them. The marketing knowledge and information held by the organization about customers, market, competition, suppliers, distribution channels, generally about the environment in which it operates, can be easily processed using those technologies specific to the computerized systems which support the marketing decision. Thus, there is created a strategic advantage for solving, in real time, the problems of the organization. Certainly, *Marketing Intelligence Systems* - implemented and operated with the efficiency of expert systems, satisfy the desire of every marketing man/woman to have a "smart tool" that emulates human thinking for activities specific to its area of expertise.

Keywords: *Marketing Intelligence, Market Intelligence, Business Intelligence. Marketing Intelligence Systems,*

1. INTRODUCTION

The new information technologies that brought numerous dot.com businesses have created a global market place, restructured whole industry sectors and redefined how business is done.

Romanian electronic enterprises increasingly consider *information as an important resource*. The challenge consists in using all the integration techniques of the day – whether they are information, data or application systems to build an marketing intelligent platform that can meet the demands of real-time businesses [1], [2]

The importance of a *marketing intelligent system* (MkIS) in any business is justified because is impossible to develop a *competitive strategy* without gathering and correctly analysing the *information from the market* [3].

2. INTELLIGENT SYSTEM VS. ARTIFICIAL INTELLIGENCE

The English-Romanian economic dictionary translates the concept of *intelligence* through: *informatie, stire, informatii confidentiale, inteligență* (*information, news, confidential information, intelligence*) [1], [3].

Intelligence involves identifying the problems in the organization: why and where they occur and with what effects. This broad set of information and activities is required to inform managers on how well the organization is performing and where problems exist. For instance, consider a commercial organization marketing a large number of different products and product variations. The management will want to know, at frequent intervals, whether sales targets are being achieved. Ideally, the information system will report only those products/product variations which are performing substantially above or below the target.

In order to understand the thematic spectrum of our research, we need to introduce the concept of *intelligent system*. Like all powerful concepts which science operates nowadays, the concept of *intelligent system* is a fuzzy one and it is characterized by a significant dynamic semantics. In fact, this should not surprise us because the phrase contains the concept of *intelligence*, which is a powerful concept discussed and analyzed semantically. This idea was developed in the engineering sciences and then amplified in the sciences of the artificial. More specifically, in the field of research devoted to artificial intelligence. In this context, *the intelligent system* is that system able to perform the functions of the human brain. In particular, the name of intelligent system was given to a software system that would perform decision processes similar to those performed by natural intelligence [1], [2], [3], [4], [5].

In the context of *organizational dynamics*, an intelligent system [4] is characterized by the following functional properties:

- it has the ability to obtain data, information and knowledge both from its internal and external environment[1].
- it has the ability to process data, information and knowledge both synchronously and asynchronously.
- it has the ability to analyze its internal condition in relation to external environmental conditions and to determine the degree of adaptation necessary for survival.
- it has the ability to decide on the optimal use of resources and capabilities to achieve a competitive advantage relative to the other competitors on the market.
- it has the ability to innovate and adapt to continuous innovation requirements of foreign competition and to the level of performance required by the internal decision environment.

[1] *The external environment* can be defined as the field of external forces of an organization, which can directly or potentially influence it.

3. GLOSSARY OF *INTELLIGENT SYSTEMS* APPLIED IN MARKETING

The terms "marketing intelligence", "market intelligence", "market research", "business intelligence" and "corporate intelligence" are, in general, used *interchangeably* in the literature [4].

We are going to present the following concepts [8]: *Marketing Information System* (MIS), *Marketing Intelligence* (MkI), *Business Intelligence* (BI), *Competitive Intelligence* (CI), *and Market Intelligence* (MARKINT), in order to remove any confusion:

2.1 A *marketing information system* (MIS)

MIS is defined as a system which is proposed "*to bring together disparate items of data into a coherent body of information*" [3], [6], [7].

- An MIS is, as will shortly be seen, more than raw data or information suitable for the purposes of decision making .
- An MIS also provides methods for interpreting the information the MIS provides.

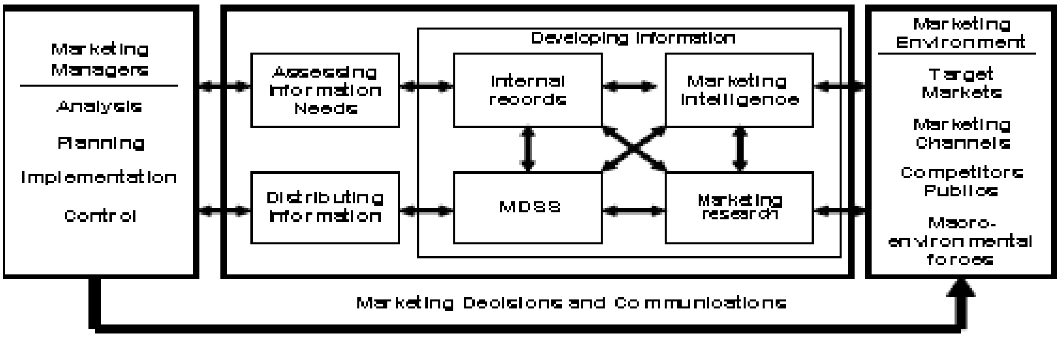

Figure 1 The marketing information system [10], [11]

Moreover, as Kotler's definition says, MIS is more than a system of data collection or a set of information technologies: "*a marketing information system is a continuing and interacting structure of people, equipment and procedures used in order to gather, sort, analyze, evaluate, and distribute pertinent, timely and accurate information for use by marketing decision makers, in order to improve their marketing planning, implementation, and control*" [10], [11].

A *marketing information system* (MIS) has four components: (a) *the internal reporting system*; (b) *the marketing research systems*; (c) *the marketing intelligence system* (MIS) and (d) *marketing models* [4]:

- *Internal reports* include orders received, inventory records and sales invoices.
- *Marketing research* takes the form of purposeful studies either *ad hoc* or continuously.
- By contrast, *marketing intelligence* (MI) is less specific in its purposes; it is chiefly carried out in an informal manner and by managers themselves rather than by professional marketing researchers [3], [6], [7].

2.2 Marketing research

Marketing research is defined as "*the systematic and objective search for and analysis of, information relevant to the identification and solution of any problem relevant to the firm's marketing activity and marketing decision makers*" [24].

2.3 Marketing Intelligence (MI)

On Wikipedia, MI is referred to "*as the information relevant to a company's markets, gathered and analyzed specifically for the purpose of accurate and confident decision-making in determining market opportunity, market penetration strategy, and market development metrics. Marketing Intelligence is necessary when entering a foreign market. Marketing Intelligence determines the intelligence needed, collects it by searching the environment and delivers it to those marketing managers who need it*." [6], [7], [8]

Marketing intelligence is "*systematic collection and analysis of publicly available information about competitors and developments in the marketing environment"* [10], [11], [25].

Marketing Intelligence (MI) is not the same as *Market Intelligence* (MARKINT). Hence, Marketing Intelligence professionals often research information and use those tools that take data from disparate data sources like web analytics, *Business Intelligence* (BI)**,** call centre and sales data, which often arrive in separate reports. It is the role of Marketing Intelligence (MI) to put this data into a single environment [5], [6], [7]. For these reasons, it is often mistakenly perceived to be (or be part of) *Business Intelligence*. It is also sometimes mistakenly perceived to be (or be part of) *Competitive Intelligence* because organizationally, Marketing Intelligence can be the name of the department that performs both the market intelligence and the competitor analysis roles [6], [7], [8], [13], [14], [15].

2.4 Market Intelligence (MARKINT)

Market intelligence is another intelligence discipline that is often confused with the other intelligence disciplines. As surprising as it may sound, it is most often misperceived to be (or be part of) *Business Intelligence* [7], [9].

On Wikipedia [8], *Market Intelligence* is referred to as a "*branch of Market research, involving collation and analysis of the available and relevant information and data on specific markets. Market intelligence typically involves the collation of data from various sources such* *as company accounts, official statistics, data from trade bodies, interviews with business contacts, and research on consumer attitudes. Whereas, Market research is often considered a consumer-orientated discipline, Market intelligence tends to offer a broader view of markets including business and sector data - such as market-sizing, - segmentation, and - share data.*"

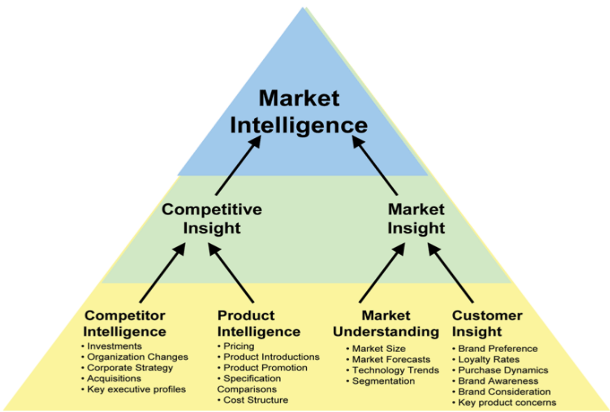

Figure 2 Market Intelligence areas [7], [13], [14]

Market intelligence yields an ongoing and comprehensive understanding of the market. Each of the four knowledge areas [7] - *competitor intelligence*, *product intelligence, market understanding*, and *customer insight* - interacts to form a complete understanding of the market. Each competitor's strategies will impact their product actions, the overall trends of market growth and segment interaction will impact the strategies, and underlying all of this, the customer's behaviors and attitudes will ultimately drive the market dynamics in terms of growth rates and product acceptance. This integration of all four knowledge areas is ultimately deliverable for market intelligence [15].

2.3.1 *Market intelligence* vs. *marketing research*

Marketing research is a critical and significant source of information. However, it does not encompass all the information areas which are covered by *Market intelligence*. The scope of information covered is one of the key differences between marketing research and market intelligence [16], [25].

When examining the communication feature of the market intelligence pyramid, the most important difference between market intelligence and marketing research is that good market intelligence involves a dialogue between the market intelligence analyst and the client/decision maker. Conversely, marketing research provides an assessment of a specific issue, or measures a specific market dynamic. While it clearly involves communication with the client/decision maker, it typically consists of limited interaction versus the full dialogue of market intelligence [13].

We can now see that Market Intelligence is actually a rather very different discipline from *Business Intelligence*, and it is actually much closer to a pure "*market research*" activity [6], [7], [8].

2.5 *Business Intelligence* (BI)

Although *Business intelligence* (BI) is widely used by companies these days, its terms and exact definition is often confused and mixed with other types of intelligence (*marketing intelligence, market intelligence*, and *competitive intelligence*) an organization looks to gather. It is therefore important for us to "*put things in order*" and help in order to better distinguish between these types of intelligence [7], [8], [9].

CIO.com [12] defines BI as "*...an umbrella term that refers to a variety of software applications used to analyze an organization's raw data. BI as a discipline is made up of several related activities, including data mining, online analytical processing, querying and reporting. Companies use BI to improve decision making, cut costs and identify new business opportunities. BI is more than just corporate reporting and more than a set of tools to coax data out of enterprise systems. CIOs use BI to identify inefficient business processes that are ripe for re-engineering.*"

On *Wikipedia* [8], BI is defined as "*...computer-based techniques used in identifying, extracting, and analyzing business data, such as sales revenue by products and/or departments, or by associated costs and incomes. BI technologies provide historical, current and predictive views of business operations. Common functions of business intelligence technologies are reporting, online analytical processing, analytics, data mining, process mining, complex event processing, business performance management, benchmarking, text mining, and predictive analytics.*"

The main mission of *Business Intelligence* is to support better business decision-making and it is often referred to as a "*decision support system*". While BI is sometimes used as a synonym for *competitive intelligence*, because they both support decision making, BI uses technologies, processes, and applications to analyze mostly internal, structured data and business processes. It goes without saying that both disciplines are important for organizations to utilize [3], [5], [7].

2.6 *Competitive Intelligence* (CI)

Competitive Intelligence - the action of defining, gathering, analyzing, and distributing information about products, customers, competitors and any aspect of the environment needed to support executives and managers in making strategic decisions for an organization [7], [8], [9], [15], [17].

We like to look at it much more simply**:** "*to stay ahead of the competition, you need as much* relevant *data as possible to make good decisions. That's where clear competitive intelligence comes in. Being able to easily monitor any information or webpage allows businesses to focus on what they do best - running their business*" [5], [17].

The term *Competitive Intelligence* is often viewed as synonymous with *Competitor Analysis*, but *competitive intelligence* is more than just analyzing competitors — it is about making the organization more competitive relative to its entire environment: customers, competitors, distributors, technologies, macro-economic data and more [8], [17].

2.5.1 *Market Intelligence* vs. *Competitive Intelligence*

Market Intelligence (MARKINT) focuses on providing a company with a view of a market using the existing sources of information in order to understand what is happening in that marketplace, to identify its issues and its market potential. It may also concern the attitudes, opinions, behavior, and needs of individuals and organizations within the context of their economic, environmental, social, and everyday activities. The emphasis is often on consumers – product, price, place, promotion, but, of course, this is not always the case [8], [9].

2.5.2 *Business Intelligence* vs. *Competitive Intelligence*

Business intelligence is concerned with Information Technology (IT) solutions for transforming the *output* from large data collections into intelligence; usually, it is made through the integration of sales, marketing, servicing, and support operations. It often covers activities such as: *Customer Relationship Management* (CRM), *Enterprise Resource Planning* (ERP), and *E-*commerce using Data Mining techniques [8], [9].

Many practitioners have defined the key differentiation between *Business Intelligence* (BI) and *Competitive or Market Intelligence* as follows. *Business Intelligence* (BI) maintains an inward focus towards the organization, whereas *Competitive Intelligence* (CI) and *Market Intelligence* is typically focused outwardly [6], [7], [8].

2.7 *Competitive Intelligence Software* (Ci)

Ci – is defined as the "*experience a better way to monitor Internet data so you can spend more time analyzing and forming conclusions about your market and competition*." [5], [6], [7], [15]

By using clear Ci flexible and competitive monitoring technology, you can automatically track almost any *web page* on the *Internet*, providing you with complete *Competitive and Market Intelligence* [8] for multiple functional or product areas within each organization. And since clear Ci was designed to detect, gather and deliver timely information to you, you can receive change alerts and updates via email or online using software application (SaaS) in the cloud (*cloud computing*) [15], [17].

2.7.1 *Cloud computing*

Cloud computing is a process where a task is solved by using a wide variety of technologies, including computers, networks, servers, and the Internet. Cloud computing is very similar to grid computing; however, usually, it is differentiated from grid computing due to its use of Internet tools [9], [18].

4. *Marketing Intelligence Systems* (MkIS)

A *marketing intelligence system* is a set of procedures and sources used by managers to obtain their everyday information about pertinent developments in the environment in which they operate. "*The marketing intelligence system supplies data about the market*" [11].

- Another definition of *marketing intelligence system* is that "*it is a system for capturing the necessary information for business marketing decision making*" [22].

The fundamental purpose of marketing intelligence is to help marketing managers make decisions they face each day, in their various areas of responsibility.

- *A marketing intelligence system is a set of procedures and data sources used by marketing managers to sift information from the environment, information that they can use in their decision making.* [15].

4.1. Intelligence using Open Source Data

More often, companies began using open source data in developing marketing intelligence. The term is defined as "*the scanning, finding, gathering, exploitation, validation, analysis, and sharing with intelligence-seeking clients of publicly available print and digital/electronic data from unclassified, non-secret, and "grey literature" sources"*[17].

Open source intelligence *"is the most frequently used form intelligence gathering in business enterprises, desirable because it is easy, inexpensive and produces abundant raw material for further processing"*[15], [17].

Managers have been known to spend several hours a day searching for information, later realizing that much of the information they acquired has little relevance or value toward meeting their needs. Companies typically spend far more time gathering information than they processing, analyzing and exploiting it. This study shows that practitioners would like to reverse this equation, and spend more time processing, analyzing and exploiting data as opposed to just gathering it.

4.2. Collecting Marketing Intelligence on the Internet

According to Kotler and Keller, the marketers can research the strength and weaknesses of the competitor's online on five different ways; (a) *independent customer goods and service review forums;* (b) *distributor or sales agent feedback sites;* (c) *combo sites offering customer reviews and expert opinions;* (d) *customer complaint sites;* (e) *public blogs* [26].

This scanning of the economic and business environment can be undertaken in a variety of ways, including:

Table 1 Scanning the *Business Environment* [18, 19, 20]

Unfocused scanning	The manager, by virtue of what he/she reads, hears and watches exposes him/herself to information that may prove useful. Whilst the behavior is unfocused and the manager has no specific purpose in mind, it is not unintentional
Semi-focused scanning	Again, the manager is not in search of particular pieces of information that he/she is actively searching but does narrow the range of media that is scanned. For instance, the manager may focus more on economic and business publications, broadcasts etc. and pay less attention to political, scientific or technological media.
Informal search	This describes the situation where a fairly limited and unstructured attempt is made to obtain information for a specific purpose. For example, the marketing manager of a firm considering entering the business of importing frozen fish from a neighboring country may make informal inquiries as to prices and demand levels of frozen and fresh fish. There would be little structure to this search with the manager making inquiries with traders he/she happens to encounter as well as with other *ad hoc* contacts in ministries, international aid agencies, with trade associations, importers/exporters etc.
Formal search	This is a purposeful search for information in some systematic way. The information will be required to address a specific issue. Whilst this sort of activity may seem to share the characteristics of marketing research, it is carried out by the manager him/herself rather than by a professional researcher. Moreover, the scope of the search is likely to be narrow in scope and far less intensive than marketing research

4.3. Key Elements of a Marketing Intelligence System

4.3.1. Information and data

A continuous flow of information is the lifeblood of a good *marketing intelligence system* - information about new technologies, markets, customers, the economic and regulatory environment etc. Both formal (routine reporting, factual) and informal information (gossip, opinions) must be tapped [13].

4.3.2. Information Management Processes

With many professionals having external information delivered to their desktops, from online services and increasingly from the *Internet*, it is easy to believe that users have all the information and data they need on tap. However, this is raw information and it needs to be transformed into *intelligence* [11]. Before that, however, this information must be classified, stored and made accessible - applying good practice principles of *information resources management* [13].

4.3.3. Intelligence Development Processes

A good intelligence system is more than information. It is a recurring cycle of linking the needs of decision makers to the processes of turning the information into actionable intelligence [17].

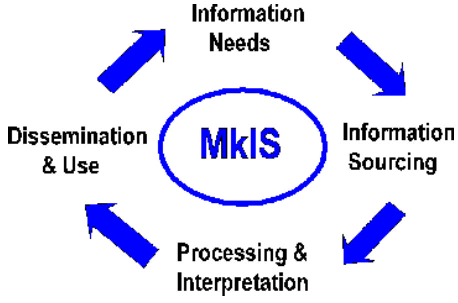

Figure 2 Marketing Intelligence Systems [13]

This requires human interpretation, communicating and sharing of information and perspectives between internal and external experts [3].

4.3.4. Computer Systems

A comprehensive *Marketing Intelligence System* (MkIS) will combine many of the features of decision support systems, online databases and library systems [13]. It is therefore likely to include many of the following:

- For *gathering information*: CD-ROMs, online data-base access, data feeds, email, Internet access, filters, intelligent agents etc.;
- For *storage and retrieval*: Database/document management facilities, text retrieval, search engines, intelligent agents;
- For *processing* and ***analysis***: modeling and visualization software, groupware, group *decision support systems.*

4.3.4.1. Marketing Decision Support System

The system represents a decision support system for marketing activity. It consists of information technology – mainly based on internet system, marketing data and modeling capabilities that enable the system to provide predicted outcomes from different scenarios and marketing strategies, so answering "what if?" questions [7].

4.3.4.2. Internal records (Database):

An electronic collections of information obtained from data sources within the company [25].

4.3.5. An Organizational Focus

Although many professionals do much of their own information gathering and analysis, there still needs to be a clear focal point of the ***Marketing Intelligence System*** responsibility. This may be a named individual or a small group of people who have the distinctive skills needed [13].

4.4. The features of a Marketing Intelligent System (MkIS)

A *Marketing Intelligent System* (MkIS) cannot replace the manager's intelligence and creativity. Huster [23] sees MIS as "*the ability to fully understand, analyze, and assess the internal and external environment associated with customers, competitors, markets, industry and use the acquired knowledge for long and short term strategic planning*". This tends to reinforce the view that the intelligence obtained is then used to aid marketing-related decisions.

The *Marketing Intelligent System* (MkIS) is a part of the company's management [20]. The importance of any system of *marketing intelligence* lies not in the logic, elegance, or harmony of its technological components. Its value is measured in its ability to help the decision. Therefore [14], a *marketing intelligent system* must be part of the company's management system - its processes have to be included in the daily activities of the company's marketing department and also in all its departments.

The system must not result in mountains of paper - it is necessary to make a synthesis of information. The *output* format of information is less relevant and depends on the importance the management gives to a *marketing intelligent system* [21].

What managers can expect from *a marketing intelligence* system is to help them get current decisions, to follow the development of their goals and to make you aware of competition and market changes.

3.2.1 Benefits of the marketing intelligence system[22]

a. A Marketing Intelligent System can*:*

- Follow the company's progress on a long run;
- Help managers take current decisions;
- Establish a link between marketing and back-office operations;
- Consider the impact of strategies on different sections simultaneously;
- Reduce costs by automating many time consuming processes;
- Help managers earmarking the budget for different marketing actions;
- Help serving customers efficiently;
- Help improving performance at all levels through better planning and control;
- Make managers aware of the unusual behavior of competition;
- Improve the control of marketing or non-marketing activities;
- Offer marketing and economic information about problems that can be solved;
- Anticipate the competitors' movements in real time, in order to counter them.

b. A *Marketing Intelligent System* cannot:

- Substitute the manager's judgment;
- Give all the necessary information for managers to make faultless decisions;
- Function well without being supported by the managers;
- Function well if not trusted;
- Function well without being properly maintained and continuously adapted to the needs of information.

4.5. Improving the system – ways and solutions

Kotler also believed that there are four steps to improve the quality and quantity of *marketing intelligence system* [11]:

- *First*, train and motivate the sales force to spot and report new developments; because they are the company's "*eyes and ears*," they are in an excellent position to pick up the information missed by other means;
- *Second*, motivate distributors, retailers, and other intermediaries to pass along important intelligence;
- *Third*, purchase information from outside suppliers/research firms; they gather data at a much lower cost than the company could do on its own.
- - And, finally, establish an *internal marketing information centre* to collect and circulate marketing intelligence. Marketing intelligence is clearly a broad and complex function whose effectiveness dramatically affects the quality of marketing decisions.

4.3.1.10 commandments for attaining high marketing productivity and profitability

Now it's up to you. Applying the solutions – improving *marketing intelligence system*, will turn the actual manager's responsibilities into the *10 commandments* [11] *for attaining high marketing productivity and profitability*. Here are the 10 commandments:

1. Segment your market, *chose the best segments*, and develop a strong position in each segment.
2. Map your *customers' needs, perceptions, preferences*, *and behavior*, and motivate your stakeholders to obsess about serving and satisfying the customers.
3. Develop a good understanding of your *major competitors*, and their strengths and weaknesses.
4. *Build partners* out of your stakeholders, and generously reward them.
5. Develop systems for *identifying and stimulating opportunities*, ranking them, and choosing the best ones.
6. Manage a *marketing planning system* that leads to insightful long term and short-term plans.
7. Exercise *stronger control* over your product and service mix.
8. Create *strong brands* by using the most cost-effective communication and promotion tools.
9. *Build marketing leadership* and a team spirit among your various departments.
10. Constantly add *technology* that will give your *business a competitive advantage* in the marketplace.

5. CONCLUSIONS

- Sometimes, *marketing intelligence systems* were also called *expert systems* because they have integrated within their knowledge a series of domain-specific knowledge, at the level of human expertise. Despite the successes in information technology, specialists have failed so far to achieve intelligent computational systems that replicate human intelligence. This did not prevent professionals to continue and even expand the semantic field of the concept of intelligent research.

- *Marketing Intelligence Systems* are intended to support management decision making processes. Management has five distinct functions and each requires support from an MkIS. These are: *planning, organizing, coordinating, decision and controlling*.

- *Marketing Intelligence Systems* have to be designed to meet the way in which managers tend to work. Research suggests that a manager continually addresses a large variety of tasks and is able to spend relatively brief periods on each of these. Given the nature of the work, managers tend to rely upon information that is timely and verbal (because this can be assimilated quickly), even if this is likely to be less accurate than more formal and complex information systems.

- Some enterprises will approach *marketing intelligence* gathering in a more deliberate fashion and will train its sales force, after-sales personnel and district/area managers in order to take cognizance of competitors' actions, customer complaints and requests and distributor problems. Enterprises with vision will also encourage intermediaries, such as collectors, retailers, traders and other middlemen to be proactive in conveying market intelligence back to them.

- Managers play at least three separate roles: interpersonal, informational and decisional. *Marketing Intelligence Systems*, in electronic form or otherwise, can support these roles in varying degrees. Marketing Intelligence Systems have less to contribute in the case of a manager's informational role than for the other two.

- Three levels of decision making can be distinguished from one another: strategic, control (or tactical) and operational. Again, *Marketing Intelligence Systems* have to support each level. Strategic decisions are characteristically one-off situations. Strategic decisions have implications for changing the structure of an organization and therefore the Marketing Intelligence Systems must provide precise and accurate information. Control decisions deal with broad policy issues and operational decisions concern the management of the organization's marketing mix.

6. REFERENCES

[1] SIMION, H.A., *The Sciences of the Artificial* (3rd ed.), Cambridge, MA: The MIT Press, 1996

[2] POPA, G., *The financial law, circulation of money and inflation in Romania.* Publicația „Rolul euroregiunilor în dezvoltarea durabilă în contextul crizei mondiale", Editura Tehnopress (acreditată CNCSIS), Iaşi, 2012.

[3] GRIGORUT, C., *Marketing*, BREN (acreditată CNCSIS), Bucureşti, 2004.

[4] TALVINEN, J. *Information systems in marketing, identifying opportunities for new applications*, European Journal of Marketing, Vol. 29, No. 1, 1995, pg. 8-26.

[5] POPA, G., *IMF role in the context of the Romanian Financial Law*, "OVIDIUS" University Annals, Economic Sciences Series, Constanta, 2012.

[6] http://www.markintell.com/**;** accessed Nov. 25, 2012;

[7] http://www.clearci.com/ ; accessed Nov. 26, 2012;

[8] http://en.wikipedia.org/wiki/;accessed Nov. 21, 2012;

[9] http://www.businessdictionary.com/; Nov. 26, 2012;

[10] KOTLER, Ph., *Marketing Management: Analysis* Planning and Control, Prentice-Hall, 1988, pg. 102.

[11] KOTLER, Ph., *Marketing Management Millennium Edition*, Tenth Edition, Prentice-Hall, 2000

[12] http://www.cio.com/; (accessed Nov. 25, 2012);

[13] BAHLOUL, M. Y. *The Role of Marketing Information System Technology in the Decision Making Process*, PhD. Thesis, Islamic University of Gaza, 2011

[14] GRIGORUT, C., BALACEANU A.V., *Elemente de Marketing*, BREN (CNCSIS), Bucureşti, 2007.

[15] WRIGHT, Sheila, CALOF, Jonathan L., *The quest for competitive, business and marketing intelligence*: *A country comparison of current practices*. European Journal of Marketing, 40(6), 2006, pg. 453-465;

[16] POP, Marius D., *Cercetări de marketing*, Colec□ia „Marketing expressus", Ed. Alma Mater, Cluj-Napoca, 2004

[17] WRIGHT, S., PICKTON, D.W., CALLOW, J., *Competitive intelligence in UK firms: a typology*, Marketing Intelligence & Planning, 20(6), 2002, pg.349-360;

[18] QIU, T., *Scanning for competitive intelligence: a managerial perspective*. European Journal of Marketing, 42(7), 2008, pg.814-835;

[19] AGNILAR, F. *Scanning the Business Environment*, Macmillan, New York, 1967, pg.47; apud: *Marketing Intelligence System, in* Chapter 9, FAO Corporate Repository; http://www.fao.org/; Nov. 26, 2012.

[20] SKYRME, David *The Planning and Marketing of the Market Intelligence Function*, "Market Intelligence and Planning", Vol. 7, No. 1/2, 1989, pg.5-10; http://www.skyrme.com /; accessed Nov. 25, 2012);

[21] SKYRME, David, *Global Intelligence Networking: Technological Opportunities and Human Challenges*, AGSI *Journal*, Nov 1995. http://www.skyrme.com /; accessed Nov. 25, 2012)

[22] SKYRME, David, *Developing Successful Marketing Intelligence: A Case Study*, Management Decision, Vol. 28, No. 1, 1990, pg.54-61, http://www.skyrme.com /; accessed Nov. 25, 2012)

[23] HUSTER Michael, *Marketing Intelligence: A First Mover Advantage*, Competitive Intelligence Magazine, Washington: Vol. 8, No. 2, 2005, p.g.13.

[24] ALBAUM, G., DUERR, E., *International Marketing and Export Management (6th Edition)*, Prentice-Hall, 2008

[25] KOTLER, Ph., AMSTRONG, G.M., Principles of Marketing, Prentice Hall, 2010

[26] KOTLER, Ph., KELLER, K.L. *Managementul Marketingului*, Ed. a V-a, TEORA, Bucure□ti, 2008

[27] POPA, G., *Tax havens and the financial law*, "OVIDIUS" University Annals, Economic Sciences Series, 2012.

CONTROLLING - A USEFULL TOOL FOR TOP MANAGEMENT

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ABSTRACT

Controlling outlines business policy of an enterprise, the term derives from an English word - to control - control, managing, setting rules and directing. The controller's duty is to serve the management as an economic navigator and to ensure that the company's ship reaches its profit targets. The controller has to be sure that he or she has an organizational support from the top management. It was suggested to establish the controlling department which can be applied to the systems of economy and which would be directed to recognizing and forecasting the future. Nowadays, a modern enterprise can successfully fight with the competition and crisis only if it puts efficient controlling processing into practice. The goal of controlling is to recognize and solve problems or suggest measures for solving them and all that, in order to avoid such problems in the future.

Keywords: *controlling, controlling system, controller, operational controlling*

1. INTRODUCTION

In a historical perspective, the management appears as an integrative science that has developed due to the contribution of other areas and only to a small extent by its own evolution. One possible explanation may be given by the complexity and dynamics of organizations, these being in constant competition for resources and market shares in an increasingly turbulent economic environment. In this context, controlling was created by an interesting combination of knowledge from the theory of automatic regulation with the pragmatic accounting ones, in an institution. Perhaps this is why there has been created a semantic confusion of the concept, by the tendency to identify its origin in the control function of management [1].

Controlling is not about product features; it is about the correlation between planned activities and the progress of their interpretation, using, as a metric, the company's financial and accounting support. By controlling, we assess the difference between what was planned and what has been achieved and there are highlighted the causes that contributed to this gap and the measures that must be taken in order to reduce or eliminate the difference.

Controlling is much more, namely a concept of functional management, with the role to coordinate the planning, control and information in order to achieve the desired results. The controller is the "economic awareness" of the company [1].

2. THE DEFINITION OF *CONTROLLING*

Controlling consists of verifying whether everything occurs in conformities with the plans adopted, instructions issued and principles established. Controlling ensures that there is effective and efficient utilization of organizational resources so as to achieve the planned goals. Controlling measures the deviation of actual performance from the standard performance, discovers the causes of such deviations and helps in taking corrective actions.

According to Brech, "*Controlling is a systematic exercise which is called as a process of checking actual performance against the standards or plans with a view to ensure adequate progress and also recording such experience as is gained as a contribution to possible future needs*."[1].

According to Donnell, "*Just as a navigator continually takes reading to ensure whether he is relative to a planned action, so should a business manager continually take reading to assure himself that his enterprise is on right course.*" [2].

3. WHY CONTROLLING?

Controlling can be considered as an internal management which a general manager and other managers use in making decisions and it gives answers to the following questions [1]

- *Do you know exactly what products record profit and where this profit has to be allocated?*
- *Do you learn in advance if everything goes according to the plan or if there is deviation from the plan?*
- *Do you know the causes of these deviations from the plan?*
- *Do you know how certain actions affect your results?*
- *Do you know the results achieved according to the business principles, i.e. without tax adjustment?*
- *Can you implement the company's strategy in concrete action plans and results?*
- *What leads to indirect cost increase?*
- *Do you know what is the best investment alternative?*

Then, the same author emphasizes that managers often think unreasonably and ignorant associates surround them. Wishing to avoid making the wrong decisions, they are forced to introduce the perfect controls. However, the desirable success often misses. If we ask the question why, the answer could be that this is because the associates avoid making decisions themselves in order not to offend their superior or to make sure they did not make any mistakes, so they return unsolved questions to their superiors. According to time, we divide controlling into operational which deals with the future up to a year.

In principle, we must distinguish strictly between controlling, as function, and controller, as responsible. Actually, controlling, in terms of management, is a central task management.

The controlling task within the company involves sorting the naturally existing individual components, checking their utility, completing and organizing them as a different system. The most important parts of the management system towards which the controller's activity is oriented are:

(1) the planning and control system;
(2) the information system.

The controlling process is characterized by the joint action of the information and planning systems. Controlling is not actually only a service brought to management, which supports it by the information provided. It is an idea which has to be communicated to all the employees of a firm. This idea includes both the mode of action oriented towards the company's success and planning, with a personalized responsibility, and towards the thinking beyond the individual activity area, in the sense of an interference management [1] based on the integrated controlling [1], [2].

The controlling instruments are based on a flexible database that leverages information from cost accounting, from the calculation of products, from the results account etc., being completed by strategic market information. These important tools used by the controller are the investment account and the involvement and establishment of indices and index systems. These instruments are used by the controller both in planning and leadership activities but also in control and reporting activities [1].

The importance of controlling within the company:

- Controlling is an innovative concept for performance management. The priority of introducing and implementing controlling within the company is "cost management or, more exactly, from financial accounting to cost accounting";
- The best practical solutions for "planning and reporting" activities. *Example*: Project Control: aimed at completing projects on time, within the budget and to the required quality level [1];
- Analyses and effective solutions from the activity of the financial – accounting sector for non-financial managers;
- Improvement of performance within Sales and Marketing departments by generalizing controlling methods and techniques:
    - How to effectively manage your customer base?
    - The Foundations of Risk Management.

4. THE CONTROLLER WITHIN THE INSTITUTION / COMPANY

Basically, the controller has two different tasks of coordination, both in relation to the planning system and to the information system. On the one hand, it deals with structuring and development, and, on the other hand, it deals with daily functioning (permanent coordination).

Firstly, the controller supports management, and, secondly, he/she is active at the decentralized level in the sense of the implementation of the idea of controlling among the employees. Its contribution to the planning process and to the information needed leads to the controller's direct subordination to the company's management. The controller transforms himself/herself from a simple service provider in a management consultant [1], [3].

- The controller's role within the planning is to coordinate the partial plans and to organize the entire planning process. Therefore, not the controller but the manager is the one who normally plans and coordinates;
- The controller's role in the information system is to disseminate the information needed, to obtain and to process them (in accounting) and to transmit them in reports.

The controlling departments are usually placed in the head office (there is a head office or a team on a management's side) as a controlling department [1]. Using the controlling, the management of an enterprise can effectively fulfil its role, which can be observed through several most important directives such as managing through defining the clear goals - from the top to the bottom and vice versa.

4.1. Controlling system (an example made by Horvath & Partners)

Every manager (financial manager and commercial manager) is faced with questions concerning his or her *controlling organization* and the appropriate resources in the company [1].

- Do we have a suitable controlling system?
- Does management within controlling stick to the dotted line as it should?
- Do we have too many controllers on board?
- Do procedures and results in planning and reporting live up to best practice expectations?

4.1.1. The solution

The Controller uses a short analysis based on benchmarks to answer these and other questions on the current state of management accounting and controlling within your company and provides concrete recommendations for improving the performance of your controlling.

4.1.2. The approach for the controlling audit

The activities of *Conntroller* consists of five core elements which are run in a tried-and-tested, step-by-step approach [1]:

- *Developing a target position for your controlling:*
  The future challenges and goals for your company shape the demands upon corporate management and thus upon your management accounting and controlling. This mid- to long-term target position is first defined with top management at the beginning of the controlling‘s activities (controlling audit). The audit’s findings are then used to firm up the target position and adopt it formally. The future role of your controlling department is anchored in a set of controlling guidelines. Management’s understanding of its role and the demands upon it are critical parameters for the future target position of your management accounting and control.
- *Analyzing the current state:*
  An evaluation of the current situation within your controlling organization is carried out by means of questionnaire-based interviews and workshops with managers and controllers. The analysis focuses on the structure of the organization, the controlling processes, the methods and approaches applied, the tools and instruments used and the resources. Here, both the way the controller sees the controlling department and the way customers see things are recorded and systematically evaluated.
- *Reflecting the results of the current-state analysis using benchmarks (positioning):*
  Underlying both the quantitative and the qualitative benchmarks is the most extensive and comprehensive controlling database. Using a standardized process model for all relevant controlling activities, the highest possible degree of comparability is both guaranteed and achieved. The results of the evaluation are laid down concisely in a detailed report.
- *Deriving the need for action (gap analysis) using best practices:*
  In order to make this possible, Controller will identify and analyze *the gap between the target position of your controlling and its current state*. What is decisive here is the integration of the various optimization measures into an overall controlling concept.
- *Drawing up the implementation plan (realization):*
  The concrete implementation planning in the last stage of the Controlling system ensures rapid transition from analysis and concept to realizing the optimization measures.

4.1.3. The result of the controlling audit

The *Controller* show you very quickly the current state of management accounting and controlling in your company in comparison with industry benchmarks and provide you with concrete recommendations on how to improve performance and to achieve a defined target position for your controlling. With the help of our initial implementation plan you can get down to realization very quickly.

4.2. Building a Controlling system

Controlling system is typical for modern businesses. In addition to central controlling (company controlling), which takes general controlling tasks for various divisions (departments) and functions, as a transversal function, there are decentralized controlling departments for each activity, sector and branch.

Significant elements of an effective controlling system specific to companies in this field:

- The *overall controlling* of the company - financial controlling; strategy planning and organization; investment controlling; coordination of subsidiaries – agencies; the general management of clients.
- *Development controlling* - the growing importance of this function, which developed in terms of costs and strategically, as a central factor for business success, increased the interest to present this field – shipping, more transparently and economically. *Controlling development* was regularly faced with the lack of activity standardization, which involved a series of implications for planning and control. Similarly to the field of developments, achieving projects is more and more presented as a success factor, which justifies the existence of project controlling.
- *Staff controlling* - flexible planning of staff involvement and productivity measurement based on scanner data - "qualification controlling".
- *Logistics controlling* - trying to replicate all the functions of Porter's value chain by emphasizing the issues related to procurement and distribution.

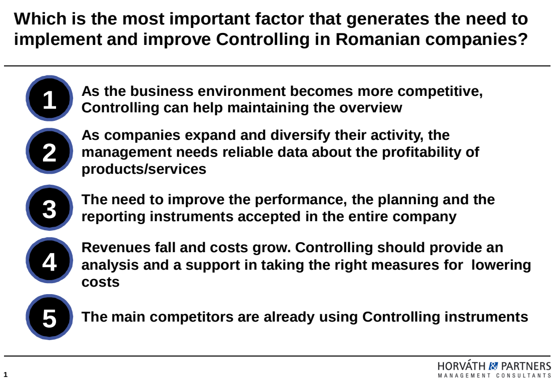

Figure 1 Challenges in improving Controlling system in Romania [1], [4].

5. CONTROLLING IN ROMANIA

When asked, “Which are the major challenges in creating a *Controlling department* and adopting different *controlling tools?”* the majority admitted that the Romanian market lacks know-how and experts in this field. This fact is not surprising, since there is no university in Romania offering a specialization on Controlling or at least a controlling course. Many managers still perceive Controlling as Accounting or Audit.

Horvath & Partners in 2011 [3] states, in our competitive today’s business environment the informational role of Accounting is no longer sufficient. The decisions of a manager must be based on information about the future, on analysis and anticipation of future problems. This applies to a greater extend to Romanian managers, which often make decision without having a solid basis, but guiding themselves after current opportunities or acting on instinct.

The message is clear: 49% of the managers attending or participating in training courses [4] recognized with what Controlling is supposed to help their organization - by being a business partner that supports the decisions of management. Due to these conditions, the market is seeking possibilities for training to adopt state of the art *controlling* practices. This is the reason why the specialists in *Controlling*, unlike in the initial plan, has decided to offer Romanian companies different solutions and best practices examples.

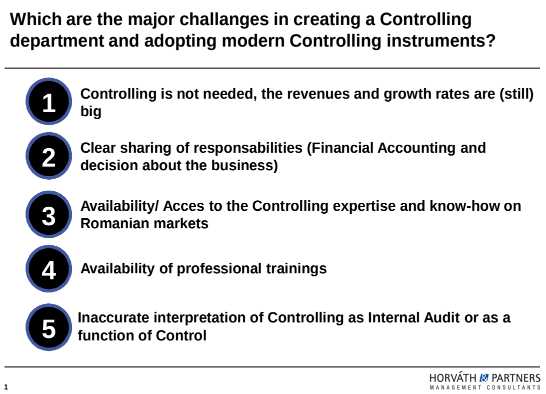

Figure 2 Tasks for creating a *Controlling department*

Besides the search for know-how and good Controlling practices, leading Romanian companies are actively developing their Controlling departments and processes. This is seen as an appropriate strategy to improve management control and transparency of results, performance and costs.

A good example that reflects the status and challenges of Romanian corporations is RTC [4], a big group that started to create and integrate a Controlling function. Like many Romanian companies, some of the Controller attributions were already performed by the Financial Officer. But because of the great amount of diverse activities, a need for specialized Controlling appeared. The company encountered some challenges in finding the right person for this position, since there are not many experts in this field. Internal Recruiting was of course preferred, because first of all a Controller must have a solid knowledge and understanding of the business processes.

The lack of communication between departments, the irrelevant or untimely reporting and other similar problems will be all overcome when Controlling will be introduced in the company, with the support and implication of top management.

6. CONCLUSIONS

As a conclusion, we can state that the companies in Romania realized that in order to grow profitably, in the setting of growing complexity of operations, higher investments and also risks, they are in great need of coordinating their business units with each other and with the external social and economical environment - the main task of Controlling. Along this tricky road, the experts in *Controlling* offer them individualized, innovative solutions and help them build a performance-oriented Controlling department easier.

7. REFERENCES

[1] HORVATH & PARTNERS, *Controlling. Sisteme eficiente de creș tere a performanțelor firmei.* Ed. a II-a, Editura C. H. Beck, București, 2009;
[2] Controlling System activities; available online at http://www.managementstudyguide.com/controlling_function.htm ; accessed 03.12.2012;
[3] PEROVIC. V., NERANDZIC, B., TODOROVIC, A., *Controlling as a useful management instrument in crisis times,* Review *African Journal of Business Management* Vol. 6 (6), 15 February, 2012, pp. 2101-2106, available online at http://www.academicjournals.org/AJBM;
[4] HORVATH & PARTNERS Focus, Romania available online at: http://www. controlingakademie.de.
[5] POPA, G., *IMF role in the context of the Romanian financial law,* “OVIDIUS” University Annals, Economic Sciences Series, 2012;
[6] POPA, G., *The financial law, circulation of money and the inflation in Romania,* in publica□ia “Rolul euroregiunilor in dezvoltarea durabila in contextual crizei mondiale, Editura Tehnopress, Iaşi, 2012.

REPUTATION BUILD ON THE COMPANIES' VALUES

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ABSTRACT

While self esteem is important for reputation, the main goal of reputation is not "the organization to be enjoyable for others" but to set it apart from competitors. Reputation precedes faith. Values are the basis of reputation, since they determine organizational decisions. Reputation may be the most important asset entrusted to the top management of the institution. As an intangible asset, it can help define and meet the needs, interests and expectations of collaborators and the public, being a differentiating factor in the competition. It is an asset which can hardly be restored as it is based on perceptions and expectations (confirmed or not).

Keywords: *Reputation, Mission, Visual brand identity, High visibility, Vision, Values, Competitive advantage.*

1. INTRODUCTION

Reputation, as a dimension of management, is a state of competitiveness achieved through a high level of efficiency and productivity, which ensures sustainable market presence, given the complex interaction of many factors [1].

Reputation philosophy implies the existence of a relationship of mutual appreciation between managers and performers; it has to start from mutual trust and develop through communication and the participation in the management process [1], [2].

Reputation philosophy relies on the skills that the manager is endowed with: customer focus; continuous product renewal; renewal of the methods used and of the organizational structures; stimulating a sense of pride within the employees, arising from their participation in its achievement [1], [3].

2. DEFINING REPUTATION

When trying to define reputation, we find that, in the last century, this notion has undergone significant changes: (1) until the twentieth century, reputation was synonymous with "honour", "respect", "fame", "dignity", "merit", "celebrity", "value" and it was used in relation to individuals, (2) afterwards, this notion has become more widely used, extending to institutions, (3) in recent years, reputation is treated as synonymous with "social responsibility" [1].

- in *Micul dicționar enciclopedic*, reputation means a favourable or unfavourable public opinion about someone or something; the way one is known or appreciated [1].
- in *Petit Larousse illustré*, reputation is defined as a favourable or unfavorable public opinion, with meanings oriented towards having a good reputation, esteem, compromising one's reputation [1].
- in its ordinary meaning [1], "*reputation is a social evaluation obtained by someone and which is the general opinion about the qualities, merits and deficiencies of any particular individual*"[6]**,** [8].

3. COMPONENTS OF THE REPUTATION

In classic marketing, *reputation* or *visibility*, are defined as [4], [17], [18], [19]:

- Be *obsessed* with your product and service - nothing comes close to superior product quality in influencing the way people feel about your organisation.
- Deserve *confidence* - lead from the front and engender trust from employees and customers.
- Be *available* - build relationships with customers, employees and suppliers.
- Admit *mistakes* - if mistakes are made, admit them and respond rapidly.
- *Engage* people's *interest* - get all staff involved.
- Have something to say – top management of the company can use their own and the business's personality to communicate with impact and colour.

Marketers focus on identity, image (brand image) and awareness, which is what Walter Lippmann (1922) called "mind images" [10], [19].

3.1. Brand, identity and reputation

"*The company's identity (…) is the sum of all those visual clues by which the public recognizes the company and distinguishes it from other companies*" [10], [11].

The company's identity varies depending on the circumstances, the institution's policies and audiences and on the public categories which the company wishes to address. These three terms are sometimes used interchangeably – brand and identity; visual brad identity - image and reputation [4], [5], [7].

3.1.1. Brand identity a step building reputation

The outward expression of a brand – including its name, trademark, communications, and *visual appearance* – is brand identity. Because the identity is assembled by the brand owner, it reflects how the owner *wants* the consumer to perceive the brand – and by extension the branded company, organization, product or service. This is in contrast to the brand image, which is a customer's mental picture of a brand. The brand owner will seek to bridge the gap between the brand image and the brand identity [5], [7].

The role of the *brand image* is to customize a company, a product or a service, allowing the user to distinguish them from others, by memorizing its specific attributes, by giving them psychological significance and by establishing affective relationships with them, in their awaiting horizons [12].

Today, it's not just what you know or who you know--it's who knows you. *High Visibility* is the difference between being just a member of the crowd and becoming a highly recognized individual [6].

3.1.2. Visual brand identity

The recognition and perception of a brand is highly influenced by its *visual presentation*. A brand's visual identity is the overall look of its communications. Effective visual brand identity is achieved by the consistent use of particular visual elements to create distinction, such as specific fonts, colors, and graphic elements. At the core of every brand identity is a brand mark, or logo [5].

a. "Visibility" vs. "high visibility"

Being *visible* means that an individual has generated a high level of awareness in the market segment that he or she serves. Many people in that segment have heard of the person and may even know the person [14], [17].

The person's *visibility* might stem for other characteristics, such as notoriety, outstanding physical or mental features, and so on.

For many individuals and organizations, *visibility* can make the difference between *success* (n.a. *reputation*) and unrealized potential. To achieve the level of success a *personal* or *corporate brand* is capable of, visibility is a core requisite. For this reason, the organizations and individuals should think as seriously about their *brand strategy* as they do their product or service strategy [16].

A *highly visible* individual is one that has achieved "memory lock" or long-term recall, to become one of the top two or three individual's people remember. However, a highly visible person does not necessary need to achieve memory lock across many sectors [17].

In organizations, *highly visible* people can serve as role models and inspiration for employees of the organization. It also can serve to crystallize the product as the person becomes an extension of it.

b. Brand loyalty

Brand loyalty, in marketing, consists of a consumer's commitment to repurchase or otherwise continue using the brand and can be demonstrated by repeated buying of a product or service, or other positive behaviors such as word of mouth advocacy [16].

3.2. Image vs. reputation

This "image" or "set of images" thus contributes to the reputation of the organisation.

Roger Muchielli defines the image as "*a representation or idea which is formed by the individuals of an environment or of a segment of the public – as a consequence of the reception of information about a social object. The image implies a view or an attitude whose roots are mostly irrational*" [5], [19].

Notoriety, a notion designating a *quantitative component of the image* (some authors even consider it a distinctive feature of a mark, organization, people), is determined as a percentage of the members of a given population who know the brand, the organization, the product or the person [6].

David Finn, Doug Newsom and others have pointed out that concepts such as *reputation* and *image* are not generally something *that can be managed directly, but are omnipresent and the global result of a firm's or individual's behaviour.* Attempting to manage one's reputation *might be likened to trying to manage one's own popularity (a rather awkward, superficial and potentially self-defeating endeavour)* [10], [16], [19].

3.3. Mission, vision, organizational value

Peter Drucker reiterated "*that the idea of going out with a mission could be the first lesson that companies should have to learn from non-profit organizations that have benefited from success*". Drucker believed that companies with good results do not start their planning with the financial return. They begin to implement their mission. Financial gains will come as a result [18].

3.3.1. Mission

Kotler defines the mission in more sustainable terms, i.e. "the rationale of the company"; it reflects the fundamental purpose of the existence of this entity. The company's mission is the means that cannot be changed. The company's operations and sphere of activity are flexible, but they must be identically aligned to the middle line [18].

3.3.2. Vision

The vision can be defined as an image of the future favourable state which the company wants to reach. It clearly shows what the company aspires to become and accomplish. In order to define all these things, a company must create a mental picture of the future, given the corporate mission [18].

3.3.3. Values – *the base of reputation*

The *values* express (in words) a "*set of corporate priorities and managerial efforts towards their inclusion in the business practices, with the hope that they will reinforce the behaviours that bring benefits to the company and to the communities inside or outside it, which further strengthens the values of the institution*"[13], [16].

On the other hand, the values can be considered "*institutional standards of behaviour of a company*" [17].

In Leoncioni's perspective, there are four different types of corporate values:

(1) *Game permission values* are behavioural rules that employees must possess when entering the company;

(2) *Aspiration values* are lacking to the company, but the managerial leadership hopes to achieve them;

(3) *Accidental values* are acquired as a result of the common personality traits of employees;

(4) *Fundamental values or common values* are real corporate culture that guides the actions of employees.

The values of professionalism and integrity are considered self-evident, so they are not fundamental (collective) values but values of the permission to play.

Values represent *the basis of reputation*, since they determine organizational decisions - in what business they should be involved, how they treat their employees, if they respect critics, associates and collaborators and, finally, how they react in a competitive environment [17], [18].

Better regarded companies build their *reputations* by developing *practices* which *integrate social and economic considerations* into their *competitive strategies.* They not only do things right – they do the right things. In doing so, they act like good citizens. They initiate policies that reflect their *core values;* that consider the joint welfare of investors, customers and employees; that invoke concern for the development of local communities; and that ensure the quality and environmental soundness of their technologies, products and services [16], [19].

4. WHO IS/SHOULD BE RESPONSIBLE FOR REPUTATION?

Reputation is a holistic responsibility in the company and it may be the most important asset left by the board in the hands of the general manager. However, the daily management of reputation is often played by public relations and marketing: there has always been a conflict between communicators and marketing people when it comes to reputation. Marketers are considered responsible for the 4Ps (product, price, placement, promotion), so they believe that if they do not deal with reputation, they do not fulfil their obligations to the company [16].

4.1. Employees as communicators of reputation

Communicators - company employees and intermediaries should play an active role not only in defining these values, but also in order to ensure that they are primary values, avoiding using them just to convince audiences / publics to positively perceive the organization [19].

5. THE IMPORTANCE OF A GOOD REPUTATION

Reputation is an intangible asset of the organization and it is a key weapon against competition. In general, it can be argued that the intangible nature of reputation, its social rarity and complexity make it difficult to imitate, which means that it can play an important role in determining the performance differences between organizations.

Moreover, intangible assets are important in order o achieve a *competitive advantage*, because they have high value, are less frequent, are either too difficult or too costly to imitate, to substitute or to transfer.

5.1. Outcomes to evaluate success or reputation

Hon and Grunig also nominate four outcomes that are indicators of successful interpersonal relationships but can be applied with equal success to relationships between organizations and their publics. Importance declines down the list: (a) *Control mutuality*; (b) • *Trust* - the level of confidence that both parties have in each other and their willingness to open themselves to the other party (based on : *Integrity; Dependability; Competence*); (c) *Commitment* - the extent to which both parties believe and feel the relationship is worth spending energy to maintain and promote; and (d) *Satisfaction* - the extent to which both parties feel favourably about each other because positive expectations about the relationship are reinforced. Each party believes the other is engaged in positive steps to maintain the relationship [7], [9], [15] [19],

6. CONCLUSIONS

Therefore, **reputation** clearly defines a unique identity and consolidates it with authentic integrity, in order to build a *strong image* for the public.

The company's identity is the institution's card to the public. It shows how the organization is structured, what are its values and nature. The company's identity and image are fundamental elements of the organizational strategy and successful implementation of an efficient management reputation.

Modest reputation remains at that level for a long time then breaks into a high level of visibility.

7. REFERENCES

[1] PETRESCU, I., *Managementul Reputației*, Editura EXPERT (acreditată CNCSIS), Bucureşti, 2007;

[2] http://www.dictionare-online.ro/ 05.12.2012

[3] CHIROVEANU A, MÂNCIU M, NICOLESCU N, RĂDULESCU Gh., ŞUTEU V, *Micul Dicționar Enciclopedic*, Editura Ştiințifică şi Enciclopedică, Bucureşti, 1978, p. 825;

[4] SOWELL, Thomas, *A Conflict of Vision*, New York, 1987, p. 32

[5] MUCHIELLI, R., *Psychologie de la publicité et de la propagande*, Librairies Techniques, Paris, 1970, p. 110

[6] FLORESCU, C., MÂLCOMETE, P., POP, N., *Marketing. Dicț ionar explicativ*, Editura Economică, Bucure□ti, 2003;

[7] http://en.wikipedia.org/ accessed on 26.11.2012

[8] ARGENTI, P.A., DRUCKENMILLER, B., *Reputation and the corporate brand*, Corporate Reputation Review, 6(4), 2004, p. 368-374.

[9] POPA, G., *Globalization and Money Laundering*, International Conference on European Integration, Realities and Perspectives (EIRP), 2012;

[10] GRIGORUT, C., ANECHITOAE, C., *Trademark vs. Brand, Emblem or Logo*, OVIDIUS UNIVERSITY ANNALS ECONOMIC SCIENCES SERIES, 2010
[11] GRIGORUT, L-M., ANECHITOAE, C., GRIGORUT, C., *The similarity of a mark in the light of the confusion risk for the consumer*, Analele Universitatii Eftimie Murgu Reşița, Fascicola Științe Economice, 2010
[12] GRIGORUT, C., ANECHITOAE, C., *The Entitlement To The Mark*, Analele Universitatii "Eftimie Murgu" Reşița, 2010
[13] ANECHITOAE, C., GRIGORUT, C., *Creativity and Innovation - Supporting the Employability of Graduates on Labor Market*, UNISO, 2010
[14]GRIGORUT, L-M., GRIGORUT, C., ANECHITOAE, C., *The Trademark: A Marketing Concept*, Analele Universității Ovidius, Seria Stiinte Economice, 2010
[15] POPA, G., *The criminality and psychological feathers*, International Conference on European Integration, Realities and Perspectives (EIRP), 2012;
[16] *Institute for Public Relations, Forum for International Communications, Reputation, December 2008;* http://www.pr-romania.ro/articole/reputatie-si-incredere/html accessed in 03.12.2012)
[17] KOTLER, Ph., REIN, I., HAMLIN, M.A., An Interview with the authors of *High Visibility Book:*; Mar 28, 2006; http://www.teamasia.com/newsroom/read-old-teamasia-news.aspx?id=87:high-visibility-an-interview-with-philip-kotler-irving-rein-and-michael-alan-hamlin (07.12.2012)
[18] KOTLER, Ph., KARTAJAYA, H., SETIAWAN, I., *Marketing 3.0. De la produs la consumator si la spiritual uman*, Editura Publica, Bucuretti, 2010;
[19]*eprints.bournemouth.ac.uk/12633/2/Chapter_13_def_reputation.pdf*; in Chapter 13 – *Reputation Management* – Bournemouth University (accessed in 27.12.2012).

THE ROMANIAN CENTRALIZED ORGANIZATIONS' RESISTANCE TO CHANGE

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ABSTRACT

We are in a period of significant change in our organizations and our communities. The need for focused leadership is critical and challenging for all. Some particular objectives of this study are to determine that: leadership and change are inextricably linked and their effectiveness in achieving beneficial outcomes for stakeholders is linked to their underlying ethical values; the importance of some approaches to change are more likely to lead to ethical outcomes than others; the need for greater ethical clarity when evaluating approaches to leadership and change; the study's objective is to demonstrate that the Romanian organization oppose change and are not adequately decentralized. There are fundamental differences between these two characteristics. Promoting the autocratic type, in combination with the bureaucratic compulsive type, determines a major gap between the executive managerial level and the operational one. The inadequate union activity is also responsible for the centralism within the organizations and the toxic influence it has on change. This paper presents the conclusions of a study regarding the Romanian union leader's perception.

Keywords: *leadership, centralism, decentralization of human resources, change, ethics.*

1. INTRODUCTION

Leadership is a process that is not specifically a function of the personal in charge. Leadership is a function of individual wills and individual needs, and the result of the dynamics of collective will organized to meet those various needs. Second, Leadership is a process of adaptation and evolution. Leadership and management are processes of dynamic exchange and the interchanges of value. Leadership is deviation from convention and a process of energy, not structure. This is the way in which Leadership is different from management: managers assure stability, while leadership is all about change ([1], Barker, 2001, p.491).

Leadership and change go hand in hand. They are also two of the most contentious and problematic elements of organizational life with much debate and Controversy over what constitutes Leadership and which are the benefits of change ([2], Beer and Nohria, 2000). As Burnes ([3], 2009; [4], 2012) points out, "implementing change in organization is not an usual aspect, only around 30% of all changes initiatives are successful" ([5]Bessant and Haywood1985; [6]Crosby, 1979; [7]Hammer and Champy 1993).

Entities, whether they be individuals, managers, teams or organizations, which do not adapt to change in timely manners, are unlikely to survive. *Fortune* magazine first published its list of America's top 500 companies in 1956. Sadly, only twenty nine companies from the top 100 on the original list remain today. The other seventy-one have disappeared through dissolution, merger, or downsizing. Survival even for the most successful companies cannot be taken for granted. Giants such as General Motors, Ford and Chrysler know that, to survive, they must adapt to accelerating and increasingly complex environmental dynamics. Today norms of change bring problems, challenges and opportunities.

Those individuals, managers and organizations that recognize the inevitability of change, learn to adapt to it, and attempt to manage it, will be the most successful.

Change is the coping process of moving a present state to a more desired state in response to dynamic internal and external factors. Essentially, change means that we have to do things differentially in the future. In general, most people dislike change because of the uncertainty between what is it and what might be. To successfully implement changes, managers need to possess the skills to convince others of the need for change, identify gaps between the current situation and desired conditions, create visions of desirable outcomes, design appropriate interventions, and implement them so that desired outcomes will be obtained. There are two major types of change. The first is unplanned change that is forced on an organization by the external environment. This type of change occurs and is dealt with as it happens through emergency measures- a practice often called fire fighting. Sources of unplanned change include technology, economic conditions, global competition, world politics, social and demographic changes and internal challenges.

Another type of change is planned. It results from deliberate attempts by managers to improve organizational operations. One example is total quality management, with a focuses on continuous process improvement. Short-run programs of implementing changes have usually unintended dysfunctional effects on participant satisfaction and the long term goal of the organization. Change programs that are aimed at improving long-term effectiveness, efficiency, and participant well-being are usually more successful.

The Lewin's experiment established the three phases of planned change, from the unfreeze, that determines change, that determines refreeze. ([8], Lewin, 1951).

In the first phase, a manager needs to help people accept that change is needed because the existing situation is not adequate. Existing attitudes and behaviors need to be altered during this phase, so that resistance to change is minimized. Unfreezing requires some event to upset current work norms and relationships. Sometimes this occurs naturally, as with changes in the economy and technology. More often, however, managers need to provide the impetus to let go of old ways of doing things. It helps to explain how the change can increase productivity for the organization, but is also necessary to demonstrate the consequences on the participants of not changing. They need to understand that the cost of making the change will be worth some other gain they care about. Managers' goals are to help the participants see the need for a change and to increase their willingness to help make the change a success. ([9] Grigoruț C., Anechitoae C., 2010).

2. LEADING CHANGE

2.1. Leaders' Identity Work. Transformational leadership

The ways individuals craft, uphold and revise their identities-captured within the definition of identity work have gathered much attention from organizational scholars. Researchers have elucidated how individuals shape their self-conceptions, within social interactions, in order to transition into or sustain a desired role ([10] Ibarra, 1999; [11] Kreiner, Hollensbe& Sheep, 2006; [12] Pratt, Rockmann& Kaufmann, 2006; [13] Thornborrow& Brown, 2009, apud [14] Petriglieri, 2012) or to avoid the taint associated with a stigmatized one [15] Ashfort& Kreiner, 1999; [16] Snow& Anderson, 1987). These studies have deemed identity work successful of individuals manage to craft identities that sustain their self-esteem and grant their social validation in their roles, and have provided the foundations for an emergent stream of organization studies concerned with the identity dynamics underpinning the emergence and the exercise of the leadership ([17] Day& Harrison, 2007; [18] De Rue&Asford, 2010; [19] Ibarra, Snook, & Guilen Ramo, 2010; [20] Lord& Hall, 2005).

Leadership is not synonymous with occupying position of formal authority or enacting requisite styles, and endeavors to account the interaction of intra-psychic and social dynamics in the making of demise, of leaders([21] DeRue & Ashford, 2010). The leaders are more effective when their message is deeply personal and yet touches shared concerns ([22] Petriglieri, 2011, p.6). Some other authors describe the leadership performance on the transformational attributes (consider contingencies to determine the best interventions). The best strategy for changing a given situation depends on various contingencies. Key factors to consider include time; importance; anticipated resistance; power situations; ability; knowledge and resources required; and source of relevant data. If a change needs to be made quickly and it is not critical important, and if resistance is not anticipated, using direct authority may be appropriate. However, if the change is important, resistance is anticipated, and the power of position of those who must change is relatively high, a participative approach might be more suitable.

Leaders can help people get through the transition period by anticipating sub-par performance and attitudinal problems and by being ready with increased support, education, encouragement and resources to help employees adapt. When people begin to experience positive results, the new behaviors will become internalized and external supports given by the manager can be reduced. Managing of change situations is also an attribute of transformational leadership. Introducing a change seldom leads immediately to the desired results because people require time to learn how to behave differently. Individual performance usually declines during the learning period, introducing fear and anxiety among participants. During this period, many participants may experience a strong desire to return to more familiar and proven behaviors.

In order to ascertain whether the change is accomplishing desired results, information needs to be gathered and compared to benchmark goals. If feedback from surveys, sensing groups, or interviews indicates that initial enthusiasm has faded as people encounter operating problems, leaders need to intervene to sustain the momentum, with motivating processes.

In *Corporate Pathfinders*, Phil Hunsaker apud. Harold Levitt ([23] Homewood, Il: Dow Jones-Irwin, 1996) describes the primary factors that a manager can target for change:

Strategy: develop new visions, missions, strategic plans;

Structure: add a new department or division, or consolidate two existing ones;

People: replace a person; or change knowledge, skills, attitudes or behaviors;

Technology: Upgrade a data processing system;

Processes: Change the pay system from hourly wages to salaries;

Management: Encourage participation, by those involved, in the solutions to the problems;

Product& Service: Marketing people pass customer complaints to research to use in the design of new products.

These solutions include strategy, structure, people, technology, processes, management, products and services. Because change targets are interdependent parts of the organizational system, a change in one will usually affect others. For example, a new strategic plan may lead to new products, which in turn stretch goals for people and require changes in technology. Changes in people and culture may also be necessary to overcome resistance to change.

Although, managers do have a responsibility to identify areas of improvement they should always be open to bottom up ideas. Employees at lower levels have the most expertise to propose meaningful changes in the jobs they perform.

Resistance to change is obvious when actions such as strikes, slowdowns, and complaints occur. It is more difficult to detect resistance that is implicit, such as decreased motivation or loyalty. Resistance to change is sometimes beneficial because it promotes functional conflict and debates, which can promote more thorough analyses of alternatives and their consequences. On the other hand, excessive or irrational resistance could hider progress and even survival. Why is change often resisted even when its benefits clearly outweigh its costs? The following paragraphs describe the main reasons why change is resisted. Some area based in human nature, and others are created by organizational dynamics.

People often perceive the same things differently. Individuals tend to focus on how they will be personally affected by change rather than seeing the big picture for the entire organization. People resist change if they do not understand what is expected or why the change is important. Many people take the attitude" if it is not broken, don't fix it". If the reasons for change are not clearly presented, the worst is often assumed in terms of initiator intensions and personal impact. In addition, if people do not have enough information about how to change, they won't know how to do and will not try. Individuals resist change when they are uncertain about how it will affect their well-being. They will ask themselves, for example, how will downsizing or new automation affects my job security? Other fears include not being able to perform as well as before change; losing position, income, status, or power; having to perform less convenient or more difficult work; and losing desirable social interactions.

Organizational processes that appear to be working satisfactorily are not usually improved upon, even though environmental conditions may have changed in ways that indicate changes are desired. People prefer familiar actions and events, even if they are not optimal. Breaking a habit is difficult, because it takes hard work and involves giving up benefits that the habit provided, even if the new behavior has more desirable consequences.

People usually react negatively to changes that seem arbitrary and unreasonable. They get angry when timing and implementation of changes lack consideration of their concerns. When their thoughts and feelings about changes that affect them are not considered, people feel controlled and fear that they are losing autonomy over their work lives. These types of actions decrease trust in the initiators' intentions breed resentment and promote resistance to change.

Changes that are beneficial to one group may be dysfunctional to another. People usually think of themselves first when evaluating potential changes. They support those who enhance their own welfare, but resist the once that reduces it. People benefiting from changes in decision-making authority, control of resource allocations, or job assignments will endorse change, but those losing benefits will resist.

Organizations create hierarchies, subgroups, rules, procedures, values, and norms to promote order and guide behavior. Organizational changes usually alter this structural stability, so they are resisted.

Harvard professors John Kotter and Leonard Schlesinger ([23] Hunsaker, Aleesandra, 2008, p.321) have developed some general strategies for overcoming resistance to change. Several of these strategies can also be applied simultaneously. Even if the consequences of a change are generally perceived as positive, extensive communication will help reduce anxiety and ensure that people understand what is happening, what will be expected of them, and how they will be supported in adapting to change. The objective is to help people learn beforehand the reasons for the change, how it will occur and what the likely consequences will be.

Education and communication are commonly used where people lack information about the change or have received inaccurate information. Education people about change can be very time consuming, but if people are persuaded that the change is a good thing, they will help with the implementation

2.2. Bureaucratic cultures and compulsive type organizations

The compulsive personality reaches faster the top of the career. Although in the management's point of view they are considered masters, the effects on the organization are toxic. Compulsive managers fear that they might find themselves in certain forms of dependency towards people or events. The main preoccupation is, to dominate or being in control. Interpersonal relationships are interpreted in terms of domination and obedience. In areas where they are in charge, they insist that the lower ranking personnel accomplish their objectives without any objections. The compulsives have a sense of perfectionism which hinders them to see the big picture ([24] Manfred Kets de Vries, 181:2003). They are preoccupied with details, establishing norms, regulations and procedures which will correspond to certain easy tasks. They prefer the routine; they are not able to stray from the planned activities, from their environment and are inflexible to change. They lack creativity, spontaneity; form is more important than the essence, the need for affiliation and relating do not manifest themselves. The usual characteristics of this manner of leadership are as follows: thoroughness, dogmatism and stubbornness, which is translated into an excessive preoccupation for the rational-legal climate, for the management's organization function and efficiency. Managing decisions is a very difficult task; the important decisions are often delayed, due to the fear that the actions might not be as efficient as were expected. The compulsive manager is a workaholic; the perception created is that "to work hard", the devotion and involvement leading to the neglect of interpersonal relationships.

The organizational culture created by this type of leadership is one that is resistant to change and it promotes an untrustworthy environment. In order to implement the coordinating function of management, the leader will prefer the formal mechanisms of control, in favor of the people's willingness, demand in favor of determination. The decisional process is accompanied by persuasion, beyond the limit of manipulation and suspiciousness. The leader's preoccupation with control will limit the employees' freedom of action, in a conflicting manner. The intrinsic motivations do not work, the organization is not decentralized and the human resources structure is divided between the decisional players (executive managerial level) and the laborer (operational level). The bureaucratic culture of the group is impersonal and inflexible, overrun by the preoccupation for control, operations and external environment. This type of leaders does not lead by means of guidance and determination of the people; they lead by demanding and legal – rational authority. The compulsive organizations do all they can to manage surprises and monitor, in certain predictable conditions, everything that happens within the organizations. The bureaucrats are the ones that feel motivated in this type of organizational system. The autonomous persons feel discouraged due to the fact that their freedom of action is confined. Whatever the management's quality and the manifestation of influential needs, this type of leader will not delegate the authority of control of the operation, limiting any type of participative management process.. ([25] Grigorut C., Berea A-O., Balaceanu, A-V., 2008). The organizational policies are not determined by the objective adaptive needs; instead they are determined by the leader's compulsiveness. The type of operation is done routinely and dominated by the interest for what's taking place within the organization. The details are carefully planned and projected, emphasizing on being thorough, precise and conformed. Just like the suspicious firms, the compulsive ones tend to emphasize on the function of control of management, although presenting specific differences. Within the compulsive firms, the control mechanisms are conceived in such a manner that it will monitor the internal aspects of the operations (productivity, costs, programming the activities and performances of the projects), whilst within the suspicious ones the control has to do with the external ones. The control mechanisms of the compulsive firms include the standardization of operations and formalizing the procedures and policies. Their procedures refer to the actions regarding production, marketing, as well as to the dress code, meeting and employees' attitude.

The compulsive firms' concentration towards the center is reflected in their strategies as well. The compulsive companies that pride themselves in a market leader position can continue to launch new products, even when the conditions do not recommend other innovations. Orienting towards the center, does not offer the compulsive type manager a correct analysis of the market ([24] de Vries, 2003, p.181). Variations are characteristics of the compulsive companies: the leaders fluctuate from innovations to the incremental lines, towards aged production lines, from a position of leader of costs towards a destructive parsimony, from the high quality line towards the total neglect regarding the quality criteria.

Management control and the change of leadership can be achieved as follows:

- demolishing the existing bureaucratic structures
- involvement in a diversification program in related areas
- major investments in research and development
- motivating entrepreneurial management and strategic innovations
- opening towards the market, quality management principles and clients' needs
- quantification of the comparison criteria with organizations that hold lead positions in certain operations (benchmarking).

2.3. Change Management. Some ethical approaches

In the article Leadership and change: the case for a greater ethical clarity, Bernard Burnes and Rune Todnem([26] 2012,p. 241) examined" the developments in leadership over the last three decades and how these relate to change and ethics". The article reviewed the two main approaches to organisational change-Planned and Emergent change-and the implications of these for ethical behaviour by leaders. Paper explored the implications for leadership and change of the consequentialist perspective on ethics, followed by a discussion of implications for organisations of the ethics underpinning the different approaches to leadership and change." The article concludes that only with greater ethical clarity can organisations ensure that their leaders will undertake changes which serve the interests of all stakeholders and avoid the financial scandals and collapses of the past two decades".

In making the case for a greater ethical clarity in relation to leadership and change, authors adopted a consequentialist perspective on ethics. Consequentualism is a philosophy which holds that the value of action drives form the value of its consequences ([27] Blackburn 2008; [28] Kaler 2000; [29] Burnes etTodnem, 2012). Stakeholders have a positive and active role to play in identifying and ending unethical practices.

3. CONTENT ANALYSIS REGARDING THE ETHICAL BEHAVIOR OF THE UNION LEADERS IN THE ROMANIAN MANAGEMENT OF CHANGE

The study's objective was to demonstrate that the Romanian organization oppose change and are not adequately decentralized. There are fundamental differences between these two characteristics. Promoting the autocratic type, in combination with the bureaucratic compulsive type, determines a major gap between the executive managerial level and the operational one. The inadequate union activity is also responsible for the **centralism** within the organizations and the toxic influence it has on change ([30], Surugiu, 2012, 303). These are the conclusions of a study regarding the Romanian union leader's perception.

In order to identify the social perception on the union leaders, we have conducted 80 unstructured interviews with the employees, at different levels and on certain areas ([31], Mina, 2009, 252). The recorded interviews have been subjected to scrupulous content analysis, resulting, due to the frequency of certain words, 5 subjects. The predominant subject is that of political involvement, expressed by phrases such as : "He/she like being with the ones in power…", "He/she carries out whatever the party tells them to", …"he/she negotiated on their own terms (the ones in power)", He/she is persuaded by the ones in power….", etc.

The conflicting attitude in the group relationships represent the second important subject, manifested by phrases such as “He/she talks nonsense/badly…”, “They treat us in a condescending manner…”, “They think they are better than us…”, “He/she is autocratic”, etc.

The union leaders are also perceived as being weak negotiators, materialized by phrases such as: “He doesn’t know how to fight for our interests…”, “He doesn’t know how to communicate to the management..”, “He can barely speak, and when he does, the director does it for him…”, etc.

Another important subject regards the personal interest, therefore the interviewed persons use expressions such as: “He’s changed three cars since he’s become union leader…”, “He is only interested in money…”, “He knows how to address the problem only if there is something in it for him….”, “He is interested only for his personal gain, the collective objectives being the last thing on his mind…”, etc.

We can also notice the inadequate relation with mass media, a union leader’s characteristic. The most frequent expressions that lead to this subject are: “He is afraid of making any statements…”, “He would probably run if the TV reporters were to drop by…”, “He is ethically compromised, he is afraid of articles from the press….”, “He is a weak relationist, who organizes inadequate press conferences”, etc.

The informational basis of the content analysis ([32], Chelcea, 2001) has been constituted by the 80 protocols, the research group being formed by 48 men (60%) and 32 women (40%):

Table 1 The biologic gender

	Frequency	Percent%	Valid Percent	Cumulative percent
Masculine	48	60.0	60.0	60.0
Feminine	32	40.0	40.0	100.0
The Total	80	100.0	100.0	

With regards to the active period within the institution, the interviewed subjects have an average of 9.26 years, a median of 10 years and a standard deviation of 3.09 years. The most frequent category is that of 11 years, active period of employees being between 4 and 14 years.

Based on the median value ([33] Schermerhon, 2002, pp.349-356) we can appreciate that the subjects with less than 10 years are considered relatively new subjects within the institution, and the ones that have over 10 years are considered older.

From the afore mentioned data it results that the distribution of the 80 interviewed subjects regarding their active time within the institution is a symmetrical type (Skewness = -0.21; Skewness standard deviation = 0.26) and mesokurtic (Kurtosis = -1.06; Kurtosis standard deviation = 0.53), elements that validate as normal the distribution of the lot with regard to the this characteristic.

Regarding the seniority level, we can appreciate that, out the 80 interviewed subjects, 53 people (66.3%) hold executive level positions and 27 (33.8%) hold headship positions.

Table 2 The seniority in the institution
Statistical Inventory

N	Valid	80
	Absent	0
Media		9,26
The median		10,00
Modul		11
Standard deviation		3,092
Skewness		-,213
Eroare Skewness		,269
Kurtosis		-1,069
Eroare Kurtosis		,532
Amplitudine		10
Minimum		4
Maximum		14

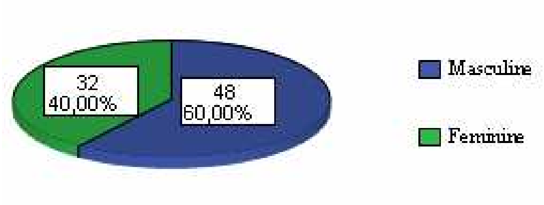

Figure 1 Bilogic Gender

This relative imbalance is explained by the number of headship positions in comparison to the executor positions, within the organizational ensemble.

After indentifying the subjects, we’ve proceeded to the codification of presence or absence of one of the five subjects, for every investigated subject. The presence of the subject was noted with a value of “1”, whereas the absence has a value of “0”.

4. CONCLUSIONS

A number of 53 interviewees (66.25%) have mentioned, in their protocols, the fact that the union leaders are weak negotiators, whereas 27 people (33.75%) were not present at this subject.

The “personal interest” subject has been identified in the case of 50 subjects (62.5%), whereas 30 subjects (37.5%) have not recognized this subject in the answers.

The political co-involvement has been identified as a subject by 60 people (75%), whereas 20 subjects (25%) have not perceived this subject about the union leaders.

Table 3 The hierarchy

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Executional	53	66,25	66,25	66,25
	Managing	27	33,75	33,75	100,0
	Total	80	100,0	100,0	

Table 4 Absence of the negotiation attributes of leadership

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Absence of issue	27	33,75	33,75	33,75
	Presence of issue	53	66,25	66,25	100,0
	Total	80	100,0	100,0	

Table 5 Individual interest

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Absence of issue	30	37,5	37,5	37,5
	Presence of issue	50	62,5	62,5	100,0
	Total	80	100,0	100,0	

Table 6 Political implication

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Absence of issue	20	25	25	25
	Presence of issue	60	75	75	100,0
	Total	80	100,0	100,0	

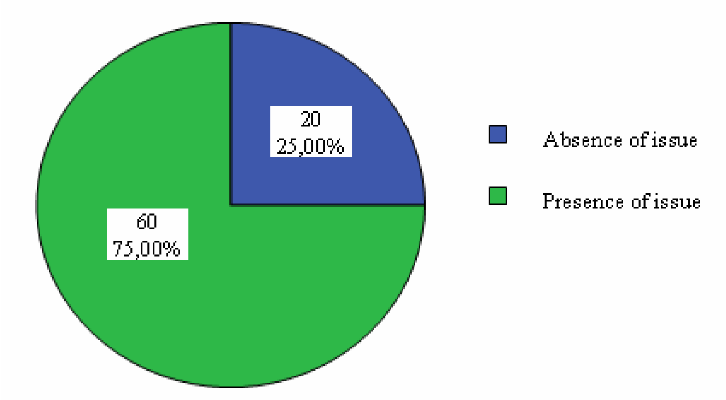

Figure 2 Political implication

he union leaders are being perceived as having an inadequate relation with the mass media (48 people-60%), whereas 32 interviewed subjects (40%) did not point out this aspect in their interview. The conflicting aspect among the group relations has been identified by 55 people (68.75%), whereas 25 people (31.25%) have not noticed this type of conflicting relations. In identifying the predominant subjects, we have used the non-parametric statistical test of difference X^2 between the observed frequency of appearance of an event and the theoretical frequency, when it is presumed the equal presence of the categories. Identifying the significant subjects with the help of the significant difference test, among the frequencies. As it can be noticed in the table, the main observed subject is political co-interest, an important subject, identified significantly by the interviewed subjects (x^2=20.00; $p<0.01$). Furthermore, the union leaders are significantly perceived as being conflicting regarding their group relations (x^2=5.00; $p<0.05$). The subject of inadequate relation with the mass media, although important, cannot be considered significant. The difference of perception of the union leader by the senior hired personnel (greater than 10 years) in comparison with the latter hired personnel (lower than 10 years) has been studied with the help of significant difference test among the ranks U Mann-Whithey ([34] 2007, pp.41-90). The meaning of the significant difference among the senior personnel and the latter could be resumed:

- A general tendency of negative increase can be observed, in the sense of the present subject, of a number of 3 subjects: the individual interest (Z=-2.66; $p<0.01$), the inadequate capacity for negotiation (Z=-2.12; $p<0.05$) and the inadequate relation with the mass media (Z=-2.11; $p<0.05$). Within this context, the senior personnel have the tendency to significantly point out the presence of these subjects in comparison to the latter, younger personnel (lower than 10 years)

Table 7 Generates conflicts in working groups

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Absence of issue	25	31,25	31,25	31,25
	Presence of issue	55	68.75	68.75	100,0
	Total	80	100,0	100,0	

Table 8 Test Statistics

	Negotiation process	Individually interest	Politically Determination	Mass media Relationships	Managing conflicts
Mann-Whitney U	603,000	552,000	722,000	598,000	637,000
Wilcoxon W	1684,000	1633,000	1803,000	1679,000	1718,000
Z	-2,127	-2,669	-,779	-2,110	-1,758
Asymp. Sig. (2-tailed)	,033	,008	,436	,035	,079

a. Grouping Variable: Seniority

5. REFERENCES

[1] Barker, R.A., *The nature of leadership*, Human Relations, 54(4), 469-494, 2001
[2] Beer, M.,& Nohria, N., *Breaking the code of change*, Boston, MA: Harvard Business School Press, 2000.
[3] Burnes, B , *Managing change*, 5th Edition, London, FT/Prentice Hall, 2009.
[4] Bernard Burnes, Rune Todnem By, Leadership and change: The case for a greater Ethical Clarity, in Springer Science+Business Media, B.V. , J.Bus, pp.240-249, DOI 10.1007/s10551-011-1088-2, 2011.
[5] Bessant, J., &Haywood, B., *The introduction of flexible manufacturing systems as an example of computer integrated manufacture*, Brighton Edition , 1985.
[6] Crosby, P.B., *Quality is free*, New York: McGraw-Hill, 1979.
[7] Hammer, M., & Champy, J., Re-engineering the corporation, London: Nicolas Brealey, 1993.
[8] K. Lewin, *Field Theory in Social Sciences*, New York, Harper& Row, 1951.
[9] Grigoruț C., Anechitoae C., *Creativity and Innovation - Supporting the Employability of Graduates on Labor Market*, UNISO 2010. UNlversity in SOciety, 9th Edition Lifelong Learning - Support for Economic Growth, 07-11 iulie 2010, Timişoara, pp. 111-117, http://media.unibuc.ro/stiri-din-universitate/cea-de-a-ix-a-editie-a-universitatii-de-vara-universitatea-in-societate-uniso-2010
[10] Ibarra, Hermina, *Provisional selves: Experimenting with image and identity in professional adaptation,* Administrative Science Quarterly, 44, 764-791, 1999.
[11] Kreiner, Glen E., Hollesbe, Elaine C.,& Sheep, Mathew L., *Where is the "me" among the "we"? Identity work and the search for optimal balance,* Academy of Management Journal, 49,1031-1057, 2006.
[12] Pratt, MichaelG., Rockmann, Kevin W., & Kaufmann, Jefrey B., Constructing professional identity: the role of work and identity learning cycles in the

customization of identity among medical residents, Academy of Management Journal, 49, 235-262, 2006.

[13] Thornborrow, Thomas, &Brown, Andrew D., *"Being regimented": Aspiration, discipline and identity work in the British parachute regiment*, Organizational Studies, 30, 355-376, 2009.

[14] Gianpiero Petriglieri, Mark Stein, *The unwanted Self: Projective Identification in Leaders' Identity Work*, in Organization Studies 33(9), www.egosnet.org/os, pages 1218-1235, sagepub.co.uk/journalsPermissions.nav, DOI: 10.1177/0170840612448158, 2012.

[15] Asforth, Blake., Kreiner, Glen E., "How can I do it?": Dirty work and the challenge of constructing a positive identity, Academy of Management Review, 24, 413-434, 1990.

[16] Snow, David A., & Anderson, Leon, *Identity work among the homeless: The verbal construction and avowal of personal identities*, American Journal of Sociology, 92, 1336-1371, 1987.

[17] Dav, David V., & Harrison, Michelle M., *A multilevel identity based approach to leadership development*, Human Resources Management Review, 17, 306-373, 2007.

[18] De Rue, D. Scott, Asford, Susan J., & Cotton, Natalie C., *Assuming the mantle: Unpacking the process by which individuals internalize a leader identity*, in L. M. Roberts& J.E. Dutton, Exploring positive identities and organizations: Building a theoretical and research foundation (pp.217-236), New York: Taylor& Francis, 2009.

[19] Ibarra, Hermina, Snook, Scott, & Guillen Ramo, Laura (2010), *Identity based leader development.* In R. Khurana& N. Nohria (Eds), Handbook of leadership theory and practice(pp. 657-678), Boston, MA: Harvard Business Press, 1999.

[20] Lord, Robert G., & Hall, Rosalie J., *Identity deep structure and the development of leadership skill*, Leadership Quarterly, 16, 591-615, 2005.

[21] De Rue, D. Scott&Asford, Susan J., *Who will lead and who will follow? A social process of leadership identity construction in organization*, Academy of Management Review, 35, 627-647, 2010.

[22] Petriglieri, Gianpiero, Wood, Jack D., & Petriglieri, Jennifer L., *Up close and personal: building foundations for leaders' development through the personalization of management learning*, Academy of Management Learning and Education, 10, 430-450, 2011.

[23] Phil Hunsaker, Tony Alessandra, *The new art of managing people*, Free Press, A Division of Simion& Schuster, Inc, NY 10020, 2008.

[24] Manfred Kets de Vries, *Leadership-the science and art of managing*, Codecs Edition, 2003.

[25] Grigorut C., Berea A-O., Balaceanu, A-V., *Evaluarea Afacerilor. Managementul financiar si realizarea performantelor*, Editura BREN, Bucureşti, 2008 .

[26] Gianpiero Petriglieri, Mark Stein, *The unwanted Self: Projective Identification in Leaders' Identity Work*, in Organization Studies 33(9), www.egosnet.org/os, pages 1218-1235, sagepub.co.uk/journalsPermissions.nav, DOI: 10.1177/0170840612448158, 2012.

[27] Blackburn, S., *The Oxford dictionary of philosophy(2nd)*, Oxford: Oxford University Press, 2008.

[28] Kaletr, J., *Reasons to be ethical: Self interest and ethical* Business, Journal of Business Ethics, 24(3), 257-272, 2000.

[29] Bernard Burnes, Rune Todnem By, Leadership and change: The case for a greater Ethical Clarity, in Springer Science+Business Media, J.Bus, pp.240-249, DOI 10.1007/s10551-011-1088-2, B.V.2011.

[30] Surugiu, F, Surugiu,I, *LEADERSHIP AND CRISIS MANAGEMENT DURING CRISIS SITUATIONS*, Constanta Maritime University's Annals, Year XIII,vol.18, Romania, pp.303-312, 2012.

[31] Simona Mina, *Prfecting in management of conflicts*, Ex.Ponto Edition, 2009.

[32] S. Chelcea, *The sociological methodology of research: qualitative and quantitative methods*, Ed. Economică, 2001.

[33] J.R.Schermerhon, G.J. Hunt, N.R.Osborn, *Organizational behavior*, Wiley, 2002, p.349-356

[34] M. Agabrian, *Content analysis*, Ed. Polirom, 2007.

ECONOMICAL AND ENVIRONMENTAL COORDINATES OF BLACK SEA REGION

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ABSTRACT

This paper represents a short analysis of a number of key points that relate to the geographical, socio-economic, institutional and to the ecological conditions of the Black Sea region and the Black Sea Basin. The Black Sea region is steeped in history and culture and forms a vital trading area linking Europe with Asia. It is the world's largest locked internal sea with a surface area of 423,000 km^2 and a unique marine environment. Anthropogenic pressures, associated with the economic situation of the Black Sea countries, has decreased during the last decade, allowing some improvement in the state and biodiversity of the ecosystem. The abundances of several native species have increased. However, mediterranization - the invasion by species from the adjacent basin and beyond-has continued. The conclusion is grounded, that biodiversity is not only inter- and intra-species diversity but also spatial-temporal variability, abundance and productivity dynamics, differences of the metabolic strategies providing sustainable existence in the changing environment. Biodiversity at the intraspecies level expresses itself in spatial and temporal variations of the Black Sea biota. It has been shown, that preservation of the Black Sea ecosystem's biodiversity must be based on the measures which should be undertaken in national and social spheres, and be directed to the recreation, stabilization and conservation of this unique sea basin.

Key words: *Black Sea region, geography, socio-economical conditions, biodiversity, environmental conditions*

1. INTRODUCTION

The Black Sea is one of the most remarkable regional seas in the world. It is almost cut off from the rest of the world's oceans, is over 2200 m deep and receives the drainage from a 1.9 million km^2 basin covering about one third of the area of continental Europe. Its only connection is through the Bosphorus Strait, a 35 km natural channel, as little as 40 m deep in places.

This channel has a two layer flow, carrying about 300 km3 of seawater to the Black Sea from the Mediterranean along the bottom layer and returning a mixture of seawater and freshwater with twice this volume in the upper layer. Every year, about 350 km3 of river water enters the Black Sea from an area covering almost a third of continental Europe and including significant areas of seventeen countries: Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Germany, Hungary, Moldova, Slovakia, Slovenia, Romania, Russia, Turkey, Ukraine and Serbia. Europe's second, third and fourth largest rivers (the Danube, Dnipro and Don) all flow to the Black Sea.

Isolation from the flushing effects of the open ocean, coupled with its huge catchment, has made the Black Sea particularly susceptible to eutrophication (the phenomenon that results from an over-enrichment of the sea by plant nutrients). Eutrophication has led to radical changes in the Black Sea ecosystem in the past three decades with a major transboundary impact on biological diversity and human use of the sea, including fisheries and recreation. Prior to the 1990s, little or no action had been taken to protect the Black Sea.

Political differences during the Soviet era, coupled with a lack of general knowledge of the environmental situation resulted in an absence of effective response. In 1992 the Black Sea countries signed the Bucharest Convention followed closely by the first Black Sea Ministerial Declaration (the Odessa Declaration) in 1993.

2. GEOGRAPHIC BOUNDARIES. BATHYMETRY

The Black Sea is an inland Eurasian sea bordering Ukraine and the Russian Federation to the north, Bulgaria and Romania to the west, Georgia to the east and Turkey to the south (figure 1). The Black Sea is located between latitudes 40° 56'N and 46° 33'N, and longitudes 27° 27'E to 41° 42'E.

It is located in the east-west depression between two alpine fold belts, the Pontic Mountains to the south and the Caucasus Mountains to the northeast. The topography of the north western coast (except for Crimea) is relatively low and flat [8].

The Black Sea is a semi-enclosed sea connected to the shallow (10–20 m) Azov Sea through the Kerch Straits and to the Mediterranean Sea through the Bosporus Straits, the Marmara Sea and the Dardanelles Straits. The flat abyssal plain (20% of free surface, depth. 2000 m) rises to the continental shelves.

The northwestern shelf (mean depth 50 m) has a shelfbreak at about 100 m between the Crimean peninsula and Varna in the South. The Danube and the Kerch fans are gentle continental slopes. The other portions of the shelf are narrow (20 km), fractured by canyons, abrupt ridge extensions and steep continental slopes. The only connection to other marine water bodies is through the winding Istanbul (Bosporus) Straits, a 35 km natural channel, as little as 40 m deep in places [10].

Figure 1 Geographical boundaries in Black Sea Region

The Black Sea is up to 2212 metres deep (North of İnebolu) and receives the drainage from a 1.9 million km2 basin, covering about one third of the area of continental Europe. The Bosporus has a two layer flow, carrying about 300 km3 of seawater to the Black Sea from the Mediterranean along the bottom layer and returning a mixture of seawater and freshwater with twice this volume.

The seabed is divided into the shelf, the continental slope and the deep-sea depression (figure 2). The shelf occupies a large area in the north-western part of the Black Sea, where it is over 200 km wide and has a depth ranging from 0 to 160 m. In other parts of the sea it has a depth of less than 100 m and a width of 2.2 to 15 km. Near the Caucasian and Anatolian coasts the shelf is only a narrow intermittent strip.

The thin upper layer of marine water (up to 150 m) supports the unique Black Sea ecosystem. The deeper and more dense water layers are saturated with hydrogen sulfide that has accumulated over thousands years as a by-product of decaying organic matter. Due to the unique geomorphological structure and specific hydrochemical conditions, very specific organisms, including protozoa, bacteria, and some multi-cellular invertebrates, inhabit the deep-sea waters.

Knowledge about forms of life in the deep waters of the Black Sea is very limited, but it is clear that disturbance of the natural balance between the two layers could trigger irreversible damage to the people and ecosystem of the Black Sea.

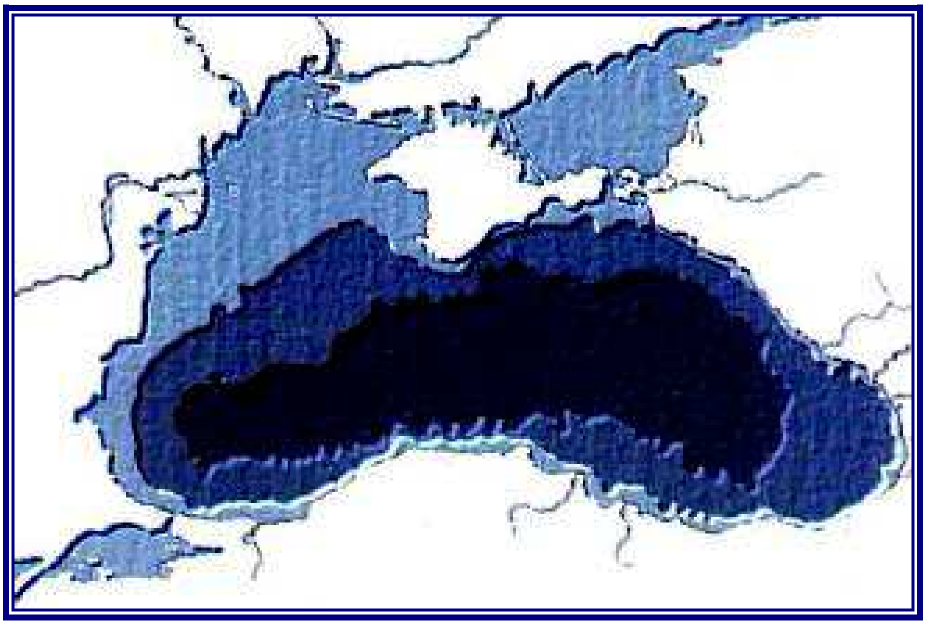

Figure 2 Black Sea bathymetry

Source: *** Black Sea Transboundary Diagnostic Analysis, may, 2007

3. COASTLINE CHARACTERISTICS

The length of the Black Sea shoreline is approximately 4 340 km (table 1). The Black Sea has similar geological properties as the major oceans, and is classified geomorphologically into three key sections namely:

- the continental shelf;
- the continental side;
- the abrasion platform.

The continental shelf covers 24.1% of the Black Sea surface area and has a 0.5-5‰ slope. This area generally extends 0-90 m depth from the shoreline. The continental shelf is very important for fishing, although it is quite narrow along the Anatolian and Caucasus coasts. The length of national Black Sea costlines is presented in table 3.1, Ukraine having the longest coast and Romania the shortest [9].

Table 1 Black Sea shoreline length (km)

Country	Length (km)
Bulgaria	300
Georgia	310
Romania	225
Russian Federation	475
Turkey	1 400
Ukraine	1 628
Total	**4 338**

Source: *** Black Sea Transboundary Diagnostic Analysis, may, 2007

4. SOCIO-ECONOMIC COORDINATES

Social and economic changes within the Black Sea Basin both impact the ecosystem and are impacted by many of the environmental changes that have been brought about during the last century. The historical socio-economic conditions of the Black Sea have largely shaped practices that continue to date. The shift from the Soviet economic system to a more free market system in the Warsaw Pact States, the movement towards EU accession of some countries and economic fluctuations in the 1990s has influenced the ecosystem of the Black Sea.

The Black Sea countries coastal zones are estimated to contain about 20 million people in their coastal areas. However, the situation with regard to Istanbul is confusing, since the coastal administrative unit which includes Istanbul has a short Black Sea coastline. Thus, if the population of this area is also included, the value increases to over 40 million people.

The proportion of national populations living within Black Sea coastal administrative areas varies widely: 0.6% in Russia, 4.5% in Romania, 10.5% in Turkey (excluding Istanbul), 14.4% in Ukraine, 26.5% in Bulgaria, 37.1% in Turkey (including Istanbul) and 38.6% in Georgia.

Avaılable data suggest the proportions of populations living in coastal administrative areas which are connected to sewerage systems range from about 53% in Russia, through 70% in Turkey (excluding Istanbul) to > 90% in Bulgaria, Georgia and Romania.

However, intuitively these values do appear to be on the high side, and bear no relationship to the level of treatment that is applied to the wastewater produced. A coastal population of some 7 million inhabitants is connected to sewerage systems discharging directly into the Sea.

5. LEGISLATION FOR TRANSBOUNDARY COOPERATION

Since the beginning of the 1990s, the countries of the region, with financial assistance from the international community, have started to co-operate in order to promote the sustainable use of transboundary water resources. The 1992 Bucharest Convention and its Protocols, the 1993 Odessa Declaration and the 1996 Black Sea Strategic Action Programme for the Protection of the Black Sea against Pollution provided the impetus and framework for cooperation among the six Black Sea countries.

The Ministries of Environment from the six Black Sea Countries are responsible for the overall implementation, at national level, of the Bucharest Convention and the Black Sea Strategic Action Programme. To achieve the purposes of the Bucharest Convention the Black Sea Commission was established, with one member from each of the six national governments. The Commission provides a supervisory role over its Permanent Secretariat which, in turn, co-ordinates the activities of the Commission.

The mandate of the BSC is broad and, with time, has been further expanded to include additional activities. The functions of the BSC are defined under Article XVIII of the Bucharest Convention. Existing protocols to the Convention have added some new functions to the already extensive list, or specified further responsibilities.

Additional functions have also been entrusted to the Commission by two declarations adopted at regular meetings of Ministers of the Environment of Black Sea states – the 1993 Odessa Declaration and the 2002 Sofia Declaration - as well as by memoranda of understanding and cooperation between the BSC and other international bodies - the ICPDR and the European Environment Agency.

For Black Sea riparian countries, ensuring a robust institutional framework is a key element in the successful protection of the Black Sea. During the last few years some of the Black Sea countries have made substantial progress in improving this framework for environmental protection, supported by major changes in the legal framework.

6. THE ECOSYSTEM AND HABITAT TYPES

The Black Sea biota reflects the general historical processes that have influenced the ecosystem of the sea. The main biotopes are sandy-bottom shallow-water areas, especially in the north-western part of the Black Sea and the Sea of Azov. The coasts of the southern Crimea, the Caucasus, Anatolia, some capes in the south-western part of the Black Sea (Kaliakra, Emine, Maslen Nos, Galata) and Zmeiny Island are mostly rocky.

The sea beds are mostly mud in the zone between 10 to 20 m and 150 to 200 m depth. The total area of Black Sea coastal wetlands is about 10 000 km^2. There are sites of reproduction and feeding and wintering grounds of many rare and commercially valuable fish species, including the sturgeon family, and are therefore biotopes of special importance.

Anoxic conditions occurring below about 120-200 m depth delimit the vertical distribution of planktonic and nektonic organisms, as well as bottom-living organisms. The structure of marine ecosystems differs from that of the neighbouring Mediterranean Sea in that species variety is lower and the dominant groups are different. However, the abundance, total biomass and productivity of the Black Sea are much higher than in the Mediterranean Sea [1].

Figure 3 Physiography of the Black Sea biogeographical region, Source: *** European Environment Agency, Europe's biodiversity - biogeographical regions and seas, Biogeographical regions in Europe, The Black Sea Region - shores and delta, ZooBoTech HB, Sweden, Linus Svenson (final edition), 2010

7. PROTECTED AREAS

The Black Sea community has a global responsibility to preserve the character of its varied ecosystems and landscapes, and to conserve the migratory species that cross the region and the threatened species that it hosts.

Measures taken to conserve or restore habitats and species in the Black Sea entail the establishment of protected areas as a major approach of *in situ* biodiversity conservation. The total surface of Black Sea marine and coastal protected areas by country is given in table 2.

The statistics show that the largest marine protected areas (MPAs) are designated by Ukraine, while protected wetlands and coastal terrestrial areas are the largest in Romania. Romania leads in terms of protected marine area per unit shoreline, followed by Ukraine and Georgia. In Bulgaria, the coverage of MPAs is clearly insufficient.

Turkey has no designated MPAs, and the least coverage of coastal protected areas compared with other Black Sea countries, albeit that Russian data were not provided.

Table 2 Total surface of Black Sea marine and coastal protected areas by country and marine protected areas (MPA) per unit shoreline

Country	Protected areas (ha)				Shoreline length (km)	MPA (ha) / Shoreline (km)
	Marine	Coastal wetlands	Coastal terrestrial	Total		
Bulgaria	1160	16902.23	115589.9	13365.13	300	4
Georgia	15742	0	28571	44313	310	51
Romania	21000	339336.98	226008	586344.98	225	93
Russian Federation	-	-	-	-	475	-
Turkey	0	31335	3000	34335	1 400	0
Ukraine	123530.7	92497.7	68658	284686.4	1 628	76
Total	**161432.7**	**480071.9**	**441826.9**	**1083331.5**	**4 338**	**-**

Source: *** Black Sea Transboundary Diagnostic Analysis, may, 2007

The majority of protected marine and coastal areas (93%) were declared during the 1990s, which is indicative of significant recent progress in *in situ* conservation of biodiversity in the Black Sea region.

Romania ranks first (56%) regarding surface of protected areas designated during the 1990s, followed by Ukraine (22%) Bulgaria (10 %) and Georgia (4%), while

Turkey has not declared any protected areas during this period.

8. BIODIVERSITY PROTECTION - BLACK SEA ENVIRONMENTAL COOPERATION

The Black Sea's marine and coastal ecosystems have a number of characteristics. Salinity (salt content) is 17.5-18 grams per litre (in the depths this rises to 20-22 g/L). There is a stable temperature at the depths below 150 m of 8.5-9 °C. The water is saturated with hydrogen sulphide at depth below 150 m and there is a lack of lack of oxygen (a state known as hypoxia).

There is a very restricted water exchange with neighbouring seas (only 0.1% of water volume per year). The sea is very deep - the shallowest area of the sea is the shelf zone in the North-Western quadrant. Because of the depth and the lack of circulation there is also very slow vertical water exchange (hundreds years). As a result of all these factors some 87% of the sea is either hypoxic or poisonous to life.

The biodiversity of the Black Sea ecosystem includes some 2,050 species of animals including Arthropoda (over 590 species), Molluscs (206), Echinodermata (14), Fish (184) and Mammals (4 species) [1].

The Black Sea wetlands (such as the Danube Delta) are of international importance as sites of reproduction, feeding and wintering grounds of numerous rare and commercially valuable fish species as well as migratory birds. The Strategic Action Plan for the Rehabilitation and Protection of the Black Sea (Istanbul, 31 October 1996) says: "The state of the Black Sea environment continues to be a matter of concern due to the ongoing degradation of its ecosystem and the unsustainable use of its natural resources."

If one looks back over a thirty year period between the 1960s to 1990s one can illustrate this situation. The Black Sea ecosystem was and continues to be threatened by inputs of nutrients, heavy metals, oil and its derivatives, persistent organic pollutants, and radio nuclides.

During the thirty year 1960-90 period 1,035,635 tonnes per year of effluent were introduced into Black Sea (85% of total amount was introduced via river transport); 53,976,963 tonnes per year of suspended solids (99% was introduced by rivers); and 111,000 tonnes per year of oil (48% was entering from the Danube river). The Danube is the biggest polluter and accounts 87.8% of the Biochemical Oxygen Demand in the sea (that is substances which are broken down by microorganisms in the presence of (and with the consumption of) oxygen - oxygen demand is then measured in terms of the oxygen consumed by microorganisms in this process) [9].

The results of this pollution have been manifold. For example there has been a decline in commercial fish stocks. By the 1960s, 26 species of fish were considered as commercially valuable; by the 1980s this number declined to 5. Landings of fish drastically declined from 360,000 tonnes in 1971 to 250,000 tonnes in 1991 (total in the region). Ukrainian Black Sea landings declined from 129,000/74,000 tonnes of total/anchovy in 1975 to 42,000/18,500 tonnes respectively in 1995. An increase in landings of fish in Turkey was only due to a significant increase in fishing efforts.

The perceived major environmental problems of the Black Sea could therefore be described as follows. Firstly a loss of habitats, notably wetlands and shelf areas, that were supporting important biotic resources. Phyllophora (a key-stone species which forms the nucleus of a biocenosis (community) of approximately 100 invertebrates and fish) decreased from 10,000,000 to 500 km2 while its biomass decreased from 10,000,000 to 400,000 tonnes.

Perennial brown algae (Cystoseira barbata, the nucleus of a biocenosis of approximately 50 invertebrates and fish) was lost completely. The total biomass of the Black Sea mussel (Mutilus galloprovincialis) decreased to one third of its original amount; the total biomass of oyster (Ostraea edulis) was reduced to 1.4% of its original amount, the quantity of grey mullet (Mugil cephalus) was reduced to 0.8% of its original amount; and the population of Monk Seal (Monachus monachus) is lost from the Black Sea ecosystem.

Along side this loss or imminent loss of endangered species and their genomes there is a concurrent problem: the replacement of indigenous species with exotic ones. The most spectacular and unpleasant example is the introduction of an exotic ctenophore (comb jelly) Mnemiopsis leidyi.

From 1982 (when the first specimens were reported) until the late 1980s, its total biomass in the Black Sea was estimated as close to one billion tonnes. Mnemiopsis feeds on planktonic crustaceans, mollusc larvae and pelagic fish eggs and larvae, resulted in a sharp decline in anchovy stocks in the Azov and Black Seas.

Beyond the effect of pollution on marine life there are other factors. There is inadequate protection of marine and coastal resources from maritime accidents. The state of the sea also causes unsanitary conditions on many beaches, bathing and shellfish-growing waters and a general degradation of the Black Sea landscape.

The underlying causes of environmental degradation are also various. Particularly pernicious are the overexploitation of natural resources, the invasion of exotic species and an increase in chemical nutrients (eutrophication). From the 1960s to 1990s, water transparency decreased by half, and the area of summer-autumn hypoxia zones increased more than 1,000 times. In summary the Black Sea has suffered a tragic decline in the last thirty years.

There have therefore been a number of international efforts of environmental protection of the Black Sea. The delegations of Albania, Azerbaijan, Bulgaria, Armenia, Georgia, Greece, Moldova, Romania, Russian Federation, Turkey and Ukraine adopted the Bosporus Declaration on the Black Sea Economic Cooperation in Istanbul in 1992. In Bucharest, also in 1992, the Convention on the Protection of the Black Sea Against Pollution aimed to protect the marine ecosystem against pollution from atmosphere, marine and land based sources. The signatories (Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine) ratified the convention which came into force in 1994 along with 4 additional Protocols.

A Ministerial Declaration made in Odessa 1993 was signed by the Ministers of Environmental Protection from Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine. This declares political obligations regarding protection and sustainable use of the Black Sea resources and specifies practical steps on implementation of the Bucharest Convention (mentioned above).

The UNDP-GEF Black Sea Environmental Program (BSEP, 1993-1998) with a programme budget of $30 million brought together Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine with the overall purpose to develop long term measures of control and prevention of the pollution of marine ecosystem and rehabilitation of the environmental economy in the region. A Strategic Action Plan for the Rehabilitation and Protection of the Black Sea (Istanbul, 1996) again signed by Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine focused on the sustainable development of the Black Sea region

A second UNDP-GEF scheme, the Black Sea Ecosystem Recovery Project BSERP, was initiated in 2000-2007 with a project budget of $20 million. This involved Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine and aims to provide a framework for coordination, dissemination and replication of successful measures for coastal zone management, protection of habitats and marine ecosystems and sustainable exploitation of resources.

This and other schemes have created institutional frameworks for Black Sea environmental cooperation that are now well-established and operational. There are a number of coordinating structures in place such as the Black Sea Commission Permanent Secretariat, a network of Activity Centers, Advisory Groups and research institutions.

The structures and institutional framework has established a Black Sea Information and Monitoring System. This inter-government collaboration also ensures that environmental policy at regional and national levels is developed and strengthened and that a strong investment program for pollution control and prevention is in place. In addition there are research and educational programs and public information and participation mechanisms.

9. CONCLUSIONS

As a general conclusion I can say that we depend on the seas for our survival and yet the marine environment is deteriorating fast. This requires better ways of managing it.

The protection of the marine environment is the responsibility of everyone. We must be conscious of the pollution threats to our waterways and oceans and the serious effects that may result. Biodiversity in the Black Sea region is highly threatened. Many rare species of plants are to become extinct in the near future unless the countries in the region take conservation action.

The marine environment is also a great contributor to economic prosperity, social well-being and quality of life [5]. It constitutes a fund of resources which can be used to achieve greater economic potential, so its protection is crucial at a time when the European Union is seeking to revitalise its economy.

The marine environment is by its very nature a transboundary issue and so must be managed through cooperation and according to common principles. On the basis of the EU’s sixth environmental action programme 2002 - 2012, the European Commission has proposed a "thematic strategy" on the protection and conservation of the marine environment.

In practice, the aim is to achieve "good environmental status" of marine biodiversity and ecosystems by protecting them, allowing their recovery, and restoring their functions and structures.

The marine strategy will form the environmental dimension of the future EU maritime policy. Together they will ensure that Europe benefits from a dynamic maritime economy which is in harmony with the marine environment.

10. REFERENCES

[1] Alexandrov B.G., Zeitsev Yü.P., editors, Black Sea Biological Diversity Ukraine (National Report). GEF Black Sea Envitronmental Programme, UN Publications, Black Sea Envitronmental Series 7, New York, 351 p.

[2] Brătianu Gh., Marea Neagră, Editura Polirom, Iaşi, 1999

[3] Dumitru, M., Romanian livestock assessment. Report to the UNDP-GEF Black Sea Ecosystem Recovery Project, 2005

[4] Ielenicz M., Vişan Gh., Morphologz of the Romanian Black Sea shoreline. Comunicări de geografie, vol. 7, pp. 7-10, Editura Universității din Bucureşti, 2003

[5] Pascu Emilia, Părăian Elena, Stanciu Ion, Fundamentele ştiinţei mărfurilor, Manual de studiu individual, Editura Universitară, Bucureşti, 2012

[6] Milea Oana Maria, Nedea Petronela-Sonia, Ecologia şi protecţia mediului. Manual de studiu individual, Editura Universitară, Bucureşti, 2012

[7] Nedea Petronela-Sonia, Traficul rutier transfrontalier în sud-vestul României - impact asupra mediului şi a aşezărilor, Editura Universitară, Bucuresti, 2011

[8] Vespremeanu E., Geografia Mării Negre, Editura Universitară, Bucureşti, 2005

[9] *** Black Sea Transboundary Diagnostic Analysis, May, 2007

[10] *** European Environment Agency, Europe’s biodiversity - biogeographical regions and seas, Biogeographical regions in Europe, The Black Sea Region - shores and delta, ZooBoTech HB, Sweden, Linus Svenson (final edition), 2010

[11] Black Sea Commission, www.blacksea-commission.org

[12] Black Sea Ecosystem Recovery Project, www.bserp.org

[13] Danube River Commission, www.icpdr.org

PRICE STABILITY

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ABSTRACT

We can talk about price stability when not seen as inflation or deflation phenomena. Thus the European Central Bank defines price stability as an increase of up to 2% per annum of the harmonized index of consumer prices. The lowest inflation rates were recorded in countries such as Greece and Sweden, and the highest in Hungary, followed by Romania, according to recent data provided in November 2012 by the European Central Bank. Overall, most countries faced with low and relatively stable levels of inflation, explained that although individual prices of products in some sectors have seen a substantial increase in overall they were compensate of price reductions in other sectors and finally reached a relatively stable general price level.

Keywords: *stability of prices, HICP, deflation, inflation.*

1. INTRODUCTION

As defined by the Central European Bank stability of prices represents an increase of 2% per annum of the harmonized index of consumer prices (HICP) of the medium term.

Therefore we can talk about price stability in the absence of deflation or inflation. These two notions are economic phenomena that negatively affect the economy of any state, characterized by decreased, respectively generalized increase in prices in the long term, affecting the purchasing power of money.

Given the major influence of inflation on price stability, its modification is an essential element. Is there when inflation is rising prices, especially taking into account the dynamics of prices in a market economy.

Inflation for the euro area is determined by "the Harmonized Index of Consumer Prices" (HICP) representing an indicator by which to determine changes in consumer prices over time. Through it can be compared data from different countries, this is suggested by the name "harmonized" indicating that all Member States apply the same methodology.

The introduction of this indicator was essential considering that in the past, before the euro became the common currency; inflation was determined by each country using methods and techniques, this frequently causing variation of some major overlaps, thus limiting comparisons between countries.

2. ANALYZING THE INFLATION IN THE EUROPEAN UNION AND ROMANIA

Determination HICP is critical to maintaining price stability, increase economic welfare, global economic growth and creating new jobs. Thus it is necessary for compliance with a set of rules legally binding, and completion of certain steps by which to determine the variation of prices of consumer goods and services at both the country and the entire euro area:

- Collecting monthly prices of different goods and services by trained observers.
- Calculating the share of product groups according to their importance considering all consumers (rich and poor, young and old).
- Calculate the weight of each country in proportion to total consumption expenditure in the euro area.

In the 90's, the inflation rate reached values significantly lower values (due to two important elements: the European Central Bank monetary policy and preparing the country for the launch of euro) compared with the 70 - 80's when inflation reached very high values in many EU countries.

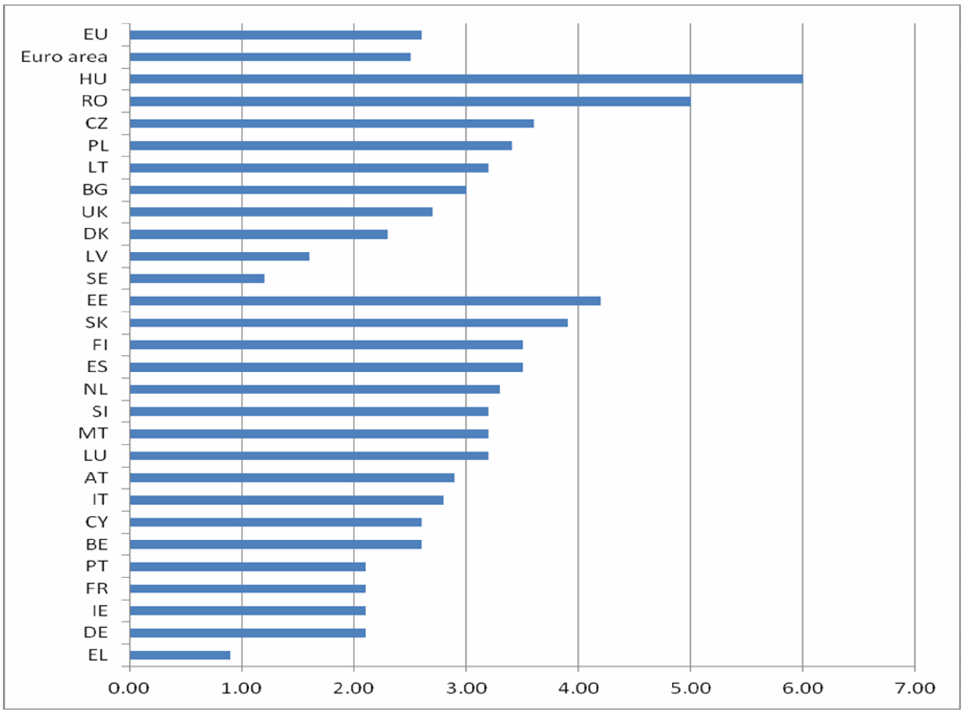

Figure 1 Inflation rates by countries

Sources: Eurostat

Based on calculations using the "Harmonized Index of Consumer Prices" (HICP) in October 2012, the lowest inflation rates were recorded in countries such as Greece (0.9%), Sweden (1.2%) and Latvia (1.6%). At the opposite pole are situated countries like Hungary (6.0%), Romania (5.0%) and Estonia (4.2%). Inflation has had a fluctuating trend in the European Union compared to September of the same year, so that it fell in 13 Member States at the same time increased in 10 and remained stable in 4 of them.

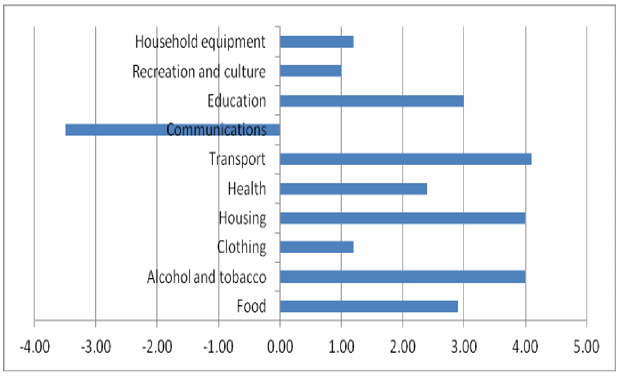

Figure 2 Inflation rates by countries

Sources: Eurostat

Items that have had a major contribution in increasing inflation in October 2012 were transport (Name Rank has a growth rate of 4.1%) and alcohol & tobacco (both an increase of 4%), unlike communications (rate 3.5%), recreation and culture (1.0% rate), clothes and household goods (each at a rate of 1.2%) who had the lowest growth rate.

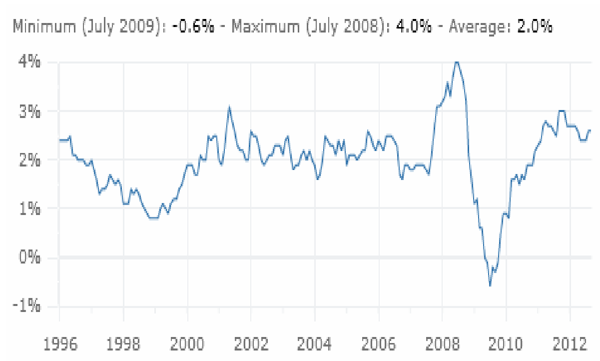

Figure 3 Highlights the inflation rate based on "Harmonized Index of Consumer Prices" (HICP)

Sources: Eurostat

The figures shows the annual percentage change in the general level of prices of consumer goods and services, since 1996, considering the percentage change compared with the same month last year. The graph shows data in the euro area. Inflation peak was reached in July 2008 and bottomed out in July 2009.

Among factors influence price level we can mention:

- Changes in interest rates influencing short-term consumption, i.e. savings, and thus the supply of products and services on the market;

- The change in market liquidity affects changes in the general level of prices and not the unemployment and real income, the latter depending on the population, technology, fiscal and social policies etc.

As stated above the annual inflation rate in Romania has increased substantially above previously recorded value by about 3%, it managed to exceed the amount projected in the "Inflation Report" with a rate of about 2%. Increasing inflation rate was based on accelerated growth in prices, resulting from a plurality of supply-side shocks that affected a large part of the consumer basket components [6]. Most variable elements that contributed significantly to register a rate of 5% inflation in Romania were: fuel (oil on evolution), excise duties on tobacco products, food products (vegetables, fruits, eggs) and food products (due to bad weather conditions).

Objective of price stability refers to the general price level in the economy and implies avoiding both prolonged inflation and deflation. The benefits of price stability can include:

- Increase living standards, generated by increased pricing transparency mechanism (easy identification of changes "relative prices") taking right decisions on consumption and investment that we can make;
- Price stability makes people recognize changes in relative prices. This allows businesses and consumers to be better informed decisions on consumption and investment, enabling more efficient allocation of resources on the market, this leading directly to increase the productive potential of the economy;
- Lack of price stability involves a request from investors "inflation risk premium" to compensate for the risks associated with holding nominal assets long term. Price stability leads obviously to reduce these premiums, automatically leading to increased incentives to invest, which supports economic prosperity;
- Increase social welfare generated by reducing distortion effects of taxation and social security systems, and avoiding the unnecessary use of protection against risks that may arise due to inflation that will eventually stimulate investment that will lead to lower unemployment and consequently to economic prosperity;
- Improving economic efficiency and consequently the welfare population through efficient use of available inputs;
- Increasing the possession of wealth in the form of cash basically involves reducing transaction costs that would be needed from a lack of liquidity;
- Maintaining stability and social cohesion: price stability prevents arbitrary and significant redistribution of income and wealth, which is common in both inflationary and deflationary at the features. Therefore, an economic environment characterized by stable prices contribute to stability and social cohesion;
- Strengthening financial stability by not affecting the amount of wealth or income sources if the economy is not experiencing deflation or inflation phenomena;

In short, price stability is in sight to achieve three important elements considered at both economic and population level:

- Make monetary policy more transparent;
- Provide a clear evaluation criteria and measures against which Europeans can excoriate the European Central Bank;
- Provide useful information to the public regarding the formation of expectations about future price developments.

3. CONCLUSIONS

Overall, most industrialized countries have experienced in recent years, with low levels of inflation and stable realtor explained that although individual product prices in certain sectors (eg fuel, energy) saw a substantial increase this per compensate total were decreases in prices in other sectors (e.g. telephone, TV, etc.) and finally reached a relatively stable general price level.

By achieving price stability can achieve objectives such as:

- Maintaining a low unemployment by creating jobs;
- Maintaining a high standard of living of the population;
- Steady increase in economic activity, i.e. rapid economic growth.

4. REFERENCES

[1] European Central Bank (2012) *Price stability - objective Eurosystem* Mp.001 Http://Www.Ecb.Europa.Eu

[2] Gerdesmeier Dieter, (2011) *Price stability: why is it important?* European Central Bank, Germany ISBN (Online) 978-92-899-0704-0 http://www.ecb.europa.eu

[3] European Central Bank (2012) *Euro area annual inflation down to 2.5%* 160/2012 - 15 November 2012

[4] National Bank of Romania (November 2012) - *Inflation report*, www.bnro.ro

[5] F. Surugiu, Gh.Surugiu, Consumers' Identity- The Role Of The 'Self' Concept In The Consumer Behavior, Analele Universitatii Maritime Constanța vol .XVII, 2012

[6] G. Raicu, A. Nita, *Modern approach to improve economical performance using knowledge management*, Black Sea 2008 Conference, Ninth International Conference on Marine Sciences and Technologies, October 23-25 Varna, Bulgaria 2008, ISBN 978-954-90156-5-2, pp. 265-268

*** http://www.ecb.int/ecb/educational/hicp/html/index.ro.html

*** http://www.ecb.int/stats/prices/hicp/html/inflation.en.html

CAPITAL REQUIREMENT FOR OPERATIONAL RISK

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ABSTRACT

Over time it was concluded that the risk associated is a vital component of all economic activities, which can not only manage the fight, considering that if they do not assume any risk you may lose opportunities to win, which means that the risk assumed under established can bring value to the institution, representing a process of risk management becomes competitive advantage. Increased operational risk in recent years has been enhanced by the creation of products and services ever more complex financial innovations, increased competition, etc.. That required an adequate operational risk management and included in the internal capital estimation and allocation. Due to its novelty and importance of operational risk treatment I chose this theme, showing how to calculate the capital requirement needed to cover operational risk for a institution in Romania using both simple methods and advanced methods, in order to highlight the approach best.

Keywords: *Operational Risk, BIA, SA, AMA, LDA, EL, UL*

1. INTRODUCTION

Risk is a future and uncertain event that could not be disregarded but only manage (ensure minimizing the likelihood and potential effects for the entity to obtain maximum profit), considering that if they do not assume any risk you may lose opportunities to win. Over time many opinions have been formulated on operational risk and its management methods, but the complete definition in terms of causes, can be adopted by any institution is formulated by the Committee on Banking Supervision Basel to consider operational risk as "risk of direct or indirect loss resulting from deficiencies or failures of procedures, personnel, internal systems or external events". Thus this definition is the main component of legal risk - "manifestation" of potential operational risk, representing an indirect question arising from one or more reasons (personnel, processes, systems or events outside the organization), but excludes: strategic risk (because is difficult to determine the financial loss incurred) and reputational risk (because although it can identify the consequences appear to be diffuse and pre-calculated data).

Basel Committee proposed three methods to quantify operational risk with varying degrees of difficulty, namely: the basic indicator approach, standardized method and advanced method. The first two approaches are considered rather security measures and not measures of determining exposures. In the advanced methods are part of the loss Distribution Approach, Internal Assessment Approach Scorecard approach, thereby providing institutions flexibility in design approaches based on internal models database and included in the operational risk management. About these approaches in the literature two views have emerged: practitioners who recommended approaches are complex since they offer advantages and practitioners who consider these methods too expensive prefer a simple approach.

2. DETERMINING THE CAPITAL REQUIREMENT

Determining the capital requirement in the following using econometric study were determined capital requirements for institutions in Romania, using the methodologies proposed by the Committee on Banking Supervision in Basel. Losses incurred due to operational risk have been identified and related international standards:- The eight business lines: corporate finance, trading and sales, retail Banking, Commercial Banking, Payments and settlement, agency services, retail brokerage, asset management- And seven types of events: internal fraud, external fraud, risks arising from relationships with customers, products and business practices, damage to physical assets, business interruption and performance, execution, delivery and management processes related to employment conditions and job security staff labor. Thus the determination of capital for operational risk under the Basic Indicator Approach apply factor 15% of average gross income obtained during three consecutive years.

In Figure 1 presents the evolution of the gross income of the institution analyzed.

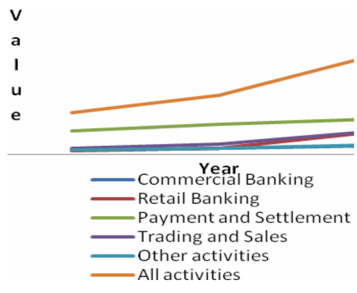

Figure 1 Evolution of gross income of the institution analyzed

Obtain high values for a particular business line gross income shows size and intensity of activity in those industries institutions, departments involved providing information about potential losses that may occur and the amount necessary to cover losses related to operational risk. As remarked in Figure 1 most active lines of business in terms of income are activities to obtain payment and settlement, trading and sales respectively. To determine capital requirements for operational risk under the Standardised Approach is the first step of allocating gross income for each business line and it will apply the appropriate risk weight (12% for Retail Banking, Retail Brokerage, 15 % for commercial banking Services, agent, asset management and 18% for corporate finance, trading and sales, payments and settlements).

Figure 2 The capital requirement under the standardized approach to business lines

Thus as shown in Figure 2 and increasing proportion of the capital requirement is allocated to payment and settlement business lines, followed by trading and sales business line consistent with results obtained and the information revealed by Figure 1.

Advanced method for considering the information provided by the institution on which analysis was done was presented individually Loss Distribution Approach was applied. Risk profile was originally developed and built operational risk matrix types of events and business lines, with the starting point for developing sources of risk - as you may have different statistical properties for the distribution frequency and severity of losses for each cell the risk matrix.

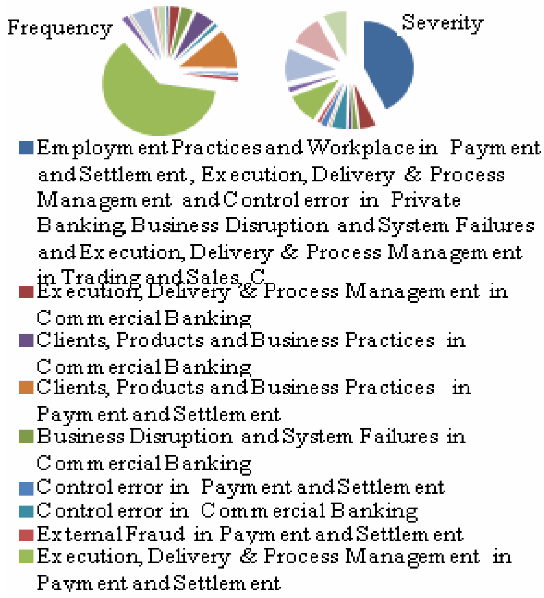

Figure 3 Allocation of number of losses and distribution of the losses on each cell of the matrix

Next to each cell of operational risk matrix observations were modeled in terms of severity and distribution of the frequency distribution Frequency distribution was modeled with the Poisson distribution parameter is set to represent the average value of loss arising for each cell of the matrix of operational risk. For modeling the severity distribution parameters were estimated gamma distributions, Exponential, Normal, Pareto, Weibull for each cell of the matrix of operational risk and reliability tests by: chi-square, Kolmogorov-Smirnov, Anderson-Darling plan
Quantive-quantum were selected Exponential distribution as the empirical distribution close.

After repeating the process for each cell of the matrix Monte Carlo simulation is used to aggregate distribution frequency and severity of losses, using VaR methodology, commonly used for distribution of aggregate losses, such as fixed capital requirement (value at risk) in each group events. Average aggregate loss distribution is determined as the product between the media and media distribution Poisson distribution Severity (exponential or normal) level resulting such provision (expected loss) Capital reserve to cover unexpected losses are determined as the distribution function of aggregate loss distribution (VaR) and the expected loss

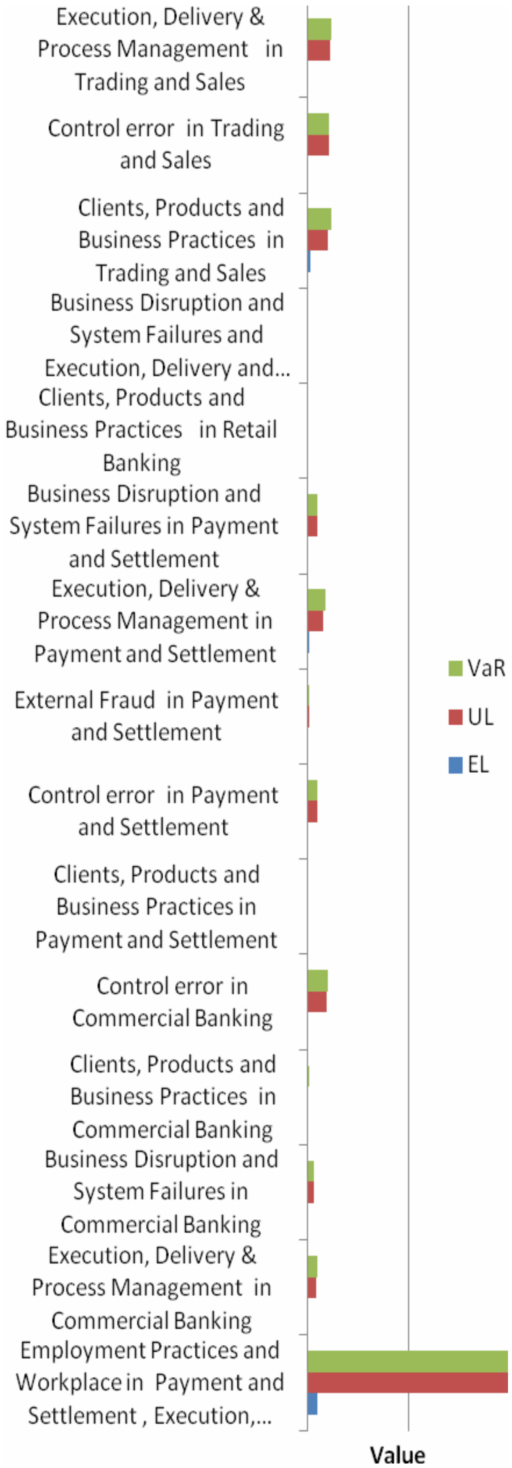

Figure 4: The expected loss, unexpected loss and total loss of business lines and event types for the institution

To cover the average loss should be a provision for expected loss, and if it wants to protect the stability of the activity must constitute a serious additional capital against potential losses related to unexpected loss.

If the institution fails to create reserves above may occur losses equal to the sum of expected and unexpected losses that affect profitability and thus will affect the outcome of the shareholders. Capital requirement is the total risk value for each cell of the matrix risk, confidence interval was set at 99.9%. Thus in Figure 5 was synthesized methods for determining operational risk capital requirements related to the institution.

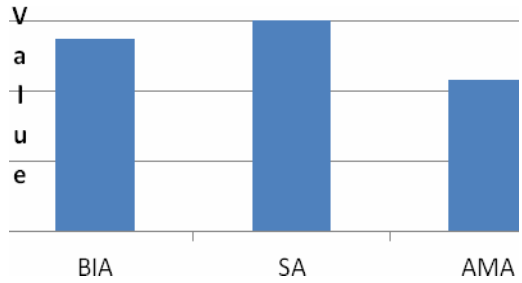

Figure 5 Synthesized methods for the institution

Analyzing the first two approaches (basic indicator method and standardized method) find an increase in capital requirements is explained by the fact that the main line of business is sales and trading and settlement payments for which α = 15% and β = 18% . Minimum capital is allocated using the Distribution loss approach because it can identify, measure and manage operational risk more effectively - achieving a consistent economic capital needed to cover this risk.

3. CONCLUSIONS

With the increasing complexity approach, equity decreased significantly explained by the fact that by using advanced approaches can identify measure and manage operational risk more effectively achieving a consistent economic capital for operational risk.

4. REFERENCES

[1] Anghelache, G.-V., A.-C. Olteanu şi A.-N. Radu (2011), *Risks Assesment for Financial Institutions in Romania*, Revista Română de Statistică,Trim.I, ISSN: 1018-046x

[2] Basel Committee on Bank Supervision (2001) *Operational Risk* Working Papers Bank for International Settlements, Basel, Elvetia www.bis.org

[3] Andrew Kuritzkes, Til Schuermann (2007) - *What we know, don't know and can't know about bank risk: a view from the trenches* Wharton Financial Institutions Center Working Paper No. 06-05

[4] Paulica Arsenie, Radu Hanzu-Pazara, Eugen Barsan, Paul Bocanete, Felicia Surugiu, Gabriel Raicu, Ionut Scriosteanu, Nicoleta Parasca, *Ship's bridge equipment and human errors*, Intermodal Conference on Safety Management and Human Factors, Sydney, Australia, 2007

[5] Tinca Adrian (2006) *The Operational Risk in the Outlook of the Basel II Accord Implementation* pg 31-34 www.ectap.ro/articole/217.pdf

OPERATIONAL RISK MANAGEMENT

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ABSTRACT

Associated risk is a vital economic activities undertaken under well established and can bring value to represent a process of risk management becomes competitive advantage ("art" to make decisions and act on the basis of insufficient data). Basel Committee on Banking Supervision has developed rules and regulations which recognized the impact of operational risk (emphasizing that the implementation of proper management of risks is vital for the existence of a financial institution). This paper aims to establish the optimal method for determining capital requirements for institution analyzed.

Keywords: *Operational risk, Operational risk management, expected loss, PE, LGE, unexpected loss, provisions, capital.*

1. INTRODUCTION

Banks' capitalization required under the Basel I and II proved to be insufficient so there was need complex prudential policies grouped under a new Basel III. Such new standards aimed at: improving risk management, strengthening transparency requirements, problems systemically important banks, in a word decrease the negative effects of financial crisis by increasing the requirements on capital adequacy, liquidity requirements and leverage.

Operational risk as defined by the Committee on Banking Supervision in Basel is the "risk of direct or indirect loss resulting from deficiencies or failures of procedures, personnel, internal systems or external events".

Thus the main categories of operational risk are:

- Internal Fraud involves intentional losses due to failure of the internal regulations of the institution's policy, laws, involving at least one company employee
- External fraud is based on a third party business losses due to fraud, prevent compliance or to acquire goods / values, violations of security systems
- Risks arising from relationships with customers, products and business practices are a product of customer negligence or professional obligations in the nature and design of product, improper business practices or market
- Involve damage to tangible losses materialized in damage, loss of physical assets of the organization and the impact on business
- Business disruption and system availability resulting from the operation.
- Execution, delivery and management processes involving losses due to faulty registration and transaction execution, monitoring and reporting faulty
- Conditions related staffing and job security due to loss-making activities contrary to law and conventions on employment, health and safety at work.

Because administration of many monetary instruments, monitoring and correcting large exposures, the number of transactions increased in a relatively short period, from several sites, including e-banking service, the complexity and volatility of the banking system and through breaches legislative and regulatory, in a word, due to internal factors and external determinants of operational risk can record a series of losses or profits estimated realizable.

Given the literature we conclude that there is a wide variety of views on operational risk and its management methods.

This was treated as operational risk, financial risk "residual" after eliminating the credit and market risk, is a vague definition which includes business risk (including market positioning, management competence, etc.).

It is also considered that operational risk arises from conduct financial transactions with the error sources, disorders, deficiencies of systems, equipment, people, techniques, etc. regardless of intentional acts performed by employees or outside the institution for fraud. Operational risk has been treated as a risk, business risk exclusion, which arises from the existence of inadequate internal control system, which also takes account of catastrophic natural events and dishonest acts within and outside the institution.

A final treatment of operational risk considers that it is direct or indirect loss resulting from technological processes, inadequate internal control procedures, technological disturbances, unauthorized activities of employees or external influence.

Enhancing operational risk is explained by changes [16] in business environment, infrastructure and organizations that have arisen because competition becoming more heated, automated technologies and electronic commerce, emergence of increasingly complex products, due to globalization, decentralization, changes since the banking system through mergers, acquisitions and consolidations, increased activity of retail trade, which led to a more careful management of this risk materialized in the assessment and allocation of capital.

Risk management is a management process that includes techniques and methods used for risk assessment and analysis (measurement, control, reporting and taking decisions) in order to provide a vision of the future into which develops policies and strategies.

Efficient risk management leads to increase of the institution by preventing crises, failures, protecting reputation, improve performance, understanding of risk Basel Committee supports vigilant risk management standard drawing up a risk-based capital adequacy ratio (increasing stability, the credibility of the banking system, equal competition).

Activity of institutions is subject to the availability and/or capital cost of providing stability and absorption losses and thus increases bank reputation.

Capital cannot be considered a substitute for appropriate management. Operational risk can occur not only in banking and that the last time manifested an intense interest in this type of risk.

Until recently, most banking institutions have treated already operational risk based on events that took place, focusing on effects rather than the causes, there was no such risk management.

But lately put increasing emphasis on proactive management that works on the principle "better to prevent than to realize a fact." This approach is based on: the identification and determination of capital for operational risk also for credit risk and market liquidity, combining types of risk and capital to aggregate risk, obtaining information on operational risk factors, choice of coverage or funding operational risk.

For institutions that have an operational risk management performance, characterized by a distant time horizon proactive management turns into a prospective, trying to identify the exposure time at which it is vulnerable due to strategic or environmental changes.

For operational risk management practices must be respected pillar of Basel aimed at setting a minimum capital of minimum funds to cover unexpected losses that may occur in the activity of financial institutions.

Measuring operational risk management is best used to determine the expected loss of operational failures, to determine the worst case loss for a confidence interval, to determine the economic capital required for operational risk and concentration risk.

If the public perceives poor operational risk management, the institution can come to a break or serious damage to business, materialized view and the legal risk.

Thus in the following a try to present an advanced model for determining the capital requirement needed to cover losses that may occur from event risk.

2. DETERMINING THE CAPITAL REQUIREMENT

Since the information provided by the institution which has made analysis were presented in the aggregate an internal assessment approach to apply the following steps.

Initial must be built operational risk matrix that contains information on seven types of events and eight standard business lines.

Next to each line of business should be determined average gross income, and for each matrix cell corresponding operational risk should determine the parameters:

Probability of loss Event (PE) the likelihood of loss-causing events for using internal historical data on the number of transactions with operating losses and the total number of transactions on-line business

For example if the banking business if there were 1.4 million transactions, and of these systems due to security risks there were 0.18 million loss a commercial, that will have an indicator value of 0.1285714 , which means that the probability of loss due to system security risks in commercial banking business line is 12.85714%.

Loss Given Event(LGE) proportion of exposure that will record the operating loss.

For example, losses of 13.125 million mu systems due to security risks in commercial banking business line, which has recovered millions 8.53125 um, so the remaining loss recognized 4.59375 million mu, LGE indicator is 0.35.

Determining the expected loss will be the product between the parameters previously determined average gross income

And unexpected loss determination that the product of the expected loss of institutions and γ factor (multiplier cell compared to the square root of loss) for every 1 year and a 99.9% confidence threshold.

For example the cell (due to business interruption losses and improper operation of systems in commercial banking activity) $\gamma = 0.007283$ for a level of confidence 99.9% loss will not be more than $0,007283 \cdot 2211402,878 = 16106,08722$ um. What is the maximum amount to be allocated to operational risk that can occur within the cell.

Capital requirements will determine the amount of expected losses and unexpected of all operational risk matrix cells.

To highlight the superiority of advanced method we determined the corresponding capital requirement for operational risk if the institutions with less elaborate methods such as

- Basic indicator approach implies that the amount of capital that it must determine constitution entity afferent multiplying average gross income of a period of three years by a factor of 15%, and

- Standardized approach involving business lines dividing the work for the allocation of gross income for each sector and a coefficient between 12% and 18%. Thus in the following figure we synthesized the three methods outlined above for the institution on which analysis was performed.

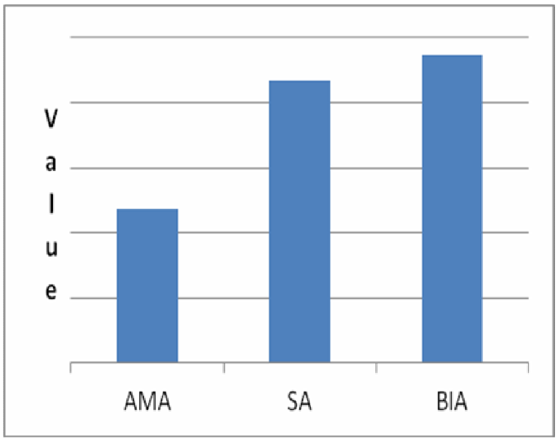

Figure 1: Capital requirement for operational risk

As seen in previous Figure minimum assigned capital is achieved by using Internal Measurement Approach as a institution can identify the affected business lines and operational risk are the main risk factors .

3. CONCLUSIONS

In last time manifested an intense interest in this type of risk and operational risk because it can occur in any sector of the economy not only in banking.

So we make a statement that this risk may be caused by:

- Internal processes including risks arising from relationships with customers, products and business practices and Execution, Delivery and Process Management
- Human risk including internal fraud, conditions related staffing and job security, risks arising from relationships with customers, products and business practices.
- Risk Business disruption and systems comprising operation
- External events such as events involving external fraud, damage to physical assets and business interruption and operation.

Establishing actual optimal level of capitalization is particularly important because it allows capital to fulfill their protective function force (absorb unexpected losses - decrease the probability of bankruptcy of the bank and increase the level of implicit trust in the banking system).

Thus there is no one best method to quantify operational risk quantification approaches proposed by the Basel Agreement has some shortcomings implicitly lead to incorrect measurement of this risk:

- While methods "simple" does not require complex database and calculation formulas are simple between indicators of operational risk exposure and cannot establish any connection (increased income is penalized by capital growth and ultimately result in lower gain entity which is the opposite strategy), in addition there is a negative correlation between losses and capital needs. Also these methods do not take into account the internal process-specific differences between institutions and markets in which it operates, cannot demonstrate what the key risk factors and of course the cost of capital is high
- Unlike the simple methods, advanced methods of risk sensitivity has a high capital cost is low but it is difficult implementation and management of data is a laborious process.

4. REFERENCES

[1] CAROL ALEXANDER (2002) “Operational risk management: Advanced Approach”
[2] GABRIELAVICTORIA ANGHELACHE, CARMEN OBREJA, BOGDAN COZMÂNCĂ, ADRIANA CATALINA HÂNDOREANU, ANA CORNELIA OLTEANU, ALINA NICOLETA RADU (2009) "Synthesis of research report on the draft capital adequacy for operational risk in the context of moral hazard," ASE http://www.acrom.ase.ro/Documente/Sinteza2009.pdf
[2] CROUGHY, M., GALAI, D., MARK, R., Risk Management, McGraw-Hill, New York, 2001 p 478-479
[3] Basel Committee on Bank Supervision (2004) Guidelines on Operational Risk Mangement. National Bank of Austria,, available online at www.bis.org
[4] Basel Committee on Banking Supervision (2003) “Sound Practices for the Management and Supervision of Operational Risk”, no.86, 91 and 96, www.bis.org
[5] Basel Committee on Bank Supervision (2001) "Operational Risk" Working Papers, Bank for International Settlements, Basel, Switzerland www.bis.org
[6] CAROL ALEXANDER (2003) "Operational risk - regulation, analysis and management" Financial Times Prentice Hall, Pearson Education
[7] KELLER JAMES S. (2001) "Request for Comments on the New Basel Capital Accord" The PNC Financial Services Group, Pittsburgh, Pennsylvania
[8] ANDREW KURITZKES, TIL SCHUERMANN (2007) - "What we know, and do not know Can not know about bank risk: a view from the trenches" Wharton Financial Institutions Center Working Paper No. 06-05
[9] MARSHALL, CH, Measuring and Managing Operational Risk in Financial Institutions, John Wiley and Sons
[10] Merrill Lynch & Co., Inc (2001) „Merrill Lynch response to the Basel Committee and European Commission”
[11] ANCA ELENA NUCU (2011) "Basel III Challenge for Romanian banking system" Theoretical and Applied Economics Volume XVIII (2011), No. 12 (565), pp. 57-68
[12] TOSHIHIKO MORI, EIJI HARADA (2001) "Internal Measurement Approach to Operational Risk Capital Charge" Bank of Japan http://www.boj.or.jp/en/type/ronbun/ron/wps/kako/data/fwp01e02.pdf
[13] FELICIA SURUGIU, SIMONA UTUREANU, CRISTINA DRAGOMIR, „Human Resources Management in a Navigation Company in the Globalized Context”, Analele Universității Ovidius, Seria: Științe

economice", Vol. X, nr. 2, 2010, pp. 757-761, CNCSIS B+, BDI, ISSN 1582-9383
[14] VIJAY UPADHYAYA (2009) "Proactive and reactive approach to Risk"
http://hack0r.blogspot.com/2009/02/proactive-and-reactive-approach-to-risk.html
[15] ERICH R. UTZ (2008) Modelling and Measurement Methods of Operational Risk in Banking Herbert Utz Verlag • Munich
http://www.utzverlag.de/buecher/40796les.pdf
[16] RAICU, G., NIȚĂ, A., *Improve economical performance using knowledge management*, International Maritime Lecturers' Association 16th Conference on MET, "Safety, Security and Quality Ojectives of MET Institutions", 14-17 October 2008, ISBN 978-975-441-256-7, pag. 567-574, Izmir, Turkey.

INFLUENCE OF TRANSPORTS ON ENVIRONMENT QUALITY

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ABSTRACT

As a result of the negative effects of polluting processes, as well as the products and services that affect the environment either during of their use or in the post-consumption, the national and international bodies have manifested concerns to develop new regulations on environmental protection.The interest for environmental issues has increased significantly compared to the situation in 1986, when an explosion occurred at the Chernobyl nuclear reactor, Ukraine, was considered an environmental disaster of large proportions.

Key words: *environmental quality, eco-friendly vehicles, transport, pollution.*

1. INTRODUCTION

The contemporary technical and scientific revolution has generated the occurrence of new products with some superior performances and caused a conflict between man and nature, a correlation between society and nature. Human interventions on nature have generated series of successive or simultaneous crises, with alarming social consequences such as the ecological crisis [3].

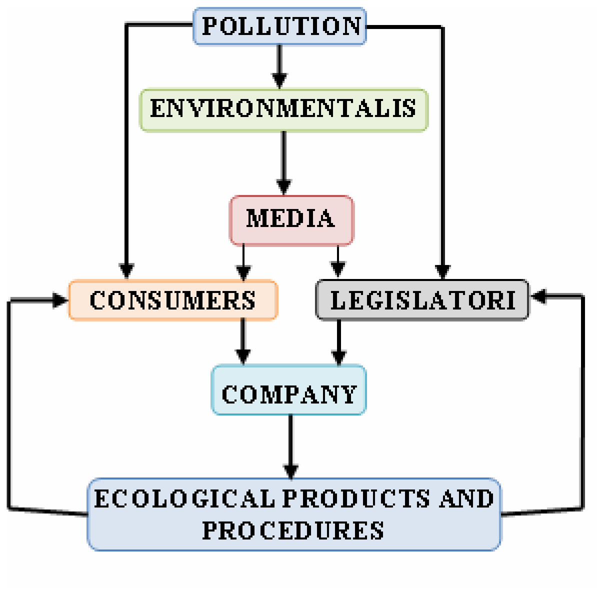

Figure 1 Environmental pressures

The legislation adopted in the environmental field by the EU member states and candidate countries has changed the perspective of business men.

Pollution is costy and the laws regulating this matter are very strict. The importance of environmental protection depends in the public's mind on the proofs regarding global heating, decrease of the ozone layer, the increasing waste generation, the destruction of tropical forests, the extinction of species.

The legislative power has expanded in most countries and this will positively influence how they will do business.

2. QUALITY OF PRODUCTS AND THE RELATIONSHIP TO ENVIRONMENT PROTECTION

The pressures that aimed at protecting ecological carried more strongly by the ecologists, consumers and legislators, determines companies to find new solutions for environmental protection by creating products, using environmentally friendly procedures (figure 1) [3].

The natural environment is negatively affected by a significant number of physical factors (air, water, light) biological (food, disease) or economical factors (some of technological processes, operational conditions and use of goods and so on). The negative effects of these factors can temporally deteriorate or they may become permanent due to human intervention.

Protection of the natural environment is conditioned, in part, of capitalizing residue of the waste by achieving of production cycles, closed type: raw material - production - product - raw material. In other words, the issue of protection the natural environment has become an issue closely linked to quality of products and services available to man today [8]. Reuse of recoverable materials and their reintegration into the economic cycle, is required acutely as a matter of environmental protection and as an economic problem of regaining some raw materials.

It is considered that among the sources of environmental pollution, an important place is occupied by: waste vehicles, of pesticides and herbicides, radioactive the substances, noise made by a series of devices, cars and equipment (goods).

Thus, the waste from clothing, furniture, household apparatus, soap, detergents, cosmetics, pharmaceuticals, household products chemicals, and especially waste of packaging, are diversified and are in the steadily increasing the quantitative.Given that a large proportion of these are not biodegradable, and some are directly toxic (eg household products insecticides) the natural purifying takes place with difficulty, thus affecting the the bacterial flora the wastewater.

Thanks to the emergence of a increasing number of new products synthetics, environmental factors they can no longer have without restriction, dual roles of providers of resources and receptors of waste, so are requires the implementation of national and international measures to protect these factors. *About the relationship: quality of products - environment, designing of new products should evaluate the possibility reintegration of their, after use, in nature, without negative effects (able to be biodegradable) or reintroduction of these products in economic cycle, as raw material.*

Global environmental problems are rooted in population growth and unsustainable economic growth, and they have effects on consumers, companies and the governments (figure 2).

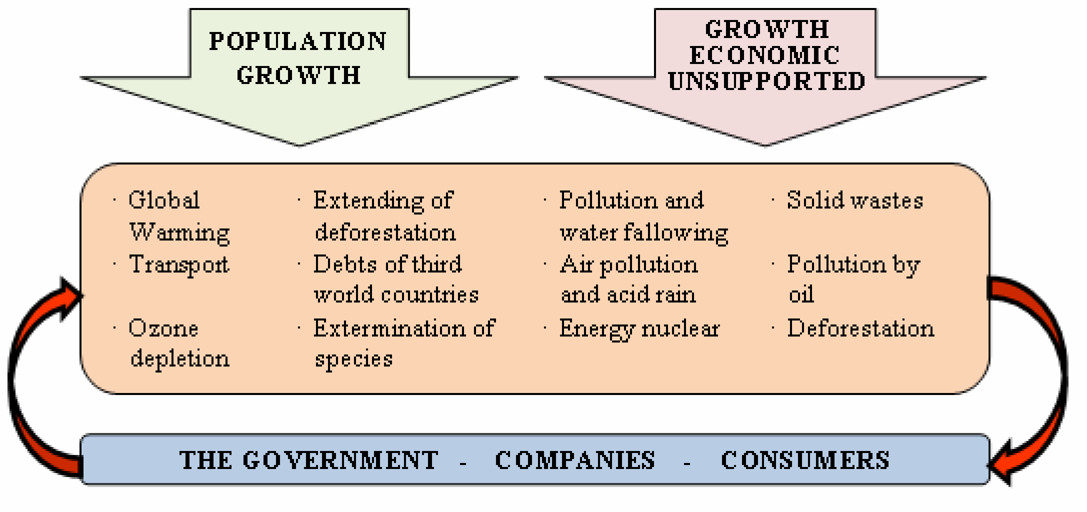

Figure2 The 12 global environmental problems [4]

3. THE INFLUENCE OF TRANSPORTS ON ENVIRONMENTAL QUALITY

The means of road transport, sea and air, who use internal combustion engine eliminate products such as carbon monoxide, nitrogen oxides and unburned hydrocarbons, which are noxious.

The means of transport with petrol give the biggest quantity of pollutants into the environment among which the lead, a very dangerous polluting agent. As we know, lead is added to gasoline as tetraethyl lead to increase the octane gasoline. To reduce the impact on environmental quality has been introduced unleaded petrol and for purification of exhaust gases from motor vehicles were introduced catalysts.

From the analyzes carried, throughout highways, there has been identified a high contamination of the soil and vegetation with lead, surpassing in crowded areas limits recommended by the World Health Organization with 2-4% (maxim 2 micrograms/m^3 air).

The carriage is responsible for around 25% of total greenhouse gas emissions, with important consequences for the sustainability of the planet.

A program developed by the International Union of Railways (ECOPASSENGER) allows comparison of air travel routes, road and railby calculating the energy consumption, CO_2 emissions and other pollutants (nitrogen oxides emissions, particulate emissions, emissions of hydrocarbons) for each selected route [5].

Also, the program is recommended for choosing the train as a means of making the journey, its use being the solution to reduce greenhouse gas emissions from the transport sector.

The transport services were among of first common policies European Union and still since the entry into force of the Treaty of Rome in 1958, transport policy was based on removing border obstacles between Member States, contributing thus to free movement of persons and goods.

The main objectives of transport policy are [2]:

- ✓ completion of the internal market;
- ✓ achieving sustainable development;
- ✓ transport network expansion across Europe;
- ✓ maximizing the use of European space;
- ✓ improve transport safety and developing international cooperation.

The single market has been an turning point for the common transport policy because together with the 2001 White Book, his policy has developed harmoniously and simultaneously different modes of transport, particularly by using each available mode of transport (land, sea or air) in a more efficient way.

In order to reduce greenhouse gases emissions have been undertaken numerous actions (research, introduction of alternative solutions, especially in road transport) and the European Union has defined a policy to promote biofuels and for reduction from road transport emissions and air transport.

Since the 70s were adopted guidelines for emissions from motor vehicles, which have resulted in a gradual reduction of emissions the gaseous pollutants and particularly in a certain extent acoustical noise emissions of second hand vehicles.

Effects transport impact on the environment aims to be reduced as more and in that effect air emission reductions set by "EURO" from I to V, standards covering four major pollutants: carbon monoxide (CO), nitrogen oxides (NOx), particulates and hydrocarbons [6].

With regard to CO_2 emissions, the EU's objective is to arrive at a average emission of 120 g CO_2/km.

European approach in this regard is based on three pillars:

- ✓ car industry to voluntarily reduce average emissions of new vehicles under 140g CO_2/km,
- ✓ improving consumer information about the fuel consumption and CO_2 emissions;
- ✓ implementation of fiscal measures to promote the purchase of less polluting cars.

4. THE DURABLE TRANSPORT AS A SAFETY PROCEDURE OF THEY ENVIRONMENT

The road transport of goods has had a massive growth in the past decades,with a volume higher than any other mean of transport,bringing prosperity to the industrion.

This growth, however, associates with problems such as:

- ✓ increasing emissions of greenhouse gases;
- ✓ noise pollution;
- ✓ increasing numbers of accidents and victims;
- ✓ higher costs for the maintenance of the road infrastructure.

"The White Book" of the European Union has been one of the firsts documents that brought to the attention the necessity of improving transport in balance with the necesitties of the envrionment.The research conclusions in this field show that "the actual transport system has no durable character"[11]

Durable transport represents a complex system aimed at securing the necessities of mobility for the current generations without damaging the envrionment factors and the healthiness.

Durable transport requires a compromise between the benefit volumes of social-econimics, decrease of the envrionment cost effects and the transport security,all accompanied by increase in the transport quality [2].

Untillrecently,the industry was considered as being the primary source of pollution on the planet.Along with the growth of the transports and,especially,with the depth of the automobile production,the balance of toxic sources and negative effects twists,transport becoming the primary source of aggression toward the envrionment and the human health.

The impact that the transport produces on the envrionment must be analized based on three factors: economical, social and ecological.

The economical factor follows:

- ✓ ensuring transport rentability;
- ✓ lowering fuel and material consumption;
- ✓ utilization of alternative fuel (biofuel, hidrogen etc.);
- ✓ encouraging the use of hybrid,clean,ecological automobiles;
- ✓ transfer of the individual transport to public transport etc;

The social factor follows:

- ✓ ensuring social mobility;
- ✓ growth of the urban transport quality;
- ✓ ensuring transport security;
- ✓ ensuring links between transports and the local or regional development;
- ✓ the protection of historical sites;
- ✓ to promote modern arhitectureetc;

The ecological factor follows:

- ✓ chemical pollution and the consequences;
- ✓ sonic pollution,stress,discomfort and health issues related;
- ✓ waste pollution and its recycling etc.

In Romania, the strategy of the Ministry of Transport for durable transport follows the balanaced development of the national transport system to assure a modern-durable transport services and infrastructures,sustained development of the economy and increasing life quality.

The specific objectives conisdered for reaching the general objective are:

- ✓ the development and modernization of the transport hubs;
- ✓ the growth of safety conditions and service quality;
- ✓ liberalization of the internal transport market;
- ✓ strengthening the social and territorial cohesion at regional and national levels;
- ✓ the compatiblity with the envrionment.

The durable transport system is achieved by non-polluted transport means or those which have a low impact on the envrionment,by increased fuel efficiency and lowered fuel consumption,by lowering fuel consumption coming from nonrenewable resources and continuous decrease of solid and liquid wastes resulting from construction,maintenance and abandonment of vehicles.

In the past years,the energy consumed by the vehicles far exceeded expectations and therefore action is required.

The main economical instruments which can be used in this purpose are taxes and permits. Therefore,lowered use of the polluted transport means, lowered energetic use,efficient transport activities, equitable redistribution of income between society and transporters and reorientation on transport-satisfaction ways can be obtained [1].

5. EUROPEAN STRATEGY ON TRANSPORT AND ENVIRONMENT

European transport strategy and environment has established some measures to integrate environmental concerns in transport policy.

They provide guidance to a range of measures in different sectors: road, air, rail, sea, etc.

The strategy defines the objectives developed by the Council of the European Union and its Member States, in order to minimize the environmental impact of transport and aims at taking into account environmental aspects in the design and implementation of transport policy in the sectors concerned.

The strategy emphasizes the positive results of already measures taken at EU level, but stresses the need for further action in the following areas:

- ✓ prevent / eliminate the negative effects of heavy traffic and measures for infrastructure planning and pricing;
- ✓ promoting public transport, intermodal transport and combined transport and transport modes less harmful to the environment (including rail and inland waterways);
- ✓ research and technological development, in particular to reduce CO_2 emissions and noise;
- ✓ informing and sensitizing drivers and industry on how to reduce the impact on the environment, using some indicators and standardization of vehicles.

Strategy requires Member States to start these actions at national and international level. The Commission is invited to gather and disseminate information in these areas, to submit proposals on pricing and emission standards and to encourage the transport sector in various ways.

This strategy was accompanied by a series of measures in the transport: road, rail, sea and air [7].

Increasing transport volumes and their use is a threat to the environment and the health of Europeans and the European Environment Agency evaluates, analyzes and informs regularly about environmental impacts of transport.

Such targets were set for reducing certain pollutants and strengthens the legal framework to fight against pollution in two main areas:

- ✓ improving legislation and
- ✓ the integration certain pollutants of environmental concerns related to air quality.

For the same purpose there has been proposed a new standard to reduce emissions from vehicles, including of light and reduction of 80% of emissions from diesel vehicles called "Eurovia".The strategy envisages also several actions to reduce emissions of SO_2 and NOx from ships.

Given the concern for urban environmental protection, it is required the implementation of sustainable urban transport plans of persons and goods.In this respect the European Commission launched a practical guide intended of authorities of urban areas in order to serve at the implementation of these plans and to disseminate good practice.

The development of this strategy was requested by the European Council in Vienna in 1998 and have been applied over time, all laying the foundation for coordinated action at EU level to integrate environmental requirements into EU policies.

6. GREEN VEHICLES - A EUROPEAN STRATEGY

Since 2010, the European Commission has developed a strategy, Europe 2020 Strategy, in favor of green vehicles and efficient energy designed to encourage development and their market penetration.This was to mitigate the impact of road transport on the environment and to boost competition in the auto industry.

European objective aims to develop a transport system appropriate social needs, economic and environmental, concomitant with reduce their negative impact.

Results pursued at European level:

- ✓ use of biofuels in transport systems and reducing emissions of greenhouse gases in this field;
- ✓ development of national and international modal transport systems and stimulation of clean transport systems locally;
- ✓ the modernization and streamlining European public passenger transport system;
- ✓ setting a maximum limit admitted CO_2 at 120g/km goods vehicles.

European strategy on clean vehicles and energy efficient, presents several lines of action aimed at fostering the development of vehicles "green" and their use on the market [9].

The strategy aims to:

- ✓ traditional vehicles with conventional internal combustion engines;
- ✓ vehicles using alternative fuels such as biofuels liquid or gaseous fuels (LPG, CNG and biogas);
- ✓ electric vehicles with batteries or rechargeable hybrid;
- ✓ vehicles with hydrogen fuel cell that removes water vapor;

and refers to light vehicles, heavy, two-and three-wheelers, as well as quadricycles.

In the European Union there are concerns and regulations covering type approval the vehicles of two, three-wheel and quadricycles as well as reducing the impact of mobile air conditioning systems in terms of fuel consumption.Fuel consumption and CO_2 emissions of heavy duty vehicles are also subject to action under European Union.

The Intense activities of research in the domain of electric cars equipped with hydrogen fuel cells that have a high manufacturing cost, can allow lower acquisition costs and their components.Meanwhile the researches are for discovery of some innovative raw materials to manufacture batteries and hydrogen storage and charging alternative technologies and energy storage.

There are already strategies long-term research in the EU's strategic plan for transportation and communication technologies for environmentally friendly transport systems.

To stimulate and encourage consumers to demand environmentally friendly vehicles, the consumer must be informed about the many possibilities, advantages and practical aspects of this type of vehicle and are given financial incentives at purchase vehicles concerned.These measures are designed to encourage the entry of such vehicles environmentally friendly eco-friendly on market.

In this respect, at European level there is already a set of guidelines on financial incentives granted to consumers at acquisition of environmentally friendly vehicles in order to encourage measures taken by Member States regarding the market demand. In order to encourage the consumers to efficiently use the classic fuels and gradually adopt the low carbon emission alternative fuels there are plans in order to review the law regarding energy taxation.

Also are required technical and safety norms about electrical safety approval of electric vehicles.

Between 2010 and 2011, the Commission issued a mandate to the European Committee for Standardization, European Committee for Electrotechnical Standardization and European Institute for Standardization and asked them to develop a standardized charging interface to ensure interoperability and connectivity between the electricity charging points and electric vehicle charger.

In addition, it is necessary to develop an adequate network of recharging electricity to meet the needs of users of electric cars and to provide them an autonomy of travel with these vehicles, significantly higher than today.

Specialists in the field are interested to pursue, to what extent the promotion of electric vehicles can generate a plus of electricity with low carbon.

The permanent growth of transport volume determines an increasing pressure on the environment particularlly in relation to the changes of climate and biodiversity loss.

The current efforts to counteract these trends contribute in the best case just at slowing of this growth.

Regarding the positive side, technological innovation helps to reduce air pollution caused by road transport, despite rising traffic volumes.

But even in these circumstances, additional measures are needed to solve the problem of urban air pollution.

The transport plays an important role in the economic development of the state, but also he is one of the biggest polluters of the environment.

The main problems that increase the impact of road transport on the environment:

- ✓ fuel quality;
- ✓ lack of automotive stations and modern parkings;
- ✓ unsatisfactory quality of the tread, especially in neighborhoods;
- ✓ the park car in the yard, on grass and sidewalks;
- ✓ longstanding and unsatisfactory exploitation of the means of transport etc.

7. PROJECTIONS REGARDING TRANSPORT INFRASTRUCTURE

In order to achieving a network connection between the network transport Romanian and network transport European, Romania and the European Union considers that imperative, upgrading infrastructure in Romania, making thus commitments assumed by Romania upon accession as well the provisions of the White Book on transport infrastructure [10].

It includes:

- ✓ construction of highways - 1,767.3 km (in operation at the end of 2013) and about 850 km detour routes - on towns edge;
- ✓ upgrading for 3208 km of conventional rail infrastructure;
- ✓ improving navigation conditions on the Danube (1075 km);
- ✓ a improvement the high gradients of the fluvial channel Danube - Black Sea (64 km); protection and strengthening of banks on Poarta Alba - Midia Năvodari (24 km);
- ✓ rehabilitation of 10 river ports (Sulina, Tulcea, Galati, Braila, Cernavoda, Calarasi Oltenița, Giurgiu Drobeta Moldova Noua);
- ✓ development and modernization Constanta seaport;
- ✓ modernization of nine airports (Arad, Bucharest-Baneasa, Bucharest-Otopeni, Bacau, Constanta, Iasi, Sibiu, Timişoara).

Starting the year Romania adhered to EU, modernisation and development of road transport infrastructure will amount to a total value of 47.000 MEUR divided as follows:

- ✓ 2007 = 1.024,15
- ✓ 2008 = 1.350,12
- ✓ 2009 - 2013= 10.817,25 (estimates)
- ✓ 2014-2020 =14.836,00 (estimates)
- ✓ 2020-2030 = 18.972,48 (estimates)

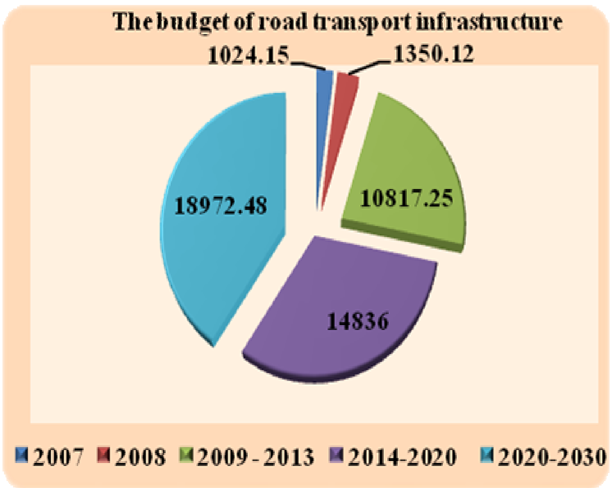

Figure 3 The budget of road transport infrastructure, in MEUR [11]

8. CONCLUSIONS

Despite the progress made over time, transport continues to be a burden, especially in terms of emissions of greenhouse gases.

Some studies have shown that improving technologies can not solve problems which are planned for future, and should be increased the effort to improve this, and not least reducing the sector's contribution to climate change.

The transport has an important contribution to producing climate change. Basic relationship between transports and climate change is simple: the transport is almost entirely dependent on oil that along with other fossil fuels (coal, natural gas) are the main sources of CO_2.

Greenhouse gas emissions from transport sphere are growing, improving the energy efficiency of different sectors of transport and introduction of biofuels are not sufficient to reduce emissions of greenhouse gases from transport domain.

9. REFERENCES

[1] BĂLĂCEANU C., APOSTOL D.M., *The theory of "growth poles" and its impact on sustainable development*, SGEM 2012, Volume IV, Conference Proceedings
[2] NEDEA P.S., *Traficul rutier transfrontalier în sud-vestul României - Impact asupra mediului şi a aşezărilor*, Editura Univesitară, Bucureşti, 2011
[3] STANCIU, I., *Managementul calităţii totale*, Editura Cartea Universitară, Bucureşti, 2004
[4] SADGROVE, K., *Ghidul ecologic al managerilor*, EdituraTehnică, Bucureşti, 1998
[5] Synthèses de la législation de l'UE - Transports, énergie et environnement, http://europa.eu/legislation_summaries/transport/transport_energy_environment/l28165_fr.htm
[6] DIRECTIVA 2008/50/CE a Parlamentului European şi a Consiliului privind calitatea aerului înconjurător si un aer mai curat pentru Europa 1999/30/CE, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:Ro:PDF
[7] Estrategia europea sobre vehículos limpios y energéticamente eficientes, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0186:FIN:ES:PDF
[8] Strategia pentru transport durabil pe perioada 2007-2013 şi 2020, 2030, http://www.mt.ro/strategie/strategii%20sectoriale_acte%20normative/strategie%20dezvoltare%20durabila%20noua%20ultima%20forma.pdf
[9] Cartea albă - Foaie de parcurspentru un spaţiueuropean unic al transporturilor, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:RO:PDF
[10] http://www.agir.ro/buletine/89.pdf
[11]http://www.insse.ro/cms/files/Web_IDD_BD_ro/index.htm

TRENDS ANALYSIS IN MANAGING MARITIME E-LEARNING TECHNOLOGIES

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ABSTRACT

During time few trends are fulfilled with current technology level. New technology achieved a high grade of interactivity since multiprocessing technology development. A large scale maritime 3D simulators and interactive users are now possible. eLearners will plan what, when, where and for how long at a time they will learn. With their input, the e-Learning system will organize the material they will learn and the way they will learn it based upon an assessment of their skills and their preferred learning modes. The roles and time required of classroom trainers and lecturers, and tutors will be greatly reduced.

Keywords: *LMS, maritime e-learning, lifelong learning, computer assisted learning.*

1. INTRODUCTION

Education encompasses teaching and learning specific skills, and also something less tangible but more profound: the imparting of knowledge, positive judgment and well-developed wisdom. Education has as one of its fundamental aspects the imparting of culture from generation to generation (see socialization). Education means „to draw out", facilitating realisation of self-potential and latent talents of an individual. It is an application of pedagogy, a body of theoretical and applied research relating to teaching and learning and draws on many disciplines such as psychology, philosophy, computer science, linguistics, neuroscience, sociology - often more profound than they realize - though family teaching may function very informally.

Lifelong, or adult, education has become widespread in many countries. However, education is still seen by many as something aimed at children, and adult education is often branded as *adult learning* or *lifelong learning*. Adult education takes on many forms, from formal class-based learning to self-directed learning.

Lending libraries provide inexpensive informal access to books and other self-instructional materials. The rise in computer ownership and internet access has given both adults and children greater access to both formal and informal education. In Scandinavia a unique approach to learning termed folkbildning has long been recognised as contributing to adult education through the use of learning circles.

Formal Education:- the hierarchically structured, chronologically graded education system, running from primary school through the university and including, in addition to general academic studies, a variety of specialized programs and institutions for full time technical and professional training.

Informal Education:- The truly lifelong process whereby every individual acquires attitude, values, skills and knowledge from daily experience and the educative influences and resources in his or her environment from family and neighbors, from work and play, from the market place the library and the mass media.

Non-Formal Education **-** any organized educational activity outside the established formal system- whether operating separately or as an important feature of some broader activity that is intended to serve identifiable learning clienteles and learning objectives.

2. EDUCATION TECHNOLOGY

Technology is an increasingly influential factor in education. Computers and mobile phones are being widely used in developed countries both to complement established education practices and develop new ways of learning such as online education (a type of distance education). This gives students the opportunity to choose what they are interested in learning. The proliferation of computers also means the increase of programming and blogging. Technology offers powerful learning tools that demand new skills and understandings of students, including Multimedia, and provides new ways to engage students, such as Virtual learning environments [1], [2].

Technology is being used more not only in administrative duties in education but also in the instruction of students. The use of technologies such as PowerPoint and interactive whiteboard is capturing the attention of students in the classroom.

Technology is also being used in the assessment of students. One example is the Audience Response System (ARS), which allows immediate feedback tests and classroom discussions. Information and communication technologies (ICTs) are a "diverse set of tools and resources used to communicate, create, disseminate, store, and manage information." [3]

These technologies include computers, the Internet, broadcasting technologies (radio and television), and telephony. There is increasing interest in how computers and the Internet can improve education at all levels, in both formal and non-formal settings [4], [5].

Older ICT technologies, such as radio and television, have for over forty years been used for open and distance learning, although print remains the cheapest, most accessible and therefore most dominant delivery mechanism in both developed and developing countries.

3. SPREADING E-LEARNING WORLDWIDE

Pedagogical elements are an attempt to define structures or units of educational material. For example, this could be a lesson, an assignment, a multiple choice question, a quiz, a discussion group or a case study. These units should be format independent, so although it may be implemented in any of the following methods, pedagogical structures would not include a textbook, a web page, a video conference or an iPod video.

When beginning to create e-Learning content, the pedagogical approaches need to be evaluated. Simple pedagogical approaches make it easy to create content [6], but lack flexibility, richness and downstream functionality. On the other hand, complex pedagogical approaches can be difficult to set up and slow to develop, though they have the potential to provide more engaging learning experiences for students. Somewhere between these extremes is an ideal pedagogy that allows a particular educator to effectively create educational materials while simultaneously providing the most engaging educational experiences for students [7].

The use of computers and the Internet is still in its infancy in developing countries, if these are used at all, due to limited infrastructure and the attendant high costs of access. Usually, various technologies are used in combination rather than as the sole delivery mechanism. For example, the Kothmale Community Radio Internet uses both radio broadcasts and computer and Internet technologies to facilitate the sharing of information and provide educational opportunities in a rural community in Sri Lanka.

The Open University of the United Kingdom (UKOU), established in 1969 as the first educational institution in the world wholly dedicated to open and distance learning, still relies heavily on print-based materials supplemented by radio, television and, in recent years, online programming. Similarly, the Indira Gandhi National Open University in India combines the use of print, recorded audio and video, broadcast radio and television, and audio conferencing technologies. The term “computer-assisted learning” (CAL) has been increasingly used to describe the use of technology in teaching.

4. VIRTUAL CLASSROOMS

Communication technologies are generally categorized as asynchronous or synchronous. *Asynchronous* activities use technologies such as blogs, wikies, and discussion boards. The idea here is that participants may engage in the exchange of ideas or information without the dependency of other participants involvement at the same time. Electronic mail (Email) is also asynchronous in that mail can be sent or received without having both the participants’ involvement at the same time.

Synchronous activities involve the exchange of ideas and information with one or more participants during the same period of time. A face to face discussion is an example of synchronous communications. *Synchronous* activities occur with all participants joining in at once, as with an online chat session or a virtual classroom or meeting. Virtual classrooms and meetings can often use a mix of communication technologies. In many models, the writing community and the communication channels relate with the E-learning and the M-learning communities [8].

Both the communities provide a general overview of the basic learning models and the activities required for the participants to join the learning sessions across the virtual classroom or even across standard classrooms enabled by technology. Many activities, essential for the learners in these environments, require frequent chat sessions in the form of virtual classrooms and/or blog meetings.

5. E-LEARNING EVOLUTION

The term e-Learning 2.0 is used to refer to new ways of thinking about e-learning inspired by the emergence of Web 2.0. From an e-Learning 2.0 perspective, conventional e-learning systems were based on instructional packets that were delivered to students using Internet technologies. The role of the student consisted in learning from the readings and preparing assignments. Assignments were evaluated by the teacher. In contrast, the new e-learning places increased emphasis on social learning and use of social software such as blogs, wikis, podcasts and virtual worlds such as Second Life. This phenomenon has also been referred to as Long Tail Learning

The first 10 years of e-learning (e-learning 1.0) was focused on using the internet to replicate the instructor-led experience. Content was designed to lead a learner through the content, providing a wide and ever-increasing set of interactions, experiences, assessments, and simulations. E-learning 2.0, by contrast (patterned after Web 2.0) is built around collaboration. e-Learning 2.0 assumes that knowledge (as meaning and understanding) is socially constructed. Learning takes place through conversations about content and grounded interaction about problems and actions. Advocates of social learning claim that one of the best ways to learn something is to teach it to others.

Distance education has long had trouble with testing. The delivery of testing materials is fairly straightforward, which makes sure it is available to the student and he or she can read it at their leisure. The problem arises when the student is required to complete assignments and testing.

Online courses have had difficulty controlling cheating in quizzes, tests, or examinations because of the lack of teacher control. In a classroom situation a teacher can monitor students and visually uphold a level of integrity consistent with an institution's reputation. However, with distance education the student can be removed from supervision completely. Some schools address integrity issues concerning testing by requiring students to take examinations in a controlled setting [9].

Assignments have adapted by becoming larger, longer, and more thorough so as to test for knowledge by forcing the student to research the subject and prove they have done the work. Quizzes are a popular form of testing knowledge and many courses go by the honor system regarding cheating. Even if the student is checking questions in the textbook or online, there may be an enforced time limit or the quiz may be worth so little in the overall mark that it becomes inconsequential. Exams and bigger tests may be harder to regulate.

Used in combination with invigilators, a pre-arranged supervisor trusted with overseeing big tests and examinations may be used to increase security. Many Midterms and Final examinations are held at a common location so that professors can supervise directly. When the Internet became a popular medium for distance education many websites were founded offering secure exam software and packages to help professors manage their students more effectively.

In the relatively new LMS market, commercial vendors for corporate and education applications range from new entrants to those that entered the market in the nineties. In addition to commercial packages, many open source solutions are available.

In 2005, LMSs represented a fragmented $500 million market. The six largest LMS product companies constitute approximately 43% of the market. In addition to the remaining smaller LMS product vendors, training outsourcing firms, enterprise resource planning vendors, and consulting firms all compete for part of the learning management market [10], [11].

6. MANAGING E-LEARNING TECHNOLOGIES IN MARITIME EDUCATION AND TRAINING AREA

Every European Maritime University must have a department which aims to provide practice-oriented technological information management and application-oriented research for making use of information systems in the field of naval and mechanical engineering.

To improve maritime education and training it has identified lack of access to quality learning material and tutors in many countries. In our opinion the increase using the information and communication technologies will be one major component for future quality improvement of maritime education and training. Since the introduction of computer based training (CBT) in some shipping companies since a decade, the use of internet has increased tremendously.

In Constanta Maritime University, applying knowledge management is important and we apply it effectively to achieve strategic objectives. We intend to encourage learning and innovation as sources of competitive advantage, to permit vision and gap analysis, identifies new sources of technology and ideas. Through Knowledge Management in our university we explore creativity and innovation [12].

Constanta Maritime University has begun E-learning in 2001, when first test distant learning was introduced. In 2004, massive investments in IT tool were made and one year later the first official CMU e-learning Campus was inaugurated.

Since 2007, in the CMU was developed a Web based IMO Tanker Courses under the EU project for distant simulation and tutorial systems on board. The new campus has the main project objective to co-ordinate the development of a maritime flexible learning system. Also, CMS ILIAS as KMS are developed to support and enhance knowledge-intensive processes, tasks or projects of e.g., creation, construction, identification, capturing, acquisition, selection, valuation, organization, linking, structuring, formalization, visualization, transfer, distribution, retention, maintenance, refinement, revision, evolution, accessing, retrieval and last but not least the application of knowledge, also called the knowledge life cycle. You can see the practical approach in figure 1.

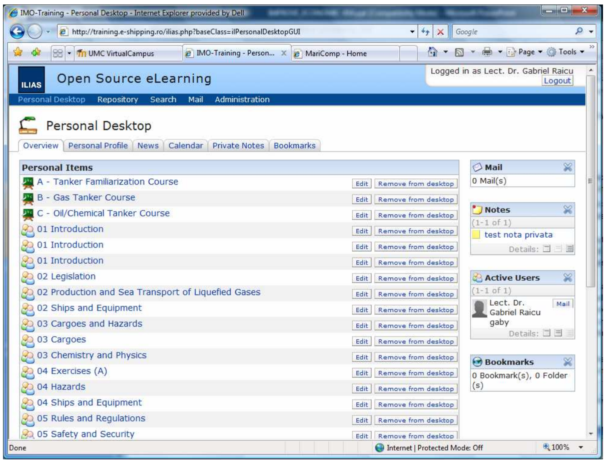

Figure 1 Web based IMO Tanker Courses

We use Moodle as Knowledge Management System; through will have an explicit Knowledge Management objective of some type such as collaboration, sharing good practice. Moodle is a Course Management System (CMS), also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). It is a free web application that educators can use to create effective online learning sites.

A Learning Management System (LMS) is a set of software tools designed to manage user learning interventions. LMS go far beyond conventional training records management and reporting and the value added for it is the extensive range of complementary functionality they offer. Via internet and LMS the participants have access to the internal tests of different topics and the students can enrol themselves directly on the website [13], [14].

7. FUTURE MARKETS AND CONCLUSIONS

LMS buyers generally report poor satisfaction based on survey results from the American Society for Training and Development (ASTD) and the eLearningGuild. The ASTD respondents were very unsatisfied with an LMS purchase doubled and those that were very satisfied decreased by 25%. The number that was very satisfied or satisfied edged over 50%. (About 30% were somewhat satisfied.) Nearly one quarter of respondents intended to purchase a new LMS or outsource their LMS functionality over the next 12 months. eLearningGuild respondents report significant barriers including cost, IT support, integration, and customization. They also report significant effort to implement with a median of 23 months being reported from requirements gathering to implementation for corporations with more than 2,000 employees.

Channel learning, is under-served. For many buyers channel learning is not their number one priority, according to a survey by TrainingOutsourcing.com Often there is a disconnect when the HR department oversees training and development initiatives, where the focus is consolidating LMS systems inside traditional corporate boundaries. Software technology companies are at the front end of this curve, placing higher priority on channel training.

Most buyers of LMSs utilize an authoring tool to create their e-learning content, which is then hosted on an LMS. Buyers, however, must choose an authoring tool that seamlessly integrates with their LMS in order for their content to be hosted. There are authoring tools on the market, such as Lectora, which meet AICC and SCORM standards and therefore content created in tools such as these can be hosted on an AICC or SCORM certified LMS.

8. REFERENCES

[1] LOUTCHKO, IOURI; KURBEL, KARL; PAKHOMOV, ALEXEI: *Production and Delivery of Multimedia Courses for Internet Based Virtual Education*; The World Congress "Networked Learning in a Global Environment: Challenges and Solutions for Virtual Education", Berlin, Germany, May 1 – 4, 2002

[2] PARKER, QUIN (2007-04-06). *A second look at school life*, The Guardian

[3] DORVEAUX, XAVIER (2007-07-15). *Apprendre une langue dans un monde virtuel,* Le Monde. Retrieved on 2007-07-15

[4] BROWN J.S & ADLER R, 2008, *Minds on Fire: Open Education, the Long Tail, and Learning 2.0*, Educause review, Jan/Feb 2008, pp 16-32

[5] BLOOM, B. S., and D. R. KRATHWOHL. (1956). *Taxonomy of Educational Objectives: Handbook 1*

[6] BÅÅTH, J. A. (1982) *Distance Students' Learning - Empirical Findings and Theoretical Deliberations*

[7] BLACK, J. & MCCLINTOCK, R. (1995) *An Interpretation Construction Approach to Constructivist Design*

[8] RAICU A, *Knowledge step in advanced materials – Polymeric Wikia*, The 6th edion of the International Conference Advanced Topics in Optoelectronics, Microelectronics and Nanotechnologies, 23-26 August 2012, ISSN 2067-158X, SPIE Organization

[9] KARRER, T (2006) *What is eLearning 2.0*? http://elearningtech.blogspot.com/2006/02/what-is-elearning-20.html

[10] DOWNES, S (2005) *E-Learning 2.0*. http://www.downes.ca/post/31741

[11] F. SURUGIU, GH. SURUGIU, *Consumers Identity-The Role Of The 'Self' Concept In The Consumer Behavior*, Analele Universitatii Maritime Constanța vol. XVII, 2012

[12] BROWN J.S & ADLER R, 2008, *Minds on Fire: Open Education, the Long Tail, and Learning 2.0*, Educause review, Jan/Feb 2008, pp 16-32

[13] *** Cisco Expands Collaboration Support

[14] *** Wikipedia, The Free Enciclopedia, http://en.wikipedia.org.

DAMAGES TO CARGO AND SHIPS – GENERAL AND PARTICULAR AVERAGES

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ABSTRACT

Due to the complexity of activities which can generate cargo surveys in respect of transport, maritime ships can be in such situations that will not allow carrying out activities onboard under normal conditions, leading to damages to the ships or carried cargo, thus entailing litigations between participants in such transport. Damages approach have had a spectacular evolution, so that the currently requested survey reports for the construction and settlement of such litigations became far-reaching and specialized. This paper will point out elements of damages going under concepts of general and particular averages.

Keywords: *Damage, cargo, survey, litigation, general average, particular average.*

1. INTRODUCTION

According to the maritime commercial literature, the damage is the total outstanding expenses and prejudice brought to the ship and cargo onboard or only to one of them subsequent to loading and departure and until their return and unloading. In the opinion of some authors, the damage is a prejudice brought to a ship or its cargo, as a result of a navigation accident or any force majeure event, as well as expenses or sacrifices incurred during transport, in order to prevent a danger threatening the ship.

Damages represent all deteriorations caused to the ship's hull, her inventory, as well as cargo onboard intended to transport.

Thus, there are two corresponding categories of damages: damages to the ship and damages to cargo.

Damages to the ship represent: the total prejudices brought to the ship's hull and her installations, being mainly generated by navigation accidents as: boarding, grounding, fire onboard, explosion onboard, touch of the sea bottom, leakage and engine damages.

Cargo damages represent: total prejudices brought to the goods due to damages to the ship or cargo.

Considering the manner of cost coverage and setting of responsibility, there are two distinct forms of damages: general average and particular average.

All overhead expenses and prejudices willingly incurred for the salvage of ship and goods are considered general averages and all prejudices brought and all expenses incurred in respect of the ship or goods onboard are considered particular averages.

2. ELEMENTS OF GENERAL AND PARTICULAR AVERAGES

2.1. Definition elements and general damages typology

The common damage is the extraordinary maritime sacrifice or outstanding expenses intentionally and rationally incurred by the ship's master, in order to save the ship and cargo (goods loaded onboard) from a danger threatening them during the maritime transport that should be borne by the parties taking benefit from it, proportionally to the asset values at risk.

Depending on the category of goods destroyed as a result of the master's decision to save the ship, general averages are classified by:

2.1.1. Damages to ship

Damages to the ship are damages intentionally caused to the ship by its master and consist of the following:

- Sacrifice of equipment and appurtenances;
- Intentional ship grounding, decided by the ship's master to save the cargo;
- Damages caused to the ship by intentional salvage act, decided by the ship's master;
- Forcing the sails or propelling ship devices and boilers on a grounded ship.

2.1.2. Damages to cargo

Damages to cargo are damages intentionally caused to cargo by the ship's master and consist of the following:

- Damaged goods in case of not enough fuel;
- Loss of goods placed on barges and boats, when the goods were loaded on such boats so that the ship may enter a port or cross the bar of a river and when the ship needs to be refloated;
- Damaged goods in case of not enough fuel or that are assigned as compensation for the settlement of a dispute or for ransom of crewmembers sent ashore during sea service on board and taken prisoners or held hostage;
- Loss of goods stowed on barges and boats, when the cargo was loaded on such boats so that the ship may enter a port or cross the bar of a river and when the ship needs to be refloated, even if this loss was caused fortuitously because the initial act which has jeopardized such goods was the master's intentional act;
- Any damages caused to goods by master's intentional act, such as damages to the goods left within ship holds by throwing overboard sacrificed goods or damages caused to goods

subsequent to fire extinguishing operations onboard.

2.1.3. Damages-expenses

Damages expenses represent costs incurred by the master for the common expedition salvage and actually constitute the ordinary form of general average:

- Refloating expenses, intended to avoid total loss;
- Salaries and food costs, due to the ship's forced staying in a port;
- Expenses incurred in order to draw up the general average regulations.
- Ransom expenses for crewmembers.

2.2. Defining elements of the general average

The following elements must coexist so that general averages may be considered:

- The general average act must be intentional. It shall not be, in any case, accidental or unavoidable;
- The general average act must be extraordinary.

For example, in order that an expense incurred by the carrier may be considered a cost included in the general average statement regulations, it must exceed the regular expenses incurred by the said voyage, being certainly determined by that intentional act.

The average statement is the document related to a general average liquidation, as drawn up by an expert called average adjuster.

Other elements for a general average:

- The general average act shall be performed only to the interests of the owners of cargo onboard;
- The general average can take place only in case of a dangerous situation which must be actual and assessed according to the actual circumstances at the time;
- The existence of a useful result for the concerned parties. In the absence of such result there is no general average act;
- The parties involved in a general average act must be parts in a common maritime expedition;
- The sacrifice made (outstanding expense incurred) must be reasonable;
- The general average contribution is not conditioned by the obtaining of a useful result. It shall be liquidated by virtue of a document called average statement, drawn up by an expert in damages (average adjuster), who is kept to set the damages to be recovered (passive) as well as the contribution values or receivables (actives);

According to commercial literature are considered general averages:

- Objects assigned by mutual agreement and as ship and cargo redemption;
- Objects thrown overboard in order to save the ship;
- Masts, sails, ropes and other tools intended to common salvage;
- Anchors and other objects abandoned or thrown into the sea for common salvage;
- Damages caused to the objects left on the ship;
- Damages caused to the ship, by throwing some objects overboard through operations of facilitating the salvage of loaded merchandise or to facilitate water leakage;
- Damages to the ship and cargo subsequent to fire extinguishing onboard;
- Expenses incurred with the personnel involved in salvage operations of ship and cargo;
- Expenses incurred with the personnel during the ship harbouring in a port because of a conflict which prevents the voyage to the port of call, until the ship and cargo are released of their respective liabilities;
- Docking or undocking costs and navigation fees paid in a port where the ship was forced to harbour because of a storm or other force majeure events;
- Expenses with the crew in a port of forced harbouring, during repairs necessary to continue the voyage when the repairs are deemed general average;
- Expenses related to unloading and reloading onboard, in order to facilitate certain operations on the ship in the port of forced harbouring; expenses for security and renting of warehouses where the objects were stored;
- Expenses incurred to secure the release or return of the arrested ship, when the arrest is not exclusively due to the ship, master or owner, as well as the crew and that period;
- Loading-unloading expenses necessary during storm or by other reasons;
- Damages due to the willing shore sinking, for salvaging the ship from the storm or other imminent danger;

Expenses incurred by the owner to ensure his liability towards the owner of goods are not allowed in the general average.

Drawing up the average statement is entrusted to an expert in such operations, that is an average adjuster, to whom all the necessary documents shall be made available and who shall set the eligible amounts in the general average, as well as the contribution of parties involved in the maritime expedition to cover such expenses.

In English law, the owner is compelled to proceed to the regulation of general average, but he is not kept to retain the services of a professional average adjuster, because he can perform this operation himself through specialized services at his disposal.

In conclusion, the aim of the general average is:

- To balance the caused losses, intending to make them reasonable to all concerned parties;
- To allow the master the leverage to act in the attempt to salvage the ship and goods under threat, by renting tugboats or by throwing the

goods overboard, without creating the concern about who shall pay for it.

The general average means the existence of a system in which all parties holding financial interest in maritime expedition pay compensations to the party incurring an intentional loss or incurred expenses to allow the completion of the voyage.

2.3. Defining elements of the particular average

The particular average is the damage caused to the cargo, subsequent to a maritime accident or due to causes closely related to the nature of things (ship or goods), without representing the will of someone or the intention of acting with regards to the same .

From this definition the following characteristics of the particular average result:

- There is a net differentiation from the general average;
- The particular average concerns either the ship or the cargo;
- The particular average is derived from navigation accidents;
- The particular average originates from the nature of cargo or is due to the ship;
- The particular average is the direct consequence of an objective event which took place;
- Within the particular average damages are caused without the possibility of their prevention.

Particular averages occur subsequent to events which directly affect the cargo, either as a result of a force majeure event (for example, a storm which led to the ship's grounding), of errors of navigation (with subsequent grounding or collision) and ship management, either as a result of vices of such goods (spontaneous combustion, degradation, condensation or mouldiness), circumstances in which the incurred deteriorations or expenses concern only a part of those concerned in the maritime expedition, either the ship or only the cargo.

According to the literature are considered particular averages:

- Any loss or damage brought to the loaded goods, due to a storm, fire, looting, shipwreck, sinking or another force majeure reason;
- Loss of masts, sails, ropes, anchors or any other type of damage caused to the ship for the reasons mentioned above;
- Any damage due to a vice of the ship, lack of supplies onboard or any other reason attributable to the owner, ship owner or ship master;
- Personnel expenses during the ordinary quarantine or repair works due to the ship's age or another cause attributable to the owner, ship owner or ship master or during the stay in a port and related expenses for to securing the release of the ship or cargo;
- Expenses to preserve the loaded cargo or repair of their packing, when these expenses are not due to damages considered general averages.

The same article sets forth that damages brought to cargo by accidents due to the master or other crewmembers negligence are particular averages to be borne by the owner of such goods, the same being entitled to claim compensations from the master.

Maritime damages can occur both to the carrier ship and its cargo. It is important to specify that under certain particular circumstances, maritime damages can be also due to the vicinity of such ships to others or some fixed port installations.

In this respect, we can state that there are special circumstances which generate damages to cargo shipped by sea.

Among those, the most important are:

- Damages to the goods, generated by damages to the ship;
- Damages due to the nature of goods;
- Damages due to the goods vicinity;
- Damages occurred prior to the goods loading;
- Damages caused by handling and transport;
- Damages caused by the wilful destruction of goods.

2.4. Damages to goods generated by damages to the ship

They can have a significant negative and rapid influence on goods. The repercussions of all navigation accidents which result in damages to the ship also generate damages to the carried goods.

Severe navigation accidents which can generate damages to the ship are:

- Shipwreck: the ship loses its nautical characteristics;
- Severe accidents: leaks, scraping. They can be generated by bad weather, unlashing of the goods in holds and breaking of deck under the weight of a package. The scraping might generate voluntary beaching subsequent to negligence regarding the study of hydro-meteorological conditions in the navigation area which may cause the ship to go adrift. Also, they can cause damage to the electrical and mechanical installations on ship's deck and engines;
- Fire, explosions onboard ship can be caused by the defective usage or neglect of basic norms regarding the usage of electrical installations, liquid and gas fuels, observance of the smoking area, etc.
- Boarding affects the ship's steadiness and floatability. Boarding can occur due to some causes, such as:
  - Abnormal functioning of an installation;
  - Insufficient monitoring of the horizon;
  - Failure to observe the International Regulation regarding the prevention of boarding at sea.

- Explosions onboard can be caused by: force majeure actions; latent vices of installations; the defective manner in which certain goods are placed onboard.
- Damage to the engines, situation in which the ship can be beached, the goods can breakout the ship, and givensuch circumstances she becomes a real danger also to other ships encountered.
- Damages to installations, situation in which the main or propulsion machine can no longer be used. The effects if it can be: ship adrift, affecting other ships, goods breakout, etc.

2.5. Damages due to the nature of goods and vicinity to other goods

2.5.1. Damages due to the nature of goods

Caused by the intrinsic characteristics of goods that is their physical-chemical characteristics.

A special attention should be paid to the hazardous cargo and their special stacking, handling, transport and storage conditions. Failure to observe the specified conditions can lead to self-ignition or explosions with destructive effects, both to the ship and cargo.

One of the special conditions to observe in case of such goods is the fact that they are not to be stacked near heating sources or in the vicinity of goods which support the burning and may self-ignite [6].

2.5.2. Damages due to the vicinity with other goods

Are damages caused by unfit stacking of goods or the fact that goods of different nature were loaded in the same area (bilge compartment, holds, cargo holds).

It is necessary that the following recommendations are taken into account:

- Two or more sorts of bulk goods are not to be loaded in the same hold;
- When liquid goods are carried, a good sealing of the connection pipes in order to avoid infiltrations from one tank to another (in case of oil tanker) must be provided.

2.6. Damages caused prior to the loading of goods onboard and those caused by handling and transport

a) Damages caused prior to the loading

The damages caused prior to loading refer to damages which can affect the goods under the following circumstances:

- During certain distances travelling to the loading port where the goods are handled on and off various means of transportation, as from the place of origin up to the loading port;
- In the port, when the goods are stored in warehouses or berths until the arrival of the ship which will take over the cargo.

Given such circumstances, the packing and even the goods can be damaged. Therefore, when the goods are loaded onboard ship, a special attention should be paid to their condition.

When it is found that the goods are damaged the following decisions should be taken:

- The loading of such goods should be refused;
- The goods are loaded, however the bill of lading shall carry anannotationin respect ofthe actualcondition of the goods upon their loading.

b) Damages caused by handling and transport

Inappropriately carried out loading/unloading operations can cause severe damages to such goods [7].

3. CONCLUSIONS

As conclusion, following situations are pointed out as being examples of inappropriate handling of goods:

- Negligent or inappropriate handling of winches (ship’s own loading/unloading installations), allowing the goods loading at too high speed or their abrupt hoisting or overload beyond the loading limit of the installations, when they can break down, causing the fall of goods from heights;
- Using certain tools during loading/unloading operations which are incompatible with the type of handled goods;
- Defective and negligent handling of goods which can lead to the flattening of packages and altering the balance of the whole stack;
- Inadequate anchoring during stacking, which causes the ship’s swinging and implicitly the moving of goods, their rubbing against each other or against the holds walls. The damage of goods by rubbing can cause severe damages, especially in case of electric or telephone cable rolls, etc.

4. REFERENCES

[1] ALEXA, C., CIUREL V.,SEBE E., MIHĂESCU A., *Asigurări şi reasigurări în comerțul internațional*, Editura All, 1992, Bucureşti.

[2] BĂTRÎNCA GH., *Comerț maritim internațional,* Editura Arvin Press, Bucureşti, 2004

[3] BEZIRIS, A., *Transport maritim*, Editura Tehnică, Bucureşti, 1988

[4] CARAIANI GH., TUDOR M. *Asigurările în transporturile maritime*, Editura Lumina Lex, Bucureşti,1998.

[5] VĂCĂREL I., BERCEA F. *Asigurări şi reasigurări*, Editura Expert, Bucureşti, 1998.

[6] BĂTRÎNCA, G., RAICU, G., POPESCU, C., *Considerations about introduction of new technologies in the maritime field and their impact on safety at sea,* 6th International Conference on the Management of Technological Changes, Management of Technological Changes, Vol. 1 Pages: 453-456, 2009, ISI Web of Knowledge indexed.

[7] ANECHITOAE, CONSTANTIN, GRIGORUT CORNEL, BRASOVEANU FLORICA, GRIGORUT, LAVINIA – MARIA, *Rules Regarding the Navigation on the Territorial Sea and in Romanian Ports*, Constanta Maritime University Annals, 2011
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TEMPERATURE AND HUMIDITY – TWO MAJOR CLIMATIC RISK FACTORS AFFECTING THE QUALITY OF CARGOES CARRIED BY SEA

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ABSTRACT

Every day, millions of tons of temperature sensitive goods are produced, transported, stored or distributed worldwide. For all these products the control of temperature and consequently the control of humidity is essential, mostly when it is about transportation of the goods by sea. The quality of these products might be changed rapidly when inadequate temperature and relative humidity conditions are not preserved during transport and storage. Temperature variations can occur in warehousing, handling and transportation. Recent studies show temperature-controlled shipments rise above the specified temperature in 30% of trips from the supplier to the distribution centre, and in 15% of trips from the distribution centre to the store. Lower-than required temperatures occur in 19% of trips from supplier to distribution centre and in 36% of trips from the distribution centre to the store (White, 2007). It is the scope of this paper to highlight the impact of air temperature and atmosphere humidity on the quality of goods carried by sea onboard maritime ships.

Keywords: *Temperature, humidity, air circulation velocity, cargo, maritime transport.*

1. INTRODUCTION

Throughout the process of transportation, a special attention should be paid to the preservation of merchandise properties and prevention of quality risks, in order to eliminate or diminish degradation and depreciation which may occur as a result of the effects of certain risk factors.

By merchandise properties we understand a cluster of typical features consistent with the specific functions of a product, its utilization value, as well as its quality.

Among the major risk factors, acting mainly in the maritime transport we specify herein the temperature, the humidity and the effects of air circulation velocity on the quality of goods shipped by sea.

2. TEMPERATURE AND HUMIDITY – CLIMATIC RISK FACTORS AT SEA

2.1. Impact of air temperature on the quality of goods shipped by sea

For each type of product intended to maritime transport it is required to ensure an optimal temperature status, because keeping it on a certain level during preservation influences both the maintenance quality and the lifespan of those products.

The preservation temperature must not fluctuate too much, especially in case of food products. This goal may be reached by proper ventilation of the storage area, procedure which can be performed either by natural way (opening of silo hatchways and ventilation cowls) or by special ventilation installations.

Temperature dropping under the levels set forth by standards may lead to alterations, such as freeze and dilation of products, precipitation, alteration of solubility and viscosity of oils and fats.

Increase in temperature above the standard levels entails a range of physical alterations, such as dilation and high pressure inside the tanks up to explosion. Also, metabolic processes are accelerated and losses of quantity occur in the products weight.

Any merchandise sensitive to temperature fluctuations demands the observation of certain requirements in this respect. If the temperature of storage areas on maritime vessels throughout the transport complies with the requirements, the necessary premises to maintain the quality of shipped merchandise are thus ensured.

2.2. Transport temperature fluctuation interval

The transport temperature is the optimal storage temperature of a product, which provides the best conditions to maintain its quality. For most goods (which do not fit the category of those under mandatory temperature control status), the optimal transport value ranges between +5°C and +20°C.

Of course, when different climate zones are crossed, different values are to be expected that is temperatures higher than +20°C for subtropical areas and lower than +5°C (even negative) for temperate areas, in winter time.

In such situations, preventive steps are called for, so that the temperature of storage area shall not exceed a high admitted level or does not decrease below a low admitted level.

If the high admitted temperature level is exceeded, considerable quality depreciations and even total spoilage of goods may occur due to the intensification of the enzymatic and microbiological processes.

High temperatures may lead to the occurrence of the phenomenon of overheating and even self-ignition of the shipped cargo (such as products with high content of oils).

Another significant example of spoilage is that of tobacco leafs which, exposed to temperatures above the high admitted threshold enter the stage of over ripening, crushing and transforming into powder.

High temperatures can be generated not only by climate fluctuations of crossed areas, but also by local sources inside the storage area, such as vicinity of tanks to heated fuel, vicinity of engine compartment walls, etc, with negative effects on the merchandise quality.

If the high temperature threshold is exceeded, depreciation may occur due to the formation of white frost on the products surface and in case of very low temperatures massive degradation can be recorded, like in case of volume expansion of products, due to frost.

From the previously presented examples, we can infer that many goods cannot withstand the maritime transport without temperature control within the storage area. Thus, some goods require heating (such as some oils), while others require a forced cooling process up to freezing (such as perishable products). The transport of such products is considered transport by controlled temperature and is carried out by using complex heating or cooling installations, as the case may be.

2.3. Impact of air humidity on the quality of goods shipped by sea

Although they carry very little weight in the total air components, water vapours present in the atmosphere have a considerable impact, as it is most visible from the daily weather fluctuations.

The fact that the atmosphere can have only a certain concentration of vapours, called saturation value and that it depends on the temperature is well known: the warmer the air, the larger the quantity of water vapours.

After the saturation value is reached, the evaporation process cannot continue, which means that the relative air humidity is 100%. For example, a60% humidity means that the air contains 60% water vapours by its saturation value.

a) The use of Molliere diagram in order to set the ratio between temperature fluctuation and relative air humidity

As aforementioned, also the relations between the two atmospheric parameters, relative humidity and temperature may be represented by way of Molliere diagrams (figure 1).

The lower the relative humidity, the more intense the water vapours sorption process is manifested, which leads to the pursuit of drying.

A reference parameter indicating the risk of condensation water occurrence is the dew spot temperature. In case of cooling, this temperature is the point when the content of water vapours in the atmosphere reaches its saturation value and if the cooling continues, the condensation water phenomenon occurs.

If the dew spot temperature is known, it is possible to estimate the risk of condensation water phenomenon occurrence for which the Molliere diagram shall be used where the air temperature and dew spot temperatures can be read on the Y coordinate, while the mix ratio – vapours (expressed in grams)/dry air (expressed in kilograms) can be read on the X coordinate.

The Molliere diagram presents the curves of relative air humidity, drawn at intervals of 10%. The first curve on the diagram basis is applicable to the value of 100%, therefore it represents the saturation curve.

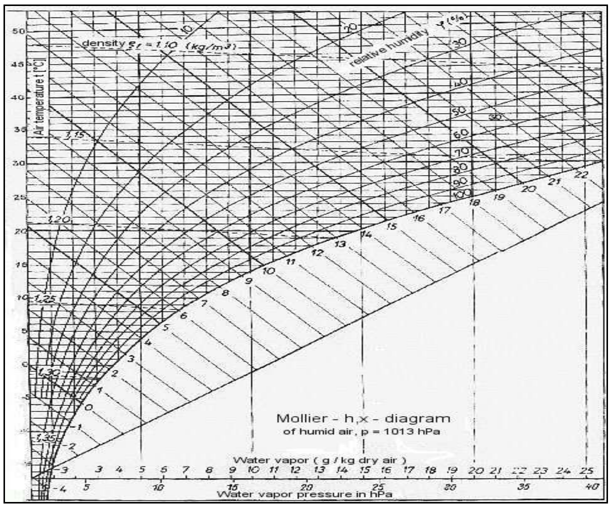

Figure 1 Molliere diagram of the possible ratio between temperature fluctuation and relative air humidity [17]

b) Sorption behavior of goods

Hygroscopicity is the term which describes the goods response capacity to the water content of air and the phenomenon manifests itself either by absorption, or water vapors elimination.

The crucial elements in the analysis of goods hygroscopicity are:

- Relative air humidity;
- Air temperature;
- Goods water content.

2.4. Classification of goods as per water content

The water content of a product is the water quantity of the total weight of that product, expressed in percents. Many hygroscopic products intended to maritime transport are organic.

However, there are inorganic products (many chemical products) which are also hygroscopic; therefore, a special attention should be paid to such characteristic during all transport phases.

Hygroscopic goods can mostly cause degradation of neutral products from hygroscopic point of view, such as metals or chemical products and therefore, a risk factor with regards to the occurrence of corrosion phenomenon.

Hygroscopic goods have the specific feature of variable water content, therefore being able to absorb humidity from the environment or releasing water vapours into it. Thus, in a relatively low humidity environment, such goods release water vapours, while in a relatively high humidity environment they absorb the humidity from the air.

This way, in case of hygroscopic goods, the water content changes and alterations in their total weight occur. Such a situation can generate more severe effects. Beside the aspect of quality alteration, depreciations what so ever may occur, leading to total depreciation of such goods.

A product is deemed dry when its water content does not affect its quality throughout the transport under normal weather conditions. For example, in case of organic goods, a high water content may generate the occurrence of mould, rotting, as well as other biochemical alterations (for example, in case of cocoa and coffee beans).

For some products (usually in bulk), these manifestations are accompanied by the phenomenon of overheating, which can lead up to self-ignition (for example, in case of oilseeds, fodders containing oil residua, etc).

2.5. Determining sorbtion isotherms in case of goods within storage areas on maritime vessels

The term “sorption” is used to describe the characteristic of hygroscopic goods to absorb or eliminate water vapors in the environment until a state of balance is reached, as per the relative temperature and humidity of the environment.

The sorptional behavior is determined by the partial pressure gradient, where, according to the law of diffusion, the water vapors move always from the higher partial pressure to the lowest until the balance of vapors pressure is reached.

A sorption isotherm, such as the graphic representation of the sorptional behavior of a product, describes the relationship between the water content of such product and the relative humidity of air in the environment at a certain temperature.

In case of closed storage area (such as the ship’s holds) we can determine the sorption isotherm depending on the water content of goods and the relative humidity within the storage area for a certain temperature, until the balance between the water content of goods and that of the air is reached, also setting the balance spot of water content.

The graphic representation of the statuses of balance between partial pressure of vapors for a certain product (depending on water content) and partial pressure of water vapors in the air for a specific temperature determines the sorption isotherm that describes the sorptional behavior of the product.

Therefore, if the water content of a product is known, it is possible to use the sorption isotherm diagram in order to determine how the product behaves in the storage area or how the climate in that area changes.

Throughout the determination of the statuses of vapors pressure balance between the product and the air, differences shall be recorded between the readings during adsorption and desorption.

The readings for the desorption isotherm are always a little higher than those for the adsorption isotherm. The specified differences reach their maximum amplitude for moderate readings of relative humidity.

In practice, the adsorption isotherm is used for a temperature of 20ºC, complying with the hygroscopic state of goods when the manufacturing process is complete.

The sorption isotherm profile is a characteristic of the hygroscopicity of a product.

Thus, the substances with high hygroscopicity have a steep sorption isotherm curve, whereas the products with low hygroscopicity have an almost straight sorption isotherm curve.

2.6. Effects of air circulation velocity on the quality of goods shipped by sea

The prevention of condensation water might be ensured by good storage ventilation, providing the cargo with optimal storage conditions throughout the maritime transport.

Adequate ventilation shall provide a constant flow of air in the storage areas, so that the heat, gases and smell emanations from goods may be evacuated, thus providing the temperature the goods need for an adequate keeping.

Storage ventilation is carried out through cowls which shall be oriented towards the resultant between the ship’s heading and wind direction.

Besides the natural ventilation system, modern vessels are also equipped with an artificial ventilation system. This system, consisting of an electric fan installed in the cowls, provides controlled ventilation to the sense of forced air intake or exhaust within the storage areas.

The method of manually adjustable cowls or wind sails is simple and classic for all vessels carrying general goods. In such cases, temporary wooden air shafts are used inside the storage areas for providing cowl-intake air distribution among stacks.

In case of cargo that emanates gas, it facilitates the forming of strong sweat and even the stowage manuals recommend the opening of hatch covers during transport, under strict supervision, depending on weather condition, for natural ventilation inside cargo.

Of course, in case of automatic ventilation installations inside storage areas such manoeuvres for ventilation are no longer necessary. A permanent air flow of 1- 4 m/sec is provided by centralized control.

Anyway, an important ventilation measure, such as opening the hatch covers shall be permanently supervised and constantly entered in the log book. This shall remain as material evidence for each survey report, should it be required in the future.

In case of bad weather, too high humidity, too high outside temperature or rain, or waves going over the deck, the storage ventilation is to be cut off.

3. CONCLUSIONS

Most of the cargo loss or damage resulting cargo claims can be prevented by a proper maintenance of vessels and proper care of cargo.

If a vessel causes loss or damage to her cargo and if carriers are held liable, carriers would have to compensate cargo interests for their damages.

Furthermore, extra time and costs will be incurred in discharging the damaged cargo. In the worst case, cargo receivers might refuse to take delivery of the damaged cargo that results in delay in the vessel's departure.

Moreover, carriers’ reputation may be deteriorated, which might result in loss of business. Accordingly, carriers are required to take proper care of cargo throughout their loading, navigating, discharging and delivering operations.

4. REFERENCES

[1] DIACONESCU, I., *Merceologie alimentară*, Editura Eficient , Bucureşti,1998.

[2] PETRESCU, V., PÂSLARU, C., SÂRBU, R., *Expertiză merceologică*, Editura ASE, Bucureşti, 2002.

[3] PETRESCU, V., PÂSLARU, C., *Expertiză merceologică*, Lito, A.S.E., Bucureşti, 1991.

[4] PETRESCU, V., PÂSLARU, C., POP E., *Expertiza mărfurilor import-export*, Editura Era, Bucureşti, 2000.

[5] PETRESCU, V., RĂDUCANU, I., *Merceologie industrială*, Editura SIC, Bucureşti, 1993.

[6] PETRESCU, V., PÂSLARU, C., *Expertiză merceologică* , Editura Metropol, Bucureşti , 2000.

[7] PÂSLARU, C., PETRESCU, V., BUCUR, I., BITIREZ, L., *Probleme actuale ale expertizării degradării produselor în timpul păstrării*, A.S.E., Bucureşti, 1999.

[8] PETRESCU, V., PÂSLARU, C., SÂRBU, R., *Expertiză merceologică*, Editura ASE, Bucureşti, 2002.

[9] PETRESCU, V., PÂSLARU, C., *Expertiză merceologică*, Lito, A.S.E., Bucureşti, 1991.

[10] PETRESCU, V., PÂSLARU, C., POP E., *Expertiza mărfurilor import-export*, Editura Era, Bucureşti, 2000.

[11] PETRESCU, V., RĂDUCANU, I., *Merceologie industrială*, Editura SIC, Bucureşti, 1993.

[12] PETRESCU, V., PÂSLARU, C., *Expertiză merceologică*, Editura Metropol, Bucureşti, 2000.

[13] PETRESCU, V., PÂSLARU, C., *Expertiză merceologică*, Universitatea Creştină "Dimitrie Cantemir"Bucureşti, 1994

[14] SÂRBU, R., *Exigențe actuale privind calitatea şi competitivitatea mărfurilor,* publicat în „Revista de Comerț" Nr.11-12 (59-60) Anul V, noiembrie-decembrie 2004, pag, 66-68;

[15] STANCIU, I., *Bazele merceologiei*, Editura Metropol, Bucureşti, 1996.

[16] STANCIU, I., *Bazele merceologiei*, Universitatea Dimitrie Cantemir, Bucureşti, 1999

[17] SCHARNOW, U., '*Moisture content and sorption behavior of goods retention of quality. Paper on the subject of humidity/moisture and its effects on goods transport'*, GDV Transport Loss Prevention Conference 1998, Hamburg.

[18] RAICU, G., NITA, A. *Evolutionary designs in elearning virtual engineering and business education,* 5th Balkan Region Conference on Engineering and Business Education/2nd International Conference on Engineering and Business Education, Lucian Blaga University, Sibiu, Romania, 2009, ISI indexed.

[19] CORNEL GRIGORUT, CONSTANTIN ANECHITOAE, *Impactul transfrontalier al poluarii mediului marina supra modificarilor geo-climatice regionale si locale ce afecteaza Dobrogea,* Buletinul Directiei Hidrografice, 2010.

[20] CORNEL GRIGORUT, MADALINA VOICU, CONSTANTIN ANECHITOAE, *Climatic conditions and their influence on maritime shores,* Constanta Maritime University – Annals, 2010.

GOODS, SHIPS AND PORTS – INTEGRATED CONCEPTUAL APPROACH FOR THE INTERNATIONAL MARITIME TRANSPORT

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ABSTRACT

Maritime transport is an important factor of economic development of every maritime country. Its basic task is providing shipping services, meaning that they may as well be considered as the product of the shipping economic activity. Regarding the current international shipping crisis, the key to success of every shipping organization, region and maritime country lies in efficiency and safety of its maritime shipping services – on one hand, and on the other hand, is about having an integrated conceptual approach as regards the key elements i.e. goods, ships and ports. It is the aim of this paper to broadly emphasize the particularities of each key element contributing.

Keywords: *maritime transport, goods, ships, ports, transshipment.*

1. INTRODUCTION

The fundamental aim of the maritime transport and trade is to ensure the domestic and international regular and safe circuit of goods, in coordination with economic efficiency and according to the conventions, laws and contract terms in force.

The transport is an element indispensable to life because it offers people the possibility to know, perceive and assimilate, as easy as possible, what human civilization and culture have to offer.

The existence and improvement of means of transportation have allowed contact between various countries and nations, which has determined the economical, political and cultural life of mankind.

The maritime transport contributes to the closeness of geographical areas, development of economic branches and territorial distribution of production and marketing.

The level of development of maritime transport has a direct impact on the social division of labor, which, in its turn, determins the specialization, as well as the increase of the degree of accessibility to natural resources and fruits of human labor.

The basic elements as indispensible to the achievement of the fundamental aim of transport are the following:

- goods - as object of maritime transport;
- ships - as maritime means of goods transportation;
- ports - as flow nodes, transshipment and warehousing of goods.

2. GOODS –SHIPS – PORTS AS KEY ELEMENTS OF MARITIME TRANSPORT

2.1 Goods - as objects of the maritime transport

It is obvious that, in the development of maritime transport by its three basic elements, the goods have an essential role, both for the ports development and evolution of ships.

All three elements are permanently interdependent, however the research performed in the past has indicated that the main element in the economy of maritime transport is, either as raw material, by traffic diversity, quantity and regularity or as manufactured products, the more diverse, complex and demanded they are in international trade, the more economic, scientific and technical progress is advanced.

Advanced technologies had an influence on the ports, which expanded in recent years and modernized in order to allow the profitable handling of goods. At the same time, at the request of owners, the innovative processes have made the transition from the classic freighter to specialized vessels, which incorporate state-of-the-art technologies, subsequent to the changes occured on the freight markets, imposed by the quality and quantity evolution of goods in maritime traffic.

It is worth to mention that the propelling element of maritime transport is the quality-quantity leap of the goods factor, the other two, ships and ports, being the effects which, in their turn, influence the cause, forming the dialectic deterministic chain.

Considering the opinions expressed in the specialized literature, we may claim that the goods influence the development of ships and ports through their physical condition, quantity and regularity on various transport routes; quality, diversity and handling and stacking characteristics; nuisance value; sensitivity; perishability and specific freight by each type of goods.

According to their physical condition and handling and stacking characteristics, the goods subjected to maritime transport can be classified into two large categories:

- bulk cargo (or continuous goods), including homogenous lots of unpacked goods, large enough to cover themselves the transport capacity of a ship or of a cargo hold, which allow a continuous or nearly continuous loading flow;
- general cargo (or discrete goods) which, by its nature, consists of non-homogenous lots of packed goods, smaller in size, which does not allow a continuous flow of loading and requires

special means of packing, loading, stacking, lashing, transshipping and unloading;

The impact of each category of goods on the evolution of ports and ships for the purpose of obtaining benefits can be emphasized by the following two aspects:

- due to the possibilities of continuous handling operations, the bulk carriers (oil tankers, dry bulk carriers, bulk carriers, etc), equipped with modern technology represent the most profitable and widely used segment of the maritime transport;
- general cargo ships which are not equipped with modern handling technologies are less profitable and consequently, their use is not remarkably beneficial. The ideal solution for the cost effectiveness of general cargo transport under the current development circumstances is to perform a continuous loading flow for this category of goods, as well.

The quantity of goods and the regularity of their flow involve the use of ships on certain routes, according to the transport system- by liner or tramps.

Depending on the features of goods (quality, diversity, handling and stacking characteristics, degree of peril, sensitivity and perishability), important easements are determined both in loading and unloading ports and onboard ships, requiring the fitting with specific machineries, as necessary for handling goods in order to maintain their quality and quantity integrity.

The freight is set depending on certain factors, such as: class and tonnage of vessel, distance between ports, season, special expenditures, volume of shipped goods, kind of goods and their nuisance value. Freight value is different depending on the range of shipped goods, which proves the influence of cargo on ships cost effectiveness through the transport price.

2.2. Requirements for ships used in goods transportation

Experience has shown that there is a close connection between the basic elements of maritime transport that is between ships, goods and ports; if one of those components would lag behind, the cost effectiveness of the whole system would be deeply and shortly affected.

Along with the diversification of goods and increased demand for raw materials and manufactured goods transportation, the diversification and specialization of ships as regards their transport capacity, fitting with modern mechanization and automation installations intended to goods handling and transshipment became necessary.

This period is characterized by the expansion and modernization of ports, roads and port basins for the access of large and modern ships, as well as of the operation front by raising quays, equipping ships with high flow installations by building specialized berths, by the modernization of maritime port terminals and management of the port area as judiciously as possible.

Returning to the ships, it is worth mentioning that they are highly complex technical constructions and extremely expensive investments.

Therefore, they must fulfill two categories of essential conditions:

a) Technical-constructive conditions intended to provide the ship’s strength to exceptional environment stress within the shipping area consisting with her class and set forth by the class certificate. Compliance with such requirements mainly guarantees the safety of the ship and, implicitly, of the goods onboard, as well as of her personnel, providing her seaworthiness – a personal obligation of the owner and an implicit prerequisite for the ship before each voyage.

Among the technical progresses, the following may be mentioned:

- building of metal hulls for ships driven by steam engines;
- replacement of steam engines with diesel engines;
- passing from hull’s rivetting to welding;
- emergence of modern systemsof shaft closing, loading installations and navigation equipments;
- introduction of various automation technologies which allow selfloading of ships and computer assisted navigation;
- computer assisted design, which reduced the quantity of metal used in shipbuilding by 30%, and increase of naval paint quality, which has reduced corrosion and resistance to advancing due to frictions;

b) Technical-economical and cost effectiveness conditions representing the total constructive and operational characteristics, as regards the performance which must ensure the efficiency of each ship, maritime transport organization and generally, of the company, all such leading to profit making.

The above ship-related conditions may be fulfilled by encompassing the following aspects:

- adequate space, appropriate facilities and profficient installations for rapid stacking, preserving and handling of goods, depending on to the type and destination of the ship;
- ensuring the best possible deadweight coefficient;
- consumption and overhead costs as low as possible, both during laying and operation of the ship;
- high speed to ensure an increased number of travellers each year.

Both technical-constructive and technical-economic conditions may be fulfilled by several factors. Naval research and design institutes and shipyards are in charge with the technical design and building of ships, while shipping companies and charterers concerned in rational and proficient exploitation of ships are responsible for organization and management matters.

Currently, the following categories of ships are intended to maritime transport of goods:

- General cargo ships;
- Bulk cargo ships;
- Oil and chemical tankers;
- Container carrier ships;
- RO-RO and vehicle carriers;
- Reefer ships.

2.3. Importance of ports, as flow nodes, transshipment and warehousing of goods

In the opinion of maritime transport experts, the modern maritime commercial port is a specially arranged seashore area where maritime and land transport ways of the continental area serving the port are joined and where there is a continuous and organized two-way trade in goods.

Initially, the ports were defined as simple places where goods were loaded or unloaded. In the course of time, they have evolved from the status of simple interface between maritime and land transport (first generation ports), to the current phase of industrial and commercial clusters where several services are rendered (third generation ports).

Thus, we reach the concept of logistic for value adding, which means that besides the primary loading or unloading functions, the ports add value to the goods. Just in order to respond to this new aspiration, ports are currently designed and developed as close as possible to the place of manufacturing and distribution of goods, within a wide area.

Taking into account the opinions expressed in the specialized literature we can state that ports, regardless of their size, have three important functions: transshipment, storage and industry.

The function of transshipment in very important and refers to the transfer of goods from ships to shore and back, in order to provide optimal conditions for the goods flow, as from the shipper to the consignee.

Improvement of such function depends on the following:

- increase in operation speed and introduction of the continuous flow of goods handling;
- reduction of the laying time, thuis leading to a decrease in the transshipment time;
- modernization of maritime terminals, fitting them with modern handling installations and means of partial and total processing of raw materials;
- efficiency of infrastructure (piers, basins and quays), as well as overstructure works, represented by means of transshipment placed alongside the berthing area, considering that the transshipment takes place in the port basin, on quays or operating berths;
- performing an active cooperation between ship and quay.

The port function of transshipment has two forms of manifestation: transitional storage and warehousing storage.

The transitional storage refers to the situation when stocks are formed in order to decrease the gap between the large capacity of modern ships and the means of land transportation.

The warehousing storage has a strong economical character and here we have several situations:

- balancing warehousing, due to the seasonal supplying in comparison to the permanent consumption flow;
- warehousing as a result of an order, for the purpose of accumulating savings;
- commercial warehousing, representing a measure of precaution against worldwide price fluctuation phenomenon;
- warehousing throughout the processing, for goods requiring maturity before processing.

The industrial function refers to the connections between large ports by inland waterways, in order to cluster heavy industry enterprises in their proximity. On the other hand, there is a tendency for modern ports development by expansion, deepening, new locks, canals and development of waterways inside the continent for ships of various types, in order to avoid large crowded ports.

However, port efficiency should be seen as a set of interrelated issues such as architecture and aquarium construction, the size of ships and cargo traffic, major operating berths, safety operation of vessels and port economic development priorities in the current requirements the seaports.

3. SYSTEMATIC ASPECT OF MARITIME TRANSPORTATION

The era of rapid economic and technical-technological development of modern production requires a well-organized and above all, a safe transport system [9]. The study of traffic as a whole involves the study of individual types and systems, especially of its most important part: maritime transport system.

Maritime transport, therefore, involves transport of passengers and/or goods by sea, which is often called shipping trade (seaborne), which can be passenger and cargo shipping.

Theoretically speaking, cargo shipping is a very broad term assuming various modes of employment of cargo ships, so there are a few types accordingly - tramp, liner and specialized shipping.

Each of these types of cargo shipping operates in accordance with their operational processes and control procedures, which are managed and controlled by quality management of shipping companies, and supervised by the competent state institutions and international organizations for control of maritime navigation.

Maritime transport involves the physical transport of cargoes from an area of supply to an area of demand for certain types of goods, together with all the activities required to support and facilitate such transport.

Maritime transport system includes three essential components important for the movement of goods, and they are as follows:

- fixed infrastructure such as ports or terminals;
- means of transportation such as ships and barges;

- organizational system necessary to ensure that ships and fixed infrastructure are used effectively and efficiently

However, the realization of shipping services involves a number of commercial activities, the existence of appropriate infrastructure, procedures for shipping operations, organizational management systems such as enterprise resource planning or information system which integrates all operations and applications within a shipping company or organization.

The efficiency of shipping services is determined by the ratio of supply and demand on the shipping market, and managerial maritime transport uses market mechanisms in the regulations of supply and demand relationship.

4. CONCLUSIONS

As a first conclusion, modern maritime ports have simultaneosly the following functions: transit gate towards maritime and land ways and maritime terminal, as organizational unit of transit improvement, as well as regional processing of mass-produced goods.

As a second conclusion, can be stated that the maritime transport is a highly complex economic activity of national and international interest, which must be considered and developped in such a way that to administer the needs and to ensure profitability.

The main function of maritime transport is to ensure the link between production and consumption and is characterized by two essential economic features:

- economic profficiency to the sense of complying with defined requirements;
- profitability, as essential prerequisite of a wide economic activity, which involves transport costs and transport-related operations costs.

5. REFERENCES

[1] CARAIANI, GH., ALEXA, V., SEBE, E., Transporturi şi asigurări, curs Universitatea Româno-Americană Bucureşti, Editura Metrolpol, 1994.

[2] CARAIANI, GH., ALEXA, C., PENCEA, R., *Reglementări şi uzanțe în transportul internațional de mărfuri*, Editura "Scrisul Românesc", 1986.

[3] BĂTRÂNCA GH., *Comerț maritim internațional,* Editura Arvin Press, Bucureşti, 2004.

[4] BERESCU S., Studiu constructiv dinamic al acvatoriului portului Constanta si consideratii privind cresterea eficintei operationale în port, Editura Nautica, Constanta, 2012.

[5] BEZIRIS A., BAMBOI GH., *Transportul maritim* , vol. I-II, Editura tehnică , Bucureşti, 1988.

[6] BEZIRIS, A., *Teoria şi tehnica transportului maritim, partea I,* Editura Didactictică şi Pedagogică , Bucureşti, 1978.

[7] BEZIRIS A., TEODOR M., RICAN, G., *Teoria şi tehnica transportului maritim, partea II,* Editura Didactică şi Pedagogică, Bucureşti, 1979.

[8] FILLIP GH., *Dreptul Transporturilor*, Editura Şansa, Bucureşti, 1996.

[9] RAICU, GABRIEL; BATRINCA, GHIORGHE; BRANZA, GRATIELA, *Technological and economic considerations about managed learning systems implementation,* 6th International Conference on the Management of Technological Changes Alexandroupolis, Greece, Vol. 2 pages: 331-33, 2009, ISI indexed.

[10] CORNEL GRIGORUT, LAVINIA GRIGORUT, CONSTANTIN ANECHITOAE, MARIANA COJOC, *From the bargain/bargaining „agreement" to the shipping agreement (II),* Constanta Maritime University Annals, 2012.

[11] LAVINIA-MARIA GRIGORUT, CORNEL GRIGORUT, CONSTANTIN ANECHITOAE, MARIANA COJOC, *From the Bargain/Bargaining „Agreement" to the Shipping Agreement (I)*, Constanta Maritime University Annals, 2010.

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