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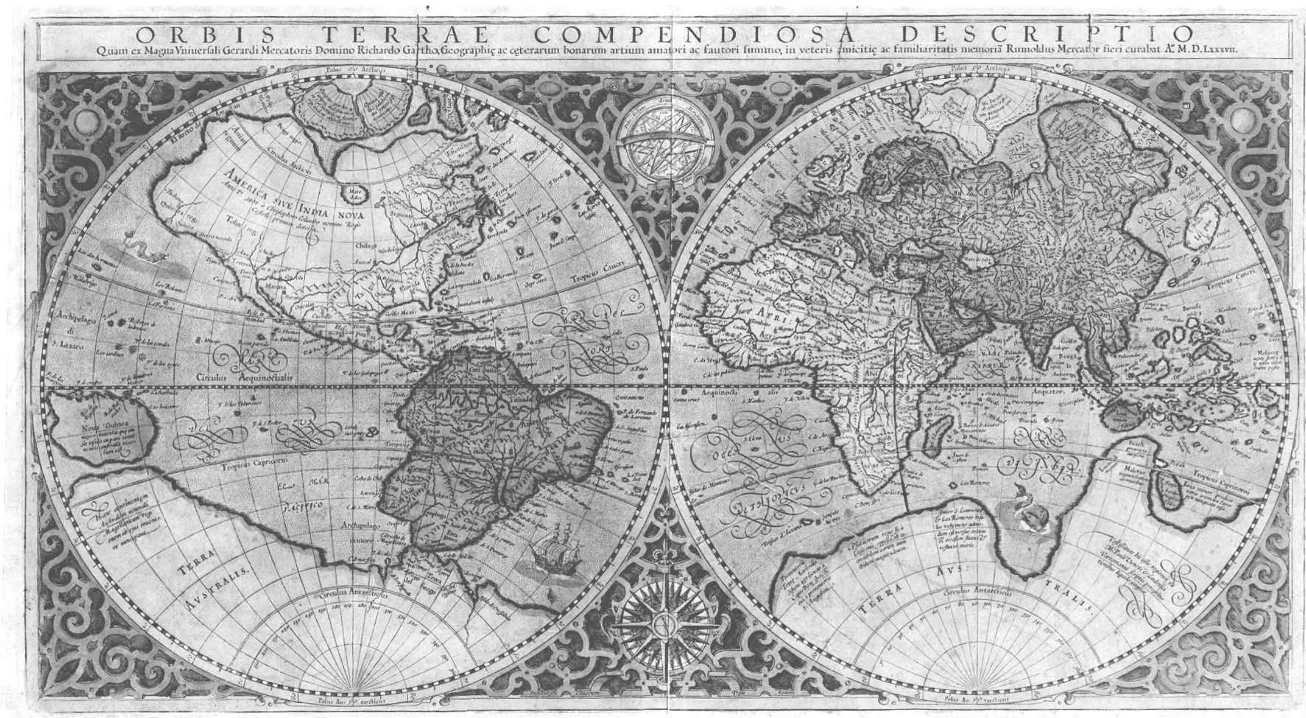

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SECTION I

NAVIGATION AND MARITIME TRANSPORT

OVERWEIGHT CONTAINERS, A SERIOUS THREAT TO SHIPS SAFETY

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ABSTRACT

The problem of overweight containers becomes a major concern of the maritime community. Huge number of containers are damaged and /or lost overboard every year as a result of stow collapse due to overweight containers. Apart from that, this problem affects in a dangerous way the safety of ships by affecting the ships intact stability. The maritime industry efforts continue to find a possible solving problem solution in order to prevent accidents but the problem still remained open. This paper presents the risks involved in overweight containers and the impact of this problem on the maritime safety and safety of ships.

Keywords: *containers, overweight, containership, safety, ship stability, maritime*.

1. INTRODUCTION

Over 40 years have elapsed since the first overseas container ship *Encounter Bay*, berthed at Sydney on 3rd of April 1969 to inaugurate a full container service from the UK/Europe to Australia/New Zealand. The container shipping industry has made gigantic strides since that pioneering voyage, completely transforming shipping as we then knew it. It was not just a gradual progression from one system to another such as sail to steam; it was a revolution that spelt the death knell to conventional shipping, as containerization rapidly took over.

Once upon a time it was cube cutting that was the fraud of choice for the world's freight forwarders but with the burgeoning trade in full load containers (FCL's) over the past few decades, often stuffed with consolidated cargo from different consignors, a new and potentially much more dangerous problem has arisen: overweight.

Today's international container shipping fleets are now comprised of a small number of operators, with many of their ships under flags of convenience. The big players now are the CMA CMG Group, Evergreen Line, Maersk Line and Mediterranean Shipping (MSC), who collectively control 25% of the total world's container tonnage. All are very reputable and highly respected companies with container shipping as their core business.

Containerization has become the dominant method of transporting almost all types cargo commodities in international trade. The intermodal method of transportation has proved to be a very efficient and cost effective way of transporting goods over long distances, whether by land or sea. Today, over 700 million containers are handled worldwide.

2. OVERWEIGHT CONTAINERS, A SERIOUS THREAT FOR MARITIME INDUSTRY

Despite the rapid progress of containerization, the freight transport system is still struggling with one basic issue: overweight of containers. The issue of overweight containers has been a subject of industry, insurance and at times government concern over the years and has from time-to-time become an issue of concern to the general public after incidents involving overweight boxes.

However, the continuing problem of overweight containers, that have dogged the industry since its inception, must surely be of serious concern. This practice is still unfortunately widespread, even in the more developed countries, although less of a problem, which has resulted in many serious incidents and shipping casualties over the years.

Overweight containers are said to interfere with road safety and generate excessive wear on roads and bridges. Yet, the issue is more complicated. It involves a wide range of players in international and domestic trade, transport and logistics, from shippers to trucking companies, seaports, and shipping lines.

There are varying contexts or definitions of "overweight". A loaded container can exceed road weight limits, rail weight limits, crane lifting limits, container carrying capacity limits or its weight as declared by the shipper, but each of those overweight situations addresses operational and safety problems. The most common overweight situation is when the actual container weight exceeds the shipper's declared weight. Having the actual weight of a container would enable a carrier and a terminal operator to knowledgeably address all the various container weight issues and requirements.

In late 2008, the Australian Senate heard testimony from Customs and other officials there that "approximately 80% of consignments from developing countries are miss-declared" and that "the evasion of duty through undeclared cargo is considered to be another incentive for more container inspections."

No accurate data exist to indicate how many containers are overloaded or have miss-declared weights, but the problem is significant and arises in almost every trade to some extent. In some geographic trade lanes, the problem is common and, at times, rampant. Ship lines have reported that in severe cases, the overweight or incorrectly declared weights reach 20% of the total cargo on board vessel. Some carriers report that it is not uncommon for actual total cargo weight aboard ship to be 3 to 7 percent more than declared weight.

The graph illustrated in Figure 1, presented by Lloyd's List Magazine in August 2011, shows the types and number of incidents on board container ships, during the first half of the year 2011, involving containers.

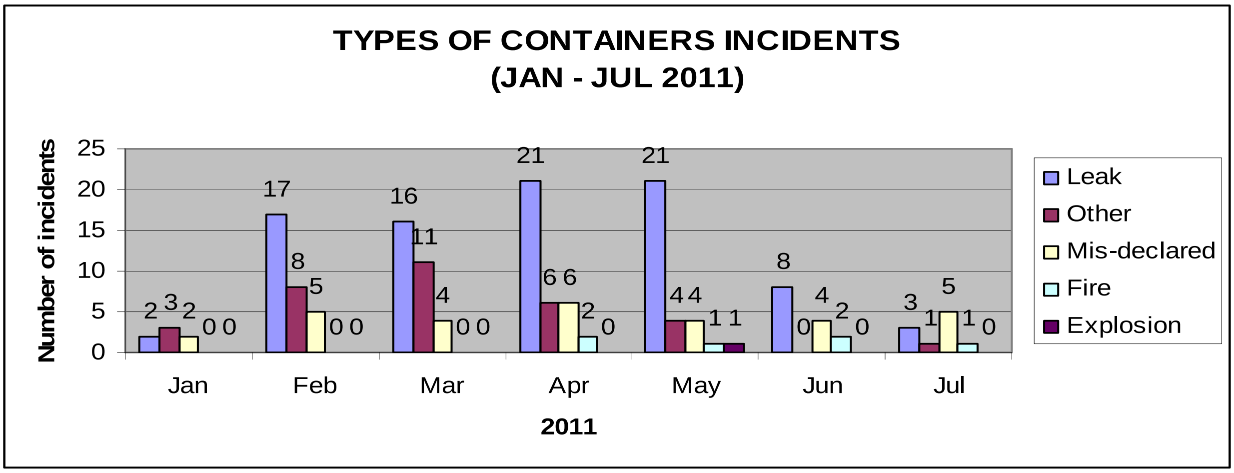

Figure 1 Types of incidents involving containers (Jan - Jul 2011)

From the above figure, it can be noted a very important aspect, namely that the incidents related to overweight containers were present every month and moreover, at high level, i.e. 19% (Figure 2) compared with other dangerous incidents like fire (4%) and explosion (1%)

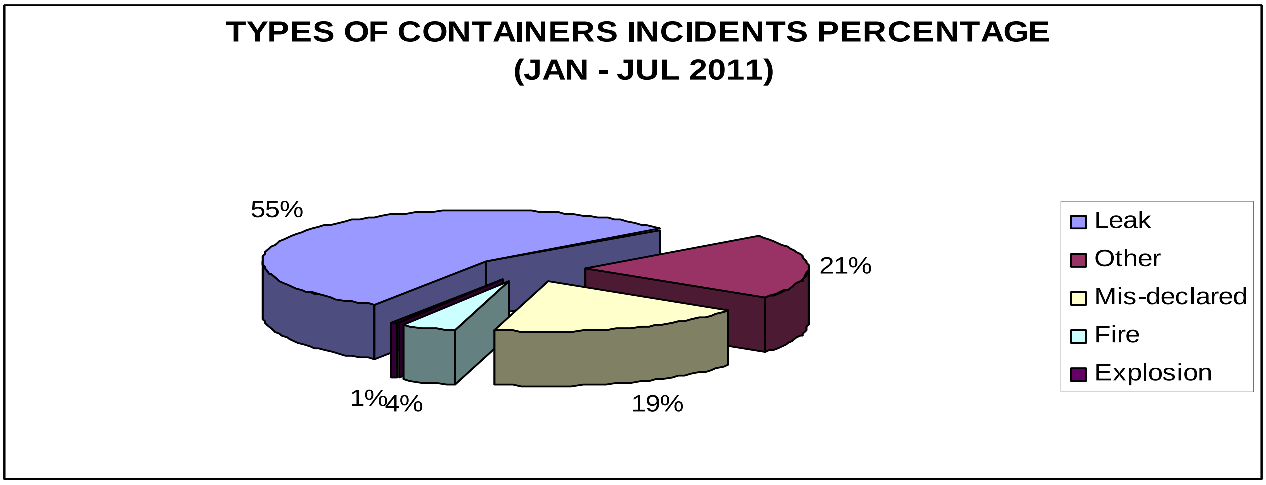

Figure 2 Percentage of incidents types involving containers (Ian – Jul 2011)

3. THE INFLUENCE OF OVERWEIGHT CONTAINERS ON SAFETY OF SHIPS

As containers are stacked higher to keep up with the growth of world trade, overweight and miss-declared weights can:

- Lead to vessels being improperly stowed, which can adversely affect vessel stability and stress;
- Produce collapsing of container stacks on board ships;
- Damage the ships;
- Cause containers lost overboard (both the overweight and containers that were not overweight);
- Be a risk of pollution damage due to contents of containers spilling into the sea;
- Impair of vessel's optimal trim and draft, thus causing impaired vessel efficiency, suboptimal fuel usage and greater vessel air emissions;
- Produce huge cargo liability claims;
- Cause damage to chassis and terminal handling equipment;
- Container stacks collapsing in ports while awaiting loading or during handling;
- Injuries to dock workers while containers are handled in container yards. Many incidents have occurred when the bottom of the container has fallen off during the lifting of the same due to the cargo weight in container exceeding the declared weight;
- Impair of service schedule integrity;
- Delay of supply chain services for shippers of properly declared containers;
- Lead to last minute shut-outs of confirmed, booked and available loads when the actual weight on board exceeds what is declared and the total cargo weight exceeds the vessel limit or port draft limit;
- Contribute to accidents on highways and railways.

The overweight of containers and miss-declared weights are caused by poor loading controls by shippers who try to maximize the space in the container. When the deck stows are not loaded correctly according to the container weights and as per the ship's standard instructions, it is a recipe for disaster. Under declared tonnage in shipping containers, deliberate or not, it has the potential to put lives at risk. Gantries, fork lifts, trucks and other handling equipment may not be up to the strain and, in worst case scenarios, ships can be incorrectly loaded leading to instability.

On board the ships, the containers are generally stowed with the heavy containers at the bottom, either on deck or under deck, and the lighter containers on top of heavy ones. This is done in order to maintain the stability of the ship and to achieve an even spread on board. If this elementary rule is not respected, the ship stability can be very seriously affected with unpleasant consequences.

For example, a client has some containers that weigh about 24 tons each but, in order to save costs on overweight, if he declared the containers as 18 tons each (this fact happens frequently), the shipping line will take the word of the client and advise the ship that these containers are 18 tons each. When the ship's planner does the planning, following the weight categories, he is going to place the 18 tons containers on top of 20 tons containers. Now if these 20 ton containers are actually the right weight, we now have a 24 ton container (miss-declared as 18 tons) sitting on top of a 20 ton container. If we imagine many such miss-declarations as this, the chief officer of the ship has a problem now to try and adjust the stability.

According to his calculations, the ship should be stable when the cargo is planned to be loaded in a certain way, but in reality because of the miss-declared weights, he is not able to get the right stability of the ship. On many occasions the shipping lines give reasons such as "*due to stability constraints we had to short ship your cargo*".

The impact of overweight containers is mainly restricted to stack weight and lashing violations and the inaccuracy of weight could lead to loss of lives and loss of vessels. Loss of vessels due to this problem is unlikely the result of negative impact on ship stability, simply assumed that overweight containers are stowed in the top tiers and is correlated with the burning of bunkers from the low situated tanks (double bottoms). Having in view that minimum metacentric height required through IMO stability regulations is only 0.15 m, this indicating that it doesn't take much to flip positive to negative.

By a simple example, if considering a container ship of 4,200 TEU capacity in a typical full load condition, as described in vessel's loading manual, as follows: Total 20 TEU containers loaded on deck: 2,603. Total 20 TEU containers loaded in hold: 1,575. Total 20 TEU containers loaded on board: 4,178. The average container weight is considered to be 9.1 mt.

Vessel commences the voyage with 96% from the capacity of fuel oil, diesel oil and fresh water and arrives at destination port with 10% of those consumable liquids. The stability calculations carried out for the departure and arrival conditions revealed that the vessel complies with all stability criteria as per IMO Res. 749 (18). The calculated initial metacentric height G_0M, corrected for free surface effects, for the arrival condition, was found to be 0.408 m.

Let's consider now that 10 % of the containers, loaded on upper tiers on deck, are overweighed with 1 tone each. This means that a number of 260 containers (with a declared weight of 2,366 tons) are overweighed 1 tone and results in an increased weight on deck of 260 tons. For the arrival condition, the metacentric height, corrected for free surface effects, will decrease with about 6 to 7 cm, which represents 17% of the metacentric height. This fact, associated with decreasing of stability when the vessel is on the wave crest, may lead to dangerous situations. That's why some of containers shipping lines, like for example Maersk Line, increased and settled the minimum value of GM at 0.6 m.

The weight miss-declarations are one of the major reasons for such instances as the planning is done in accordance with the weights provided by the shippers, but it doesn't always work in that direction. Thus, correct weights are essential for the ship's officers to accurately compute the ship's stability and the various hull stresses and to ensure the ship is within the safe parameters for the voyage.

The location of standard size containers may seem to be more precise but the ship's officers are unlikely to have any knowledge of the centre of gravity of each container. This will, almost in all situations, be lower than the container's mid height, as they are unlikely to be filled right up to the top, or contain heavy items overlying lighter ones.

However, there are exceptions like in the case of containerized suspended meat carcasses where their weight acts at the container top. Thus, exceptions do occur and, though this particular example should be readily identifiable, others may not be. Even though the shipping lines are taking many precautions and deterrents such as Over Weight Surcharge, Miss-declaration penalties etc, these situations continue to be present. This can seriously affect the lives of the innocent crew on board the ship if anything should happen to them due to such negligence.

Not only the stability is then compromised, but also those "rouge" containers of unknown weights, when under certain circumstances, if they are heavy and stowed on the top tiers with light or empty containers, the additional dynamic forces created could also be the trigger for a stow collapse.

The potential dangers that might lurk within any of the hundreds of those steel boxes onboard these large container ships, because of false declarations, is indeed a situation that no shipmaster should have to contend with. The overboard loss of containers may be a potential risk of consequential damage to ships colliding with (semi-) submerged containers floating around.

The number of incidents of either small feeder vessels capsizing alongside berths, or on the larger container vessels, deck stows collapsing when in bad weather, all due to miss-declared weights, must be cause for alarm. Unfortunately, the problem of miss-declared container information seems to be in a "too big basket" for many of the shipping companies. Despite the growing concerns from such organizations as the

Classification Societies, Government Agencies, Maritime Unions and Associations, P& I Clubs, marine surveyors and other parties associated with marine transport, little action seems that have been succeeded to address this issue.

4. WHAT ARE THE POSSIBLE PROBLEM SOLVING SOLUTIONS?

It is inconceivable and completely unacceptable that there is no mandatory requirement for containers to be weighted prior to shipment, in many ports in the world. The weights are all as per shipper's advice, which lends itself to abuse by unscrupulous operators. In addition, many of the weights supplied, even if accurate for the contents, do not always take into account the tare weight of the container.

Too many under declarations of weight can put a ship at risk, a rather new angle. It is the shipper's responsibility to declare the weight, and declare it correctly. This leads to who should insist on the requirement of declared weight, how can it be checked, by whom and when? Modern loading gantries can check the weight of the container being loaded, but by then it is too late.

While the container key industry players attest that safety is of paramount concern, evidence suggests that, in reality, the safety of ships, crews and the environment is being compromised by the overriding desire to maintain established schedules or optimize port turn round times.

For solving this problem, many proposals have been put forth, but most of them need further exploration and evaluation. The main important aspect is to find a correlation between shortcomings and consequences of all the ideas proposed. What does seem clear at present is that no single solution is adequate by itself; a comprehensive solution acceptable to most parties will probably require some combination of approaches.

The principal ideas of possible solutions can be grouped in categories like education, enforcement through weighing, state cooperation in enforcement, assigning weight responsibility, modified tariffs or specialized equipment.

Possible amendments to SOLAS Convention, which has competence and jurisdiction over the ship-port interface, to ensure verification of container weight prior loading on board vessel could be a start. In this context, it can be required to marine terminal operators to weight a stuffed cargo container upon receipt and to have a verified container weight before loading a stuffed container on board the ship for export. This requirement to be applied to all loaded containers, whether received through the port facility gate or transshipped at the port facility via another vessel, barge or rail wagon. In this way the verified container weight to be provided to the vessel operator for use in confirming and finalizing the vessel stowage plan.

Weighing of containers prior loading commences is one of these measures and is endorsed and recommended by almost all container shipping lines. Delaying containers from being shipped due to overloading will be a powerful incentive to shippers to correctly declare the weight and there were moves to educate those who stuff the containers.

A possible solution can be that all lifting equipments/machinery in the marine chain to be fitted with devices that permit to determine the weight being lifted. In this way, the power is passed in the marine terminal operator's hands to verify the accuracy of declared weight and take the correct loading decisions accordingly.

Whenever a container is lifted, it is the possibility to determine accurately the weight, by fitting with equipments like:

- Quay crane – so the weight is known before the crane driver attempts to move the a container (a driver attempting to unload an overweight container from the ship needs to know it before he moves the container a significant distance);
- Truck gates - to capture the weight prior quay area. Weight scales are commonly added on existing gate lanes to enable this function for entering traffic;
- Train/Rail Interchange – weighing systems installed on spreaders of the container handling equipment that service the train.

The problems identified in casualties related to overweight containers revealed a compelling need for a "Code of Practice" for the container shipping industry. The "Code" can serve as a benchmark for ship operators, charterers and port operators providing them with guidance on the minimum standards expected for companies who might wish to operate in this sector. One of the elements to be addressed in the "Code' should be to ensure that ship's staff are provided with sufficient time to verify/approve proposed cargo plans, noting that at present the pace of modern container operations is such that it is very difficult for ships' staff to maintain control of the loading plan. Other subjects to be addressed in the "Code" will be to ensure that comprehensive cargo securing manuals are in a ready and easy format, changes in vessels GM and securing details are easily found.

5. CONCLUSIONS

Accurate cargo weight is an important factor in ensuring the safe operation of ships. Container stacks continue to collapse due to positioning heavy containers on top of light or empty ones. But the most common cause of container losses is commercial pressure on masters and vessels to maintain their schedule and not to slow down, especially for bad weather.

There are certain terminals where pressure has been put on the master to have the gangway raised and lines let go as soon as the last container has been loaded and the last stevedore leaves the vessel. Safety has been compromised by the overwhelming desire to maintain schedules. Realistically, with fast turnaround times and commercial pressure, the ship's staff hasn't so much control as they should have.

The maritime industry efforts still have not solved the problem of overweight container. Development of prevention measures to avoid accidents or loss of containers overboard due to overweight containers remained open and should therefore continue to a final and reliable solution.

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CARRIAGE OF SCRAP METAL IN BULK A HIDDEN RISK SERIOUSLY AFFECTING THE SHIP STABILITY

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ABSTRACT

The present paper presents the problems which arise from the transport of scrap metal in bulk on board vessels. Risks and factors involved in such transports, as well as proprieties of cargo and assessment of ship's stability, have to be correctly evaluated by all parties involved. A recent maritime casualty, related to loss of stability and sinking of vessel, revealed the hidden risks in this matter.

Keywords: *scrap metal, ship stability, stowage factor, centre of gravity.*

1. INTRODUCTION

The maritime transport of scrap metal in bulk is growing up every year. Scrap is seen increasingly as a global commodity. It is a cargo that apparently is easy to load, stow and transport by ships. The reality proved the contrary. In the last years a number of ships, loaded with scrap metal, lost their intact stability and, furthermore, most of them capsized. The main objective of this article is to point out and raise an alarm about risks involved in such transport. The motivation came from the fact that, in a recent case, a vessel loaded with scrap metal in bulk capsized and sunk in doubtful conditions.

2. SCRAP METAL – A HOMOGENOUS OR BREAK BULK CARGO?

As a normal rule, in practice, the weight of bulk cargoes is determined by dividing the volume of cargo hold to the stowage factor. Of course, this rule applied as most of the bulk cargoes are homogenous cargoes. But what means homogenous cargoes? According to maritime publications, homogenous cargo is that stowed loose in the hold and is not enclosed in any container such as box, bale, bag, cask or the like. Bulk cargoes consist entirely of one commodity and are usually shipped without packing. Specifically, bulk cargo is composed of either:

- free flowing articles such as oil, grain, coal, ore and the like which can be pumped or run through a chute or handled by dumping, or
- uniform cargo that stows as solidly as bulk cargo and requires mechanical handling for landing and discharging.

An aspect of bulk cargoes which have to be taken into consideration is fungibility (goods that are identical with others for the same nature).

Under normal circumstances, break bulk cargoes means the cargo that is not containerized and thus cannot be classified as bulk cargo under the above definition. It is important to note that the difference between bulk and break bulk is based not only on the type of cargo, but also on the way in which the cargo is stowed or loaded.

The first problem which arises is where can be categorized the cargo of scrap metal in bulk: homogenous cargo or break bulk cargo. As per above mentioned definitions, we can conclude that this type of cargo is neither homogenous nor break bulk cargo. However, such cargo should be never considered as homogenous cargoes.

From the commercial point of view, such cargo is described as bulk freight. As a matter of loading on board vessel, being a relatively light weight cargo, in all situations, the total weight of cargo to be loaded is determined by vessel's Master in such a way, using in calculations the entire volume of cargo spaces, cargo being loaded by volume occupied.

A very important aspect is what volume of cargo holds have to be used in case where structural members, such as frames, are exposed inside the hold, with reference to bale or grain capacity. Scrap metal in bulk, loaded on board vessels, usually consists in pieces of metal of various sizes, shapes and weights and it is difficult to be stowed compactly and moreover to occupy the entire space between various structural members exposed inside cargo hold.

Of course, the commercial parties are using the volume of cargo holds which fulfil their interests in order to load cargo as maximum vessel's capacity. In such cases, vessel's master is between hammer and anvil and has to satisfy the commercial interest as well as vessel's safety (which in many cases was on the second plan).

3. PARTICULARITIES OF LOADING AND STOWAGE OF SCRAP METAL ON BOARD SHIPS

Such type of cargo is usually loaded by shore cranes using grabs, cargo being freely dropped into vessel's cargo holds. During loading, from time to time, Master requests that the cargo to be pressed, in order to compact the cargo stow and increase the remaining volume of cargo hold. This kind of operation consists in dropping of one "weight" from a high point above cargo hold.

In many situations, this procedure proved to be dangerous for ship. During pressing of cargo, hard pieces of scrap metal penetrated the ship's structure resulted in damage to structural members, ballast tanks and even side shell plating. In normal conditions, these kinds of damage are difficult to be ascertained, having in view that inspection inside cargo holds is practically impossible, particularly if such damage occurs over the night.

In the worst case scenario, we can presume, for example, that during pressing of cargo the side shell plating was penetrated at location below water line and water ingresses into cargo hold. The vessel could leave the port, without any knowledge about the damage, and the final result can be catastrophic. Such situations often happen.

Another problem which arises is related to cargo stowage factor. According to International Maritime Solid Bulk (IMSB) Code, shippers must provide the master with accurate stowage factors of different parcels of cargo loaded. Most of the shippers involved in such transports evaluate the stowage factor of the scrap metal between 60 and 90 cbf/t, but these values are extremely wide. It is hard to ascertain exactly the total weight of cargo to be loaded on board vessel when this kind of information is provided to ship's Master. The more precisely is determined the weight of cargo, the more precisely is assessed the intact stability of ship.

A high risk involved in the transport of scrap metal in bulk is shifting of cargo. Being a "mixed" type cargo of various irregular forms and weights, with large broken spaces, it is vulnerable to shift during transport. This can happen not only in rough seas, but also during a normal heeling of vessel, like for example turning.

4. ESTIMATING THE POSITION OF THE CARGO'S CENTER OF GRAVITY

The inaccurate determination of cargo weight is reflected in an erroneous assessment of the position of the cargo's vertical centre of gravity. Hence, as the weight of the cargo is the main element influencing the ship's stability, it is very clear that the calculation and assessment of ship's intact stability is affected from the beginning.

The problem is more complicated because scrap metal, stored at loading places, are a mixture of metal pieces with different densities, i.e. stowage factors, so a proper estimation of weights and positions of centre of gravity is very difficult. Incorrect estimates can have serious consequences as the voyage progresses with reducing stability margins. Again, vessel's Master is in a difficult situation.

Normally, shippers must advice vessel's masters when and where are loaded on board vessel cargoes of different densities. This is practically impossible, because since from the collecting and then discharging at storage places, scrap metal is not separated by weight due to insufficient storage place or time, facilities and expenses involved.

As the problem of cargo density is not solved from the beginning, due to inaccurate information provided by shippers, the only one solution is that to be ascertained during loading. The solution is that the weight of cargo to be determined on board vessel, at least every 12 hours, by draught survey method. In this way, master will not only know the weight of cargo but he will also be able to ascertain the correct stowage factor by measuring the volume occupied inside the cargo hold. Moreover, in this way he will have a control of the position on board vessel of the parcels of cargo with different densities and can stop the loading operations when, for example, heavy cargoes are loaded on top of light cargoes. So, the only method which can be used for the assessment of a close value of weight, and in this case of stowage factor, remains a method which is well known that give a lack of accuracy.

5. DISASTROUS ENDING OF A VESSEL LOADED WITH SCRAP METAL IN BULK

A general cargo ship loaded a cargo of scrap metal in bulk. Vessel cast off the lines around midnight and shortly upon pilot was disembarked and altered the heading the vessel start "flopping" from side to side and finally developed a list to portside. Even after ballasting of the tanks in opposite side, i.e. starboard side, the list increased more to portside. As the list continued to increase, Master decided to drop the anchor. When it became evident that the situation is not under control, i.e. why the list is continuously increasing, the crew abandoned the ship. After few hours the vessel capsized and finally sunk.

The cargo loaded on board vessel consisted in pieces of metal of various shapes, types and weight. As these pieces were mixed and loaded in the same time, it was difficult to obtain a stowage factor for such a cargo and moreover hard to estimate when and in what position inside vessel's cargo holds the heavy cargo or light cargo/pieces was loaded.

On completion of loading operation the vessel has a large angle of list to starboard side. To adjust the list, vessel was ballasted in a "randomly manner", port and starboard tanks, without filling completely any of the tanks. As soon as ballast operations completed in one side, vessel starts "flopping" to opposite side.

The fact that vessel started "flopping" from side to side and finally developed a list was a clear indication that the vessel started to gradually loose the stability, probably being in a unstable equilibrium condition. This might be the evidence that the cargo's centre of gravity was considerably higher than had been assumed, so high, that the vessel's initial metacentric height was negative. This leading to the idea that the scrap metal that was loaded initially was a lot lighter than that which was loaded later on top.

The fact that the vessel completed loading with a large angle of list revealed that loading operations were not under control, in order to load the cargo as to finally put the vessel in upright condition. Investigations revealed that no stability calculation was carried out on board vessel during and upon completion of loading operation according to actual loaded condition.

6. CONCLUSIONS

Shippers should inform the vessel the stowage factors of the cargoes that are to be loaded. Moreover, a vessel's officer should closely monitor the loading in order to check the accuracy of the information supplied. Cargo weights rely on the accuracy of the information provided by shippers, which can be very variable, whilst the location of these weights within the spaces of cargo holds depends to a considerable extent on the judgement of the ship's staff.

Ship's officers who are responsible for loading should ensure that any assumption about cargo's centre of gravity is valid. Daily records of the loaded quantities should be kept in order to assess the weight and the position of the cargo loaded and furthermore the next sequences of loading. On completion of loading, the vessel must be, as much as possible, in upright position.

Ballast condition on board vessel should be checked regularly and soundings should be recorded. Preferably, the vessel to be, at the commencement of loading, either with ballast tanks pressed up or with ballast tanks empty. No slack tanks are allowed in order to avoid the negative influence of free surface effects on ship's stability. When correcting angles of heel, care is necessary to avoid the danger of inappropriate ballasting, especially when the vessel has an angle of loll caused by a negative metacentric height. The effect of free surface and the vertical transverse movement of the centre of gravity have to be taken into consideration. A wrong interpretation may lead to disastrous consequences.

Liquid weights, as fuel, ballast and water, are based on the tank soundings, which are affected by trim and list, and, although ships are supplied with sounding correction tables that take these factors into account, there is still scope fore some errors in the values.

Stability calculations should be carried out at the beginning, during and upon completion of loading operation to ensure all the time that vessels comply with stability criteria as stated in their "stability book".

It is very important to have in mind that the righting moment is the true measure of a vessel initial stability and not GM alone. Even so, complying with stability criteria does not ensure immunity against capsizing. Master should therefore take the appropriate actions and exercise prudence and good seamanship heaving regard to the season of the year, weather forecasts, navigational zone and cargo type. When the calculated final KG is close to minimum stability criteria to have in mind that the calculated GM and dynamic stability determined from GZ curve could be more in error.

The minimum stability criteria apply to the complete diverse range of commercial vessels may be inadequate for a particular ship in a particular situation. Smaller ships usually require a greater minimum GM for safety than larger vessels for the reason that even without taking the displacement into account, smaller ships are usually at risk of capsizing in heavy seas than larger ships with the same upright GM and hull form, as the resistance to increasing angles of heel increase with hull size.

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. Appropriate values between calculated and observed drafts is an evidence that the estimated weight and its longitudinal distribution are reasonably accurate, but there is no check on the calculated KG, other than by any list due to a weight loaded off centre. If such list seems excessive for the estimated asymmetry in the athwartships weight distribution, then this would suggest that the ship is more tender than probably desirable.

An important aspect is also related to the lightship weight and its distribution which changes over years through important alterations to the ship construction, accumulation of paint, stores and steel wastage.

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FACTORS AND TRENDS THAT INFLUENCE THE GLOBAL INTEGRATED TRANSPORT SYSTEM

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ABSTRACT

Multimodalism is not a current concept; it has been used in the human history ever since the beginning of diversification of transportation phase. Along with the expansion of transportation networks, the interlinking and integration of all these networks in a global transport network, the multimodal transport systems, allowed the access in almost all the points from the surface of the Earth in which there are human communities.

The process of globalization had as a consequence the creation of a worldwide global integrated transport system, a system that is permanently influenced by the evolution of the regional commercial markets.

Keywords: *globalization,global integrated transport system, multimodalism, intermodalism, trends.*

1. INTRODUCTION

The global transport system represents the totality of production factors that compete for the achievement of the transport activity in the global transport market.

The main production factors of this transport system are: the roadways, the transport terminals, transportation and the workforce used to serve them.

The organization of the efficient exploitation of these production factors and their combination possibilities for serving the purpose for which they were conceived (the transport activity) form the logistic system of the transport activity.

2. THE STRUCTURE OF THE INTEGRATED TRANSPORT SYSTEM

Generally, the passenger or cargo transport which is done through the use of only one transportation facility or of more transportation facilities which serve only one transportation facility is called uni-modal transportation.

The passenger or cargo transport which is done by means of a combined system of two or more transportation facilities, having different ways of movement, is called multi-modal transport.

The transport facilities, which compose a system, have terminals at their extremities, which allow the loading-unloading of cargo.

The transport terminals may be specialized to serve only one way of transport - uni-modal terminals.

They generally form an extremity of the global transport network.

Most of the transport terminals confer the possibility of transfer of the parcels between different ways of transport and are called multi-modal terminals.

The interlinking of different transport systems, through multi-modal transport terminals at the extremities, allows the creation of integrated multi-modal transport flows- intermodal transports.

The integration of the transport systems is being done by means of the inter-modalism: they are interlinked and inseparably associated with one another, interdependent and substitute for a common purpose.

The assembly of production factors, from which the totality of transport systems interlinked with one another is made up of, constitutes an integrated transport system.

The main evolutions in the transport activity plan had, at times, low consequences, and other times immediate ones on the evolution of human civilization at a social and cultural plan.

The table below is an attempt to exemplify, for an easier understanding, some ways in which the evolution of an economical characteristic has consequences at a social and cultural level, by only tangentially touching this aspect, which is the object of study of other sciences, like sociology or social science.

Economic level	Social level	Cultural level
Efficiency and swiftness regarding the passenger and cargo transfer	Reasonable access to goods and at creating a pattern for a global consumer	The creation of a global culture based on common elements
Economical growth by developing new markets	The growth of the people’s welfare and quality of life.	The increase of the importance of human rights and the value of life
Safety, predictability, and reasonable access to travel	The growth of social mobility of traveling for recreational and economical purposes	The development of multiculturalism and of inter-ethnical tolerance

Therefore the logistic system based on inter-modalism allowed the transport activity to exceed the classical approved limits, placing a strong impression economically, socially, and culturally on the current human society.

From this perspective the global transport network, which includes the totality of the integrated transport systems around the globe, forms a unitary assembly of production factors combined efficiently with one another and substituting for the same purpose, assembly which shall be called the global integrated transport system.

The global integrated transport system has the following characteristics:

- it is an intermodal system;
- it is oriented toward ensuring an easier access to people and goods in the system, from any location around the globe;
- it is organized in such a manner in order to ensure the fastest transport of people or goods toward any destination around the globe;
- it is a system in which the need for transport is balanced by the global supply and demand.

3. THE DETERMINISM BETWEEN THE GLOBAL INTEGRATED TRANSPORT SYSTEM AND GLOBALIZATION

Certainly the global integrated transport system does not accomplish its purpose with the same efficiency all around the globe.

There are huge discrepancies between the peak areas of this system situated in the developed regions of the world (Europe, North America, and South East Asia) and the poor regions (Africa, Latin America, and Central Asia).

However, the global integrated transport system allowed in the last decades the creation of a logistic global system, system which through its local and regional subsystems accomplishes the efficient combination of all the global production factors that compete for the achievement of the transport activity.

The integration of the markets has as a consequence the reduction of discrepancies between the poor and the rich regions of the world and the transport represents one of the engines of this process.

In fact, there is a double determinism between the development of the transport activity and globalization:

- the development of the global integrated transport system makes it possible for the interlinking of the markets and their integration in a worldwide market;
- the integration of the markets in a worldwide market creates new needs for transport and has, as a consequence, the development of the global integrated transport system.

The integration of the markets at a global level is a historic process, which began nearly 6000 years ago. The most important step in this integration took place after World War II, through what is known as globalization.

Through globalization it is meant the process through which the flows of the production process and the commercial flows of the cargo exchanges, resulted from the production process, gain a global nature, exceeding the physical or political boundaries of a state or region.

Globalization is not a linear and uniform process at the level of all the markets. It is manifested through the regional integration of the markets and the development of some multilateral commercial relations, which create interdependence between these markets.

The most important regional markets, established through multilateral commercial agreements, not being the only ones, at a worldwide level are:

- European Union (E.U.) - is a confederation of states founded in 1958, which includes 27 European states since 2007, covering a market of 485 million inhabitants;
- North American Free Trade Agreement (N.A.F.T.A.)- established in 1992 between USA, Canada and Mexico- covers a market of 375 million inhabitants;
- The Association of Southeast Asian Nations (ASEAN)-an economical union formed between 10 states from Southeast Asia, which covers a market of 560 million inhabitants;
- The Organization of Petroleum Exporting Countries (OPEC)-a cartel formed in 1965 between 12 of the largest petroleum exporting states;
- Asia-Pacific Economic Cooperation - (APEC)- was initiated in 1989 uniting 18 states, including the USA and Australia;
- The cooperation treaty between Argentina, Paraguay, and Uruguay starting with 1994, whose objective was the creation of the Southern Common Market-MERSOCUR;
- The African states also signed regional treaties: Economic Community of West African States (C.E.D.E.A.O.); Economic Community of Central Africa (C.E.E.A.C.); The Union of the Arab Maghreb (U.M.A.), and so on.
- Other large global markets are represented by states such as: Japan, Germany, Great Britain and the BRIC countries-Brazil, Russia, India, and China.

For all of these markets the global integrated transport system represents the optimum global solution for interlinking.

Although it is impossible to measure which is the total of transported goods at a global level, a global estimation can be based on the extrapolation of the existent data of the World Bank, of the International Monetary Fund and of the United Nations Conference of Trade and Development (UNCTAD).

The quantity of transported goods at a global level can be estimated at nearly 50 trillion tons during 2009-2010, as following:

Type of goods	The quantity of transported goods (trillion tons)	Total balance
General merchandise	7,37	15%
Solid bulk	25,11	51%
Liquid bulk	16,43	34%
Total	48,91	100%

In terms of the commercial exchange volume, the quantity of merchandise is not a relevant indicator.

It must be taken into account the fact that any quantity of goods can suffer of the course of the intermodal flow multiple transports, the same amount of goods is transported as raw material, semi-finished products, and finished products.

Therefore, the transported quantity of goods and the share that the various types of goods have in the overall turnover lose relevance.

A much more relevant indicator is the ton-kilometer.

A ton-kilometer is the equivalent of the movement of a parcel which has the mass of a ton on a distance of a kilometer.

4. THE ROLE OF GLOBAL INTEGRATED TRANSPORT MARKET

The global production of goods and services has doubled in less than a quarter of a century: in 1995-estimated by the World Bank at nearly 30.000.000 trillion USD and in 2008-estimated at over 60.500.000 trillion USD.

Simultaneously, the import-export global market tripled, increasing from nearly 6.500.000 trillion USD to over 19.500.000 trillion USD.

It can be said that over a quarter of the global production of goods is intended for export, and the rest is intended for the internal consumption of the inhabitants of the states in which those goods are being produced.

The demand for transport is a derived demand from commercial exchanges.

The purpose of this activity is to move in space the goods resulted from the production process, according to the commercial demands.

Therefore, it can be said that by extrapolation, that, in the share of global transports, in 2009, the international transports had a share of approximately 21,7%, increasing to a share of 32,5% in 2008 and tending to occupy increasingly more space.

The difference of 67,5%, from the total of goods and services, is intended for internal transport, one that has a basic character.

The basic character lies in the fact that even the goods intended for export are transported by internal routes in the production process from the raw material to the finished product.

Meanwhile, in the export share of international services, as defined by the Balance of Payments Manual (1993), of the International Monetary Fund, transport services occupy the first place, with a share of 35%.

By means of transport, according to the definition found in the manual The totality of transport services (water, air, land, inland, in space, pipeline), which one national economy provide to another, and includes passenger transport, goods transport, renting means of transport with a crew and the auxiliary and related services of this activity.

The following are not considered part of the transport service:

-goods' insurance-which is included in the insurance services,

-goods intended for own consumption of the crews and transport vehicles (food, fuel, spare parts, etc.), purchased from the transport terminals (ports, airports, railway terminals and bus stations) - which are included in the trade of goods,

-repairs of the transport infrastructure (terminals, transportation)- which are included in the construction industry,

-rental of vehicles without crews-included in other services.

In the table below the share of international transport services from all the services can be seen, according to the IMF and World Bank estimates:

Type of service	The share from the total of services
Transportation	35%
Tourism	25%
Insurance, finances	13%
Other services	28%
Global Total	100%

Basically no production activity can take place if the workforce, the raw material, and the means of production cannot be transported where they are needed for the production flow.

At the same time, the delivery of the finished products and services towards the final consumers cannot be done outside the transport activity.

The transport activity is a crucial one for the economy and trade.

Both depend directly on the transport of passengers and of goods.

As shown above, the need for transport is a basic one, that is why *transports have an integration role of all the other markets.*

5. CONCLUSIONS

Hence, by integrating these markets, in the last decades, the global transport system has allowed *the orientation of the transport activity toward the consumer*, turning this activity into an *acceleration factor of the globalization,* of growing markets, interlinking them and generally developing the exchange economy.

It is estimated that, as a feedback of this globalization process, that in the next 50 years, the global integrated transport system will suffer an accelerated growth process, both in efficiency and in the degree of markets' service.

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ASPECTS OF THE MARITIME TRANSPORT EVOLUTION DURING THE MIDDLE AGES

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ABSTRACT

The evolution of the naval transports during history has not been a linear one, not even a unidirectional one. It has been characterized by moments of isolated development or of downfall, by a non-uniform growth of the transport markets and most of the times there is no sufficient data that attests every transited step.

Generally, the evolution of the naval transports has been a concomitant process with the one of the development of the commerce.

The evolution of the transport fleets was also a parallel process with the evolution of the war fleets, which have determined the political control of the markets.

The Middle Ages were characterized by a fracture of the markets due to the fall of the Roman Empire, fracture that had as a consequence an unprecedented contraction in the history of the world of the maritime transport markets.

This contraction lasted for nearly a millennium, having a powerful reanimation not until around the 1500s, along with the Renaissance.

Keywords: *maritime transport, evolution, middle ages.*

1. INTRODUCTION

After the fall of the West Roman Empire, around the year 500 B.C., the commerce and the maritime transports had a powerful decline. The main reasons of this downfall were caused by economical, as well as by political and social causes:

- the disintegration of the traditional markets, caused by the dissolution of the political-administrative Roman State

- the drop of the consumption, because of decrease of the level of civilization, of going back to an austere way of life in most of the empire

- the limitation of the navigation routes, as a consequence of the decrease of safety, through the development of the piracy along with the disappearance of the military fleet of defense of the commercial ships.

2. THE EVOLUTION OF THE MARITIME TRANSPORTS DURING THE 500s AND 1500s B.C.

In the early Middle Ages, until the Renaissance, the maritime transports were fractured, practically not having a worldwide market, but more likely some local and regional markets:

- The seas from the northern Europe were dominated by the Scandinavian peoples of the Vikings beginning with the 5th century until around 1200s B.C. They were considered to have made the first maritime incursion to North America, probably through Greenland, around the 1000s.

Although they were warriors, most of their activities were dedicated to the commerce with their neighbors from the British islands, from the north and the center of Europe and even from the Mediterranean area.

They exported mainly raw material: skins, furs, wood. In turn, they imported silver from the Arabs, glass and domestic utensils from Rhine, weapons and metal tools from Francia, silk and spices from the Byzantium.

During a time in which commercial routes were insecure, they managed to keep safe routes on the Volga till Kiev, and even a commercial route with the Byzantium.

- In the southern Europe, the Mediterranean Basin, the commercial routes were dominated by the so called Sailor Republics: Venice, Genoa, Amalfi and Pisa. Starting with the 5th century, the void left by the Romans was filled by the Venice sailors, who practiced intense commercial exchanges especially in the eastern basin of the Mediterranean Sea and in the Black Sea.

Along with the fracture of the Roman German Empire, Genoa becomes also an independent republic and a great maritime commercial force.

Up until the 16th – 17th centuries, the Marine Republics dominated the global maritime commerce, developing the first modern financial systems in the world: the banking system, first insurance system, the check, etc.

After discovering America (by a Genovese – Christopher Columbus), the commercial exchanges from around the Byscaia Gulf, the North Sea and the Transatlantic led to the decrease and the collapse of the Mediterranean commerce.

-Between the 7th and the 13th centuries, the Arab Empire also developed a powerful regional maritime commerce on the Nile, the Tigris and the Euphrates, and the Red Sea.

Byzantium had a well developed commercial fleet, which operated in the Black Sea and the Mediterranean Sea, as a revolving base plate of the commerce between the Orient and the Occident.

Beginning with 1453, after conquering Constantinople, the Ottoman Empire developed strong commercial routes in the Black Sea, on the Danube, to the center of Europe.

The Far East was also dominated since the Ming dynasty (the 14th century) by the Chinese navigators, who had developed commercial routes along the Indian Ocean and East China Sea to Japan.

The Somali maritime kingdom also developed powerful commercial routes, after the 1000s, in the Indian Ocean and the Persian Gulf.

Basically, for over a millennium, the maritime commerce crossed a period of growth, characterized though by the fracture of the markets and a certain regional enclave.

However, this period was the age of some important technical, economical and cultural developments, which created the premises for the beginning of a new era of global evolution.

The main evolution factors from that period, which created the premises for the arrival of the great geographical discoveries era, that will coincide with the third technological leap in developing the naval transports, were:

- The invention of the astrolabe, made by the Greeks, and the development of the astronomical navigation, made by the Arabs, which made possible the orientation to very long navigational routes;
- The invention of the magnetic compass, done by the Chinese, which gave the possibility to have a very precise navigation;
- The invention of the central helm, made by the Europeans in the 11th and 12th centuries, which made possible an easier maneuver of the ships;
- The invention of the circular hand wheel, in the 16th century, which made an easier maneuver of the ships by the crew;
- The development and specialization of the canvas and the mast, which allowed the increasingly efficient drive of the ships, autonomy, speed and a bigger transport capacity;
- The introduction of the modern financial systems (the banking system, insurance, check), made by the Genovese, allowed the financing of the fleets, the emergence of more important shipment and the development of markets;
- The emergence and development of the great European states allowed the advancement of some powerful economies, capable of sustaining fleets, which will later lead to the appearance of the great global maritime empires: England, France, Spain, Portugal, Holland, Denmark-Norway;
- The development of science in general and the increase of the interest in art, culture and progress, specific to the Renaissance period, which created a favorable environment for the initiation of some scientific expeditions outside the Old World.

These are only some of the most important factors that facilitated the road towards the third technological leap in the history of the naval transports.

3. HISTORICAL PREMISES OF THE NAVAL TRANSPORTS DEVELOPMENT AROUND THE YEAR 1500

The evolution of the human societies during the Middle Ages had as a convergent point, in the 13th and 14th centuries, a pluralism of political, social, economical, and cultural transformations, which had as a consequence the transition of the medieval society towards the modern society.

During that time, a series of quasi-contemporary events took place, which were about to mark a new era-that of Renaissance, an era in which navigation was the revolving base plate of the economical and political development and integration of the entire world.

These gradual events left their mark on the evolution of the human society, which in the course of less than two centuries replaced the old era with a new one:

- The Great Plague ravaged around the year of 1330, first in India and China, being brought by the Genovese sailors in Europe in 1347.

Between 1347 and 1351 it killed nearly half of the European population, continuing with some important waves and disappearing barely at the end of the 15th century.

This determined an unprecedented migration of the remaining workforce, an increase of its importance and value, and to unprecedented specialization, social reorganization and urbanization.

The consequence of this fact led to the increasing demand for raw material and consumer goods and to a larger pressure on the relatively under-developed transports.

- The Jewish pogroms were started by the crusaders and continued by the western European monarchies-England, France, Spain, Portugal-during the 14th century, culminating in the foundation of the Inquisition by Tomas de Torqemada, in 1482, whose role was to expose the untrue Christians (crypto-Hebrew).

These pogroms had as a consequence the removal of the Jewish from the economical life and the emergence of Christian trades people, who were in an acerbic competition for conquering the uncovered left markets, therefore creating the premises for developing new commercial routes.

- The invention of the typography in 1440, by Johannes Gutenberg, allows for the first time the printing and multiplication, facilitating the wide access to a lot of scientific treaties, maps, and navigational books.

The emergence of the typography was an important step, for the science of navigation and naval transports, in the education of the ones who, only in a few decades, would be the greatest sailors of the world.

- The development of the transport infrastructure and of maritime commercial routes, beginning with the 13th century in the Baltic Sea and North Sea basins, through the institution of the Hanseatic League of the cities in that area, created the basis for the war with Holland during 1438-1441. The breakage of the monopoly, created by the Hanseatic League, by Holland established the basis for the appearance of a new power: the Dutch maritime empire.

- The appearance of the assault cannon (invented by a Transylvanian called Orban) and its use on a wide scale, especially after the conquering of Constantinople in 1453, by the Ottoman Empire, made the building of fortified citadels useless, and resulted in the collapse of the feudal system created around the great medieval citadels.

Therefore a relaxation of the taxation appeared, especially of the local customs fees, resulting in the growth of the international commercial exchanges.

- The falling of Constantinople into the hands of Mohamed The Conqueror in 1453, who transported his fleet by land, to get into the Golden Horn, cutting the provision of the city by Genovese ships, reinforced the Ottoman domination in Eastern Europe and Asia Minor and led to the political and military reorganization, and to a long term stability in the eastern basin of the Mediterranean Sea and to the control of the commercial routes from the Black Sea and subsequently the Danube, by the Ottomans.

- The falling of the Mongol Empire and Timur Lenk's expeditions led to the increase of piracy acts and to the gradual abandonment of the terrestrial routes towards India and China.

The control of Suez, by the Mameluke, and of the Black Sea, by the Ottomans after 1453, resulted in the emergence of an impetuous need for finding a maritime route to the Far East.

- The conquering of North Africa (Senegal, Gambia, and Guinea) and of numerous islands from the North Atlantic, by the Portuguese prince Henry the Navigator, established the basis for the Portuguese maritime empire, 1425 -1460, small Portugal being the first European state ready to become a maritime and colonial force. At the same time, the development of the African slaves' commerce, led to the emergence of a new workforce market, exploited until it was abolished by the USA, after the Civil War.

- Along with the conquering of England by the Normans of Wilhelm the Conqueror, his successors claimed the old domains which they owned in France. The completion of the 100 years war between the House of Valois and the House of Anjou in 1453, ended some periods of successive wars, which had begun four centuries back, and directed the attention of the two royal houses towards the development of two greatest maritime empires of the world: France and England.

- The peace treaty from Lodi in 1454, resulted in the stabilization of the Italian peninsula, of the relations between five states (Venice, Milan, Florence, Napoli, and the Papal State), and of these states with the Ottoman Empire, ensued a period of relative peace of approximately 40 years, in Europe-a favorable period for the development of an economical climate based on growth.

- The ending of a 800 years old domination of the Moor in Spain, through the conquering of the Granada Emirate in 1492 by Castile and Aragon, marked the finality of the Reconquista and created the basis for the great maritime Spanish empire.

- The alliance from Kalmar in 1397 between Denmark, Norway and Sweden, with their possessions, created an important empire in the north of Europe in the 14th century, boosting the Old Danish Empire, descendant of the Vikings.

After the denunciation of this union by Sweden, the treaty between Denmark and Norway lays the basis for the future Danish-Norwegian maritime empire.

4. CONCLUSIONS

For over 1000 years after the fall of the West Roman Empire, the naval transports did not reach the level of development from the Roman era.

However, the pluralism of events, which took place over less than two centuries-the 14th and 15th centuries, have led to technological and economical possibilities, as well as to political premises for financing some great expeditions of geographical discoveries, dictated by the desire of some brave people to explore the world and the will of future maritime empires to conquer it.

They led to the beginning of the globalization of economy and of human civilization, and to the passage towards the great geographical discoveries era- a period which basically begins with the Portuguese and Spanish sailors from the beginning of the 15th century, a time that coincides with the start of the glorious era of the Renaissance.

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DEVELOPMENT ON QUALITY MANAGEMENT CONCEPTS

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ABSTRACT

The purpose of this paper is to perform an analysis of the history of the Total Quality Management (TQM) in the private sector, taking a closer look at its five stages in the Western hemisphere: quality inspection, statistical quality control, system-oriented quality assurance, company-wide quality control, total quality management.

Keywords: *quality management, quality control, quality inspection, quality assurance.*

1. INTRODUCTION

(Total) quality management has its roots in the private sector, as do so many government reforms. Thus, it may be beneficial to analyse the "history" of TQM in the private sector in order to improve our understanding of the potential and limits of TQM. As table 1 shows, TQM is the last development in the evolution of quality management systems in the private sector at present. It follows from the trajectory of quality management systems that TQM is unlikely to be the final answer to quality management. As environmental conditions continue to change gradually, there will also be the need for a new quality management system.

The history of private sector quality management in the Western hemisphere can be divided into five phases:

2. QUALITY INSPECTION

The starting point of private sector quality management was the breakdown of the Japanese telephone network after World War II (Ishikawa, 1985:15). The American Allied Forces, as well as Japanese industry, regarded the low quality of the telephone network as the main reason for this problem. As a consequence, efforts were made to apply modern methods of *quality inspection*. This meant that monitoring activities became the exclusive task of additional hierarchical and functional units.

Quality inspection had a purely technical function: it had to detect the good products and let them pass and had to stop the bad product. The percentage of unacceptable products determined the quality of the production. Quality consisted of "*conformance to requirements*" (Crosby, 1979:17), specified as a list of technical characteristics. Since quality inspection focused on the *final product* solely, it usually had no implications for productivity.

The main management instruments were *technically specified norms and standards* that helped to carry out inspections correctly. All in all, quality inspection had an important function in creating common industrial norms in post-war Japan and later in the U.S. and Western Europe (Wongigeit, 1994:34). Nevertheless, quality inspection suffered from the fact that total inspection of all products was impossible and that conclusions from small samples were not representative. As a result, the ratio of detecting defects by quality inspection was low and quality inspection therefore inaccurate.

3. STATISTICAL QUALITY CONTROL

In order to overcome this problem quality inspection was further developed to *statistical quality control*.

This phase of quality management was strongly influenced by the U.S. quality expert Deming.

Deming stressed the importance of variation problems and its causes. In particular, he distinguished between systematic mistakes caused by men or machines and random mistakes like bad quality input factors. The main management instruments were *statistical methods* like sampling methods. The mass production of armament during the Second World War also encouraged statistical quality control in the U.S. and Great Britain (Zink and Schildknecht, 1992:76). Statistical quality control still focused on the end product and was the task of specialized inspection departments.

The environment of these early quality management systems was characterized by the "*basic needs era*" (Reiss and Zydromomyslaw, 1994:34). This meant that the fulfilment of basic needs had first priority in terms of individual goals which was made possible by mass production on large scale. On markets, the price was the decisive competitive parameter. In terms of quality, the goal function of producers was to produce a certain level of quality at least cost.

This concept of quality and quality control is only adequate for goods which the producer can specify before sale (and the consumer can investigate the characteristics before purchase). Nelson (1979) defines this type of goods as search goods. The Ford Tin Lizzy would clearly fall into this category, to give one example. This *producer-oriented perspective* (Bouckaert, 1992:7) defined quality at the output level as a set of features of a good or service corresponding to a predetermined description of the good or service to be produced.

Quality, in this sense, was an *objective concept* (Bouckaert, 1992:7) since the judgment on quality was based on quantitative data. Specialized functional divisions were responsible for the assessment of product quality, which is a *third-party assessment* from the workers' perspective. At the same time, it is a *static view* that emphasizes technical conformance, no matter how much the specification for a product may have become inappropriate for the circumstances in which this product must now be used.

4. SYSTEM-ORIENTED QUALITY ASSURANCE

In the 1950s, environmental conditions changed. Successful organisations now had to manage external rather than internal systems (Walsh, 1991:504). The meaning of quality therefore shifted to quality as "*fitness for use*" (Juran, 1979a:2). This definition of quality means meeting the objectives of the various customers. In order to do so, quality management in Japan then turned to *quality assurance* which " is broadly the prevention of quality problems through planned and systematic activities" (Oakland, 1993:15).

The focus is no more on the final product but on the *production process*. Quality improvement takes place by *root cause analysis* (Juran, 1979b:16-9 – 16-44). The aim is to raise product quality continuously and to adapt it to the changing needs of customers.

The behaviour of customers is determined by increasing material well-being and forming a critical attitude towards technical progress in the "*growth era*" (Reiss and Zydromomyslaw, 1994:34). Markets are characterized by globalization and shorter product cycles. Low prices are no more sufficient to attract customers in *buyer markets*. Quality has become a competitive parameter and a strategic goal for companies. The types of goods being produced have also changed: with the service sector becoming larger at the expense of the industrial sector, experience goods (Nelson, 1979) become more and more important.

Experience goods are those which are impossible, impracticable or too expensive to investigate before purchase.

This has several implications for the judgment of quality which becomes a function of individual perceptions and expectations. This "*consumer-oriented, subjective quality*" vision (Bouckaert, 1992:8) measures quality at the effect-level as the "fitness for use" (Juran, 1979a:2). Even though system-oriented quality assurance was based on the idea that "quality is everybody's job" (Feigenbaum, 1983:158), in practice responsibility for quality assurance has only shifted from inspection departments to top management. Therefore, it is legitimate to refer to the assessment concept of quality as third-party assessment from the perspective of the operational level.

5. COMPANY-WIDE QUALITY CONTROL

Company-wide-quality control was introduced by Ishikawa in 1968 (Ishikawa, 1985:91). The basic concept of quality is similar to Juran's: *quality requirements are derived from individual needs and translated into technical specifications*. However, customer-orientation does not only refer to the external, but also to the internal customer so that the whole company may be interpreted as a network of customer-relationships. As a consequence, all management efforts concentrate on the fulfilment of customer needs.

Market research has an important function in company-wide-quality-control, using techniques such as *quality function deployment* (Sullivan, 1986:18). Company-wide-quality-control means that all functional divisions and employees are responsible for meeting customers' requirements in the production process.

Quality in this management system becomes a strategic business issue and is seen as the key success factor for long-term competitiveness (Ishikawa, 1985: 104 f.).

The evolution of quality from a technical function to a strategic business goal may be explained by the change of the external environment. The "*quality era*" (Reiss and Zydromomyslaw, 1994:34) may be characterized by a general consciousness and awareness of quality among customers as well as by competition through quality. Today's *service economy* is based on personal company-customer relationships rather than on standardized production processes, which is the reason for quality becoming a *subjective concept*.

Comprehensive quality management concepts like company-wide-quality-control try to *combine the old producer-oriented quality control and customer-oriented quality assurance* concept so that the idea of customer-orientation is also introduced into the production process: The preceding production units become the internal customers of the performance recipients in the added-value chain. The term product therefore includes each single output of a production process. Since customer requirements have to be met at every stage of the production process every employee has to make sure that the products have all the necessary quality specifications. Thus, quality assessment is based on *self-assessment*.

Company-wide-quality-control and TQM are often referred to as synonyms in literature. Even though their approach and emphasis is similar, there are important differences.

6. TOTAL QUALITY MANAGEMENT

In the Western world, TQM was seen as one of the success factors for the Japanese becoming the number one in the electronics and car market. Indeed, TQM was widely and apparently successfully applied to Japanese manufacturing industry in the late 1970s and 1980s and was subsequently re-exported to the West in the 1980s (Pollitt and Bouckaert, 1994:4). It percolated from manufacturing to the commercial services sector and eventually to public services.

The U.S. Department of Defense provides a comprehensive definition of TQM in its Total Quality Management Guide which states that "TQM is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organisation. TQM is the application of quantitative methods and human resources to improve materials and services supplied to an organisation, to improve all the processes within the organisation, and to improve the degree to which the needs of the customer are met, now and in the future.

TQM integrates fundamental management techniques, existing improvement efforts and technical tools under a disciplined approach focused on continuous improvement” (U.S. Department of Defense, 1990:11).

TQM is based on a definition of quality that comes from consumer psychology literature and sets *customer expectations* as the first and ultimate goal of each activity in an organisation. In order to function properly, TQM requires the full and active involvement of all employees to a corporate quality plan as well as comprehensive information systems that collect and process information with regard to customers, suppliers, corporate-wide processes and competitors. TQM also requires a willingness to invest substantially in training. Last but not least, TQM involves cultural change towards continuous improvement.

It becomes obvious that TQM is a very demanding quality management system and challenging to implement even in for-profit business settings. As the following chapter will suggest, TQM has to be modified to make it appropriate for use in public services.

Summing-up, the private sector’s understanding of quality has changed considerably over time. In particular, three key concepts of quality may be distilled from the detailed description above:

- Technical conformity with norms and standards or specifications based on engineering science
- “Fitness for use” based on systems analysis
- Fulfill or exceed customer’s expectations based on customer psychology.

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EXCELLENCE MODELS IN PUBLIC ADMINISTRATIONS IN THE EUROPEAN UNION

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ABSTRACT

Among excellence models in public administrations in the EU, CAF and EFQM are used most. In use are also models that countries have adapted or designed themselves (for example: the Swedish Quality Model, used since 1992, INK developed by the Netherlands and also used by Belgium, and KVIK in Denmark).

Keywords: *excellence model, CAF, public administration, quality management.*

1. INTRODUCTION

Most quality excellence models have first been developed for the private sector and have been transferred to the public sector as a result of a paradigm shift taking place in the public administration in Western countries. In Europe, they clearly cluster around two core models - the 1999 version of the European Excellence Model (previously known as the Business Excellence Model) and the 1998 version of the Speyer Quality Award for German-speaking countries. A detailed comparison identifies the following organisational and managerial key criteria, which are also found in most Western European national quality awards that involve public service organisations (see Löffler, 2001):

- leadership
- policy and strategy
- people
- resources
- processes
- different categories of “objective” and “subjective” results

Naturally, the weightings given to these different components and the sub-criteria used within them differ between the award schemes.

I will provide information concerning how excellence models in public administration work in several countries from E. U., as it follows:

Bulgaria:

The use of excellence models is not widespread in the country. In the last 2 years, certain administrations started applying the CAF model (one regional administration, one municipal administration, the National Revenue Agency). The MSAAR organised several events and published materials in order to stimulate more administrations to apply such tools.

Further activities are foreseen for 2008. A PHARE project (Twinning Light) was carried out in 2007 aimed at strengthening the capacity of the MSAAR for QM in PA (mainly in CAF) in order to provide better support to other administrations in the process of CAF implementation and validation.

Denmark:

EFQM, in use since 1996: The Excellence model is recommended and communicated by SCKK. The use of the model is voluntary. The Danish Quality Award, which is given to worthy public institutions is build up around the excellence model. Only institutions who have improved their organisation through the Excellence model can win the price.

KVIK (CAF), in use since 2003: The Danish version of CAF was developed as a simpler self-assessment method based on request of the public sector organisations. The use of the model is voluntary.

France:

CAF was introduced in France in 2000, but is not broadly used, and there is no official support from the central government. However, CAF is used in some public agencies and local government. The French National Geographic institute experience was presented at the CAF user event in Lisbon in 2007. EFQM is mainly used in private businesses, but also in some public services and local governments.

Certification systems have been set up for users/customers in some sectors:

- Qualifinances: tax and public revenue departments
- Qualiville: town/city administrations
- Qualipref: prefectures

There are also formalised service commitments in employment agencies.

Hungary:

The official Hungarian version of the CAF was elaborated in 2003. This version was the 2002 European CAF version. Since 2003, the government has been encouraging national dissemination of the model with an extensive incentive system.

The application of the model was helped by guidelines. The Ministry of the Interior has contributed to the dissemination of the model among public administration agencies with consultations as well. In the beginning, the CAF self-assessment system was tested with pilot projects in the national public administration. We have created a central, Internet-based CAF database, which has been working since January 2004. The developed national questionnaire can be submitted online. After registration, each public administration agency can use the whole system.

The Hungarian government has made it mandatory to develop and disseminate the Hungarian adaptation of the CAF. In public administration the use of the CAF has been recommended but not mandatory. The government encouraged the dissemination of the CAF by inviting applications for support. On this basis, the Ministry of the Interior solicited applications for the quality development of public administration agencies in 2003. The aim of the grant was to subsidise Hungarian quality development projects, and especially to promote the introduction of the CAF model. The precondition for participation in the CAF application was that agencies had to return the completed questionnaires to the Ministry of the Interior, to the central CAF database. The total amount of the grant was HUF 41.5 million. From among the 117 eligible applicants, 52 were granted a subsidy.

All information and services are free and are available in two ways: the informative publications are available to anyone, but the use of the CAF online system requires registration, which facilitates the completeness of the CAF database and statistics.

In 2006, the Office of the Prime Minister elaborated the Hungarian version of the 2006 CAF version and methodology. At the same time, these developments were also harmonised with European CAF developments.

In Hungary, the CAF questionnaire has been specifically tailored to a number of different sectors, such as:

- law enforcement,
- pension insurance
- labour

The CAF online system (in use since 2004) was further developed in 2007, according to the 2006 CAF version. In Hungary, 250 users have registered in the database of the Office of the Prime Minister. The total number of national users can be estimated as greater than the number of registered users by at least 10–20%. Hungary has also operated a CAF methodological feedback system since 2005, which enables public administration agencies to get external feedback about CAF use.

Some public administration agencies use other excellence models (e.g. EFQM), depending on the decision of the respective organisations and their QM culture.

Lithuania:

As mentioned before, it is not compulsory for public sector institutions to use quality management models, but some institutions do so in practice. In 2007, a survey was conducted in order to determine the level of use of quality management models.

The results of the survey showed that CAF is used in practise by 10.3% of public administration institutions, but half of the institutions could not indicate which version of the model they are implementing. So practically there are about 5% of public administration institutions using CAF. In the database of the European Public Administration Institute, public administration institutions implementing CAF are registered, of which the majority are using the 2002 version of the model. The 2006 CAF version was introduced to public administration institutions in 2007, and it is expected that in the coming years more institutions will implement the CAF. The main problems for implementation are: increased workload, lack of worker motivation and information about the use of the model. So basically the problems are related to human resources.

Some institutions are using specific quality management models because of their specific activities: ISO 9001, 9002, 9003. The ISO 9000 family of standards are used in practise by 31% of public administration institutions. The ISO Standards is the most popular QM model in Lithuania compared to others. Other QM models are used by 20% of public administration institutions, such as: LST EN ISO 17025, 17020, and the Balanced Scorecard method.

The Ministry of the Interior is collecting information on CAF users and provides this information on the website: www.vrm.lt. In the period 2007–2013, the Ministry is planning to use money from the European Social Fund (EU support) for the promotion, implementation and certification of different QM tools and systems in Lithuania public administration institutions.

Romania:

The Common Assessment Framework (CAF) was launched at national level in Romanian public administration in 2005 in order to increase the quality of public services. The Ministry of Interior and Administrative Reform is responsible for coordinating the use of the CAF model.

The approach to CAF implementation is as follows:

- Phase 1: Training sessions on quality management – CAF for top management in targeted public institutions
- Phase 2: Training sessions on quality management – CAF for civil servants in all county councils and prefecture institutions
- Phase 3: CUPAR received and planned the requests for technical support from interested public authorities, which were sent on *a voluntary basis*
- Phase 4: CUPAR’s CAF team assisted the public authorities in running the exercise *on site*

Results of CAF 2008 in Romania:

CUPAR received 47 technical support requests from public administration institutions on a voluntary basis:

- 31 prefecture institutions
- 7 county councils
- 3 deconcentrated public services
- 2 municipalities
- Ministry of Economy and Finance (1 General Directorate)
- Ministry of Education, Research and Youth (3 Directorates)
- National Institute for Administration
- Central Unit for Public Administration Reform
- 386 civil servants were trained in CAF and were able to disseminate the information related to it
- 84 high civil servants, representatives of prefectures and county councils from all 42 counties in Romania were trained on the self-assessment instrument

- Action plans were elaborated in the institutions based on CAF implementation conclusions

The principal domains proposed for improvement are:

- internal communication (drafting internal strategy communications, creating an intranet network, introducing integrated document management)
- strategic planning (reviewing the multi-annual modernisation strategy)
- Employee motivation (their involvement in drafting the action plan for the institution, in drafting internal communications and the multi-annual modernization plan through working groups)
- Results measurement for both personnel and beneficiaries (established a set of indicators)
- Customer/citizen satisfaction (questionnaires were drafted in order to have a clear view on their satisfaction)

2. QUALITY AWARDS

In the majority of cases, Member States join conferences on quality with rewarding achievements in the field of quality. In the selection procedures, countries use various models or approaches to assess applicant organisations. As the basis for assessing the State, the CAF model is used in some places (e.g. in the Czech Republic, Greece and in some countries only indirectly); elsewhere, their own quality or excellence models are used, and in some countries, a range of several criteria is used.

Bulgaria

In June (on the occasion of State Administration Employee's Day) the Minister of State Administration and Administrative Reform awards public institutions for their contribution to the process of modernisation of the administration.

The awards have been given since 2006. Awards have been granted in the following categories:

"Accessible and quality administrative service delivery"

"Best on-line services"

"Effective human resources management"

"Best PR practice in state administration"

In 2003, 2004 and 2005, the Institute for Public Administration and European Integration organised several competitions and awarded good practices in the areas of administrative service delivery, e-government, transparency, etc.

Denmark

The Danish State rewards achievements in the field of quality with The Danish Quality Award, since 1997.

France

The **Public Service Quality** trophies were created in 2003 by the Ministry in charge of State reform, in order to send a strong signal:

- **to the public,** about the wealth of outstanding initiatives taken in the administration, and
- **to civil servants,** to restore their confidence in the administration's capacity for modernisation.

The objectives were the following:

- to enhance outstanding initiatives
- to encourage innovation
- to improve the image of the State administration
- to share good practices

Initially dedicated to the State services, the award was gradually opened to public agencies controlled by State, to courts, to social welfare agencies, to public establishments and organisations in the social and medico-social sector.

In 2006, if was opened to local and regional governments.

Categories have been defined according to various priorities:

- From 2003 to 2006: reception, remote services, management, partnership, language simplification, services to disadvantaged persons, listening to users, user participation, etc.
- **5 categories in 2007:** reception and guidance, administration more accessible to disadvantaged persons, simplification of administrative formalities, rethinking of user-oriented organisations, improved quality of internal service delivery
- **In 2006, creation of a consumer organisation award**

To **evaluate** 60 to 100 candidates each year, the jury grew from 8 members in 2003 to 16 in 2007.

- a jury of public figures with a variety of cultural approaches (civil servants, representatives of large companies, former award winners, etc.); each candidate's application is examined by 7 jury members
- an evaluation grid based on 4 criteria: **relevance, method, outcomes, exemplary nature**
- a rating grid (scoring from 1 to 10)

Hungary

Quality award in public administration, since 2004

To recognise the activities of public administration agencies with outstanding quality results, the Minister of the Interior founded the Hungarian Public Administration Quality Award in 2003. The first awards were granted on 1 July 2004. The Minister may grant five awards each year. The winners are selected on the basis of applications upon the recommendation of the Hungarian Public Administration Award Committee. Applicants must meet four fundamental conditions:

- continuous, strategic quality development in the organisation;
- application of a quality management system – CAF was separately named in the ministerial decree founding the Award;
- continuous monitoring of customer satisfaction;
- practical application of development principles based on learning from each other and on benchmarking.

Public administration agencies must present their respective organisations on the basis of CAF criteria in the applications submitted or the award. Though the application of CAF is not a mandatory precondition for granting the award, we intend to encourage the dissemination of CAF in Hungary indirectly by means of the above-mentioned tools.

Since 2006, the awards have been given by the Minister heading the Office of the Prime Minister.

Lithuania

There are no special quality awards in Lithuania. Nevertheless, during the quality conferences held every two years the best projects involving best practices are awarded with a certificate, prize and the opportunity to represent Lithuania at the Quality Conference for Public Administration in the European Union.

The first time Lithuania took part in the third Quality Conference for Public Administration in the European Union 3QC. Three best practice cases from Lithuania were presented at the conference:

- Building a Civil Servants' Training System
- Development of an Education Quality Management System
- Quality Management in Health Care Institutions

At the Quality Conference for Public Administration in the European Union 4QC, the following best practice cases from Lithuania were presented:

- Adaptation of Recreational Objects in the Forests for Psychically Disabled Needs
- Implementation of the Integrated Model of Health and Social Care
- One-Stop Shop in Vilnius

Romania

Excellence Award in Public Administration, since 2005 Romania has had several initiatives for awarding good practices within the public sector, for instance: excellence awards organised by the Romanian Leaders (7th edition in 2007), the Award for Excellence in Public Administration (3rd edition) and the awards offered by National Institute for Administration (1st edition in 2007).

The Award for Excellence in Public Administration is meant to emphasise efforts for developing the Romanian public administration system, to reward the positive initiatives of public administration specialists and important projects implemented by representatives of the local and central administration. The ceremony takes place early and is organised by the portal: www.administratie.ro and by the OSC Agency (specialised in communication).

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AVOIDANCE OF COLLISION RISK

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ABSTRACT

Over the past decades there has been a continuous increase in the public concern about general risk issues. The consequence of this trend is that whenever a catastrophic accident occurs - and receives media coverage - there is an immediate political and public demand for actions to prevent the same type of catastrophe in the future. Many of the past improvements in safety of marine structure have been triggered by disasters but there is a change in this trend nowadays.

The maritime society is beginning, although 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.

Collision risk or danger usually occurs in high sea, when navigation is led by Officer on Watch, as well as by traffic devices, when the breaking of rules is more significant: the rules have not been observed and/or efficient collision avoidance measures haven't been taken in due time.

Collision risk is an imminent risk, which requires immediate and firm measures for the re-establishment of the safety situation with respect to the collision with the target or other vessel that could bring about human accidents, serious damages to the vessel's hull, pollution, wrecking, scuttling, etc.

Collision risk is directly related to the „preventing method" of collision risk avoidance by assessing the collision probability together with the potential consequences. It is specific to „I" intersection angle of collision free courses.

Keywords: *ship, collision, avoidance, risk.*

1. INTRODUCTION

When talking about avoidance of collision risk, we mainly must refer to Rule 15 - „Crossing courses", when the determined **„**closest proximity of approach (CPA)**"** indicated an imminent collision and the burdened vessel shall insure the avoidance by increasing the CPA to the value of the nCPA, the value of the new closest proximity of approach, expressed in miles, established as such by the captain, which can occur in one of the situations described below. This situation covers any value of collision angle „C".

2. AVOIDANCE OF COLLISION RISK

At any moment, if OOW determines a slightly fluctuant bearing, almost constant, and a decreasing distance with respect to the target, it is possible to immediately calculate, in maximum 6 minutes, the distance at which the vessel will pass the target CPA, calculated through the distances „m" and the bow bearings „Ab" tangent to the circle with safety range to starboard or port, which means the necessary angular deviation.

In the case of collision danger, the data can be graphically calculated in a triangle with fixed angles or on the manoeuvring board, where the relative movement vector passes through the centre of the board - the target, meaning the CPA = zero.

All the information necessary to the avoidance is solely based on the own observations and is enough if properly used, which means that the determination of the elements regarding the target's movement is no longer strictly necessary. Currently, the AIS - Automatic Information System - device allows the electronic entry in the target's navigation system, thus obtaining information on its identity and elements of motion, which makes the precision of the OOW calculations beyond any doubt.

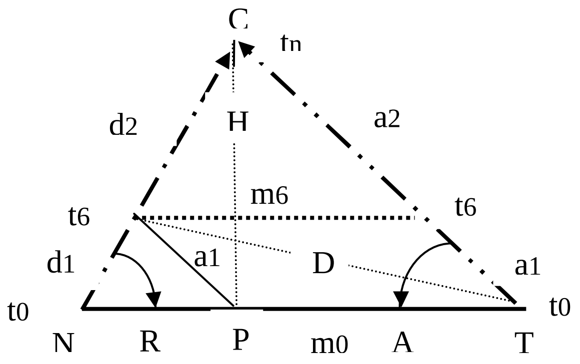
By seeing the distance and the bearing of the other vessel on radar, or by assessing it visually or by sound alerts, any OOW is able to establish the initial situation - first of all:

a. constant bow bearing or with an insignificant fluctuation, rapidly decreasing distance: it means imminent collision danger;
b. slight fluctuation of the bearing, decreasing distance - this means that one of the vessels:

(1) "gains" bearing – passes on the other vessel's bow side;
(2) „looses" bearing – passes on the other vessel's stern side;
(3) there is a risk and therefore it is highly important to check the real distance between the vessels
(4) the burdened vessel – mainly, and the privileged one secondarily –shall reach a new closest proximity of approach, both vessels having responsibilities clearly stipulated by COLREG, Rule2.
(5) constant bearing, constant distance – vessels on parallel courses on the sea;
(6) constant bearing, increasing distance – the vessels bear away one form the other, there is no risk.

Noticing any kind of light on the sea or hearing the sound signals of a ship which is closer than the regular distance but at least equal to the ship’s turning range, allows the avoidance „in extremis” of any kind of collision, including by turning to stern.

If there is a better visibility or the radar devices are working, it is rather hard to find excuses for a collision in front of the juridical and insurance bodies, and the privileged party will bear at least 10% of the damages, even when the guilty captain was on duty.



Other graphical constructions of triangulation are also possible

1. $c^2 = a^2 + b^2 - 2ab \cos C$

2. $\sin A / a = \sin B / b = \sin C / c$

Figure 1 Collision Triangle

2.1 The case of reciprocal or nearly reciprocal courses

The avoidance of collision in the case of reciprocal or nearly reciprocal courses is provisioned by Rule 14:

- When two vessels meet on reciprocal or directly reciprocal courses (the vessel’s courses are marked on the map), each vessel shall alter its course to starboard, thereby keeping the other ship to the port side.

Such is the case of a vessel which sees the other ahead or nearly ahead, so that:

a. by night it will see the masthead lights of the other in a line and/or both sidelights;
b. by day, it will see the other vessel’s corresponding bearing (estimated or provided by ARPA - NA).
c. If a vessel is in any doubt as to whether such situation exists, it shall assume that it does, and act accordingly.

2.2 The case of almost reciprocal courses

The situation of almost reciprocal courses could be met anywhere:

(1) in open sea – the target must be discovered in time and avoided;
(2) in narrow channels– according to Rule 9, see navigation in Bosporus, Dardanelles, English Channel and Dover narrow, etc., now with well established rules;
(3) on rivers – according to local regulations. In this case, it is worth noticing that the vessel’s speed depends on the currents’ velocity with their immersion and suction effects.

The maneuver recommended by COLREG is that each vessel should alter its course to the right, until it reaches the safety distance. When in doubt, alter the course a little more to starboard.

Given the vessel’s bearing and the aspects of 0 - 4.5˚ the table for small angles shall be used for computations, when sine and tangent have approximately the same values, under 10% of the values of visibility distances.

2.3 The case of overtake

Collision avoidance when overtaking is provisioned by Rule 13 of COLREG and it states:

a) Notwithstanding any other provision contained in part B, the vessel overtaking on other one shall keep out of the way of the vessel it is overtaking (Rule 16 is not privileged).
b) The overtaking vessel is the one coming up with another vessel, from a direction (stern sector) more than 112.5 degrees, which means that it is in such position, that by night it could only be able to see the stern light of that vessel but neither of the sidelights.
c) If a vessel can’t establish for certain whether it is overtaking another, it shall assume that it is and make a maneuver accordingly.
d) Any subsequent alteration of the bearing among the two vessels shall not make the overtaking vessel consider that it crosses the path of the latter vessel.

This situation has also led to various disputations regarding the real courses followed by the two vessels - and especially regarding the moment when each of them determined the relative position - distance bearing, as follows:

- by day, the situation depends on the interpretation of the situation by night, when the vessel is only able to see the stern light , but neither the masthead lights nor the sidelights, with their descending intensity, outside the angle of 112.5 degrees, as follows:

1) from the masthead: 112,5 + 5 = 117,5 degrees; this sector is larger than the one of the sidelights;
2) from the sidelights: 112,5 + 3 degrees = 115,5 degrees; not taken into consideration;
3) stern: 180 – 117,5 = 62,5 degrees in each of the sides.

The vessel which is only able to see the stern light+ / – 62,5º and by day– correspondingly, alters its course and overtakes, thus avoiding any risk of collision.

Since the masthead lights exceed more than the red lights towards stern, the invisible sector of the masthead lights is 2 x 117,5 + 235 degrees, which means that their invisible sector is 360- 235 = 125 degrees, which represents the stern sector, exclusively visible for stern lights, or 125 : 2 = 62,5 degrees stern bearing in both sideboards.

Given the above, COLREG strongly recommends that the vessel which is overtaking should be forced to bear away from the overtaken vessel. When in doubt, you should bear away even more. If you are an overtaken vessel and maneuver in order to bring the other vessel towards the stern, you will loose the quality of overtaken vessel!

2.4 Crossing courses

It is the most frequent situation, especially in high sea and Rule 15 of COLREG clearly stipulates that: if there is a risk of collision, the vessel which sees in its starboard other vessel must keep out of the way and, if possible, avoid the other vessel's stern side.

In this case, everything depends on the value of the first determination of CPA: is it or not safety CPA, in which situation only the captain can decide by Standing Order or, at the most, by Night Order.

In this situation, the vessel seeing the target in its starboard sector comprised between 3º bow (directly opposing) and 62.5º stern (can't be overtaken) must keep out of the target's way. Normally, one should pass on the target's stern side.

If there is a speed limit or the conditions allow the passing on the bow side, one should take into consideration the tension laid upon the target.

2.5 Conduct of vessels in restricted visibility

Rule 19 applies when the vessels „are not in sight of one another", when they are navigating near or in an area with restricted visibility, when the targets are to be discovered only with the radar.

Rule 3 stipulates that „restricted visibility" is that situation when the vessels are in sight of one another, although only one can be visually noticed by the other, if - according to the title of Rule 3, the context doesn't stipulate otherwise.

This situation has raised many disputes: the limits of the visual discovery distance and the reasons why „only one vessel could be visually noticed".

The judicial practice keeps record of such situations when the visibility was restricted to 2-3 miles, had an „internal gap", and the vessels could mutually see one another at several cables, thus being forced to maneuver as shown below and take more exigent measures than in the case of the first vessel which discovers the other. Therefore, as a rule, a vessel which sees a target only on radar, must navigate at the minimum velocity - so as to be able to immediately stop on a distance equal to half the visibility distance (counting on the fact that the other vessel shall act in the same manner).

This rule also introduces for the first time the notion and abbreviation „closest proximity of approach (CPA)" followed, after the avoidance calculus has been made, the notion and abbreviation of „new closest proximity of approach (nCPA)".

We get back to the correct understanding and application of Rule 2 - the collision shall be avoided, even at the risk of departing from the present rules"!

3. CONCLUSIONS

The avoidance maneuver shall be deemed to be concluded only when the target has been completely overtaken and the risk has been fully cleared.

One should bear in mind that, usually, if the maneuver is delayed, the privileged target could:

a. be hit in her starboard, if she wants to pass through the target's bow;
b. hit the target's port, if the vessel wants to pass through the target's stern.

Location of the impact spot depends on the vessels' lengths and the last minutes of the maneuver!

The most dangerous impact is the one which occurs in the area of the berths, the mess and the places where the crew fulfills its activities and leads to life loss or severe bodily harm, as well as the impact followed by the breaking of the skin of major compartments: engines, cargo tanks, or stores.

The bow - bow collision can also have serious consequences, especially on rivers, while the bow - stern collision occurs more seldom.

Any avoidance maneuver means - first of all, leaving the course marked on the map and marching on at least two segments (course lines, „CL").

Navigation occurs through map calculations, even electronic map, with courses determined with the use of the compass and subsequently turned into real courses and through covering the distances at high speeds.

The return on the course marked on the map (see the figure above) can also consist of one or more segments, a march for which everything is made based on reckoning graphical calculus.

The march on several course lines, outside the one marked on the map, represents a delay of the plan and therefore these maneuvers shall be briefly recorded in the sailor's book, as motivation for not fulfilling the marching plan during that watch, while the avoidance decisions shall be well grounded by the details recorded in the „OOW Register - scrab log". The return must occur during the own watch, by choosing a direction ahead the XTD beam.

It is worth reminding that the course marked on the map is the planned one, deemed by the captain as the safest from wrecking and other situations of this kind, as well as the shortest way to destination.

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RISK MANAGEMENT TODAY IN SHIPPING COMPANIES

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ABSTRACT

The risks at sea continue to be subject of many shipping documents describing the voyages completed by carriers engaged in maritime trading. The current policies aim for the development of some mutual insurances to cover the risks to which the ships are exposed to and, in particular, the crew which must be reimbursed in case of accidents. Currently, one of the biggest impediments standing in the way of the naval industry's progress on an international level is the lack of methods for determining risk levels. The volume of commercial activities and the pressure put on the market requires orientation towards new methods and techniques of risk administration, in other words the elaboration of a risk management plan, which, as professor Kuo also said, has the purpose of "maintaining and controlling risks and dangers between certain tolerance margins, to a practically negligible level". I consider that a coherent managerial plan must include techniques of identifying potential accidents and of analyzing risks, in order to improve the safety measures and to reduce the loss of human lives and also to increase the quality of decisions. The practice of an efficient management requires some quality standards to be set, which must be set progressively after a careful analysis of the organization and of the evolution perspectives. Therefore, synthetically, a system of safety management is based on going through the following steps: elaborating clear policies and safety objectives; planning concerning the development of action plans , with the determination of roles and the assignment of responsibilities; implementing the action plans and the methods; periodical evaluation, by comparing the results obtained with the objectives set; and last but not least, improving performance, by identifying malfunctions, periodical updating of the risk evaluation and by taking corrective measures.

Keywords: *Risk, management, safety, shipping, maritime industry*

1. INTRODUCTION

In Marine Insurance Act from 1906 risk was definite as:

The term risk is used in different senses, and must always be constructed by the light of its context. Sometimes it is used to denote the perils themselves to witch insurable property may be exposed, as when sea risk are contrasted with land risks, or when goods are insured against "all risks". Sometimes it is used to denote the risk run by a person whose property is exposed to danger. But more commonly perhaps ,it is use to denote the liability undertaken by the insurer in respect of his contract as, for example, when goods are lost, and it is said that "the risk had not attached"., that it to say, that the goods were not at the time of the loss covered by the policy".

On sea safety in principal is assure by:

- International Safety of Life at sea Convention.
- International Regulations for Preventing Collisions.
- Standards of Training Certification and Wachkeeping Convention.
- Rules of classification societies.
- International Ship Safety Management Code.

Risk can be seen as a chance of an incident happening and it has two components- the frequency and the consequence. The UK HEALTK and SAFETY EXECUTIVE divide risks into three categories:

- Negligible, where no risk reduction measures are needed.
- Tolerable, where the risk should be "as low as reasonably practical-ALRP".
- Intolerable, where risk measure must be taken irrespective of cost

Quantified risk assessment in the use of numerical estimate of hazards so as to make a calculated evaluation of risks. The savings in cost by reducing risks is the main economic reason for using the method of risk management.

Although the concept was used in different ways, the growth of shipping companies objectively led to the adoption of the principles of risk management.

Particularly shipping companies that provide services for the oil industry, nuclear industry, chemicals and liquefied gases, were the first to adopt these principles. Jhon Spruyt observed [2,3]: " most shipping businesses are getting more complex , impacted on by relation ,international economics and theological development. High intelligence, numeracy and judgment will be required of management. The world pool of bright people is not infinite. We have to compete with service industries than have more glamorous images". Spruyt recognized that the best risk management strategy is to have excellence in management. His criteria are as follows:"Shipping managers of the next decade must:

- Be recruited from industry in general as well as from seafarers and sipping specialist, and the role models appropriate to the industry's long term needs.
- View shipping's traditions and history as part of learning process, eschewing defensive nostalgia.
- Welcome new ideas and have the courage to find solutions to chronic problems.
- Face up to and solve the fundamental structural weakness of an industry that operates globally, but is a regulated nationally.

- Enthuse over total quality, zero defect management objectives.
- Be reedy to take control of public image building and to ensure effective spokesman ship.
- Reverse the industry’s aversion to training especially in the personal development of senior management and seagoing officers. Use the business school, but also ensure the shipping orientated trainers are delivering what the industry needs. Be highly skilled in the fields of personnel management, industrial relations and employee welfare, and keen to work in multi-cultural teams.
- Think strategically about their relationship with governments, with markets and with trade unions.
- Believe in profitability as an achievable objective for an ethical, high quality, and caring industry, resisting the temptation to use the bottom line as an excuse for shot term sloppy management.

Excellence produces excellent balance sheets”. A company witch is taking an investment risk in a new building or preventing losses through hazards identification and risk assessment is addressing two sides of the same coin. What matters, of course, is how those risks are assessed and managed.

There are risk related elements to:

- Business development.
- Innovation in ship theology.
- Communication and organization.
- Commercial contracting.
- Loss prevention.

Typically a risk profile will involve for fundamental risk categories:

- Propriety.
- Liability.
- Pecuniary.
- Personnel.

At the organizational level, in risk management 3 stages have been identified:

- First, it is necessary to have a person who understands the principles of risk management and who knows how to evaluate results;
- Second, it is necessary to establish a commission to assess risks;
- Third, the organization should have an interdisciplinary team that should be able to assess the nature of risks and also draw conclusions about reducing unacceptable risks.

When knows all of this, company can take proper measures for risk management.

“Risk is a measure of hazard’s significance involving simultaneous examination of his consequence and probability of occurrence using a combination and practical experience and relevant information on the system and its operating environment”.

“Managing and controlling the risks of hazards to ensure that they are always at a tolerable or negligible level”[1]

For proper risk management it is essential to create and update all databases on accidents, in other words, to collect relevant information in this field. In the completion of these databases, two elements are essential: frequency means repetition and severity of accidents.

In this case, it is advisable to use tools (standards) of comparison from the industrial field, which can be found in industrial associations, P & I Club, government statistics and classification societies.

Review priorities in the risk analysis process are dictated by circumstances and are based on:

- Analysis of incidents and avoidance of their repetition;
- Infrastructure development such as, for example creating new landing craft terminals;
- Analysis of current operating procedures;
- Review of these procedures for reducing risks through performance management.

As in most activities, a major role is played by the planning process, which requires that documents contain at least the following data:

- Field of the investigations;
- Measures that need to be taken for risk reduction;
- Individual responsibilities;
- Time evolution;
- Data of the planning review;
- Name of the person in charge of the review.

Techniques that can be applied in this process can be chosen according to the following criteria:

- Experience and analysis skills;
- Experts resorting;
- Quantitative evaluation;
- Development of the multidisciplinary risk matrix.

If, after review, the event falls in the shaded area, then it is likely to have serious consequences. (fig.1)

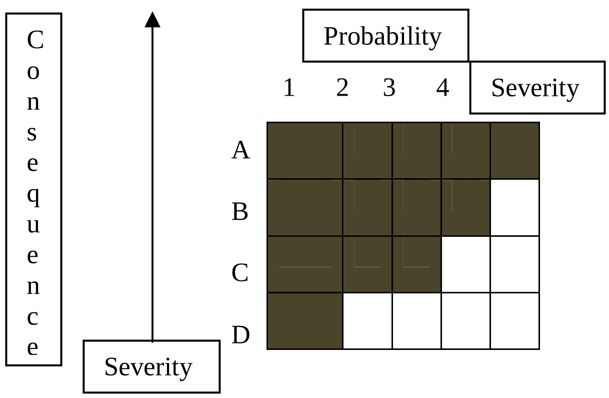

Figure no. 1.

One of the major phases in a risk management plan is represented by plan approval. This requires a careful risk assessment and a detailed analysis of contract terms. The plan should cover: Shipbuilding standards (norms); The methods used for the correct assessment of the plan; Structural Integrity; Vessels impact; Pipelines, Aces; Engine room; Deck; Navigation system; Anchor handling; Accommodation spaces; Cargo plan; Rescue measures; Warehouses; Bunker tanks; Safety systems.

When a ship is built in order to meet a specific operational requirement such as a passenger ship, the owner will manage a team of designers. They will consider feasibility in accordance with the following principles:

- Safety management
- Risk Management
- Feasibility and maintenance
- Integrating human factor

An important part of the process is ensuring that the main systems and subsystems function as designed and that they are tested.

In any complex operational environment things can go wrong. A latent defect may lead to a catastrophe, people make errors, communications can be misunderstood, the team may not be familiar with a certain system. In such situations the following principles can be applied:

- Speed of response
- Effective use of resources
- Management, control and coordination

Many dangers can be scrutinized and response plans can be issued.

There is a need to provide training about risk management techniques, hazard identification, awareness, risk assessment and control.

Professional training is required for risk reduction, since these skills can not be simply acquired. Training materials need to be used and professional trainers, well prepared for the navigation industry.

As part of major loss prevention plan, The Nautical Institute has undertaken an international tour in order to raise awareness of preventive measures. It was proved that all the incidents (collisions and standings) took place between well-equipped ships and with qualified personnel on board.

Det Norske Veritas is the first classification society to introduce risk based class rules. [4]

This establish:

- Safety for the ship and equipment.
- Safety for the cargo.
- Safety for personnel.
- Safety for environment.
- Economy through vessel availability.

Risk classification according to certain rules is:

• Safety for ships and equipment
• Safety of products
• Crew safety
• Environmental Safety
• Economy by ship availability

In according with this classification societies involved in this process can provided a ship life cycle. Lloyds Register developed the IT program The Mariner. It consists of three components: program for Lloyds Register, for the office and for the ship. It is an electronic interactive system that allows both office and personnel at sea to:

• Identify hazards in each operation on board
• Assess the risk associated with each operation on board
• Establish where the operational control can be improved
• Maintain improvement by setting realistic goals

The main point in this process is represented by link between ship management and classification society. Now, when the I.S.M. code is a reality, shipping companies may use the recording data and managing the operation of ships more safety. Risk management take a complementary view in considering the risk exposure over the full spectrum of company operations and is the way of linking the commercial technical and operational risks in the way which makes it possible for senior management to make Decision Maker Process better. Managing risk within acceptable limits, although it may not be a legal requirement as such, is certainly a professional responsibility. Examples where risk management techniques have proven effective:

- Reduction of collision incidents in multinational fleets
- Control of secure operation of a passenger line in a new port of call. All aspects included, from navigation to garbage collection
- Protection against piracy
- Design and construction of chemical tankers
- Introduction of escort tugs
- Tanks with double hull tankers compared to simple hull tankers;
- Operation of ships carrying liquefied gas and security of the population in the terminal areas
- Marine Constructions
- Planning routes depending on the weather
- Negative influences of media involved in the case of oil spill

Both ship-owner and cargo insurer use insurance as a risk control measure. For the ship-owner it is trough the liability cover provided by the P&I Clubs and for the cargo owner, the indemnity cover offered by, amongst others, the London market through Lloyds, the international Underwriters Association (IUA) and what is termed the Agency company market.

The provision of cargo insurance encompasses much more than underwriting element and includes the specialist broking community who undertaken much of the administrative work and manage the interface between the assured and the underwriter.

Outside the direct market are the specialist law firms whose expertise can focus a penetrating light on the effectiveness of a carrier's risk management procedures. The basis of cargo insurance is the Institute Cargo Clauses(ICC) but around this many shippers will negotiated through their brokers an open cover witch goes beyond the facultative voyage policy covering a single transit and provides protection foe all the assureds voyages on world wide basis.[5,6]

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THE ROLE OF INTERMEDIATES IN THE EU-27 BUSINESS COLLAPSE: CAUSE, EFFECT OR BOTH

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ABSTRACT

Some important changes in intermediary goods trade have emerged over the last decade regarding the geographical structure of trade. Results of the intermediate goods trade analysis revealed that the composition effect is not the major explanation for the pronounced decrease of exports and imports of parts and components of the EU-27 countries. Thus, while the composition effect and possible the inventory adjustments may have contributed to the proportionately decline of exports and imports of parts and components, it seems insufficient to be responsible for the observed changes. However, severe decline of trade with intermediate goods is one of the reasons that explain why the trade decrease was even more pronounced than was suggested by the income elasticity of long-term trade. Observing the recovery of trade flows, we can expect a rapid expansion of the EU-27 trade if the sharp fall of parts and components was due inventory cycle, as empty stocks must be restored. There is however a risk that disruption / disintegration of supply chains caused by the financial crisis has a negative effect on trade during the recovery period

Keywords: *Intermediates, parts and components trade, financial crisis.*

1. INTRODUCTION

Trade bankruptcy followed by the financial market turbulence from September 2008, which peaked in the winter of 2008/2009, was in many ways unprecedented. The financial crisis has been even steeper than the Great Depression (Eichengreen and O'Rourke, 2009), and occurred at a global scale with an exceptionally high degree of synchronization (Araujo and Martins, 2009; Araujo, 2009). In addition, the decline in global trade in real terms was far more pronounced than that of Gross Domestic Product. This also reflects a change in the global trade patterns , which is characterized by vertical specialization across countries, i.e. countries are not necessarily specialized in the production of goods, but in certain stages of production of certain goods. Vertical specialization implies that countries produce and export large amounts of semi-manufactured products, parts and components in particular, which are then processed or assembled in other parts of the world.

Therefore, before a country exports a final product, a series of trade flows of intermediate goods (including imports of primary goods, semi-finished and parts and components) will be taken place. If, as was the case during the economic crisis, order declines in many parts of the world, it affects not only trade flows with finished goods but also the related trade of semi-finished goods and parts and components. Through this mechanism, intermediate goods trade increases the sensitivity of trade on business cycle changes. Growing role of international supply chains and consequently the vertical specialization have led to a significant increase in income elasticity of the economy, which is well documented in the literature (eg, Cheung and Guichard, 2009; Freund, 2009). For EU - 15, this elasticity was 1.95 between 1961 to 1984, which means that this global trade has changed with a rate of 1.95 when global GDP has changed by 1%. Elasticity increased at a rate of 2.45 during 1985 to 2009.

For 2009, however, global trade grew stronger than suggested by long-term elasticity of trade, as global trade has exceeded real GDP decline by a factor of 5 (IMF, 2009). It has been suggested several explanations for the trade collapse disproportionately during 2008 - 2009, including increased marketing costs due to credit crisis (Escaith and Gonguet, 2009), protective tendencies of most trading partners (Evenett, 2009) and a composition effect, i.e., the industries most involved in international trade have been hit harder by the downturn in global demand.

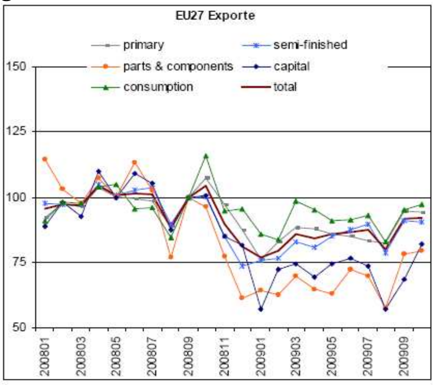
What happened with intermediate goods and especially with parts and components - a subset of intermediaries totaling about 30% of EU-27 trade - during crisis is interesting as such, given their important role in international supply chains. Parts and components represent a category of special interest because they are the goods category most associated with the notion of international supply chains in the vertical domestic industry from the current database. There are, therefore, most affected by potential structural changes that could occur during crisis because of decisions of companies operating globally. This section analyzes in detail the development of export and import of parts and components EU-27 using monthly trade data.

Referring to the crisis impact on trade flows by end users categories, first step in analyzing the crisis impact on trade flows is by comparing the decline in different categories of end users, including parts and components, with that of general trade. Looking first at the development of aggregate exports during the crisis, Figure 1 illustrates that exports volume declined between October 2008 and January 2009, when the index of aggregate exports has reached a maximum level of 77%

to the volume of September 2008 that means a 23 percent decline in real values. Beginning and intensity of commercial bankruptcy were similar on the import, but the decline was somewhat larger, lasting until April 2009, when the volume index reached 80 percent decrease. Therefore, during the crisis peak, the export decline by 24 percent was greater than the decline in imports, which amounted to 20 percent in real terms.

Is also observed the differences in the initial phase of recovery, perceptible in the export side, starting with February / March 2009 and – disseizing the decrease of August - lasting until October 2009 which is the last observation available for this analysis. In contrast, for imports, can not be detected any real recovery before September 2009, so one year after the crisis outbreak, the exports index was 4 percent higher than the one of imports, despite the sharp fall of the exports volume. These differences in trading volume recovery reflect high differences in the total recovery, which is lower in the EU27 than in other regions, especially Asia and China.

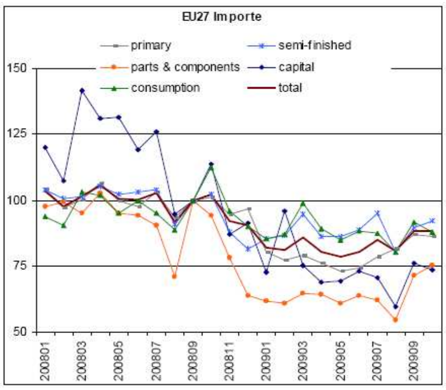
Against this background, the most remarkable point that emerges from Figure 2.8 is that the parts and components have registered the most pronounced decrease of trading volume both in export and import, followed by capital goods. For example, in January 2009 parts and components imported remained at about 62 percent of the volume from September 2008 and remained very low until September 2009 when they began to recover. Both on the import and export side EU-27 trade with parts and components remains low at about 75% of the level of September 2008 at the end of testing period. In contrast, trading volume of consumer goods fell less than that of sales of other categories of goods.



EU 27 Export

- primary
- parts and components
- consumption
- semi-finished
- capital
- total

Figure 1 Development of EU-27 exports and imports by category of end users during the crisis (Trading volume, September 2008 = 100)



EU 27 Import
- primary
- parts and components
- consumption
-semi-finished
-total capital

Source: COMEXT, WIIW-calculations

Share of parts and components trade declined due to the crisis. The most proportionate decline in parts and components trade led to a decline regarding the share of these categories of goods when comparing averages preceding and following crisis.[1] More specifically, for exports, the share of trade with parts and components decreased by 2.3 percent from 17% to 14.8%. For imports relative decline amounted to 1.1 percent from 15.5% to 14.4%. But the fact that the parts and components category of goods were the hit of the EU 27 trading markets -makes them very important to explain the collapse.[2]

One explanation for the sharp decline in trade with parts and components may be changing in trade patterns regarding parts and components trade, i.e. a partial trade return toward deeper and more complex forms of vertical specialization. Such a trend could be attracted to a less favorable international environment, with higher trading costs and potential protection policies implemented by trading partners. Another explanation for the sharp decline in parts and components that could be both a rival and a complementary factor is again the effect of composition similar to that mentioned above. According to this hypothesis, the most powerful trade crisis was in parts and components trade as major industries from world trade that are also parts and components trade-intensive such as automobile industry, were relatively more affected by the shock in aggregate demand than other industries. It is assumed that this causal hypothesis derived from industries at shares in parts and components in total commercial manufacturing. If the effect of composition leads downward motion effect of parts and components trade, stronger decline in this product category should disappear at individual industries level. On the other hand, international supply links were partially disrupted as a consequence of the crisis, as suggested in the first explanation, the share of this category in total trade should have declined both in the total production and in individual industries.

Referring to trade in parts and components and commercial collapse of industries we closely examine the share of trade with parts and components in the individual industries. Figure 2. and 3. presents the share of trade with parts and components in individual industries for exports and imports on the vertical axis and the industries index specific to the commercial decline on the horizontal axis. Horizontal axis shows the developments in the months between September 2008 and the month showing the lowest value since September 2008. The series is build as an index with the level of September 2008 equals 100. Lines that exceed “Total production” data point indicate the share of parts and components trade and respectively, the commercial decline index for comparison of the total production.

These figures show that vertical specialization, as measured by trade with parts and components, plays an important role in about half of manufacturing industries,

[1] Pre-crisis averages are calculated for carts from January 2008 to September 2008 and the post-crisis for the period October 2008 - October 2009.

[2] Note that the proportional decline of parts and components is not the result of multiplier effect than trade in semi - manufactured from trade statistics.

especially those with moderate and high intensity. Industries with a high level of vertical specialization are found above the vertical line at “Total manufacturing”. The highest level of vertical specialization in EU-27 exports is found in electrical machinery industry (NACE 31), with 57% of exported goods being parts and components trade, followed by machinery and equipment industry (NACE 29), with a 39% share in the trade of parts and components, see Figure 2. The transport equipment (NACE 35) and the automotive industry (NACE 34), parts and components account for 36% and 34% respectively, of industry exports. Industries layout based on the share of parts and components imports look similar, except for some differences.

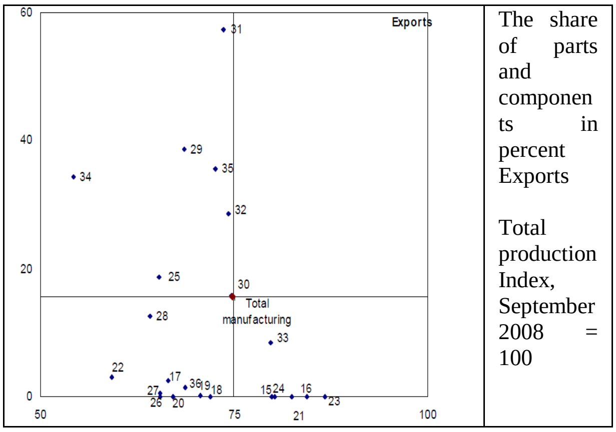


Figure 2: Index of export actual values versus share of parts and components trade from individual industries

Note: Horizontal and vertical axes refer to the share of the total production index. Industries on the left (right) shows a stronger decline (less strong) in trade compared to total production; the index refers to the smallest value after crisis and therefore may differ from industry to industry. Industries above (below) shows a higher share (less) in parts and components trade compared to total production.

Source:COMEXT, wiiw-calculations, August 2009, neglected values due to seasonal fluctuations.
The index of total trade for individual industries and the whole manufacturing sector is the corresponding index for September 2008 reduced monthly.

While the machines electrical industry (NACE 31) has the largest share of parts and components in imports by 55%, followed by transport equipment by 45%, see Figure 3 the machines and equipments industry, radio and television industry (NACE 32) and also the automotive industry have relatively large shares of parts and components in imports, see Figure 3. So, although there are some differences in the precise ordering, the importance of parts and components is similar both in exports and in imports, the five industries mentioned are those with the highest level of vertical specialization.

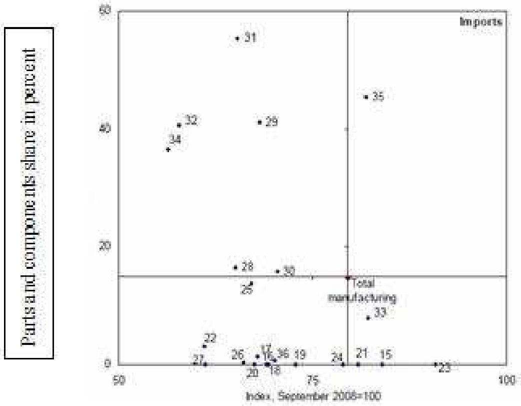


Figure 3: Index of import actual values versus share of parts and components trade in individual industries

Note : Horizontal and vertical axes passing through "Total production" refers to the shares and total production index. Industries on the left (right) shows a strong commercial decline (less powerful) than total production; the index refers to the lowest value after crisis and thus may differ inside industries. Industries above (below) indicates a higher rate (lower) of parts and components trade share in comparison to total production.

Source: COMEXT, wiiw calculations. Values in August 2009 have been neglected due to seasonal fluctuations. The index of total trade for individual industries and the entire production sector is the appropriate index of the monthly minimum post September 2008.

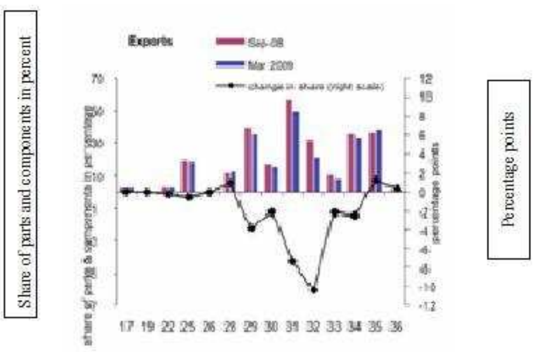
Composition effect hypothesis could serve as a plausible explanation for the sharp decline in the case of parts and components trade unless those industries with a high share of parts and components trade have registered more than a sudden proportional drop. As indicated above, Figures 3 and 4 show graphically the relationship between each share parts and components from the total EU-27 exports and imports (vertical axis) and severity of commercial decline that the respective industry has registered (horizontal axis). Industry positions along these dimensions are presented in comparison with the entire manufacturing sector (NACE 15-36). Severity of commercial decline in each industry is measured by actual commercial value index at the monthly minimum post-crisis time.

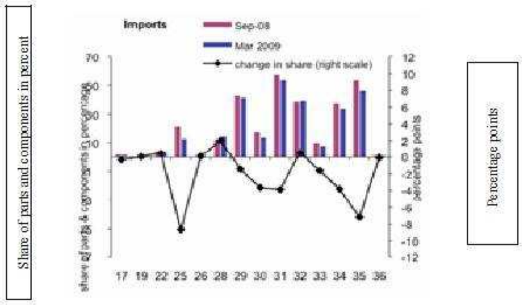
Values in September 2008 serve as base month. Therefore a lower index indicates a sharp decline of exports and real imports value. Therefore, industries that have registered a sharp decline compared to production can be found on the left in Figure 2 and 3 while industries that have experienced positive results, as the chemical industry (NACE 23) are found on the right. Index numbers on the horizontal axis are related to parts and components share from the same industry, which are presented on the vertical axis. Figures show that there is indeed a high degree of variation in growth performance of individual sectors (see dispersion along the horizontal axis).

Focusing first on industries with the most pronounced declines of actual commercial values, exports and imports of automotive industry (NACE 34) have registered the most pronounced declines representing about 45 percent of the level of September 2008.[3] In accordance with the composition effect hypothesis, the automotive industry is among the industries with the largest share of parts and components trade. Although evolutions in the automotive industry have been devastating, other industries were noted with high levels of parts and components trade. However, machinery and equipment industry (NACE 29) recorded a decline of actual commercial values clearly above the average, as was the case of imports attributed to electrical equipment industry (NACE 31) and radio and television industry (NACE 32). The same thing is still true for a number of other industries performing a small volume of parts and components trade such as publishing and printing industries (NACE 22), rubber and plastics industries (NACE 25), mineral products (NACE 26) and basic metals industry (NACE 27). In addition, transport equipment industry (NACE 35) has recorded a sub-average decline in imports.

Thus, Figures 3 and 4 indicates only a weak negative correlation between the decline of industries in exports and imports during crisis. The share of parts and components trade gives limited support to the composition effect as the main explanation for the sharp decline of parts and components trade and loss of relative importance of this category of goods in world exports and imports.

In addition, Figure 5 indicates that the crisis has also led to a decline regarding the share of parts and components in EU-27 global trade in almost all industries where vertical supply chains play a major role, as is the case of electrical equipment industry (NACE 31), mechanical equipment industry (NACE 29) and the automotive industry (NACE 34).





September 2008
March 2009
share change (right scale)

This image supports the hypothesis that some of the international supply chains have been broken. This could be the result of changes in the case of supply strategies inside multinational corporations, such as switching to domestic suppliers or internal implementation of activities that previous were made offshore. Regarding the decline of parts and components share at the industry level in the EU-27 general trade, a third factor, inventory adjustments, can explain the evolutions. While inventories may influence the commercial values evolution of intermediate goods on short term, it is unlikely that this is a major factor, because trends of just-in-time delivery (without downtime) for production reduce the impact of inventory adjustments on imports and exports evolution. In addition, semi-manufactured goods tendencies don't show the same models as parts and components; this also supports the case of potential changes in trade structure regarding parts and components trade.

2. SUMMARY AND CONCLUSIONS

Intermediate goods trade analyzes indicate their relative importance compared to other product categories and their dynamics over time. The share of intermediate goods imports in total EU-27 trade is about 55% of total trade. Intermediate goods trade is not very different from other categories of products despite its relative importance and nature.

The study shows that these shares of imported intermediate goods in total trade are rather stable for each industry, and there is a correlation between these shares at the industry level inside countries. This suggests that patterns of specialization may play an important role in explaining differences and changes over time. Analyses indicated that there is a general tendency towards increasing intermediate goods trade shares over time. Slightly higher growth of trade with intermediate goods compared to other categories of products is largely due to modification towards industries related to knowledge/science where imports of intermediate goods are more important than in other industries.

Some important changes in intermediate goods trade have emerged over the last decade regarding the

[3] As Figures 2.7 and 2.8 measure indices of total exports and imports within industries, trade declines are equal with 100 minus the respective index.

geographical structure of trade. Taking into consideration the EU-27 imports in the first place, a common trend is that EU-15 countries, advanced OECD countries as well as Asian countries have lost market shares in all product categories, while EU-12 countries and BRIC countries have gained market share. A surprising aspect is that these changes can be observed in all industrial categories. In particular, import quotas in the BRIC countries have increased relatively more in the case of high-tech industries in detriment of EU-15 and advanced OECD countries, while EU-12 have gained market shares especially in high-tech consumer goods. Changes are similar to those in other industrial categories but less pronounced. A similar pattern can be observed for EU-27 exports, with growing export shares observed for EU-12 and BRIC countries.

Analysis of commercial collapse is built on monthly trade data (CN8 at 8 digits) for EU-27 from COMEXT database, which provides the same level of details as the annual trade data described. However, we opted for a more refined classification of end use, which is more relevant for the analysis of commercial collapse. In particular, the analysis follows the approach of Gaulier et al. (2007), and separates the comprehensive category of intermediate goods of OECD classification in (i) primary goods, (ii) semi-manufactured goods and (iii) parts and components (P&C). The two groups of final goods, industrial goods and consumer goods are treated separately according to OECD. Another important difference in this classification is that groups of products for passenger cars (51 BEC category) are included in consumer goods category (rather than in comprehensive group of "unclassified" or "mixed"). This separation of intermediate goods is motivated by the fact that - although all intermediate goods enter in the production process - the reaction to the crisis was very different for the categories of intermediate goods. Location and decisions for sources of primary goods are probably different from those for parts and components, which also include a large share of trade among multinational companies. Analysis of parts and components trade, which compared to primary goods and semi-manufactured goods include a high share of technologically sophisticated goods, may be a more appropriate proxy for vertical specialization in particular industries.[4]

Overall, the analysis suggests that intermediate goods trade model and changes over time are not very different from other product categories, despite its complex role as input in the production process. As such, it seems that there is no requirement for specific or distinct policies on different product categories. These findings are suggestive for the importance of international supply with products used in production processes that have to be considered in any bilateral measures policy. Another conclusion is that industry size, which means models of specialization, outline general patterns and volumes of intermediate goods trade for individual countries. In some cases, the results indicate that this intermediate goods trade can serve as an important vehicle for trade integration in world markets and may allow countries to overcome adverse initial patterns of specialization, thus allowing dynamic changes in the structures of comparative advantage through learning effects. Countries such as China (and others) present dynamic models for high technology industries or products, not only regarding consumer goods, but also intermediate products.

Analyses indicate that most countries are both exporting and importing (which means two-way trade share is quite high) even in the industry. Smaller economies, namely the EU-12, are relatively more specialized in trade of intermediate goods compared with other economies. Again, these patterns of specialization can be found both for imports and exports.

Analyses were performed for both manufacturing and services industries. Intermediate goods are most important for high-tech industries with an import share of about 55%. Imports of intermediate goods are also important for medium-advanced technology industries, where import share is 50%, respectively 48% for medium-low technology industries and for low technology industries only 30% of goods are imported. Again, there are significant differences between countries showing higher rates for small savings. These differences seem more pronounced for high technology industries. These shares, with few exceptions, have increased over the period 1995 -2005. Regarding service industries, imports generally plays a much less important, from 16% in trade and hospitality industry and about 26% in transport services. Differences in service industries are smaller in comparison with manufacturing industries.

Analyses indicate an increase of connections between industries and countries over time. The increase of inter-industry connections means an industry that is experiencing increased demand requires more goods (inputs) from other industries to meet demand. Industrial bonds between countries mean that industry demand for goods is satisfied by suppliers from another country. Calculations of multiplier outputs (production) from input-output tables indicate that there is an increase in the output multipliers for EU-15 economies, but shows a decrease for the EU-12 economies, thus demonstrating stronger inter-industrial linkages in the first group of countries. When analyzing the internal / domestic multipliers, the first group indicates multipliers more or less constant, suggesting that higher imports of intermediate goods are trigger mechanisms for binding in terms of multiplier effects.

Finally, when analyzing the crisis impact for EU-27 trade flows, there have been offered some explanations for the trade collapse in 2008/2009 winter months. Growing role of intermediate goods trade plays a central role. The first reason is that a higher share of intermediate goods trade has increased trade income elasticity, which was confirmed here for the EU-15 trade. One of the major results of the analysis is that parts and components were also a category of goods worst affected by the crisis, registering in the height of the crisis 62% from the September 2008 volume. As a

[4] Trade statistics as used here, in fact, allow disclosure of vertical intra-industry specialization because the products are always allocated to industry that typically produce this product and not to industry where is used for production purposes.

result, the relative importance of parts and components in the EU-27 decreased, post-crisis share of parts and components in EU exports decreased by 2% and in imports by 1%. This decline seems to be rather small, but when taking in consideration the individual industries, changes become more pronounced for countries with a high share of parts and components trade, reaching 7% for the share of parts and components EU-27 exports in the electrical machinery industry. This result supports the hypothesis that some of the international supply chains created during globalization have been affected due to changes in sourcing strategies of multinational companies that have responded to a less friendly commercial environment.

Results of the parts and components trade analysis also revealed that the composition effect is not major explanation for the pronounced decrease in parts and components exports and imports of EU-27 countries. Thus, while the composition effect and possible the inventory adjustments may have contributed to the proportional decline of parts and components exports and imports, it seems to be insufficient to be responsible for the observed changes. However, severe decline of parts and components trade is one of the elements explaining why the trade decrease was even more pronounced than was suggested by the income elasticity of long-term trade. Observing recovery of trade flows, can expect a rapid expansion of the EU-27 trade if sharp decline in parts and components trade was due to inventory cycle, as empty stocks must be rebuilt. There is however the risk that disruption/disintegration of supply chains caused by the financial crisis has a negative effect on trade during recovery.

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MOTORWAYS OF THE SEA

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ABSTRACT

In its communication aim, the European Commission presents the following definition: short distance shipping means the movement of cargo and passengers by sea between ports situated in Europe geographical area or between those ports and ports situated in non-European countries located at closed seas on the border of Europe.

Keywords: *shipping, cargo.*

1. INTRODUCTION

In its communication aim, the European Commission presents the following definition: short distance shipping means the movement of cargo and passengers by sea between ports situated in Europe geographical area or between those ports and ports situated in non-European countries located at closed seas on the border of Europe.

Transport over short distances is according with EC definition, the maritime transport which doesn't involve ocean crossing.

The notion includes shipping along the coastlines between EU continental ports and its insular possessions.

This includes goods transport both within an individual Member State and between Member States.

European ports agree on the importance of transport over short distances.

For many, this is the main part of their traffic.

It is therefore not surprising that the Commission was asked this question and that on July 5, 1997 it was adopted a "Communication on short-navigation for future challenges", which analyses which is the best way to promote this mean as a viable alternative to land transport.

Short distance navigation has a number of generally recognized strong points. European Union geography is very favorable to it.

With over 67,000 km of coastline, very few industrial centers are located over 400 km from a seaport.

In addition, the EU has 25,000 km of rivers and waterways.

Infrastructure costs are relatively small and are fully borne by users, unlike the costs of rail and road infrastructure which are borne by taxpayers.

Energy consumption is insignificant, as evidenced by data from the British Transport Department, which shows that shipping consumption is of 0.12 to 0.25 mega-Joules per ton / km, compared with 0.70 to 1.20 for road transport Road and about 0.60 for rail traffic.

Short distance navigation is environmental friendly, as its CO2 emanations are less than 30 grams per ton / km, compared to 41 g for rail and 207 g for road transport.

Safety levels are high: British statistics showing that the number of deaths on a billion passenger-km is 0.5 at sea, compared to 2 by rail and 13 by road.

Short distance transport promotes economic development in the islands and peripheral regions of the European Union and is often the only mean of access available to them.

This encourages the activities in shipbuilding because approximately 50% of the ships built in Europe are manufactured for short distance navigation.

Contrary to these advantages, certain obstacles must be overcome before transport over short distances can help mitigate congestion of land routes.

The biggest of the problems identified are deficiencies in terms of port facilities.

Inadequate or outdated port facilities are largely responsible for slow shipping.

Ships are forced to spend too much time in port due to equipment badly adapted to current conditions.

Ship owners estimate that their vessels spend on average 60% of the total transport time in ports and only 40% at sea.

Similarly, highly variable port fees, many and large, suddenly increase shipping costs.

They represent up to 70-80% of the cost of transport over short distances, especially in ports where the vessels are charged for services that they do not want and they do not need.

Also, problematic are inadequate links between ports and inland centers; burdensome administrative processes; an image overtaken by senders who are often unknowingly regarding the services it can offer this mean of transport; slow ships, growing aging which increase transport duration.

The Commission main proposals for overcoming these obstacles Commission include establishing research and development activities to design modern ships and effective loading and unloading techniques and a better integration of maritime transport in the intermodal chain.

On June 1st, 1997, Information Office for short sea transportation, opened for business, is responsible to promote the multiple benefits offered by short sea shipping based on a "door to door" transport to many European destinations.

Goals of the Information Office regarding short sea shipping are:

- To provide shippers (Seafarers) information on the many and varied possibilities of short distance operations in Europe, especially on intermodal "door to door" transportation.
- To raise awareness among seafarers and shipping agents about short sea shipping .
- To analyze the problems that may affect navigation on short distances, to ensure competition on an equal footing with other modes of transport.
- To create and maintain a database regarding short sea shipping services.
- To be a source of objective information about freight and industry, commerce transport, etc..
- To act as spokesman for short sea shipping sector.

The analyses of the way short sea shipping can be put on an equal footing with other modes of transport, is focusing on three main areas of action:

- Short sea shipping quality and effectiveness improvement. Specific transportation program to be prepared for this purpose would consider finding rapid systems and techniques of water transport as well as river-sea ships, bulk carriers, automatic self-unloading and port containers.
- Infrastructure and port efficiency improvement. Ports are connecting points of maritime, road and river transport.

Proper functioning of these ports and their full integration into transport chain is the only way to fully exploit short sea shipping.

Ports are an integral part of trans-European transport plan. It is therefore useful to undertake port projects of common interest to answer a set of general principles applying to all transport modes as to various specific port conditions.

- Preparation of short sea shipping for the opening to Europe.

Implementation of EU agreements with several countries in Central and Eastern Europe will boost trade and increase the demand for freight transport.

Most of these countries are maritime countries with major ports in the Black Sea and Baltic Sea.

Trans-European motorways of the sea focuses freight flow concentration on maritime logistics routes so as to improve existing maritime links or to establish new viable maritime links, regular and frequent for transport of goods between and/or to improve access to peripheral and island regions and states.

Motorways of the sea should not exclude combined transport of people and goods, providing that goods transport to be predominant.

Trans-European motorway of the sea network consists of facilities and infrastructure that involves at least two ports in two different Member States.

Equipment and facilities include at least one Member State, items such as port facilities, electronic and logistics management systems, safety and security procedures and administrative and customs procedures as well as road and maritime direct access infrastructures, including means of ensuring navigability throughout the year, particularly by providing dredging equipment and icebreakers for admission in winter time.

Waterways or canals linking two motorways of the sea or two sections of a sea motorway and substantially contribute to shorten shipping routes, increasing efficiency and leading to reduction of the navigation time, are part of the trans-European motorway of the sea network.

Projects of common interest in the trans-European motorways of the sea network shall be proposed by at least two Member States and are oriented to actual needs. Proposed projects generally involve both the public and private sector in accordance with procedures which, before adding, as appropriate, Community financial assistance to national budget financial assistance, foresee to be organized a tender process under one of the following forms:

a) public tenders organized jointly by the concerned Member States, aimed to establish new connections;
b) if ports location is comparable, public tenders organized jointly by the Member States concerned, targeting consortia bringing together at least shipping companies and ports located in one of the maritime areas;

Projects of common interest in the trans-European motorways of the sea:

a) aims first of all equipment and infrastructures that form the motorways of the sea network;
b) may include initially financial help if, as a result of the tender shall be considered that for financial viability of the project public support is needed; financial aid is limited initially to two years and is granted only to cover capital costs justified accordingly; financial aid may not exceed the minimum deemed necessary to start the relevant connections; financial aid must not lead to distortions of competition, contrary to the common interest, in the relevant markets;
c) can also includes activities that have a wider range of benefits that are not linked to specific ports, such as the provision of facilities for icebreaking operations and dredging, as well as information systems, including traffic management systems and electronic reporting systems.

Projects of common interest in the trans-European motorways of the sea network are presented for approval to the European Commission.

Within three years from 2009, the Commission shall draw up an initial list of specific projects of common interest. Thus is reflected the concept of sea motorways.

This list is also communicated to the European Parliament. For the purposes of the above arguments the European Commission attaches great importance to Motorways of the Sea priority project.

The project is defined in the TEN-T guidelines based on the conceptual approach which sets the objectives and procedures for identifying common interest projects.

This allowed the Community to implement a co-modal transport solution designed to improve accessibility and reduce emissions from road freight transport.

There are available different Community and national instruments, including TEN-T budget, which aims mainly its internal waterways and ports infrastructure.

The complexity of procedures for obtaining financial support from public budget and lack of clarity of objectives and criteria has not allowed, so far, implementation of the concept.

For the development of Motorways of the Sea as an alternative to land transport, there are designated four corridors of major interest:

- Motorway of the Baltic Sea (linking the Baltic Sea Member States with Member States in Central and Western Europe);
- Motorway of the sea of western Europe (from Portugal and Spain to the North Sea and Irish Sea);
- Motorway of the sea of south-east Europe (connecting the Adriatic Sea to Ionian Sea and eastern Mediterranean, including Cyprus);
- Motorway of the sea of South-West Europe (western Mediterranean, connecting Spain, France, Italy, Malta, connects with South-East Maritime Highway and Black Sea).

In the context of supporting Romanian interests in the development of motorways of the sea it is necessary to emphasize the importance of new transport lines in the Black Sea.

Constanta – Poti maritime line

Constanta Poti maritime line must meet the following functions:

- Logistics component of the Black Sea Economic Cooperation Organization;
- User of available capabilities;
- Extension line of the European Agreement network on Main International Combined Transport Lines and related equipment;
- Connecting line on IVth Corridor - Black Sea;
- Completing line of the transport network of the Black Sea;
- Eurasian multimodal transport connection.

It must have the following basic characteristics:

- Reliability, seamless transport throughout the year;
- Lower costs;
- Competitive journey time.

Black Sea Economic Cooperation Organization (BSEC) was established in 1991. It consists of 11 countries: Albania, Azerbaijan, Armenia, Bulgaria, Georgia, Greece, Moldova, Romania, Russia, Turkey and Ukraine.

BSEC includes all aspects: economic, financial, information technology, manufacturing, telecommunications, energy, environment, transport, chemistry and biochemistry, metallurgy, fishing, agriculture, geology, seismology, physics, urban planning, biotechnology.

In 2007 the governments of member countries signed in Belgrade BSEC MoU on development of motorways of the sea which states that:

"The Parties shall cooperate in matters of common interest to support their position on the identification and expansion of motorways of the sea in the BSEC region.

The Parties shall cooperate in improving infrastructure and transport facilities, and maritime services in the Black Sea and Caspian Sea. "

In transports, the BSEC is taken into account especially the infrastructure and logistics required to:

- Ensure the interchange of passengers and goods;
- Creation of the Black Sea market;
- Attracting transit relationship Europe - Asia;
- Exploitation of resources in the Black Sea;
- Use the Black Sea as an alternative to land routes;
- Improve and diversify the transport offer.
- Black Sea, natural way of communication, can best meet the stated purpose, offering the possibility of establishing direct links between ports.

Such maritime links already exist between Greece, Turkey, Bulgaria, Ukraine, on the one hand and Georgia on the other hand; the only missing connection from the logistics network of the Black Sea was that between Romania and Georgia, which makes the exchange of import - export and transit between Romania and Caucasian countries to be made on alternative routes, with high costs and long journeys.

Currently, direct link Romania - Georgia is a necessary BSEC and East-West direction international transport corridor.

Transport network across the Black Sea and arround the Black Sea includes a road ring of about 4,000 km, coastal or ports of Constanta - Mangalia, Odessa - Kerch (ferryboat over Kerch - Caucasian Strait), Tuapse – Poti - Batumi service railway lines as well as shipping lines operating between ports on the Black Sea.

This network provides the development of coastal areas and links between them.

Constanta - Poti line – provides necessary connections for Dobrogea and Colhida regions development.

This line uses the existing maritime infrastructure and transport means of the two ports.

The establishment of this line reduced transport distance from land routes, as follows:

- Constanta – Poti maritime distance is of 1,074 km and the land distance via Turkey, on road is about 2,000 km;
- By rail, via Galati - Odessa - Kerch distance is of approx. 1,800 km and approx. 2,200 km via Galati - Donetsk - Rostov on Don with the Azov Sea bypassing.

Constanta - Poti line is a connecting line between the European and Asian transport networks which must be taken into account within the combined transport network expansion in the Caucasus – Asia region.

Also this line achievement will provide transport continuity on the East - West direction and the existence of a Romanian Black Sea maritime line on the East – West direction.

Constanta - Poti line is a link of the transport chain, in the variant Caspian Sea - Black Sea.

This road passes through an area considered to be among the most economically dynamic, especially in the Asian part due to immense wealth in oil, gas, coal, ores, cotton, agricultural products, timber, wood, industrial products and precious metals.

To achieve the transport chain connecting the Eurasian multimodal transport can be considered the following infrastructures:

- Poti terminal;
- Constanta terminal;
- Danube - Black Sea canal;
- Caucasus railway network;
- Railway networks in the countries of Central Asian countries and their links with railway networks of Kazakhstan, Russia, Iran and China;
- Romanian road and railway network;
- Constanta - Samsun and Constanta - Poti ferry – boat lines;
- Volga – Don canal;
- Baku - Turkmenbashi and Baku - Aktau ferry - boat lines of Caspian Sea.

Constanta – Odessa - Istanbul line

Commissioning of the regular passengers, on a relation including the ports of Constanta, Odessa and Istanbul was an event of great importance in the Romanian maritime gate history.

Voyage duration between two stationary points is about 14 hours. On board of passengers ships can be loaded cars and jeeps.

Constanta - Samsun line

Commissioning of the ferry line between Constanta and Samsun provides a faster and shorter connection by 30-50% between Romania and Iraq, Iran, Syria given to railway transport on the same route.

The situation is shown in the following table:

Romania's railway connection		Route	Duration (days)	Distance (km)
IRAN	by CIS	Romania (Socola), Moldova (Ungheni) – Ukraine – Russia -Iran (Djufala)	12	IRAN
	by Bulgaria	Romania (Giurgiu), Bulgaria (Ruse - Svilengrad), Turkey (Kapicule - Kapokoy)-Iran (Razi)	16	
	ferry vessels	Romania (Constanta), Turkey (Samsun-Kapikoy)- Iran (Razi)	8	
IRAK	by Bulgaria	Romania (Giurgiu), Bulgaria (Ruse - Svilengrad), Turkey (Kapicule - Nusaybin) - Syria (Elquamichliye - Yaroubiech) – Irak (Uglat)	15	IRAK
	ferry vessels	Romania (Constanta), Turkey (Samsun - Nusaybin), Syria (Elquamichliye - Yaroubiech), Iraq (Uglat)	8	
SYRIA	by Bulgaria	Romania (Giurgiu), Bulgaria (Ruse - Svilengrad), Turkey (Kapicule - Maydan) - Syria (Ekbez)	12	SYRIA
	ferry vessels	Romania (Constanta), Turkey (Samsun - Maydan) - Syria (Ekbez)	6	

Ferry line Constanta-Samsun serves many Central and Western European countries.

The average duration of transport to and from (2 x 390 Nm) is 4 - 5 days, 8 hours loading time and 72 trips per year.

Transport capacity for a vessel is 200,000 t/year.

From Constanta ferryboat goods can be transported in wagons, containers and trucks on the ferry lines:

Constanta Ferry -Izmir, Mersin (Turkey)

Constanta Ferry -Samsun (Turkey)

Constanta Ferry -Poti-Batumi (Georgia)

Due to relatively short distances between ports in the Black Sea basin, the appropriate crossing time is also short, no more than 1-2 days.

For optimal movement of vessels, residence time in ports is required to be as short as possible.

Therefore routes between the Black Sea ports are amed for the further development of containerized transport, Ro-Ro and ferry traffic, to ensure fast goods loading and unloading by forwarding to specialized terminals inside the ports, equipped with high efficiency operating equipment.

2. STRATEGIC GOALS AND RECOMMENDATIONS FOR THE EU MARITIME TRANSPORT POLICY UNTIL 2018

In January 2009, the Commission launched a Communication to the European Parliament, the Council, the Economic and Social Committee and the Committee of Regions.

In this communication there are Strategic objectives and recommendations for the EU maritime transport policy until 2018.

From these objectives are given below some guidance on the development of short sea shipping and maritime transport services to provide measures to ensure that ports can efficiently meet the "access gates" function. In this respect, it would be necessary to undertake new infrastructures and to improve use of existing capacities by increasing the existing capacities by increasing ports productivity. It is necessary to adapt the existing system, including hinterland connections and freight corridors, to meet expected growth.

To this end, the main priorities should be:

- Establishing a genuine "European maritime transport space without barriers" by removing all unnecessary administrative barriers, duplicated border controls, lack of harmonization of documents and all other factors that constitute barriers for potential development of short sea shipping ;
- Implementation of measures announced for a European port policy; must be followed the safety, security and sustainable development requirements, and port services should be ensured in all cases in accordance with the principles of fair competition, financial transparency, non-discrimination and cost effectiveness;
- Ensuring appropriate conditions for attracting investment flows to the port sector, giving priority to projects of modernization and expansion of port infrastructure and hinterland connections infrastructure in areas most likely to be affected by problems of traffic congestion;
- In terms of environmental assessments for port expansion should be generalized accelerated procedures that significantly reduce the overall execution time; in this respect the Commission will issue guidelines regarding permanent application of environmental legislation to port development;
- Strengthening the EU 's strategy to ensure full development of motorways of the sea projects, further facilitating the initiation of innovative integrated intermodal transport solutions, by simplifying administrative requirements and by supporting Commission proposed initiatives in respect of green transport;
- EU funding programs such as trans-European transport network projects, should contribute to these developments and focuses on modal shift factors.

A major challenge is the design of modern ships and the development of new equipment to improve safety and environmental performance. Specific initiatives of research and technological development should lead to new forms of design, advanced structures, materials, clean propulsion means and efficient solutions for energy. Also, for achieving sustainable mobility is necessary technological and logistical development and formulas identification that enhances efficiency of the entire transport chain through short distance maritime transports and inland waterways transports.

3. SHORT SEA SHIPPING

Despite its importance, short sea shipping has attracted relatively little attention of researchers in the field of transport and shipbuilding.

Increasing the number of road vehicles and a corresponding increase in traffic congestion with long-haul heavy trailers forced the European shipping industry to introduce and implement new strategies for the development of combined and intermodal transport using road, railway, inland and respectively maritime network engineering.

To get a better division and integration of the flow of goods across different transport modes and at the same time minimizing the negative social effects (pollution, energy waste, road congestion), it emphasizes the need of a structural support for vehicles less harmful to the environment, such as - inland and coastal shipping networks, especially because speed restrictions are expected in Europe for cars, trucks, trailers, larger and larger transit fees of different countries and even complete circulation interdictions on Saturday and Sunday.

Compared with other modes of transport, water transport has several advantages. Cabotage has a minimal impact on the environment and requires a relatively low level of infrastructure facilities.

It is particularly significant to create and provide modern and efficient technological means for short sea shipping.

At European level, short sea shipping in the Atlantic Arc, the Scandinavian countries, the coasts of England and France is particularly active, seeking to be more and more extended.

In order to promote short-distance transport in the Black Sea is proposed as follows:

- Creating a network of transport data over short distances in Europe;
- Creation of port "pairs" representing a traffic model in short distance transport development;
- Creating a uniform "Electronic Data Interchange" (EDI) system, including ports, operators, for quick access to information;
- Stimulate the design of vessels for short sea shipping;
- Design of new types of ships, to make sea short shipping competitive in terms of quality, frequency, safety, etc.;
- Stimulate expansion of multimodal terminals in inland waterway ports;
- Internationalization of external costs created by the different modes of transport;
- Creation of a "short sea transport promoting service" in the Black Sea.
- Stimulate the development of port infrastructure.

4. CONCLUSIONS

Black Sea cooperation programs and during development of TEN-T transport network is necessary that Romania to lead a policy of harmonization of transport infrastructure.

Thus it is necessary to harmonize maritime, river, railway, road and combined transport infrastructures.

The main purpose of this paper is to propose an idea of traffic reorientation towards water transport.

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ECONOMIC AND SOCIAL COHESION FACTOR (FCES)

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ABSTRACT

Cohesion, as defined by Article 158 of the European Communities Treaty, is necessary to promote "the general harmonious development" of the Community and requires a reduction of "disparities between development levels of different regions and lack of progress in disadvantaged regions," including rural areas.

Keywords: *economic, development, reform, territorial cohesion.*

1. ECONOMIC AND SOCIAL COHESION POLICY

Cohesion, as defined by Article 158 of the European Communities Treaty, is necessary to promote "the general harmonious development" of the Community and requires a reduction of "disparities between development levels of different regions and lack of progress in disadvantaged regions," including rural areas.

Economic and social cohesion policy of the European Union is a policy of financial solidarity, based on the redistribution of a part of the Community budget made by contribution of Member States to the poorer regions of the European Union, to promote a high level of competitiveness and employment.

Economic and social cohesion policy of the European Union requires an amount of intervention at Community level, including both the regional development policy (aimed mainly at reducing disparities, regenerating declining industrial areas) and certain aspects of social policy (e.g. combating long term unemployment and support of education and continuous training, encouraging actions to increase the adaptability and social inclusion).

Taking into consideration the new European context, marked by enlargement of the EU and global challenges, since 2007, there was a new reform of cohesion policy.

Reform seeks to implement a new framework for cohesion policy programming to simplify and decentralize the programming, implementation and decision making process. Thus:

a) It was adopted a new legal framework of the Cohesion Policy 2007 - 2013,

b) There were established new targets of intervention for the main financial tools through which the cohesion policy is achieved.

There are several factors that influence the effectiveness and impact of European cohesion policy.

An economic environment characterized by price stability and sound budget balances will benefit from lower interest rates.

In return, this stimulates investment and capital accumulation, increasing both productivity and employment of labor. It also helps to level increase and innovation diffusion and reduce cost of capital.

Efficiency and effectiveness of public administrations at national, regional and local level is another critical factor.

Finally, external factors, notably globalization, are often the main factors of structural changes at all levels and have a major impact on economic development and jobs creating.

However, as a result of a rigorous approach, cohesion policy has managed to have an impact on living standards and levels of opportunity across the EU.

2. REFORM OF COHESION POLICY – 2007-2013

European Council in spring 2005 showed that:

"It is essential to relaunch the Lisbon Strategy without delay and to refocus priorities on growth and employment. Europe must renew the basis of its competitiveness, increase its growth potential and its productivity and strengthen social cohesion, placing the main emphasis on knowledge, innovation and optimization of human capital.

To achieve these objectives, the Union must mobilize to a greater degree all appropriate national and Community resources - including cohesion policy - in the direction of the Strategy's three dimensions (economic, social and environmental) for a better approach to their synergies in the overall context of sustainable development".

Most EU efforts made to reduce disparities in the EU Cohesion Policy are achieved by cohesion policy.

This takes the form of conditional grants, conditions being attached to the transfers at objectives level and implementation system.

Following the 2006 reform of cohesion policy for 2007-2013 period, the main aim of cohesion policy remains to reduce disparities between Member States and regions by focusing resources on the less developed areas.

For the 2007-2013 period, most resources will focus on the poorest regions and countries: in 1989, 56% of available resources were allocated to regions with the lowest income, at the end of the new programming period the proportion will be of 85%.

The new Member States, representing about 21% of EU-27 will receive just a little over 52% from the total.

However, under the new agenda aimed at economic and employment growth, the policy emphasis more on improving the competitive position of regions in the world economy.

3. STRENGTHENING SOCIAL AND TERRITORIAL COHESION

Strengthening of strategic options will be considered in the social and territorial environment:

3.1. Social cohesion

Will be achieved the guarantee of a minimum general accessibility to public services (education, public health, welfare, social care, etc.) for all citizens, giving particular importance to vulnerable groups (children, elderly, persons with reduced mobility, etc.).

Will be defined the "key areas" of territory which will comprise mainly the transport nodes and areas where there is a high mobility for work reasons, leisure time or other.

Towards 2020 should be guaranteed access to public transport for all the above mentioned, reaching in 2030 to the quality conditions as defined by the European Union.

Detailed assessment of total costs (including external costs) for each type of transport and for the portion supported by the user to identify possible effects of regressive income distribution (2013).

Developing a model to correct these effects in the entire transport system (2015) to be applied starting 2020.

3.2 Territorial cohesion

Links between cities will be improved by promoting interurban public transport services and administration management.

2020 is expected to reach a coherent modal distribution in passenger transport between these cities.

Attention will be paid to links connecting the river ports and airports in order to improve integration into the transport networks.

Long distance travels will be done on alternative routes and services of comparable quality to avoid passing through the major hubs of the transport system (2020) and below.

Public transport accessibility to areas with low population density and dispersed centers will be at minimum levels, as set in agreement with the competent local authorities (2020).

Given the above information we will further try an exposure for a concept determination purpose namely "economic and social cohesion factor", indicator that can be the basis for prioritization of so-called "priority projects".

Economic and social cohesion achievement aims to increase Gross Domestic Product.

This is defined as the value of all final goods and services produced in an economy in a certain period of time.

This indicator is used to measure economic activity in a country or region.

The calculation formula is as follows:

$$GDP=C+G+I+(X-M)$$, where:

C is private consumption,
G is government spending,
I is companies investments in capital goods,
X is export,
M is import.

We define:
G_r as employment labor

$$Gr = \frac{Nsal}{Na} \cdot 100$$ where

Nsal- number of employed persons

Na - number of active persons

To achieve the EU policy to increase economic and social cohesion is desirable to achieve an increase in employment labor (Gr) as well an increase of the investment value (I).

These two indicators are those which increase the Gross Domestic Product (GDP), including the case we assume that government spending (G) or the difference between exports (X) and imports (M) are constant.

G= constant
(X-M)= constant

An investment put into operation (In) lead to the achievement of a number (n) of new created jobs.

In this case employment labor:

$$Gr = \frac{Nsal}{Na} \cdot 100$$

$$Gr = 100 \cdot \frac{Nsal + n}{Na}$$

$$G_r \cdot N_a = 100 \cdot N_{sal} + 100 \cdot n$$

$$G_r \cdot N_a - 100 \cdot N_{sal} = 100 \cdot n \cdot C_{wp}$$

$$GDP_{o-n} = C_o + C_{wp} + G + I_o + I_n + (X-M)$$

$$GDP_n = C_o + \frac{G_r \cdot N_a - 100 \cdot N_{sal}}{100 \cdot n} + G + I_o + I_n + (X-M)$$

$$GDP_n = \frac{G_r \cdot N_a - 100 \cdot N_{sal}}{100 \cdot n} + C_o + G + I_o + I_n + (X-M)$$

$$F_{ces} = \frac{G_r \cdot N_a - 100 \cdot N_{sal}}{100 \cdot n} + I_n$$

$$GDP_n = F_{ces} + C_o + G + I_o + (X-M)$$

Suppose that for 1 job matches 1 working place expenses (private consumption):

1 WP = 1 Cwp
n WP = n Cwp

In this case:

$$G_r \cdot N_a - 100 \cdot N_{sal} = 100 \cdot N_{wp}$$
$$G_r \cdot N_a - 100 \cdot N_{sal} = 100 \cdot n \cdot C_{wp}$$

In terms of achieving a new investment GDP increases

$$GDP_{o-n} = C_o + C_{wp} + G + I_o + I_n + (X - M)$$

$$GDP_n = C_o + \frac{G_r \cdot N_a - 100 \cdot N_{sal}}{100 \cdot n} + G + I_o + I_n + (X - M)$$

$$GDP_n = \frac{G_r \cdot N_a - 100 \cdot N_{sal}}{100 \cdot n} + C_o + G + I_o + I_n + (X - M)$$

N = Co + PIBo-CLM + G + Io + In + (X-M)

We define

$$F_{ces} = \frac{G_r \cdot N_a - 100 \cdot N_{sal}}{100 \cdot n} + I_n$$ - social and economic cohesion factor

$$GDP_n = F_{ces} + C_o + G + I_o + (X - M)$$

Given the above it is proposed:

- Introduction of economic and social cohesion factor notion – FCES
- Defining FCES – measurement guide mark of economic and social cohesion
- FCES value to determine prioritization of projects in EU
- Commission evaluation should include quantification of economic and social cohesion factor to determine the intake volume of financial instruments
- Economic and social cohesion factor is the most important criterion in prioritizing project implementation.

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CONSIDERATIONS ON THE DEVELOPMENT OF INTERMODAL TRANSPORT NETWORK

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ABSTRACT

Individual existence of "homo sapiens" is accompanied from "sunrise" to "sunset" in most cases, by the questions "Why?" "What is it?" "What means?" "How?" and often, "How much?".

Precisely because of this, there can be asked simple questions to which, sometimes, there are a multitude of answers and conclusions.

In the theme of these lines we are trying to identify answers to several questions.

Keywords: *transport, management, shipping, cargo, traffic*

1. DEFINITIONS

1.1 What is intermodal transport?

In the terminology of the European Economic Commission we can find the following definitions:

Intermodal transport: cargo forwarding using two or more modes of transport, but in the same loading unit or road vehicle and without the same cargo to be loaded or unloaded.

By extension, intermodality describe a transport system whereby two or more modes of transport are used by the same loading unit or the same road vehicle without being loaded or unloaded to produce a "door to door" transport chain .

The final communication of the European Commission COM (17) 243 uses the intermodality term to characterize a transport system whereby at least two different ways are used in an integrated manner to achieve a "door to door" transport chain.

The load unit term is used here as intermodal transport unit and means any container, mobile box, trailer or semi-trailer suitable for combined transport of goods.

Modern intermodal transport is characterized by intermodality.

Intermodal transport allows the achievement of an integrated transfer chain of goods between the sender and recipient, in order to meet production needs and aims the acceleration of goods distribution by reducing the capital included in goods stocks, useless transport, delays caused by additional movement of vehicles, etc.

It is an advanced transport to which all modes of transport compete to reduce the duration and costs.

It is based on container, containerized transport means, containers handling and transshipment technologies, logistics and information technology.

Integrated transport logistics connects production systems with transport systems and represents all activities aimed for the physical movement of goods between the place of origin and destination.

It involves collaboration between transport, storage, collection and distribution of goods.

Central feature of intermodality is to provide a "door to door" transport service with a single transport document. This requires a prior number of changes in organization and information control.

Electronic Data Interchange (EDI) allows the collection, processing and transmission of information regarding movement of goods, being essential for public and private transport companies and government officials to deal with a global transport system.

The economic advantages of intermodal transport are:

- Combining the advantages of various transportation means, such as elasticity in operating the vehicle for local collection and distribution of goods; high speed and high capacity transport on long-haul railways;
- Possibility of extending modern technologies of transport and mechanization of loading and unloading operations at points of high traffic concentration;
- Increasing transport safety;
- Reducing transshipment costs;
- Ensuring the integrity of goods, both quantitatively and qualitatively;
- Reducing congestion on highways, accidents and casualties resulting from road transport activity.

Transport means integration is a modern organization of transport and aims to improve traffic by participation of several means. This need arises when the link between senders and recipients can not be achieved solely by a single mode of transportation, forcing the cooperation of at least two means belonging to different modes of transport.

This traffic type generates the need of solving specific technical, organizational and economic issues, by:

a) cooperation between transport modes, based on specialization of transport vehicles and concentration of goods traffic in certain transport nodes, specially equipped to achieve fluidity of transport;
b) improvement of means of transport cooperation by expanding modern technologies of transport (pallets and containerization) and imposing some special regulations, simplified and operational, on the transport documents, relations between beneficiaries

and carriers or between transport vehicles and pricing establishing;

c) Enforcing integrated construction, handling, transport and container management methods.

Thus, multimodal transport involves two categories of containers: ISO standardized general use containers (as recommended by International Organization for Standardization) and non-standard containers used by certain transport enterprises.

International nature of multimodal transports determines the international character of the rules governing such movements: legal, commercial and financial, operational procedures regarding the technical aspects of infrastructure and transport means, etc.. These regulations are subject to international conventions and agreements, and their purpose is to promote multimodal transports.

The choice between single-mode or multimodal transport, as well as the choice of transport modes for goods flows between different localities, is based on the characteristics of the transport system: the territorial distribution of the transport network, speed, safety, cost, etc.. Companies in the entire transport system operate in a market governed by the mix of cooperation and competition.

Intermodal transport is the transport organized with multiple transport modes, in which one a carrier organizes all transport from one point of origin, through one or more interface points, to the final point:

- If the carrier that organizes the transport assumes the responsibility only for the segment carried out by him and issues an intermodal transport document, the transport is called segmented;
- If he takes responsibility for the whole transport and issues a multimodal transport document, the transport is called multimodal.

World trade requires a faster movement with lower costs and greater security of goods.

Major obstacle in achieving these goals consisted of each interface between two modes of transport, causing travel delays and increasing transport chain cost with more than the cost of a "mobile element" of the chain.

In intermodal transport, shippers entrust "door to door" transport of their goods to one "multimodal transport entrepreneur ", which is a specialist dealing with different transport modes and has an international operational network. Thus, multimodal transport is advantageous.

For example, multimodal transport of containers from Yokohama (Japan) to New York (United States) takes 14 days and segmented transport on the same takes 3 weeks.

Currently, the most used methods of combined freight and passenger transport are: road- rail, road-ship, road-air, rail-road, rail-ship, rail-air, air-road, air-rail.

1.2 What is a transport network?

A transport network can be defined as an ensemble composed by more systems of communication lines that cross with each other.

Transport network as a whole, has the following components: transport infrastructure, network traffic management and network positioning and navigation system.

Transport infrastructure includes road, rail, inland waterways networks and networks distribution nodes / points. The road network consists of motorways, expressways and national roads, existing or to be made, and bypassing the main urban centers on the routes identified on the network.

Railways network is made of high-speed rail lines and conventional rail network comprising lines for conventional rail transport, including rail segments for combined transport.

Inland waterway network comprises the Danube River, rivers on their navigable parts, navigable canals and various arms connecting them.

Inland waterways network includes inland ports fulfilling certain conditions

Network distribution nodes / points consist of ports on inland waterways, maritime ports, airports and combined transport terminals.

Inland ports on inland waterways must meet the following conditions:

- To be opened to commercial traffic;
- To be located on the inland waterway network;
- To be interconnected with other European transport routes;
- To be equipped with transshipment facilities for intermodal transport or with an annual fright traffic volume of at least 500,000 tons.

Maritime ports allow maritime transport development as well as achievement of the link between maritime transport and other modes of transport.

Maritime ports infrastructure should be achieved such that it can receive ships for cargo and persons transportation on long-distance, short or coastal shipping, including ferry transport.

Airports should allow the development of air links and air transport link with other modes of transport. They are classified depending on the volume and type of traffic that they serve and in accordance with their functions in the network.

International distribution points and national distribution points are at the core of airports network.

Regional distribution points and access points have to facilitate access to the network core and to contribute at the opening of peripheral and isolated regions.

Combined transport network consists of all transport infrastructures that enable the combined transport. This includes:

- Railways and inland waterways which are suitable for combined transport and maritime routes which, together with any initial and / or final road transport, allow long distance goods transport.
- Goods transshipment facilities between transport modes (road/rail/ship-rail/ship/road) in terminals.
- Appropriate rolling stock, with temporary character, when the characteristics of infrastructure, yet inadequate, requires.

Minimum technical characteristics for combined transport network are those defined in the European

Agreement regarding Important International Combined Transport Lines and Related Installations (AGTC).

Management and traffic information network consists of:

- Management and road traffic information network
- Management and rail traffic information network
- Management and maritime and inland waterways traffic information network
- Air Traffic Management Network

All these networks are composed of specific components for each mode of transport in part, as follows:

- Technical installations
- Management systems
- Information systems
- Communication Systems
- Hazardous situations and safety systems

Positioning and navigation network includes satellite positioning and navigation systems.

These systems provide an efficient and reliable position determination and navigation service, which can be used by all modes of transport.

1.3 What is an intermodal transport network?

In the Commission Communication to Parliament and the Council on Intermodality and Intermodal Freight Transport in the European Union states it is specified that to be able to cope with the complexity of mobility requirements in a sustainable manner it is required an overall systemic approach.

Intermodality is a quality indicator of the level of integration between different modes: more intermodality means more integration and complementary between modes which provide a more efficient transport system.

Intermodality economic bases are those that transport modes, which individually displays intrinsic operational and economic characteristics, can be integrated in a door to door transport chain in order to improve the overall efficiency of the transport system.

Integration between modes should occur in infrastructure and other hardware (e.g. loading units, vehicles, telecommunications) as well as in operations, services and regulatory conditions (Fig. 1).

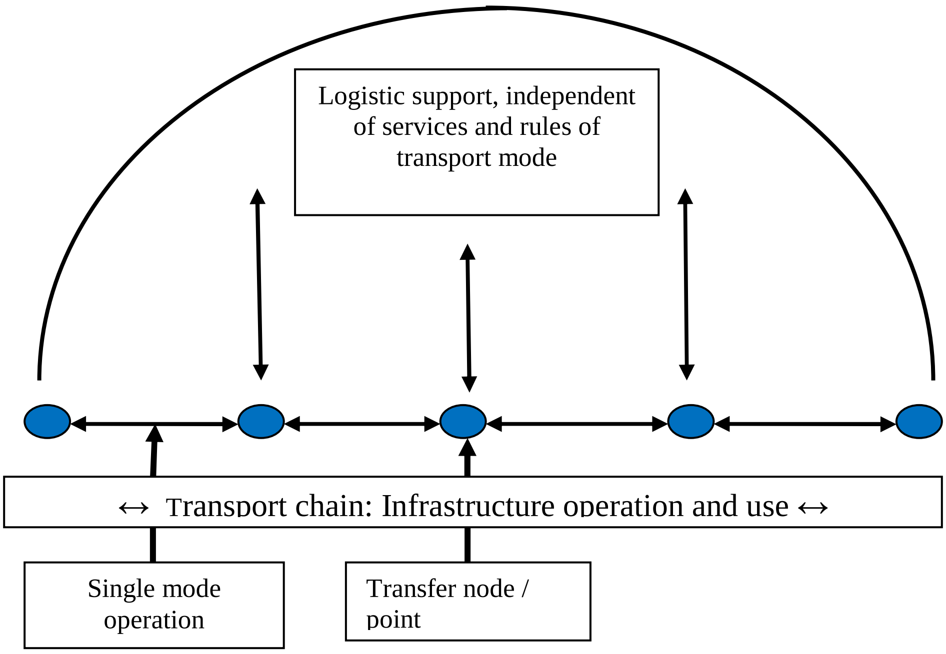

Fig.1. Intermodal transport chain

The terminology included in the European Conference of Ministers of Transport ECMT-Geneva 2001, is used as a definition for Combined transport as being the Intermodal transport, where most of the European journey is by rail, inland waterway or sea and any initial and / or final part is carried on road over a distance as short as possible.

From this definition it can be concluded that intermodal transport network is identical to the combined transport network.

Achievement of an intermodal transport network must meet the following conditions:

- The existence of an integrated infrastructure so as the intermodal infrastructure network to ensure interoperability and interconnection between modes
- Definition of intermodal connections to result in a transfer point network based on criteria that take into account the flow of present and future goods, and in perspective the supply-distribution chain requirements as well as constraints related to land use and environment.

In conclusion, intermodal transportation network includes:

- Transport infrastructure specific to each mode of transport: road, rail, water and air
- Intermodal terminals or distribution nodes / points
- Management and information systems
- Logistics infrastructure
- Node logistic
- Logistics platform.

Logistics can be defined as managing the flow and storage of raw materials, work process, finished goods and related information from point of origin to point of final consumption in accordance with customer requirements. In a broader sense it also includes the recovery and disposal of wastes.

Intermodal terminal can be defined as a central logistics hub, the point from which the vehicle itineraries or freight flows are made.

Studying of the relationship between commercial activities led to the development of a true logistics industry. This type of industry plans the optimization of the logistics network.

At European level it was proposed to realize a Distribution Council which, among other activities, to demonstrate that the efficiency of logistics will be directed toward profit.

It also intends, that for optimization of logistics network, to be used a very old commercial economic principle still applies today: "The advantage of the other."

1.4 Are this notions components of a technological system? But a technological intermodal transport system?

2. TECHNOLOGICAL SYSTEMS

This paper proposes an approach of the specialized transports defined in the combined transport as technological systems that use multimodal transport infrastructure.

The technological transport system can be defined as a set composed of several elements of process equipment and vehicles, able to perform the loading, transport and unloading of goods through certain procedures.

All this set uses specific infrastructure of each transport mode.

More conditions are imposed to a technological system of transportation, the first being to do the work for which it was designed.

The second condition requires that the system to enable adjusting of the parameters of transport activity at their optimum, technically or economically. Also technological system must be able to retrieve all requests of mechanical, thermal, chemical, etc. nature, occurring during transport.

The complex system is a sum of interconnected systems in a hierarchical structure.

Characteristic particularities of a complex system are: the presence of distinct systems, for each of them it can be determined operation purpose, the existence of internal materials, energetic and informational relations between parts of the system and external considered system connections to other systems.

Because of systems complexity there is the need of finding a rational relationship between the quality indices of the component systems such as reliability and cost.

One of the most important issues in implementing complex systems, whose solution provides a significant economic effect, is the problem of their reliability, because if lifetime increases is possible to reduce maintenance and repairs costs.

Also a considerable reduction in cost is achieved by mechanization and operations automation.

3. INTERMODAL TRANSPORT TECHNOLOGICAL SYSTEM

Previously it was defined the concept of intermodal transport.

In the paper "International Transports and shipping" - All 1995 publisher, author Constantin Alexa, it is specified that transports can be defined as a dynamic and rational system, consisting of specific technical means, equipment, communication means, etc., served by specialized personnel and intended to movement in space and time of goods and people.

The Commission Communication to the European Parliament having the theme Intermodality and intermodal freight transport in the EU, there is a systemic approach of freight transport where "the Commission recommends an intermodal transport system, which encourages cooperation and complementarity between transport modes and which promotes competition between carriers".

Given the above arguments it can be concluded that the terms used in the definition of intermodal transport and intermodal transport network are components of a technological system and by default of the technological system of intermodal transport.

4. NECESSITY OF INTERMODAL TRANSPORT NETWORK DEVELOPMENT

Globalization, the effect of policies and strategies of political and administrative reorganization, records evolutionary trends of development of various infrastructure and related services market.

In this context, the segment of transport market specific activities recorded major changes in accordance with produced mutations and developments.

Thus, over time, development and structure coordinates of the transport system were marked by the development of three major evolutionary processes, driven by technological advances, production needs and the efficiency of economic-financial and commercial performance indicators.

In the first stage, transport system had induced structural changes due to technical discoveries whose application has helped the transition from primitive forms of transport to modern document of carriage.

Another milestone in the evolution of transport activities was the need to align the requirements in the development of global production.

In this context, to meet the goal of providing raw materials and energy flows from areas with significant resources to the less potent, but with a superior level of industrialization, has become necessary to adapt vehicles according to load needs of various categories of goods, leading to so-called "specialization" of transport activity.

Thus, as the design of means used in carriage was modified and aligned with the requirements of the structure of categories of goods subject to the act of transport as well as specialized capacities.

In this respect were put into service capabilities such as those for goods in bulk or in general category, petroleum products or chemicals, minerals, food, etc..

Although these changes taken in the structure have benefited transport activities, were further highlighted a number of disadvantages arising from the increased effort required to ensure the volume of cargo for full capacity loading and efficiency improvement of travel parameters, increased costs arising of loading / unloading, creating conditions for conservation of the features of goods and provision of goods during the voyage, etc..

In this context the stages of change in the structure of transport was necessary to adopt solutions to standardize the way of packaging / transport of goods, so they do not require additional operations of sorting / loading / handling and enable involvement in activities of carriage of multiple modes.

Thus, at the carriers level, it has revealed the need to address the specific activities from new concepts, aimed to achieve the connection of services to specific business requirements of various products / retail markets at zonal / regional / continental level, mainly oriented on:

- Operational transport capacity development to cope with rising volume of flows of goods / persons in transit
- Improving performance of the transport fleet, to be able to serve long distance routes in terms of technical quality and financial efficiency;
- Specializing of vehicles and operating elements correlated with the packaging / packing of goods standardization tendency;
- Ensuring an integrated management system, which allow continuous knowledge of vehicles positioning
- Development of transport activities in line system;
- Optimization of transport activities through the application and use of new technological products of research

In accordance with the general trend of transport activities aligning, it was highlighted the need of efficient capitalization of all advantages and opportunities specific to each mode of transport (air, rail, water and road) in a consistent set - called intermodal system.

A first step in applying the concept of intermodal transport was the introduction of containerization of goods, consisting of loading goods in standardized transport units (with different sizes - 20 feet to 40 feet), allowing on the one hand, to protect the conditions of high integrity / security of products and on the other hand, easy handling (both in terms of operating time and cost, net reduced) and easy transshipment from one mean of transport to another, ensuring thus fluency in the carriage circuit.

The first containerized transports were made in 1965, in North Atlantic ocean, by the American shipping company "Sea-Land" and two years later were already adopted international standard container sizes.

Containerized transport, as sub-system of intermodal transport, provides a range of trade technical and economic advantages, as follows:

- Free movement of goods without intermediate loading operations, and thus reducing / eliminating the hazard of the physical-chemical properties alteration;
- Enhanced security of goods during the course of carriage activity;
- Increased possibility of goods fragmentation, as required, provided loading space, product features, points of destination, etc..;
- Unrestricted access to all categories of goods to containerized system;
- Increased mobility in goods transport from production sites to destination without further unloading / reloading / packaging operations etc., which leads directly to considerable reduction of carriage costs;
- Ensuring constant flow of collection and transport of goods, so that manufacturers to plan transport activities and regularity of deliveries to beneficiary;
- Easiness in choosing of transport modes engaged in containers carriage according to local / zonal / regional possibilities and distances to be covered;
- Monitoring throughout the voyage container / cargo position, with the advantage, therefore, to regulate the contract duration according with the carriage act evolution;
- Considerable reduction of bureaucratic act for traditional transportation contracts as a result of using a single document of origin / ownership of goods throughout the voyage, whatever mode of transport involved in the act of carriage on producer -beneficiary relationship.

Given the economic and financial benefits arising from the use of containerized transport system, this form of carriage has become more prominent over time in the world market of transport, getting the consistency of about 40% of goods included in trade flows, fact reflected also by the large number of regular lines providing commercial links between production / sales networks at intercontinental, regional, zonal, etc. level.

Multiple possibilities and facilities conferred by intermodal transport has led to diversification of goods carriage on a "door to door" principle, by combining different modes, depending on business needs and market requirements in an integrated transport system.

Thus, starting from transport speed increasing requirements, operating capacity development and it flexibility to access / exploit large diversified amounts / parties of freight, namely to ensure the safety and comfort in traffic, the concept of intermodal transport - have known, especially in recent years, together with globalization increasing process, more important connotations in the foundation and implementation of economic and commercial policies /strategies in all states / unions participating in the international transport act.

In this context efforts are part of the EU Member States' representatives to develop intermodal transport system by combining all the advantages / disadvantages conferred by each mode in part as follows:

a) Air
- Advantages: large area coverage, high operating speed, good level of safety and low degree of environmental pollution;
- Disadvantages: higher operating costs, limited transport capacity, heavy accessibility;

b) Rail
- Advantages: low power consumption, relatively high transport capacity, traffic safety, reduced operating costs, low pollution;
- Disadvantages: higher operating / delivery time, poor quality of transport, reduced freedom of movement, conditioned by the existence of specific infrastructure.

c) Shipping
- Advantages: involves lowest transport costs, high load capacity, high coverage, operational safety, medium pollution level;
- Disadvantages: relatively high duration for transport;

It is noted that the European representatives consider imperative to develop Maritime Highways as alternatives of land transport, for this being designated four main corridors of interest:
- Maritime Highway of the Baltic Sea (linking the Baltic Sea with Central and Western Member States
- Western Europe Maritime Highway (from Portugal and Spain to the North Sea and Irish Sea);
- South Eastern Maritime Highway (connecting the Adriatic Sea to Ionian Sea and eastern Mediterranean, including Cyprus);
- South-Western Maritime Highway (western Mediterranean, connecting Spain, France, Italy, Malta, connects with South-East Maritime Highway and Black Sea).

Moreover, to support the development of intermodal transport, the EU finances a number of research / development activities in the field, and from 2003, the European Commission proposed a Framework Directive of the European Parliament and Council on standardization and harmonization of inter-modal facilities.

The objective of this measure is to increase the efficiency of intermodal transport by standardizing sizes of containers that circulate on the continent and helping them implement effective integration of short sea shipping in intermodal transport chain.

Shipping and ports are essential for international trade. Note that 90% of the European Union's external trade and over 40% of internal trade is transported by sea. Europe's leadership in this global industry is certain, with 40% of the world fleet. Thus, approximately 3.5 billion tons of cargo per year and 350 million passengers pass through European ports.

Nearly 350,000 people work in ports and related services which together generate an added value of cca.20 billion euros.

Prospects for the two sectors are growing, with global trade and development progress in Short Sea Shipping (maritime transport on short distances) and Maritime Highways in Europe.

Shipping is a catalyst for other sectors, notably shipbuilding and marine equipment.

Auxiliary maritime services such as insurance, banking, brokerage, classification and consultancy are another area where Europe should maintain its leadership.

d) Road
- Advantages: cost effective especially on short distance, great flexibility, good delivery time, increased speed of operation;
- Disadvantages: increased levels of pollution, high energy consumption, reduced operational security (index given by the large number of accidents).

Substitution or complementarity given by the specific advantages/disadvantages to each mode of transport requires complex analysis and evaluation of transportation system chosen for concluding contracts, based on mathematical models to optimize the costs - in relation to distance, volume and category of goods transported, existing infrastructure, any tariff barriers imposed by tax legislation specific to each transit area, etc.. - so as, by combination of profitability indicators, to be used the most optimal formulas of intermodal transport.

Thus, from comparative analysis of competitive advantages specific to each mode of transport, it can be concluded on the optimization of the cost by using rail and water transport for long distances and high transport volume and road transport for short routes.

From combining these systems, were separated intermodal forms of high efficiency, being relevant in this regard inclusively specialized approaches of transportation activities by developing specific capabilities and dedicated operating terminals, such as container handling, ferry boat (allowing rail coaches boarding / landing on naval units), RO-RO and RO-LA (facilitating vehicle loading on rail platforms or specialized ships), etc..

Given the changes occurring in transport activity (which led to higher traffic volumes and service areas extension, aspects that led to the phenomenon of overcrowding), plus enhancing environmental protection requirements, intermodal transport system acquires significant connotations in socio-economic satisfaction and sustainable development requirements, representing a solution of modernizing, streamlining and alignment of the act of transportation to quality standards and safety in operation at the highest level.

In this context there is a world tendency to develop transport activities in intermodal system, concept that gives on the one hand, consistency in economic and financial plan and business efficiency, and on the other hand, generates multiple possibilities for balancing transport act on all four classic ways, by downloading tasks imposed on some segments (particularly the road, which are notoriously crowded / traffic jams recorded on urban and interurban networks) and even uniform translation to other categories of specific activities (depending on existing infrastructure, economic opportunities and, not least, maintaining social stability and environmental protection).

Following trends of geo-political and strategic reconfiguration as a result of globalization, is important to note the fierce struggle that recently has become a particular focus, registered especially in the industrialized states to take control of important segments of international freight flows on the producer-beneficiary relationship, appealing in this regard to intermodal transport, with the enhancement of the entire logistics park owned and providing a viable / effective commercial chain and with a strong continuity character.

In this respect, it is highlighted the growing interest of foreign operators for significant investments aimed to consolidation/modernization of transportation means and specialized infrastructure development (by creation of logistics centers in the national territory and of other states space) to ensure continuity of intermodal transport act and consistency in participation in commercial activities carried out worldwide.

5. CONCLUSIONS

The progress of intermodal transport, it can be revealed a global trend of application and development of this concept, which allows on the one hand, consistent economic and commercial benefits and, on the other hand, provides multiple opportunities of consolidating transport networks with a strong character of mobility, flexibility and adaptability to market needs and, last but not least, the potential to support economic expansion objectives, by elimination of trade barriers.

All the terms used in the definition of intermodal transport and intermodal transport network are components of a technological system and by default of the technological system of intermodal transport.

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TOOLS USED TO BENCHMARK THE EFFICIENCY OF CONTAINER PORTS AND TERMINALS

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ABSTRACT

Container terminal is an important element in the contemporary global economy; on the international market it is very important to know who operates efficiency. In this paper the efficiency of container port or terminal is benchmarked by Data Envelopment Analysis, which is a non–parametric linear programming method; the method identifies efficient or inefficient DMUs and diagnoses the factors that differentiate the performance of inefficient DMUs. This paper presents a model of DEA and examines some recent studies about the container port production efficiency.

Keywords: *Efficiency, Data Envelopment Analysis (DEA . Production, Container Terminal.*

1. INTRODUCTION

Data Envelopment Analysis is a methodology based on linear programming and it was developed for performance measurement; this technique measures the performance efficiency or inefficiency of organizational units which are termed Decision-Making Units (DMU). The Decision making units (DMUs) can include: bank branches, hospitals, container port, universities, schools, tax offices, manufacturing units, department of gib organizations, police stations, prisons, defence bases.

DMU converts multiple inputs into multiple outputs and their performances are to be evaluated:

$$\text{Productivity}=\frac{output}{input}$$

Data envelopment analysis uses the concept of efficiency or productivity which is the ratio of total outputs to total inputs; the score of efficiencies estimated is relative, that is relative to the best DMU (or DMUs if there is more than one best).

$$\text{Efficiency}=\frac{VirtualOutput/by.weight}{VirtualInput/by.weight}$$

The basic model is proposed by Charnes, Cooper and Rhodes in 1978 [1]; for each DMU they formed a virtual input and output [2] (by weights) and tried to determine the optimal weights. They transform a fractional program to linear program.

2. THE MATHEMATICAL FORMULATION

There are many models of DEA [3] (linear programming); one of them is:

2.1. Input Oriented model (the envelopment model):

$$\text{Min } \theta-\varepsilon\left(\sum_{i=1}^{m} s_i^- +\sum_{r=1}^{s} s_r^+\right) \qquad (1)$$

Subject to:

for CRS (Constant Return to Scale):

$$\sum_{j=1}^{n}\lambda_j \times x_{ij} + s_i^- = \theta \times x_{io}\text{ , i=1,2…m;}$$

$$\sum_{j=1}^{n}\lambda_j \times y_{rj} - s_r^+ = y_{r0}\text{ , r=1,2…s;}$$

$$\lambda_j \geq 0\text{ , j=1,2…n}$$

for VRS (Variable Return to Scale), we add:

$$\sum_{j=1}^{n}\lambda_j = 1$$

for NIRS (Non-Increasinge Return to Scale), we add:

$$\sum_{j=1}^{n}\lambda_j \leq 1$$

for NDRS (Non-Decreasing Return to Scale),we add:

$$\sum_{j=1}^{n}\lambda_j \geq 1$$

the efficient target is (optimal solution):

$$\begin{cases}\hat{x}_{io} = \theta^* x_{io} - s_i^{-*} \\ \hat{y}_{ro} = y_{ro} + s_r^{+*}\end{cases}\text{ , i=1,2…m}$$

r=1,2…s;

2.2. Output Oriented model (the envelopment model):

$$\text{Max } \phi+\varepsilon\left(\sum_{i=1}^{m} s_i^- +\sum_{r=1}^{s} s_r^+\right) \qquad (2)$$

Subject to:

$$\sum_{j=1}^{n}\lambda_j \times x_{ij} + s_i^- = x_{io}\text{ , i=1,2…m;}$$

$$\sum_{j=1}^{n}\lambda_j \times y_{rj} - s_r^+ = \phi y_{r0}\text{ , r=1,2…s;}$$

$$\lambda_j \geq 0, \text{ j=1,2…n}$$

for VRS (Variable Return to Scale), we add:

$$\sum_{j=1}^{n} \lambda_j = 1$$

for NIRS (Non-Increasinge Return to Scale), we add:

$$\sum_{j=1}^{n} \lambda_j \leq 1$$

for NDRS (Non-Decreasing Return to Scale),we add:

$$\sum_{j=1}^{n} \lambda_j \geq 1$$

the efficient target is (optimal solution)::

$$\begin{cases} \hat{x}_{io} = x_{io} - s_i^{-*} \\ \hat{y}_{ro} = \phi^* y_{ro} + s_r^{+*} \end{cases}, \text{ i=1,2…m}$$

r=1,2…s;

Where:
N is the number of DMUs,
x is input vectors(m inputs),
y is output vector(s outputs),
s_i^- , s_r^+ are slacks ,
ϕ and θ are wheights,
ε is non-Archimedean number,
λ is a measure for benchmark (efficiency score).

3. SOFTWARE PACKAGE

The Efficiency Measurement System (EMS) [4] is a useful tools which solves Data Envelopment Analysis problems. It was developed by Holger Scheel and is free for academic users; problems are optimized with BPMPD interior-point solver.

EMS computes Data Envelopment Analysis efficiency scores, accepts data in text format or MS Excel.

Other software package [5] are:

- DEAP;
- PIM-DEA;
- DEA Frontier;
- Konsi DEA Software;
- Banxia Software;
- DEA-Solver.
- Warwick DEA
- STATA
- AMPL
- Mathematica

4. INPUT(S) AND OUTPUT(S) DATA

One of the most important objective of the application using Data Envelopment Analysis is the proper choose of input and output date.

Data input used in most of the application are:

- number of berths
- total length of the berth / container berth length
- number of cranes
- number of tugs
- number of quayside gantries
- labour expenditure
- number of quay cranes
- number of transfer cranes
- number of yard gantries
- ship-shore container gantry cranes
- number of port authority employees
- number of reach stackers
- number of straddle carriers
- number of container terminal workers
- terminal area of ports
- depreciation charges
- total length of the terminal
- total quay length
- other expenditures

The output data used to benchmark container port and terminal are:

- revenue obtained from rental of port facilities
- throughput (teu)
- ship calls
- number of ships
- ship working rate
- total cargo handled (tons)
- container throughput (number of containers handled)
- ship working rate
- service level

5. SOME RECENT RESEARCH ABOUT MEASURING THE EFFIENCIES OF CONTAINER PORTS

The DMU in this studies is container port or container terminal, and the authors use Data Envelopment Analysis methodologies for comparing the efficiency of container terminals.

Figure1 Container Port

Benchmarking the operating efficiency of Asia container ports' [6] is a study published in the European Journal of Operational Research, 2010; this study employs DEA to measure scale efficiencies, technical efficiencies and determines the current returns to scale for Asian container ports, from China, Taiwan, Philippines, Malaysia Thailand, Indonesia, South Korea and Japan; The study published efficiency score of 31 Asia containers ports: only 26% of the Asian container ports are regarded as efficient and 74% of Asian container port need to reduce their inputs if they are to become efficient.

The input(s) data are: terminal area (m2), ship-shore container gantry (no), container berth (no) and terminal length (m); the output data is container throughput (teu).

Figure 2 Container Port, Terminal, Singapore

Cullinane K and Song D. [7] evaluate the efficiency of the world's 57 most important container ports and terminals using DEA; the output variable is: throughput(teu) and the input are: quay length(m), terminal area(ha), quayside gantries(no.), yard gantries(no.) and straddle carriers(no.).

The efficient terminals are: Hong Kong (Terminal 3), Los Angeles, Long Beach, Antwerp(Noordzee), Port Klang (Klang Container), Gioia Tauro Keelung and Colombo.

Figure 3 Container Port, Durban

International Journal of Operations & Production Management [8] published a study which compared efficiency scores of two large container operators, APMT (39 terminals) and European terminals of PSA (seven terminals); the research included only terminals with an annual throughput of at least 500.000 TEU.

The most efficient terminals are: Qingdao PRC-APMT, Raysut/Salalah Oman-APMT, Singapore-PSA-Brani, Houston USA-G-APMT and Kaohsiung Taiwan-APMT-Terminal 5.

European Journal of Scientific Research published in 2008 [9] a study about efficiency of 22 seaports in the Middle Eastern and East African region; the inputs data are: berth length(m), storage area (m2), handling equipment and the output is measured by: ship calls and throughput (movement of general cargo dry and liquids and containers).

This study uses Window Analysis and calculates the average efficiency of CCR and BCC models of DEA. The date were obtained from annual statistics reports.

The results show that performance seaports are: Khor Fakkan Sharjah, Dubai Emirates, Kuwait, Mukalla Yemen, Bander Abbas Iran and Djibouti.

Figure 4 Yantian, container port

In International Journal of Logistics: Research and Applications [10], Cullinane K. analyses 69 Europe's container terminal; with annual throughput over 10000 TEUs. The input data are: terminal length(m), terminal area(ha) and equipment(number); the output data is container throughput(teu).

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REALITIES AND PERSPECTIVES IN THE DEVELOPMENT OF TRANSPORT ACTIVITIES

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ABSTRACT

Transport is not only the link between economic branches and the movement of trade in goods between the different States of the world, but also an important factor in the GDP and population. Thus, without a system organized at the global level can achieve international economic exchanges and may not be integrated in all areas of the world circuit and geographical regions of the world and cannot take advantage of globalization.

Keywords*: transport system; globalization; competitivity; port management, port reform.*

1. NTRODUCTION

In the context of globalization of markets, transport activities constitutes a decisive factor in maintaining and increasing the competitiveness of European competitiveness depends not only on the technical quality or productivity, but also the quality of transport in all modes of transport. Achievement of European standards in this area of work involves extensive paperwork on rearranging the components of the transmission system in a logical, bringing transport infrastructure to a level performance, environmental protection, safety of goods and passengers, stimulate private initiative, the restructuring of transport capacities and cultural remodeling of organisations active in this area. Moreover the success in the real economy, the company’s performance and competitiveness depend on a great extent on the quality of management. The dynamic economic environment and qualitative changes that are involved by the conduct of economic activity create a proper foundation for the marketing employment and extend the scale of application of its methods and techniques. Thus in the current economic context it is necessary to design a sustainable port management program, whose components are focused on operating items, maintenance or development of port activities in the view of achieving the efficiency parameters.

2. PORT MANAGEMENT IMPORTANCE IN TRANSPORT ACTIVITIES DEVELOPMENT

Setting up an effective organization is the essential factor deriving from its managerial capacity in the competitive economy we strive after. This capacity is not only a fundamental attribute but the conditioning parameter and guarantor of organizations sustainability and longevity in an effervescent environment that is continuously changing of the competitive economy. Like all economic entities in the port sector as well, management is looking for through various objectives, enabling the port management to accomplish the intended goals, to adopt measures and courses of actions and development which comply with the environment in which they evolve.

The constant need for change that the developing countries have been facing is the result of a combination between their domestic situation, unsatisfactory both economically and socially and the continuously changing of the external environment. We mention that without being properly prepared, the developing countries have been subject to the same forces generated by globalization and increasing economic competition with developed countries.

This exposure occurred while opening their domestic markets, which allowed benefits generated by the recent international trade opportunities (question benefits induced by internal market opening and liberalization of foreign trade). Besides the direct benefits resulting from a shift towards an exports-based strategy, the trade liberalization and opening domestic markets has allowed developing countries to acquire the necessary technology, know-how and foreign experience, which together with the increase levels regarding the use of electronic data interchange (EDI - Electronic Data Interchange) will stimulate the economic development process.

In this regard, an export-based strategy requires adjusting the economic, commercial and most often social characteristics of a country in order to accomplish a business approach from an ethical perspective and of current practices in the international competition game.

Taking into account the rapidly changing environment of technological innovation and of the increasingly sophisticated demand, the economic transition to market-oriented practices is neither easy nor smooth. Moreover, the required time for a gradual assimilation of transition and evolution to economic and social conscience is lacking. On the other hand, it should not be neglected the possible pressure which is not uncommon however, from various interested groups, often even justifiable, which is designed to protect the environment, ethics, traditions, culture and the religious values.

At the same time, the high levels of port development and transport have been frequently argued to slow the developing country exports, which already lack diversification and are dependent on commodity prices on international markets.

For these reasons, these countries have resisted the principle of "comparative advantage" as a cause of worsening the international trade and of generating discrepancies on the balance of payments, that have a negative influence on the other hand on the economic increase opportunities through diversification.

Another important aspect of the port industry and international cooperation is of multimodal transport systems, made the most of the transshipment hub at the junction of corridors. For this reason, are very important model for cooperation and integration of systems, which are compiled based on development decisions, and operating cash flows. Currently, there are a number of factors consisting of complex development of integrated multimodal transport, logistics and EDI networks, which have a major impact on the optimal conditions for carrying out port, so independent trade houses and multimodal transport, simply by accessing The program can scan markets for products and services, can select routes, methods of transport and transport in such an integrated approach that ensures quality, speed and safety while optimizing transport and generalized costs and cost balancing time.

In this particular environment, governments have been increasingly aware of the impact of the unsatisfactory and at the same time expensive port service offer may have on the development of international trade and national economy.

Moreover, unsatisfactory quality port services not only "redirect" the profits away from local producers but remove that country out of international trade market.

In this regard, goods containerization has revolutionized the international transport and also the port industry. This technical solution has had a significant impact on vessels architecture and size, on their design, development, port operation, on the transport requirements and currently on the perceptions related to the development of integrated transport chain. This transport system has several significant advantages over the traditional way based on physical labor. In addition to major progress in terms of safety operation, loss-reducing, litigation, the main quality of the integrated system is the reduction of the physical work, which is expensive and the considerable reduction of the time spent on operating a vessel.

Due to heavy, expensive and inefficient operating procedures encountered before vessels containerization, the general cargo ships were famous for the long periods of time spent in ports, waiting, loading or unloading. For this reason, in many cases the shippers had tried to avoid ports and had chosen other types of transport (rail or road).

Moreover, delivery speed increase has imposed due to goods diversification, qualities that have determined the reduction of transit times to increase the shippers' circulation of goods and to diminish the inventories costs. However to the previously mentioned aspects there should be added the use of advanced principles of logistics and accuracy increasing that have contributed together with punctuality and safety liner that made possible the adaptation of the producing industries to "just-in-time" and "make-to-order" flexible concepts. Among other benefits, these manufacturing technologies have provided the opportunity to integrate into the development strategies, the uncertainties related to seasonal or other cycles of business and trade.

Unit problem must be addressed organizational restructuring and management in shipping and maritime, focusing primarily on areas such as development of models for unconventional indicators (which take into account the characteristics of transport logistics in general) and indicators measuring river and maritime transport competitiveness indicators implemented in the organization of transport scenarios to highlight the impact on the environment, energy and other resources. Scenarios and management procedures based on business models and organization and is based on the fact that the market requires integrated transport systems, aimed at aligning the activities undertaken by different actors in the transport market and organizations. Also developing new concepts of innovative logistics must have these initiatives focusing on new services (for small and medium-range), based on the requirements of shippers and logistics service providers (services at the right time, promptly to request). In conclusion, we can say that developing countries are aware of the importance of effective national port, seen as catalysts for international trade and essential elements in their economic development.

Transport has been considered as the subsystem of a technologic system that incorporates both production and transport itself thus leading to several important consequences, which may be identified in the steps of a modern port developing.

Theoretically speaking, the port is an integral part of several transport systems. Thus a port is the geographic location where several production chains are converging. A "section" through these chains shows that these production chains are converging in various stages of completion-perception, allowing the port to play a major role in the integrated logistics chains.

Basically a lot of activities take place in the port terminal, like storage, transport and transshipment activities (trans-shipment).

The conclusion that emerges is that although the transport system is mainly the same, there are the same traditional stages in which a product goes on its evolution path from origin to final consumer, the technological development leading to interrelated changes on these stages, changes that generate the need to adapt to various "actors" which can be encountered on the value chain.

Transport industry has undergone significant changes over the last three decades. This aspect has had a continuous and fundamental impact on the port operations and management.

The general management principles can be also applied to ports, port management being actually a service system management.

In this context, the port and port management objectives should be designed to meet the commercial and marketing department requirements, considered as important procedures to follow by the port in order to accomplish its goals.

The practice in this particular area indicates that port management objectives should be specific, quantitative and focused on the port services production by port authorities and operators and to be defined so as to facilitate the application of certain necessary actions in order to achieve these objectives that would allow the outcome control and evaluation.

Like any other economic entity, the objectives can be grouped into general objectives and secondary objectives in the port field as well.

General objectives apply to port community and frequently to port authority. The role played by the port in developing national economy and region should be taken into account in their definition.

From the macro perspective, port defines its objectives by facing the limitations imposed by the political power. It can control the practice of price or port services quality and on the other hand, can take advantage of the assistance from public power, by funding its infrastructure or benefiting of favorable tax provisions.

On the microeconomic level, the port is able to set up freely its management objectives, thus port representatives will establish port exploitation and development objectives, based on the port interests that should meet the social requirements as an economic and commercial enterprise.

Regarding the **secondary objectives**, they must be accurate, applicable to all port operators, port operators and services. Those objectives would be better defined and their development to follow a series of requirements, such as:

- must be applied at all levels and for each management unit in hand;
- must be independent;
- their number is limited;
- each unit of organization (the port authority, operator) must have their own objectives and their number should be even lower as it descends the steps of command;
- main objective should be coordinated with the work "key" port company.

By every objective, management seeks to enable the port management that will manage forms closest to achieving the aims of his.

Meanwhile, port management has many tools that port managers to operate and manage the organization. The main instruments are the administrative, economic, financial, commercial, technical, operational and human resource development.

Administrative instruments specific to ports are company structure and regulations are necessary. Regulations, intended to inform customers and port users on the measures taken to ensure proper functioning of the organization; in principle, a good regulatory framework are the basis necessary for the proper functioning of the port, and the existence of legal services to port several experienced avoids conflicts, incidents, and avoid costs incurred by them. Laws and regulations should be as small numbers refer to the key issues.

Economic instruments: the main tools of economic management port are:

- Pricing port - is another major economic tool for both the port authority and operator.
- Port Planning - is aimed at preparing an economic tool for the future port. Port development planning must be done systematically according to most parameters of the port system development. A major holds strategic planning, which aims to minimize the costs of developing the port, it shall adopt, by rule, under conditions of uncertainty of achieving its goals.
- The system for collecting and transmitting data and port statistics - data, information necessary for this system may be provided by the specialized press, the general studies conducted outside the port community, financial and statistical documents issued or made by nationally competitive services port.
- Scoreboard - is an economic instrument, which provides a periodic collection of all the economic parameters that determine the development activities of the port. This allows monitoring of port activity and is an important tool for economic decision.

Financial instruments - the main financial instruments are:

- general accounts - is a way for port managers to manage monetary and financial flows.
- analytical accounts or cost - allowing the progress of expenditure and revenue income and expenditure on facilities, and serve as a basic financial education, economic, tariff and provides tools for logical decisions.

Commercial instruments - trade is the main tool to collect and analyze business information, followed by research and development structures to promote the port to the port community. Basically, the port of commercial activity is limited to market research, its evolution, the level of demand and competition. Depending on their results, "convince" the need to release the port company funds to purchase necessary equipment or infrastructure improvements, will establish regulations for the operation of port facilities to enable their use in optimal conditions and will oversee the quality of services all links in the chain of transmission to function normally under a strong competitive environment.

Technical and operational instruments - because the current period, characterized by profound structural changes and business practices and international freight, each port must be adapted to technological changes that are intrinsic to modern technologies. After knowledge of technological change in port, and traffic forecasting results, the next step is to examine how the port will be used respectively to define the operational or operational systems of the port. Operational systems play a role in choosing equipment in development plans or development of infrastructure, and human resources development plan. Moreover, maintenance of equipment has become one of the major internal functions, authorities and port operators, a key factor in the functioning of operational and cost reduction.

Human resource development - most important tool available to port managers is the port staff, which is the hardest instrument to master and used as the port area outside their particular people management, difficulties arise and tradition, historical conditions, which can sometimes be incompatible with the principles of modern management. Personnel qualifications required are more complex (education, skills, mobility) for staff to be able to assume the responsibilities necessary. Staff quality assessment refers to the degree of achievement of objectives that have been fixed, innovation capacity, behavior with colleagues, customers and to the organization.

3. THE COMPETITIVENESS OF THE PORT

The evolution of the transition process brings about significant changes in the structure of the economy-generating mechanisms, and in their turn, they lead to reorganizing the strategy of the economic agents. Within the present economic context, it is imperative that the economic agents pass from survival strategies to action in order to create and maintain the competitive advantage.

Today's business world is at an unprecedented competitive level. But, in the harsh, hostile environment in which entrepreneurs act, it is absolutely necessary to evince the nodal points on market economy, which necessarily requires a coherent managerial vision from a macroeconomic point of view, able to potentiate the action of economic agents with the power necessary to acknowledge and predict the changes in the business world.

Competition is a natural, objective phenomenon, always present in the environment; it does not characterize only economic life, but it is also manifest in the sphere including the economic phenomenon: the social sphere.

In other words, competition has an all-encompassing scope, which means that there is no area or aspect in the life of economic agents or means to which they might resort in their approach that can be situated outside competition.

Competition is the essential, determining factor in the success or failure of companies. It determines the opportunity of the activities of a company which may contribute to its performance, such as innovations, a unitary culture or proper implementation.

On the other hand, competition constitutes the framework of competitivity validation. The fundamental requirement ensuring economic effectiveness, competitivity is based on information that it transforms into strategic instruments.

There are a series of principles of competition that generate, within the present economic context, competitivity such as:

- The need for rules – in the sense that restrictions should be manifested in a transparent, regulated form, by norms and rules, and not anarchic and spontaneous;
- The need of freedom within the framework – anything that is not forbidden by law, is allowed;
- The need for dynamism within the framework of freedom – anything allowed as far as competition is concerned should be analyzed in theory, tested in experimental simulation and eventually in the practice of competition;
- The need to dynamically and timely adapt rules – no rule should outlive its timeliness period;
- The need for moral rules – anything not forbidden by law and moral is allowed.

The setup of these general "rules" and clarifications of the approach of the defining processes of real competition are generated by the complexity of real economy, the dynamism of the market structure, and the confusions that may appear in treating the economic legitimacy of the behaviour of economic agents.

Competitivity resources are to be found within the company that is granted the primary role of their activation in the unstable outer environment, specific to the transition period. Mastering the competitivity stake is an extremely complex process, consisting of establishing the key factors of competitivity and examining the way in which companies, on the basis of the strategies they set and apply, "endow" themselves with these factors, organizing and coordinating them, thus developing the competitional abilities with a view to improving economic performance.

The term competitivity related to a company suggests efficiency, quality, better products/services and optimal costs, high productivity, safety, adaptability, modern management, or in other words, success.

The need for continuous reporting on environmental conditions and requirements of specific reference in operating his management company, put in a new perspective, focused on a strategic thinking on targeted actions directed against competitors, in order to maintain a competitive advantage, in order to consolidate the success in business. This vision has triggered a strong tendency for restructuring scheme monolithic operating company, which is based on a rule set for functional strategies, functional activities (marketing research-development, production, sales, finance, personnel, etc.) or on product lines, geographic areas, types of reviews, etc. and which relate to the short time horizons and long-term actions.

Harbour industry, like any industry, has its own rules of competition and hierarchy of the factors contributing more or less to the competitive position or advantage.

The study and analysis of the competitive company evince common characteristics, but they found their success in business on certain competences. The performance criteria ensuring a high degree of competitivity at a microeconomic level include labour productivity, labour cost, product/ service quality, the degree of meeting the customers requirements, etc.

Harbours are directly or indirectly "caught" in a competitive market. In this sense, there are many factors that influence competitivity; a harbour may modify its competitive position as compared to other harbours, and to a certain harbour user, by improving one or more factors. In this context, harbours aiming at being competitive for a certain merchandise or category of goods, should know exactly which factors have to be improved and extended as well as the intended results.

Harbour specialization bears upon the manner of approaching competitivity. Thus, an important aspect for harbours is constituted by the minimization of distribution costs, according to which harbours should devise an active policy in order to improve competitivity.

Taking into account their competitive nature, when analyzing competitivity or marketing strategies for a certain route or sailing line, harbours should make a series of calculations which they model with the necessary adjustments, according to their own criteria. On the other hand, all the factors that affect harbour competitivity are to a certain extent dependent on one of the three basic elements: cost, time and risk.

On the other hand, the necessity of developing long-term strategies are essential to providing quality services. In principle, there are no methods or recipes for change quickly and radically the attitudes, habits and knowledge of the people. Only ports that insists for the provision of quality services, raising the quality of port operations and even manage to meet the requirements and exceed the expectations of customers.

Also, transport safety, their elasticity are important aspects which refer to assess the level of quality of transport services. In this context, it aims to establish an optimum level of port, designed, that users of ports to be fully satisfied customers, especially in terms of time and effort where the investment is minimised dosed.

In addressing the strategic port optimum as element in ensuring the competitiveness of the port requires a rigorous analysis on large expenses involved in all the work on the port and harbour facilities performing, but more expensive.

Another factor of competitiveness is the generator of employment danas, expressing how to use the operating capacity of the operating front, question how to use the full potential of port. The element that makes, however, the efficiency of operating capacity is volume of traffic being carried out through the port. It is also a result of your marketing activity, carried out by the operator for attracting traffic into a structure diverse. Determination of the optimum port is a key component of major importance for everyone involved in the activities of the port, starting with shippers, shipowners and ending with the performance of the port.

The viability of a port is determined by the operating profit, as well as operating subsidies, reduced or even non-existent.

The managerial approach of harbour activity has evinced that harbours may be considered and analyzed as complex agents, providers of specific services, which determine their role and place within the system of business organization.

Among the most important factors of harbour competitivity, one may mention:

- Geographic localization – represents an intrinsic harbour condition, i.e. the harbour has a certain advantage, when it is strategically placed;
- The link with inland transportation – considered a natural factor of the harbour, taking into account that the harbour is more and more involved in achieving projects of access on railroads and roads towards harbours;
- Harbour services – regarding the aspect of availability and effectiveness;
- The price of harbour services – as a factor, even if it is not comparatively important in hierarchising customer' preferences, it allows the comparative analysis of harbours.

At the same time, in order to obtain the competitive edge, a harbour should manly focus on all the elements that contribute to the implementation of the price policy and the differentiation of he services provided. In keeping with that, specific strategies are drawn up, divided into objectives with quantitative targets, such as:

1. improving operational effectiveness – increasing the handling effectiveness, reducing the total operating time, reducing operational costs, inflicting fines or bonuses related to merchandise storage;
2. investments in granting facilities and equipment – high-productivity reducing total costs and transport and operation time;
3. market-oriented price policies – strategies based on tariffs under the circumstances of market-orientation improve the competitive edge by cutting tariffs to their user value;
4. promoting various harbour services – marketing activities are of strategic importance in order to popularize among potential customers the competitional advantages of the harbour, especially in the situations in which a harbour attempts to set out, by providing specialized services and in a large range of logistic services.

In principle, the structure of tariffs and their level partly reflects legal regulations, and partly the limitations and objectives identified by harbour management through the perspective of the competitive environment.

Pricing is one of the major elements of the implementation of the strategic plan for the development of a port. Mainly the port services are charged to generate a profit, that is to cover the costs involved in the conduct of all activities. For there to be a certain margin of profit, revenue generated must allow for the modernisation and extension of the equipment and, indirectly, by the action of the port administration facilities.

Port pricing is a tool with economic importance both for the port authority and operators. Prices in ports are market prices, taking into consideration when assessing their competition and their own payment possibilities. Whereas there is no direct competition between ports, each has its own tax system port must compensate for costs and to ensure getting a reasonable return on investment. At the same time, to obtain competitive advantage, the port put emphasis on all the elements that contributes to the realization price and differentiation of services offered.

4. CONCLUSIONS

Essential changes that have occurred within the transport industry over time, and have had continuous and fundamental impact in terms of port activities and port management.

General principles apply and port management, port management is, in fact, a system management services.

In this context, the objectives of port and harbor management must be geared to meet the commercial and marketing department, considered major pathways followed by the port facilities to achieve.

We can say that developing countries are aware of the importance of effective national port, seen as catalysts for international trade and essential elements in their economic development.

In conclusion, the entire port system should focus on overall management of the available resources and at the same time should develop the capacity to tackle service related issues, costs and markets in a much more critical manner than ever. Moreover it is important to adopt concise policies and strategies that can be applied on a long term and which should lead Romanian shipping industry on an upward trend.

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DIMENSIONS IN THE DEVELOPMENT OF SHIPPING ACTIVITIES

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ABSTRACT

Achievement of European standards in the maritime navigation involves extensive paperwork on rearranging the system components in a logical, bringing transport infrastructure to a level performance, environmental protection, the safety of passengers, stimulate private initiative, the restructuring of transport capacities and remodeling cultural organizations operating in this area.

Keywords: port *management; port marketing; maritime transport; development.*

1. INTRODUCTION

The European Ports, maritime or inland facing complex problems: an application of transport permanent fluctuation; significant technological transformations (container transport, telecommunications, computerization); constraints on the environment, including inter modal transport management to promote the role of ports; the need for a dialogue between all participants in the activities of the port, and compliance with Community rules on competition and transparency. In addition, the integration of European transport is a problem of integration of dynamic systems, based on the adaptation of national systems, on the harmonization of European infrastructure networks, on the harmonization of existing standards and norms. At the same time, what strategies should be adopted involves avoidance of risk as less transport systems evolved to orbit around the developed world, offering solutions to the problems of authority and power logistics integrated system.

2. THE NECESSITY OF A SUSTAINABLE PORT MANAGEMENT IMPLEMENTATION

In a competitive economy, the essential factor for creating an organization effective managerial ability derives from it. This ability is not only a fundamental attribute, but also the conditionant parameter and guarantor of viability and environmental organizations longevity seething, permanent evolutionary economic competition. Like all economic entities, and in port area the objectives, management seeks to enable the management port management forms of achieving its goals, the adoption of measures and strands and development, in accordance with the environment evolves.

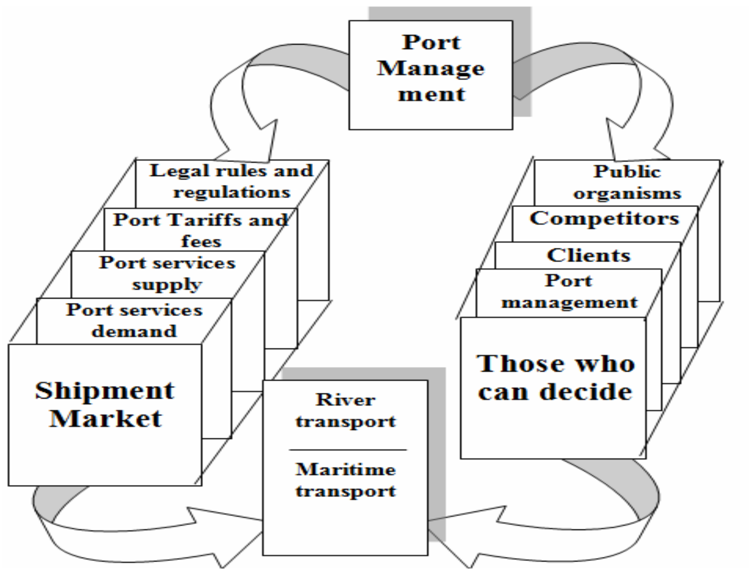

Fig. 1. Port management place and role in the economy dynamics

In an attempt to emphasize the importance of achieving sustainable management throughout the port industry we have developed a descriptive model, a model that shows the place and role of port management in a highly complex and dynamic environment in which both transport river and sea transport have a major contribution to the environment, geographic, economic, social, technological, political, legal, information configuration as well as to its dynamics, and the role of the port is seen from all these perspectives, even if his action is predominantly economic.

Such, the port system is involved in a network of relationships with all active entities in nature and society, relationships that are carried by the movement of goods, services, information, money, rights and obligations, by people's behavior, attitude and activity that are involved in each of these activities. Also, in view of the harbor, the owners have full decisional competence, setting strategy and concrete objectives to be achieved, and for the owners, the port is a means of recovery of capital. From the viewpoint of customers, the role assigned to the port is mediated by the services they offer, and for the port, all actions converge towards the identification of clients, designing the tender in accordance with the characteristics of demand, attracting customers and developing markets. From the perspective of employees, the port, the trader is offering a job, with loads of work attractive or not, subject to certain conditions of employment, with specific responsibilities and rewards. From the port, it is proposed to ensure conditions for the exploitation of the resource. Like any company, attempt to make the port as well as all the services provided by public institutions, the legal framework created to "take advantage" of the support of the state in international relations.

Moreover the success in the real economy, the company's performance and competitiveness depend on a great extent on the quality of management. The dynamic economic environment and qualitative changes that are involved by the conduct of economic activity create a proper foundation for the marketing employment and extend the scale of application of its methods and techniques. Thus in the current economic context it is necessary to design a sustainable port management program, whose components are focused on operating items, maintenance or development of port activities in the view of achieving the efficiency parameters. The **basic components** of such a program can be structured as follows:

- **Financial resources management –** despite decentralization and the high degree of financial autonomy, port sector funding witnesses in the EU Member States different levels of financial autonomy and granted public funding, but also the lack of transparency in the pricing of port services. In this regard, there should be established instruments related to income yield and means of development of these budgets as well as financial instruments between the government and port authorities. Also in this direction is necessary to establish fair and transparent conditions for investors, port operators and users, aimed, in particular the role of port authorities, public financing, leasing ports, water services, technical services, goods handling, port charges and competition with other countries.

- **Land Management –** many ports face hindrances due to capacity connections or organization. Thus, ports expansion and constant changes of naval and maritime traffic have not kept up with the requirements of port facilities (a shortage manifested in port installation, difficulties in achieving terminals modernization, improper location of facilities). Therefore the insurance of proper conditions regarding the access to port land and services is crucial in managing integrated port system. It must also review and improve regulations on land use, upgrading information systems and creating databases on ports, waterways and preliminary data traffic, new security and telecommunications systems, automated acquisition of new port equipment, but European surveillance systems interoperability, an important role in simplifying transport and encourage market development and maritime shipping in the internal market.

- **Infrastructure –** requires standards, processes, equipment for the proper performance of all port activity, using various legal and institutional systems as tools for management regarding infrastructure. Another important aspect that should be taken into consideration is the port terminal concession on certain periods of time (the example of many EU member states) since it offers many advantages, the most important being the following: more rapid handling of goods, reducing the vessels turn times and of the waiting time for goods, reducing operating costs, more transparent purchasing procedures, lower charges for handling of goods but also investments increase with a positive economic impact.

- **Environment Management –** environmental laws ensure sustainable port operation. In this respect progress has been recorded in environmental management, while the constraints in terms of environmental protection applied in the port sector projects have led to the emergence of some complex procedures. In addition, costs of compliance with environmental standards are primarily the level of their performance and port dimensions. In this respect, many EU member states have raised uncertainty of environmental legislation and its implementation in different national laws, proposing the development of guidelines for their interpretation to allow for better environmental management. Important is the creation of adequate waste treatment facilities, proper management of water bodies and sediments, and climate change and air pollution. Increasing standards of environmental management in ports and achieving a balance between environmental protection and growth process involving the use of economic resources following: legal and institutional framework as a means of regulating the implementation of management strategies, prices and taxes as a means to control the allocation resources and services, and coordination of environmental issues and strategies to improve the activities related to waste management, pollution abatement, water quality improvement.

In the port industry is important to the existence of a package of measures regarding the establishment of clear rules and an open and transparent procedure for access to port services, designed to open up port services in the face of competition, thus to check the authenticity of the fundamental freedoms guaranteed by the EC Treaty and to impose competition rules in the various ports and between ports; These measures should generate growth and efficiency of ports. In addition, these measures should make transparent the financial relations between ports and port systems and providers of port services, of the one part, and State authorities, on the other hand.

- **Human resource management and other social aspects** – professional training is significantly important for a secure and efficient operation of ports. However currently there are no specific community rules on the professional training of port workers. In this regard, one regulatory option might be considered. But there are general EU rules on health and safety of workers and compliance with those standards is extremely important and should be carefully monitored. It is also necessary to provide more flexible employment and social dialogue can and not least to improve the public image of ports.

At the same time, the process of opening the markets in transport imply fair conditions of competition both at the individual level, for each mode of transport in hand, and between them. For this reason, the approximation of laws, regulations and administrative provisions, including the technical framework conditions, social and fiscal, has acquired over time increasing importance.

Successful completion of the internal European market, the elimination of internal borders, lowering the price for transport as a result of the opening and liberalization of transport markets, and changes in production systems and storage methods have led to a steady growth in transport volume. Although highly effective and dynamic in economic terms, the transport sector faces further social and ecological costs of increasingly large. As a result, the model "sustainable mobility" has gained increasing significance. This model lies in the zone of confrontation of the two categories of objectives with different character. On the one hand, it aims at ensuring an effective mobility and advantageous in terms of costs, for people and goods, as the central element of a competitive internal market and the EU which are the basis for free movement of people. On the other hand, it outlines the need to control the growing traffic and to minimize the associated costs are generated in the form of accidents, respiratory disorders, noise, harmful effects on the environment or traffic jams.

The application of this model incorporates an integrated approach to optimizing the efficiency of the transmission system, organization and transport safety and reducing energy consumption and environmental impact. The fundamental elements are defined, inter-alia, strengthening the competitive capacity of ecological transport procedures, establishment of integrated transport networks which use two or more modes of transport (inter modal and combined transport) and the establishment of fair conditions of competition between modes of transport, through the imposition of costs generated by them.

The role of the special management in current economic circumstances is dictated by the need to create a general capacity for innovation, flexibility and even if the environment is unsafe, management must be as stable, ensuring the success of limited opportunities in most situations. Assessing the need for the existence of an operational management, and outlines some issues related to the transition requirements management and change management concepts and practice macroeconomic level. These two components, intersect each other.

Many businesses and activities come not from lack of energy or personal ambition, but owing to a lack of realism and defining objectives, ignoring the fact that business may not be geared towards resolving problems in the short term. Only strategic management can provide a competitive market behavior analysis, estimation of new opportunities and justification of decisions by which resources are allocated.

In the current economic circumstances, the success in the real economy, the performance of transport activities and the competitiveness of firms conduct their business in this area depend to a large extent on the quality management in these conditions, without a rigorous management, you cannot refer to the size and structure of the current and future market requirements, will not be able to develop and implement strategies and rational strategy and will not be able to reshape the management system to manifest the dynamism, creativity, flexibility and functionality inherent in the system of market economy.

3. PORT – POLICY - THE PREMISE OF THE PORT DEVELOPMENT

Globalization of national economies, manifested as a trend of the past few years has produced important mutations in the field of maritime transport: new ships, new tourist attraction areas, new maritime routes as a result of embargoes imposed on certain countries, new policies in the field of naval personnel. Moreover, adaptation to environmental change, from the perspective of firms involves changes to the port, and different ways of establishing pathways. This attitude makes it possible to draw up a timely opportunities, integration of the new restrictions and taking new decisions to abandon certain activities, the adoption of a commercial policy etc.). On the other hand, companies are faced with a medium port moving, can adapt effectively acts quickly. This aspect involves the financial means, technological, human, as well as flexible structures. The time period between the advent of a new environment and when the company react should be short, in order to maintain competitiveness.

The evolution of the transition process brings about significant changes in the structure of the economy-generating mechanisms, and in their turn, they lead to reorganizing the strategy of the economic agents. Within the present economic context, it is imperative that the economic agents pass from survival strategies to action in order to create and maintain the competitive advantage.

Today’s business world is at an unprecedented competitive level. But, in the harsh, hostile environment in which entrepreneurs act, it is absolutely necessary to evince the nodal points of the transition to market economy, which necessarily requires a coherent managerial vision from a macroeconomic point of view, able to potentate the action of economic agents with the power necessary to acknowledge and predict the changes in the business world.

Competition is essential determining factor in the success or failure of companies. It determines the appropriateness of those activities of a firm which can contribute to its performance, such as innovation, a uniform culture or a judicious implementation. On the other hand, the competition constitutes a framework for validation of competitiveness. The fundamental requirement to ensure economic efficiency, competitiveness is based on information which the latter becomes a strategic tool.

Competitive resources are within the company, which has the primary role of their activation in unstable external environment, specifically the transitional period. Mastering stake competitiveness is a very complex process, which is to establish key factors of competitiveness and to examine how firms based on strategies that establish and apply them to "equip" with these factors, it organizes and coordinates, developing their competitive abilities in this way to improve economic performance.

The term competitiveness associated with a firm quality efficiency, suggests, products/services and optimal costs, higher productivity, security, adaptability, modern management, in a word – successful.

The port industry, as every industry has its own rules of competition and its own hierarchy of factors that contribute most towards or less competitive position and competitive advantage.

Study and analysis of competitive business shall register the common characteristics, but shall base its success and succeeding in business on the basis of specific skills. Of performance criteria that ensure a high level of competitiveness at the microeconomic level, we can specify the cost of labor, labor productivity, the quality of products/services, satisfaction of needs of beneficiaries, etc.

Ports are directly or indirectly "trapped" in a competitive market. In this respect, there are a multitude of factors affecting competitiveness; a port may change its position and competitive with other ports with a certain user port by improving one or more factors. In this context, the ports that are to be competitive for a particular category of goods or merchandise, you must know exactly what are the factors to be improve and whose extension is required, and the results you want to get.

Port specialization influences how approach to competitiveness. Thus, an important aspect for ports is to minimize distribution costs, consideration for which ports must formulate an active policy in this respect in order to be able to improve their competitiveness.

Given the nature of their competitive ports competitiveness or the study of marketing strategies for a particular route or line navigation, should carry out a series of calculations that you established with appropriate adjustments, in line with their own criteria. On the other hand, all factors affecting the competitiveness of the port are to a certain extent addicted to one of the three basic elements: time, cost and risk.

A managerial approach to port work highlights the fact that the ports can be viewed and analyzed as complexes, specific service providers, which they determine the role and their place in business organization system.

The essential changes that have taken place within the transport industry overtime; they had and have a continuous and fundamental impact in terms of port and port management activity. General management principles are also applicable to ports; port management is, in fact, management of a system of services. In this context, the objectives of port and port management must be oriented in such a way as to serve the commercial and marketing, considered as important avenues to be followed by the port to their facilities.

The entire port system should focus on overall management of available resources and at the same time, to develop capacity to address the issues of services, costs and markets in a much more critical than ever before. In addition, it is important to adopt policies and strategies concise, applicable to long term, leading shipping industry on an upward trend.

In this context, adapting to changing the environment from the perspective of firms involves changes the port information and different ways of establishing pathways. This attitude makes it possible to draw up a timely opportunities, integration of the new restrictions and taking new decisions to abandon certain activities, the adoption of a commercial policy etc.). Furthermore, the company faced with a moving average, can adapt effectively acts quickly. This means behaving plan financial, technological, human, as well as flexible structures. Period of time between the appearance of a new environment and when the company react should be short, in order to maintain competitiveness.

Transport policy is among the first policy areas included in the Treaty of Rome. In addition to opening the markets of transport and the creation of conditions for fair competition, sustainable model of "mobility" has gained significance in recent years become increasingly more important. The opening of the markets in transport imply fair conditions of competition both at the individual level, for each mode of transport in hand, and between them. For this reason, the approximation of laws, regulations and administrative provisions, including the technical framework conditions, social and fiscal, has acquired over time increasing importance.

Mainly, the conditions for the success of a sustainable port development policy include:

- creation of the legal framework necessary for the operation of all modes of transport in accordance with economic and social goals arising from competitive market;
- ensuring the financing of programs for restructuring and modernization, development of internal and external sources;
- the intensive use of the potential technical, scientific and technological developments;
- providing a modern, creative management, based on achieving results and on concrete economic flourishing of managers and employees.

An essential element of policy on maritime transport is security; in this connection, the size of the world shipping market requires the development of security standards as uniform worldwide and recognized by IMO. Therefore it required the participation of

Member States of the world community to the development and perfecting of conventions of international law and the adoption of complementary measures at EU level.

Of particular importance are the technical cooperation projects aimed at implementation of platform for resource management port companies and develop programs of vocational training; in the same sphere will be registered and investment projects, both public and taken by entrepreneurs for the rehabilitation of port infrastructure.

On the other hand, must be taken to ensure an effective mobility and advantageous in terms of costs, for people and goods, as the central element of a competitive internal and which are the basis for free movement of people. At the same time, it outlines the need to control the growing traffic and to minimize the associated costs are generated in the form of accidents, diseases of the respiratory tract, noise, harmful effects on the environment or traffic jams. Also in the sphere of control is that relating to subsidies and the conditions of competition in the field of ports and port operators, in an efficient and in similar conditions for all ports and all operators. Implementation of these measures incorporates an integrated approach to optimizing the efficiency of the transmission system, organization and safety of transport and to reduce energy consumption and environmental impact.

At the same time, requires a comprehensive and coherent policy for maritime transport, which, inter alia, should be based on the following additional measures: the prohibition of navigation for vessels which do not comply with the requirements, the establishment of a liability regime which to lie down on the entire maritime transport chain, as well as improving the living conditions, employment and training of seafarers. It also has importance and creating a European body of coastguard, the requirement of pilotage in sea areas of sensitive environmental and difficult to navigate, and the establishment of a decision-making and command structure, in the Member States, for emergency situations at sea, in particular with regard to the designation of a place of refuge, question. a port for emergency situations.

All firms must draw its energy and resources to advance in the present conditions of competition. The existence of products, services and sales, although quality is an essential element, it is not yet effective. Firms should place greater emphasis on global management and to develop their capacity to address the problems related to the products/services, costs and markets in a manner much more critical than in the past. In addition, they will have to implement a concise strategy applicable to long term.

Strategic conception on the development of transport, as an overall picture of the main branches of the economy, may be deemed to be a connection to the trends of worldwide modernization of factors involved in making the logistical chain, productive and integrated. Logistical efficiency has to be sustained once gained so that performance is not short-lived. In this direction, the firm must measure the performance of the logistics and to react dynamically to the results obtained. The most efficient logistic operations are those that make no direct link between the methods of operation and overall logistics strategy.

Thus, as fundamental elements are defined, inter alia, strengthening the competitive capacity of ecological transport procedures, establishment of integrated transport networks which use two or more modes of transport (intermodal and combined transport) and the establishment of conditions for fair competition between modes of transport, through the imposition of costs generated by them.

Contemporary scientific-technical revolution and the complexity of the problems of market reinforces the ambient of a firm, elastic forms required for the Organization as well as an adequate capacity to adapt to the demands arising from the market economy. Current economic trends and perspective, implies firms market data to ensure increasing their contribution to the achievement of the programme of economic and social marketing policy formulation, which, based on development through the improvement of the work carried out and provide services as more complex segments of users, which is addressed in the context of the market.

The contribution of management is not confined to the economic side, being especially important and efficiency, which relate to non quantifiable directly, but with multiple consequences on all factors involved in company activities and primarily on the human element.

Thus, managerial communication requires an understanding of the significance of developments in the external environment and the implications of these transformations, so the firm to identify with the strategic objectives, achieving a genuine social partnership.

For successful adoption and implementation of packages of measures, policies and strategies that contribute to the sustainable development of transport activities, taking into account the following considerations:

- implementation of management for the future - the company has to “*hold*” a sense of future and a clear strategic vision, as this implies a balance between action, solving problems quickly and innovation;
- existence of a strategic action plan - the manager must continuously develop a strategic plan for achieving competitive advantage;
- organizational culture - employees must be committed to values of the company, its habits and be willing to take risks to achieve them. The key factor in contemporary competitive world is developing strategic entrepreneurship (this assumes the existence of a sense of autonomy and trust in the company's values and aims) and the management of creativity;
- strategic flexibility-any firm must be prepared to react to rapidly changing environments, trying to anticipate mutations, even if it means reformulating or changing organizational culture strategy.

Practice shows that in a dynamic and competitive environment, if a company fails to submit to a well-defined purpose to, sooner or later it will fail. And stationing is prohibited. The difference between success and failure lies in the ability of managers to carry out the function of strategic leaders, to develop such an organization thrive.

The crossing difficult moments, the adoption of successful solutions, the prospect of stabilization in the economic situation, the implementation of sustainable policies and strategies in the port industry, create real premises to ensure that the activities of transport to develop harmoniously in order to face the competition at European level.

4. CONCLUSIONS

Enactment and enforcement of measures and actions in the context of viable port will enable consistent implementation of a port management, professional services, oriented towards the adoption of rules favorable to the development of high quality, modern port facilities and efficient transport links, in order to encourage private firms to establish and operate in and near the port attract domestic and international and EU standards in ports on the quality of service, safety, environmental conditions, provided for and by the port community.

Supported by a dynamic and international marketing, this policy will lead to a good reputation of ports and will absorb any excess traffic and customers, resulting in increased economic activity, in particular for transit cargo, to capitalize on the many benefits of a prosperous port for the whole society.

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ROMANIA EUROPE'S CROSS-ROADS PAN-EUROPEAN CORRIDORS AND TEN-T PRIORITY AXES. CURRENT CONDITIONS AND PERSPECTIVES

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ABSTRACT

Transport networks in the Balkans have developed for centuries according to actual trade and travel requirements but also to political constrains. Both factors have significantly changed recently, but the links to provide basic accessibility to the region already exist, even if many of them are sub-standard and provide a poor level of service, largely as a result of accumulated under-investment and a lack of adequate maintenance. Intermodal transport is still rare in the Balkans and inter-modal facilities or equipment do not, for the moment, constitute an impediment to the development of long distance traffic through the region. Following the political and economic opening after 1989, Romania, an E.U. frontier state becomes an important international traffic component which raises issues that will need to be solved not only from a technical point of view but also in compliance with the European environmental policies.

Key words: *Pan-European Corridors, TEN-T priority axes, sustainable development of romanian transport sector*

1. COORDINATES OF TRANSPORT NETWORKS IN THE BALKANS AREA

Transport networks in the Balkans have developed for centuries according to actual trade and travel requirements but also to political constrains. Both factors have significantly changed recently, but the links to provide basic accessibility to the region already exist, even if many of them are sub-standard and provide a poor level of service, largely as a result of accumulated under-investment and a lack of adequate maintenance.

The extensive use of the notion of "Corridor" and "Network" has obviously had positive effects in bringing some "long distance communication" coherence to the development of transport networks in Central and Eastern Europe. However it may also be counter-productive if interested countries concentrate their efforts and their external financing resources on these corridors and networks, to too great an extent. Facilitation of long distance transport operations should not lead to overstating transport infrastructure. In this context, one should not consider that a road "Corridor" should be systematically equipped with a motorway. A modern two-lane highway, with good characteristics, appropriate shoulders and a crawler lane on long steep gradients, may accommodate significant levels of traffic to high standards of comfort and safety.

Conversely, as is seen sometimes in the Balkans, a motorway constructed from an existing sub-standard two lane highway, by dualling through the provision of a new carriageway without shoulders, may not offer the sought level of comfort and safety and result in higher maintenance costs.

Intermodal transport is still rare in the Balkans and inter-modal facilities or equipment do not, for the moment, constitute an impediment to the development of long distance traffic through the region. Most intermodal transfer operations are accommodated in seaports or river-ports, or in railway stations, with equipment and personnel under the responsibility of relevant rail or port companies/agencies. The development of intermodal transfer capabilities is thus generally included in individual developments plans for ports and railways.

In order to discuss the Romania's situation regarding the trans-European corridors we should first take a few steps into the EU analysis towards those major transport axes. Thereby, is it important to mention the fact that in April 2004 the European Union adopted a comprehensive plan to build by 2020 a trans-European transport network (TEN) on its territory[1]. This new plan concentrates investment priorities on 30 major trans-European axes that primarily serve long-distance and international traffic. It covers the territory of the enlarged EU as well as Romania and Bulgaria and aims at better integrating the new Member States to the Union. The EU enlargement meant that the external borders of the Union have shifted further towards the East and to the South, introducing several new neighbouring countries to the EU.

Following enlargement, the Pan-European Corridors developed during two Ministerial Conferences in Crete in 1994 and in Helsinki in 1997, are now mainly within the EU and thus part of the TEN network giving new impetus to review and in some cases realign these Corridors.

Good transport connections between the European Union (EU) and its neighbours are essential for trade and economic development. Effective, safe and secure transport systems reinforce sustainable economic growth and competitiveness and ensure the efficient movement of passengers, goods and services.

Following the political and economic opening after 1989, Romania, an E.U. frontier state becomes an important international traffic component which raises issues that will need to be solved not only from a technical point of view but also in compliance with the European environmental policies. Consequently, beside the complex measures of lining up the economy and

[1] EC(2004) 884 Official Journal 7 June, 2004.

legislation to the European standards, a set of measures which aim at the development and facilitation of cross border traffic imposes itself, especially for the cross-European corridors.

From this point of view, Romania inscribes itself into the above mentioned coordinates, since three Pan-European corridors (IV, VII, IX) pass through our country and two of them belong to the trans-European transport network (Axis 7, 22, 18).

The infrastructure development in Romania will contribute and round up to the socio-economic growth of Romania and E.U., the strategic investments in this area (in progress or starting soon) having as a purpose the facilitation of people, goods and services circulation and the improvement of the quality of life.

The transport infrastructure, according to the Romanian Constitution, is public property of the State. These assets therefore are administrated by national entities, or companies or corporations under the jurisdiction or the monitoring of the Ministry of Transport, Communication and Tourism which may award these assets for concession, in accordance with the provisions of Romanian laws.

The Ministry, through general directorates, is in charge of setting up the general transport strategy and policy, defining the needs in terms of network development, dealing with international organizations and monitoring transport activities through licensing of operators and setting up rules and regulations for the transport sector.

Currently there is a series of instruments / documents issued by the Ministry of Transport, Communication and Tourism and the Ministry of Public Finances which acts in order to solve major problems regarding the harmonization of the national transport strategy with the European Commission's strategy in connection with the development of the TEN-T transport corridors and of the Trans-European corridors on the Romanian territory.

Thereby, the main scope of the National Strategic Reference Frame (NSRF), elaborated by the Goverment of Romania under the direction of the Authority Management of the Ministry of Public Finances is to strengthen the strategic focus of economic, social cohesion and regional policies of our country as well as establishing the connection with E.C.'s policies, especially with the Lisboa Strategy which elaborates economic development and employment strategies.

NSRF originates from the National Development Plan (NDP) which has been created as an instrument to guide the approach the national, community-financed and other type of funds granted to Romania. It justifies and prioritizes public investments within the European economic policy and social cohesion framework and defines Romania's strategic planning and multianual financial planning. NSRF demonstrates the way in which Romania intends to include in its strategies the concepts of sustainable development and equality of opportunities in order to fight social exclusion. NSRF presents the means of implementing the Structural Instruments. The document has been elaborated in partnership with the main actors and there has been organized a session of public consultations in order to obtain other opinions as well.

The Sectorial Operational Transport Program (SOTP) is a document having as subject the utilization of E.U. financing sources and of the co-financing national funds in the field of transports in Romania. The program is implemented by the Ministry of Transport, Communication and Tourism of Romania. SOTP is elaborated on the basis of National Strategic Reference Frame (NSRF) and mainly on its transport-related objective which envisages "promoting a transport sistem in Romania which will facilitate the rapid and effective circulation of persons and goods both internally and internationally, safely and according to the European standards".

SOTP establishes the objectives, priority axes and key fields of intervention for supporting the framework which will make possible the submission of proposals for co-financing from the E.U. Structural and Cohesion Funds. SOTP will be financed by the European Fund for Regional Development (EFRD) and from the Cohesion Fund (CF).

The Romanian Government has adopted the Law no.203/2003 regarding the development and modernization of the transport network of national and European importance, relying on the strategies of infrastructure development at European standard as per the White Chart of European Transport Policy and directives regarding transeuropean transport networks (TEN-T).

The Plan of Arranging the National Territory defines, in the section dedicated to transport routes, the structure of the national transport networks. The plan proposes balanced solutions for Romania's economic development and takes into consideration the common European objectives. It identifies priority projects with repect to short, medium and long term actions for the development of the three major Priority Axes (7, 22, 18) which cross Romania and connect Central and Eastern Europe and Northern and Western Europe respectively. Investments in the TEN-T network will represent the main objective for the future period.

The integration of the national transport strategies with the E.C.'s strategy related to the development of the transport corridors TEN-T requires the creation of modern railway and road networks and maximizing the opportunities in the aerian transport and in the naval transport (commercial and touristic). More than this, ensuring the connectivity between the means of tranport will promote a competitive advantage; advertising inter-modality and safety will represent the basis for these policies. These measures will consolidate Romania's geographic and strategic position as a gate towards the extended Europe. The strategy aims to maximize the economic benefits for Romania, resulting in the consolidation of Romania's strategic position as a transit area to Asia.

The major investments in the transport area will try to minimize any negative impact on the environment and to increase the positive input of transport in acquiring sustainable development.

The modernization of railway, road and aerian infrastructure are meant to create conditions that will facilitate the accessibility and the support of economic and social cohesion objectives at regional, national and European level. The strategy will have a positive impact on the modernization of motorways, roads and railroads, of the fluvial and aerian transport thus ensuring a balanced transport infrastructure which will comply to the European standards.

By these means, the accessibility and the business opportunities will increase, the quality, effectiveness and speed of transport services will improve, the travel time will decrease and the volume of passengers and goods traffic will increase and the environment protection requirements will be obeyed. More than this, the strategy will contribute to territorial cohesion and reduction of regional disparity, improving the local and regional transport infrastructure through the rehabilitation and modernization of local and county road network.

The purpose of the measures taken both at national and regional level is to increase the attractiveness and accessibility of regions and to stimulate their socio-economic development.

2. MAIN COMPONENTS OF ROMANIA'S INFRASTRUCTURE

The *main components of Romania's infrastructure* for the period 2007-2013 are presented below, as well as NSRF's most important objectives.

Road transport. The modernization and construction of trans-European roads infrastructure consists in building new motorways and finalizing those under construction, building 4-lane roads and national roads, alternatives for avoiding the towns that are in or close to TEN-T network and rehabilitating the roads and bridges in the TEN-T network.

In what the national roads are concerned, the strategy will focus on their modernization and rehabilitation; the actions will be similar to those described in the case of the roads in the TEN-T network and will facilitate the access to industrial and urban centers and to interchanges (traffic generating junctions/knots). This will contribute to the business's efficiency, will reduce regional disparities and travel times, will increase safety, all the above leading to a better quality-price rate.

The modernization of county and local roads will play an important part in this strategy and will help both urban and rural areas (local roads will be supported by the European Fund for Regional Development- EFRD). Better county and local roads will influence the creation of durable communities and collaboration between regions, will increase the mobility of the labor force and will support the development of regional labor force markets by inter-connectivity between localities and regions.

Railway transport. The modernization and development strategy for the railway TEN-T networks has in view the interoperability of the TEN-T railway infrastructure and improving the quality of the railway services (train stations, signalization equipments, ITC systems etc.). One of the main objectives for the TEN-T railway network is increasing maximum operational speed to 160 km/h for passenger trains and 120km/h for the goods trains. Replacing the old equipment, wagons and locomotives will encourage the use of these transport means and will facilitate inter-operability.

At a national level, there will be taken similar measures as for the TEN-T railway network, leading to a better use of the network, reduced and safer travel time, intermodal services and general improvement of railway services at E.U. standards. This will result in the rise of the number of passengers and a steady development of the businesses.

These measures will finalize with ensuring a better connection between regions, the improvement of attractiveness and durability of the railway transport system. The introduction of high-speed passenger trains for long and short distances is also envisaged.

Naval transport. The modernization and development strategy of the TEN-T naval transport infrastructure aims to improve the navigation conditions, eliminate the throttling on Priority Axis 18 and establish the national connections with the Danube and other navigable channels.

This implies the modernization of the Romanian-Bulgarian sector of the Danube, the Sulina branch, the Danube-Black Sea Channel and Poarta-Alba- Midia Navodari Channel as well as he continuation of the works in the Danube area between Calarasi and Braila. The main investments will result in the rising of navigation depth and improvement of harbor facilities.

Aerian transport. The strategy has in view the financing of the modernization and development of the selected airports in the TEN-T network or outside it in order to improve their effectiveness, increase the traffic and make them more attractive for beneficiaries. Connections with E.U. and international markets and centers will thus be established.

The main plan for the Romanian aerian transport infrastructure will establish the priorities for TEN-T airports and for regional airports selected outside the TEN-T area, where the analysis cost-benefit will demonstrate their economic viability. The strategy will rise the standards for aerian transport infrastructure and will ensure a rationally planned and efficient development of the airports in Romania.

Thus, the national and international passengers and goods transport will benefit of quality services which will satisfy needs of the global economy and international community.

Inter-modality. The purpose is to ensure inter-modality between road, railway, aerian and naval infrastructures. The strategy will create measures meant to ensure rapid, effective and comfortable connections for passengers and goods.

The connection of local, county and national transport networks will improve the accessibility, resulting in a more rapid access to TEN-T and a growth in the number of passengers and goods accessing our country. More than this, the modernization and consolidation of the stations will increase the inter-modality of the road and railway transport systems.

The sustainable development of the transport sector. Romania’s transport strategy is based on the sustainable development principle, according to the conclusions of European Council in Cardiff (1988) and Sustainable Development Strategy of the E.U.(Gothenburg 2001).

The actions envisaged will have as a consequence the rise of safety standards, will reduce the negative effects on the environment, will ensure the transport infrastructure to protect against natural disasters and to eliminate the dangerous "negative elements". Promoting the noise control projects, installing the oil/water separation tanks and hazardous substances neutralization devices, collecting the residual waters, creating an ecological transport system in accordance with the Kyoto Agreement will be major priorities.

The Strategic National Reference Framework describes the strategy which support the Operational Programs which will be co-financed by the European Fund for Regional Development, The European Social Fund and the Cohesion Fund. Romania’s entire territory will be eligible for financing in the framework of the Convergency Objective. This Section includes a general presentation of the operational programs of this objective. Romania will also benefit of financing in the framework of the European Territorial Cooperation Objective.

The global objective of the Operational Transport Program (OTP) is promoting in Romania a transport system which will facilitate the rapid and effective national and international circulation of passengers and goods, in the best safety conditions and at European standards.

Priority axis 1. Modernization and development of TEN-T priority axes

This priority axis should aim at enhancing the territorial cohesion between Romania and the EU member states, by significantly reducing travel times with improved safety and quality of service to principal destinations, domestically as well as Europe-wide, for both passengers and freight, along the TEN-T priority axes 7, 18 and 22.

It will be achieved through the development and upgrading of motorways and railway, and water transport infrastructure, with a view to improving the quality, efficiency and speed of transport services, door-to-door, and increasing volumes of freight and passenger traffic from eastern to western Romania. The source of funding is represented by the Cohesion Fund (CF) and the Romanian State budget.

The Romanian transport system across all modes is insufficiently developed and of inadequate quality as compared to EU member states impeding the quality, safety and O-D travel time for people and goods. Long distance Romanian and inter-European transit traffic is particularly disadvantaged due to lack of transport infrastructure at European standards across the TEN-T priority axes 7, 18 and 22. The Danube navigation, as well as the rail and road priority axes require major improvements in their respective infrastructure to offer transport at European standards.

Improved infrastructure along the TEN-T priority axes would enhance the possibilities of increased traffic from Asia via the Black Sea, with Constanta being the principal entry port to Europe. According to the provisions of the Community strategic guidelines for the cohesion policy in support of growth and jobs, 2007-2013, EU member states should give priority to the thirty projects of European interest located in regions under the

Convergence objective, which in the case of Romania are situated on the TEN-T priority axes 7,18 and 22. These operations will target construction of new motorways and construction of bypasses for cities located on, or adjacent to TEN-T priority axis 7.

In accordance with the commitments made by Romania during the negotiation process for the Chapter 9 "Transport Policy in the field of transport", implementation of projects for developing and upgrading the transport infrastructure on the *Priority axis TEN-T-7*, is an absolute priority. These operations will aim at completing the construction of the motorway on the northern arm of Priority axis TEN-T-7 (Nadlac - Constanta).

Figure 1. Modernization and development of road infrastructure along the TEN-T priority axis 7 Source: DG TREN, Project No 7, Trans-European Transport Network Priority Projects, 2005, March 9th.

This Operation addresses TEN-T Priority axis 18, which includes the River Danube along its full length, the Black Sea canal to the port of Constanta as well as the Midia - Poarta Alba canal. It aims at developing the inland water transport infrastructure in Romania in order to increase its utilization.

Initiatives for the Danube river and canals are mostly intended to reduce the incidence of low water and therefore allow barge convoys to travel fully instead of part-loaded, and to increase average speeds by removing obstructions and reduce the need to wait for other vessels to pass.

Some projects aim to increase the flow of the river, creating a self-dredging effect to reduce bottlenecks and ensure the minimum river depth of 2.5m at times of drought.

The conditions for navigation on the Calarasi-Braila and Sulina Branch sections of the Danube will continue to be improved, the bottlenecks on the shared Romanian-Bulgarian Danube section will be addressed, and the Danube-Black Sea Canal banks will be strengthened and completed.

For the purpose of ensuring coherence in the implementation of the project for improvement of navigation on the Danube's Romania / Bulgaria common sector, Romania will prepare the feasibility study for works on the common sector of the Danube, which will include a schedule of projects on both sides of the border/river.

In order to formalize the timely implementation of the project a bilateral agreement on its implementation will be sought. These projects are intended to increase the competitiveness of inland waterway transport and increase its share against road and rail.

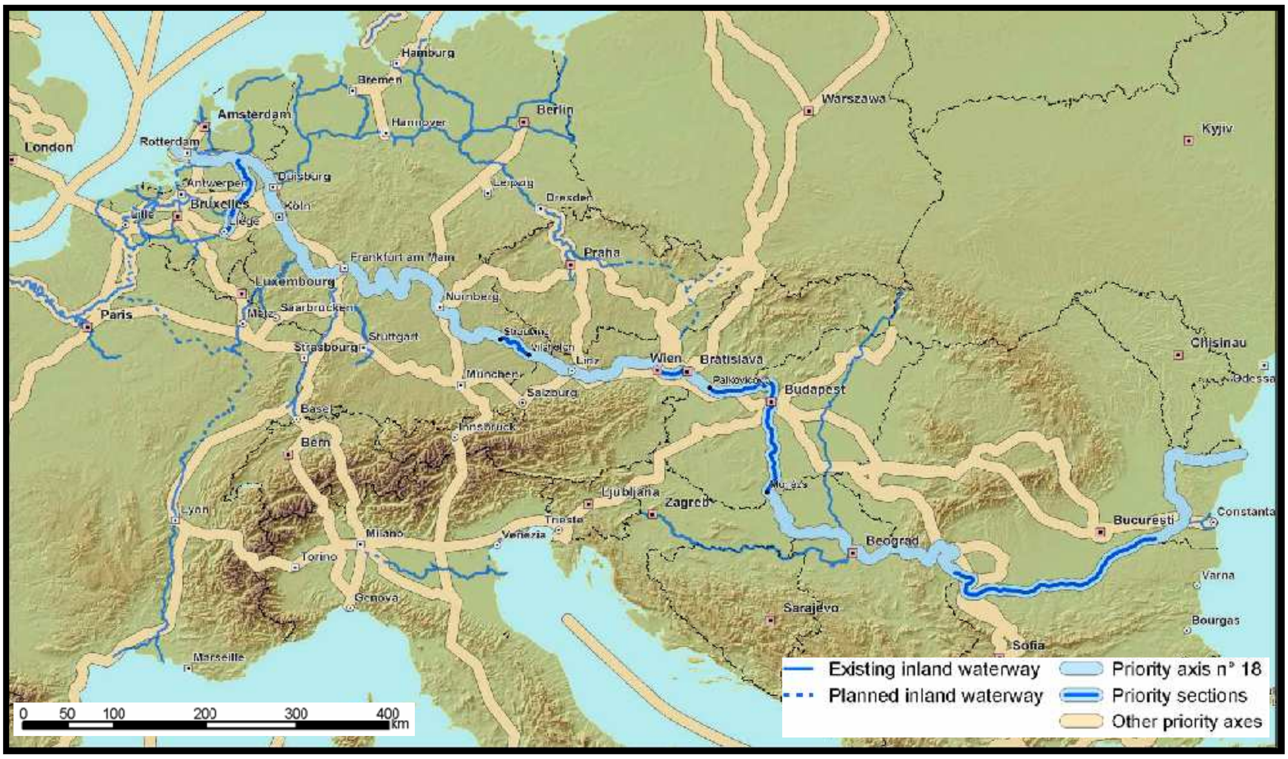

Figure 2. Modernization and development of railway infrastructure along the TEN-T priority axis 18
Source: DG TREN, Project No 18, Trans-European Transport Network Priority Projects, 2005, March 10th.

These operations aim at making the railway infrastructure inter-operable along the TEN-T priority axis 22; also at improving the quality of rail service by modernizing the railway infrastructure and raising the maximum operational speed to 160 km/h for passengers trains and 120 km/h for freight trains. Another objective of it is for rail to retain its present market share of passenger traffic at 15%, while increasing safety level and reducing travel time. Similarly, the objective for freight is to increase its market share by becoming more attractive and more competitive, particularly against road transport through the provision of higher quality of service and speed based on modern European infrastructure standards. These operations will aim at rehabilitating / upgrading / modernizing Priority axis TEN-T-22 (Curtici - Constanta). In addition to modernizing rail infrastructure and in order to ensure effective inter-operability, the project envisaged by this operation will include the introduction of ERTMS/ETCS level 2 systems. Romania will undertake to develop the ERTMS 2 in full cooperation with its neighbours

Figure 3. Modernization and development of water transport infrastructure along the TEN-T priority axis 22
Source: DG TREN, Project No 22, Trans-European Transport Network Priority Projects, 2005, April 29th.

Priority axis 2. Modernization and development of national transport infrastructure outside the TEN-T priority axes

This priority aims at modernizing and developing road, rail, water transport and air transport infrastructure located on the national network outside the TEN-T priority axes. Its objective is to increase passenger and freight traffic with higher degree of safety, speed and quality of service including rail interoperability; in light of the cohesion policy's objective of developing secondary network connections to the TEN-T priority axes in order to address effectively territorial cohesion Europe-wide as well as among Romania's regions.

In the pursuit of achieving this objective the SOPT will take full account of other OPs. Possible overlaps with other OPs have already been addressed and eliminated. The source of funding is represented by the ERDF and the Romanian State budget.

Priority axis 3. Upgrade the railway passenger rolling stock on the national railway network

Priority axis three aims at promoting appropriate balance among modes of transport. It aims at faster, safer and higher quality services at interoperable European standards for domestic and international rail passengers by modernizing the railway rolling stock thus allowing rail to compete effectively with the growing road passenger transport.

This objective is part of the overall effort to revitalize the railways for the *balancing of modes* objective of the White paper –European transport policy for 2010 (EC, 2001). The source of funding is represented by the ERDF and the Romanian State budget.

Priority axis 4. Sustainable development of the transport sector

This Priority aims at implementing the principles of sustainable development of the transport sector in Romania, as per the Cardiff conclusions of the European Council (1998) and the European Strategy for Sustainable Development (Gothenburg 2001).

It will promote increased levels of safety, minimize adverse effects on the environment as well as promote intermodal and combined transport. The source of funding is represented by the ERDF and the Romanian State budget.

Priority axis 5. Technical Assistance (TA)

Proper implementation of the structural instruments requires institutional support and strengthening of the administrative capacity in the coming years. This support and strengthening will need to come in the form of hiring and training additional personnel in both general administrative duties and technical aspects of transport project management within the MTCT and the beneficiaries.

Having clarified the respective competencies of the OP for TA in the area of human resources (HR), one of the objectives of the SOPT will be the training of personnel on the technical aspects of implementing transport projects, as detailed below. Another objective of this priority is to promote understanding and appreciation of the role and purpose of structural instruments, and the EU's contribution in developing the transport infrastructure of Romania. The source of funding is represented by the ERDF and the Romanian State budget.

3. PAN-EUROPEAN TRANSPORT CORRIDORS AND AREAS

The *Pan-European Transport Corridors and Areas* were established during three Pan-European Transport conferences. The overall concept was developed at the first conference in Prague in 1991. Nine long-distance transport corridors as priorities for infrastructure development were defined at the second conference in Crete in 1994. A tenth corridor and the Pan-European Transport Areas for maritime basins were added at the third conference in Helsinki in 1997.

The Transport Corridors include cross-border road and rail traffic routes between the EU17 and the Central and Eastern European countries as well as airport, sea and river ports along the routes serving as intermodal nodes. On the basis of the results of the Pan-European Transport Conferences of Crete in 1994 and of Helsinki in 1997, the concept of the Pan-European Transport Corridors and Transport Areas has generally been accepted as an emerging priority regarding transport infrastructure development all over Europe.

However, following the enlargement of the EU in 2004 and 2007, most of the Corridors are now part of the TEN network. The remaining sections are in the territory of the Balkans, Russia, Belarus, Moldova, Ukraine and Turkey. In the Balkans significant progress has been made in defining a regional core transport network and priority projects. In June 2004, the countries signed a Memorandum of Understanding for the development of the core transport network.

For Russia as well as for Belarus, Moldova and Ukraine, the Pan-European Corridors and Areas form the reference network, while the identification of priority projects remains to be completed. Turkey is in the process of preparing a transport infrastructure needs assessment. Russia and the EU have recently signed an MoU on the creation of an EU-Russia transport dialogue. One of the areas covered is transport infrastructure development and financing, especially public-private partnerships.

The alignment of the Corridors that cross Romania is summarized as follows:

❖ **Corridor IV -** Road and rail connection between Dresden– Prague – Vienna –Bratislava – Budapest

❖ **Corridor VII -** The Danube waterway with the components:

- Danube inland waterway
- Black Sea-Danube Canal
- Danube branches Chilia and Sulina
- Danube-Sava canal
- Danube-Thissa canal
- Relevant port infrastructures situated on these inland waterways

❖ **Corridor IX -** Road and rail connection between Helsinki – St. Petersburg –Pskov/Moscow – Kiev – Ljubasevka – Chisinau – Bucharest – Dimitrovgrad –Alexandroupolis

Romania's territory is included to the **Black Sea Transport Area**, the littoral countries of the Black Sea being as followed: Turkey, Georgia, Russia, the Ukraine, Romania, Bulgaria) as well as Greece and Moldova (observer status for Armenia and Azerbaijan).

4. PAN-EUROPEAN CORRIDOR IV. DEFINING ELEMENTS FOR ROMANIA

From its starting point in Germany, Corridor IV runs south-eastwards through Prague, and Győr in Hungary, to Budapest and then over the Romanian border to Arad. Here the corridor splits, with an eastern branch running to Constanta at the Black Sea, and a southern branch running towards Thessaloniki and Istanbul. Major parts of this corridor run through countries which are new EU members or candidates to join the EU.

The corridor can thus be seen as the backbone of the Trans-European Transport Network (TEN-T) extended eastwards and southwards. The corridor encompasses most of the TEN-T priority railway axis no. 22, running from Dresden to Athens. The following TEN-T railway priority sections have been established on Corridor IV:

❖ *Nuremberg- Prague-Brno-Breclav*
❖ *Vienna-Budapest*
❖ *Curtici-Arad-Brasov*
❖ *Vidin-Sofia-Kulata*

It also encompasses parts of TEN-T priority motorway axis no. 7 (Igoumenitsa/Patra-Athina-Sofia-Budapest). Corridor IV was defined on the Pan-European Transport Conference on Crete in 1994. The Memorandum of Understanding was signed by the Ministers of Transport of the respective countries and by the European Commission in May 1999 in Warsaw. The task of the technical secretariat was assigned to DiaLog Gesellschaft für Service und Kommunikation mbH, Germany.

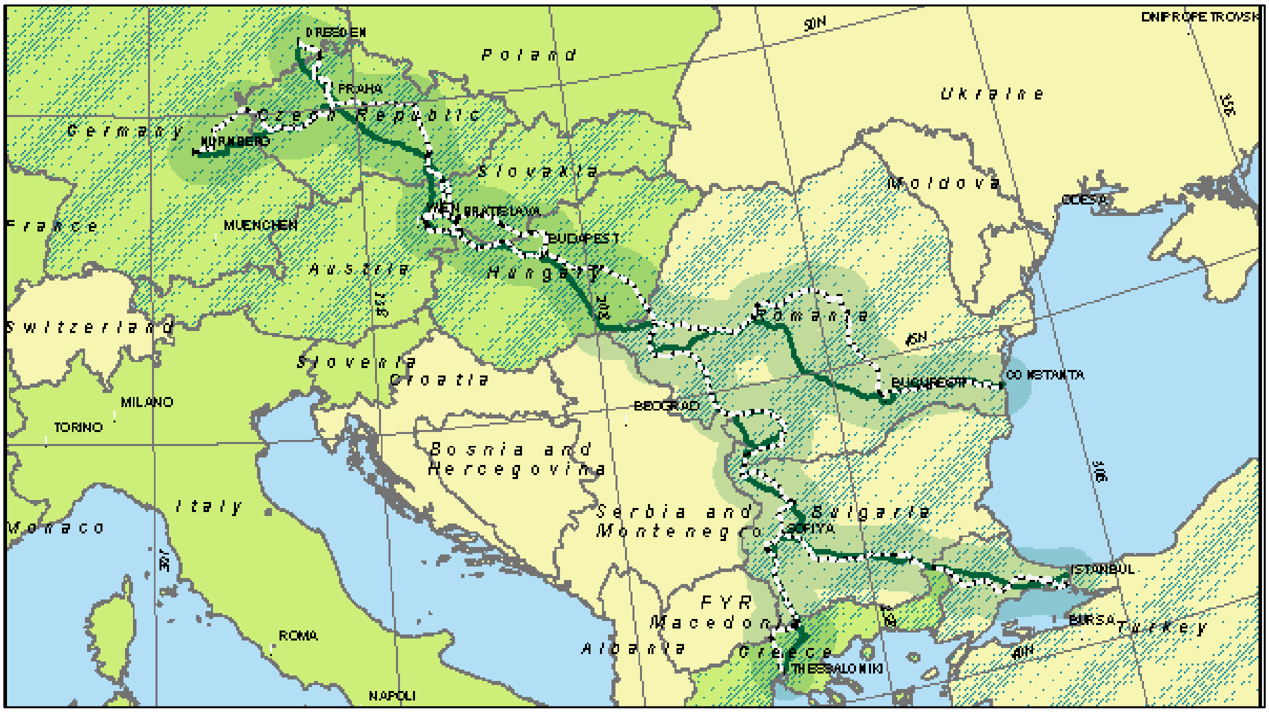

Figure 4. Pan-European Corridor IV

Source: *Pan-Eurostar. Pan-European Transport Corridors and Areas Status Report*, Final Report, HB-Verkehrsconsult GmbH, Germany, VTT Technical Research Centre of Finland, 31 Jan., 2006, page 58.

The *road* alignment in Romania runs from the Hungarian border at Nadlac via Arad and Timisoara to Lugoj. In Lugoj, the Main Axis splits into two braches. Branch B continues from Lugoj via Sibiu, Pitesti and Bucharest to Constanta. Branch C continues from Lugoj via Craiova to the Bulgarian border at Calafat. A Nadlac-Timisoara-Lugoj-Deva motorway (210 km) is considered as a priority project to be developed until 2012. The works for the Timisoara bypass started in 2003 with JBIC Japanese financing and were completed in 2005.

A feasibility study is under way for the Deva-Sibiu motorway. Regarding the Brasov-Bucharest motorway, a feasibility study was finished in 2002. A PPP financing model is considered. Works for the Pitesti bypass were ongoing in 2004 and were finished in 2007. Regarding the Bucharest motorway ring, a feasibility study was finished in 1997 (for the south ring) and 2002 (for the north ring).

On Branch B to Constanta several plans for motorway construction are considered. Regarding a motorway on the section Bucharest-Drajna-Fetesti (134 km), a financing agreement by the Romanian government with EIB was concluded. Civil works for Bucharest-Drajna section were completed in 2004. The construction of a motorway on the section Drajna-Fetesti-Cernavoda with a total budget of 71.71m EUR was approved by the EU/ISPA.

On Branch C, rehabilitation works on the section Timisoara-Bulgarian border (379 km) are ongoing. Works on Timisoara-Craiova section was completed by 2006. Works on Craiova-Calafat section were completed in 2007. A motorway construction will be taken into account after 2015.

The construction of the mixed road and railway bridge will be performed over Danube river in the Vidin (Bulgaria) and Calafat (Romania) area situated north from the two cities at km 796. This transport infrastructure represents a component part of the European system of international motorways as well as a part of the Southern sector of the Pan-European Fourth Corridor (Berlin-Salonic).

There is a bridge over Danube, between Romania and Bulgaria, in the Giurgiu-Ruse area, South from Bucharest (Trans-European transport corridor IX). The plans for the construction of a second bridge exist since the ‘80s.

The final agreement regarding the general location of the bridge has been signed June 5, 2000 between the Romanian and Bulgarian governments, all activities regarding the construction of the bridge being coordinated by the Project’s Implementing and Management Unit of the Bugarian Ministry of Transport and Communication.

Previously, the Bulgarian government ensured the financing of preliminary design and construction through 5 agencies: European Investment Bank, ISPA European Commission, French Development Agency, Kreditanstalt für Wiederaufbau and Bulgarian Government.

There has also been created a mixt Romanian-Bulgarian Commission which approves the works of nine mixt teams in project fields regarding technical, financial environmental protection, juridical and management aspects.

The bridge over Danube river in the Calafat-Vidin area represents a cross-border project. Despite this, it must be mentioned the fact that in this case, the project has a supporter in each of the countries involved (the

Ministry of Transport and Communication in Bulgaria and the Ministry of Transport, Communication and Tourism in Romania), both countries having been signed the UNECE convention regarding the assessment of cross-border impact (Espoo Convention).

Once the new bridge over Danube is accomplished, a new access will be established between Bulgaria and South-West Europe. This aspect will enhance the strategic significance of NR56 (Craiova-Calafat) which will connect in a more direct manner the Corridor IV and Bulgaria, the users of this itinerary being thus favorized, if we take into account the actual and foreseen growth of the road traffic on this route.

However, similar to other infrastructure works of such dimensions, the construction of the bridge has the potential to generate a negative impact on the environment as a result of its physical structures ad of the infrastructure’s exploitation.

.The main impact generated by the future road and railway traffic is constituted by the destruction of certain animal and floral biotops in the (rail)road territory and in certain areas of deeper/wider excavation or gradients.

The only element of national importance both for Bugaria and Romania which will be affected by this construction is the Danube however taking into account the measures proposed for diminishing the negative impact, the significant effects on the biocenosis associated to the Danube will be excluded.

The importance of the construction of this transport infrastructure is essential from the point of view of the social and economic benefits (except the positive effects that the population of Calafat will observe once the traffic becomes more relaxed), but we can certainly say that there will be no other real benefits for the other ambiental domains (flora, fauna, soil etc).

The *rail* alignment in Romania runs from the Hungarian border at Curtici to Arad. In Arad, the Main Axis splits into two branches. Branch B continues from Arad via Alba Iulia, Brasov, Ploiesti and Bucarest to Constanta.

Branch C continues from Arad via Timisoara and Craiova to the Bulgarian border at Calafat. Branch B of the corridor (Arad-Constanta, 880 km) will be upgraded to AGC and AGTC standards for a design speed of 160 km/h for passenger trains and 120 km/h for freight trains. Construction works were completed between 2008 and 2010. A Memorandum between the governments of Romania and Japan was signed in 2001 for the financing of the rehabilitation of the sections Bucarest North – Bucarest Baneasa and Fetesti - Constanta (297.85m EUR).

For the section Bucarest Baneasa – Fetesti, an ISPA application form for the total costs of 231.73m EUR was approved by the ISAP Management Committee in 2000. Works have commenced in 2001. Branch C of the corridor (Arad - Bulgarian border, 400 km) is planned to be upgraded for speeds of 160 km/h for passenger trains and 120 km/h for freight trains.

5. PAN-EUROPEAN CORRIDOR VII. DEFINING ELEMENTS FOR ROMANIA

Corridor VII is the Danube waterway, a unimodal Corridor, established during the second Pan-European Transport Conference of Crete, in March 1994. The corridor is part of the TEN-T priority axis no. 18 – Rhine/Meuse-Main-Danube inland waterway.

Corridor VII consists of the Danube and its connecting canals. The Danube is the second largest river in Europe and is navigable over nearly 2,300 km of the 2,500 km of its total length, which makes it a prime prospect for a major, environmentally-friendly transport corridor, on a Northwest-Southeast axis. Numerous hydroelectric dams harness the power of this river, and at the same time ensure there is sufficient depth for inland water transport.

The Danube crosses Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Moldova and the Ukraine; however, its influence as inland waterway extends to various other countries like the Netherlands, the Czech Republic and Slovenia. The importance of the Danube is based not only on the fact that this is a main inland waterway route, but also on the function of its inland ports, which is not limited to inland shipping. Apart from the seaport Costanta, lying at the mouth of the Danube-Black Sea Canal, there are 44 main inner harbours situated along the Danube.

The interlinkage of the major water axis with other rail/road corridors is very important to ensure the intermodal connectivity of the total network. Most of the ports along the Danube have rail connections as well as road connections, thus attracting combined transport.

The Danube traffic is strongly imbalanced from a geographical point of view. It is concentrated towards the West and near the mouth in the East, the central part being characterised by very low traffic volumes: in the western part, traffic is concentrated in Germany, Austria, the Slovak Republic and northern and central Hungary.

In Romania the investment priorities for inland waterways are:

- the improvement of the Calarasi-Braila navigability,
- the improvement of the Batin Avia navigability,
- the establishment of an intermodal centre at Calafat.

The establishment of modern signalling and traffic management systems is among the main concerns of the Romanian government for inland waterways transport.

The Trans-European Network for Transport (TEN-T) represents a program of the E.U. which aims at improving the connections between the markets of the old (Western) and new (Central and Eastern) members.

In the context of an extended European Union the strategic importance of the Danubian region grows, the Danube might be considered as a central axis and perceived as the ideal environment for the relations between Western and Eastern Europe.

The connection of this major navigation axis with other road/railway transport corridors is absolutely necessary for ensuring a multimodal interconnectivity and this fact grants them the opportunity to develop a combined transportation.

The Danube is a strategic fluvial transport corridor in Central and Eastern Europe, Danube's importance being also reflected in the prognosis for the goods transportation that can be attired by the it. However, there are areas where the navigation on the Danube is still obstructed in certain areas, fact that determines the restriction of Danube's capacity as transport corridor (we will make reference in the below only to the Romanian sector of the Danube).

Figure 5. Pan-European Corridor VII

Source: *Pan-Eurostar. Pan-European Transport Corridors and Areas Status Report*, Final Report, HB-Verkehrsconsult GmbH, Germany, VTT Technical Research Centre of Finland, 31 Jan., 2006, page 111.

With the support of the international PHARE program, there has been conducted a study which identified the main critical elements for navigation along the Romanian and Bulgarian sectors of the Danube but for the implementation of the measures a common effort is required.

6. PAN-EUROPEAN CORRIDOR IX. DEFINING ELEMENTS FOR ROMANIA

Corridor IX was defined on the Pan-European Transport Conferences in 1994 and 1997. The Memorandum of Understanding was signed by the Ministers of Transport of the respective countries and by the European Union in 1995. The corridor is divided into three sections:

- *The* **Northern Section** *consists of the road/rail transport route between Helsinki-St.Petersburg-Moscow;*
- *The* **Middle Section** *consists of the road/rail transport route running from Moscow and from St. Petersburg to Odessa including the branches from Kaliningrad and Klaipeda;*
- *The* **Southern Section** *consists of the road/rail transport route between Odessa and Alexandroupolis.*

The *railway* component in the Romanian territory is the European Line E95, which is traversing Romania from North to South, following the route: Ungheni Prut – Iasi –Pascani – Bacau – Focsani – Buzau – Ploiesti Sud – Bucharest – Giurgiu Nord / Videle –Giurgiu Nord. This route is also a component of the AGC, AGTC and TER Project.

The section Bucharest – Ploiesti (58 km) has been rehibilitated in 2001-2003, including rehabilitation of earthworks, bridges and retaining walls as well as earthworks reinforcements and replacement of more than 160 culverts.

In order to meet the AGC parameters for the railway route and to ensure the technical conditions for a speed of 160 km/h on limited sectors, local rectification of curves and new route variants have to be carried out. The investment costs of 190m EUR are covered by EIB (135m EUR) and the national budget (55m EUR).

Seaports. At Giurgiu Port, works were done in 2004-2007 to upgrade and re-build the stone brick reinforcement wall to facilitate access for Romanian-Bulgarian cross-border traffic. The investment costs of 0.8m EUR are covered by PHARE (0.3m EUR) and the national budget (0.5m EUR).

Aviation. At Iasi Airport 43.9m EUR were spent from 2006-2008 for the development of the airside, the extension of the passenger terminal and a cargo terminal building, financed by a public-private partnership. At "Henri Coanda" Bucharest-Otopeni International Airport 240m EUR have been spent in 1994-2004 for terminals, platforms, taxiways, runways and technical installations.

At the International Airport Bucharest Baneasa - Aurel Vlaicu 72.5m EUR were spent from 2005-2010 to increase the transport and operating aircrafts capacity, to increase traffic safety in the airport and in the responsibility areas and to diversify the facilities offered to the passengers and to the airlines. At Suceava Airport 14m EUR were spent from 2005-2008 to upgrade the existing infrastructure, to invest in the airport area as well as in the responsibility area, diversifying the facilities offered to the passenger and to the airlines.

Figure 6. Pan-European Corridor IX

Source: *Pan-Eurostar. Pan-European Transport Corridors and Areas Status Report*, Final Report, HB-Verkehrsconsult GmbH, Germany, VTT Technical Research Centre of Finland, 31 Jan., 2006, page 131.

7. PAN-EUROPEAN OIL PIPE LINE CONSTANTA-TRIESTE

On April 3th 2007, at Zagreb, the capital of Croatia, was signed the agreement for the oil pipe construction between Constanta (Romania) and Trieste (Italy) and beside those countries Serbia and Slovenia are participating to this project.

The project is not a new one, it was participating at the competition in 1998 when the Turkish project (Baku-Tbilisi-Ceyhan) has won because of the USA and Great Britain interests and support. The project benefits are:

- a shorter land distance (1400 km towards 2000 km BTC)
- 2/3 of the oil pipes are already existing, being necessary only to connect them
- the absence of the conflict areas (in Turkey, BTC crosses a conflict area)
- it crosses low regions
- the Constanta port has major endowments for stocking and distributing oil
- Romania has a large capacity for oil refining (over 30 milions tones/year)

8. PAN-EUROPEAN GAS PIPE LINE NABUCCO

After the "gas war" between Rusia and Ukraine (2005-2006) the European Commission became interested about NABUCCO project which means gas for the Central Europe.

Its purpose is the transport of gas from the Caspic See region (mainly from Azerbaidjan but the "Iranian branch" is also considered) to Central Europe on the route Turkey-Bulgaria-Romania-Hungary-Austria.

Like the Pan-European oil pipe line Constanta-Trieste, this NABUCCO gas pipe line aims to reduce the dependence from Rusia who is the main supplier for the European Union.

9. CONCLUSIONS

The integration in the structures of the European Union implies the creation of a competitive and prosperous Romania by reducing the social and economic disparities between Romania and the countries members of the E.U.

The are still numerous issues that need to be surpassed, establishing major long term objectives being a necessary step towards the infrastructure development at European standards: the enhancement of economy's competitiveness and the better use of human capital as well as the consolidation the consolidation of an effective administrative capacity and not in the last place promoting a balanced territorial development.

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THE IMPORTANCE OF DANUBE RIVER AS STRATEGIC NAVIGATION CORRIDOR

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ABSTRACT

Since the dawn of known history the Danube has connected the nations and civilizations living along its banks with each other and with the rest of the world. The Danube has been for a long time, an important transport route that connects the Black Sea to a large number of harbours in south-eastern and central European countries, with further connections to Western Europe (Germany and Rhine-Main-Danube Canal), Eastern Europe and Turkey. The Danube basin is the most multinational river basin in the world, and the fact that the river flows directly over territories of ten riparian countries (Austria, Bulgaria, Croatia, Germany, Hungary, Moldova, Romania, Serbia, Slovakia and Ukraine) and that the basin itself consists of additional 9 states (Albania, Slovenia, Bosnia and Herzegovina, the Czech Republic, Italy, FYR Macedonia, Poland, Montenegro and Switzerland) makes it very important for their economies and enables extraordinary opportunities for transport, trading, tourism and many other means of communication among the people that live there.

Key words: *Danube River, strategic transport corridor, legislation and international conventions*

1. INTRODUCTION

Since the dawn of known history the Danube has connected the nations and civilizations living along its banks with each other and with the rest of the world. After the Volga, the Danube is the second largest European river, with a basin covering 801,463 km^2 and hosting approximately 81 million inhabitants, with the total population of Danubian countries reaching 120 million. Population density is 102 persons per square kilometer.

The Danube basin is the most multinational river basin in the world, and the fact that the river flows directly over territories of ten riparian countries (Austria, Bulgaria, Croatia, Germany, Hungary, Moldova, Romania, Serbia, Slovakia and Ukraine) and that the basin itself consists of additional 9 states (Albania, Slovenia, Bosnia and Herzegovina, the Czech Republic, Italy, FYR Macedonia, Poland, Montenegro and Switzerland) makes it very important for their economies and enables extraordinary opportunities for transport, trading, tourism and many other means of communication among the people that live there.

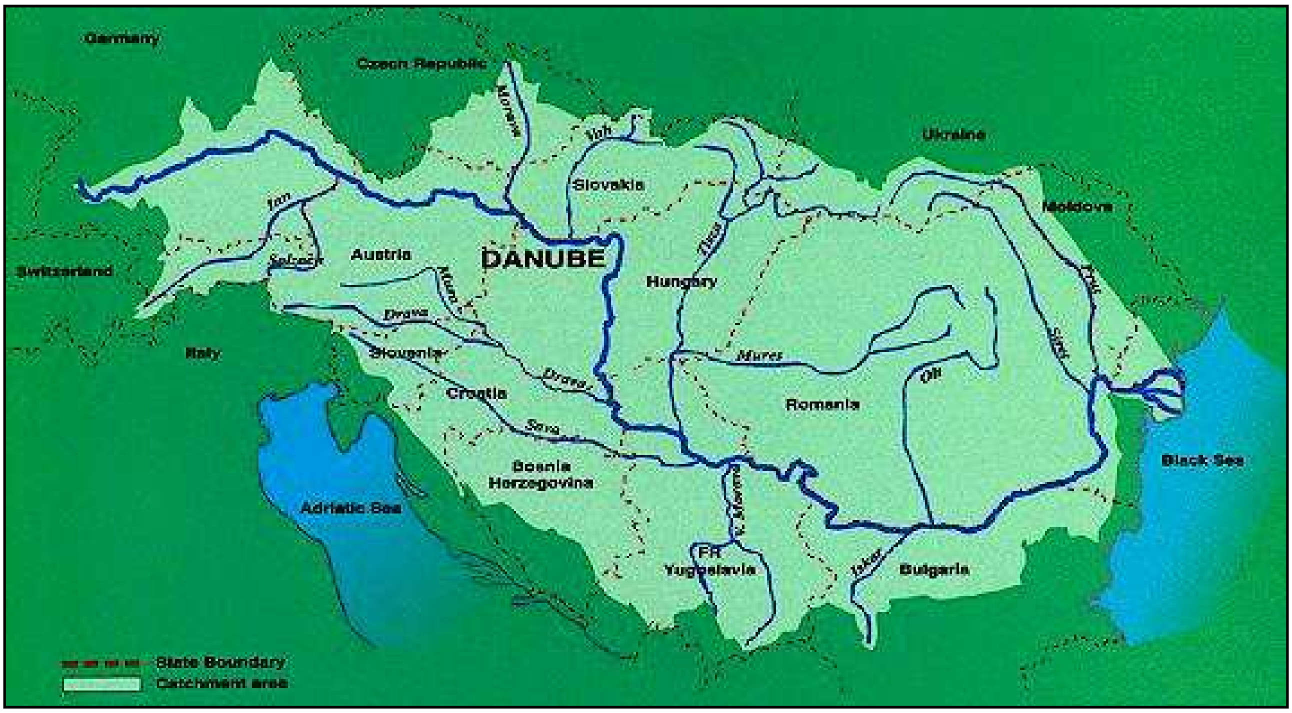

Figure 1. Danube River Basin
Source: ******* The RAMSAR Convention of Wetlands, New "Ecological Expert Group" launched for Ramsar Management in the Danube River Basin, january 1th, 2002

Out of the 300 tributaries of the Danube River, 120 are more important and only 39 are suitable for navigation. It passes through 4 national capitals: Vienna

(Austria), Bratislava (Slovakia), Budapest (Hungary) and Belgrade (Serbia).

Also, Danube is connected through artificial channels with the rivers Main and Rhein, offering a unique opportunity for movement from the biggest Atlantic Ocean ports—Hamburg in northern Germany or Holland’s Rotterdam, all the way through the heart of Europe to the Black Sea and further, to the Mediterranean.

The genetic features, the structure of the basin, the hydrographical features as aspects that have generated the three sector divisions of the river valley (Velcea Valeria, 2001), that seem to have almost the same lengths:

- *Upper Danube*, from its origin all the way to the Devin spot, near Vienna (alpine sector);
- *Middle Danube*, from Devin point to Bazias (the Panonian sector);
- *Lower Danube*, from Bazias to its mouth at the Black Sea (the Carpathian and Pontic sector).

The river is suitable for navigation on almost 2600 km, between Ulm (257 km from its origin) and Sulina. It is also the only European river that has imposed the name of *Danube states* for all the countries that it crosses.

2. HISTORY AND REGULATIONS

The Danube rises in Germany’s Black Forest, flows through the heartland of Austria, forms the border with Austria and Slovakia, then Slovakia and Hungary, before flowing through Hungary, into Croatia and Serbia, to then form the boundary between Serbia and Romania, then Romania and Bulgaria, where it finally empties into the Black Sea.

The Danube has been for a long time, an important transport route that connects the Black Sea to a large number of harbours in south-eastern and central European countries, with further connections to Western Europe (Germany and Rhine-Main-Danube Canal), Eastern Europe and Turkey.

A Danube sector, of more than 150 km also allows the traffic of ships, from the Black Sea on Sulina branch and then on Tulcea branch and upstream on the Danube towards the harbours of Galati and Braila.

Romania has many Danube harbours that have been economically improved benefiting by the possibility of goods shipment along the river: Orsova, Turnu Severin, Calafat, Corabia, Turnu Magurele, Zimnicea, Giurgiu, Oltenita, Calarasi, Cernavoda, Fetesti, Braila, Galati, Tulcea. It is important to know there are 53 major harbours on the banks of the Danube and among them, 24 are located in Romania.

Other harbours on the lower Danube are those from Serbia, Bulgaria, Republic of Moldova, Ukraine. The most important of them, except the Romanian ones, are:

- Germany - Passau, Regensburg, Kelheim şi Deggendorf;
- Austria - Viena, Linz, Enns şi Krems;
- Slovakia - Bratislava şi Komarno;
- Hungary - Budapesta, Dunauvaros, Komarom, Györ, Almàsfüzitö-Szöni şi Mohaci;
- Croatia - Vukovar;
- Serbia - Novi-Sad, Belgrad, Pancevo, Smederevo şi Prahovo;
- Bulgaria - Silistra, Ruse, Lom, Vidin, Somovit, Svistov şi Tutrakan;
- Ukraine - Chilia, Izmail, Reni şi Usti Dunaisk.

Many centuries ago, some Danube sectors have been used for transport by local population, as well as the Byzantines and the Genovese have set commercial locations at the Danube mouth. Navigation on the Lower Danube was controlled by the Ottoman Empire in the XVth century.

Navigation on the Danube connects three capitals from three European states (Vienna, Budapest, Belgrade) to the Black Sea.

The use of navigable way on the Danube has been regulated by successive agreements between some states, during the last centuries:

- the Austrian-Turkish Treaty of 1616;
- the Russian-Turkish Treaty of 1774;
- Treaty of Paris of 1856 by which the Danube was settled as international river and the Danube European Commission was established;
- Paris Convention in 1921 that established the International Commission of the Danube;
- The Convention on the Regime of Navigation on the Danube in 1948 (modified by a Protocol in 2000), signed in Belgrade, by which the Danube Commission was established; this Commission has its headquarters in Budapest.

Taking into consideration the multiple uses of this water course, Declaration of the Danube Countries to Cooperate in the field of Danube Water Management, especially for the Danube protection against pollution (Bucharest Declaration) was signed in 1985**.**

The Convention on cooperation for sustainable protection and use of the Danube River (Convention for the Danube River protection, Sofia, 1994) was signed in the last decade of the XXth century; as a result, the International Commission for the Protection of the Danube River (ICPDR), with its headquarters in Vienna, was set up.

This Convention provides that the contracting parties will make efforts in order to meet the aims of a water sustainable management, including rational conservation, improvement and use of surface and ground waters within the hydrographic basin, to the extent that all of them are possible.

International Commission for the Protection of the Danube River and Danube Commission within the Convention Regarding the Regime of Navigation on the Danube, considering the development of inland navigation, have prepared the following document: Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin.

The European program NAIADES for promoting the transport by inland waterways (The European Action Programme for the Promotion of Inland Waterway Transport) sets an action framework to improve this transportation mean and shipping, from environmental point of view and the development of waterways infrastructure. One of the prioritary projects within the Trans-European Transport (TEN-T) Guidelines includes the Danube, that is the main transport axis.

On the other hand, the European Agreement on Main Inland Waterways of International Importance (AGN) sets features of navigability for these transport ways on water.

More general directions, from the viewpoint of sustainable development requirements are mentioned within the sustainable development strategy of the European Union (Renewed EU Sustainable Development Strategy). One of the main discussed problems is that of sustainable transport and transport on inland waterways was promoted.

The Belgrade Convention sets that navigation on the Danube will be free and open to commercial vessels and goods from all the states that are on a footing of equality regarding the harbour rights and navigation fees, as well as conditions to which the commercial shipping is subject (mentioning that these requirements will not be applied to the traffic between harbours belonging to the same state).

The Convention is applied to the navigable part of the Danube, from Kelheim to the Black Sea, following the arm of Sulina with access to the sea, by Sulina channel.

This convention provides the commitment of the Danube states to maintain their sectors on the Danube, under navigability conditions for inland ships, and with regards of sectors belonging to faring ships, to execute the works necessary to ensure and improve the navigation conditions and not to inhibit the navigation on navigable channels of the Danube.

3. GENERAL NAVIGATION ADVANTAGES COMPARING TO OTHER TRANSPORT SYSTEMS

Water transport capacity is high due to ship tonnage and its weight may be comparable with that of the other main transport ways: railway and road transport. The water transport has a specific lower cost per ton of goods and km, comparable with the other transport systems.

Goods transport system on navigable ways is among the safest ones, due to the following aspects: the high level of standardization for transport vessels, relatively regular traffic with a minimum number of exceedings, relatively low number of crossings and ship approaches, low velocities.

Regarding the specific energy consumption per ton and kilometer, the inland navigation has a convenient position comparable with the other transport systems. Emissions of greenhouse gases are smaller for the same volume of transported goods. Therefore, developing the transport on water results in smaller values of greenhouse gas emissions in comparison with values that would result from road transport development for a similar volume of goods.

The Danube waterway makes possible the ship access and shipping between the Black Sea and riverine countries up to Central and Western Europe. On the Romanian sector of the Danube, the harbours of Tulcea, Galați and the upstream ones have the capacity to manage significant amounts of the vessel traffic.

APDF data on goods shipping along the Danube within the riverine harbours, in 2009 are the following:

- within Moldova Veche harbour: 2982 tons of loads and unloads, total handling of 51 ships;
- within Orşova harbour: 63124 tons, total handling of 72 ships;
- within Drobeta Turnu Severin harbour: 431633 tons, total handling of 495 ships;
- within Calafat harbour: 57476 tons, total handling of 52 ships;
- within Giurgiu harbour: 290988 tons, total handling of 303 ships;
- within Oltenita harbour: 205860 tons, total handling of 188 ships;
- within Chiciu harbour: 939021 tons, total handling of 864 ships;
- within Cernavoda harbour: 196071 tons, total handling of 205 ships.

In 2009, loading and unloading activities were carried out for 2230 ships, for an amount of 2187155 tons of goods. Other ships loaded and unloaded goods within inland harbours on the Bulgarian bank of the Danube.

The vessel traffic with its destination or origin in upstream harbours (Germany, Austria, Slovakia, Hungary and Serbia) and those from the maritime Danube (Romania, Ukraine) are added to the above mentioned harbours.

Freight transport volume on the river Danube increased by 18.6% in 2010. Goods receipt rose by 25.4%. According to Statistics Austria, a total of 11.1 million tons (t) of goods was transported as freight transport on the Austrian section of the Danube in 2010, which constitutes an increase of 1.7 million t (+18.6%) compared to 2009.

The total transport performance (i. e. the product of transport volume and distance travelled) on the Danube was 11.5 billion ton kilometres (tkm) (+19.4%). On Austrian national territory, the transport performance amounted to 2.4 billion tkm (+18.6%). The number of laden journeys rose by 7.5% to 10 391.

The international goods receipt grew by remarkable 25.4% to 6.2 million t compared to the previous year. International goods dispatch showed an increase in transport volume of 5.5% to 1.7 million t. For transit a growth of 10.6% to 2.7 million t was determined. The tonnage in inland transport rose by 38.6% to 0.5 million t in the reference year.

4. RELEVANT LEGISLATION IN ROMANIA

The Romanian legislation complies with the European Union legislation in the field of environment.

The main components of European environmental legislation and Romanian legislation concerning environmental protection and water management are the following:

- General legal framework for environmental protection and procedures to assess the environmental impact of projects, plans and programs;

- Specific legislation on environmental components (water quality, air quality and climate changes, soil polution, noise level, nature protection), hazardous matters, waste management, pollution control and risk management.

Water framework Directive, 2000/60/EC has been adopted at the European level. This Directive, addresed to Member States, has the purpose to protect and improve the state of the water bodies.

One of the main provided tools is the River basin management plan, that has to be prepared for each main river.

The Danube River Basin Management Plan is based on the proposals submitted to ICPDR by the riparian states and it will be finalized by the end of the year 2009.

States that participated in the Convention of 1994, for protection of the Danube River committed themselves to cooperate for essential issues of water management and will take all the necessary legal, administrative and technical measures to maintain at least and improve the present status of environment and quality conditions for the Danube water and those from its hydrographic basin, in order to prevent and reduce, as possible, unfriendly impacts and changes that occur or might be caused.

Taking into account the emergency of pollution reducing measures and necessity for rational and sustainable use of water, the parties will establish the appropriate priorities and enhance, harmonize and coordinate the taken measures and those planned to be taken at national and international level for the whole Danube basin, aiming at sustainable development and protection of the Danube River environment, providing a sustainable use of water resources in order to supply with drinking and industrial water and that for irrigation works, as well as to preserve and reconstruct the ecosystems.

The management in the field of water management will be focussed on a sustainable management of waters, beginning with criteria of an appropriate ecological and stable development, that aims, at the same time, to maintain the general quality of life and continuous access to natural resources, avoid long lasting ecological damages and provide ecosystem protection and applying a preventive aproach.

The framework for water management in Romania is specified by the Water Law 107/1996, with amendments and annexes, including Law 310/2004 and Law 112/2006.

Provisions of the Water Framework Directive are applied in Romania by:

- Law 310/2004 for modification and amendment of Water Law 107/1996 (definitions, provisions, annexes of the Framework Directive 2000/60/EC).
- Law 112/2006 for modification and amendment of Water Law 107/1996 (pollution control, extraction of sand and gravel, dredging works on the navigable ways, protection of water and aquatic ecosystems, protection against floods). Locations and conditions for the dredged material storage are annually set by: National Adimistration "Apele Romane", River Administration of the Lower Danube and CN Administration of Navigable channels, Constanta.
- GUO 12/2007 to modify and complete some standards that transpose the Acquis communautaire in the field of environmental protection. This adds new articles (on communication to the European Commission and European Union Member States) to Water Law no. 107/1996, completing the national legislation related to Water Framework Directive.
- MO 161/2006 to approve the Standard on classification of surface water quality in order to establish the ecological conditions of water bodies.

Romanian legislation regarding the other environmental factors and waste management, toxic and hazardous substances management, biodiversity (including the Natura 2000 network of protected areas) is harmonized with European legislation. The regime of protected areas and Natura 2000 sites in Romania are set by:

- OUG 57/2007 on the regime of natural protected areas, conservation of natural habitats, wild flora and fauna, (based on the Birds Directive 79/409/EEC with amendments, Habitats Directive 92/43/EEC with amendments, Directive 2006/105/EC to comply with other environmental directives after the accession of Bulgaria and Romania). There are mentioned natural protected areas of nationa, international, community, local or county interest. GEO 57/2007 has provisions on administration responsibilities for natural protected areas, management plans, conservation of natural habitats and wild flora and fauna species, conservation of other assets belonging to the natural heritage (caves, for example).
- GD 1284/2007 on declaring the areas of special bird fauna protection, as integral part of the European ecological network Natura 2000 in Romania. 108 areas are declard by this Governmental Decision. For all projects that are to be developed within areas of special bird fauna protection, as well as in their vicinity, the environmental impact assessment report has to emphasize all the bird species of community interest from this site and propose measures to reduce the project impact, conservation and/or compensatory measures, as necessary.
- MO 1964/2007 on appointing the regime of natural protected area for sites of community importance, as integral part of the European ecological network Natura 2000 in Romania. 273 areas are declared by this order. For all projects that are to be developed within sites of community importance, as well as in their vicinity, the environmental impact assessment report has to emphasize all the species and/or types of habitats of community interest whose conservation was appointed by this site and propose measures to reduce the impact on them, conservation and/or compensatory measures, as necessary.

The procedure for environmental impact assessment is based on the following regulations:

- MO 860/2002 to approve the Procedure for environmental impact assessment and environmental agreement issuing

- MO 863/2002 on approving the methological guidelines which are applied to stages of framework procedure for environmental impact assessment
- GD 1213/2006 on setting up the framework procedure for environmental impact assessment for certain public and private projects (based on EIA Directive 85/337/EEC, amended by Directives 97/11/EC and 2003/35/EC, as well as on Aarhus Convention on access to information, public participation in decision-making in environmental matters).
- Law 86/2000 regarding the Convetion on access to information, Public participation in Decision-making and Access to Justice in Environmental matters (Aarhus).

The procedure for environmental impact assessment and environmental agreement issuing for a project is specified by competent authorities for environmental protection, after they receive the request related to the project.

Environmental protection authorities submit a guideline for environmental impact aseessment, where they mention specific matters that are to be investigated.

Public participation is provided within the procedure of environmental impact assessment and environmental agreement issuing, according to legislation in force.

5. LEGISLATION FOR TRANSBOUNDARY IMPACT ASSESSMENT

Romanian legislation regarding projects with potential transboundary impact follows the procedure of notifying other states, according to provisions of national and international legislation:

- Convention on Environmental Impact Assessment in a Transboundary Context (Espoo);
- Law 22/2001 regarding the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo);
- OM 864/2002 to approve the Procedure for environmental impact assessment in the transboundary context and public participation in decision making in case of transboundary impact projects.

6. ENVIRONMENTAL ISSUES

The Danube is home to 7 fish species found nowhere else in the world, 10 diadramous fish including 5 sturgeon species, and altogether 103 fish species, which is more than half of the sum of European species.

The basin has 88 freshwater mollusks (with 18 found only in this basin), over 18 amphibian species and 65 Ramsar wetlands of international importance (WWF, 2010). Today only 6.6% of the basin is protected.

The habitats created by the Danube and its tributaries host a unique mix of species, with about 2,000 vascular plants and more than 5,000 animal species, including over 40 mammals, about 180 breeding birds, a dozen reptiles as well as amphibians (ICPDR, 2010).

New infrastructures for shipping, eight planned large dams, flood protection systems, but first of all industrial pollution are main threats to the wild life and precious unique species living in the Danube like the white pelican, the white-tailed eagle or the black stork.

The Danube delta on the Black Sea is one of Europe’s most ecologically important areas and is shared 80% by Romania and 20% by Ukraine. It is one of the Europe’s most valuable habitats for wetland wildlife and biodiversity.

The total delta area of 679,000 ha is under legal protection, including floodplains and marine areas, and the delta is still spreading seaward at a rate of 24 to 30 meters annually. Since 1991 the core of the reserve (312,400 ha) has been designated as a World Natural Heritage Site.

Up to 75 different species of fish can be found in the delta’s unique ecosystems, consisting of a labyrinthine network of river channels, shallow bays and lakes and extensive marshes, which form a valuable natural buffer zone, filtering out pollutants from the River Danube, and helping to improve water quality in the vulnerable waters of the north-western Black Sea.

It is, though, affected by changes upstream, such as pollution and the manipulation of water discharge, as well as by ecological changes in the delta itself.

7. CONCLUSIONS

Even though the Danube is the second longest river in Europe after the Volga, it is the most important one. Unlike the other major rivers of Europe, the Danube crosses Europe on a west-east direction, thus amplifying its position as an economic and geopolitical strongpoint of Europe.

This river crosses various regions, with very different economies, relief and influences that come from the Mediterranean, Atlantic and continental Europe.

It is obvious that the EU is showing a high interest in the River Danube, not only as an international traffic corridor and valuable economic and natural resource of the continent, but for all countries whether member states or not of the wider Danube basin.

The Danube valley has long been an area of attraction for human communities due to the various natural resources. The capitalization form of these natural resources has been quite different, according to the needs of time and the features of the local communities.

Numerous projects, programs and The Danube Strategy itself are dealing with all aspects of the economic, cultural, political and social life of the more than 100 million inhabitants of this region. All of them should (and will) benefit from close cooperation between Danube countries, their universities, companies and citizens.

The economic value of this river is huge, not only to riparian and basin countries, but for the whole of Europe and the Mediterranean region as well. There are no obstacles, natural or formal, to river transport carrying goods between the Mediterranean and Central Europe without re-loading, and even North Sea ports are accessible through the Rhine-Main-Danube channel.

Hydroenergy as one of the cleanest sustainable sources of electric power, highly effective and already technologically developed, gives a great chance to Danubian countries to make themselves energetically independent and gain profit by exporting power.

Drinkable water, one of most precious natural resources in years to come, is at hand and irrigation potential is also there. Development of all varieties of tourism and related services is a chance for a good and constant source of income as well.

Using the Danube as an international "water highway" not only for commercial transport, but for individual travel too, and the development both of commercial ports and marinas for small craft along this trans European corridor will surely lead to increases in direct and indirect employment in local communities, boost existing and introduce new businesses while at the same time bringing international interaction and cooperation to a higher level, making the flow of knowledge, goods, money, and ideas closer to the people of all the regions involved.

The Danube provides a chance to all people to cooperate, travel, meet various cultures and nations, to learn more about each other interact and obtain firsthand experience of the richness and diversity of human society.

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SECTION II

MECHANICAL ENGINEERING AND ENVIRONMENT

A SPINNING TAIL MISSILE CFD AERODYNAMIC STUDY

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ABSTRACT

Applied aerodynamics has, historically, involved a very strong mix of theory and experiment. This is partly because experiments can be very costly and computations are rarely sufficiently sophisticated. This will continue to be the case. Computational Fluid Dynamics (CFD) is playing an ever increasing role in aerodynamic design for advanced missiles either for performance improvement of the existing system for new missions or for new concept development for future missions. A cost effective design process is to judiciously combine the wind tunnel tests and CFD studies that exploit the inherent strengths of each of these. The objective of the current paper is to present a reliable CFD advanced technique for obtaining supersonic spinning tail missile aerodynamics. In achieving this goal state of the art software was involved: Fluent 6.1, along with all its facilities. As simulation scenarios, were considered four missile spinning tail angular velocities corresponding to 500, 1000, 1500 and 2000 rpm and a comparative study of computed results was conducted. The outcome of this paper should be a comprehensive and exhaustive study in CFD sense, of this special class of missiles.

Keywords: *Missile; CFD; Spinning Tail; Aerodynamic*

1. INTRODUCTION

Applied aerodynamics has, historically, involved a very strong mix of theory and experiment. This is partly because experiments can be very costly and computations are rarely sufficiently sophisticated. This will continue to be the case. A recent, very simple, wind tunnel model with a few control surfaces but no pressure measurements, cost $200,000 to build. That would buy a fair amount of computer time. It also took several months for the model to be delivered. There is great motivation to use computational methods when possible. On the other hand, the missile geometry is quite complicated and one may be interested in the behavior of a leading edge vortex, the onset of flow separation, and the spanwise flow of the boundary layer. Such features require solution of the complex Navier-Stokes equations. Even the NS code which can predict wing-alone characteristics takes weeks before one can get a converged solution.

Perhaps the ideal method of predicting the aerodynamics of a vehicle is flight test in real conditions. There are several reasons why this is not always the ideal method of aerodynamic testing. The cost involved in building and changing full scale designs and making repeated flights is extremely high; the instrumentation is generally not as good as ground-based instrumentation; the atmosphere is not static and it does not take much convective activity in the atmosphere to introduce significant errors in the results

Computational Fluid Dynamics (CFD) is playing an ever increasing role in aerodynamic design for advanced flight vehicles either for performance improvement of the existing system for a new missions or for new concept development for future missions. A cost effective design process is to judiciously combine the wind tunnel tests and CFD studies that exploit the inherent strengths of each of these.

The objective of the current paper is to present a reliable CFD advanced technique for obtaining supersonic spinning tail missile aerodynamics. In achieving this goal state of the art software was involved: Fluent, and all its facilities. As simulation scenarios, were considered four missile spinning tail angular velocities corresponding to 500, 1000, 1500 and 2000 rpm and a comparative study of computed results was conducted. The outcome of this paper should be a comprehensive and exhaustive study in CFD sense, of this special class of missiles.

Weapon systems consist of four major equipment areas-the Detect, Direct, Deliver, and Destroy units.

Missiles, for the most part, are made up of several sections or shells (Fig.1). They are usually machined from metal tubing and contain the essential units or components of the missile. Sectionalized construction of a structure has the advantage of strength with simplicity. It also provides for easier replacement and repair of the components, since some sections are removable as separate units. The sections are joined by various types of connections which are also designed for simple operation. Covers and access doors are often installed on the outside of the structure to provide easy access to key interior components. The missile exists to carry the warhead to the target. Therefore, the structure is designed around the size and weight of the warhead. The structure of the missile must be as light and compact as possible, yet strong enough to carry all the necessary components.

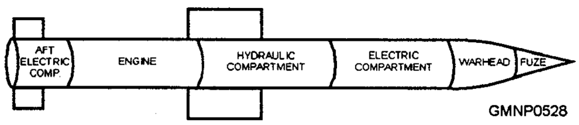

Figure 1 Compartments of a missile

The principal forces acting on a missile in level flight are thrust, drag, weight, and lift. Like any force,

each of these is a vector quantity that has magnitude and direction. Thrust is directed along the longitudinal axis of the missile is the force that propels the missile forward at speeds sufficient to sustain flight.
Drag is the resistance offered by the air to the passage of the missile through it. This force is directed rearward. Weight is comparable to the force of gravity acting on missile. Lift is an upward force that supports the missile in flight. Lift opposes the force of gravity and is directed perpendicular to the direction of drag. Lift is the force that concerns us the most.

The overall missile aerodynamic loads are calculated by summing up the aerodynamic characteristics of the major components separately (e.g., body, wing, tail, etc.) and then adding components interference factors. The missile's configuration here is composed of an axisymmetric forebody, a cylindrical after body, and two sets of in-line cruciform fins. Missile's body can be divided into three main parts: the forebody (or nose), the mid-section, and the aft (or boattail). There are many forebody shapes, but the conical, ogival and power series (or hemispherical) shapes are the most commonly used. They are selected on the basis of combined aerodynamic, guidance, and structural considerations. From the cross flow theory formulated by Allen and Perkins [8], an accurate prediction of the normal force coefficient of the body is:

$$C_{Nb} = 2\alpha + \frac{4C\lambda_{cyl}\alpha^2}{\pi} \tag{1}$$

where: α is the angle of attack, λ_{cyl} is defined as the cylinder fineness ratio ($\lambda_{cyl} = L_{cyl}/d$), missile's cylinder length over missile's diameter) and C is a constant depends on the flow type:

$$C = \begin{cases} 1.2\_\ for\_Laminar\_Flow \\ 0.3...0.4\_\ for\_Turbulent\_Flow \end{cases} \tag{2}$$

Missile surface platforms include wing, tail, and canard surfaces. These may be fixed or movable (i.e., control surfaces). The surface normal force coefficient is a function of Mach number, local angle of attack, aspect ratio, and the surface platform area. CN, which is based on the missile reference area, decreases with increasing supersonic Mach number and increases with angle of attack and the wing surface area.

The normal force coefficient derivative for rectangular platform wing finite span with no sweep is [8]:

$$C_{N\alpha} = \frac{-4}{\sqrt{M^2-1}}\left[1 - \frac{1}{2AR\sqrt{M^2-1}}\left(1 - \frac{\gamma M^4 + (M^2-2)^2}{2(M^3-2)^{3/2}}\right)A^l\right] \tag{3}$$

where: M is the Mach number, AR is the aspect ratio for the wing or tail and A^1 is related to thickness to chord ratio (t/c).

From [1] [9] and [14] the missile's total normal force coefficient after adding up all the components is:

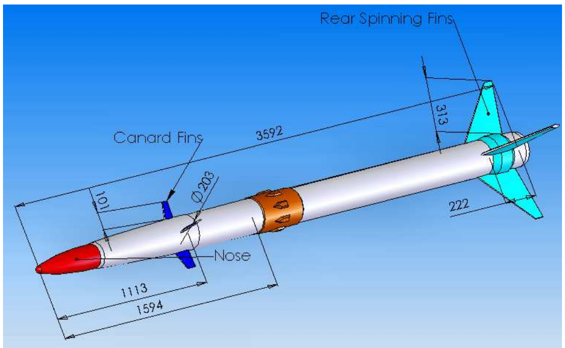

Figure 2 Definition of missile structure/dimensions [mm] for our simulation

$$C_N = C_{Nb} + C_{Nwa}(K_w + K_b)_w K_l \alpha Aw + C_{Nwa}\left[(K_w + K_b)_t \alpha + \right.$$
$$\left. + (k_w + k_b)_m \sigma\right] K_2 \left(1 - \frac{d\varepsilon}{d\alpha}\right) A_t \tag{4}$$

where σ is the tail deflection angle. $(K_w+K_b)_w$, $(K_w+K_b)_t$, K_2 and k_m are correction factors. K_1 is a constant. A_w or (A_t) are defined as the ratio of wing or (tail) area to missile's cross section area. $d\varepsilon\ d\alpha$ is the change of downwash angle. The subscripts w and t stands for wing and tail, respectively.

The drag on the missile can be divided into several major components, they are: wave drag due to the presence of shock waves and dependent on the Mach number, viscous drag due to friction, induced drag due to the generation of lift, base drag due to the wake behind the missile, interference drag due to the interaction of various flow fields and finally roughness drag due to surface roughness. For conical fore body the wave drag coefficient from [8] and [10] is:

$$C_{Dwc} = \left(0.083 + \frac{0.096}{M^2}\right)(5.73\theta)^{1.96} \tag{5}$$

where θ is the half missile nose cone angle in radian.

The wave drag coefficient of an isolated, rectangular wing or tails of finite span is [8]:

$$C_{Dw} = \frac{K_l (t/c)^2}{\sqrt{M^2-1}}\left[1 - \frac{1}{2AR\sqrt{M^2-1}}\right] \tag{6}$$

where t/c is the thickness to chord ratio and K_1 is a constant depending on the type of airfoil.
Viscous drag coefficient is the main component at hypersonic speeds, from [8] and [11]:

$$C_{Df} = \begin{cases} \dfrac{1.328}{\sqrt{R}};\ for\_R < 1e6 \\ \dfrac{0.427}{(\log_{10} R - 0.407)^{2.64}};\ for\_R \geq 1e6 \end{cases} \tag{7}$$

where: R is the Reynolds number based on the wetted area and the length of the missile. For large missiles, turbulent flow can be assumed. Induced drag coefficient is due to the generation of lift i.e. depending on angle of attack and is approximated by [8]:

$$C_{Di} \approx C_N \alpha \tag{8}$$

Base drag is a function of both the missile flight condition and geometry (i.e. the shape of the missile). The parameters affecting base drag are Reynolds number, Mach number, angle of attack, body's (missile's total length) fineness ratio (*L/d*), fin proximity, and the presence of boat tail or flare. Reynolds number, angle of attack, body fineness ratio and fin proximity are often ignored because they are negligible. And, in general the contribution of the base drag to the total drag is very small. Thus the base drag coefficient is [10]:

$$C_{Db} = 0.3129 e^{-0.38745M} \tag{9}$$

2. COMPUTATIONAL FLUID DYNAMICS (CFD)

Computational fluid dynamics (CFD) [14] is an engineering method in which flow fields and other physics are calculated in detail for an application of interest. Any CFD model is relying on several state equations to fully describe its behavior in fluid mechanics terms.

Missiles with dynamic components (as spinning tail fins) can pose significant challenges for numerical simulation. In the present example, the spinning tail is a by-product of the forces on the missile and is integral to its aerodynamic performance. Nevertheless, the performance of the missile is often characterized by the spin-averaged aerodynamic coefficients, and hence time-dependent, moving-body simulations are required to predict even static stability and control (S&C) information. Moreover, the spin-rate of the fin system is governed not only by the wind vector and canard deflections, but also by the strength and location of the convected canard vortices, whose induced velocity field differentially loads the tail fins at low angles of attack.

Conservation laws, such as the Euler and Navier-Stokes equations can be written in the following integral form:

$$\int_{V(t_2)} Q dV - \int_{V(t_1)} Q dV + \int_{t_1}^{t_2} \oint_{S(t)} \vec{n}\vec{F} dS dt = \int_{t_1}^{t_2} \int_{V(t)} P dV dt \tag{10}$$

In this equation, Q is a vector containing the set of variables which are conserved, e.g., mass, momentum, and energy, per unit volume. The equation is a statement of the conservation of these quantities in a finite region of space with volume $V(t)$ and surface area $S(t)$ over a finite interval of time $t_2 - t_1$. In two dimensions, the region of space, or cell, is an area $A(t)$ bounded by a closed contour $C(t)$. The vector **n** is a unit vector normal to the surface pointing outward, **F** is a set of vectors, or tensor, containing the flux of Q per unit area per unit time, and P is the rate of production of Q per unit volume per unit time.

The Navier-Stokes equations form a coupled system of nonlinear Partial Diferential Equations (PDE) describing the conservation of mass, momentum and energy for a fluid. For a Newtonian fluid in one dimension, they can be written as:

$$\frac{\partial Q}{\partial t} + \frac{\partial E}{\partial x} = 0$$

$$Q = \begin{bmatrix} \rho \\ \rho u \\ e \end{bmatrix}; E = \begin{bmatrix} \rho u \\ \rho u^2 + p \\ u(e+p) \end{bmatrix} - \begin{bmatrix} 0 \\ \frac{4\mu}{3}\frac{\partial u}{\partial x} \\ \frac{4\mu}{3}\frac{\partial u}{\partial x} + \kappa\frac{\partial T}{\partial x} \end{bmatrix} \tag{11}$$

where ρ is the fluid density, u is the velocity, e is the total energy per unit volume, p is the pressure, T is the temperature, μ is the coefficient of viscosity, and κ is the thermal conductivity. The total energy e includes internal energy per unit volume $\rho\varepsilon$ (where ε is the internal energy per unit mass) and kinetic energy per unit volume $\rho u^2/2$. These equations must be supplemented by relations between μ and κ and the fluid state as well as an equation of state, such as the ideal gas law. Note that the convective fluxes lead to first derivatives in space, while the viscous and heat conduction terms involve second derivatives. This form of the equations is called conservation-law or conservative form. Non-conservative forms can be obtained by expanding derivatives of products using the product rule or by introducing different dependent variables, such as u and p. Although non-conservative forms of the equations are analytically the same as the above form, they can lead to quite different numerical solutions in terms of shock strength and shock speed, for example. Thus the conservative form is appropriate for solving flows with features such as shock waves.

The simplest linear model for convection and wave propagation is the linear convection equation given by the following PDE:

$$\frac{\partial u}{\partial t} = v\frac{\partial^2 u}{\partial x^2} \tag{12}$$

where v is a positive real constant. For example, with u representing the temperature, this parabolic PDE governs the diffusion of heat in one dimension. Boundary conditions can be periodic, Dirichlet (specified u), Neumann (specified $\partial u/\partial x$), or mixed Dirichlet/ Neumann.

In common with the equations governing unsteady fluid flow, our model equations contain partial derivatives with respect to both space and time. One can approximate these simultaneously and then solve the resulting difference equations. Alternatively, one can approximate the spatial derivatives first, thereby producing a system of ordinary differential equations. The time derivatives are approximated next, leading to a time-marching method which produces a set of difference equations.

The simplest mesh involving both time and space is shown in Figure 3. Inspection of this figure permits us to define the terms and notation needed to describe finite-difference approximations. In general, the dependent variables, u, for example, are functions of the independent variables t, and x, y, z.

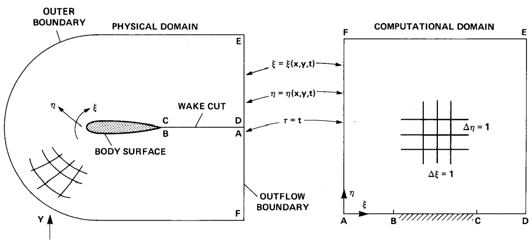

Figure 3 Physical and computational spaces

$$x = x_j = j\Delta x \qquad t = t_n = n\Delta t = nh \tag{13}$$

where Δx is the spacing in x and Δt the spacing in t.

A difference approximation can be generated or evaluated by means of a simple Taylor series expansion. One strategy for obtaining finite-difference approximations to a PDE is to start by differencing the space derivatives only, without approximating the time derivative. Another strategy for constructing a finite-difference approximation to a PDE is to approximate all the partial derivatives at once. This generally leads to a point difference operator which, in turn, can be used for the time advance of the solution at any given point in the mesh.

Finite-volume methods have become popular in CFD as a result, primarily, of two advantages. First, they ensure that the discretization is conservative, i.e., mass, momentum, and energy are conserved in a discrete sense. While this property can usually be obtained using a finite-difference formulation, it is obtained naturally from a finite-volume formulation. Second, finite volume methods do not require a coordinate transformation in order to be applied on irregular meshes. As a result, they can be applied on unstructured meshes consisting of arbitrary polyhedra in three dimensions or arbitrary polygons in two dimensions. This increased flexibility can be used to great advantage in generating grids about arbitrary geometries. Finite-volume methods are applied to the integral form of the governing equations.

$$\frac{d}{dt}\int_{V(t)} Q dV + \oint_{S(t)} \vec{n}\vec{F} dS = \int_{V(t)} P dV \tag{14}$$

The basic idea of a finite-volume method [15] is to satisfy the integral form of the conservation law to some degree of approximation for each of many contiguous control volumes which cover the domain of interest. Thus the volume V in Eq. (14) is that of a control volume whose shape is dependent on the nature of the grid. Examining Eq. (14), we see that several approximations must be made. The flux is required at the boundary of the control volume, which are a closed surface in three dimensions and a closed contour in two dimensions. This flux must then be integrated to find the net flux through the boundary. Similarly, the source term P must be integrated over the control volume.

After discretizing the spatial derivatives in the governing PDE's (such as the Navier- Stokes equations), we obtain a coupled system of nonlinear differential equations in the form:

$$\frac{d\vec{u}}{dt} = \vec{F}(\vec{u}, t) \tag{15}$$

These can be integrated in time using a time-marching method to obtain a time accurate solution to an unsteady flow problem. For a steady flow problem, spatial discretization leads to a coupled system of nonlinear algebraic equations in the form:

$$\vec{F}(\vec{u}) = 0 \tag{16}$$

As a result of the nonlinearity of these equations, some sort of iterative method is required to obtain a solution. For example, one can consider the use of Newton's method, which is widely used for nonlinear algebraic equations. This produces an iterative method in which a coupled system of linear algebraic equations must be solved at each iteration. These can be solved iteratively using relaxation methods, or directly using Gaussian elimination or some variation thereof. Alternatively, one can consider a time-dependent path to the steady state and use a time-marching method to integrate the unsteady form of the equations until the solution is sufficiently close to the steady solution. When using a time-marching method to compute steady flows, the goal is simply to remove the transient portion of the solution as quickly as possible; time accuracy is not required. Application of a time-marching method to an Ordinary Differential Equation (ODE) produces an ordinary difference equation (ODE).

In the case of the nonlinear ODE's of interest in fluid dynamics, stability is often discussed in terms of fixed points and attractors. In these terms a system is said to be stable in a certain domain if, from within that domain, some norm of its solution is always attracted to the same fixed point.

In our simulation the compressive option of transient CFD was selected, in turbulent flow hypothesis (a standard *k-ω* turbulence model was selected.). Differences in results (pressure, density, velocity distributions) between the incompressible and compressible algorithms can exist at Mach numbers as low as *0.3*, and are quite pronounced when the Mach number is as high as *0.7*. Typically, we know the Mach number or the velocity or the mass flow along with the static temperature for the inlet. Knowing the velocity or Mach number enables us, using the above equations, to calculate the appropriate total temperature. If we know only the mass flow rate, we can approximate the pressure at the inlet by the reference pressure and use it with the equation of state to approximate the inlet density and thus the velocity. For subsonic problems, the boundary condition strategy is similar to that used for incompressible flow problems, that is, velocity or pressure at the inlet and pressure at the outlet. For supersonic-hypersonic problems, however, the nature of the equations changes and the effects of downstream boundary conditions cannot propagate upstream. It is common in such cases to apply both pressure and velocity to upstream locations. Free stream conditions are often applied as far field boundary conditions for external flow problems. Often specification of pressure at these boundaries helps. However, as the solution develops, phenomena such as shock waves propagate to these boundaries. Also, if the boundary is too close to the region of interest (e.g. the airfoil the flow is moving past), the velocity solution near the boundary will tend to be greater than the free stream velocity. In such cases, a better choice for the velocity boundary conditions is the symmetry condition (only specify the velocity normal to the boundary as zero).

We must solve compressible analyses as pseudo-transient or transient problems. This is due to the non-elliptic nature of supersonic-hypersonic problems. The pseudo-transient approach is quite adequate when the time-history of the developing transient is not of interest. In that approach, we'll apply inertial relaxation to the pressure equation.

Artificial viscosity helps to prevent negative temperatures. We'll set it at the beginning of the analysis, and must reduce it slowly for subsequent continuations of the analysis. The magnitude of the artificial viscosity required can vary greatly. The smaller the starting value, the fewer the global iterations required. But if it is not large enough, we may encounter negative static temperatures. We'll use the laminar and effective viscosities to gauge a good starting value. It is typically a couple orders of magnitude higher than the effective viscosity, which in turn is initialized as a multiple of the laminar value. Generally, a value 3 or 4 orders of magnitude higher than the laminar viscosity is a good approximate starting point.

In a compressible problem, the final answer would be a function of the artificial viscosity if it were not removed. Therefore, after stability has been achieved, gradually remove the artificial viscosity during repeated analysis continuations.

Inertial relaxation helps to stabilize a solution by increasing the magnitude of the main diagonal of the matrix equation along with a corresponding increase in the forcing function. Values used are generally between 1.0×10^{-3} (less relaxation) and 1.0×10^{-6} (more relaxation) for pressure. The smaller values provide more diagonal dominance and thus equation stability. The cost of this is slower convergence since it de-emphasizes the influence of the cross-coupling terms present in the equations.

Unlike artificial viscosity, the inertial relaxation does not affect the answer if the problem is converged and thus does not have to be removed. It is best to reduce the magnitude to the range of 1×10^{-4} later in the analysis.

All the techniques discussed so far involve the steady state algorithm. It is common for supersonic-hypersonic problems, even if they are posed as steady state to be solved with the transient algorithm. An initial velocity field can be imposed as a first guess. The inertial relaxation acts similarly to the transient algorithm and its use is considered redundant in transient analyses.

3. NUMERICAL INVESTIGATION

3.1 CAD Geometry and CFD mesh

The simulation environment was supposed to be a portion of the wind tunnel where the missile is subjected to specific tests. That's why the fluid domain is circumscribing the missile as a "box" with walls having imposed null fluid velocity boundary conditions; the fluid velocity is *800 m/sec* at the inlet area and atmospheric pressure condition on outlet area.

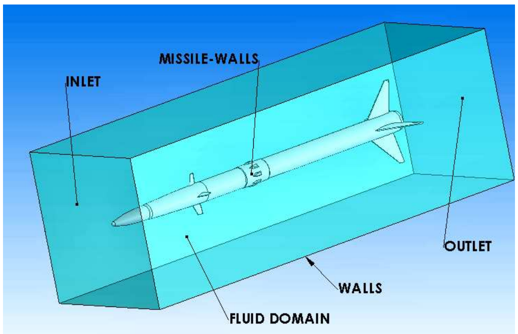

Figure 4 CAD geometry of the fluid domain

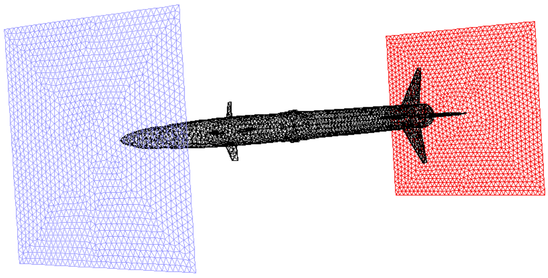

Figure 5 Inlet, Outlet and Missile Wall's CFD mesh (for clarity fluid domain mesh wasn't shown)

The fluid was considered, of course, the air with its standard density and viscosity at sea level. Having defined the mesh, material, boundary conditions, viscosity model, the study will consider 4 scenarios in which, keeping constant all the model above stated conditions, the spinning tail angular velocity will be varied as corresponding to *500*, *1000*, *1500*, and *2000 rpm*. Initial model which will be used for comparing the computed results will have the spinning tail fixed.

3.2 CFD simulation for the initial model

As said above, the initial model will consider the angular velocity of the missile spinning tail as null. The missile velocity was deemed to be *800 m/sec*, for the present and for all the subsequent scenarios. For clarity, one longitudinal and two transversal sections (intersecting the fins sets where is expected to have special flow conditions) were considered.

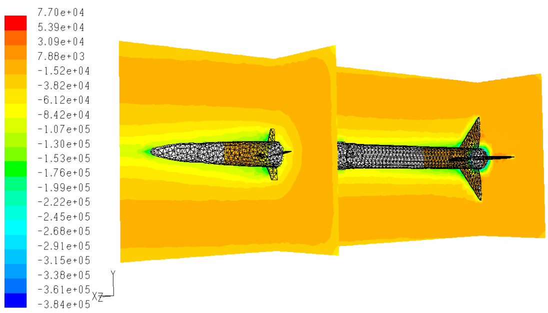

Figure 6 Total Pressure distribution for initial model

The total pressure in the fluid domain is given in the figure above. As somehow expected (since is common knowledge that the most intense flowing conditions will develop at the rear of the missile), the biggest dynamic pressure of *7.7 e4 Pa*, is computed at the rear end of the missile.

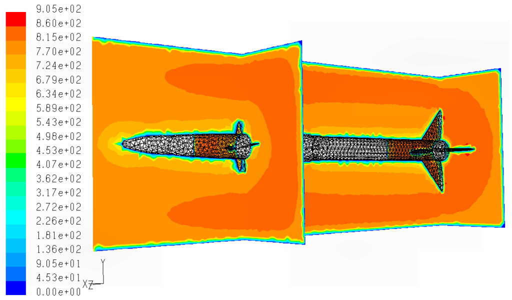

Figure 7 Fluid velocity magnitude distribution for initial model

On the figure above is presented the fluid velocity magnitude distribution around the model. The influence of walls where the velocity was imposed to be null is slowing down the fluid in its immediate vicinity and the model is determining the specific supersonic flow separation, wake and swirls all around the structure. The maximum achievable velocity inside the fluid domain is *905 m/sec*.

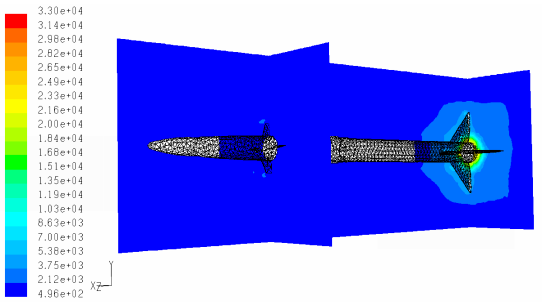

Figure 8 Fluid turbulent kinetic energy distribution for initial model

The fluid turbulent kinetic energy distribution is highlighting that zones which are characterized by intense turbulent regimes, as in the rear edges of fins and missile. The maximum turbulent regime is developing at the rear end of the missile.

The pressure exercised by fluid upon the missile's structure will result in structural stress of the missile. The maximum wall shear stress (*2.63e3 Pa*) of course will occur where the maximum fluid pressure is developing, namely on the missile fins and rear end.

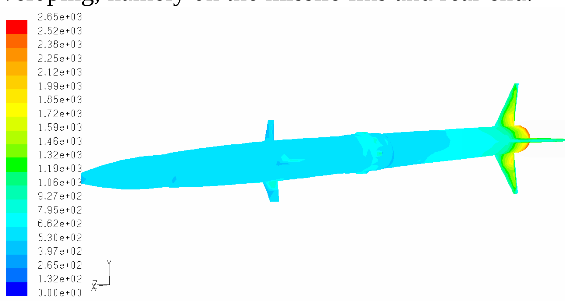

Figure 9 Wall Shear Stress distribution for initial model

3.3 Simulation Scenario 1-Spinning Tail 500 rpm

Since there is no change in the geometry and initial conditions for the present and for the following scenarios, except the spinning velocity of the missile tail, the computed aerodynamic parameters for the front of the missile are kept unchanged whereas they change in the rear end zone of the fluid domain. We'll focus our attention to this portion of the missile.

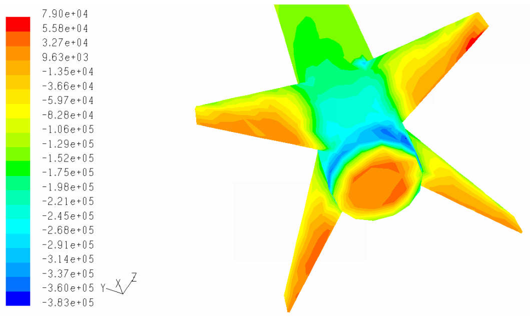

Figure 10 Total Pressure distribution the model with Spinning Tail 500 rpm

Even is not yet too visible t this stage, a certain asymmetry between the total pressures exerted on opposite faces of the tail fins of the missile is in place as may be seen on the figure above. By probing the dynamic pressure on two opposite faces of the tail fins, one was computed as 9627.2 Pa and the other 55845.8 Pa.

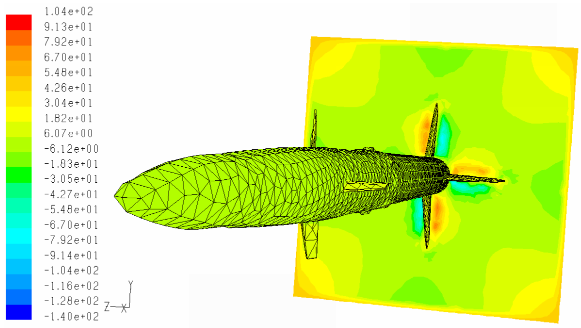

Figure 11 Tangential Velocity distribution the model with Spinning Tail 500 rpm

The tangential velocity distribution instead, for this scenario, is perfectly visible, being unequally distributed on opposite faces of each tail fin. The maximum computed tangential velocity is 104 m/sec. By probing the velocity on two opposite faces of a fin, one was computed as 66.9 m/sec and the other -79.2 m/sec.

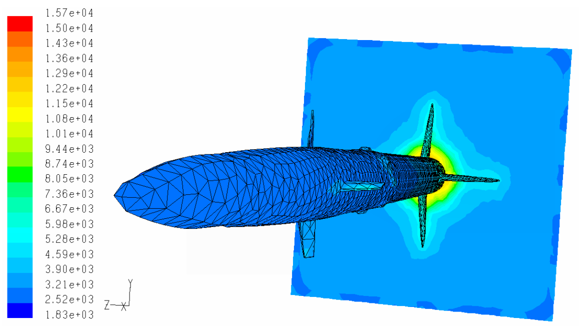

Figure 12 Turbulence Intensity distribution the model with Spinning Tail 500 rpm

The turbulence intensity reaches a maximum of *1.57 e4 %* in the same area of the missile's tail, as seen in the figure above.

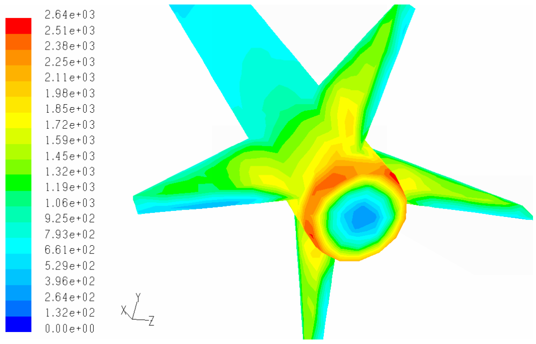

Figure 13 Wall Shear Stress distribution the model with Spinning Tail 500 rpm

The wall shear stresses exerted on the tail fin's opposite faces, as seen in the figure above, are asymmetrical, witnessing the effects of spinning motion on the load situation in this area. By probing the dynamic pressure on two opposite faces of a fin, one was computed as *1850 Pa* and the other *1717 Pa.*

3.4 Simulation Scenario 2-Spinning Tail 1000 rpm

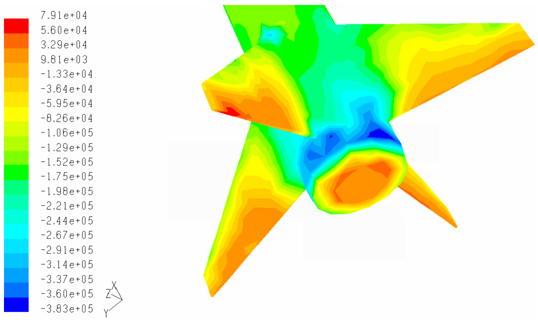

Figure 14 Total Pressure distribution the model with Spinning Tail 1000 rpm

The uneven distribution of total pressure on the opposite sides of tail fins is becoming more visible by now. By probing this pressure on one side was found *9808 Pa*, and on the other *56015 Pa*. The small change in respect with the previous scenario, demonstrate that the impact of spinning motion is small in absolute terms, over the ruling effect of supersonic velocity of the missile.

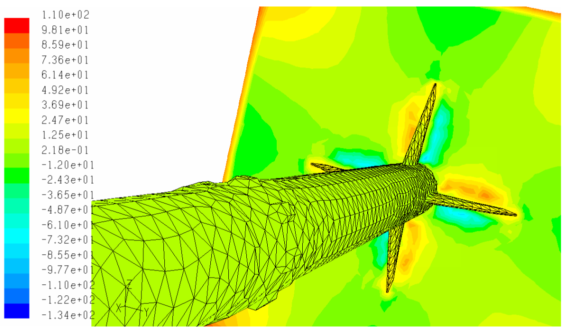

Figure 15 Tangential Velocity distribution the model with Spinning Tail 1000 rpm

The tangential velocity distribution instead, for this scenario, is again, perfectly visible, being unequally distributed on opposite faces of each tail fin. The maximum computed tangential velocity is *110 m/sec.* By probing this velocity on one side was found *73.6 m/sec*, and on the other *-85.4 m/sec*.

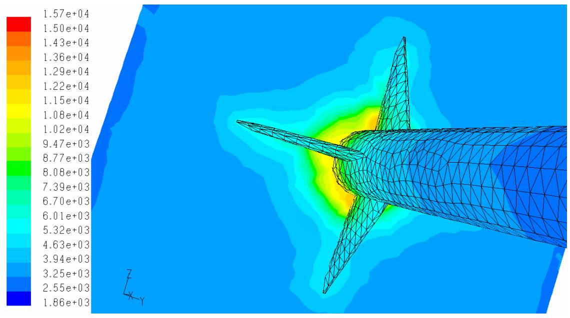

Figure 16. Turbulence Intensity distribution the model with Spinning Tail 1000 rpm

The turbulence intensity reaches a maximum of *1.57 e4 %* in the same area of the missile's tail, as seen in the figure above.

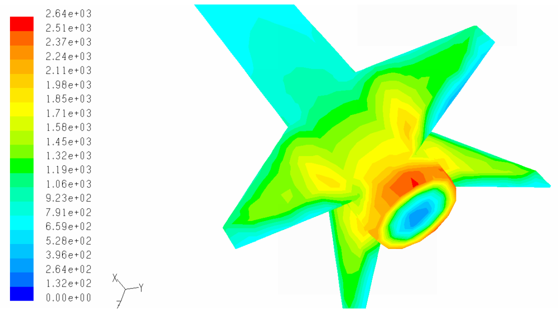

Figure 17 Wall Shear Stress distribution the model with Spinning Tail 1000 rpm

The wall shear stresses exerted on the tail fin's opposite faces, as seen in the figure above, are asymmetrical, witnessing the effects of spinning motion on the load situation in this area. By probing the dynamic pressure on two opposite faces of a fin, one was computed as *1978.4 Pa* and the other *1846.5 Pa.*

3.5 Simulation Scenario 3-Spinning Tail 1500 rpm

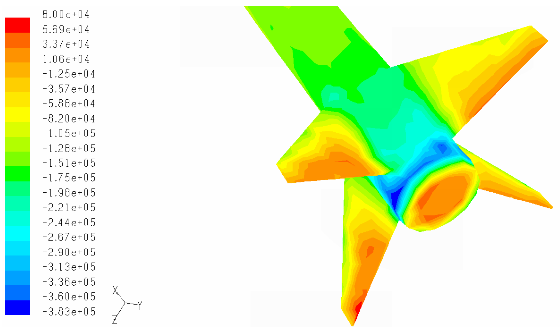

Figure 18 Total Pressure distribution the model with Spinning Tail 1500 rpm

By probing this pressure on one side was found *10607 Pa*, and on the other *56886.3 Pa*.

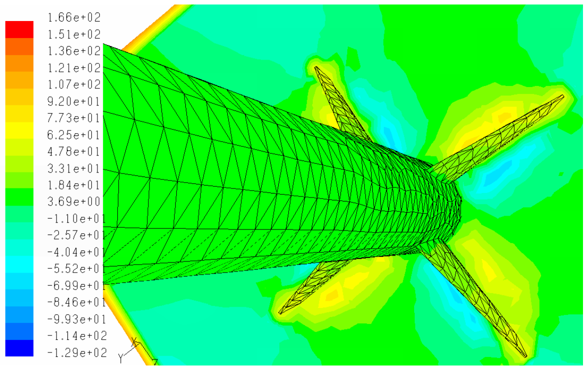

Figure 19 Tangential Velocity distribution the model with Spinning Tail 1500 rpm

By probing this velocity on one side was found *77.2 m/sec*, and on the other *-99.3 m/sec*.

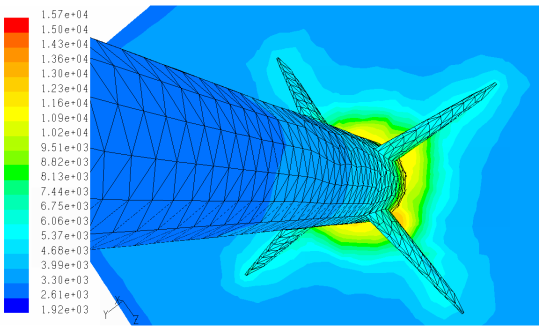

Figure 20 Turbulence Intensity distribution the model with Sinning Tail 1500 rpm

The turbulence intensity reaches a maximum of *1.57 e4 %* in the same area of the missile's tail, as seen in the figure above.

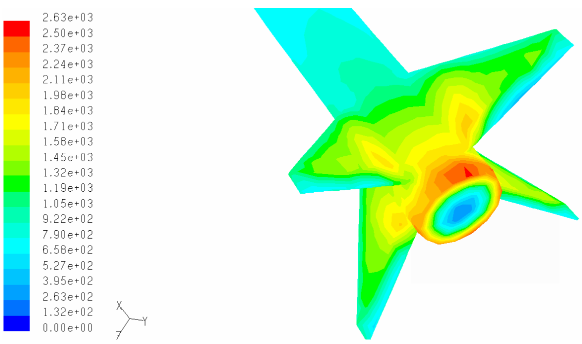

Figure 21 Wall Shear Stress distribution the model with Spinning Tail 1500 rpm

The wall shear stresses exerted on the tail fin's opposite faces, as seen in the figure above, are asymmetrical, witnessing the effects of spinning motion on the load situation in this area. By probing the dynamic pressure on two opposite faces of a fin, one was computed as *1975.1 Pa* and the other *1843.4 Pa*. It seems that these values are well near the ones computed for the previous scenario.

3.6 Simulation Scenario 4-Spinning Tail 2000 rpm

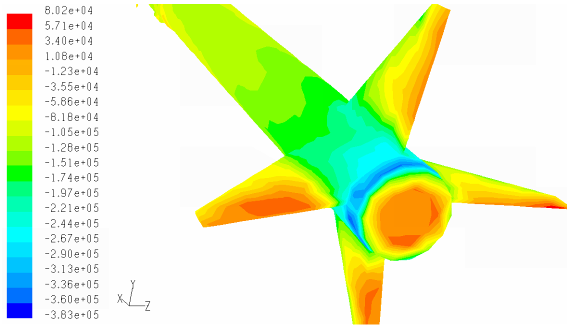

Figure 22 Total Pressure distribution the model with Spinning Tail 2000 rpm

By probing this pressure on one side was found *10811 Pa*, and on the other *57101.5 Pa*.

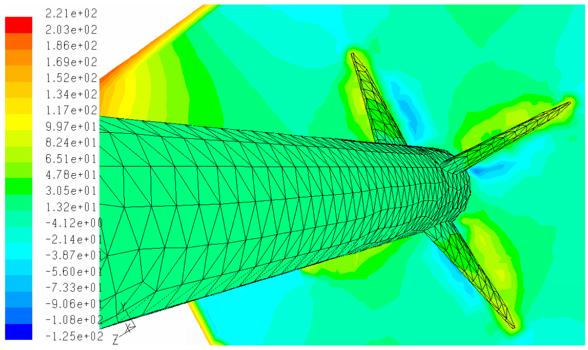

Figure 23 Tangential Velocity distribution the model with Spinning Tail 2000 rpm

By probing this velocity on one side was found *82.3 m/sec*, and on the other *-107.8 m/sec*.

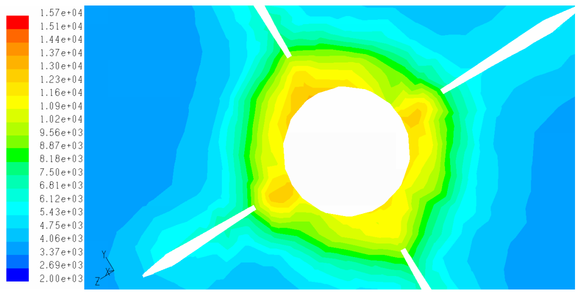

Figure 24 Turbulence Intensity distribution the model with Spinning Tail 2000 rpm

The turbulence intensity reaches a maximum of *1.57 e4 %* in the same area of the missile's tail, as seen in the figure above.

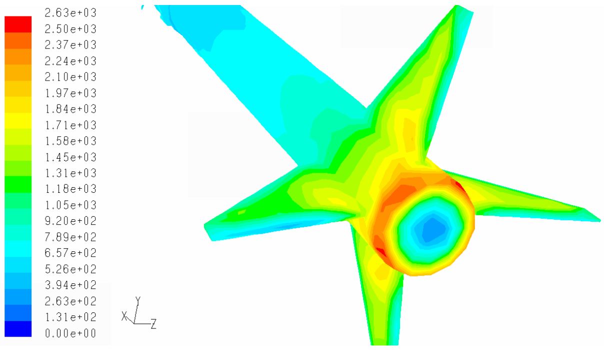

Figure 25 Wall Shear Stress distribution the model with Spinning Tail 2000 rpm

The wall shear stresses exerted on the tail fin's opposite faces, as seen in the figure above, are asymmetrical, witnessing the effects of spinning motion on the load situation in this area. By probing the dynamic pressure on two opposite faces of a fin, one was computed as *1972.3 Pa* and the other *1840.8 Pa*. It seems that these values are well near the ones computed for the previous scenario. For these spinning velocities the shear stress is almost stagnating.

4. CONCLUSIONS

As seen in the graph below, the minimum total pressure (depending on Tail spin velocity) is increasing and has the biggest slope within the interval *1000-1500 rpm*, which may be seen as the most sensitive interval in terms of impact on overall aerodynamic condition of missile behavior.

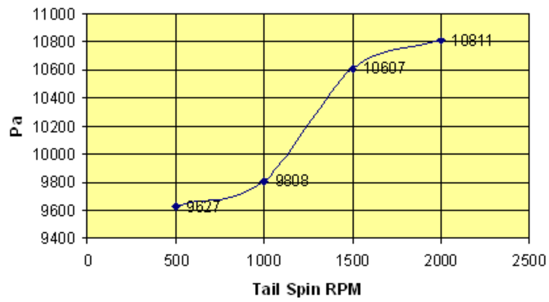

Figure 26 Minimum total pressure evolution

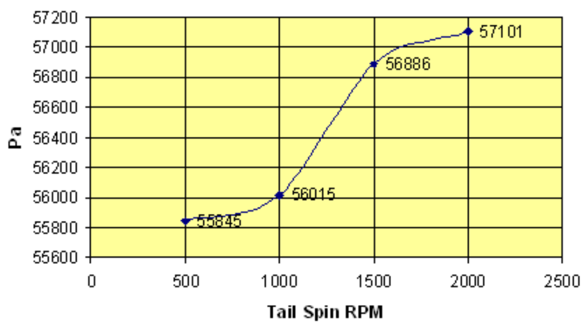

Figure 27 Maximum total pressure evolution

The same phenomenon is occurring for the maximum total pressure evolution versus the tail spin angular velocity, the most sensitive range of angular velocities being *1000-1500 rpm* as well.

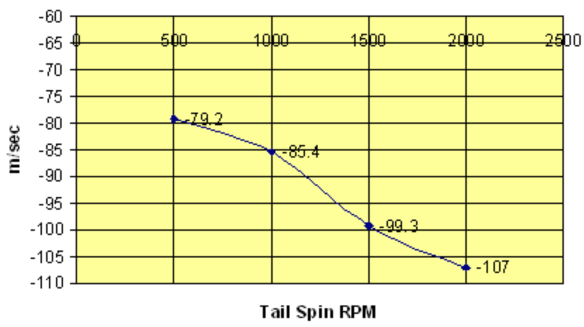

Figure 28 Minimum tangential velocity evolution

The minimum tangential velocity is slowing decreasing for the intervals *500-1000 rpm* and *1500-2000 rpm*, the sloppiest decreasing being computed in the same sensitive range of *1000-1500 rpm.*
Instead the maximum tangential velocity evolution on the other side on tail fin is almost linear for the entire spinning velocities domain.

The Minimum Wall Shear Stress evolution (Fig.30) is characterized by an abrupt increase in the interval *500-1000 rpm*, being followed by a virtually constant evolution.

Precisely the same sort of evolution is encountered for the Maximum Wall Shear Stress (Fig.31).

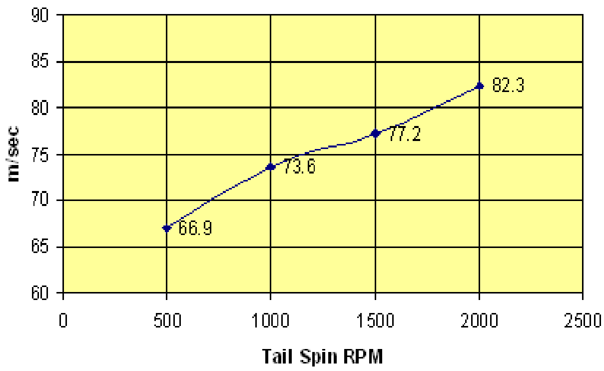

Figure 29 Maximum tangential velocity evolution

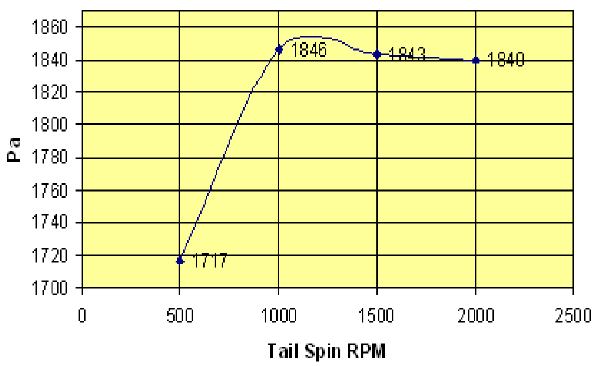

Figure 30 Minimum Wall Shear Stress evolution

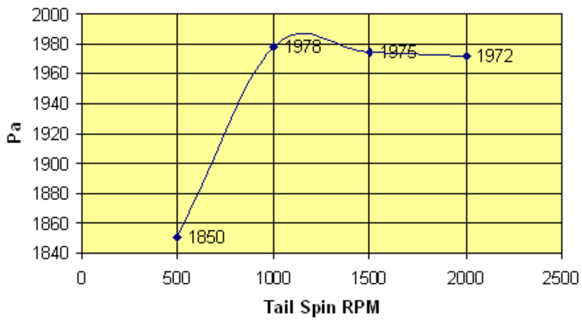

Figure 31 Maximum Wall Shear Stress evolution

The numeric model presented in this paper, provides consistent and reasonable results for the spinning tail missile structural-aerodynamic analysis. Its results are comparable with other approaches but this kind of analysis must be done on a case-by-case basis.

The results obtained from the CFD numeric simulation, may be used to define a certain structure-shape of this special class of missiles prior any attempt to in depth analyzing and testing it, this shortening the needed time for design and testing programs.

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EXPLOATATION OF OIL AND GAS DEPOSITS IN THE BLACK SEA. ENVIRONMENTAL IMPACT OF SESIMIC ACTIVITY

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ABSTRACT

The prospecting and exploitation activity of hydrocarbon deposits in Romania has experienced a major development in the nineteenth century and has remained since a major component in achieving energy independence in our country. In 1970 the oil and gas production in Romania reached a peak of over 14.5 million tons of crude oil. Gas production reached 33 million tons of oil equivalents. After 1990 the production level fell again, because of the depletion of the existing resources and the lack of investment prevented the discovery and the development of new fields. They have led in the last few years to a decrease of the oil production level to less than 5.0 million tons of oil and of the gas production of 10,3 million oil equivalent. After 1990 the Romanian Government through THE NATIONAL AGENCY FOR MINERAL RESOURCES has decided to organize international auctions to award a series of contracts regarding exploration and participation to rates of production of specialized companies that run all the financial funds and necessary technologies for the development of hydrocarbon prospecting activities. That is why in the Black Sea, beside the oil and gas deposits leased to OMV Petrom, there were also leased 7 areas needed for research, exploration and possible exploitation of oil and gas deposits. This paper presents the effects of seismic research works on the environment, considering that these are the first that will run on the platform of the Black Sea shore

Keywords: *research, seismic, Black Sea, impact assessment.*

1. INTRODUCTION

The exploitation of oil and gas in the Black Sea began in 1972 when the Marine Research Institute Constanta triggered a complex recovery program of the continental shelf resources. Within the program there were studied equipments, devices, facilities and machinery specific to offshore drilling, as well as data about the marine installations in the Black Sea. In 1975 (November 9th) was launched afloat the first offshore platform Gloria (fig. 1) that on September 16th, 1976 began offshore operations. They were held at a distance of 72mM and at a depth of 90 m.

In 1980 in the Black Sea there were found hydrocarbons [2]. There were performed over a hundred drilling and on May 7th, 1987 at 16:45 there were discovered more deposits, part of the two perimeters (Istria XVIII and Neptun XIX) in the area of 13880 square kilometers and currently available in OMV-Petrom lease. The deposits in operation (Lebada Est, Lebada Vest, Sinoe, Pescarus and Delta) [3] produce 32,000 boe per day, which represent 18% of Petrom's production. After 1990, due to the lack of financial resources, the Romanian State through the NATIONAL AGENCY OF MINERAL RESOURCES held several rounds of auctions, currently being leased 10 maritime areas (Table 1). Except the areas leased by STERLING RESOURCES (that started its petroleum activity in 2007) all the other companies started their petroleum activity in 2011. The petroleum activity consists in developing the following steps [4]:

a. Opening a branch of the company in Romania,
b. Signing the concession agreements,
c. Programming an exploration program and presenting it for approval to ANRM,
d. Obtaining permits for exploration of perimeters,
e. Commencement of perimeters seismic research activity,
f. Interpretation of data resulting from seismic research,
g. Starting the drilling program of producing wells,
h. Research of drilled layers and economic analysis of outlined deposits
i. Starting exploration drilling and preparing deposits for exploration,
j. Installation of oil extraction facilities, primary processing and transportation to shore of crude oil and gas,
k. Payment to Romanian State of petroleum royalties and of related taxes.

2. MARINE DEPOSITS GEOLOGY

Interpretation of the 2D seismic data collections made in the 1980s and early 1990s in conjunction with geological information from wells drilled in the Black Sea indicate possible accumulations of hydrocarbons at about 2300-2800 m depth. The deposits are located in the sands of the Lower Pontian and the limestone in Oligocen. Both levels are stratigraphic traps, the Oligocen being dependent of stratigraphic slope on the erosion sectioning emergence towards west, the Pontian being dependent of the wedging out of sands also of the stratigraphic slope on the emergence towards west. The quality of existing seismic data is poor. Is needed seismic research in 2D in order to better define potential deposits of hydrocarbons and research in 3D to check seabed structure.

3. ACTIVITIES DEVELOPED FOR SEISMIC RESEARCH

Seismic activity encloses the following steps:

a. Data acquisition phase: analog and digital investigations on future wells locations and sampling sedimentation test from the seabed.
b. Phase of processing and interpretation of data on land and reporting: multichannel seismic data of high resolution which are realized in an analysis center in France or England. The two phases take place rapidly (data harvesting period for 1000 sq km is of maximum 60 days and for data processing is of maximum 90 days) so that the petroleum activity to not encounter downtime.

The seismic research consists in using a special vessel that will carry out the following activities:

- Emission of seismic waves transmitted by an artificial source by shooting with air jet,
- Reception waves and especially marking reception time of these waves,
- Recording the time of reception of seismic waves and of the angle of reception,
- Processing data by analyzing the response time of seismic waves and especially of the angle of response, depending on the nature of the layer penetrated by waves,

Delivery of data to beneficiary and correlation of geological data with seismic data.

Since each concession company will want to make their own seismic studies, environmental analysis shows that the maximum water depth is of 110 m and the projects will consist of issuing seismic waves on different lengths (depending on the equipment used) but the shoots will take place every 12,5 m, at a speed of 40,5 knots (optimum interval of reception of seismic waves). The geophysical investigation system consists of GPS and DGPS positioning equipment, sea depth control devices (with an eco-sonar) for determining any natural obstacles or man-made and located in the research area in the seabed and high-resolution seismic prospecting system consisting of an air gun battery at a pressure of 2000 psi, a receiver consisting of hydrophones mounted in line and towed by boat as well as a computer data recording.

Seismic profiles are placed on the work surface in a grid (as a network of lines parallel and perpendicular to the geological structure), and the vessel that conducts the exploration will move along each line emitting acoustic signals at intervals of approximately 8 seconds. The acoustic signals emitted by the source diffuse into the basement from where they return as reflections caused by geological formations, which are received by hydrophones (placed on a long cable/streamer), then recorded on the computer of the ship and then processed and interpreted from the geological point of view.

The reflected acoustic signal is detected by receivers called hydrophones (hydrophone = electromagnetic powered microphone which can be used under water). Hydrophones groups are fixed on a long cable (streamer), which is towed at the stern of a vessel for seismic research. The working depth at which the streamer is towed is contained within a 5 to 7 m.

Data is recorded on the recorders on board and will be processed to obtain seismic profiles that can be interpreted by geophysicists or geologists. While seismic data strings can be produced at speeds of about 50-100 kilometric lines/day (depending on the weather conditions and considering that there are no technical problems), to interpret and process the data takes several weeks.

Seismic energy source is represented by a battery consisting of more than 72 air guns towed by the ship at a depth between 4 and 6 m. The air gun is a pneumatic mechanism that generates acoustic signals by the rapid release of a volume of compressed air at different pressures (in the case of this project, of 2000 psi = 138 bar). The air expands violently causing an initial impulse that results in a series of pulses of decreasing amplitude with each oscillation. Guns used in a series have the pneumatic chamber volume between 40 and 300 inch^3, the total volume being of 3480 inch^3.

Sound frequencies are of maximum 280 Hz. The highest amount of sounds is directed vertically toward the seabed, the air-gun being designed as to achieve maximum targeting of the waves front.

4. INFORMATION REGARDING PHYSICAL AND BIOLOGICAL POLLUTANTS

Table 2 provides information on the physical pollutants generated by seismic prospecting activities to be held on site, as well as measures to eliminate / reduce pollution. After describing the technical parameters of sound waves (frequency, amplitude, spectral pressure) that have seismic sources (air guns) used on ship, it is clear that the most vulnerable organism from the perimeter site of seismic works are the three species of marine mammals living in the Black Sea – the dolphins Tursiops truncates, Phocoena phocoena and Delphinus delphis – because they emit and receive sounds in the frequency band specific to seismic sources used in acquisition. As for the seal Monachus monachus, another marine mammal from the Black sea, its' preferential habitat is the area of Capul Kaliakra (Cape of Kaliakra); so surveying will have no effect upon them.

The effects of noise on marine mammals can be direct (bodily injury and/or auditory trauma, up to chronic effects and stress effects, manifested by decrease of individual viability, increased vulnerability to disease, increased potential for the impact of cumulative adverse effects, sensitivity to noise etc.) and indirect (lowering the availability of food, increasing vulnerability to predators). At the same time the sounds specific to prospects may cause trauma only in the early stages of development of benthic invertebrates and fish (eggs, larvae and juveniles) and only on a very small range. As for pelagic fish species, the physical effects of acoustic waves on fish can be lethal only at distances less than 5 m from it. From an experimental study conducted by authors revealed a mortality of 0,018%, for the worst scenario, negligible in comparison with the mortality average rate of 10% / day.

The only clearly documented effects are the behavioral effects of fish in the area, namely the temporary removal from the area, with a reduction of fishing during the prospecting period and about five days after their termination. After this time the local stock of fish recovers gradually, quickly reaching the previous values.

Plank tonic organisms of animal and vegetable origin are the only ones on whom the effects of seismic surveying noises can be fatal. It is estimated that this mortality will be lower than natural mortality, and their effects will be rapidly annihilated by the diffusion and mixing processes and dead animals will be replaced quickly due to their short life cycles.

5. CONCLUSIONS

Geophysical research works do not have major effects on the environment but on marine mammals. Therefore there will be seen the works started only if the animals are not in the area on a range of 500 m and blasting shall be done progressively during the first 30 minutes of prospecting. Also, prospecting will be not take place at the same time in all the operating perimeters (it will be accepted only a vessel of seismic research).

Fig. 1 Gloria offshore platform [1]

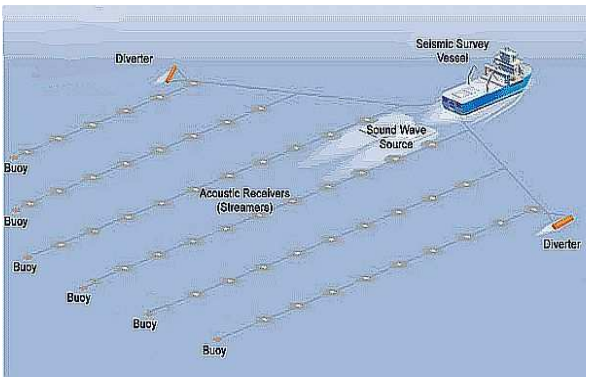
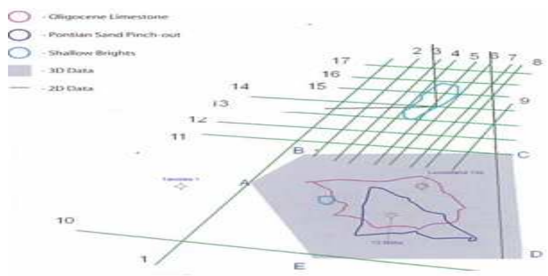


Fig. 2 Seismic research principles [5]



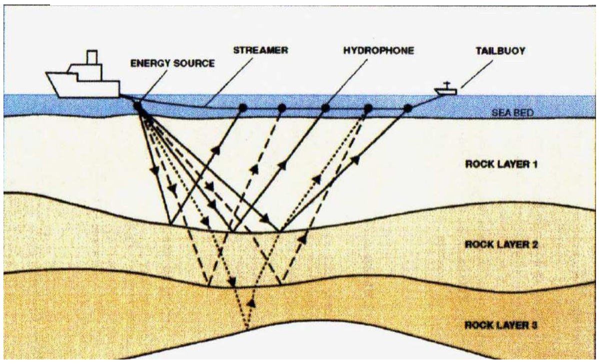


Fig. 3 Emission and reception of seismic waves [5]

Fig. 4 Network of seismic profiles [5]

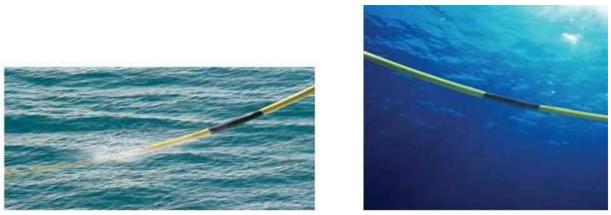


Fig. 5 Streamer [5]

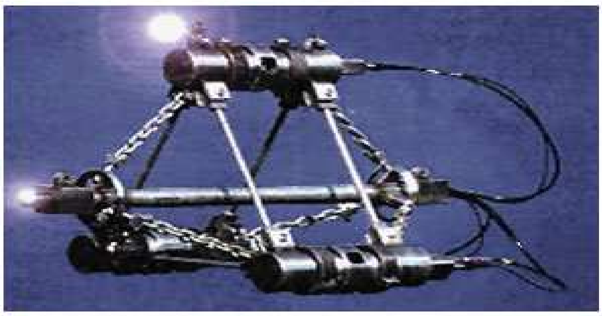


Fig. 5 Air-gun [5]

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Table 1. Leased perimeters in the offshore platform of the Black Sea

Perimeter / Name	Number	Surface (sq km)	Operator
Est Rapsodia	26	**1000**	**Lukoil**
Trident	26	**1000**	**Lukoil**
Midia	4	**3500**	**Sterling Resources**
Pelican	4	**1000**	**Sterling Resources**
Luceafarul	28	**1000**	**Petro Ventures**
Muridava	24	**1000**	**Melrose Resources**
Cobalcescu	24	**1000**	**Melrose Resources**
Neptun	15	**9900**	**Petrom+Exxon**

Table 2 Information on physical and biological pollution generated by seismic prospecting activities on site

Pollution type	Pollution source	Source no.	Calculated pollution caused by the activity on the target	Means of elimination/ reducing pollution
Noise	Air-gun batteries	72 guns	222 dB (re 1 Pa at 1 m), In the aquatic environment	Not exceeded the forecast work period (60 days) Audible warning before starting the activity
Atmospheric emissions	From burning fuel oil for ship movement	1	Emissions calculated for a consumption of 18 tons of fuel/day over a period of 60 days; total = 1080 tons of fuel	Not exceeded the forecast work period (60 days) Use of fuel with low content of sulfur in accordance with G.R. no. 470/2007
Waste-water	Vessel consumption (47 persons x 200 tons x 60 days)	1	564 tons	Not exceeded the forecast work period (60 days) Compliance with legislation in force regarding planned discharges.

COMPUTER STUDY OF STRESS STATE ON A SINGLE FLOOR PLATE USING FINITE ELEMENT METHOD

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ABSTRACT

The purpose of this paper is to verify the induced stresses of a framework element from central area of the chemical tanker ship type.

This static calculation was performed by the finite element method with Femap software as modeler and NX Nastran as solver.

Keywords: *mechanical structural, hydrostatic water pressure, stress calculation.*

1. INTRODUCTION

The main concern regarding the development with finite element is to generate a model providing the best possible results of the structural strength.

Sizing of the model was made in accordance with the rules of the classification company Germanischer Lloyd.

For modelling and analysis of the stresses around the relief cut-outs of a frame element, in this case of a floor, we used finite element software system FEMAP version 9.3.1.

The ship considered is a chemical tank type ship being designed for transporting chemicals.

1.1 Main dimensions and characteristics

Length between perpendiculars	L_{pp} = 213.5 m
Length of water line at T	L_{wl} = 216.5 1 m
Breadth	B = 32,2 m
Depth	H = 18 m
Scantling draught	T = 14,4 m
Block coefficient	C_b = 0.836
Max. speed in calm water	v = 14 kn
Frame spacing in cargo holds area	a = 0.8 m
Web frame spacing	4a = 3.2 m
Displacement	Δ = 72000 dwt

1.2 Modeling the Structure:

The hull structure considered in the 3-D hold model includes three cargo tanks of the parallel mid-body, as shown in Figure 1.

The global coordinate system of the finite element model is defined as follows:

X-axis: Longitudinal, positive from aft to fore;

Y-axis: Transverse (athwart ships), positive toward portside;

Z-axis: Vertical, positive upwards;

Origin: Base-line.

The following units are used for analysis

- Length: millimeters (mm)
- Pressure: Megapascals (N/mm^2)
- Mass: kilogramme (kg)
- Stress: N/mm^2 (MPa)

2. DESCRIPTION OF THE MODEL

Register conditions recommend, for the analysis with the finite element method of a ship structure, to consider two or three merchandise store rooms (cargo tanks) in order to reduce the influence of the edge conditions, throughout pressure distribution in the master section.

For this calculation we used a model extended on the length of three store rooms from the central area of the ship, so as to avoid the end effect and more precisely we have studied the central store room.

The elements of the plate were used for ground, double bottom, supports, and rod elements were used for simple framework.

The size of total mesh is 1/2 of the longitudinal distance (356 mm). In the area of interest 1/8 (Figure 2) of the longitudinal distance (89 mm) was finely modeled.

In order to eliminate the links influences, smooth meshing was used for the floor plate in the middle of cargo hold area.

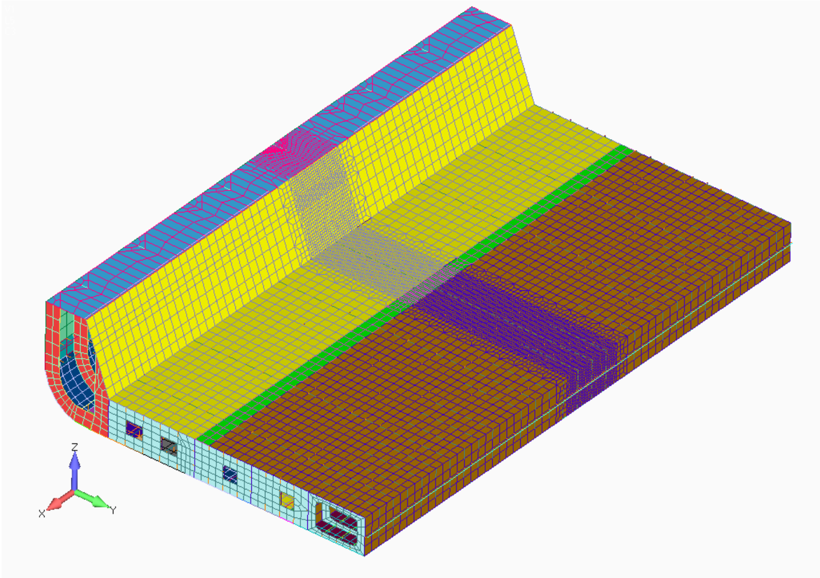

Figure 1 Global model

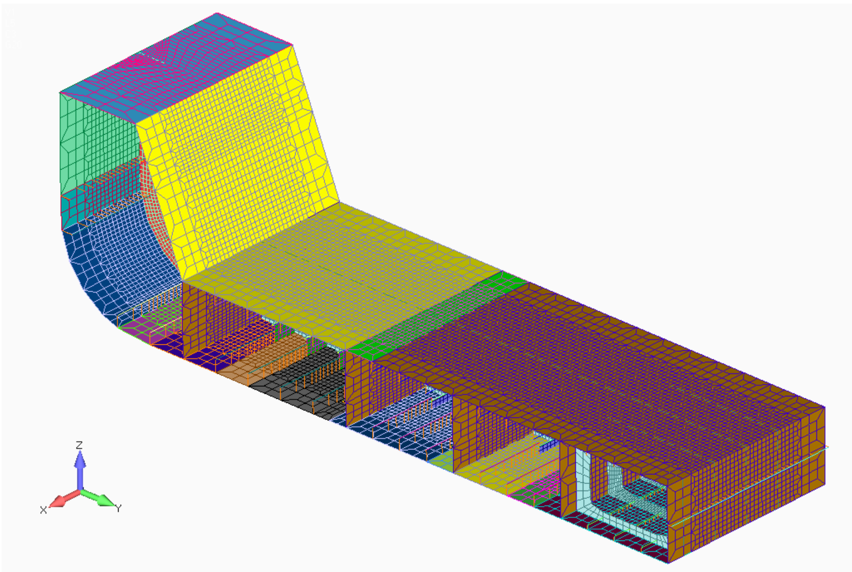

Figure 2 Mesh 1/8

Table 1 presents the characteristics of the model CAD-FEM and material characteristics of the ship.

Table 1 CAD-FEM characteristics of the model

Young's modulus	2,1E+5 N/mm^2
Poisson's coefficient	0,3
Steel density, ρ	7,7E-6kg/mm^3
Steel flow limit, R_{eH}	315 N/mm^2

3. EDGE CONDITIONS

Table 2 Edge conditions

Translatii				Rotatii		
CL		**Uy**				
Pupa	**U_x**				R_y	R_z
Prova	**U_x**				R_y	R_z
Suport			**U_z**			

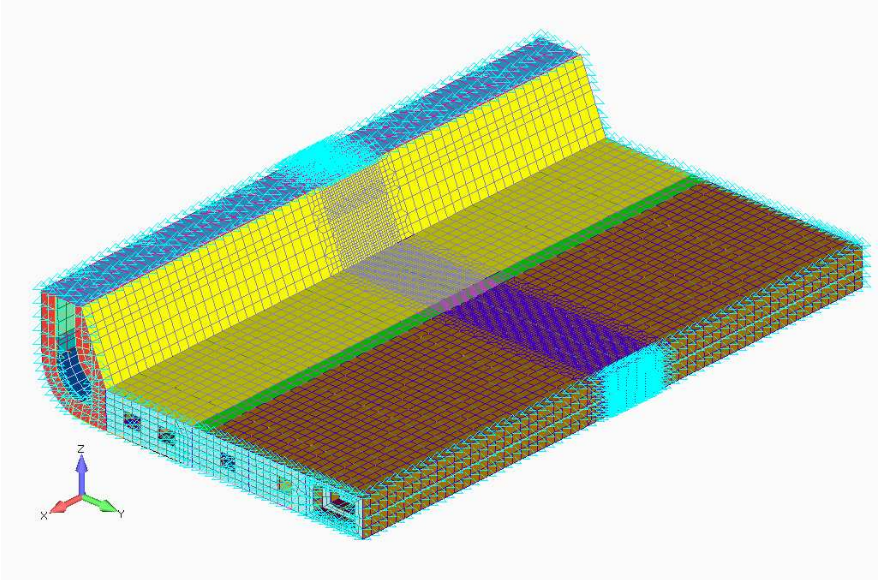

Figure 3 Edge conditions

4. LOADING THE STRUCTURE

Two loading cases were considered: with heavy loads and with ballast water

1. In case of heavy loads, the ship was considered stationary in still water at scantling draught.
The structure model was realized using the load generated pressure and the hydrostatic pressure on the side plating.
2. In case of ballast water, the ship was considered stationary in still water at ballast draught.
The structure model was realized using the ballast water generated pressure and the hydrostatic pressure on the side plating.

- The static pressure of the merchandise (Figure 4)

The static pressure of the merchandise, p_{hys} is:

$$p_{hys} = \rho_{sw} g (T_{LC} - z)\text{, kN/m}^2 \quad (1)$$

where:

z - the vertical coordinate of loading point in [m] and it should not be higher than T_{LC} ;

$\rho_{sw} = 1{,}025 t/m^3$ - density of sea water;

T_{LC} - draft in m;

$g = 9{,}81 m/s^2$ - gravitational acceleration.

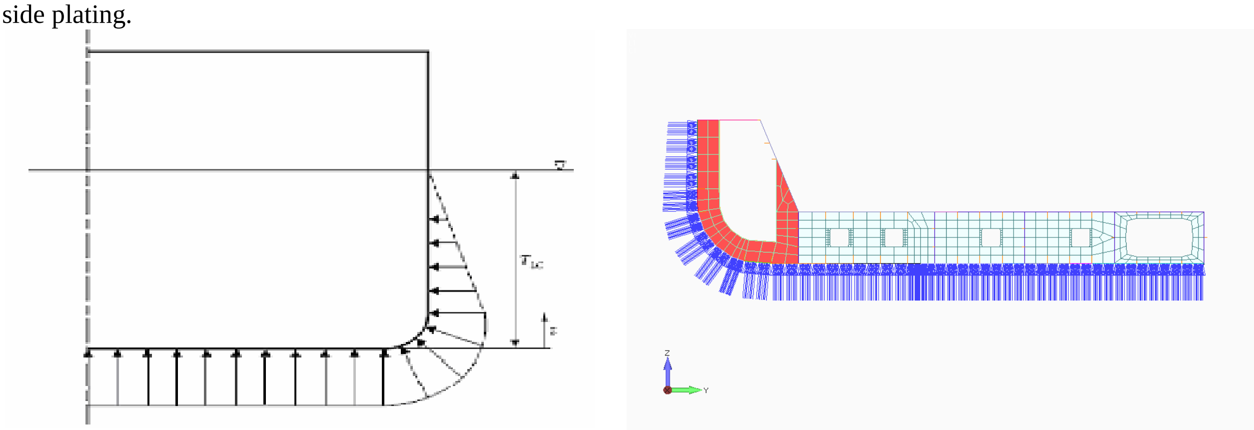

Figure 4 Hydrostatic watter pressure distribution

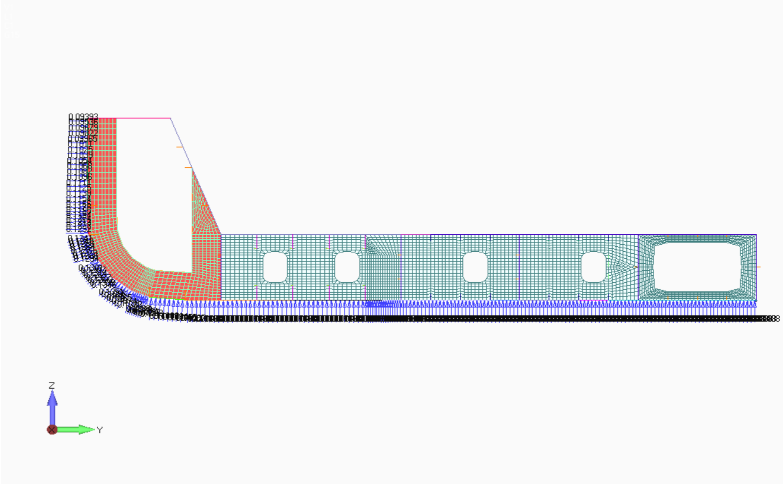

Figure 5 Case 1 – External pressure in refined mesh zone

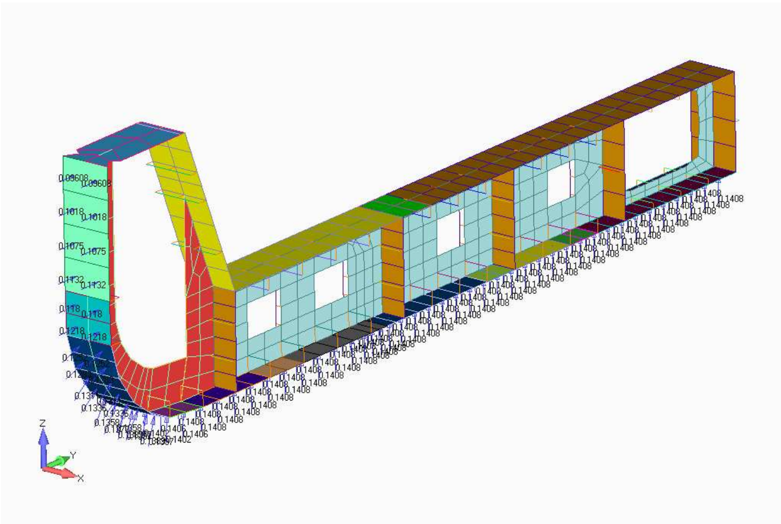

Figure 6 Case 1 – external pressure 3D view

- The static pressure (Figure 7)

The static pressure of the merchandise, p_{in-tk}, is:

$$p_{in-tk} = \rho g z_{tk} \text{, kN/m}^2 \qquad (2)$$

where:

z_{tk} - vertical distance the highest point of the merchandise in the tank, [m];

ρ - density of the merchandise in the tank, [t/m^3];

$g = 9{,}81 m/s^2$ - gravitational acceleration.

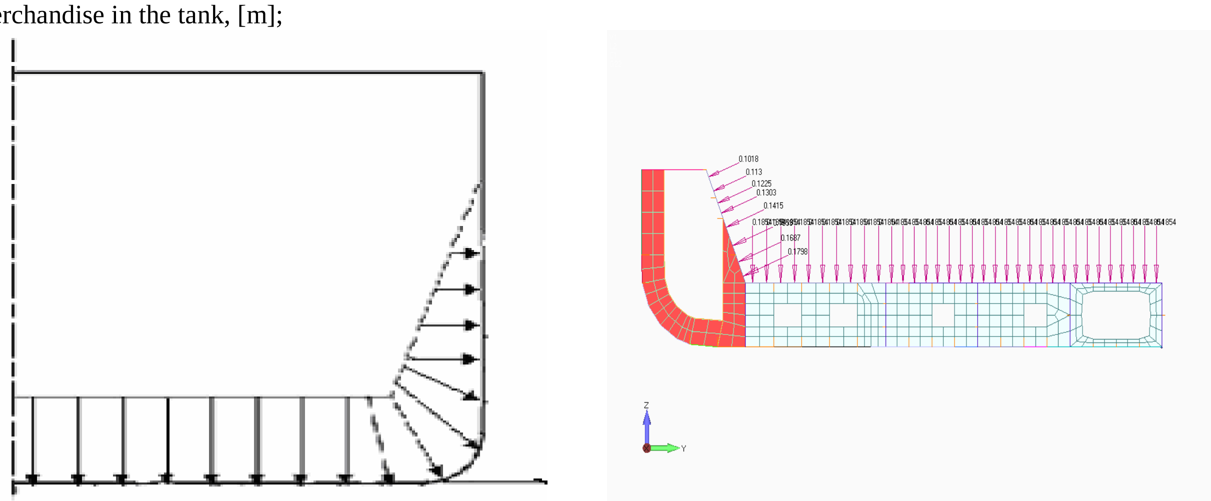

Figure 7 Hydrostatic cargo pressure distribution

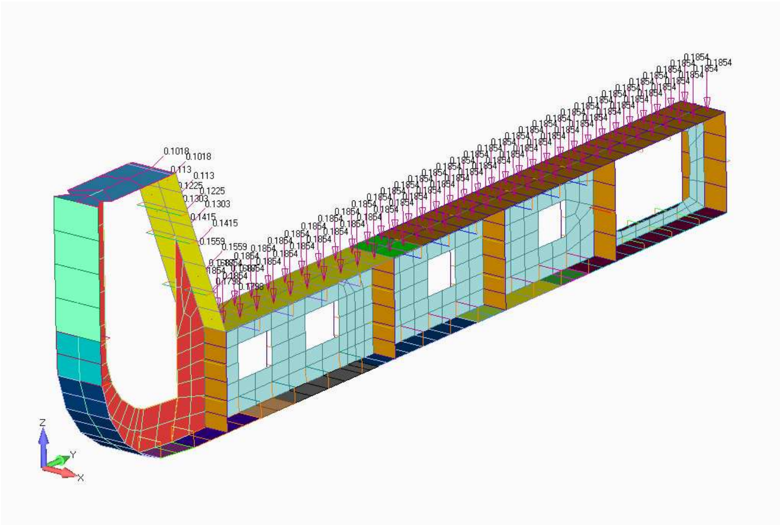

Figure 8 Case 1 – Cargo pressure 3D view

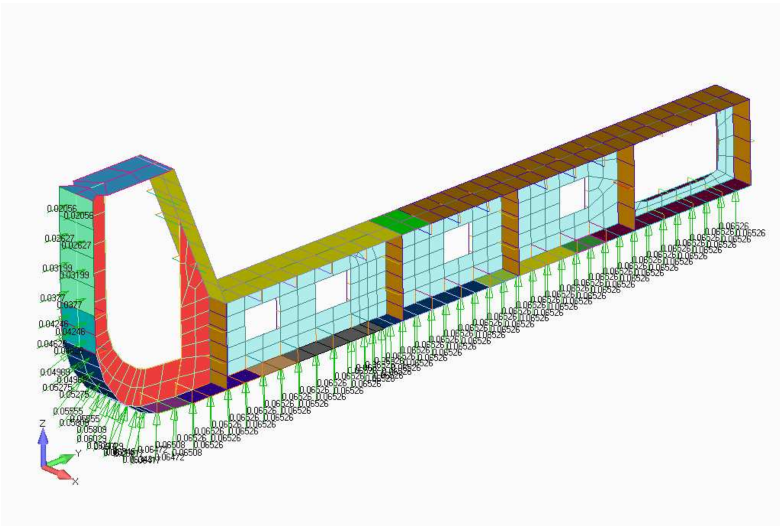

Figure 9 Case 2 – External pressure 3D view

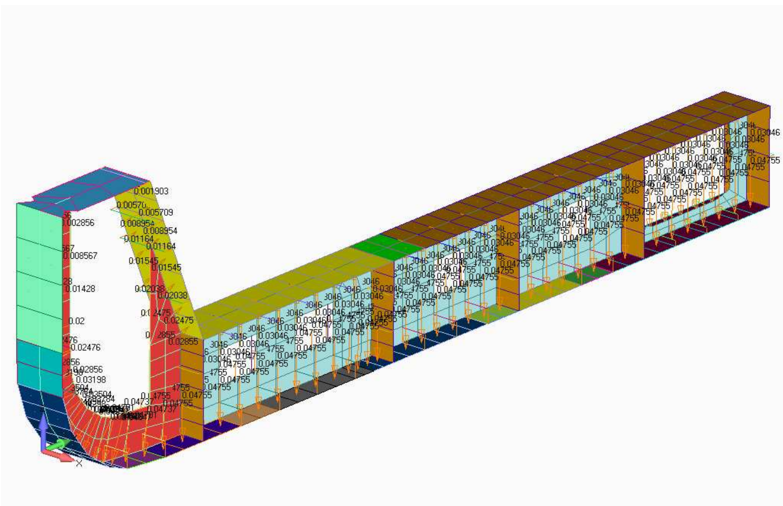

Figure 10 Case 2 – Ballast pressure

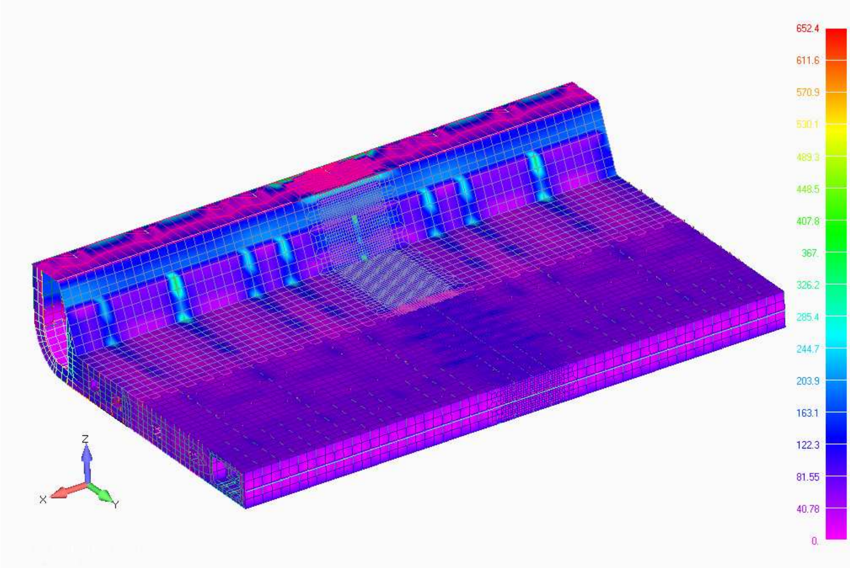

Figure 11 Case 1 - Global stress (Von Misses)

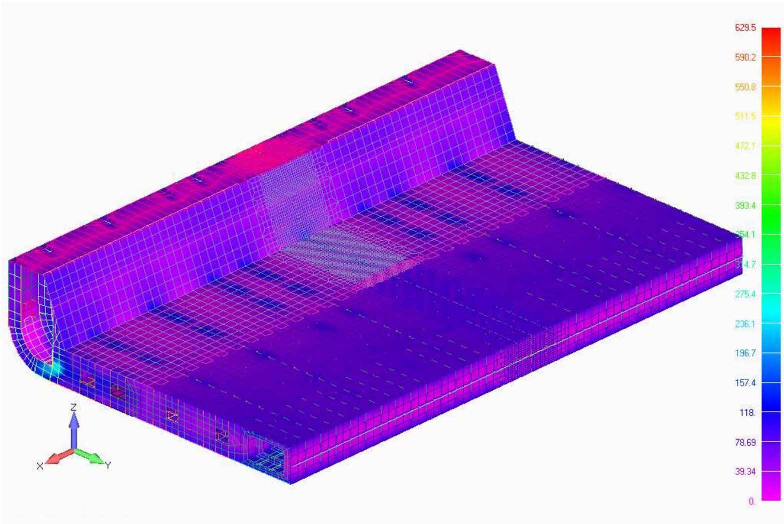

Figure 12 Case 2 – Global stress (Von Misses)

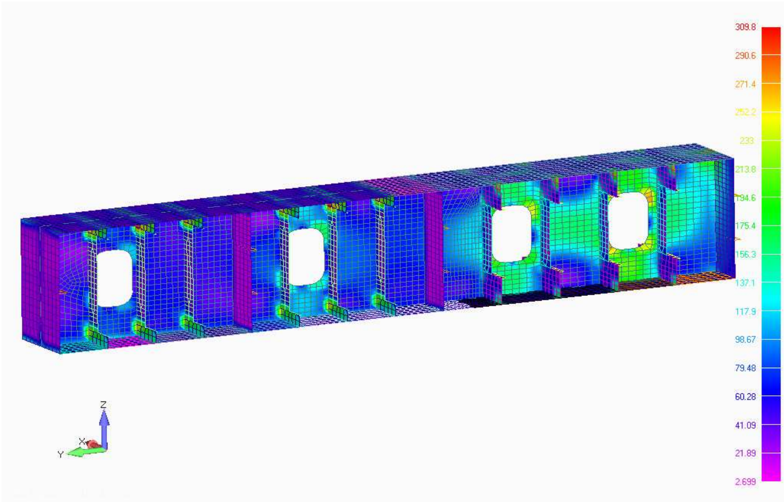

Figure 13 Case 1 – Local stress (Von Misses)

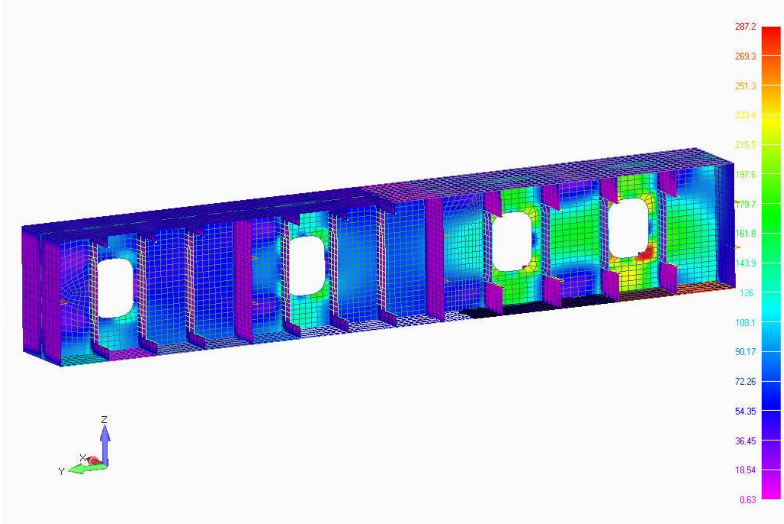

Figure 14 Case 2 – Local stress (Von Misses)

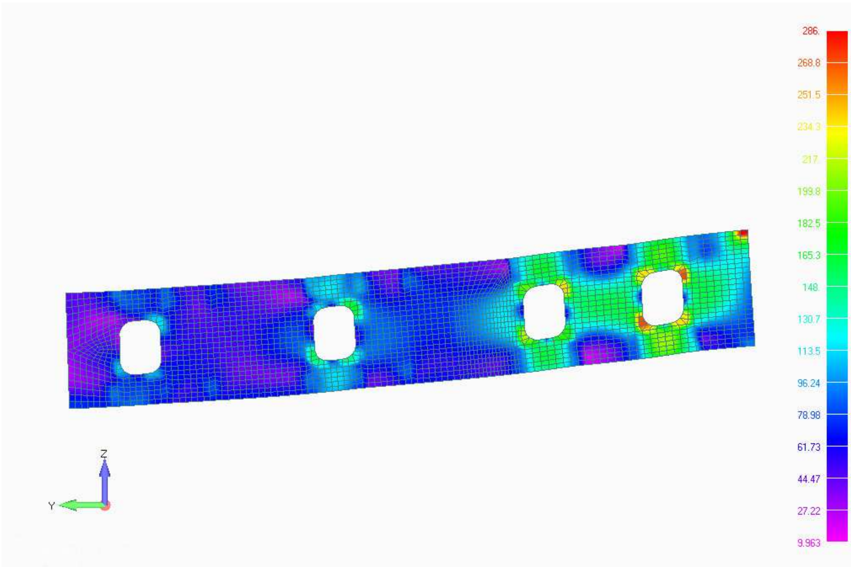

Figure 15 Case 1 – Stress and strains

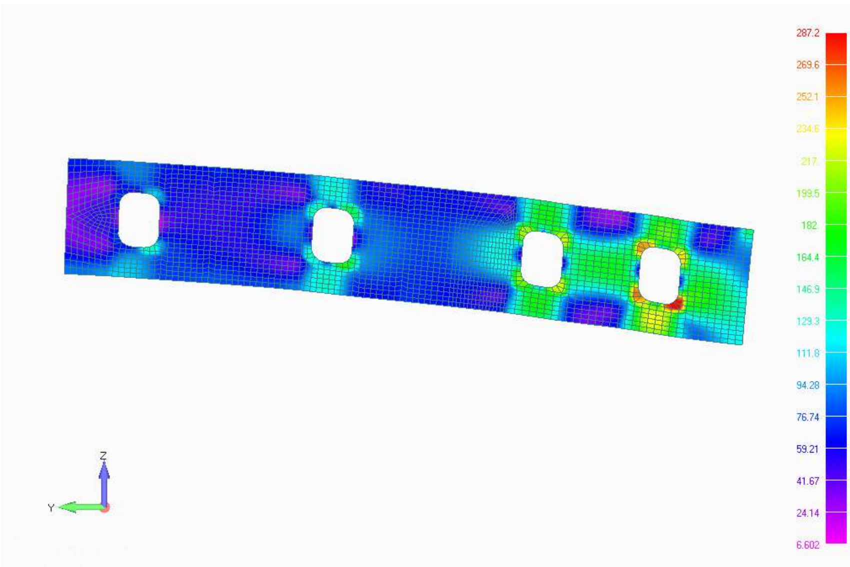

Figure 16 Case 2 – Stress and strains

5. CONCLUSIONS

External pressure		Cargo pressure	
Case1	Case2	Case1	Case2
0.096	0.02	0.1	0.0028
0.01018	0.026	0.113	0.0085
0.01075	0.031	0.1225	0.014
0.1132	0.037	0.13	0.02
0.1182	0.042	0.1415	0.024
0.1218	0.046	0.1444	0.028
0.125	0.049	0.1467	0.032
0.183	0.052	0.1798	0.035
0.1311	0.055	-	0.03784
0.1336	0.058	-	0.0395
0.1358	0.060	-	0.041
0.1377	0.062	-	0.043
0.138	0.063	-	0.045
0.1402	0.06417	-	0.04701
0.1406	0.06472	-	0.04737
0.1408	0.065	0.1854	0.04755

Zone	**Maximum local stress (VON MISSES)**		**Maxime strains shear**	
	Case1	Case2	Case1	Case2
Zone1	165	179,8	82	109
Zone2	78	108	59	44
Zone3	78	72	36	36
Lighten hole 1	268	297	121	133
Lighten hole 2	251	233	113	109
Lighten hole 3	148	179	74	85
Lighten hole 4	130	143	59	52

Zone	**Maximum Displacement**	
	Case1	Case2
1	0,825	0,185
2	7,35	6,9
3	10,3	15,85
4	17	20,3
5	22	29
6	25	31
7	27	36

The maximum stress in floor plate in cargo and ballast case does not exceed the admissible stress for AH32 material which is 315 N/mm^2.

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[5] **x x x** – FEMAP 9.3.1 / NX NASTRAN 5.0 User's Guide, UGS Corporation / Siemens PLM Software Inc.,2007

OPTIMAL SIZING OF THE SECTION IN THE SYSTEM OF EQUIVALENT GIRDER

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ABSTRACT

In the preliminary design phase if the ship has an important cylindrical portion, master section sizing gives a relevant image on the rest of the structure. The objective function can be weight per linear meter of the structure elements with regular repetition in longitudinal direction.

There are situations when the resulting structure is oversized (or possibly undersized), so that a new calculation of structure sizes is necessary to achieve the best.

Keywords: *optimization, sampling, structure of the ship.*

1. GENERALIZATION

The hull of the ship represents a complex girder with thin walls, as coatings thicknesses are very small in relation to the size of the ship. The cross section of the body must include all longitudinal structural elements that extend over a fairly large portion of the length of the ship.

The equivalent girder also includes longitudinal elements of framework. Due to the variation of sheet thickness on the plating and the presence of the elements of longitudinal framework, the section of the equivalent girder is more complex.

In the process of designing the structure of a ship, there are methods on the mode of sizing the elements of structure also using the recommendations of the classification societies – in this case we used the rules of Lloyd Germanischer register.

The main goal immediately following structure sizing and which leads directly to the values of optimal dimensions is that to reduce the weight of material used in ship construction.

The main load is given by the total bending moment of the ship structure; the optimization procedure will focus on resistance to bending as one of the main constraints although other constraints may be also chosen.

The main sizing of the ship is made according to Lloyd Germanisher classification rules, fig. 1.

The ship considered is a chemical tank type ship being designed for transporting chemicals.

2. MAIN DIMENSIONS AND CHARACTERISTICS

Length between perpendiculars	L_{pp} = 110,596 m
Length of water line at T	L_{wl} = 110,596 m
Breadth	B = 18,5 m
Depth	H = 10 m
Scantling draught	T = 7,4 m
Block coefficient	C_b = 0.730
Max. speed in calm water	v = 14 kn
Frame spacing in cargo holds area	a = 0.8 m
Web frame spacing	4a = 3.2 m
Displacement	Δ = 8000 dwt

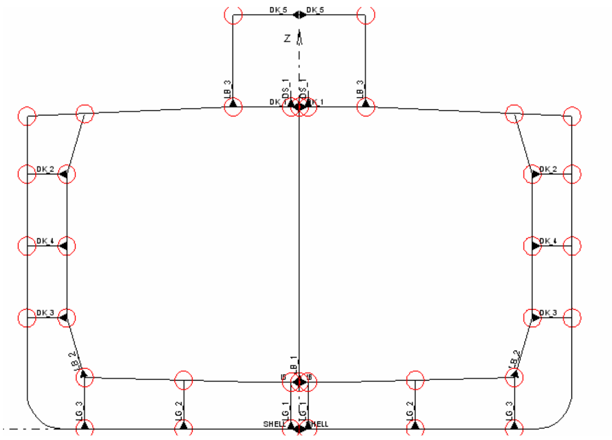
Fig. 1 Functional elements of a chemical tank

3. THEORETICAL MODEL

The method of optimization applied to this structure is intuitive, which consists in creating models of some alternative solutions of the structure – and by repeated attempts – an optimal variant of it will be obtained.

The following notations were used for the calculation of the girder

$b_i[m]$, width of the longitudinal structural element;

$t_i[m]$, thickness of the longitudinal structural element;

$z_c(i)[m]$, distance of the longitudinal element on the axis Oz;

$A_{sh}(i)[m^2]$, cross-sectional area of horizontal elements;

$A_{sv}(i)[m^2]$, cross-sectional area of vertical elements;

$A_{so}(i)[m^2]$, cross-sectional area of obliquely arranged elements;

$A_{sb}(i)[m^2]$, cross-sectional area of circular elements;

n_i [pcs], number of items with the same dimensional characteristics at the same level;

$A_s[m^2]$, total area of the section;

$G_s[t/m]$, weight of longitudinal elements;

$I_{ys}[m^4]$, moment of inertia of the entire section;

$M_{ys}[m^3]$, statical moment of the section;

$M_{vt_{\max}}[kNm]$, maximum value of the total bending moment in vertical plane, $M_{vt_{\max}} = 3{,}866 \cdot 10^5 [\text{kNm}]$;

$z_N[m]$, neutral axis position in relation to the basic plan

$$z_N = \frac{M_{ys}}{A_s}[m] \tag{1}$$

Areas of structural elements are calculated as follows:

- for horizontal elements:

$$A_{sh}(i) = n_h(i) \cdot b_h(i) \cdot t_h(i)\left[m^2\right] \tag{2}$$

- for vertical elements:

$$A_{sv}(i) = n_v(i) \cdot h_v(i) \cdot t_v(i)\left[m^2\right] \tag{3}$$

- for oblique elements:

$$A_{so}(i) = n_o(i) \cdot L(i) \cdot t_o(i)\left[m^2\right] \tag{4}$$

- for circular elements (bilge):

$$A_{sb} = n_b \cdot \pi \cdot r_b \cdot t_b / 2\left[m^2\right] \tag{5}$$

Weight of structural elements is calculated as follows:

- for horizontal elements:

$$G_h(i) = A_{sh}(i) \cdot \rho[t/m] \tag{6}$$

- for vertical elements:

$$G_v(i) = A_{sv}(i) \cdot \rho[t/m] \tag{7}$$

- for oblique elements:

$$G_o(i) = A_{so}(i) \cdot \rho[t/m] \tag{8}$$

where $\rho = 8000\left[kg/m^3\right]$

Total area of the section is determined by the relation:

$$A_s = 2 \cdot \sum_{i=1}^{n} A_{si}\left[m^2\right] \tag{9}$$

Weight of longitudinal elements is determined by the relation:

$$G_s = 2 \cdot \sum_{i=1}^{n} G_{si}[t/m] \tag{10}$$

The moment of inertia of the entire section:

$$I_{ys} = 2 \cdot \sum_{i=1}^{n} I_{yi}[m^4] \tag{11}$$

The statical moment of the entire section:

$$M_{ys} = 2 \cdot \sum_{i=1}^{n} M_{yi}[m^3] \tag{12}$$

The coefficients of resistance are calculated as follows:

- for the bottom edge of the equivalent girder, that is for bottom:

$$W_f = \frac{I_{ys}}{z_f}[m^3] \tag{13}$$

where $z_f = z_N[m]$.

- for double bottom:

$$W_{df} = \frac{I_{ys}}{z_{df}}[m^3] \tag{14}$$

where $z_{df} = Hdf - z_f[m]$.

- for the upper edge of the equivalent girder:

$$W_p = \frac{I_{ys}}{z_p}[m^3] \tag{15}$$

where $z_p = D - z_N[m]$.

Based on maximum value of the total bending moment in vertical plane, we can calculate the maximum normal stresses in extreme fibers of the equivalent girder of the ship.

Maximum normal stresses in the extreme fibers of the equivalent girder are determined by the relations:

- for the bottom edge of the equivalent girder:

$$\sigma_f = \frac{M_{vt_{\max}}}{W_f} \le \sigma_{admf-GL}[N/mm^2] \tag{16}$$

Where $\sigma_{admf-GL} = \frac{175}{k_{matf}}[N/mm^2], k_{matf} = 1$;

- for double bottom:

$$\sigma_{df} = \frac{M_{vt_{\max}}}{W_{df}} \le \sigma_{admdf-GL}[N/mm^2] \tag{17}$$

Where $\sigma_{admdf-GL} = \frac{175}{k_{matdf}}[N/mm^2], k_{mat\,df} = 1$;

- for the upper edge of the equivalent girder:

$$\sigma_p = \frac{M_{vt_{\max}}}{W_p} \le \sigma_{admp-GL}[N/mm^2] \tag{18}$$

Where $\sigma_{admp-GL} = \frac{175}{k_{mat\,p}}[N/mm^2], k_{mat\,p} = 0.78$,

Where $k_{matf}, k_{matdf}, k_{matp}$ - structural safety factors.

Optimization problem can be defined as follows:

- The main objective of the design is to have a minimum weight (namely to use as little material as possible):

$$\min \sum_{i=1}^{n} A_{si} \cdot \rho \tag{19}$$

- To ensure ship resistance namely stresses in the extreme fibers are to comply with the conditions:

$$\sigma_f \le \sigma_{admf-GL}, \sigma_{df} \le \sigma_{admdf-GL}, \sigma_p \le \sigma_{admp-GL} \tag{20}$$

- Maximum cross area of the hold should be as large as possible to ensure maximum useful load of ship namely:

$$A_m = B \cdot D \cdot c_M \cdot k_m \cdot k_f[m^2]$$
$$A_u = (B - 2 \cdot bDB) \cdot (D - Hdf) \tag{21}$$

Where: A_h - required area of the hold;

c_M - cross section coefficient;

k_m - ratio between total area of the hold and cross-sectional area;

k_f - filling ratio of the hold;

B – width of the ship;

D – headroom;

Hdf – height of the double bottom;

bDB - width of the double board.
So the area constraint is:

$$A_u \geq A_m \quad (22)$$

The restrictions given by the thickness of plate boards:

$$t_{\min} \leq t_i \leq t_{\max}, i \in [0.5, 1, ..., n] \quad (23)$$

Thickness of plate boards can appear explicitly in restrictions as minimum value for other boards but especially in the sizing of all framings welded on it representing the sheet-metal strip associated with that profile. The range of variation of plate thickness is discontinuous.

The restrictions for spaces are:
- for double board: $bDB_{\min} \leq bDB \leq bDB_{\max}$
- for double bottom: $Hdf_{\min} \leq Hdf \leq Hdf_{\max}$

The restrictions for discrete values:
$t_i \in N$, where N is the space with integers.

All variables of the optimization problem must be positive numbers namely:

$$t_i, h_{DF}, b_{DB} \geq 0, i \in [1, 2, ..., n] \quad (24)$$

The objective function is weight per linear meter of the structure elements with regular repetition in longitudinal direction. Minimization of the objective function assumes weight calculation of all structure elements.

4. CHAIN OF WORK

The process of optimization consists in:
Step. 1 - Ship data – At this step the main dimensions of ship and shape of the hull as well as all data necessary to calculate the total bending moment are defined.

Step. 2 – Scantling of the ship – At this step we used the program provided by Germanischer Lloyd register that is Poseidon v.10 to calculate the main dimensions of the structural elements.
Step. 3 – Building of the optimization problem using MATLAB program.

To this effect, a database in an Excel spreadsheet was created that we will import later to MATLAB program and by means of which we will calculate the characteristics of the equivalent girder.

We can accentuate a number of characteristic parameters such as:
z_i – appropriate distance at the neutral axis of the ship to the distance z_N from baseline;
z_C – distance from the center of the element area to the baseline of the ship.

Table 1 also highlights a number of constants:

The tables below highlight how longitudinal elements are arranged.
- Structural elements arranged in horizontal direction, table 2.

Table 1 Constants of the ship

L [m]	B [m]	D [m]	d [m]
110.596	18.5	10	7.4
V [m^3]	Depl [t]	Dwt [tdw]	km
12112.4739	12415.28	9932.22	0.8
kf	c_M	Hdf [m]	bDB [m]
0.95	0.987	1.3	1.2
M_{vtmax} [kNm]			
386625.144			

Table 2 Structural elements arranged in horizontal direction

			[m]	[m]	[m]
No.	**Name of the horizontal element**	**n_h(i)**	**t_h(i)**	**b_h(i)**	**z_{ch}(i)**
1.	Plate keel 740x13.5	1	0.0135	0.740	0.000
2.	plate F - 2180x11.5	1	0.0115	2.180	0.000
3.	plate F - 2180x11.5	1	0.0115	2.180	0.000
4.	plate F - 2050x11.5	1	0.0115	2.050	0.000
5.	plate F - 900x11.5	1	0.0115	0.900	0.000
6	plate F - 188.3x11.5	1	0.0115	0.188	0.000
7	plate DF - 1100x16	1	0.0160	1.100	1.300
8	plate DF - 420x16	1	0.0160	0.420	1.300
9	plate DK_1 - 1100x11.5	1	0.0115	1.100	10.300
10	plate DK_1 - 1200x11.5	1	0.0115	1.200	10.300
11	plate SB11200x9	1	0.0090	1.200	3.550
12	plate SB2 1200x9	1	0.0090	1.200	5.850
13	plate SB3 1200x9	1	0.0090	1.200	8.150
14	Longitudinal of the board L16 - 150x10	1	0.0100	0.150	1.500
15	Longitudinal of the board L28 - 160x11	1	0.0110	0.160	8.770
16	Longitudinal of the board L29 - 160x11	1	0.0110	0.160	9.385
17	Longitudinal DB - 200x12	1	0.0120	0.200	4.125

18	Longitudinal DB - 200x12	1	0.0120	0.200	4.700
19	Longitudinal DB - 200x12	1	0.0120	0.200	5.275
20	Longitudinal DB - 200x12	1	0.0120	0.200	6.425
21	Longitudinal DB - 200x12	1	0.0120	0.200	6.975
22	Longitudinal DB - 200x12	1	0.0120	0.200	7.525
23	Longitudinals SL1 - 150x10	2	0.0100	0.150	0.280
24	Longitudinals SL2 - 150x10	2	0.0100	0.150	0.930
25	plate DK_2 - 1150x10.5	1	0.0105	1.150	13.250
26	plate DK_2 - 1091.5x10.5	1	0.0105	1.092	13.250
27	Longitudinal DK_2 - 140x9	1	0.0090	0.140	10.950
28	Longitudinal DK_2 - 140x9	1	0.0090	0.140	11.565
29	Longitudinal DK_2 - 140x9	1	0.0090	0.140	12.155
30	Longitudinal DK_2 - 140x9	1	0.0090	0.140	12.745
31	DS_1 - 150x15	1	0.0150	0.150	10.850

- Structural elements arranged in vertical direction, table 3.

Table 3 Structural elements arranged in vertical direction

			[m]	[m]	[m]	[m]	[m]
No.	**Name of the vertical element**	**$n_v(i)$**	**$t_v(i)$**	**$z_{1v}(i)$**	**$z_{2v}(i)$**	**$h_v(i)$**	**$z_{cv}(i)$**
1	plate B - 467x16.5	1	0.0165	1.200	1.667	0.467	1.434
2	plate B - 1450x13.5	1	0.0135	1.667	3.117	1.450	2.392
3	plate B - 1700x16	1	0.0160	3.117	4.817	1.700	3.967
4	plate B - 1700x16	1	0.0160	4.817	6.517	1.700	5.667
5	plate B - 1700x16	1	0.0160	6.517	8.217	1.700	7.367
6	plate B - 1783x10.5	1	0.0105	8.217	10.000	1.783	9.109
7	plate DB - 1091x10	1	0.0100	3.559	4.650	1.091	4.105
8	plate DB - 1200x10	1	0.0100	4.650	5.850	1.200	5.250
9	plate DB - 1100x9	1	0.0090	5.850	6.950	1.100	6.400
10	plate DB - 1200x9	1	0.0090	6.950	8.150	1.200	7.550
11	plate PL - 8989x17.5	0.5	0.0175	1.312	10.300	8.989	5.806
12	plate of the side head LG_1 - 1300x17.5	1	0.0175	0.000	1.300	1.300	0.650
13	plate of the side head LG_2 - 1366x9	1	0.0090	0.000	1.366	1.366	0.683
14	plate of the side head LG_3 - 1458x12.5	1	0.0125	0.000	1.458	1.458	0.729
15	Bottom longitudinals - 200x14	7	0.0140	0.000	0.200	0.200	0.100
16	Longitudinals of DF - 240x15	2	0.0150	1.060	1.300	0.240	1.180
17	Longitudinals of DF - 240x15	1	0.0150	1.080	1.320	0.240	1.200
18	Longitudinals of DF - 240x15	1	0.0150	1.103	1.343	0.240	1.223
19	Longitudinals of DF - 240x15	1	0.0150	1.149	1.389	0.240	1.269
20	Longitudinals of DF - 240x15	1	0.0150	1.172	1.412	0.240	1.292
21	Longitudinals of DF - 240x15	1	0.0150	1.195	1.435	0.240	1.315
22	Longitudinals SB1 -150x10	2	0.0100	3.400	3.550	0.150	3.475
23	Longitudinals SB2 -150x10	2	0.0100	5.700	5.850	0.150	5.775
24	Longitudinals SB3 -150x10	2	0.0100	8.000	8.150	0.150	8.075
25	Deck longitudinals DK_1 - 160x11	2	0.0110	10.312	10.472	0.160	10.392
26	Deck longitudinals DK_1 - 160x9	1	0.0090	10.278	10.438	0.160	10.358
27	Deck longitudinals DK_1 - 160x9	1	0.0090	10.241	10.401	0.160	10.321
28	Deck longitudinals DK_1 - 160x9	1	0.0090	10.205	10.365	0.160	10.285
29	Deck longitudinals DK_1 - 160x9	1	0.0090	10.169	10.329	0.160	10.249
30	Deck longitudinals DK_1 - 160x9	1	0.0090	10.133	10.293	0.160	10.213
31	Deck longitudinals DK_1 - 160x9	1	0.0090	9.896	10.056	0.160	9.976
32	Deck longitudinals DK_1 - 160x10	1	0.0100	9.867	10.027	0.160	9.947
33	Deck longitudinals DK_2 - 140x9	2	0.0090	13.110	13.250	0.140	13.180
34	DS_1 - 538.5x9	1	0.0090	10.312	10.850	0.538	10.581
35	LB_3 - 1389x8.5	1	0.0085	10.312	11.700	1.389	11.006
36	LB_3 - 1550x8.5	1	0.0085	11.700	13.250	1.550	12.475

- Structural elements arranged in oblique direction, table 4.

Table 4 Structural elements arranged in oblique direction

			[m]	[m]	[m]	[m]	[m]	[m²]	[m]	[m]
No.	**Name of the oblique element**	**$n_o(i)$**	**$t_o(i)$**	**$y_{1o}(i)$**	**$z_{1o}(i)$**	**$y_{2o}(i)$**	**$z_{2o}(i)$**	**lung(i)**	**$L_o(i)$**	**$z_{co}(i)$**
1	plate of bilge tank1200x11	1	0.0110	7.290	1.458	7.700	2.586	1.440	1.200	2.022
2	plate of bilge tank 1025.8x11	1	0.0110	7.700	2.586	8.050	3.550	1.052	1.026	3.068
3	plate of anti-roll tank1000x8.5	1	0.0085	8.050	8.150	7.684	9.081	1.001	1.000	8.616
4	plate of anti-roll tank1078.5x8.5	1	0.0085	7.684	9.081	7.290	10.084	1.161	1.078	9.583
5	DF plate 2554.8x16	1	0.0160	1.520	1.300	4.074	1.370	6.527	2.555	1.335
6	DF plate 2475x16	1	0.0160	4.074	1.370	6.548	1.438	6.126	2.475	1.404
7	DF plate 742.2x16	1	0.0160	6.548	1.438	7.290	1.458	0.551	0.742	1.448
8	plate DK 1 1850x11.5	1	0.0115	2.300	10.300	4.150	10.220	3.429	1.852	10.260
9	plate DK_2 1650x11.5	1	0.0115	4.150	10.220	5.800	10.149	2.728	1.652	10.185
10	plate DK_3 1650x11.5	1	0.0115	5.800	10.149	7.445	10.078	2.711	1.647	10.114
11	plate DK_4 1806.5x11.5	1	0.0115	7.445	10.078	9.250	10.000	3.264	1.807	10.039
12	Longitudinal of anti-roll tank160x11	1	0.0110	7.848	8.660	8.003	8.700	0.026	0.160	8.680
13	Longitudinal of anti-roll tank160x11	1	0.0110	7.662	9.138	7.810	9.198	0.026	0.160	9.168
14	Longitudinal of anti-roll tank160x11	1	0.0110	7.476	9.611	7.624	9.671	0.025	0.160	9.641
15	Hooper Longitudinal - 200x14	1	0.0140	7.481	1.892	7.667	1.966	0.040	0.200	1.929
16	Hooper Longitudinal - 200x14	1	0.0140	7.662	2.475	7.821	2.355	0.040	0.200	2.415
17	Hooper Longitudinal - 200x14	1	0.0140	7.839	2.991	8.011	2.888	0.040	0.200	2.940

- Structural elements arranged in a circular direction, table 5.

Table 5 Structural elements arranged in a circular direction

			[m]	[m]	[m]	[m]	[m]
No.	**Name element bilge**	**n_b**	**t_b**	**r_b**	**z_{cob}**	**z_{ob}**	**z_{cb}**
1	bilge plate 1200x10.5	1	0.0105	1.200	0.436	0.000	0.436

Three cases of optimization were carried out:

Case 1

- variation in thickness of plate boards with 5mm, 1mm, 1.5mm and 2mm;
- spatial variation for double board bDB = 1.2m;
- spatial variation for double bottom Hdf = 1.3m.

Case 2

- variation in thickness of plate boards with 5mm, 1mm, 1.5mm and 2mm;
- spatial variation for double board bDB = 1.35m;
- spatial variation for double bottom Hdf = 1.25m

Case 3

- variation in thickness of plate boards with 5mm, 1mm, 1.5mm and 2mm;
- spatial variation for double board bDB = 1.5m;
- spatial variation for double bottom Hdf = 1.35m

Iteration 1 (table 6)

- spatial variation for double board bDB = 1.2m;
- spatial variation for double bottom Hdf = 1.3m;
- variation in thickness of plate boards horizontally arranged.

Iteration 2 (table 7)

- spatial variation for double board bDB = 1.2m;
- spatial variation for double bottom Hdf = 1.3m;
- variation in thickness of plate boards vertically arranged.

Iteration 3 (table 8)

– spatial variation for double board bDB = 1.2m;
– spatial variation for double bottom Hdf = 1.3m;
– variation in thickness of plate boards arranged obliquely.

About 56 iterations will be carried for each case, the algorithm being supposed to stop when normal stresses exceed the allowable value, thus requiring a review of the dimensions of longitudinal structural elements.

Based on the data presented above the characteristics of the equivalent girder will be determined using the MATLAB program and also a comparison with the results obtained with Poseidon program will be made.

Table 6 Design variables – iteration 1

Variables						
Plates of Bottom/ Double bottom						
Hdf [m]	tF1 [m]	tF2 [m]	tDF_inclined [m]	tDF [m]		
1.3	0.014	0.012	0.016	0.0165		
Plates of board/Double board						
bDB [m]	tB1 [m]	tB2 [m]	tB3 [m]	tDB1 [m]	tDB2 [m]	
1.2	0.0135	0.016	0.0105	0.010	0.009	
Bridge plates			Bilge plate	Plates of Stringers of plating		
tDK_1 [m]	tDK_2 [m]	tDK_1_inclined [m]	tG [m]	tSB1 [m]	tSB2 [m]	tSB3 [m]
0.012	0.011	0.0115	0.016	0.0095	0.0095	0.0095
Plates of the side heads			Plates of the longitudinal wall	Plates of bilge tank	Plates of anti-roll tank	
tSL1 [m]	tS2 [m]	tS3 [m]	tPL [m]	tH [m]	tW [m]	
0.009	0.0125	0.0175	0.0175	0.011	0.0085	

Table 7 Design variables – iteration 2

Variables						
Plates of Bottom/ Double bottom						
Hdf [m]	tF1 [m]	tF2 [m]	tDF_inclined [m]	tDF [m]		
1.3	0.0135	0.0115	0.016	0.016		
Plates of board/Double board						
bDB [m]	tB1 [m]	tB2 [m]	tB3 [m]	tDB1 [m]	tDB2 [m]	
1.2	0.014	0.0165	0.011	0.0105	0.0095	
Bridge plates			Bilge plate	Plates of Stringers of plating		
tDK_1 [m]	tDK_2 [m]	tDK_1_inclined [m]	tG [m]	tSB1 [m]	tSB2 [m]	tSB3 [m]
0.0115	0.0105	0.0115	0.016	ă .009	0.009	0.009
Plates of the side heads			Plates of the longitudinal wall	Plates of bilge tank	Plates of anti-roll tank	
tSL1 [m]	tS2 [m]	tS3 [m]	tPL [m]	tH [m]	tW [m]	
0.0095	0.013	0.018	0.018	0.011	0.0085	

Table 8 Design variables – iteration 3

Variables						
Plates of Bottom/ Double bottom						
Hdf [m]	tF1 [m]	tF2 [m]	tDF_inclined [m]	tDF [m]		
1.3	0.0135	0.0115	0.0165	0.016		
Plates of board/Double board						
bDB [m]	tB1 [m]	tB2 [m]	tB3 [m]	tDB1 [m]	tDB2 [m]	
1.2	0.0135	0.016	0.0105	0.010	0.009	
Bridge plates			Bilge plate	Plates of Stringers of plating		
tDK_1 [m]	tDK_2 [m]	tDK_1_inclined [m]	tG [m]	tSB1 [m]	tSB2 [m]	tSB3 [m]
0.0115	0.0105	0.012	0.016	0.009	0.009	0.009
Plates of the side heads			Plates of the longitudinal wall	Plates of bilge tank	Plates of anti-roll tank	
tSL1 [m]	tS2 [m]	tS3 [m]	tPL [m]	tH [m]	tW [m]	
0.009	0.0125	0.0175	0.0175	0.0115	0.009	

Table 9 Design variables – iteration 56

Variables						
Plates of Bottom/ Double bottom						
Hdf [m]	tF1 [m]	tF2 [m]	tDF_inclined [m]	tDF [m]		
1.3	0.014	0.012	0.0165	0.0165		
Plates of board/Double board						
bDB [m]	tB1 [m]	tB2 [m]	tB3 [m]	tDB1 [m]	tDB2 [m]	
1.2	0.014	0.0165	0.011	0.0105	0.0095	
Bridge plates			Bilge plate	Plates of Stringers of plating		
tDK_1 [m]	tDK_2 [m]	tDK_1_inclined [m]	tG [m]	tSB1 [m]	tSB2 [m]	tSB3 [m]
0.012	0.011	0.012	0.0165	0.0095	0.0095	0.0095
Plates of the side heads			Plates of the longitudinal wall	Plates of bilge tank	Plates of anti-roll tank	
tSL1 [m]	tS2 [m]	tS3 [m]	tPL [m]	tH [m]	tW [m]	
0.0095	0.013	0.018	0.018	0.0115	0.009	

Comparative graphs will be drawn on change in several features of the equivalent girder (figures 2÷13).

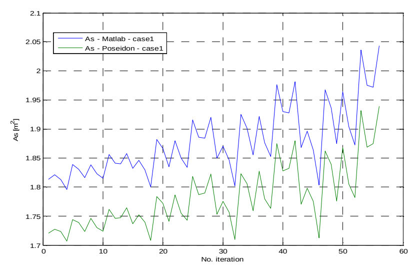

Fig. 2 Change in cross-sectional area

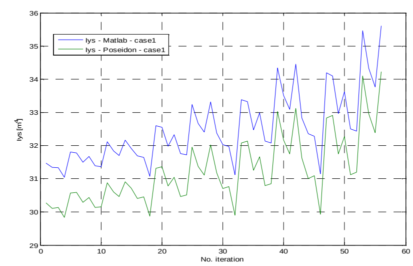

Fig. 3 Change in cross-sectional moment of inertia

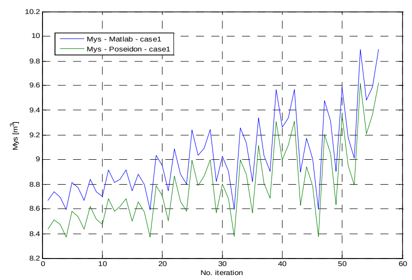

Fig. 4 Change in the statical moment of the cross section

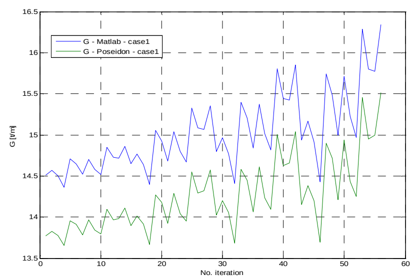

Fig. 5 Change in the weight of longitudinal elements

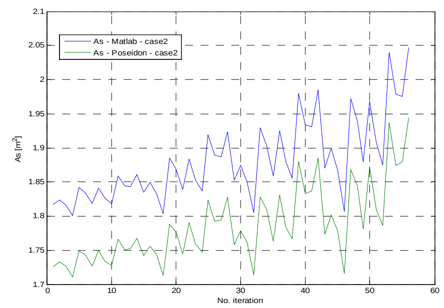

Fig. 6 Change in cross-sectional area

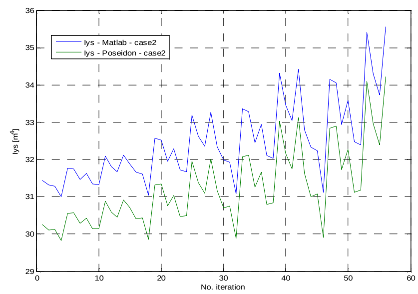

Fig. 7 Change in cross-sectional moment of inertia

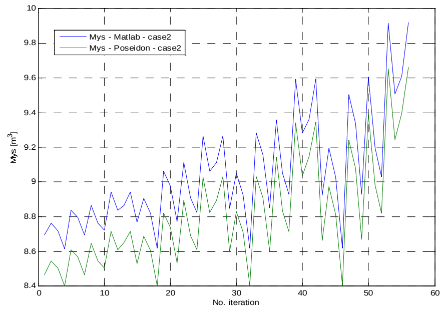

Fig. 8 Change in the statical moment of the cross section

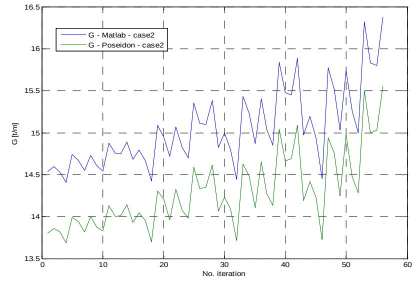

Fig. 9 Change in the weight of longitudinal elements

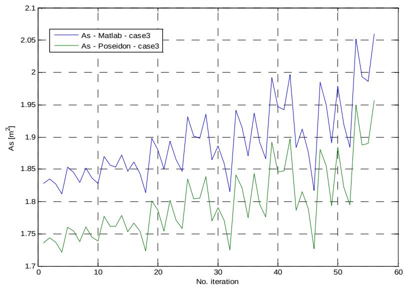

Fig. 10 Change in cross-sectional area

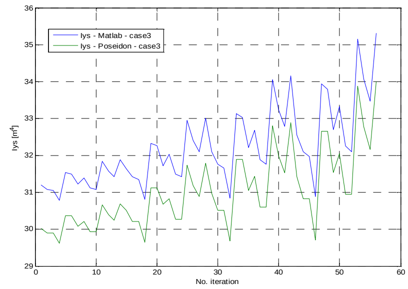

Fig. 11 Change in cross-sectional moment of inertia

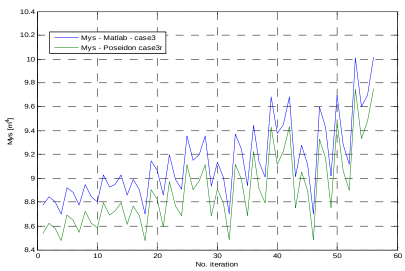

Fig. 12 Change in the statical moment of the cross section

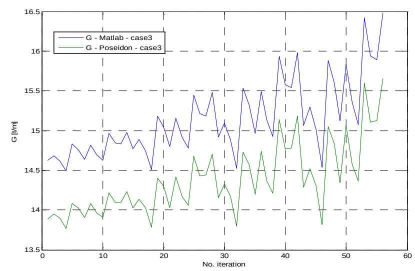

Fig. 13 Change in the weight of longitudinal elements

5. CONCLUSIONS

For the optimal sizing of the cross section it was considered that the main load is given by the total bending moment of the ship structure. For the calculation of geometrical characteristics we have created our own program in MATLAB, based on which about 56 iterations were made for the three cases of optimization, the algorithm being supposed to stop when normal stresses exceed the allowable value, thus requiring a review of the dimensions of longitudinal structural elements.

The results from this program were compared with those provided by the program POSEIDON, after which there was a deviation of about 5%, which proves that it falls within the allowable limits of 10%.

By this approach, one can avoid the loss of time by checking a number of design iterations, which is the main advantage of the procedure.

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ABSTRACT

This article considers the properties of the oceans such as water properties, circulation, currents and tides. How these properties affect the operation of underwater vehicles, such as submarines and remotely operated vehicles (ROVs) and equipment, is discussed.

Earth is the only planet known to have water resident in all three states (solid, liquid and gas). It is also the only planet to have known liquid water currently at its surface.

The oceans cover 70.8% of the earth's surface, far overreaching earth's lands mass. Of the ocean coverage, the Atlantic covers 16.2%, the Pacific 32.4 %, the Indian Ocean 14.4 %, and the margin and adjacent areas the balance of 7.8 %.

Water in known as the 'universal solvent'.

The circulation of the world's water is controlled by a combination of gravity, friction and inertia.

Keywords: *Ocean, circulation, currents, tides, water, properties, ship.*

1. INTRODUCTION

While pure water is the basis for life on earth, as more impurities are added to that fluid the physical and chemical properties change drastically. The chemical makeup of the water mixture in which an ROV may operate will directly dictate operational procedures and parameters if a successful operation is to be achieved.

2. PROPERTIES OF WATER

Two everyday examples of water's physical properties and their effect on our lives are (1) ice floats in water and (2) we salt our roads in wintertime to 'melt' snow on the road. Clearly, it is important to understand the operating environment and its effect on ship and ROV operations. To accomplish this, the properties and chemical aspects of water and how they're measured will be addressed to determine their overall effect.

The early method of obtaining environmental information was by gathering water samples for later analysis in a laboratory. Today, the basic parameters of water are measured with a common instrument named the 'CTD sonde'. Some of the newest sensors can analyze a host of parameters logged on a single compact sensing unit.

Fresh water is an insulator, with the degree of electrical conductivity increasing as more salts are added to the solution. By measuring the water's degree of electrical conductivity, highly accurate measure of salinity can be derived. Temperature is measured via electronic methods and depth is measured with a simple water pressure transducer. The CTD probe measures 'conductivity/temperature/depth', which are the basic parameters in the sonic velocity equation. Newer environmental probes are available for measuring any number of the water quality parameters such as pH, dissolved oxygen and CO_2, turbidity and other parameters.

The measurable parameters of water are needed for various reasons. A discussion of the most common measurement variables the commercial or scientific ROV operator will encounter, the information those parameters provide, and the tools/techniques to measure them follow.

2.1 Chlorophyll

In various forms, chlorophyll is bound within the living cells of algae and other phytoplankton found in surface water. Chlorophyll is a key biochemical component in the molecular apparatus that is responsible for photosynthesis, the critical process in which the energy from sunlight is used to produce life-sustaining oxygen. In the photosynthetic reaction, carbon dioxide is reduced by water and chlorophyll assists this transfer.

2.2 Circulation

The circulation of the world's water is controlled by a combination of gravity, friction and inertia. Winds push water, ice and water vapour around due to friction. Water vapour rises. Fresh and hot water rise. Salt and cold water sink. Ice floats. Water flows downhill. The high-inertia water at the Equator zooms eastward as it travels toward the slower-moving areas near the Poles (coriolis effect – an excellent example of this is the Gulf Stream off the East Coast of the USA). The waters of the world intensify on the Western boundary of oceans due to the earth's rotational mechanics (the so-called 'Western intensification 'effect). Add into this mix the gravitational pull of the moon, other planets and the sun, and one has a very complex circulation model for the water flowing around our planet.

In order to break this complex model into its component parts for analysis, oceanographers generally separate these circulation factions into two broad categories, 'currents' and 'tides'. Currents are broadly defined as any horizontal movement of water along the earth's surface. Tides, on the other hand, are water movement in the vertical plane due to periodic rising and falling of the ocean surface (and connecting bodies of water) resulting from unequal gravitational pull from the moon and sun on different parts of the earth. Tides will cause currents, but tides are generally defined as the diurnal and semi-diurnal movement of water from the sun/moon pull.

A basic understanding of these processes will arm ROV operators with the ability to predict conditions at the work site, thus assisting in accomplishing the work task.

Per Bowditch (2002),'currents may be referred to according to their forcing mechanism as either wind-driven or thermohaline. Alternatively, they may be classified according to their depth (surface, intermediate, deep or bottom). The surface circulation of the world's oceans is mostly wind driven. Thermohaline currents are driven by differences in heat and salt. The currents driven by thermohaline forces are typically subsurface.' If performing a deep dive with an ROV, count on having a surface current driven by wind action and a subsurface current driven by thermohaline forces-plan for it and it will not ruin the day.

An example of the basic differences between tides and currents follow:

- In the Bay of Fundy's Minas Basin (Nova Scotia, Canada), the highest tides on planet earth occur near Wolfville. The water level at high tide can be as much as 45 feet (16 metres) higher than at low tide. Small Atlantic tides drive the Bay of Fundy/Gulf of Maine system near resonance to produce the huge tides. High tides happen every 12 hours and 25 minutes (or nearly an hour later each day) because of the changing position of the moon in its orbit around the earth. Twice a day at this location, large ships are alternatively grounded and floating. This is an extreme example of tides in action.
- At the Straits of Gibraltar, there is a vertical density current through the Straits. The evaporation of water over the Mediterranean drives the salinity of the water in that sea slightly higher than that of the Atlantic Ocean. The relatively denser high salinity waters in the Mediterranean flow out of the bottom of the Straits while the relatively lower (less dense) salinity waters from the Atlantic flow in on the surface. This is known as a density current. Trying to conduct an ROV operation there will probably result in a very bad day.
- Currents flow from areas of higher elevation to lower elevation. By figuring the elevation change of water over the area, while computing the water distribution in the area, one can find the volume of water that flows in currents past a given point (volume flow) in the stream, river, or body of water. However, the wise operator will find it much easier to just look it up in the local current/tide tables.

a) Currents

The primary generating forces for ocean currents are wind and differences in water density caused by variations in heat and salinity. These factors are further affected by the depth of the water, underwater topography, shape of the basin in which the current is running, extent and location of land, and the earth's rotational deflection.

Each body of water has its peculiar general horizontal circulation and flow patterns based upon a number of factors. Given water flowing in a stream or river, water accelerates at choke points and slows in wider basins per the equations of Bernoulli. Due to the momentum of the water, at a river bend, the higher volume of water (and probably the channel) will be on the outside of the turn. Vertical flow patterns are even more predictable with upwelling and downwelling patterns generally attached to the continental margins.

Just as there are landslides on land, so are there mudslides under the ocean. Mud and sediment detach from a subsea ledge and flow downhill in the oceans, bringing along with it a friction water flow known as turbidity current. Locked in the turbidity current are suspended sediments. This increase in turbidity can degrade camera optics if operating in an area of turbidity currents.

Currents remain generally constant over the course of days or weeks, affected mostly by the changes in temperature and salinity profiles caused by the changing seasons.

Of particular interest to underwater vehicle operators is the wind-driven currents culled into the so-called 'Ekman spiral' (Figure 1).

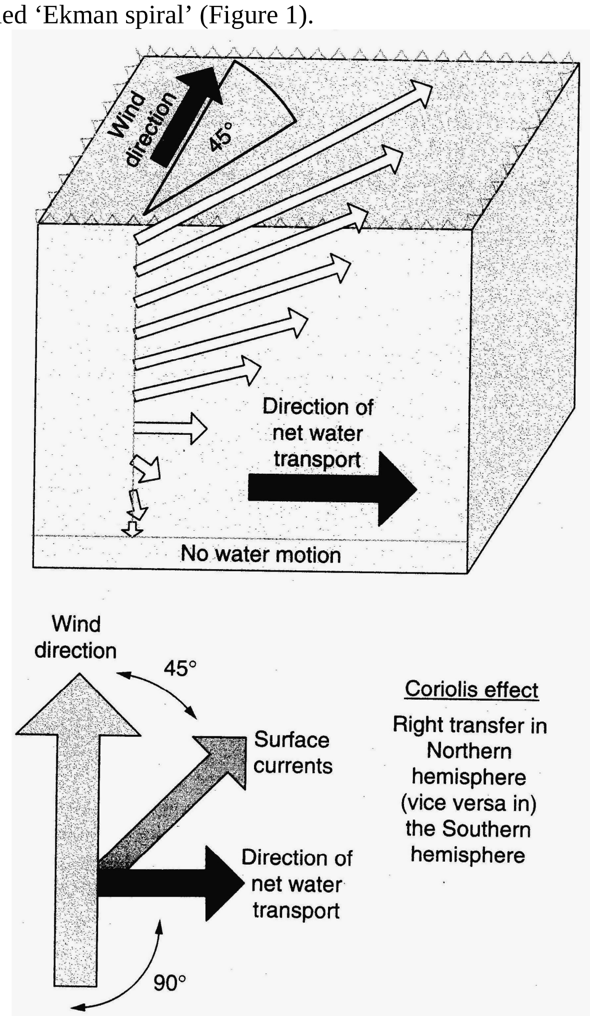

Figure 1. Ekman spiral.

The model was developed by physicist V Walfrid Ekman from data collected by arctic exploration legend Fridtjof Nansen during the voyage of the Fram. From this model, wind drives idealized homogeneous surface currents in a motion 45° from the wind line to the right in the Northern hemisphere and to the left in the Southern hemisphere. Due to the friction of the surface water's movement, the subsurface water moves in an ever-decreasing velocity (and ever-decreasing vector) until the momentum imparted by the surface lamina is lost (termed the 'depth of frictional influence'). Although the 'depth of frictional influence' is variable depending upon the latitude and wind velocity, the Ekman frictional transfer generally ceases at approximately 100 m depth. The net water transfer is at a right angle to the wind.

b) Tides

Tides are generally referred to as the vertical rise and fall of the water due to the gravitational effects of the moon, sun and planets upon the local body of water (Figure 2).

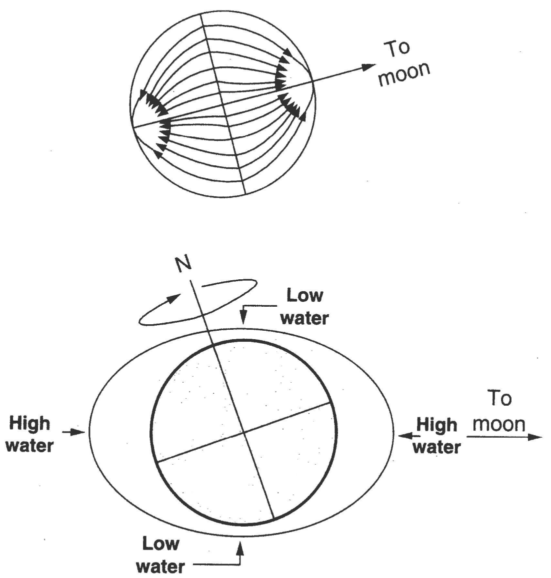

Figure 2. Tidal movement in conjunction with planets.

Tidal currents are horizontal flows caused by the tides. Tides rise and fall. Tidal currents flood and ebb. The ROV operator is concerned with the amount and tide of the tide, as it affects the drag velocity and vector computations on water flow across the work site. Tidal currents are superimposed upon non-tidal currents such as normal river flows, floods and freshets. All of these factors are put together to find what the actual current will be for the job site (Figure 3).

On a vertical profile, the tide may interact with the general flow pattern from a river or estuary; the warm fresh water may flow from a river on top of the cold salt water (a freshet, as mentioned above) as the fresh water creeps for a distance up the river. According to Van Dorn (1993), fresh water has been reported over 300 miles at sea off the Amazon. If a brackish water estuary is the operating area, problems to be faced will include variations in water density, water flow vector/speed, and acoustic/turbidity properties.

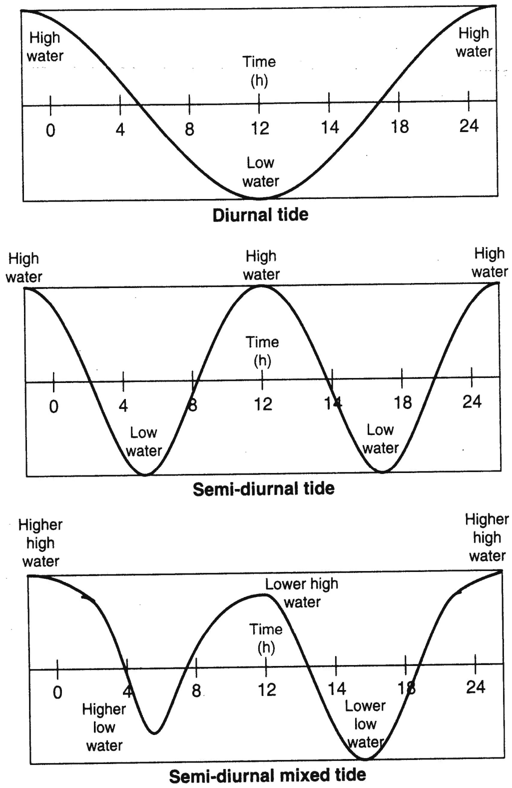

Figure 3. Tide periods over a 24-hour span.

2.3 Compressibility

For the purposes of observation-class ROV operation, sea water is essentially incompressible. There is a slight compressibility factor, however, that does directly affect the propagation of sound through water. This compressibility factor will affect the sonic velocity computations at varying depths.

2.4 Conductivity

Conductivity is the measure of electrical current flow potential through a solution. In addition, because conductivity and ion concentration are highly correlated, conductivity measurements are used to calculate ion concentration in solutions.

Commercial and military operators observe conductivity for gauging water density for vehicle ballasting and such and for determining sonic velocity profiles for acoustic positioning and sonar use. Water quality researchers take conductivity readings to determine the purity of water, to watch for sudden changes in natural or waste water, and to determine how the water sample will react in other chemical analyses. In each of these applications, water quality researchers count on conductivity sensors and computer software to sense environmental waters, log and analyse data, and present this data.

2.5 Density

Density is mass per unit volume measured in SI units in kilograms per cubic metre (or, on a smaller scale, grams per cubic centimetre). The density of sea water depends upon salinity, temperature and pressure. At a constant temperature and pressure, density varies with water salinity. This measure is of particular importance to the operation of an underwater vehicle for determination of the neutral buoyancy for the vehicle.

The density range for sea water is from 1.02200 to 1.030000g/cm3 (Thurman, 1994). In an idealized stable system, the higher density water sinks to the bottom while the lower density water floats to the surface. Water under the extreme pressure of depth will naturally be denser than surface water, with the change in pressure (through motion between depths) being realized as heat. Just as the balance of pressure/volume/temperature is prevalent in the atmosphere, so is the temperature/salinity/pressure model in the oceans.

A rapid change in density over a short distance is termed a ‘pycnocline’ and can trap any number of energy sources from crossing this barrier, including sound (sonar and acoustic positioning systems), current and neutrally buoyant objects in the water column (underwater vehicles). Changing operational area from lower latitude to higher latitude produces a mean temperature change in the surface layer. As stated previously, the deep ocean is uniformly cold due to the higher density cold water sinking to the bottom of the world’s oceans. The temperature change from the warm surface at the tropics to the lower cold water can be extreme, causing a rapid temperature swing within a few metres of the surface. This surface layer remains near the surface, causing a small tight ‘surface duct’ in the lower latitudes. In the higher latitudes, however, the difference between ambient surface temperature and the temperature of the cold depth is less pronounced. The thermal mixing layer, as a result, is much larger, over a broader range of depth between the surface and the isothermal lower depths, and less pronounced (Figure 4).

In Figure 4 a), density profiles by latitude and depth are examined to display the varying effects of deep-water temperature/density profiles versus ambient surface temperatures. Figures 4 b) and c) look at the same profiles, but focusing on temperature and salinity.

Figure 4 d) demonstrates a general profile for density at low to midlatitudes. The mixed layer is water of constant temperature due to the effects of wave mechanics/mixing.

A good example of the effect of density on ROV operations comes from a scientific mission conducted in 2003 in conjunction with National Geographic magazine. The mission was to the cenotes (sink holes) of the Northern Yucatan in Mexico. Cenotes are series of pressure holes in a circular arrangement, centred around Chicxulub, the theoretical meteor impact point, purportedly left over from the K-T event from 65 million years ago that killed the dinosaurs.

The top water in the cenote is fresh water from rain runoff, with the bottom of the cenote becoming salt water due to communication, via an underground cave network, with the open ocean. This column of still water is a near perfect unmixed column of fresh water on top with salt water below. A micro-ROV was being used to examine the bottom of the cenote as well as to sample the salt water/freshwater (halocline) layer. The submersible was ballasted to the fresh water on top layer. When the vehicle came to the salt water layer, the submersible’s vertical thruster had insufficient downward thrust to penetrate into the salt water below and kept ‘bouncing’ off the halocline. The submersible had to be re-ballasted for salt water in order to get into that layer and take the measurements, but the vehicle was useless on the way down due to it being too heavily ballasted to operate in fresh water.

2.6 Depth

Depth sensors measure the distance from the surface of a body of water to a given point beneath the surface, either the bottom or any intermediate level.

Depth readings are used by researchers and engineers in coastal and ocean profiling, dredging, erosion and flood monitoring and construction applications.

Bathymetry is the measurement of depth in bodies of water. Further, it is the underwater version of topography in geography. Bottom contour mapping details the shape of the sea floor, showing the features, characteristics and general outlay. Tools for bathymetry and sea bottom characterization follow.

a) Echo sounder

An echo sounder measures the round trip time it takes for a pulse of sound to travel from the source at the measuring platform (surface vessel or on the bottom of the submersible) to the sea bottom and return. When mounted on a vessel, this device is generally termed a fathometer and when mounted on a submersible it is termed an altimeter.

According to Bowditch (2002), ‘the major difference between various types of echo sounders is in the frequency they use. Transducers can be classified according to their beam width, frequency and power rating. The sound radiates from the transducer in a cone, with about 50 % actually reaching the sea bottom. Beam width is determined by the frequency of the pulse and the size of the transducer. In general, lower frequencies produce a wider beam and at a given frequency, a smaller transducer will produce a wider beam. Lower frequencies penetrate deeper into the water, but have less resolution in depth. Higher frequencies have a greater resolution in depth, but less range, so the choice is a trade-off. Higher frequencies also require a smaller transducer. A typical low-frequency transducer operates at 12kHz and a high-frequency one at 200kHz’. Many smaller ROV systems have altimeters on the same frequency as their imaging system for easier software integration (same software can be used for processing both signals) and reduced cost purposes (Figure 5).

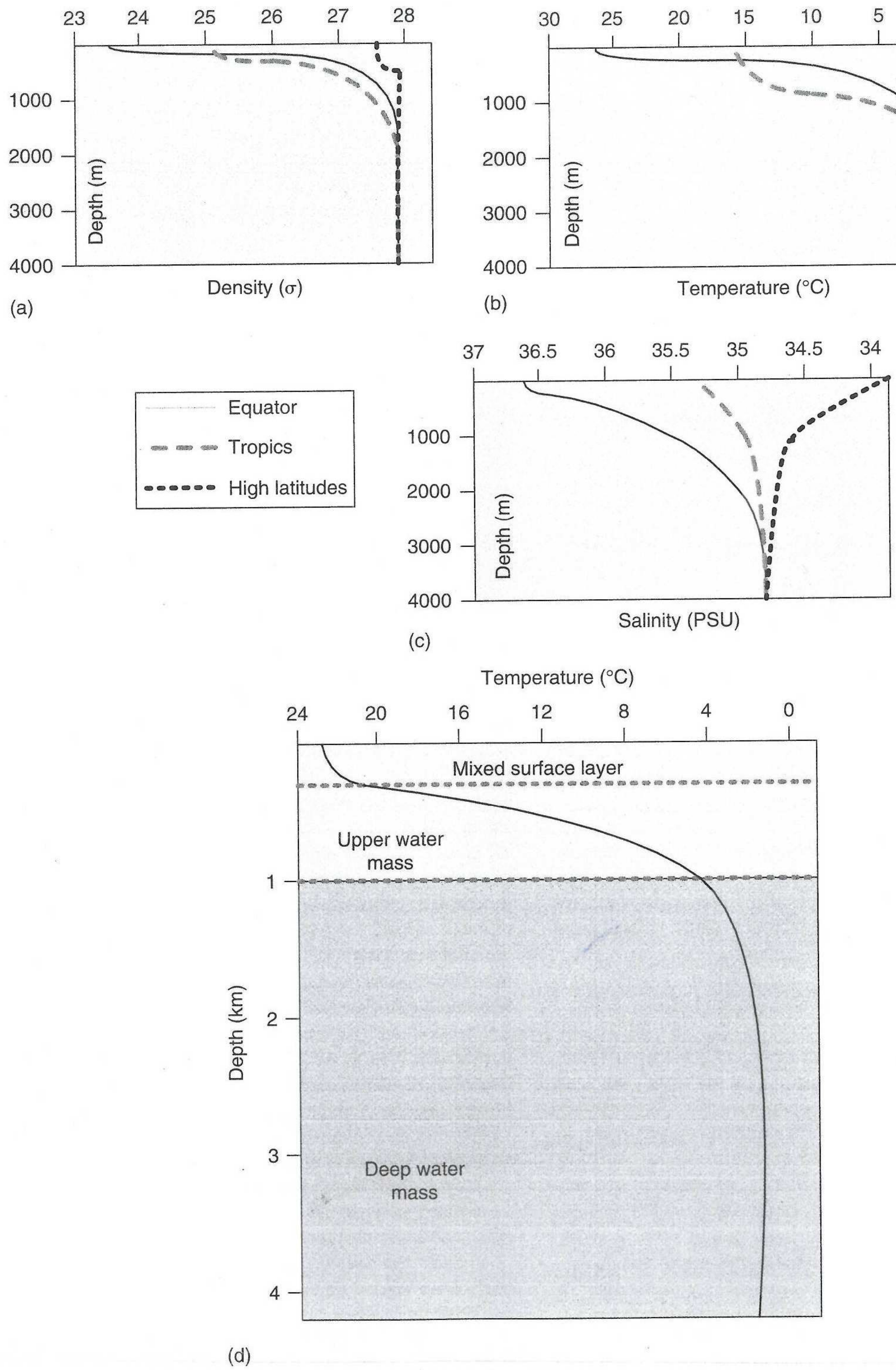

Figure 4. Density profiles with varying latitudes along with a general density curve

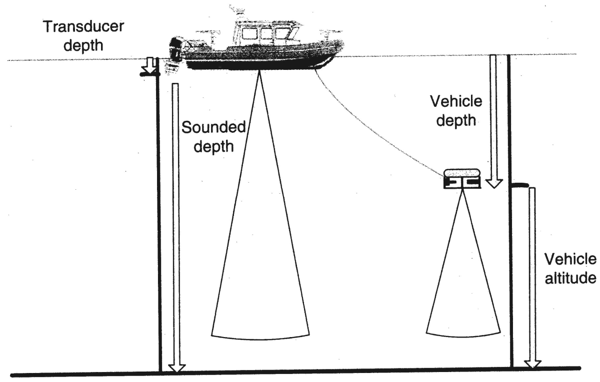

Figure 5 Vessel-mounted and sub-mounted sounders.

Computation of depth as determined by an echo sounder is determined via the following formula:

$$D = (V \times T/2) + K + D_r \quad (1)$$

where D is depth below the surface (or from the measuring platform), V is the mean velocity of sound in the water column, T is time for the round trip pulse, K is the system index constant and D_r is the depth of the transducer below the surface.

b) Optic-acoustic seabed classification

Traditional sea floor classification methods have, until recently relied upon the use of mechanical sampling, aerial photography, or multi-band sensors for major bottom-type discrimination (e.g. mud, sand, rock, sea grass and corals). Never acoustic techniques for collecting hyperspectral imagery are now available through processing of acoustic backscatter.

Acoustic seabed classification analyses the amplitude and shape of acoustic backscatter echoed from the sea bottom for determination of bottom texture and makeup, Figure 6.

Sea floor roughness causes impedance mismatch between water and the sediment. Further, reverberation within the substrate can be analysed in determining the overall composition of the bottom being insonified. Acoustic data acquisition systems and a set of algorithms that analyse the data allow for determining the seabed acoustic class.

3. CONCLUSIONS

Earth is the only planet known to have water resident in all three states (solid, liquid and gas). It is also the only planet to have known liquid water currently at its surface.

The early method of obtaining environmental information was by gathering water samples for later analysis in a laboratory. Today, the basic parameters of water are measured with a common instrument named the ‘CTD sonde’. Some of the newest sensors can analyse a host of parameters logged on a single compact sensing unit.

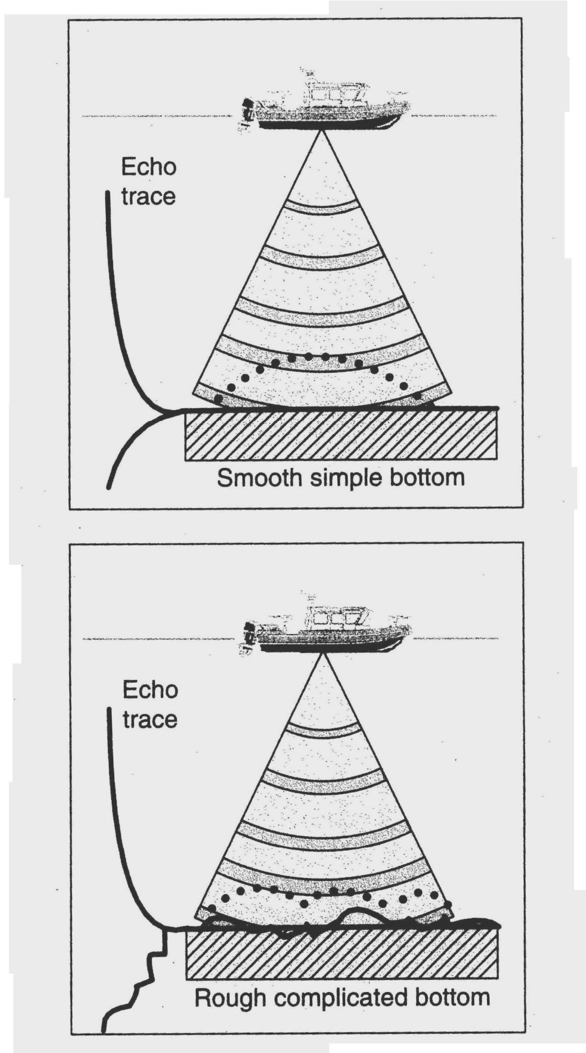

Figure 6. Acoustic seabed classification

Fresh water is an insulator, with the degree of electrical conductivity increasing as more salts are added to the solution. By measuring the water’s degree of electrical conductivity, highly accurate measure of salinity can be derived. Temperature is measured via electronic methods and depth is measured with a simple water pressure transducer. The CTD probe measures ‘conductivity/temperature/depth’, which are the basic parameters in the sonic velocity equation. Newer environmental probes are available for measuring any number of the water quality parameters such as pH, dissolved oxygen and CO_2, turbidity and other parameters.

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THE COLD WELDING ON COGGED SURFACES

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ABSTRACT

Welding by cold pressing on cogged surfaces, produces the joint of a component made from an easy deformable metal by pressing on the cogged surface of a harder metal component. Different welds between aluminium (the easy deformable component) and copper, brass, steel, stainless steel (harder component, cogged on the contact surface) can be obtained. The experimental results show that the weld can be achieved at lower deformation rates than in the classical cold welding case. The weld is obtained only by deforming the aluminium component at a deformation rate of 20 … 20%. The welding on cogged surfaces of materials with different plasticity makes possible the production of bimetallic or multilayer elements. The weld tensile strength is up to 10% of aluminium ultimate tensile strength, better results being obtained for the shearing strength. A thermal treatment can be used to double the joint resistance, by activating the materials diffusion on the contact surface. The weld contact electric resistance is negligible, recommending the process for producing dissimilar elements used in electrotechnics..

Keywords: *cold welding, pressure welding, aluminium joints*

1. INTRODUCTION

Aluminium and its alloys can be joined by brazing, soldering, welding or through different hybrid processes [1]. From the pressure welding processes, cold welding is easy to achieve, presenting the following characteristics [8]:

- before pressing the process require the careful cleaning of the joining surfaces;
- during pressing, high plastic deformation rates, surpassing 70% for aluminium and 90% for copper are achieved;
- high up-setting pressures are used, producing the materials hardening; for example, in case of 99%Al, the up-setting pressure is of 800…1000 Mpa, being 8…10 times bigger than its shearing strength.

Nowadays, the cold welding is used in butt, spot or rolling variants.

Cold welding on cogged surfaces is a technology developed by researchers from Robotics and Welding Department, Dunarea de Jos University of Galati. Easy deformable samples, having plane surfaces, are pressed on cogged surfaces of harder samples [6]. Of importance for joint achievement is the deformation rate of the easy deformable material.

The practical advantage of the cold welding on cogged surfaces is due to the fact that the joint is obtained only by deforming the easy deformable sample, at lower deformation rates than in the case of classical cold welding. At the same deformation rate, the weld was achieved only in case of pressed samples on cogged surfaces, the pressed plane samples couldn't be joined [5].

Cold welding on cogged surfaces can be achieved in the following variants:

- direct, between two samples with different plasticity;
- indirect, between two samples with the same plasticity, using an intermediate easy deformable material.

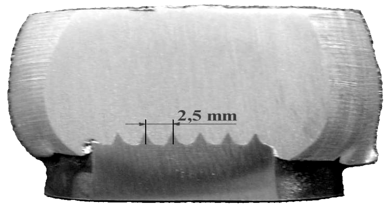


Fig. 2.1 Welded cylindrical sample

2. DIRECT WELDING

Through direct welding by cold pressing on cogged surfaces an easy deformable material is joined with the cogged surfaces of a harder metal. Were used cylindrical samples with 30 mm diameter and highs of 20...40 mm (figure 2.1). The contact surfaces were firstly mechanically cleaned with a rotating steel-wire brush, at a rotating speed of 2800 rot/min. Immediate after the samples' cleaning, a hydraulic press was used for samples up-setting [5].

Different welded joints were achieved between aluminium (easy deformable sample) and copper, brass, steel and stainless steel (harder, cogged sample). Based on the mechanical test results, several conclusions about the characteristics of the cold welded on cogged surfaces joints were drawn:

A) The cogs geometry must be correlated with the dimensions of the welding samples. In small samples case, the cog angle must be up to 45^0 for a pitch over 2.5 mm (figure 2.2);

B) Deformation rate. The weld was achieved only by deforming the aluminium sample, at a deformation rate of 20-30%. Higher deformation rates aren't recommended [2]

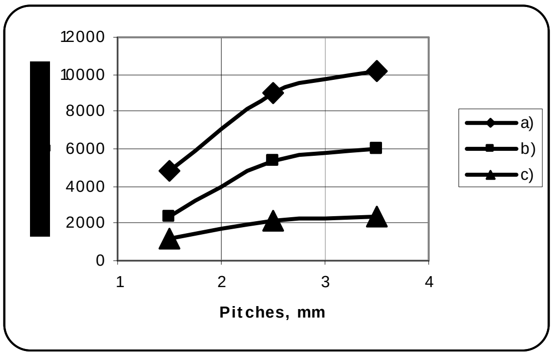


Fig. 2.2 The ultimate strength at different pitches: a) by cross shearing; b) by longitudinal shearing; c) by stretching [4]

Figure 2.3 presents the tensile strength - deformation rate dependency in case of cold welding on cogged surfaces of the aluminium with different materials. Analysing these curves plotted in case of pressing the aluminium component on copper, steel, respectively stainless steel, small differences regarding the joint resistance can be noticed, which allow grouping these materials in two categories:

- 1st group: copper and brass; the joint maximum resistance is obtained at 20% deformation rate (computed only for the aluminium component);
- 2nd group: steel and stainless steel; the joint maximum resistance is lower than in copper and brass case and is registered at 30% deformation rate (computed only for the aluminium component).

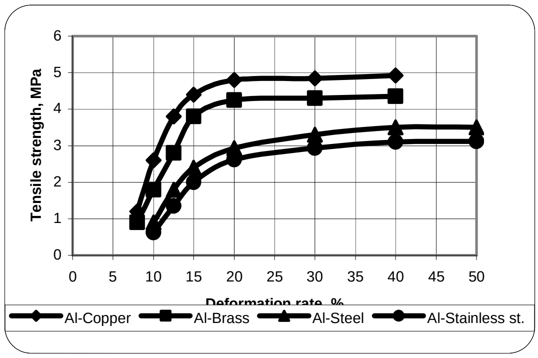


Fig. 2.3 The tensile strength-deformation rate dependency

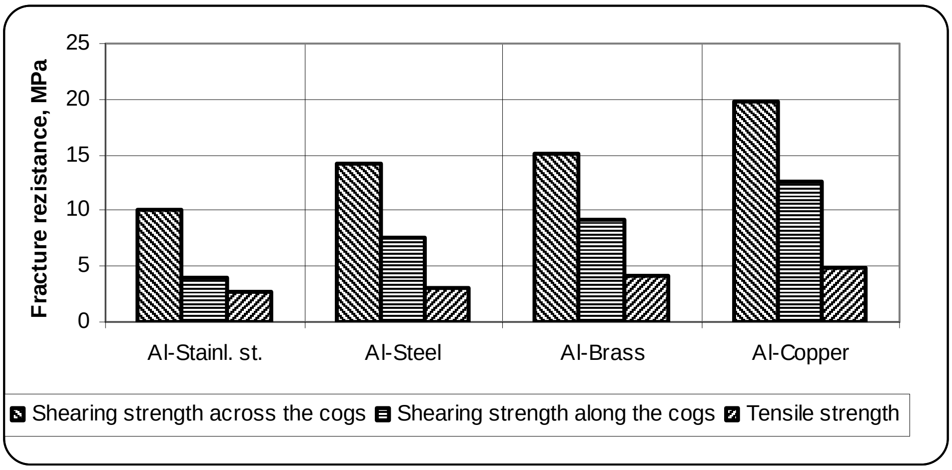
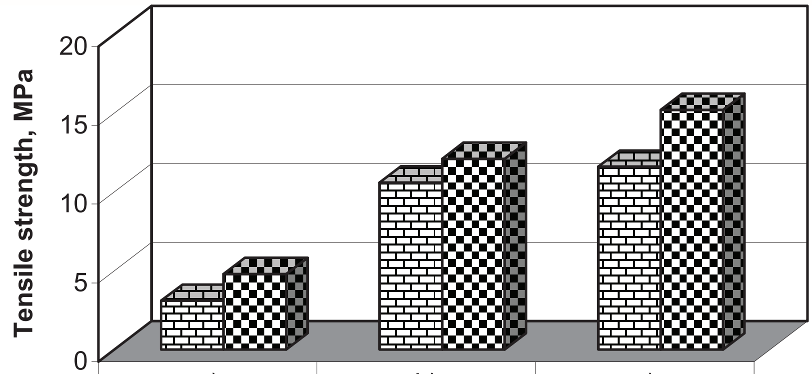


Fig. 2.4 The fracture rezistance for different cold-welded samples on cogged surfaces [3]

C) The joint mechanical characteristics are: the tensile strength is up to 10% of aluminium ultimate tensile strength (50 … 80 N/mm^2), double values were registered in case of the shearing strength (figure 2.4).

D) Thermal treatments. The mechanical characteristics can be improved through thermal treatments; up to a 3 times increase can be obtained by joints' 30 minutes heating at 500 ^{0}C, at normal atmosphere (figure 2.5).



	a)	b)	c)
Al-Steel	3.1	10.6	11.6
Al-Copper	4.8	12.1	15.2

Fig. 2.5 Thermal treatment influence on the joint tensile strength: a) without thermal treatment; b) with thermal treatment; c) with thermal treatment and preliminary compression

3. INDIRECT WELDING

At indirect welding, the intermediate metal must be weld with each sample, according to their plasticity. Depending on their plasticity, it can be discussed about:

- cold welding on cogged surfaces with an intermediate easy deformable layer;
- cold welding on cogged surfaces with an intermediate hard metal layer.

It must be underlined that the plasticity characteristic is relative, comparing with the steel, the copper is easy deformable and the steel is harder than the aluminium or lead [7].

Indirect welding with an intermediate easy deformable layer of aluminium or lead was used for dissimilar hard metals (having cogged contact surfaces) joints as Cu-Al-stainless steel, brass-Al-steel etc. Figure 3.1 presents the brass-Al-brass and Cu-Al-Cu joint.

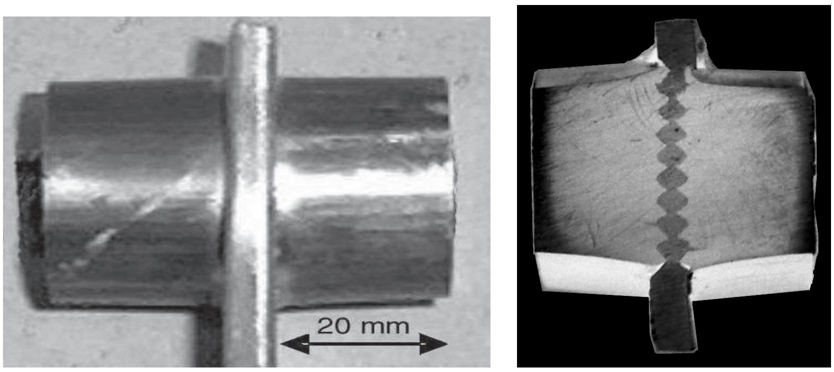


Fig. 3.1 Cold welding samples with Al intermediate layer

Indirect welding with hard metal intermediate layer. Easy deformable samples with plane contact surfaces ar welded through a cogged intermediate layer of a hard metal. The intermediate sample, adapted to the easy deformable samples shape, can be obtained by chipping, forming, drawing or bending. Figure 3.2 presents different cold welded samples with intermediate cogged layer:

– 2 aluminium plates of 10 mm thickness are joined through a square shape (60x60 mm) sample of copper;
– lead-copper-aluminium cold welded samples.

Fig. 3.2 Cold welded samples with intermediate cogged layer

4. CONCLUSIONS

Cold pressed welding on cogged surfaces can be obtained at lower deformation rates of the aluminium component, up to 20… 30%.

Bi-metallic or multi-layer components can be produced by cold welding on cogged surfaces between materials with different plasticity properties.

The joints' tensile strength can be improved by thermal treatment, with or without pressing, stimulating the diffusion process of the peripheral atoms of the two materials.

The contact electric resistance of the cold welded samples on cogged surfaces is negligible, recommending this type of joints for the electrical engineering applications.

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ELECTRICAL ENGINEERING APPLICATIONS OF THE WELDING ON COGGED SURFACES

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ABSTRACT

The welding on cogged surfaces between aluminium and copper to be useful so as to replace the mechanical aluminium-metal contact with the copper-metal contact. The possible applications in this respect have been analyzed for the following concrete directions: The welding of electric aluminium conductor bars; The sheathing of electric aluminium conductor bars; The sheathing of the aluminium clips. The contact electric resistance measurements made with a CA 10 Microhmeter indicates negligible values of 1-5 μΩ. These values are constant in time during the exploitation of the electrical contact (tests during months of exploitations were also performed). The temperature in the contact area was measured with a Therma Cam PM 675 PAL thermographic camera. The efficiency of the sheathing is obvious if we were to consider the overheating inside the substation with only 3°C as compared to the 30-40°C normally existing there in the case of classical joints..

Keywords: *contact electric resistance, aluminium-copper joints, cold welding*

1. INTRODUCTION

The fact should be pointed out that the contact between aluminium and other metals should be avoided for the assemblies of metallic or electric constructions. For example, when brought into contact with the copper or the iron, aluminium forms galvanic couples and corrosion progresses rapidly. The formed layer has a higher electric resistance and leads to the contacts' heating. We expect the welding on cogged surfaces between aluminium and copper to be useful so as to replace the mechanical aluminium-metal contact with the copper-metal contact, for which there are not such problems as those mentioned above.

The possible applications in this respect have been analyzed for the following concrete directions:

- The sheathing of the aluminium conductors' clips;
- The welding of electric conductor bars;
- The sheathing of electric conductor bars.

2. THE SHEATHING OF THE ALUMINIUM CONDUCTORS' CLIPS

The sheathing of the large sized aluminium clips may represent another useful application. In the electric supply and control sub-stations the devices' connecting conductors are bound to copper bars by using aluminium clips and cables. Due to the contacts' oxidation in time, the conductors are gradually heating themselves until the isolation is destroyed out. In order to avoid the heating, the sheathing in figure 2.1, where clips with a cable section of 240 mm.

The proposed clips have been used in electric supply sub-stations, in order to check the correctness of our proposal. In figures 2.2 it can be observed that such clips are used, without a previous cleaning of the contact surface, on one of the supplying phases of a real consumer, the first on the left. In order to convince ourselves of the equal charging on the three cables, the passing currents have been measured with a DIGICLAMP clipper.

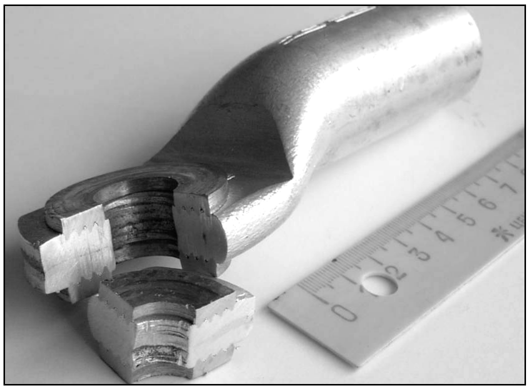

Fig. 2.1 The sheathing of the aluminium clips

After 24 hours of functioning the temperature in the contact area of these three cables was measured with a Therma Cam PM 675 PAL thermographic camera produced by Flirs Systems AB Sweden. The efficiency of the sheathing is obvious if we were to consider the overheating inside the substation with only 3°C as compared to the 30-40°C normally existing there in the case of classical joints. The analysis of the linear temperature variation along the clips with the help of the Agema report 5-4 computer program shows that the steel screws used for the bounding of the clips are an important thermal source. In the superior part (figure 2.2) the first two screws reach the same temperature of 54 °C and the third one reaches a higher temperature of 67°C. The different heating of the classical clips may be explained by means of the heating caused by their contact resistance.

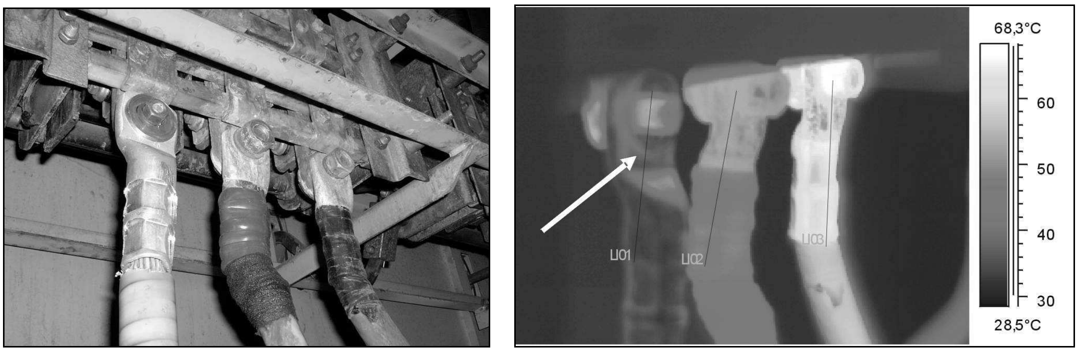

Fig. 2.2 The checking of the sheathed aluminium clips during their functioning and the thermographic analysis

3. THE WELDING OF ELECTRIC CONDUCTOR BARS

One of the most important practical application of spot cold welding is the aluminium bars welding (the replacement of copper bars). In Russian railway electric sub-station aluminium welded bars were used for transport big currents [1]. For plates sections having 6 x 60 mm the spot cold welding of the plates was achieved in specialized dies, with 4 rounded punches. 5 rounded punches were necessary for bigger sections. The punches are ensuring the spot cold welding achievement on an 80% minimum deformation rate for the base material.

We would like to propose the cold joint of the aluminium band with an intermediary double cogged copper plate the resulting assembly joint having the aspect in figure 3.1. The theoretical estimations demonstrate the superiority of the joining on cogged surfaces as compared to the cold spot welding because both the mechanical resistance and the electric contact surface increase [2]

.

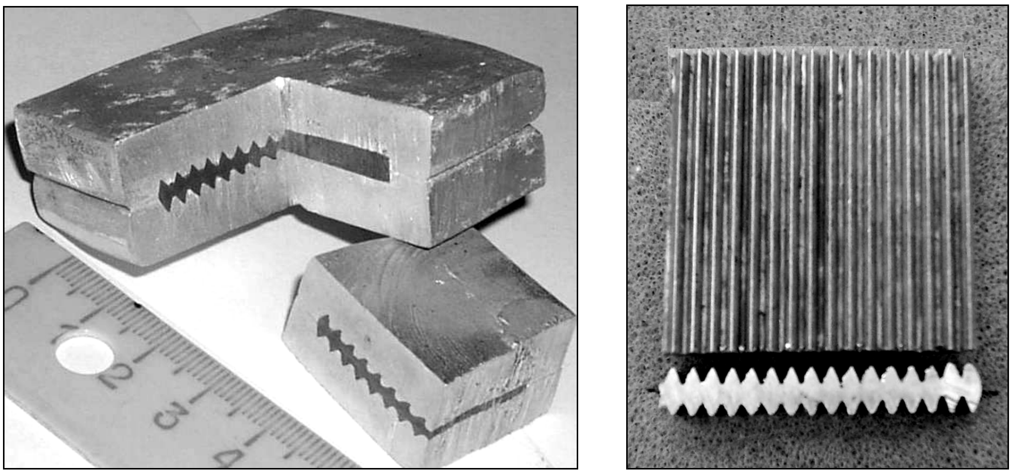

Fig. 3.1 Proposal for the cold welding of the aluminium bands: the joint aspect and the intermediary element

4. THE SHEATHING OF ELECTRIC CONDUCTOR BARS

The coating of aluminium with copper is another important example for cold welding on cogged surface applications. It’s about the bimetallic crossing aluminium–copper from connection terminal zones of electrical bars, to prevent in time oxidation of the electrical contact of aluminium transport lines. The aluminium conductor will have a lower contact electrical resistance and will act in service like a copper conductor, without overheating or accelerated oxidation.

We would like to propose the local placing of some linearly or circularly cogged plates in the area of the binding screw like in figure 4.1a. The pressing may be done unilaterally, only on the bands’ contact zone (fig 4.1b) or bilaterally. If the pressing is done after having made the hole, the general deformation is reduced, but the diameter of the hole will decrease and the hole will have to be made again. If the pressing is done before having made the hole and the plate is placed near the margin, the material will slightly flow to the exterior. The welding of the plates and the hole may be done simultaneously with the same pressing device [3].

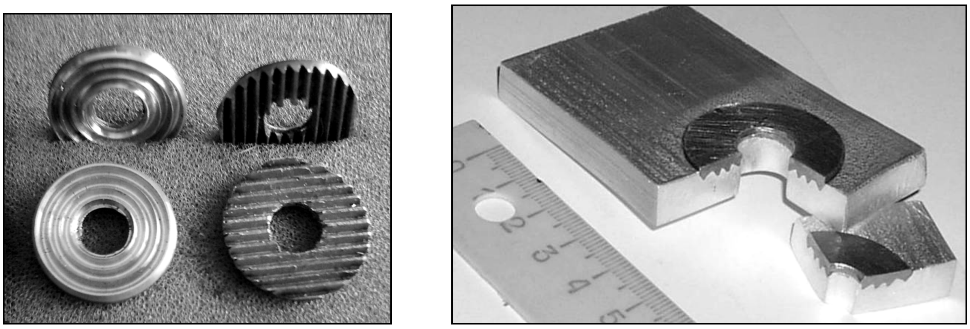

Fig. 4.1 The sheathing of the aluminium bands' contact zones:
a) the shape of the copper plate; b) unilateral sheathing

For the proposed variant the following aspects should be pointed out:

The electric contact surface is larger;

The total welding is larger but obtained smaller unitary effort;

There exists the possibility of using some simple devices, actioned manually, which can make position weldings in site conditions;

The reduced stretch resistance of the joints on cogged surfaces is no longer important because these joints are compressed during the exploiting; we would like to mention the fact that this reduced resistance is sufficient to prevent the displacement of the components during the cutting by means of chipping.

In order to observe the various aspects related to the different coupling ways, the samples in figure 4.2 have been produced. Screws have been tightened up with the dynamometric key at the same force of 3 daN. The contact resistance of these joints has been measured at different intervals of time, the results obtained being presented in the diagram 4.3.

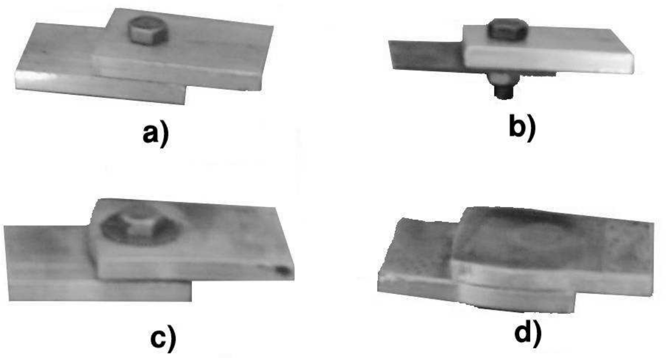

Fig. 4.2 Coupling variants for the electric aluminium bars:
a) – Classic screw-nut disk joint made of aluminium-aluminium;
b) – Classic screw-nut disk joint made of aluminium-copper;
c) – Classic screw-nut disk joint of the bars sheathed with cogged washers;
d) – Cold welded joint with an intermediary cogged copper element

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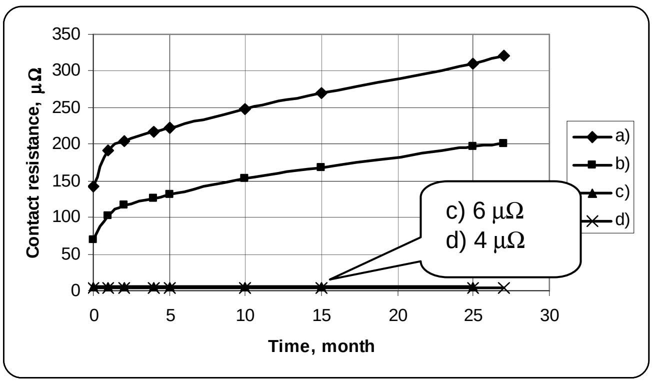

Fig. 4.3 The time variation of the contact resistance

The measuring confirmed our theoretical suppositions, namely [4]:

- The big contact resistance is that of the mechanic aluminium-aluminium joining, due to the aluminux oxid existing on the surfaces;
- The contact resistance for the aluminium-copper is of one half due to the insignificant resistance of the copper oxide;
- The minimum contact resistance is obtained only for those welded samples which were carefully cleaned before being welded;
- The contact resistance of the sheathed samples is a little better than of welded ones due to the mechanic Cu-Cu contact;
- The contact resistance of the mechanic joints increases rapidly proportionally with the time; the resistance of the joints welded on cogged surfaces remains reduced.

5. CONCLUSIONS

Welding by cold pressing on cogged surfaces can be done using much lower rates of deformation as compared to the classic cold welding. The welding is obtained only by means of the aluminum component deformation with a deformation rate of 20…30%.

Welding on cogged surfaces of some materials which have different plasticity (mild material + rigid material) offers the possibility of obtaining some bimetallic, multilayered prismatic or flat elements. The stretch resistance is reduced but can be improved by diffusion thermal treatment.

The contact wasteful resistance of the joint is insignificant, aspect which recommends this method of joining the aluminum with other metals, especially for the field of electrotechnics.

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POROUS MATERIAL ANALYSIS REGARDING HUMIDITY EFFECTS OVER THERMICAL CONVEYANCE

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ABSTRACT

The study presents the influence of moisture of the thermical transfer coefficient about the material with high permeability at water/vapours and/or active capillary. There is an evidence in the next determination methods of the thermical transfer coefficient active, passive, and with the help of a device with hot protected plate.

Keywords : *transfer, capillary, thermical, coefficient, enthalpy*

1. INTRODUCTION

Because of the constructions materials porousity, the real heat conveyance is realised by conduction and convection, so that the practical values of thermical conductivity coefficient defines the complex aspect of the heat transmission by porous materials.

he research over the thermical conduction in a porous capillary environment showed us that, besides the classic thermical conductivity term, thermical flow density q contains steams and water inter-relationed enthalpy flow densities*:*

$$q=\lambda\frac{\partial\theta}{\partial x}+\left[\left(r+c_{p,y}\theta\right)\frac{\delta_{aer}}{\mu}\frac{\partial p}{\partial\theta}\right]\frac{\partial\theta}{\partial x}+\left[\left(r+c_{p,y}\theta\right)\frac{\delta_{aer}}{\mu}\frac{\partial\varphi}{\partial\mu}p+c_1\theta\rho_1 D_1(u)\right]\frac{\partial u}{\partial x} \quad (1)$$

$\frac{\delta_{aer}}{\mu}$ - steams conductivity

$D_1(u)$- capillary conductivity at water

r- exhalation enthalpy

φ(u)-relative and reverse humidity over the sorption isotherm

Second and third term reach considerable values when the material is permeable to water/steams and/or capillary active.

Figure 1 shows how strong is influenced intern humidity of a closing element (light covering) to the border conditions, determined by the climatic conditions of the environment.

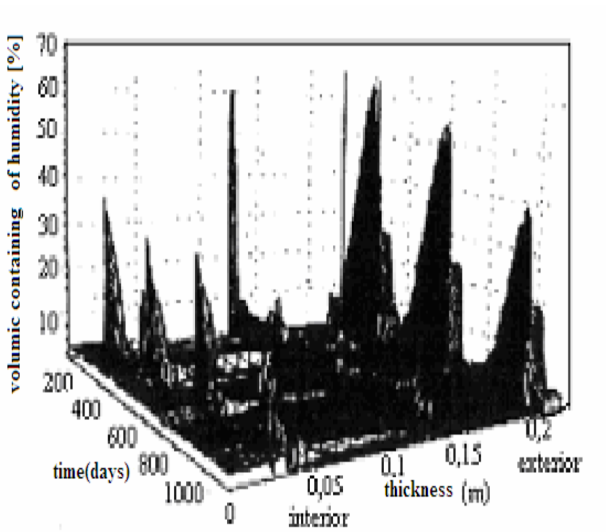

Figure 147. Humidity distribution in a light covering made of light concrete – barrier against the steam water – cinder hair thermoisolation – diffusion layer – plywood - asphalt

Humidity circulation is present in the roof element over several years, considered as inherent humidity of the wood. Heat flow density alteration and enthalpy flow density can be highlighted (by radiation alternation) and his effect over the thermical transmission (fig.2) [1].

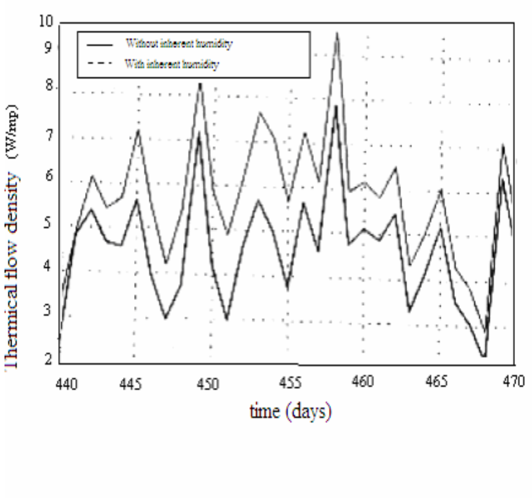

Figure 2. Thermical flow densities

A study over the thermical conveyance coefficient reveals the construction element humidity.

2 ACTIVE METHOD FOR THERMICAL CONVEYANCE COEFFICIENT DETERMINATION

In this case, temperature gradient is created by using a heat foil, environment independent. The heat is realised through a layer (felt) in contact with the measuring object. On the opposite face, to prevent energetical flux dissipation, the equipment is covered with a heat insulating layer.

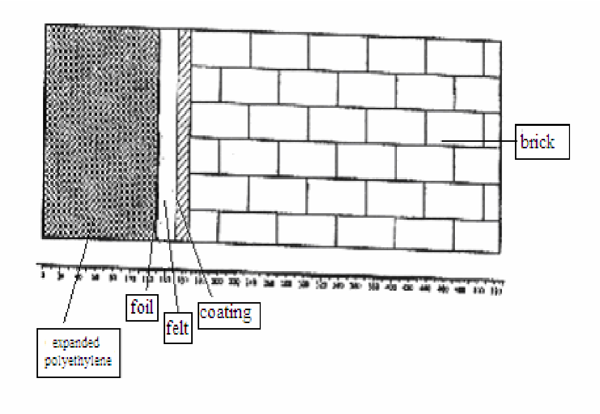

Figure 3. Brick wall whom has been measured by active method the value of thermical conveyance coefficient (U)

Graphic 3 – dimensional from figure 4 represents the humidity field of the ansamble determined due to 4 weeks of measuring on the brick wall from figure 3, in the fifth year of climateric requirement.

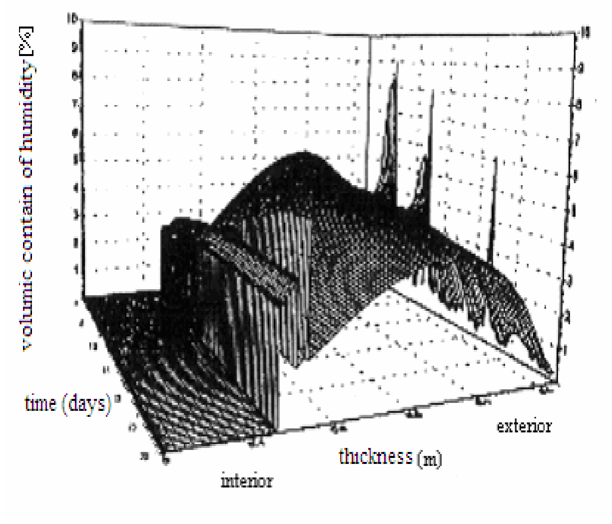

Figure 4. Humidity distribution in the brick wall obtained through thermical conveyance coefficient measuring by the active method

Behaviour is caused by an exterior climate (radiation, windy rain etc) specific to Essen (Germany), in conditions of a constant interior climate (20^0C, 50%). The adjustment of the thermical conveyance coefficient , caused by drying due to moisture and heat transport, is limited (fig.5).

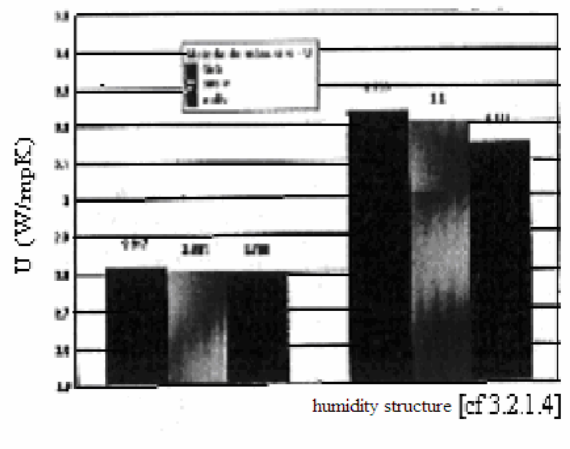

Figure 5. U values ($1/\alpha_i$ and $1/\alpha_e$) for the brick wall

Obviously, another structures with another characteristics generates another results. For example, fig. 6 shows manufactural humidity departure of a concrete wall in the extern isolating layer, which raises the transmission coefficient value at structure level from 0,42 W/m^{2}K to 0,60 W/m^{2}K.

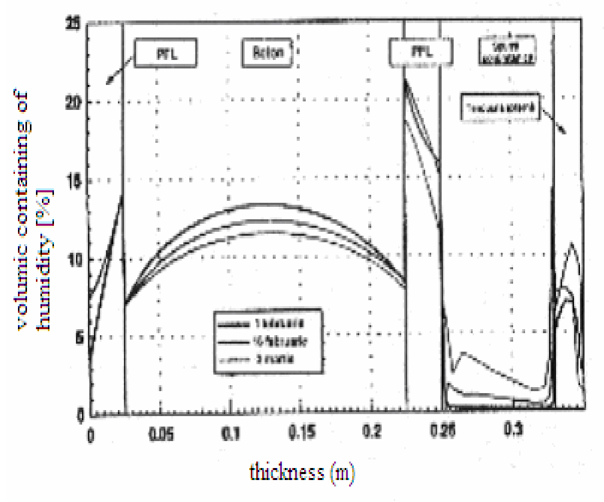

Figure 6. Humidity movement in a moist concrete wall with external isolation highlighted through active measure method of the thermical conveyance coefficient

3. PASSIVE METHOD FOR THERMICALCONVEYANCE COEFFICIENT DETERMINATION

Total contact of a measuring sensor of the thermical flow on an envelope element surface has the effect of a barrier against the steams and influences the enthalpy transfer and behaviour regarding natural drying. It doesn't surprise the adjustment bearing of the thermical transmission coefficient value , but the small value (fig.5), in conditions of a bidimensional account. Therefore, the efforts on a thermical flow measuring sensor elaboration, which has to be steam permeable, is irrelevant to most of the measurements.

4. THERMICAL CONVEYANCE COEFFICIENT MEASUREMENT WITH A HEAT PROTECTED PLATE DEVICE

According to ISO 8301/02, sample material must be dry when the test is taken. An international standard project has been prepared by ISO TC163/SCI, WG 9 for moist effects assessment about thermical appearance.

In conditions of a initial homogenous distribution of the humidity, the usual heat drop generates a humidity transfer to the cold face. This process is combined with an enthalpy flow which basically grows thermical conductivity. The reached fixed condition is tagged by an asimetrical distribution of the moist and a balance between the heat transfer and the bulk. For the same thermical conductivity the humidity movement is changed, likewise the energy transfer and thermical conveyance coefficient, related with his properties : steam resistance factor μ and capillary conductivity function D_l (u). This thing is proved by curves comparison in fig. 8.

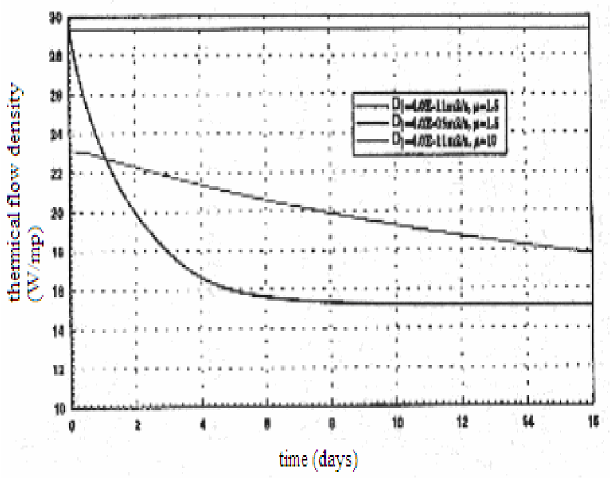

Figure 7. Thermical flow density in cinder hair sample in variety conditions of the capillary conductivity and steams

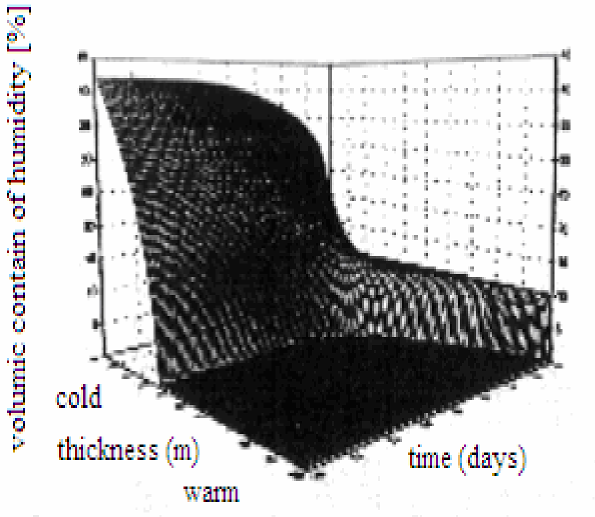

Figure 8. Humidity density in a cinder hair sample during thermical conductivity measurement with a warm plate device

First curve (D_l =4,0 E-11 m^2 /s, μ=1,5) complies with the cinder hair sample. Heat flow density doesn't reach balance earlier than a week.

5. CONCLUSIONS

It's obvious that the capillary transfer in diminished reverse direction of the cinder hair is the absolute reason for the higher value of the aggregation time, compared, in case of the cellular concrete. Second curve (the above) from figure 7 shows heat flow density for the same μ value, when D_l value is very big

(D_l=4,0 E-0,5 m^2/s). While the steam flow diffuses to the cold phase, liquid is flowing in reverse direction. From here it results a constant high density of the heat flow, containing latent enthalpy flow. The answer at the questions refering to necessary measurement time can be obtained for each material, using numerical assumption methods.

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OPTIMIZATION OF OPERATING REGIMES OF NAVAL PROPULSION PLANTS BASED ON MINIMUM COST OF TRANSPORT

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ABSTRACT

The problem of optimization of the functioning regimes of the energetic plant with internal combustion engines is very complex and must be solved hierarchically, on the base of the component sub-systems optimization, using the corresponding optimization methods, with the necessary calculation algorithms.

The paper presents the calculation of specific cost of transport to an oil tanker.

Keywords: *energetic plant ,oil-tanker, auxiliary engines, fuel consumption, deadweight , diesel*

1. INTRODUCTION

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. WORDING OF THE OPTIMIZATION PROBLEMS OF THE ENERGTIC PLANTS WITH INTERNAL COMBUSTION ENGINES

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.

The ship is equipped with three generators Diesel, 960 kW of power, speed 900 rpm. The crew consists of 31 persons.

By introducing the technical state, as an independent variable, the periods of time, during which the capital a naval propulsion plant fixing must be done, must be considered, as well as the ship docking in order to clean the careen, etc, so as the exploitation costs should be minim.

In the case of exploitation of a naval propulsion plant at the transitory regimes, the system processes must be modelled in the conditions of not taking into account the component elements' resilience or taking into consideration their resilience (vibrations), the optimization criteria being different, connected to the quality of the transitory process, the admitted requests of the component elements, taking into consideration tiredness, etc.

Annual maintenance and operating expenses of the ship is calculated as a sum of costs (C_T):

$$C_T = C_s + P_s + C_a + C_R + C_{apa} + C_L + C_{Suez} + C_{CAS} + A_s + C_{com} + C_d \qquad (1)$$

C_s-expenses for salaries crew;
P_s - port and agency costs;
Ca- annual share of redemption;
C_R - expenditures for repairs and equipment maintenance inspections;
C_{apa} - water boarding expenses;
C_L- total spending fuels and lubricants;
C_{Suez} - expenses for crossing the Suez Canal;
C_{CAS}- contribution to social insurance
A_s - expenses for providing ship
C_{com} - the common costs (for safety, uniforms, trips, social services, training staff)
C_d - different costs;

It was calculated the cost of fuel and lubricant for different regimes of the ship is functional.

COCMP[kg/h]- hourly consumption of fuel propulsion engine

CCMP [tone/voiaj]- fuel propulsion engine

CCMP[tone per year]- annual fuel consumption propulsion engine

COCMA[kg/hour]- fuel consumption of auxiliary engines hourly;

CCMA [tone/travel] - fuel consumption of auxiliary engines on travel;

CUUMP[tone/travel]-main engine oil consumption (on travel);

CUMA[tone/year]-oil consumption for auxiliary machines.

In conformity with fuel and oil consumption will have the following expenses:

-The cost of fuel for propulsion engines and auxiliary engine;

-The cost of oil for main engine and auxiliary engines;

Total spending fuels and lubricants for different operating regimes.

Table 1. Total spending fuels and lubricants

n [rotations / min]	v [nodes]	C_L [€/year]
80	9.425	1624344,189
100.8	11.905	2709289,249
110	12.968	3366936,766
115.4	13.627	3755697,149
122.6	14.477	4426945,782
127	15	4881350,531

$$C_{ST} = C_T \cdot \frac{1}{G \cdot 2R \cdot N_v} \quad (2)$$

C_{ST} - specific cost of transport; C_T - total cost of transport;
G[tone]-quantity of products shipped per year;
R = 4600 [Mm]- is the distance between the extremes of route;
N_V - number of annual trips.

Table 2. Total cost and specific cost of transport

v [nodes]	C_T [€/year]	C_{ST} [€/tmM]
9.425	6800615.442	0.00283618
11.905	7954773.379	0.00262564
12.968	8691057.471	0.00263331
13.627	9131945.413	0.00263299
14.477	9849601.582	0.00267305
15	10329143.702	0.00270540

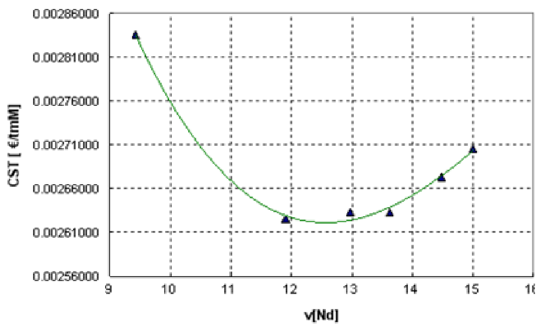

Figure 1 Dependence between specific cost o transport and ship speed

3. CONCLUSIONS

Of operating regimes considered, the profitable is the ship speed to run the regime n =100.8[rotations / min], and v =11.905[nodes].

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THE WIND DIRECTION AT CONSTANTA PERIOD 1961-2000 I

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ABSTRACT

This study is based on the analysis, interpretation and graphical representation of the wind data, a period of 40 years for Constanta weather stations.

Keywords: *climate, rose of the wind, baric contrasts*

1. INTRODUCTION

The wind or the air moving over the earths surface is the dynamic element of the climate, that tends to balance the baric contrasts appeared in different regions of the planet, causing non-routine variations to the other meteorological elements, intensifying the evaporation and the evapo-transpiration, determining the superficial morphology of the snow layer and acting mechanically with deflation, corrosion etc.
imensions, causes effects of aerodynamic housing or of emphasizing by joining the drift lines.

The wind direction is appreciated according to the cardinal points, the frequency diagram that blows on the place of measuring and in a certain period, making the so called- wind rose. The frequency is expressed in percents for every eight cardinal directions and for calm. The configuration of the wind roses at Constanta, in the way it appears from the means calculated for the period 1961-2000 is presented in the figure1, based on the dates from the tables 1-5.

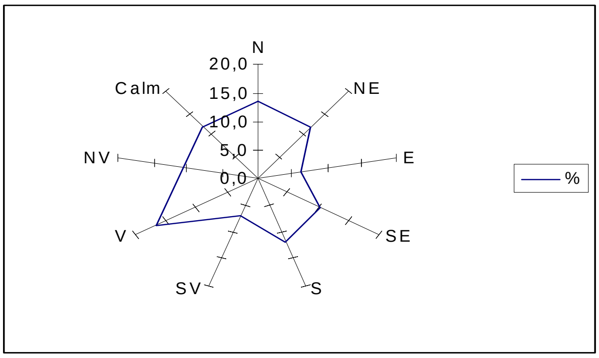

Figure 1. The yearly rose of the wind direction at Constanta. Period 1961-2000

Table 1. The average monthly and yearly frequency of the wind direction and calm at Constanta Period 1961-2000

At the same, the wind is steadily influenced by the relief that offers it local or specific characteristics. The structure and the character of the active surface make different conditions of heating which aut different types of local thermal circulations, with a periodical character and the natural and anthropogenic obstacles of various

Dir / Monn	N	NE	E	SE	S	SV	V	NV	Cal
J	18,9	9,5	2,6	3,2	8,0	8,1	25,7	14,5	9,5
F	19,1	13,8	3,4	5,5	10,3	7,5	19,2	11,3	9,8
M	15,7	18,4	5,7	10,1	12,5	6,8	11,3	8,3	11,1
A	9,2	13,1	7,9	16,0	17,4	5,8	12,7	7,6	10,3
M	7,7	11,2	8,2	16,6	16,4	6,6	12,1	7,1	14,1
J	7,6	8,8	7,4	15,5	15,5	6,7	15,8	9,4	13,4
J	10,5	10,8	7,8	12,6	12,1	5,2	14,3	12,3	14,4
A	10,4	12,3	9,1	11,6	10,5	5,3	12,6	12,2	16,0
S	12,2	11,6	9,0	11,7	11,5	5,8	14,8	9,1	14,3
O	18,6	14,2	5,7	10,2	10,5	7,6	13,1	8,6	11,4
N	14,5	9,1	4,9	7,0	11,1	8,4	21,8	12,1	11,1
D	17,9	7,6	2,2	3,3	8,7	9,7	26,2	15,2	9,3
Avera	13,5	11,7	6,2	10,3	12,0	7,0	16,6	10,6	12,1

The biggest yearly frequencies devolves upon the west winds, 16,6%, northern, 13,5%, the smallest frequency have the winds an eastern direction, 6,2%.

At 1 o clock, the prevalent direction is the west – 17,8%, north -14,2%. He wind with east direction has the smallest frequency 3,2%.

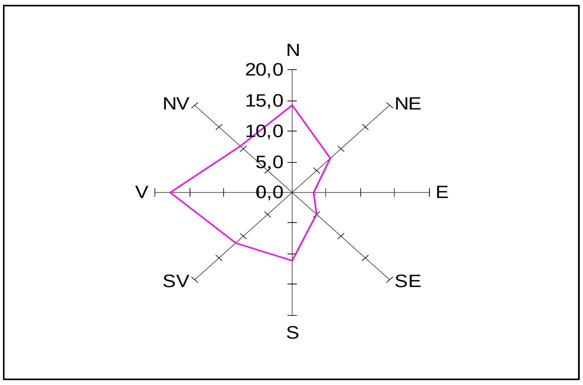

Figure 2. The yearly rose of the wind directions at 1 o clock, at Constanta. Period 1961- 2000

Dir / Mon	N	NE	E	SE	S	SV	V	NV	Cal
J	19,1	8,9	2,3	1,9	7,7	10,2	24,8	13,1	12,0
F	20,1	11,2	2,7	3,9	9,7	10,5	18,1	10,2	13,6
M	17,2	16,7	3,4	5,5	12,4	11,0	9,6	8,5	15,6
A	10,7	8,3	4,8	8,7	17,3	11,1	14,3	8,2	16,8
M	9,0	6,6	3,2	6,8	15,2	13,2	14,0	7,9	24,0
J	7,2	3,4	3,0	5,5	13,0	15,8	20,1	9,7	22,3
J	10,2	3,7	2,2	4,1	9,0	11,3	22,5	12,1	24,8
A	10,3	4,3	2,4	4,4	8,9	12,6	16,7	13,8	26,6
S	13,7	5,9	3,7	5,4	11,8	11,2	15,8	10,1	22,5
O	18,3	8,7	4,7	6,4	10,4	12,2	12,7	9,1	17,5
N	15,7	7,8	4,2	5,8	11,1	9,1	21,2	10,6	14,7
D	18,8	6,4	2,0	3,0	7,8	11,7	24,7	14,3	11,4
Ave	14,2	7,7	3,2	5,1	11,2	11,7	17,8	10,6	18,5

Table 2. The monthly frequency of the directions and calm at 1 o clock at Constanta. Period 1961-2000

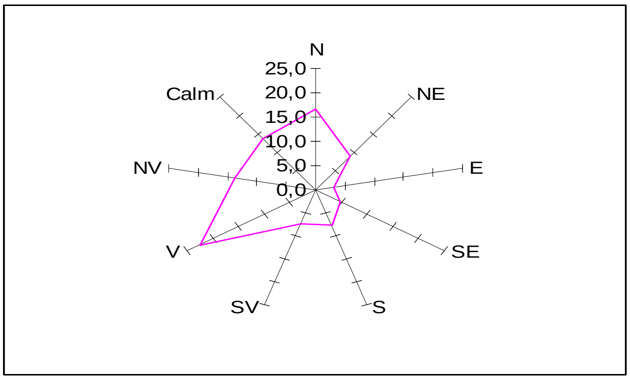

Figure 3. The yearly rose of the wind directions at 7 o clock, at Constanta. Period 1961- 2000

Dir / Mon	N	NE	E	SE	S	SV	V	NV	Cal
J	18,8	8,5	2,8	2,5	6,9	7,7	28,3	14,4	10,1
F	19,8	12,3	1,9	4,5	8,7	7,6	22,8	11,7	10,6
M	18,1	14,4	3,8	5,1	9,0	8,1	14,9	11,5	15,2
A	13,3	11,4	3,8	9,4	12,2	6,4	20,6	10,6	12,4
M	13,1	10,6	4,7	7,4	10,7	6,0	19,0	11,9	16,6
J	13,8	7,9	2,4	5,8	8,4	6,4	25,2	15,3	14,8
J	18,9	7,5	2,2	3,3	6,6	5,0	21,4	20,4	14,8
A	18,3	6,8	2,6	2,8	4,7	5,6	23,1	18,7	17,4
S	18,3	6,8	3,1	4,0	5,8	8,0	24,1	12,5	17,6
O	19,9	9,8	3,3	5,4	6,8	9,9	20,1	10,7	14,1
N	13,1	7,6	3,9	5,0	8,3	9,6	23,9	15,2	13,5
D	16,8	8,0	1,7	2,7	6,9	10,6	28,5	14,7	10,2
Ave	16,8	9,3	3,0	4,8	7,9	7,6	22,6	14,0	14,0

Table 3. The average monthly frequency of the wind and calm at 7 o clock, at Constanta. Period 1961-2000

At 7 o clock, the prevalent direction is the west- 22,6% and north- 16,8%.

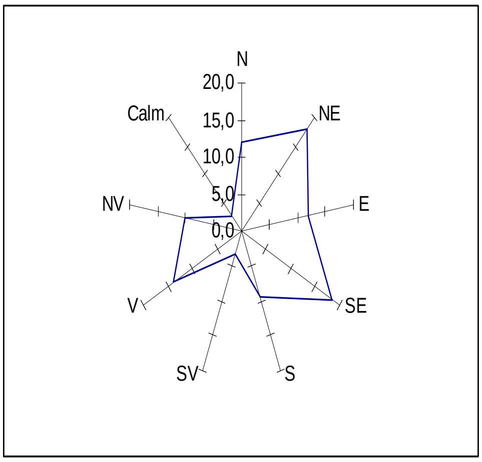

Figure 4. The yearly rose of the wind directions at 1 o clock p.m., at Constanta. Period 1961- 2000

Dir / Mo	N	NE	E	SE	S	SV	V	NV	Calm
J	19,7	10,4	2,5	4,8	7,1	6,8	26,1	18,0	4,7
F	19,9	15,6	4,4	8,1	9,5	5,3	19,6	13,5	4,2
M	14,2	24,0	9,1	18,5	9,3	2,3	11,5	8,4	2,7
A	7,4	19,3	13,4	27,3	13,1	1,7	8,6	6,3	2,8
M	4,2	17,4	17,9	30,8	12,3	2,5	8,6	4,8	1,5
J	4,7	16,4	18,2	31,3	11,1	1,0	8,4	6,9	2,0
J	6,2	23,0	18,8	25,9	8,0	0,9	5,9	9,5	1,8
A	7,0	27,0	21,1	21,4	6,8	1,0	6,0	8,7	1,0
S	8,9	21,9	19,6	21,9	7,4	1,2	10,0	7,9	1,1
O	17,2	22,0	8,4	16,9	9,1	3,5	11,6	8,7	2,6
N	15,8	10,8	6,3	9,6	11,4	6,5	22,3	13,4	4,0
D	18,9	8,5	2,1	4,0	8,8	8,4	27,7	17,1	4,6
Av	12,0	18,1	11,9	18,4	9,5	3,4	13,8	10,3	2,7

Table 4. The average monthly frequency of the wind directions and calm at 1 o clock pm, at Constanta. Period 1961-2000

At 1 o clock pm, the prevalent direction is the south-east- 18,4% and the west- 13,8%.

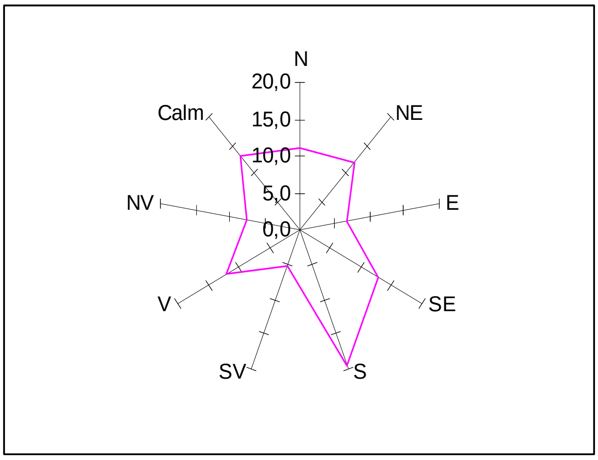

Figure 5. The yearly rose of the wind directions at 7 o clock p.m., at Constanta. Period 1961-2000

Dir / Mon	N	NE	E	SE	S	SV	V	NV	Cal
J	17,9	10,3	2,8	3,6	10,4	7,8	23,5	12,6	11,0
F	16,5	16,4	4,5	5,6	13,3	6,6	16,4	9,7	11,0
M	13,3	18,6	6,6	11,5	19,3	5,7	9,3	5,0	10,6
A	5,5	13,3	9,4	18,6	27,0	4,1	7,1	5,5	9,4
M	4,7	10,4	7,1	21,4	27,3	4,7	6,9	3,5	14,1
J	4,8	7,6	5,8	19,3	29,3	3,7	9,6	5,6	14,3
J	6,9	9,0	7,8	17,0	24,7	3,6	7,4	7,3	16,2
A	5,9	11,0	10,2	17,9	21,5	2,1	4,8	7,6	19,0
S	8,0	12,0	9,5	15,6	20,8	2,9	9,2	5,8	16,2
O	19,0	16,5	6,4	11,9	15,9	4,7	8,1	5,8	11,6
N	13,6	10,3	5,3	7,4	13,5	8,4	19,8	9,4	12,3
D	17,2	7,4	3,1	3,5	11,3	8,1	23,9	14,6	10,9
Ave	11,1	11,9	6,6	12,8	19,6	5,2	12,1	7,7	13,1

Table 5. The average monthly frequency of the wind directions and calm at 7 o clock pm, at Constanta. Period 1961-2000

The prevalent direction at 7 o clock p.m. is the south 19,6% and south- east 12,8%.

Non-periodic variations of wind speed is due to variations in atmospheric pressure that exerts an influence on the reverse.

Air movement suffer frequent changes. Rarely takes places in strictly horizontal plane. Particle analysis of atmospheric air currents and outcomes allowed distinction of three types of movement- laminar air movement, turbulent air movement and air movement in bursts. The laminar motion is uniform movement without any change in direction and speed of air masses. This type of motion occur over smooth surfaces. The turbulent motion is characterized by turbulence and variability of direction and velocity of air particles. This kind of motion is expressed by an average particle velocity and speed.

It can be concluded that wind speed is directly proportional to the gradient horizontal barrel and air density and inversely proportional to the sine of the latitude at which locality is.

The local recurrent air circulation in the form of breezes, physiologically noticeable in the summer, in anticlyclone synoptic conditions or with insignificant baric gradients, develops as a consequence of uneven heating and cooling that creates noticeable thermal and baric contrasts between the atmosphere of the two active surface of the territory exploited by us.

The marine breezes are local recurrent winds which charge their direction night and day. Their frequency and evolution have the highest values in the summer in an anticlyclone conditions.

During the day, over the strongly heated land the isobaric surfaces are carried away from each other, while above the water they stay more close.

Thus, in the inferior atmospheric layer, they lean from the sea to the land. The generated air current is called marine breeze or day breeze and is noticeable, at Constantza, around 7- 8 o clock pm, when the land is more cooled and the sea stays warmer, the isobaric surfaces lean backwards. At the earth s surface level, the horizontal baric gradient is leaned towards the sea. This phenomenon is noticed at Constantza around 7-8 o clock pm.

The breeze have an important role in the genesis of the seaside topoclimates. During the day, the marine breeze causes a diminution of the air temperature on the shore, and at night the land breeze reduces the temperature comparatively to the sea inside.

The breeze have an important influence on the nebulosity, the precipitations and the storms. The precipitations on the Romanian seaside of the Black Sea often fall at night, when the wetter air of the sea gets into an ascending moving.

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THE WIND SPEED AT CONSTANTA. PERIOD 1961-2000 II

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ABSTRACT

This study is based on the analysis, interpretation and graphical representation of the wind data, a period of 40 years for Constanta weather stations.

Keywords: *climate, rose of the wind, baric contrasts*

1. INTRODUCTION

The wind or the air moving over the earths surface is the dynamic element of the climate, that tends to balance the baric contrasts appeared in different regions of the planet, causing non-routine variations to the other meteorological elements, intensifying the evaporation and the evapo-transpiration, determining the superficial morphology of the snow layer and acting mechanically with deflation, corrosion etc.

At the same, the wind is steadily influenced by the relief that offers it local or specific characteristics. The structure and the character of the active surface make different conditions of heating which aut different types of local thermal circulations, with a periodical character and the natural and anthropogenic obstacles of various dimensions, causes effects of aerodynamic housing or of emphasizing by joining the drift lines.

The wind speed represents the second characteristic of the wind and depends on the value of the general or local baric gradient when the local baric gradient is bigger than the general one. The average values of the wind speed for Constanta are represented in table 1 and figure 1.

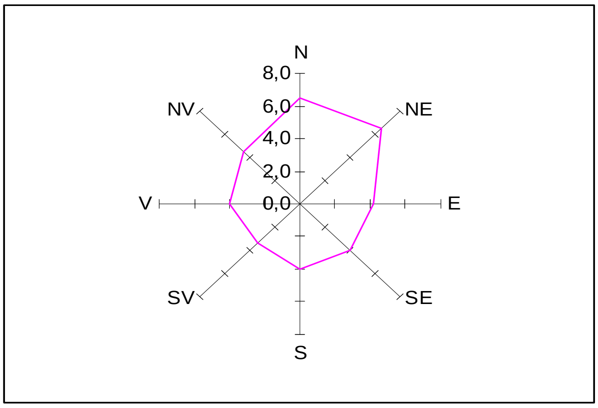

Figure 1. The rose of average yearly speed (m/s) on the main wind directions at Constanta. Period 1961-2000

Dir Mont	N	NE	E	SE	S	SV	V	NV
Jan	7,5	8,4	4,8	4,2	4,0	3,8	4,4	4,7
Feb	7,0	7,4	4,0	3,6	4,2	4,2	4,5	4,7
Mar	7,0	6,8	4,4	4,0	4,4	3,7	4,3	4,7
Apr	7,0	7,5	3,8	4,2	4,3	4,2	4,5	4,5
May	5,4	5,6	3,9	4,0	4,0	3,4	4,2	4,1
Jun	5,0	4,7	3,7	4,1	3,9	3,2	3,8	4,3
Jul	5,2	4,9	3,7	3,8	3,7	2,9	3,8	4,4
Aug	5,6	5,0	3,6	3,8	3,5	2,7	3,3	4,3
Sep	6,5	6,1	4,2	4,3	3,8	3,1	3,5	4,3
Oct	7,1	6,7	4,5	4,3	3,8	3,0	3,6	4,5
Nov	7,3	7,4	5,1	4,1	4,0	3,3	4,0	4,9
Dec	8,0	7,6	5,4	4,0	4,3	3,7	4,3	4,6
Ave	6,5	6,5	4,2	4,0	4,0	3,4	4,0	4,5

Table 1. The average yearly and monthly values of the wind speed (m/s) at Constanta. Period 1961-2000

As you can see in table 2 and figure2, the biggest average yearly wind speed is noticed in the winter and the smallest one in the summer.

Month	I	II	III	IVV	V	VI	VII	VIII	IX	X	XI	XII	Year
m/s	5,2	5,2	4,8	4,2	3,8	3,7	3,6	3,6	4,4	4,7	4,7	5,0	4,4

Table2. The average monthly and yearly values of the wind speed at Constanta. Period 1961-2000

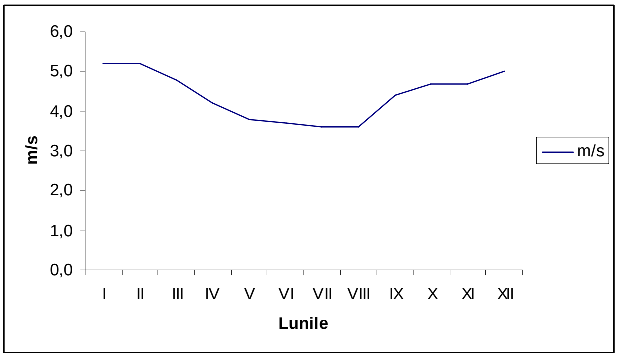

Figure2. The yearly variation of monthly wind speed at Constanta. Period 1961-2000

Table 3. The frequency of the days with an average wind speed included between certain thresholds, at Constanta. Period 1961-2000

Thresholds	0..1	2..5	6..10	21..24
January	6,8	23,1	16,6	0,1
February	7,3	23,0	15,7	0,0
March	7,7	23,9	15,8	0,0
April	7,4	28,3	13,1	0,0
May	7,8	27,8	11,6	0,0
June	9,8	29,2	10,6	0,0
July	10,5	29,0	10,1	0,0
August	11,6	27,5	10,8	0,0
September	10,1	25,9	13,0	0,0
October	8,6	23,8	15,7	0,0
November	8,2	24,4	14,6	0,0
December	7,4	24,0	15,5	0,1

The most numerous days with a wind speed between 0-1m/s are noticed in the summer especially in august, 11,6 days the smallest ones in the winter, 6,8dazs. In case of the wind speed between 2-5m/ s, the numerous days are noticed in the same season, in the summer, and the smallest ones in the winter. Regarding the speed between 6-10m/s, the biggest values are noticed in the winter months and the smallest ones in the summer.

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THEORETIC BASIS OF ENERGY AND EXERGY ANALYSIS

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ABSTRACT

The first law of thermodynamics deals with the quantities of energies of different forms transferred between the system and its surroundings and with changes in the energy stored inside the system. This principle is not able to show where irreversibility occurs in a system or process. To determine the irreversibility it is suitable the exergy analysis method which provides an indicator that reveals in which direction efforts should focus in order to improve the performance of thermodynamic systems.

This paper offers an overview on concepts like energy, entropy, exergy and plant systems.

Keywords: *law, energy, exergy, analysis, thermodynamic.*

1. INTRODUCTION

Energy analysis is revealed through the first law of thermodynamics which embodies the principle of conservation of energy; it is the classic way to approach the issue related to the performance and efficiency of energy systems and processes. Exergy analysis is a thermodynamic analysis method for systems and processes based on the first and second laws of thermodynamics. The exergy method is seen as a powerful tool in improving the performance of the systems due to its benefits:

- more strict efficiencies are assessed by the use of the exergy analysis since exergy efficiencies are an indicator of the approach to the ideal;
- inefficiencies encountered during a process are assessed with exergy analysis because the kind, causes and places of losses are identified and evaluated.

In other words, the first law of thermodynamics only deals with the magnitude of energy and does not refer to its quality, while the second law of thermodynamics states that energy is featured both by quantity and quality.

2. FIRST AND SECOND LAW ANALYSIS

2.1 Exergy and entropy

Exergy is the maximum amount of work that can be produced by a steam of energy or matter, or from a system, as it is brought into equilibrium with a reference environment. Exergy is regarded as an expression of the quality of energy.

Entropy is a measure of the intensity of molecular disorder within a system. Thus, a system having a high degree of molecular disorder has a very high entropy value and vice versa.

The entropy of the state of a system is a measure of the probability of its occurrence. States of low probability have low entropy and vice versa. In any situation of transfer or conversion of energy the entropy of the system is increasing. The explanation is found in the fact that the spontaneous direction of the change of state of a closed system is from a less to a more probable state.

The difference between reversible and irreversible processes was first introduced in thermodynamics by the help of entropy. All energy transfers or conversions are irreversible. They will be developed spontaneously in the direction of entropy increasing. The irreversibility in thermodynamic systems may be due friction, heat transfer or mixing of fluids. The amount of irreversibility illustrates the losses in thermal systems.

A system can only generate, not destroy entropy. Entropy generation is closely connected to the thermodynamic irreversibilities.

Together with the entropy production, the quality of energy (the exergy) decreases. The larger the entropy generation is, the larger the loss of useful energy is seen. Entropy (S) is the ratio of the heat absorbed by a substance to the absolute temperature at which it was added. Every process leads to an entropy production (generation), noted as ΔS, which corresponds to the loss of quantity of useful energy equal to $T_0\Delta S$ (where T_0 is the temperature of the environment). Exergy is the expression of loss available energy due to the generation of entropy in irreversible system or component, having in mind the above statements, it is exactly $T_0\Delta S$.

2.2 The importance of exergy

As stated before, exergy in the "useful" energy, or the ability to do work and presents the following benefits:

- it is a strong tool in best approaching the impact of energy resource utilization on the environment;
- it is a complex method, based on the conservation of mass and conservation of energy principles together with the second law of thermodynamics, used in the design and assessment of energy systems;
- it is an adequate technique when it is aimed a more efficient energy resource use since it allows the identification of locations, types and real magnitudes of wastes and losses;
- it is an accurate technique able to point out whether or not and in what measure it is possible

to design more efficient energy systems by diminishing the inefficiencies met in a focused system;
- it is a major aspect in getting sustainable development.

The traditional analysis method based on the first law of thermodynamics consists in writing the equation of energy balance, but doing so, no information is available on the degradation of energy occurring in the process.

The exergy method of analysis overcomes the limitations of the first law of thermodynamics.

Unlike energy, exergy is consumed during real processes due to irreversibilities. The statement of the second law of thermodynamics sounds like: exergy is always destroyed, partially or totally. We have already mentioned that destroyed exergy is proportional to the generated entropy.

In order to distinguish the two concepts, energy and exergy, the following comparison is done (see Table 1).

Table 1. Differences energy – exergy

Energy	Exergy
it depends only on parameters of matter or energy flow and it is independent of the environment parameters	it depends on the parameters of matter or energy flow as well as on the environment parameters
it is never equal to zero	is equal to zero in dead state by equilibrium with the environment
it is based on the first law of thermodynamics for all the processes	it is based both on the first and second law of thermodynamics
it is the ability to produce motion	it is the ability to produce work
it can not be destroyed or produced, it is always conseved	it is always consumed in irreversible processes; it is conserved only in reversible processes
it is only a quantity indicator	it is both a quality and quantity indicator due to entropy

2.3 On exergy analysis

Exergy analysis is performed when it is aimed the maximum performance of a system and the identification of locations of exergy destructions. When dealing with complex systems, exergy analysis can be developed by studying the parts of the system separately. The loss of exergy (irreversibility) provides a generally applicable quantitative measure of process inefficiency. Assessing a complex plant it is possible to determine the total plant irreversibility distribution among the plant components, revealing those contributing most to the overall plant inefficiency.

Exergy analysis applications are various:
- electricity generation using conventional devices but also alternative devices (like fuel cells);
- energy storage systems (as thermal energy storages);
- combustion technologies;
- all types of transportation systems;
- heating and cooling systems for buildings or industrial purposes;
- cogeneration systems;
- chemical processes (ex: sulphuric acid production) or petrochemical processing and synthetic fuels production;
- metallurgical processes;
- non thermodynamical fields: economics, policy, environmental impact assessment, etc.

For viable results, specialist recommend the use of exergy analysis or energy and exergy analysis in the assessment and optimisation studies. An energy and exergy analysis can be described by the help of the following chart (see Figure 1).

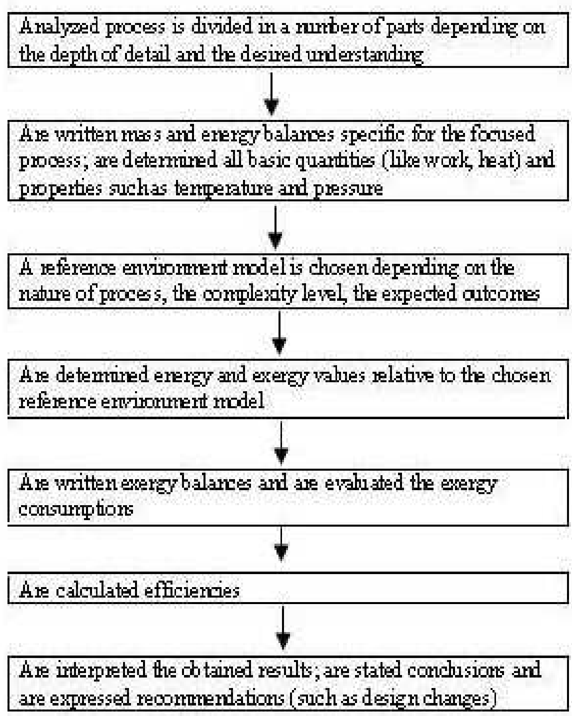

Figure 1 Chart of a general energy – exergy analysis

In the above presented analysis, one step was the calculation of efficiencies. First and second law efficiencies are also known as energy and exergy efficiencies. It is normal to see that exergy efficiencies have values bellow energy efficiencies because the irreversibilities met in processes destroy a part of the input energy. Unlike energy efficiencies, exergy efficiencies indicate how close a system operates in comparison to the ideal situation. Developing an analysis on plant sections on processes with the lowest exergy efficiencies it is certain that the result is the efficiency improvement, while working only with energy efficiencies might not lead to accurate results.

3. ENERGY AND EXERGY ANALYSIS EQUATIONS

These two approaches (energetic and exergetic) form a more powerful analysis tool of systems.

For a steady state, steady flow process, the literature is offering the following equations.

The mass balance equation:

$$\sum \dot{m}_{in} = \sum \dot{m}_{out} \tag{1}$$

where $\dot{m}$ is the mass flow rate and subscripts refer to inlet and outlet.

The general energy balance:

$$\sum \dot{E}_{in} = \sum \dot{E}_{out} \tag{2}$$

The total exergy of a system $(\dot{E}x)$ has four components: physical exergy $(\dot{E}x_{Ph})$, kinetic exergy $(\dot{E}x_{Kn})$, potential exergy $(\dot{E}x_{Pt})$ and chemical exergy $(\dot{E}x_{Ch})$, when there is no electricity magnetism, surface tension and nuclear reaction:

$$\dot{E}x = \dot{E}x_{Ph} + \dot{E}x_{Kn} + \dot{E}x_{Pt} + \dot{E}x_{Ch} \tag{3}$$

For a facile calculation, often it is used the total specific exergy, given by:

$$ex = ex_{Ph} + ex_{Kn} + ex_{Pt} + ex_{Ch} \tag{4}$$

The general exergy balance:

$$\sum \dot{E}x_{in} - \sum \dot{E}x_{out} = \sum \dot{E}x_{dest} \tag{5}$$

or:

$$\dot{E}x_{heat} - \dot{E}x_{work} + \dot{E}x_{mass\ in} - \dot{E}x_{mass\ out} = \dot{E}x_{dest} \tag{6}$$

where:

$$\dot{E}x_{heat} = \sum \left(1 - \frac{T_0}{T_K}\right)\dot{Q}_K \tag{7}$$

$$\dot{E}x_{work} = \dot{W} \tag{8}$$

$$\dot{E}x_{mass\ in} = \sum \dot{m}_{in} ex_{in} \tag{9}$$

$$\dot{E}x_{mass\ out} = \sum \dot{m}_{out} ex_{out} \tag{10}$$

In the last four equations:

$\dot{Q}_K$ – heat transfer rate through the boundary at temperature T_K at location k;

W – work rate;

Ex – specific exergy.

In fact, ex is ex_{Ph}. Physical exergy is the work that can be obtained by taking a substance through reversible physical processes from its initial state (featured by temperature T and pressure p) to the state having the temperature and pressure conditions of the environment (T_0 and p_0).

$$ex = (h - h_0) - T_0(s - s_0) \tag{11}$$

where h and s are enthalpy and entropy respectively.

Physical exergy plays a significant role when it is aimed the optimization of thermal and mechanical processes, but it is insignificant when discussing about large scale systems (like metallurgical processes at industrial level). In this situation, chemical exergy plays the key role in resource accounting and environmental assessments.

The rate form of the entropy balance includes the rate of entropy generation:

$$\dot{S}_{in} - \dot{S}_{out} + \dot{S}_{gen} = 0 \tag{12}$$

Other form of the above equation being get considering the mechanisms of transfer: entropy transfer by heat $(S_{heat} = Q/T)$ and entropy transfer by mass $(S_{mass} = m s)$.

Thus:

$$\dot{S}_{gen} = \sum \dot{m}_{out} s_{out} - \sum \dot{m}_{in} s_{in} - \sum \frac{\dot{Q}_K}{T_K} \tag{13}$$

First, it is calculated S_{gen} and after that, by the help of the Gouy Stodola equation, it is evaluated the exergy destroyed, the irreversibility respectively, the exergy destroyed being proportional with the entropy generated in the system.

The exergy analysis can be used to determine where and how much of the available work is lost due to the exergy destruction (irreversibility) and to reduce the irreversibility in order to improve the overall efficiency of a process.

The first law (energy) efficiency η_I of a system or system component is defined as the ratio of energy output to the energy input of system or system component:

$$\eta_I = \frac{\text{Desired output energy}}{\text{Input energy sup plied}} \tag{14}$$

The second law exergy efficiency is defined as:

$$\eta_{II} = \frac{\text{Desired output}}{\text{Maximum possible output}} \tag{15}$$

or as the ratio of total exergy output to total exergy input:

$$\eta_{II} = \frac{\dot{E}x_{out}}{\dot{E}x_{in}} = 1 - \frac{\dot{E}x_{dest}}{\dot{E}x_{in}} \tag{16}$$

Subscript “out”, meaning output, refers to “product” or “desired valve” or “benefit”.

Subscript “in”, meaning input, refers to “used” or “fuel” or “given”.

5. CONCLUSIONS

Only writing the energy balance will not always be enough to identify the system defect. In these cases, the exergy analysis is addapted to indicate the imperfections of a system.

The exergy analysis is based on the first and second laws of thermodynamics and the concept of irreversible generation of entropy. This type of analysis is carried out by many engineers in the thermodynamic analysis of thermal processes and plant systems because the first law analysis resulted to be insufficient from an energetic performance point of view.

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CONTINUUM TRIBOLOGICAL PROCESSES FOR METALURGICAL EQUIPMENT

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ABSTRACT

This paper presents a coupled thermo-elastic contact problem with tribological processes on the contact interface (friction, wear or damage). The unilateral contact between the cilindrical roll system and a deformable foundation (slab, bloom, etc) is modeled by the Kuhn-Tucker (normal compliance) conditions, involving damage and/or wear effect of contact surfaces.

The continuum tribological model is based on gradient theory of the damage variable for studying crack initiation in fretting fatigue [11], [14], [15] , and the wear is described by Archard's law. The friction law that we consider is a regularization of the Coulomb law.

The weak formulation of the quasistatic boundary value problem is described by using the variational principle of virtual power, the principles of thermodynamics and variational inequalities theory. Thus, the main results of existence for weak solution are established using a discretization method (FEM) and a fixed-point strategy [5].

Keywords: *Continuous casting, Thermoelastic contact, Friction, Wear, Fretting fatigue, Variational Inequalities, Galerkin Discretization Method*

1. INTRODUCTION AND DERIVATION OF CLASIC VECTORIAL PROBLEM

In this work we deal with a model for the *unilateral contact* between an elastic-deformable body and a reactive obstacle (the casted steel, as elastic-viscoplastic deformable foundation) in the presence of the heat conduction, of the tribological processes also, and of the water cooling, on the contact surfaces, on full time period of solidification (*Figure 1.a* and *1.b*) .

The paper is organized as follows:

- *Section 1* is dedicated of the *clasic-vectorial description* to the contact problem **(P)**
- In *Section 2* we present the *variational formulation* of the clasic problem , denoted by **(VP)**
- In *Section 3* we propose our main *existence and uniqueness* results for the *weak solution*
- *Section 4* is reserved to the concluding remarks

The elastic thermo-deformable body (walls of the mould, cilindrical rolls system) occupies a regular domain $\Omega \subset \mathbb{R}^d$ $(d = 2,3)$ with surface Γ that is portioned into three disjoint measurable part $\Gamma = \Gamma_u \cup \Gamma_\sigma \cup \Gamma_c$ such that means $(\Gamma_u) > 0$. Let $[0,T]$ be the time interval of interest with $T > 0$. The body is clamped on $(0,T) \times \Gamma_u$ and therefore the displacement field vanishes there. We denote by $\boldsymbol{S}_d$ the spaces of second order symmetric tensors, while "$\cdot$" and $|\cdot|$ will represent the inner product and the Euclidean norm on $\boldsymbol{S}_d$ or $\mathbb{R}^d$. Let $\boldsymbol{n}$ denote the unit outer normal on Γ, and everywhere in the sequel the index i, j run from 1 to d (summation over repeated indices is implied and the index that follows a comma represents the partial derivative with respect to the corresponding component of the independent variable).

We also use the following notation and physical nomenclatures:

$\Omega_T = (0,T) x\ \Omega$;

$\overline{\Omega}_T = [0,T] \times (\Omega \cup \Gamma)$;

$\Gamma = \partial\Omega$; $\Gamma_T = (0,T) x\ \Gamma$;

$\Gamma_{i;T} = (0,T) x\ \Gamma_i$, $i \in \{\boldsymbol{u}\ ;\ \boldsymbol{\sigma}\ ;\ c\}$;

$t \in [0,T]$ time variable;

$\boldsymbol{x} \in \Omega$ spatial variable;

$\boldsymbol{u} : \overline{\Omega}_T \to \mathbb{R}^d$ displacement vectorial field;

$\dot{\boldsymbol{u}} = \left(\frac{\partial u_i}{\partial t}\right)$; $\ddot{\boldsymbol{u}} = \left(\frac{\partial^2 u_i}{\partial t^2}\right)$ velocity and inertial vectorial fields, respectively;

$\boldsymbol{\sigma} : \bar{\Omega}_T \to \boldsymbol{S}_d$ stress tensor field (second order Piola –Kirchhoff);

$\boldsymbol{\varepsilon}(\boldsymbol{u}) = \frac{1}{2}(\nabla\boldsymbol{u} + \nabla\boldsymbol{u}^T)$ strain tensor field (linearized tensor Green-St. Venant);

$\theta : \bar{\Omega}_T \to \mathbb{R}$ temperature scalar field;

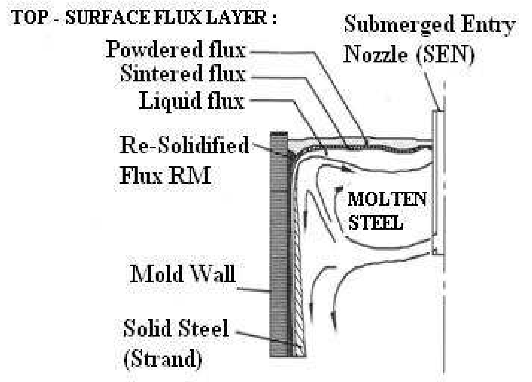

Figure 1a. Schematic unilateral contact with pure sliping between the walls of mold and molten steel [5], [12], [14]

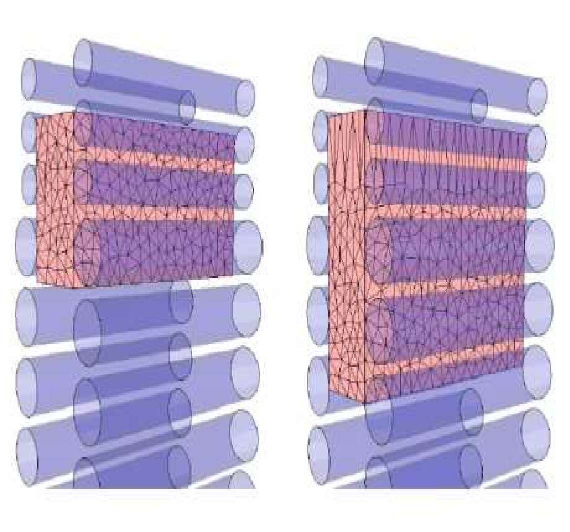

Figure 1b. Schematic unilateral contact with pure rolling between the support-rolls and steel slab [5], [12]

We assume that a quasistatic process is valid and the constitutive relationship of an elastic-viscoplastic material can be written as,

$$\boldsymbol{\sigma} = \mathcal{A}\varepsilon(\dot{\boldsymbol{u}}) + \mathcal{G}\varepsilon(\boldsymbol{u}) - \boldsymbol{C}\theta \qquad (1.1)$$

where $\mathcal{A}$ and $\mathcal{G}$ are *nonlinear* operators whitch will be described below, and $\boldsymbol{C} = (c_{ij})$ represents the *thermal expansion tensor*. Here and below, in order to simplify the notation, we usually do not indicate explicitly the dependence of the functions on the variables $\boldsymbol{x} \in \overline{\Omega}$ (on the time $t \in [0, T]$ sometimes). Examples of constitutive laws of the form (2.1) can be constructed by using *thermal* aspects and *rheological* arguments, (see e.g. [3], [5], [6], [10], [11]).

When $\boldsymbol{C} = \boldsymbol{O}_d$ the constitutive law (1.1) reduces to the *Kelvin-Voigt viscoelastic* behaviour of the materials,

$$\boldsymbol{\sigma} = \mathcal{A}\varepsilon(\dot{\boldsymbol{u}}) + \mathcal{G}\varepsilon(\boldsymbol{u}), \qquad in\ \Omega_T \qquad (1.2)$$

Finally, the evolution of the temperature field is governed by the *heat transfer equation* (see [1], [3], [6]),

$$\dot{\theta} - div(\boldsymbol{K}\nabla\theta) = q - \boldsymbol{C}\cdot\nabla\dot{\boldsymbol{u}}, \qquad in\ \Omega_T \qquad (1.3)$$

where: $\boldsymbol{K} = (k_{ij})_{i,j=\overline{1,d}}$ is thermal conductivity tensor;

$\boldsymbol{C} = (c_{ij})_{i,j=\overline{1,d}}$ is thermal expansion tensor;

q represent the density of volume heat sources.

In order to simplify the description of the problem, a *homogeneous condition* for the temperature field is considered on $\Gamma_u \cup \Gamma_\sigma$,

$$\theta = \theta_r, \quad \text{on} \quad \Gamma_{u;T} \cup \Gamma_{\sigma;T} \qquad (1.4)$$

It is straightforward to extend the results shown in this paper to more general cases.

Also, we assume the associated *temperature boundary condition* is described on Γ_c,

$$(\boldsymbol{K}\nabla\theta)\cdot\boldsymbol{n} = -k_e(\theta - \theta_r), \text{ on } \Gamma_{c;T} \qquad (1.5)$$

where θ_r is the reference temperature of the obstacle, and k_e is the heat exchange coefficient between the body and the rigid foundation.

Thus, the *thermo-mechanical problem* in the *clasic vectorial formulation*, can be written as follows:

Problem (P):

Find a *displacement field* $\boldsymbol{u}$: $\overline{\Omega}_T \to \mathbb{R}^d$ a *stress tensor field* $\boldsymbol{\sigma} : \overline{\Omega}_T \to \boldsymbol{S}_d$ and, a *temperature field* $\theta : \overline{\Omega}_T \to \mathbb{R}$ such that,

$$\dot{\boldsymbol{\sigma}} = \mathcal{A}(\varepsilon(\dot{\boldsymbol{u}})) + \mathcal{G}(\varepsilon(\boldsymbol{u})) - \boldsymbol{C}\cdot\theta \qquad (1.6)$$

$$-div\,\boldsymbol{\sigma}(\varepsilon(\boldsymbol{u})) = \boldsymbol{f},\ in\ \Omega_T \qquad (1.7)$$

$$\dot{\theta} - div\,(\boldsymbol{K}\nabla_x\theta) = q - \boldsymbol{C}\cdot\nabla_x\dot{\boldsymbol{u}} \qquad (1.8)$$

$$\boldsymbol{u} = \boldsymbol{0},\ on\ \Gamma_{u;T} \qquad (1.9)$$

$$\boldsymbol{\sigma}(\varepsilon(\boldsymbol{u}))\cdot\boldsymbol{n} = \boldsymbol{g},\ on\ \Gamma_{\sigma;T} \qquad (1.10)$$

$$u_n \le 0,\ \sigma_n \le 0 \text{ a.i. } u_n\cdot\sigma_n(\boldsymbol{u}) = 0,\ on\ \Gamma_{c;T} \qquad (1.11)$$

$$|\boldsymbol{\sigma}_\tau(\boldsymbol{u})| \le \mu|\mathcal{T}\sigma_n(\boldsymbol{u})|,\ on\ \Gamma_{c;T}\ i.e. \qquad (1.12)$$

$$|\boldsymbol{\sigma}_\tau(\boldsymbol{u})| < \mu|\mathcal{T}\sigma_n(\boldsymbol{u})| \Rightarrow \dot{\boldsymbol{u}}_\tau = 0 \qquad (1.13)$$

$$|\boldsymbol{\sigma}_\tau(\boldsymbol{u})| = \mu|\mathcal{T}\sigma_n(\boldsymbol{u})| \Rightarrow$$

$$(\exists)\lambda \ge 0\ :\ \boldsymbol{\sigma}_\tau(\boldsymbol{u}) = -\lambda\dot{\boldsymbol{u}}_\tau \qquad (1.14)$$

$$(\boldsymbol{K}\nabla_x\theta)\cdot\boldsymbol{n} = -k_e(\theta - \theta_r),\ on\ \Gamma_{c;T} \qquad (1.15$$

$$\theta = \theta_r, \ on\ \Gamma_{u;T} \cup \Gamma_{\sigma;T} \qquad (1.16)$$

$$\boldsymbol{u}(0) = \boldsymbol{0}\ ;\ \theta(0) = \theta_0,\ in\ \Omega_T \qquad (1.17)$$

Here, $\boldsymbol{u_0} = \boldsymbol{0}$ and θ_0 represent the initial displacement and the initial temperature, respectively. Also, a volume force of density $\boldsymbol{f}$ acts in Ω_T and a surface traction of density $\boldsymbol{g}$ acts on $\Gamma_{\sigma;T}$.

We will consider a nonlocal Coulomb friction law and in fact a regularization of it in order that the boundary terms in the formulation of our problem make sense. In the sequel, $\mathcal{T} : H^{-\frac{1}{2}}(\Gamma) \to L^2(\Gamma)$ will represent a smoothing operator that is linear, continuous and this satisfy,

$$(\mathcal{T}\boldsymbol{\sigma}(\boldsymbol{u}))_n \leq 0\ if\ \sigma_n(\boldsymbol{u}) \leq 0\ ,\ on\ \Gamma_{c;T} \qquad (1.18)$$

2. VARIATIONAL FORMULATION. EXISTENCE AND UNIQUENESS RESULTS

In order to obtain the *variational formulation* of *Problem* **(P)** , let us introduce additional notation and assumptions on the problem data.

Let, $\boldsymbol{\varepsilon} : \ \mathbb{H}_1 \to \boldsymbol{\mathcal{H}_1}$ and $div : \ \boldsymbol{\mathcal{H}_1} \to \mathbb{H}$ the *Hooke deformation* and *divergente operators*, respectively, defined by:

$$\boldsymbol{\varepsilon}(\boldsymbol{u}) = \left(\varepsilon_{ij}(\boldsymbol{u})\right)_{i,j=\overline{1,d}}$$

$$\varepsilon_{ij}(\boldsymbol{u}) = \frac{1}{2}\ (u_{i,j} + u_{j,i})$$

$$div\ \boldsymbol{\sigma} = (\sigma_{ij,j})_{i,j=\overline{1,d}}$$

Also, we denote the real Hilbert spaces $\mathbb{H}$, $\boldsymbol{\mathcal{H}}$, $\mathbb{H}_1$ and $\boldsymbol{\mathcal{H}_1}$ respectively:

$$\begin{gathered} \mathrm{H} := \mathrm{L}^2(\Omega);\ \mathbb{H} := \mathrm{L}^2(\Omega)^d; \\ \mathrm{H}_1 := \mathrm{H}^1(\Omega); \\ \boldsymbol{\mathcal{H}} := \{\boldsymbol{\sigma} = (\sigma_{ij}) \in \boldsymbol{\mathcal{S}_d}\ : \\ \sigma_{ij} \in \mathrm{L}^2(\Omega)\ \} = \boldsymbol{\mathcal{S}}_d(H); \\ \boldsymbol{\mathcal{H}_1} := \{\ \boldsymbol{\sigma} \in \boldsymbol{\mathcal{H}} :\ \mathrm{div}\ \boldsymbol{\sigma} \in \mathbb{H}\ \}; \\ \mathbb{H}_1 := \{\ \boldsymbol{u} \in \mathbb{H} :\ \boldsymbol{\varepsilon}(\boldsymbol{u}) \in \boldsymbol{\mathcal{H}}\ \} \end{gathered} \qquad (2.1)$$

and the cannonical inner products, defined by:

$$\begin{gathered} (u\,,v)_{\mathrm{H}} = \int_\Omega u \cdot v\, dx; \\ (\boldsymbol{u}\,,\boldsymbol{v})_{\mathbb{H}} = \int_\Omega \boldsymbol{u} \cdot \boldsymbol{v}\, dx; \\ (u\,,v)_{\mathrm{H}_1} = \int_\Omega u \cdot v\ dx\ + \int_\Omega \nabla u \cdot \nabla v\ dx\ ; \\ \|\boldsymbol{u}\|^2_{\mathbb{H}} = (\boldsymbol{u}\,,\boldsymbol{u})_{\mathbb{H}};\ \|\boldsymbol{u}\|^2_{\mathrm{H}_1} = (u\,,u)_{\mathrm{H}_1}; \end{gathered}$$

$$\begin{gathered} (\boldsymbol{\sigma}\,,\boldsymbol{\tau})_{\boldsymbol{\mathcal{H}}} = \int_\Omega \boldsymbol{\sigma}(\boldsymbol{\varepsilon}(\boldsymbol{u})) : \boldsymbol{\tau}(\boldsymbol{\varepsilon}(\boldsymbol{u}))\, dx = \\ \int_\Omega \sigma_{ij}\tau_{ij}\, dx\,; \\ \|\boldsymbol{\sigma}\|^2_{\boldsymbol{\mathcal{H}}} = (\boldsymbol{\sigma}\,,\boldsymbol{\sigma})_{\boldsymbol{\mathcal{H}}}\,; \\ ((\boldsymbol{u}\,,\boldsymbol{v}\,))_{\mathbb{H}_1} = (\boldsymbol{u}\,,\boldsymbol{v})_{\mathbb{H}} + (\,\boldsymbol{\varepsilon}(\boldsymbol{u})\,,\boldsymbol{\varepsilon}(\boldsymbol{v})\,)_{\mathrm{H}}; \\ \|\boldsymbol{u}\|^2_{\mathbb{H}_1} = ((\boldsymbol{u}\,,\boldsymbol{u}))_{\mathbb{H}_1}; \\ ((\boldsymbol{\sigma}\,,\boldsymbol{\tau}\,))_{\boldsymbol{\mathcal{H}}_1} = (\,\boldsymbol{\sigma}\,,\boldsymbol{\tau}\,)_{\boldsymbol{\mathcal{H}}} + (\,\mathrm{div}\,\boldsymbol{\sigma}\,,\mathrm{div}\,\boldsymbol{\tau}\,)_{\mathbb{H}}; \\ \|\boldsymbol{\sigma}\|^2_{\boldsymbol{\mathcal{H}}_1} = ((\boldsymbol{\sigma},\boldsymbol{\sigma}))_{\boldsymbol{\mathcal{H}}_1}. \end{gathered}$$

We denoted by $\|\cdot\|_{\mathbb{H}}$, $\|\cdot\|_{\boldsymbol{\mathcal{H}}}$, $\|\cdot\|_{\mathbb{H}_1}$ and $\|\cdot\|_{\boldsymbol{\mathcal{H}_1}}$ the cannonical norms induced by coresponding inner products in the respectively spaces.

For every element $\boldsymbol{v} \in \mathbb{H}_1$ we also use the notation $\boldsymbol{v}$ to denote the trace of $\boldsymbol{v}$ or Γ (i.e. $\gamma_0\boldsymbol{v} = \boldsymbol{v}|_\Gamma$) and, we denote by v_n and $\boldsymbol{v_\tau}$ the *normal* and the *tangential components* of $\boldsymbol{v}$ on Γ given by,

$$v_n = \boldsymbol{v} \cdot \boldsymbol{n}\ \ ;\ \ \boldsymbol{v_\tau} = \boldsymbol{v} - v_n\boldsymbol{n} \qquad (2.2)$$

We also denote by σ_n and $\boldsymbol{\sigma_\tau}$ the *normal* and the *tangential traces* of the element $\boldsymbol{\sigma} \in \boldsymbol{\mathcal{H}_1}$ given by,

$$\sigma_n = (\boldsymbol{\sigma} \cdot \boldsymbol{n}) \cdot \boldsymbol{n}\ \ ;\ \ \boldsymbol{\sigma_\tau} = \boldsymbol{\sigma n} - \sigma_n\boldsymbol{n} \qquad (2.3)$$

We recall that the following *Green's formula* holds: for a regular function $\boldsymbol{\sigma} \in \boldsymbol{\mathcal{H}_1}$ fixed , and $(\forall)\ \boldsymbol{v} \in \mathbb{H}_1$

$$\begin{gathered} (\,\boldsymbol{\sigma}\,,\boldsymbol{\varepsilon}(\boldsymbol{v})\,)_{\boldsymbol{\mathcal{H}}} + (\,\mathrm{div}\,\boldsymbol{\sigma}\,,\boldsymbol{v}\,)_{\mathbb{H}} = \\ = \ <\ \boldsymbol{\sigma n}\ ,\boldsymbol{v}\ >_{H^{-\frac{1}{2}}(\Gamma)^d\ ,\ H^{\frac{1}{2}}(\Gamma)^d} \end{gathered} \qquad (2.4)$$

We remember that the elastic-viscoplastic body is occupies of the regular domain $\Omega \subset \mathbb{R}^d$ with the surface Γ that is a *sufficiently regular* boundary, portionned into three disjoint measurable part, $\Gamma = \Gamma_u \cup \Gamma_\sigma \cup \Gamma_c$ such that $ds - \mathrm{means}\ (\Gamma_u) > 0$.

Thus, we define the closed subspaces $\mathbb{V}$ and U of $\mathbb{H}_1$ and H_1, respectively, by:

$$\mathbb{V} := \{\ \boldsymbol{v} \in \mathbb{H}_1 : \boldsymbol{v} = \boldsymbol{0}\ ,\ \ on\ \Gamma_u\ \} \qquad (2.5)$$

$$U := \{\ \theta \in \mathrm{H}_1 :\ \theta = 0\ ,on\ \Gamma_u \cup \Gamma_\sigma\ \} \qquad (2.6)$$

and $\mathbb{K}$ be the convexe set of admisible displacements given by,

$$\mathbb{K} := \{\ \boldsymbol{v} \in \mathbb{V}\ :\ v_n \leq 0\,,on\ \Gamma_c\ \} \qquad (2.7)$$

Since $ds - \mathrm{means}\ (\Gamma_u) > 0$, Korn's inequality holds (see [9], 1997 - pp.291) and there exists $\alpha > 0$, depending only on Ω and Γ_u, such that:

$$\|\boldsymbol{v}\|_{\mathbb{H}_1} \le \alpha \|\boldsymbol{\varepsilon}(\boldsymbol{v})\|_{\mathcal{H}},\ (\forall)\ \boldsymbol{v} \in \mathbb{V}. \qquad (2.8)$$

Hence, on $\mathbb{V}$ we consider the inner product given by,

$$(\boldsymbol{u}, \boldsymbol{v})_{\mathbb{V}} = (\boldsymbol{\varepsilon}(\boldsymbol{u}), \boldsymbol{\varepsilon}(\boldsymbol{v}))_{\mathcal{H}},\ (\forall)\ \boldsymbol{u}, \boldsymbol{v} \in \mathbb{V} \qquad (2.9)$$

and the associated norm,
$\|\boldsymbol{v}\|_{\mathbb{V}} = \|\boldsymbol{\varepsilon}(\boldsymbol{v})\|_{\mathcal{H}},\ (\forall)\ \boldsymbol{v} \in \mathbb{V}$.

It follows that $\|\cdot\|_{\mathbb{H}_1}$ and $\|\cdot\|_{\mathbb{V}}$ are equivalent norms on $\mathbb{V}$ and therefore $(\mathbb{V}, \|\cdot\|_{\mathbb{V}})$ is a real Hilbert space. Moreover, by the Soblev's trace theorem and (2.9), we have constant $\gamma > 0$ depending only on the domain Ω and the its boundaries Γ_u and Γ_c such that,

$$\|\boldsymbol{v}\|_{L^2(\Gamma_c)^d} \le \gamma \|\boldsymbol{v}\|_{\mathbb{H}_1},\ (\forall)\ \boldsymbol{v} \in \mathbb{V} \qquad (2.10)$$

In an analogous way, we can prove that the norm $\|\theta\|_U \le \|\nabla\theta\|_{\mathbb{H}}$, $(\forall)\ \theta \in U$ associated to the inner product on U given by $(\theta, \eta)_U = (\nabla\theta, \nabla\eta)_{\mathbb{H}}$ is equivalent to the classical norm on H_1.

Hence $(U, \|\cdot\|_U)$ is a real Hilbert spaces. We also recall, that for every real Banach spaces E we use the notation $C^0([0,T];E)$ and $C^1([0,T];E)$ for the space of continuous and continuously differentiable function from $[0,T]$ to E, respectively, $C^0([0,T];E)$ is a real Banach space with the norm,

$$\|\boldsymbol{u}\|_{C^0([0,T];E)} = \max_{t\in[0,T]} \|\boldsymbol{u}(t)\|_E \qquad (2.11)$$

while $C^1([0,T];E)$ is the real Banach space with the norm,

$$\|\boldsymbol{u}\|_{C^1([0,T];E)} = \|\boldsymbol{u}\|_{C^0([0,T];E)} + \|\dot{\boldsymbol{u}}\|_{C^0([0,T];E)} \qquad (2.12)$$

If $k \in \mathbb{N}$ and $p \in [1,\infty]$ are arbitrary, then we use the standard notation for the Lebesgue spaces $L^p(0,T;E)$ and for the Sobolev spaces $W^{k,p}(0,T;E)$,

$$\|\boldsymbol{u}\|_{W^{k,p}(0,T;E)} =: \sum_{|m|\le k} \|D^m \boldsymbol{u}\|_{L^p(0,T;E)} \qquad (2.13)$$

While the Banach spaces E is $W^{k,p}(\Omega)$ we have,

$$\|\boldsymbol{u}(t)\|_E = \|\boldsymbol{u}(t)\|_{k,p,\Omega} =: \sum_{|m|\le k} \|D^m \boldsymbol{u}(t)\|_{L^p(\Omega)} = \sum_{|m|\le k} \left(\int_\Omega \|D^m \boldsymbol{u}(t)(x)\|^p\, dx\right)^{\frac{1}{p}} \qquad (2.14)$$

$t \in [0,T]$; $m \in \mathbb{N}^k$

In this paper we use as an example $E = \mathbb{V}$, and we also use the Sobolev space $W^{1,\infty}(0,T;\mathbb{V})$ equipped with the norm,

$$\|\boldsymbol{u}\|_{W^{1,\infty}(0,T;\mathbb{V})} = \|\boldsymbol{u}\|_{L^\infty(0,T;\mathbb{V})} + \|\dot{\boldsymbol{u}}\|_{L^\infty(0,T;\mathbb{V})} = \text{ess sup}_{t\in[0,T]} \|\boldsymbol{u}(t)\|_{\mathbb{V}} + \text{ess sup}_{t\in[0,T]} \|\dot{\boldsymbol{u}}(t)\|_{\mathbb{V}} = \text{ess sup}_{t\in[0,T]} \|\boldsymbol{\varepsilon}(\boldsymbol{u}(t))\|_{\mathcal{H}} + \text{ess sup}_{t\in[0,T]} \|\boldsymbol{\varepsilon}(\dot{\boldsymbol{u}}(t))\|_{\mathcal{H}} \qquad (2.15)$$

Finally, we recall the following abstract result concerning some evolution equations (see [2], 1997-pp.151; [9], 1997 - pp. 124), and which will be used in *Section 3.* of this paper.

Theorem 2.1

Let $V \subset H \subset V'$ be a *Gelfand triple*, and $A : V \to V'$ is a *hemicontinuous* and *monotone* operator, i.e. $(\exists)\ \alpha, \gamma, \delta \in \mathbb{R}, (\alpha, \gamma > 0)$ such that,

$$< Av, v >_{V',V} \ge \alpha \|v\|_V^2 + \delta,\ (\forall)\ v \in \mathbb{V} \qquad (2.16)$$

$$\|Av\|_{V'} \le \gamma(\|v\|_V + 1),\ (\forall)\ v \in \mathbb{V} \qquad (2.17)$$

If $\boldsymbol{u_0} \in \mathrm{H}$ and $\boldsymbol{f} \in L^2(0,T;V')$ are given functions, then the *evolution operatorial problem*,

$$\begin{cases} \dot{\boldsymbol{u}}(t) + A\boldsymbol{u}(t) = \boldsymbol{f}(t), & t \in (0,T) \\ \boldsymbol{u}(0) = \boldsymbol{u_0} \end{cases} \qquad (2.18)$$

has a *unique solution* which satisfies the L^2- regularity properties,

$$\boldsymbol{u} \in L^2(0,T;V) \cap C^0([0,T];H), \quad \dot{\boldsymbol{u}} \in L^2(0,T;V') \qquad (2.19)$$

We recall the Green formula, which is valid in this regular functional context:

$$(\boldsymbol{\sigma}(\boldsymbol{\varepsilon}(\boldsymbol{u})), \boldsymbol{\varepsilon}(\boldsymbol{v}))_{\mathcal{H}} + (div\, \boldsymbol{\sigma}(\boldsymbol{\varepsilon}(\boldsymbol{u})), \boldsymbol{v})_{\mathbb{H}} = < \boldsymbol{\sigma}(\boldsymbol{\varepsilon}(\boldsymbol{u})) \cdot \boldsymbol{n}, \boldsymbol{v} >_{\mathbb{Y}',\mathbb{Y}},\ (\forall)\ \boldsymbol{v} \in \mathbb{H}_1$$

where, we denote the functional spaces:

$$X = \mathrm{L}^2(\Gamma) \ ;\ \mathrm{Y} = \mathrm{H}^{\frac{1}{2}}(\Gamma) \ ;$$

$$X_i = \mathrm{L}^2(\Gamma_i) \ ;\ \mathrm{Y}_i = \mathrm{H}^{\frac{1}{2}}(\Gamma_i) \ ;\ (\mathrm{i} = \boldsymbol{u}, \boldsymbol{\sigma}, c)$$

$$\mathbb{X} = \mathrm{L}^2(\Gamma)^d \ ;\ \mathbb{Y} = \mathrm{H}^{\frac{1}{2}}(\Gamma)^d \ ;$$

$$\mathbb{X}_i = \mathrm{L}^2(\Gamma_i)^d \ ;\ \mathbb{Y}_i = \mathrm{H}^{\frac{1}{2}}(\Gamma_i)^d \ ;\ (\mathrm{i} = \boldsymbol{u}, \boldsymbol{\sigma}, c)$$

$$\mathrm{Y}' = \mathrm{H}^{-\frac{1}{2}}(\Gamma) \ ;\ \mathbb{Y}' = \mathrm{H}^{-\frac{1}{2}}(\Gamma)^d \ ;$$

$$\mathrm{Y}_i' = \mathrm{H}^{-\frac{1}{2}}(\Gamma_i) \ ;\ \mathbb{Y}_i' = \mathrm{H}^{-\frac{1}{2}}(\Gamma_i)^d \ ;\ (\mathrm{i} = \boldsymbol{u}, \boldsymbol{\sigma}, c)$$

and obtained, $\boldsymbol{\sigma}(\boldsymbol{u}) \cdot \boldsymbol{n} \in \mathbb{Y}'$, $(\forall)\ \boldsymbol{\sigma} \in \mathcal{H}_1$.
Let $\mathbb{V}$ denote the closed subspace of $\mathbb{H}_1$ defined by,

$$\mathbb{V} = \{\boldsymbol{v} \in \mathbb{H}_1 : \boldsymbol{v} = \boldsymbol{0}, on\ \Gamma_u\} \qquad (2.20)$$

We note that the *Korn inequality* holds (see [9], 1997-pp. 96), i.e. exist $\alpha > 0$ only depend by Ω *and* Γ_u:

$$\|\varepsilon(\boldsymbol{u})\|_{\mathcal{H}} \geq \alpha\|\boldsymbol{u}\|_{\mathbb{H}_1}, (\forall)\ \boldsymbol{u} \in \mathbb{V}.$$

By using the inner product on $\mathbb{V}$, $(\boldsymbol{u}, \boldsymbol{v})_{\mathbb{V}} = (\varepsilon(\boldsymbol{u}), \varepsilon(\boldsymbol{v}))_{\mathcal{H}}$, and the norm induced $\|\boldsymbol{u}\|_{\mathbb{V}} = (\boldsymbol{u}, \boldsymbol{u})_{\mathbb{V}}$ we obtain that $\mathbb{V}$ is a Hilbert space.

Next, we denote by $t \to \boldsymbol{F}(t)$ an element of $\mathbb{V}'$ given by:

$$< \boldsymbol{F}(t), \boldsymbol{v} >_{\mathbb{V}',\mathbb{V}} = (\boldsymbol{f}(t), \boldsymbol{v})_{\mathbb{H}} + (\boldsymbol{g}(t), \gamma_0 \boldsymbol{v})_{\mathbb{X}_\sigma}, (\forall)\ \boldsymbol{v} \in \mathbb{V},\ t \in [0,T] \quad (2.21)$$

where, $\boldsymbol{f}$ and $\boldsymbol{g}$ are input data, and $\gamma_0 \boldsymbol{v} \in \mathbb{Y}_\sigma \subset \mathbb{X}_\sigma$ is the trace over Γ of the vector $\boldsymbol{v} \in \mathbb{V} \subset \mathbb{H}_1$.

For the *variational* description of the *friction law*, we denote the *friction functional*,

$$j : \mathcal{H}_1 \times \mathbb{V} \to \mathbb{R},$$
$$j(\boldsymbol{\sigma}, \boldsymbol{v}) = \int_{\Gamma_c} |\mu| |\mathcal{T}\sigma_n| |v_\tau|\ ds \quad (2.22)$$

where,

$$|\mu| = \|\mu\|_{X_c};\ |\boldsymbol{v}_\tau| = \|\gamma_0 \boldsymbol{v} - \gamma_2 \boldsymbol{v}\|_{\mathbb{X}_c};$$
$$\mathcal{T} : \mathbb{Y}'_c = \mathrm{H}^{-\frac{1}{2}}(\Gamma_c)^d \to \mathbb{X}_c = \mathrm{L}^2(\Gamma_c)^d \text{ i.e. } |\mathcal{T}\sigma_n| = \|\mathcal{T}\sigma_n(\boldsymbol{v})\|_{\mathbb{X}_c};$$

Thus, for the *variational* description of the *unilateral contact condition*, we introduce the space $\mathrm{Y}_c = \mathrm{H}^{\frac{1}{2}}(\Gamma_c)$ as the set of restrictions to Γ_c of the $\mathrm{Y} = \mathrm{H}^{\frac{1}{2}}(\Gamma)$ functions which are null on Γ_u.

Also, we denote by $< \cdot, \cdot >_{\mathbb{V}',\mathbb{V}}$ the duality pairing between $\mathrm{Y}_c = \mathrm{H}^{\frac{1}{2}}(\Gamma_c)$ and its dua l $\mathrm{Y}_c{}' = \mathrm{H}^{-\frac{1}{2}}(\Gamma_c)$,

$$< \sigma_n(t), v_n >_{\mathrm{Y}'_c, \mathrm{Y}_c} = \int_{\Gamma_c} \sigma_n(t)\, v_n\ ds,$$
$$(\forall)\ \boldsymbol{v} \in \mathbb{V},\ \boldsymbol{\sigma} \in \mathcal{H}_1, \text{ a.p.t. } t \in (0,T) \quad (2.23)$$

Now, let us introduce the *convex* set of admisible displacements, defined by

$$\mathbb{K} = \{ \boldsymbol{v} \in \mathbb{V} : v_n \leq 0, \text{ on } \Gamma_c \}. \quad (2.24)$$

Finally, in the study of the thermo-mechanical problem $(\boldsymbol{P}) \equiv (1.6) - (1.17)$ we assume that the operators $\mathcal{A}$, $\mathcal{G}$ satisfies some regularity conditons ([5], [6], [12]).

Thus, the *variational formulation* for thermo-mechanical problem $(\boldsymbol{P}) \equiv (1.6) - (1.17)$ is obtained.

Problem (VP): Find, a *displacement field* $\boldsymbol{u} : [0,T] \to \mathbb{V}$, a *stress field* $\boldsymbol{\sigma} : [0,T] \to \mathcal{H}$ which satisfy the *evolutionary quasivariational problem*:

$$\boldsymbol{\sigma} = \mathcal{A}(\varepsilon(\dot{\boldsymbol{u}})) + \mathcal{G}(\varepsilon(\boldsymbol{u})),\ t \in (0,T) \quad (2.25)$$

$$(\boldsymbol{\sigma}(t), \varepsilon(\boldsymbol{v}) - \varepsilon(\dot{\boldsymbol{u}}(t)))_{\mathrm{H}} + j(\boldsymbol{\sigma}(t), \boldsymbol{v}) - j(\boldsymbol{\sigma}(t), \dot{\boldsymbol{u}}(t)) \geq < \boldsymbol{F}(t), \boldsymbol{v} - \dot{\boldsymbol{u}}(t) >_{\mathbb{V}',\mathbb{V}} + < \sigma_n(t), v_n - \dot{u}_n(t) >_{\mathrm{Y}'_c, \mathrm{Y}_c}, (\forall)\ \boldsymbol{v} \in \mathbb{V}, \text{ a.p.t. } t \in (0,T) \quad (2.26)$$

$$< \sigma_n(t), w_n - u_n(t) >_{\mathrm{Y}'_c, \mathrm{Y}_c} (\forall)\ \boldsymbol{w} \in \mathbb{K}, (\forall)\ t \in [0,T] \quad (2.27)$$

$$\boldsymbol{u}(0) = \boldsymbol{u}_0 \quad (2.28)$$

We assume that the *input data* of *quasivariational problem* (**VP**) ≡ (2.25)−(2.28) satisfies the minimum regularity conditions,

$$\boldsymbol{f} \in L^\infty(0,T;\mathbb{H});\ \boldsymbol{g} \in L^\infty(0,T;\mathbb{X}_\sigma),\ \boldsymbol{u}_0 \in \mathbb{K} \quad (2.29)$$

Theorem 2.2 ([7]) (for the *existence* of *weak solution* $\{\boldsymbol{u}: \boldsymbol{\sigma}\}$)

Assume that the input data satisfies the minimum regularity conditions (2.29), and the regularity hypotesis for the *elasticity operator* $\mathcal{G}$ and for the *viscoplasticity operator* $\mathcal{A}$ respectively, to hold good.

Then, there exist a *weak solution* $\{\boldsymbol{u}: \boldsymbol{\sigma}\}$ to the problem (**VP**)≡(2.25)−(2.28) satisfying the minimum regularity conditions,

$$\boldsymbol{u} \in W^{1,\infty}(0,T;\mathbb{V}) \cap C([0,T];\mathbb{K}),\ \boldsymbol{\sigma} \in L^\infty(0,T;\mathcal{H}_1). \quad (2.30)$$

Remark 2.3

We could have taken data $\boldsymbol{f}$ and $\boldsymbol{g}$ with the L^2 – *regularity properties* in the time variable,

$$\boldsymbol{f} \in L^2(0,T;\mathbb{H});\ \boldsymbol{g} \in L^2(0,T;\mathbb{X}_\sigma) \quad (2.31)$$

and $\boldsymbol{u}_0 \in \mathbb{K}$, then we would obtain the existence of weak solutions for the problem (**VP**), also, satisfying the L^2*–regularity properties*,

$$\boldsymbol{u} \in H^1(0,T;\mathbb{K});\ \boldsymbol{\sigma} \in L^2(0,T;\mathcal{H}_1) \quad (2.32)$$

3. MAIN EXISTENCE AND UNIQUENESS RESULTS

In this section we use the *temporal semi-discretization Galerkin method* for the proof of the existence concerning the weak solutions of the (**VP**) problem, (see [5], [6], [12]). For this, we need the following notations, which assume to introduce a new variational formulation of the initial problem (**P**).

We define the following functionals, $a : \mathbb{V} \times \mathbb{V} \to \mathbb{R}$ a *bilinear form* by,

$$a(\boldsymbol{u},\boldsymbol{v}) = \left(\mathcal{A}\left(\varepsilon(\boldsymbol{u})\right),\ \varepsilon(\boldsymbol{v})\right)_{\mathcal{H}}; \qquad (3.1)$$

$b :\ \mathbb{V} \times \mathbb{V} \to \mathbb{R}$, a *linear form* only with respect to the second argument given by,

$$b(\boldsymbol{u},\boldsymbol{v}) = \left(\mathcal{G}\left(\varepsilon(\boldsymbol{u})\right),\ \varepsilon(\boldsymbol{v})\right)_{\mathcal{H}}; \qquad (3.2)$$

$l :\ \mathbb{V} \to \mathbb{R}$ *linear form*,

$$l(\boldsymbol{v}) = (\boldsymbol{f}(t), \boldsymbol{v})_{\mathbb{H}} + (\boldsymbol{g}(t), \gamma_0 \boldsymbol{v})_{\mathbb{X}_\sigma} + < \sigma_n(t), v_n >_{Y_C',\ Y_C} = \int_\Omega \boldsymbol{f}(t)\boldsymbol{v}dx +$$

$$+ \int_{\Gamma_\sigma} \boldsymbol{g}(t)\boldsymbol{v}ds + \int_{\Gamma_c} \sigma_n(t) v_n ds, \text{ a.p.t. } t \in (0,T); \ (3.3)$$

Thus, the *quasi-variational evolutionary problem* (**VP**)≡(2.25)−(2.28) find, a *displacement field* $\boldsymbol{u} : [0,T] \to \mathbb{V}$, and a *stress field* $\boldsymbol{\sigma} : [0,T] \to \mathcal{H}$ which satisfies the following *problem for a quasi-variational inequality*,

$$\boldsymbol{\sigma} = \mathcal{A}\left(\varepsilon(\dot{\boldsymbol{u}}) + \mathcal{G}(\varepsilon(\boldsymbol{u}))\right),\ t \in (0,T) \qquad (3.4)$$

$$a\left(\dot{\boldsymbol{u}}(t),\ \boldsymbol{v} - \dot{\boldsymbol{u}}(t)\right) + b\left(\boldsymbol{u}(t),\ \boldsymbol{v} - \dot{\boldsymbol{u}}(t)\right) + j\left(\boldsymbol{\sigma}(t),\ \boldsymbol{v}\right) - j\left(\boldsymbol{\sigma}(t),\ \dot{\boldsymbol{u}}(t)\right) \geq l\left(\boldsymbol{v} - \dot{\boldsymbol{u}}(t)\right),$$

$$(\forall)\ \boldsymbol{v} \in \mathbb{V}, \text{ a.p.t. } t \in (0,T) \qquad (3.5)$$

$$< \sigma_n(t), v_n - u_n(t) >_{Y_C',\ Y_C} \geq 0,\ (\forall)\ \boldsymbol{v} \in \mathbb{K},\ (\forall)\ t \in [0,T] \qquad (3.6)$$

4. CONCLUSIONS

In the present paper has been investigated a mathematical model for as well triboprocess involving

the coupling thermal and mechanical aspects by specific behaviour laws of materials.

The contact condition for this quasistatic processes has described as effect of a normal and tangential damped response properties.

The *classical* as well as a *variational formulations* of the thermo-mechanical problem are presented.

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QUALITY OF CASTABILITY IMPROVEMENT FOR TREATED STEEL GRADES

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ABSTRACT

Uncontrolled changes in inclusion composition may result in shifts from erosion to clogging, or vice versa, of the steel flow control refractory.

The conditions that result in Mg contamination of Al killed Ca treated steel grades is discussed and how it influences the nature, number, composition of inclusions and its influence in clogging. Several cases will be used to illustrate how the chemical equilibrium between Al-Ca-Mg-O-S influences steel castability.

Keywords: *steel impurities, Al killed Ca, clogging, refractory erosion, castability.*

1. INTRODUCTION

Steel castability often fluctuates from clogging, to neutral to erosive behavior without changing steel grade and for no apparent obvious reason.

This apparently erratic behavior is more often found when casting Al killed Ca treated steel grades and Mn-Si killed grades, while Al killed steel grades are comparatively more stable.

In order to better understand and predict the castability of Al killed Ca treated steel it is proposed to consider the equilibrium between Al-Ca-Mg-O-S instead of the more traditional Ca/Al ratio. The evolution of inclusion composition and phases is plotted against the evolution of total O and Mg content in steel and the influence in castability is analyzed.

2. STEEL DEOXIDATION BY COMPLEX ALLOYS

Deoxidation using more de-oxidants leads to forming of variable compositions solutions, with quantitatively hard to explain links and because the oxides phases, that are formed after de-oxidants adding, are separated in the beginning based on the mass transfer law, from the steel ladle determining partial equilibriums in the ladle and between the ladle and the slag, continuous changing equilibriums until the reaching of the final state.

In industrial practice are used for deoxidation, Ca alloys with different proportion of Ca, Al, Mn and Si. In figure 1 is shown the Ca activity at 1350°C, for the most used alloys based on Ca: Ca-Al, Al-Ca-Si and Si-Ca. Due to combinations forming, calcium activity has for all three mentioned alloys a negative strong deviation towards ideal behavior.

Usage of Al in combination with Ca, by successive adding of Al and Si-Ca alloy, or by using the Si-Ca-Al complex alloy, is based on the concept after which aluminum increases Ca efficiency due to decantation speed (fig.2 and fig.3) and residual composition influence by combination of more deoxidation agents.

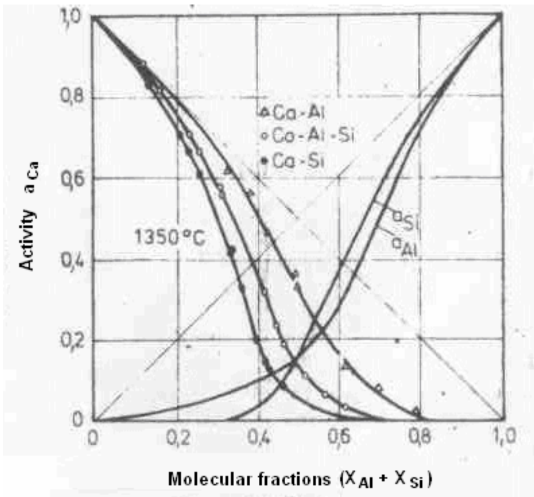

Fig. 1 Ca activity in binary system Ca-Si and Ca-Al and in ternary system Ca-Si-Al ($x_{Si} = X_{Al}$) at 1350°C

Utilization of calcium based alloys with low specific weight, with high tendency towards reactions, depends greatly on the adding technique, that has to ensure also the losses of Ca by vaporization.

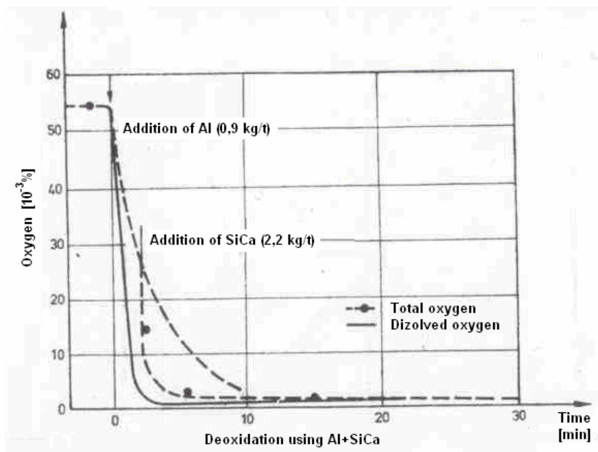

Fig. 2 Oxygen content variation during sequential deoxidation by successive adding of Al and Si-Ca

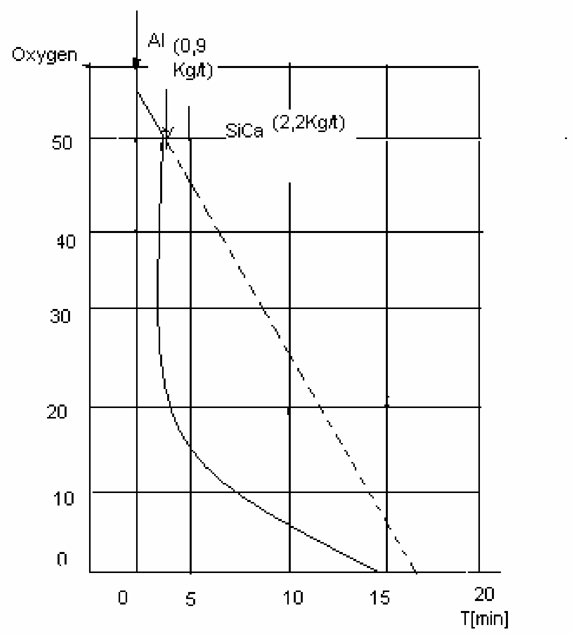

Fig. 3 Oxigen elimination kinetics as non metallic inclusions in sequential deoxidation with Al and Si-Ca

3. AL KILLED, CA TREATED STEEL

Refractory erosion when casting Al killed Ca treated steel can be effectively avoided using Zirconia slide gate refractory materials or MgO-C for stopper and Submerged Inner Nozzle seats [1].

Inconsistent castability with Al killed Ca treated grades, is more often related to clogging than to erosion. In this type of grades there are two common types of clogging:

- Alumina or Aluminate clogging related to insufficient treatment or strong re-oxidation.
- Calcium sulfide and spinel rich clogging, related with incorrect steel composition, or Mg contamination to the steel.

In most cases the amount of Ca used for treatment is fixed at a certain quantity per ton of steel in order to achieve a pre-specified Ca/Al ratio and without considering any other variable.

Once the desired ratio is confirmed by the steel analysis the treatment is considered finished.

As demonstrated by K. Larsen et. Al. [2] it is necessary to consider the total Oxygen content of the steel, to judge from the effectiveness of the treatment and to estimate if the desired type of Calcium Aluminate has been obtained.

Table 1 below shows how keeping all other variables constant the inclusion type and composition may change completely in function of total Oxygen.

In the example below, in spite of the total Oxygen change from 15 to 35 ppm, the active Oxygen barely changes from 1 to slightly below 2 ppm. Such tiny differences are not reliably measurable in operational conditions.

If we exclude obvious operational errors that result in abnormal steel re-oxidation, most cases of clogging with Ca treated steel are related to insufficient treatment.

Due to the long time necessary to make an inclusion analysis to the steel, it is not possible by this method to estimate by the end of ladle treatment if the desired Ca-Aluminate has been obtained.

However, total Oxygen measurement coupled with an inclusion calculation model is a valid alternative to inclusion analysis. In spite of the current availability of quick methods to measure total Oxygen content in steel, this practice is still quite uncommon. Such practice would allow the early detection of insufficient Ca treatment on time for corrections.

As also shown by K. Larsen et. Al. [2] Calcium Sulfide may also form depending on the amount of Al present in the steel.

As it shown in the example in Table 1, the formation of Calcium Sulfide depends on the type of Ca-Aluminate present in the steel and the CaO activity on the Aluminate.

Table 1. Inclusion composition in Al killed Ca treated steel at 1550 ^{o}C and variable total O levels.
(Mn - 0.75%, Al - 325 ppm, Si - 325 ppm, Ca - 16 ppm, S - 65 ppm)

	Total Oxygen (ppm)				
	15	20	25	30	35
Al_2O_3 (%)	43.3	53.7	60.8	66.5	70.8
CaO (%)	54	45.7	38.8	33.1	28.9
CaS (%)	8.4	1.6	0.2	0	0
Solid fraction (%)	4	0	0	28	61
Solid Phases	CaS	-	-	CA, CA2	CA, CA2

It is then necessary to consider the equilibrium of all four elements Al-Ca-O-S to calculate the right amount of Calcium to achieve a desired type of Ca-Aluminate and it is necessary to reduce the S level to values below the formation of Calcium Sulfide.

The reduction of S to avoid the Sulfide formation is necessary as Calcium Sulfide is the other major reason for clogging when casting Calcium treated Al killed steel.

However the formation of Calcium Sulfide is not related only to the Al-Ca-O-S equilibrium at any given temperature. It is also necessary to include the total Mg present in the steel to be able to have a full idea of the formed inclusions prior to casting.

Mg contamination to steel may come from:

- Contaminated ferro-alloys namely the Al used to kill the steel.
- MgO reversion from ladle slag, as a function of MgO activity in the slag, Oxygen potential and temperature.
- Carbon reduction of MgO in lining materials.

As a consequence, Mg contents in excess of up to 10 ppm are common, particularly in Ladle Furnace or VAD treated steel.

By precipitating Alumina in the form of spinel at high temperature, Mg is effectively capable of lowering the amount of Alumina in the Aluminate. As a consequence the CaO Activity in the Aluminate may increase to the point where Calcium Sulfide forms.

Fig. 4 below shows this phenomenon. Taking the case of column 4 (30 ppm of total Oxygen) from Table 1, the graph shows how Mg contamination in the range from 1 to 5 ppm modifies inclusion composition and triggers the formation of Calcium sulfide.

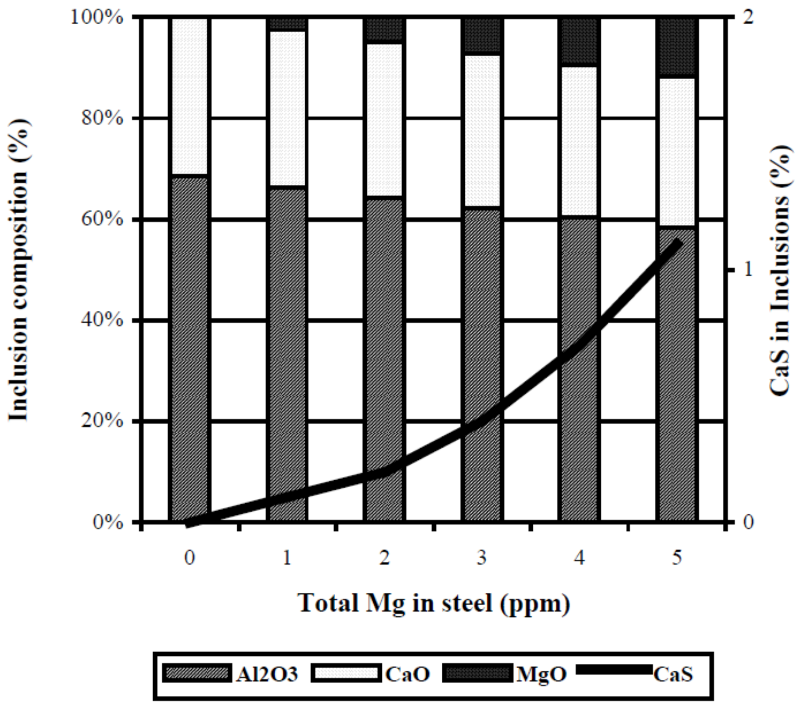

Figure. 4. Inclusions in Al killed steel Ca treated at variable Mg contamination levels (T = 1550 ^{o}C)

The inclusions start with 77% of liquid Aluminate a solid fraction of 23% formed by CA-CA2 and no CaS. At 1 ppm of total Mg in the steel the solid fraction becomes near zero and CaS starts to form. At 5 ppm the solid fraction is almost 23% made only of spinel and CaS is present in an amount sufficient to result in clogging.

This example shows that to enable the correct prediction of the formed inclusions as a result of Calcium treatment it is necessary to consider the full 5-element equilibrium Al-Ca-Mg-O-S.

Unfortunately very few plants are capable to analyze Mg in the steel or when capable only do it after the facts. Added either voluntarily [3], or involuntarily [4] the control of Mg content in steel is necessary to achieve effective control of Calcium treatment.

With the constant trend for the reduction of ladle slag FeO to reduce re-oxidation, Calcium Sulfide ladle clogging is becoming more and more common, even if quite often goes unnoticed as ladle casting times are not very long.

The structure of Calcium Sulfide clogging deposit is shown on Fig. 5 from a recent publication [5].

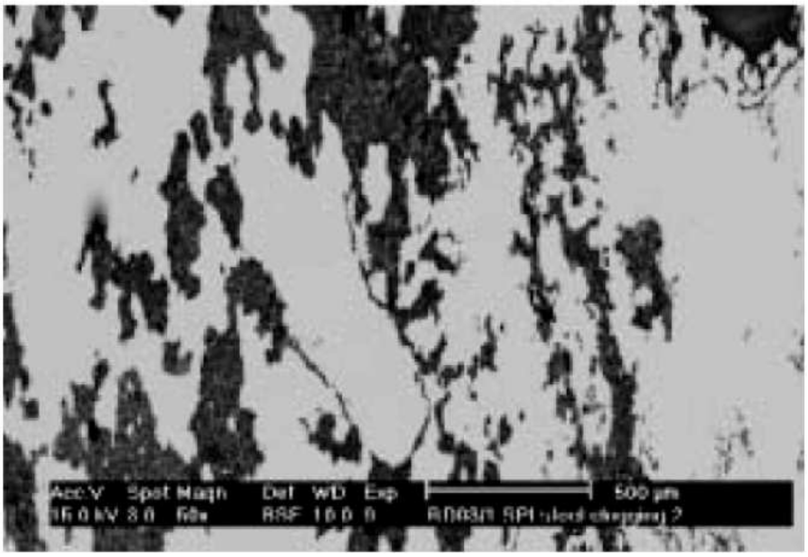

Fig. 5 Oxy-Sulfide deposit (dark) in steel (light)

It is very difficult to detect the presence of Calcium Sulfide in a clogging deposit that has been exposed to the atmospheric Oxygen after casting because:

- Calcium Sulfide is just a small fraction of the inclusion mass;
- Usually it precipitates at the surface of the inclusions;
- In the presence of Oxygen it quickly decomposes into CaO releasing gaseous S.

Only when Calcium Sulfide is well protected by steel it is possible to identify its presence in clogging deposits. And then it is commonly misidentified as frozen steel.

Calcium Sulfide clogging almost always forms associated with Al_2O_3-MgO spinel, indirectly confirming the role that Mg may have on its formation.

In a recent ladle clogging deposit that the authors had access, close to 76% of the deposit was pure spinel.

4. CONCLUSIONS

In order to improve castability for Al killed Ca treated steel it is possible to propose the following conclusions:

- Total Oxygen measurement during ladle treatment is necessary for accurate Calcium treatment.
- Mg analysis in steel is necessary for Al killed Ca treated steel for both quality (inclusion content) and castability purposes.
- All methods and means applied for inclusion engineering can and should be applied for castability improvement.

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CAD/CAM/CAE TECHNOLOGY IN INJECTION MOLD DESIGN

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ABSTRACT

The paper presents the concept of using the CAD/CAM/CAE technology to design the injection mold. Now, there are many dedicated software which leads users through a logical step by step approach to create polymeric injection molds. The softwares offer dramatic time saving potential by removing much of the repetition prevalent in mold tooling design and freeing up our time for more important tasks. Mold Design furnishes standard component libraries, an extensive choice of industry standard mold bases, automated generation of all required components and associative electrode design, reduces time to market, improves quality and lower cost.

Keywords: *CAD/CAM/CAE technology, polymeric material, mold injection.*

1. INTRODUCTION

Professional mold designers now have everything they need to completely design an entire mold assembly, core and cavity, mold base in one package. Software like NX, Pro/Engineer, Catia, Solid Edge, Solid Works, Inventor combines all the features of Tool Design and Expert Mold Base, offering a powerful combination of capabilities for specialized mold assembly creation.

These softwares can create even the most complex single and multiple-cavity molds. A process driven workflow guides the user through each step. Automated parting surface creation and automated splitting make it easy for even the occasional user to create complex tooling quickly.

They are parametric, solid modeler. It allows you to build fully detailed, parametric designs, plus all the associated drawings and bills of materials. This is very helpful when dealing with an assembly, because if the modification is made to a single part, the modification is carried through the assembly. The purpose of mold assembly is to show how the parts fit together in the assembly and to suggest the function of the entire unit. Also, it is questionable how well these objectives are met [1].

Pressure to reduce costs and improve quality are driving the growth in the use of digital simulation throughout the Product Lifecycle Management. By moving analysis to an earlier stage in the design cycle, you can be sure designs are optimized, reducing costly prototypes and testing.

2. INJECTION MOLD DESIGN

The dedicated Mold Tooling application provides a powerful automated workflow that makes it fast and easy to design plastic injection molds. Standard component libraries and capabilities support the design of multi-core, multi-cavity plastic injection molds of unlimited size, including complex 3-plate and stripper-plate molds.

Using the dedicated module for the Mold Design Process for some software we can access the online components catalog, then select, assemble and modify mold parts and mold bases, including DME, Hasco, Pedrotti, Futaba, National, DMS and Progressive. With dedicated software, tooling design teams can readily exchange design data with other systems using built in translation tools. These support two way conversions of widely used design formats, including AutoCAD, IGES and STEP neutral format, and formats used by a host of CAD, CAM, and CAE programs [3].

For mold manufacturers you have also the option for the Electrode Design application which guides users through a logical step-by-step workflow to develop and document single or compound electrodes.

2.1 Design the injected part:

Injection molding forms a part by forcing (injecting) a hot, molten thermoplastic into a closed mold, under pressure, until the part has cooled or cured and can be ejected from the mold. Molds separate into at least two halves, called the core and the cavity to permit the part to be extracted.

In general the shape of a part must not cause it to be locked into the mold. For example, sides of objects typically cannot be parallel with the direction of draw (the direction in which the core and cavity separate from each other). They are angled slightly, draft, and examination of most plastic household objects will reveal this.

The first requirement is to have a properly modeled part that is fully moldable, figure 1. The part must have sufficiently drafted faces to easily eject the part so it is desirable to have no back drafted faces as the part would have to deform upon ejection from the mold or a lifter or slide would have to accommodate the undercuts.

Using the geometry of a reference model while working with dedicated software design it sets up a parametric relationship between the design model and the mold components. Because of this relationship, when the design model is changed, any associated mold components are updated to reflect the change. However, if changes to the original design model are made, those changes will appear in all of the reference models.

These softwares lead users through a logical step-by-step approach to create plastic injection molds. The part is made from ABS. Before starting the mold process we have to set up the shrinkage for the part. In our case we apply for the shrinkage a coefficient value of 0,6%.

All plastic parts will shrink when ejected from the mold and begin to cool [1].

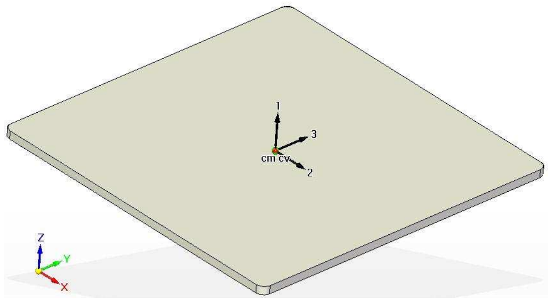

Figure 1 Polymeric part

2.2 Design the core and the cavity:

These dedicated softwares automatically create a parting surface to determine correct geometry for the core and cavity, which can be machined directly into the plates or separate core and cavity blocks. The core and cavity blocks are automatically sized based upon the physical part size, using pre-defined preferences that you can override or make adjustments to anytime.

You can easily create a pattern of the blocks for multi-cavity molds. You can quickly reorient the individual blocks and automatically center them in the mold base for a balanced runner system.

The final step is to perform a Boolean operation, subtracting the original part from the simplified core object. This operation removes the material from the simplified core block where the hook like feature exists. The result is a core object that matches the exact geometry of the original part. The same operation is then repeated on the cavity object to recapture the area with zero draft [4].

2.3 Design the Mold Base, Plates and Standard Components:

The dedicated software allows users to create moldbase layouts in a familiar 2D environment and automatically generate a 3D model to leverage the benefits of 3D design. The 2D process-driven guides you toward your optimal design and updates automatically during the development of the moldbase. You can choose from a catalog of standard components (DME, Hasco, Futaba, Progressive, Stark, etc.) or customized components. The resulting 3D models are then used for interference checking during mold opening, as well as for automatic generation of deliverables such as production detail drawings and Boms [1].

Automatic functions, such as on the fly customization, component sizing, placement, trimming, and clearance cut and thread creation, are provided for the following: Complete Moldbase Assemblies, Plates and Insulation, Guide, Leader and Return Pin Assemblies, Multi-Cavity and Family Molds Supported, Support Pillar Assemblies, Latch Lock Assemblies, Locating Rings and Sprue Bushing, Ejector Pins, including Sleeve Ejection, Screws and Washers, Dowel Pins, Cooling Circuit with Fittings, Plugs and O-Rings, Slider and Lifter Assemblies.

Through a dialog or menu interface, you add all the tool's functional components from gates, runners, ejection, cooling, and slide right down to individual screws, pins, and bushings. As these components are added, the mold-base software also creates the associated holes and features for those components, keeping track all the while of relations between features.

2.4 Design the Runner System and the Gate

For cylindrical or symmetrical shaped parts (boxes, cups, helmets, etc.) that are molded in single-cavity molds, a sprue gate is preferred. In our case, the part is gated directly from the sprue. If the sprue is cold, then there is no gate and the sprue directly connects to the part. However, with a hot sprue, a small gate is used to facilitate automatic degating.

3. CASE STUDY – DESIGN THE MOLD INJECTION USING DEDICATED SOFTWARE

The mold creation process starts with the empty Assembly model provided and the reference and work piece are assembled to it. The mold base, figure 2 was developed with VISI software [1].

VISI is acknowledged as one of the world's leading PC based CAD/CAM/CAE solutions for the mold and die industries. It offers a unique combination of applications, fully integrated wireframe, surface and solid modelling, comprehensive 2D, 3D and 5 axis machining strategies with dedicated high speed routines. Industry specific applications for plastic injection tool design including material flow analysis and progressive die design with step-by-step unfolding provide the toolmaker with unsurpassed levels of productivity [2].

Expert Mold base provides smart mold bases and mold components. Any changes made to the design model automatically propagate to the mold components and assemblies. Professional mold designers now have everything they need to completely design an entire mold assembly – core, cavity and mold base – in one package.

VISI Software offers dedicated solutions that eliminate the links between varying software suppliers and the solid-to-surface or CAD/CAM/CAE geometry conversions required by traditional systems.

VISI can work directly with Parasolid, IGES, CATIA, ProEngineer, UG, STEP, Solid Works, Solid Edge, ACIS, DXF, DWG, STL and VDA files. The extensive range of translators ensures that users can work with data from almost any supplier. The ability to skip corrupt records during the import process provides a platform from where the most inconsistent data can be managed. Very large files can be handled with ease and companies working with complex designs will benefit from the simplicity with which their customer's CAD data can be manipulated.

Essential model preparation tools are available to automatically inspect model data for molding feasibility, redundant geometry, sliver faces and geometry inconsistency. The draft analysis provides the ability to quickly interrogate a model using user-defined colour draft zones to easily identify undercut and non-drafted faces. Duplicate geometry can be highlighted, extracted and automatically isolated into warning layers. Sliver face detection and automatic removal provides the ability to delete potentially problematic faces whilst maintaining solid topology. Finding potential design issues at this early stage will generate huge time savings further along the design process.

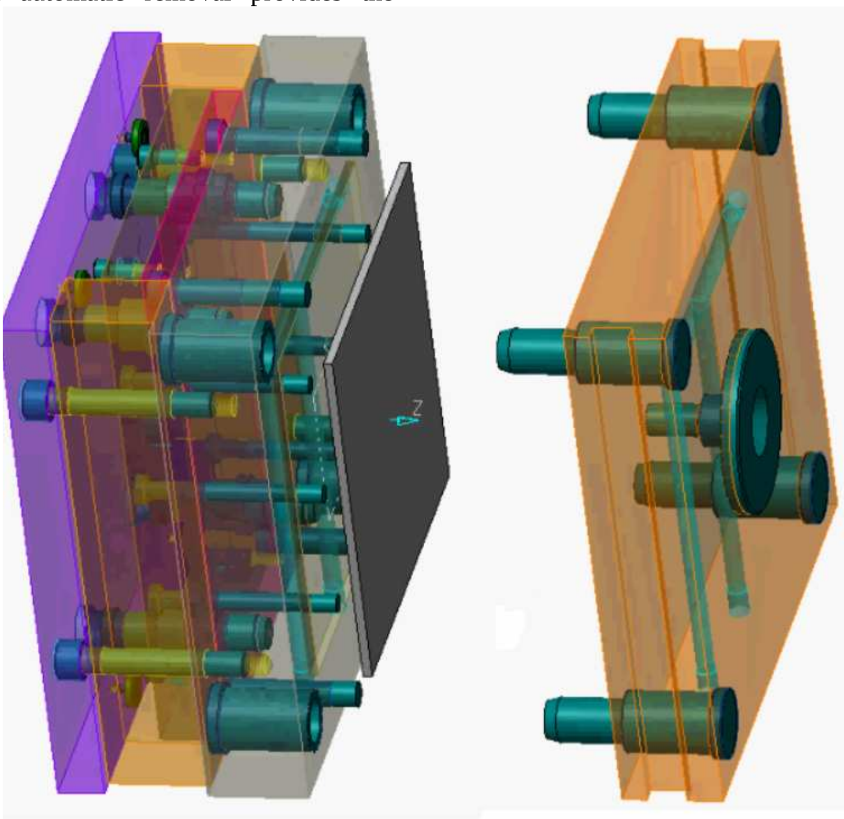

Figure 2 Injection mold design

A complete set of 2D detailed drawings can be generated directly from the solid tool assembly. This includes fully editable 2D and isometric sections views, automatic plate dimensioning and whole type and position tables (figure 3). Individual details can be created from any component in the assembly and displayed as a mixture of 3D rendered and 2D drawings. Any standard catalogue component will have the correct detail representation within a section view. A change in the solid model will result in a modification to the 2D view along with any fully associative dimensions. Parts list table items and their respective balloon references can be added to the drawing using dedicated assembly management tools [1].

Due to the integrated nature of VISI, manufacturing of individual plates can be completed using feature recognition. Drilled hole features and apertures are automatically selected with the correct drilling cycles and 2D milling routines applied. For more complex core and cavity work, VISI Machining can be used to generate 3D - 5 axis conventional and HSM cutting toolpaths. Keeping the model within the same product environment throughout the entire project, from design to manufacture will guarantee data consistency and greatly smooth the design process.

You can see a part from the CNC program (the *.mpf file) for the cavity using the milling machine model DMC 63V [1].

```
N5 G54 G641 M7 M85 G90 G40 M3;
N6 T1 D1
N7 L6
N8 MSG("FRESA TORICA DIA 42  RAD 6")
N9 S2000 M3 M8 F1500 T1
N10 G17
N11;( ROUGHING SPIRAL)
N12 G0 X-15 Y-3
N13 Z33.205
N14 G1 Z18.205 F750
N15 X-14.928 Z16.735
N16 X-14.712 Z15.279
N17 X-14.354 Z13.851
N18 X-13.858 Z12.465
N19 X-13.229 Z11.134
N44 X6.622 Y-1.368 Z3.07
N45 X7.054 Y-1.132 Z3.061
N46 X7.477 Y-0.881 Z3.051
N47 X7.891 Y-0.616 Z3.042
N48 X8.296 Y-0.336 Z3.032
N49 X8.691 Y-0.043 Z3.022
N50 X9.076 Y0.264 Z3.013
N51 X9.449 Y0.584 Z3.003
N52 X9.812 Y0.916 Z2.993
N53 X10.163 Y1.261 Z2.984
N54 X10.502 Y1.618 Z2.974
N55 X10.828 Y1.986 Z2.965
N56 X11.141 Y2.365 Z2.955
N57 X11.441 Y2.755 Z2.945
```

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……………………………………………
……………………………………………
N5278 Y-60.168 Z10.205
N5279 Z25.205
N5280 G60
N5281 M9
N5282 MSG("TOOL T1 TIME: 0:13:51")
N5283 M30.
```

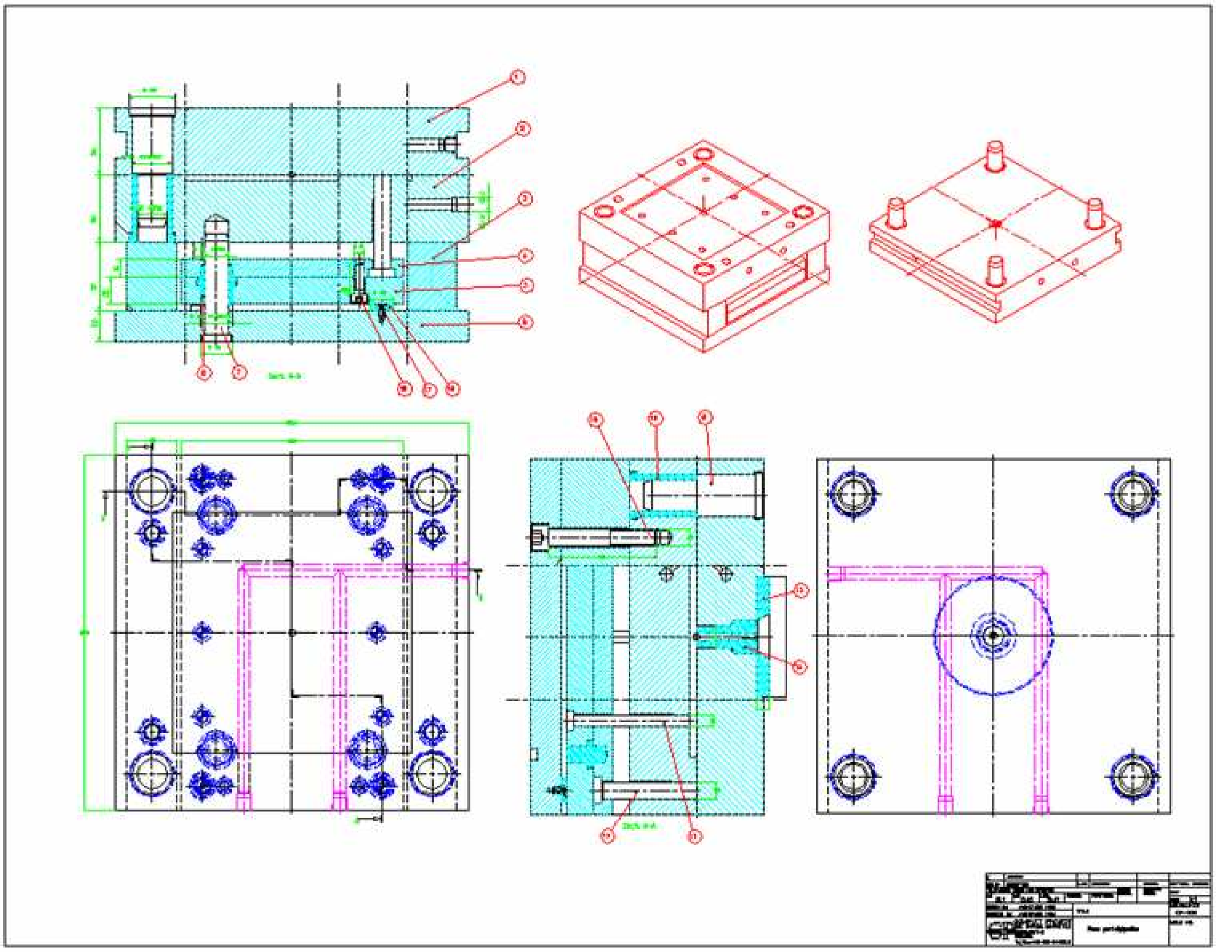

Figure 3 Mold design – section view

All 3D toolpaths can be converted to 5 axis operations which dramatically increase the number of strategies available to cover any scenario. Using this approach will apply high speed machining technology to 5 axis toolpaths. The 3D - 5 axis conversion provides intelligent collision detection and will automatically tilt away from the piece only when required. This type of semi-automatic toolpath will dramatically speed up programming and shorten the learning curve.

4. CONCLUSIONS

Using the software's capabilities, we can easily generate the core and cavity blocks. As a result, this new system provides a powerful, feature-based solid modeler that allows users to make modifications to parts for mold design.

Using CAD/CAM/CAE technology we can define even the most complex geometry for creating single and multiple cavity molds and casts. We can evaluate easily mold draft, undercut and thickness problems and examine forming and secondary forming dies.

With help of CAD/CAM/CAE we reduce need for redesigns through automatic updating of tooling models, drawings and electrodes. And the main important advantage is that using CAD/CAM/CAE we will eliminate costly rework via interference checking and mold opening simulation.

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STRAIN GAGE ROSETTE MEASUREMENTS IN MOLDED PLASTIC PARTS

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ABSTRACT

The paper presents the strain gage rosette measurements on polypropylene molded parts. The strain measurement on a plastic or composite test object will frequently call for much greater skill, expertise, and knowledge of mechanics than that typically required with the structural metals. The characterization of plastics for engineering purposes necessitates considerably testing than is typical for metals primarily because of time, temperature, moisture, and aging effects on the material behavior. With the increasing number of plastic structural components, it can be expected that the need to measure service strains on these materials will increase correspondingly and the strain gage application technology must be advanced accordingly. It is very important for plastic materials to determine the Young's modulus and the Poisson's ratio using the strain gage rosette.

Keywords: *plastic material, strain gage rosette, elastic constants, mold injection.*

1. INTRODUCTION

Injection molding is the most important commercial process for the production of plastic parts. It can be divided into four basic stages: plastification, injection, packing, cooling, and ejection.

Plastic materials are nowadays widely employed as much for the manufacturing of a lot of daily objects as in the high-tech sector. These materials are well known for the extremely complex behavior strongly depending on the time and the temperature.

The study of the phenomena appearing during a scratch test on amorphous polymers needs a correct understanding of the mechanical behavior. This paper presents the measurements using the strain gage rosette on the molded plastics polypropylene (PP) to determinate the Young's modulus and the Poisson's ratio.

With the complexity of the applications for polymers increasing, the need for more sophisticated testing techniques has also increased. State of the art plastics testing laboratories today utilize test equipment that is fully instrumented and capable of collecting data with higher accuracy that not only includes the basic properties but also the more complicated effect of external variables on those properties.

A data collection method from the American Society for Testing and Materials (ASTM) was used in this paper to measure strain for modulus determination.

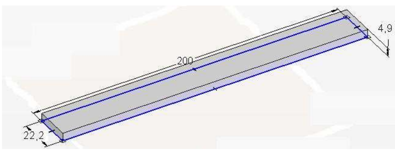
2. EXPERIMENTAL METHOD

Stress-strain tests are considered a short-term test, which means that the mechanical loading is applied within a relatively short period of time. This limits the usefulness of stress-strain tests in the actual design of a plastic part. Stress-strain tests fail to take into account the dependence of rigidity and strength of plastics on time. This serious limitation can be overcome with the use of creep and stress relaxation data while designing a part.

2.1 Plastic samples:

The polymer of interest is polypropylene (PP). Stretching tests were performed on these polypropylene samples. The samples have the height (h), the width (b) and the design as you can see in the table 1 [1].

Table 1. The PP samples sizes

PP Sample	h [mm]	b [mm]
	4,9	22,2

The plastic parts were prepared directly from the injection molding as a flat plate with 200x200x5mm dimension. The plastic samples (figure 1) for tensile tests were obtained by cutting the plates using a cutting tool, which is fabricated with the aid of CNC wire cut electrical discharge machining (EDM) to ensure that the samples dimensions are of high precision.

To determinate better and precisely the elastic constants we bonded four pieces of aluminum at the termination of the samples for the grip in the machine because in that sector we could have the compression and we want also, to remove definitely the bending from the samples. For bonded the pieces of aluminum we used a fast setting cement kit, RS-200 from Vishay to firmly attach them to the test part. Also, the measuring sector and the samples were gently smoothing with a small hand-held grinder, and cleaned of impurity with alcohol ethyl, figure 1.

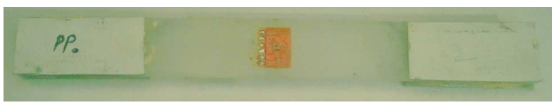


Figure 1 The PP test part with strain gage

Next step, we installed a special three-element strain gages rosette, CEA-06-062UL-120 type on the test part at the point where we indented to determinate the elastic constants, bonded carefully with M-Bond 200 from Vishay, figure 1.

We need a special strain gages rosette, because after that we intend to determinate the residual stresses from the flat plates, with the hole-drilling strain gage method described in ASTM Standard E837. The gages are constructed of self-temperature-compensated foil (06 and 13 S-T-C) on a flexible polyimide carrier, and incorporate a centering target for use with a precision milling guide, CEA-Series (A-Alloy) gages have encapsulated grids, and rugged, copper-coated solder tabs [2].

The strain measurement on a plastic or composite test object will frequently call for much greater skill, expertise, and knowledge of mechanics than that typically required with the structural metals. We needed 3 threads for each rosette with a length of one meter, which were attached with tin at T=230 degree Celsius, see figure 2 [1].

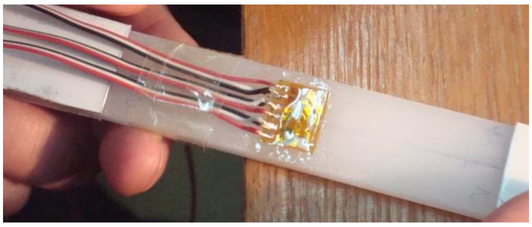


Figure 2 The test part prepared for the measuring

2.2 Injection molding:

The plastic samples for tensile tests were obtained by cutting flat plates with 200x200x5mm dimension which were prepared directly from the injection molding. As we said earlier, we used a cutting tool, which was fabricated with the aid of computer numerical controlled (CNC) to ensure that the samples dimensions are of high precision.

Injection molding is the most important commercial process for the production of three-dimensional plastic parts. It can be divided into four basic stages: plastification, injection, packing, cooling, and ejection. In the plastification stage the raw material in solid form is transformed into molten material through the combined action of the friction provided by a rotating screw and the heat provided by external heating elements. The screw retracts during rotation in order to accommodate the molten material that accumulates in front of the screw. Once a sufficient amount of material is available, the screw moves forward, causing the molten material to fill the cavity. Upon completion of filling, additional material is packed into the cavity in order to compensate for the shrinkage occurring during the cooling stage. Once solidified, the molded article is ejected and the sequence of events is repeated in a cyclic manner. Due to the poor thermal conductivity of polymeric materials, the cooling time generally constitutes the dominant portion of the molding cycle.

2.3 Test method:

The mechanical properties, among all the properties of plastic materials, are often the most important properties because virtually all service conditions and the majority of end-use applications involve some degree of mechanical loading. The basic understanding of stress-strain behavior of plastic materials is of utmost importance for a design engineer.

Tensile elongation and tensile modulus measurements are among the most important indications of strength in a material and are the most widely specified properties of plastic materials. Tensile test, in a broad sense, is a measurement of the ability of a material to withstand forces that tend to pull it apart and to determine to what extent the material stretches before breaking. Tensile modulus, an indication of the relative stiffness of a material, can be determined from a stress-strain diagram. Different types of plastic materials are often compared on the basis of tensile strength, elongation, and tensile modulus data. Many plastics are very sensitive to the rate of straining and environmental conditions.

For this work a concern with a generalized constitutive relationship that relates stress to strain was used and the method was for tensile tests is ASTM D 638 or ISO 527-1. One of the simplest stress-strain relationships is termed Hooke's Law, which relates stress [3]:

$$\sigma_j = \frac{F_j}{A}\left[\frac{N}{mm^2} = MPa\right]. \tag{1}$$

The strain is:

$$\varepsilon_j = \frac{\Delta l_j}{l} = \frac{l_j - l}{l}\left[\frac{\mu m}{m}\right] or \left[\frac{m}{m}\right]. \tag{2}$$

This relationship yields the material quantity, modulus. Therefore, Hooke's Law is:

$$\sigma = E \cdot \varepsilon. \tag{3}$$

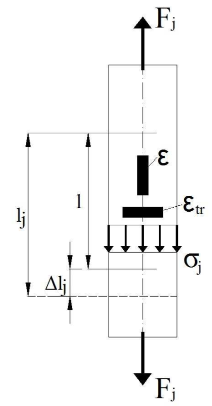
Where E is Young's Modulus, σ is stress and ε is strain. This implies that stress is directly proportional to strain. This is indeed true for a perfect elastic solid. However, as mentioned earlier, plastic materials are viscoelastic and can become inelastic as a result of large deformations. First, at low strains, polymeric materials will indeed behave as an elastic solid and thus obey Hooke's Law. We made the experiments in section of the reversible elastic strains [3].

The stress is the dependent variable along the y-axis and the strain is the independent variable along the x-axis. Young's Modulus is the slope of the line. Hence, Hooke's Law is a linear relationship Young's Modulus can be calculated at any point along the straight line portion of the curve. It is important to note that modulus is a material parameter. That is, a specific material will have a modulus that is unique to it, property that is related to polymer attributes. Young's Modulus is taken from the initial slope of the stress strain curve, where the stress is directly proportional to the strain.

The sample is placed in the grips of the testing machine, which pulls the sample apart at a prescribed rate. The force required pulling the sample apart and the amount of sample stretch are measured. These values along with the sample cross-sectional area in the gauge region are used to calculate the Young's modulus and the Poisson's ratio [4].

For experiments we use a microcomputer-control electronic universal testing machine WDW 50-E, having the maximum testing capacity of 50kN and the stretching tests were performed on samples applying the four different forces 200N, 400N, 600N and 800N, accordingly with table 2. The time between applying the forces was 100 seconds, because we wanted to be in the stationary regime. In these tests, the temperature was measured at 23 ± 2 °C [1].

Table 2. The tensile tests

The machine test WDW 50-E	The stretching scheme
	

Tensile tests were conducted on a universal testing machine piloted in displacement mode using a Strain indicator; model P3 from Vishay, functions as a full bridge and transducer to measure the strain of the parts, as you can see in figure 3.

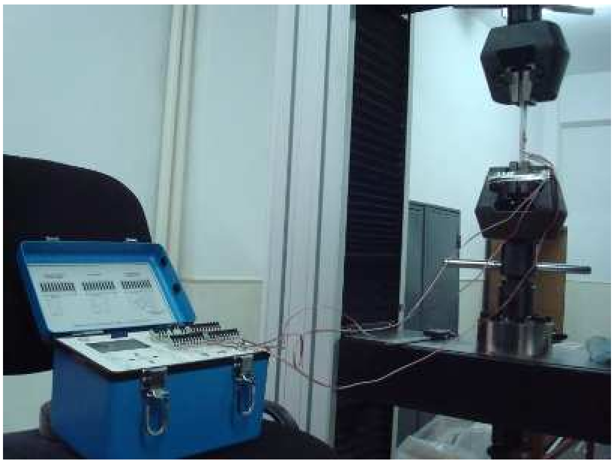


Figure 3 The apparatus for the tensile tests

The output of the measured deformation and load were continuously stored using a PC for data acquisition. As soon as the stress is applied, the elastic deformation takes place and continues until the load is removed. A substantial portion of the elastic recovery is not immediate and the material continues to return to its original size or length. We obtained the longitudinal strain ε and transversal strain ε_{tr} [3].

With the value of the strain ε and ε_{tr} and using the equations (1) and (2) we could calculate the Young's Modulus:

$$E = \frac{F}{\varepsilon \cdot A \cdot 10^{-6}} [MPa], \qquad (4)$$

the Poisson's ratio:

$$\nu = \frac{|\varepsilon_{tr}|}{\varepsilon} \qquad (5)$$

and the shear Modulus, modulus of rigidity:

$$G = \frac{E}{2(1+\nu)}. \qquad (6)$$

3. RESULTS AND DISCUSSION

In a stretching experiment a test part is placed under tension, causing the length to increase and the cross-section to decrease. For these stress-strain measurements the test part has shoulders at both ends, and is held at its broader parts in the clamps of the testing machine. The machine then pulls the clamps apart at constant speed, whereby a force of 200N, 400N, 600N and 800N is transmitted to the test part. You can see the value of the strain ε and ε_{tr} measured on the bridge, table 3. The Young's Modulus was taken from the initial slope of the stress strain curve, where the stress is directly proportional to the strain. Young's Modulus is the slope of the line, as you can see in the figure 4. Next, we determinate in the same manner the Poisson's ratio represented the diagram with the strain ε variable along the x-axis and ε_{tr} variable along the y-axis, figure 5 [1].

4. CONCLUSIONS

Mechanical properties are among the most important properties for material selection and use applications. Virtually all applications involve some type of material loading and responses. Consequently, such properties as modulus, tensile strength, and impact are essential for product design, material selection, and specifications. Mechanical behavior in general terms is concerned with the deformation that occurs under loading.

It is very important for plastic materials to determine the mechanical properties and the elastic constants because the number of plastic structural components is considerably increasing and for all following tests we have first to know precisely them.

Table 3. The PP characteristics

PP								
F [N]	b [mm]	h [mm]	A [mm2]	ε [μm/m]	|εtr| [μm/m]	ν	E [MPa]	σ [MPa]
200	22,2	4,9	108,78	706	305	0,432	2604,211	1,839
400	22,2	4,9	108,78	1710	742	0,434	2150,378	3,677
600	22,2	4,9	108,78	2820	1310	0,465	1955,929	5,516
800	22,2	4,9	108,78	3191	1576	0,494	2304,699	7,354

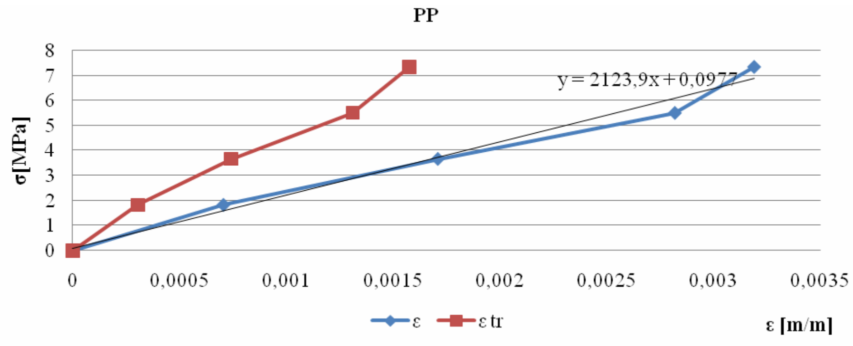


Figure 4 The PP stress-strain diagram

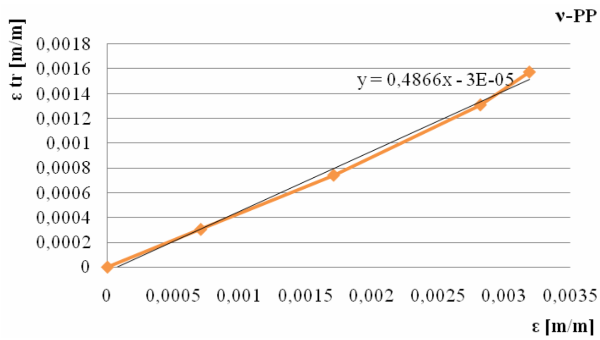


Figure 5 The PP Poisson's ratio diagram

The elastic constants, such as Young's modulus and the Poisson's ratio are different for the same material, produced by different manufacturers, because they have an extremely complex behavior strongly depending on the time and the temperature.

From the tensile tests using the strain gage rosette we obtained the value for the mechanical properties and elastic constants for PP: E=2124MPa, ν=0.487, G=714MPa, σ_c=24.79MPa, σ_r=28.66MPa.

5. ACKNOWLEDGMENTS

The experimental studies mentioned in the paper were conducted by Professor Paul Bârsănescu, from the Technical University of Iasi.

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THE EFFECTS OF COOLING WATER SYSTEM OF NUCLEAR POWER PLANT CERNAVODA ON DANUBE ZOOPLANKTON STRUCTURE

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ABSTRACT

During three times in April, June and August of 2010, water samples were collected from 6 Danube River key stations around Cernavoda Nuclear Power Plant and the structure of zooplankton community was studied. Totally, 54 taxa (excluding 4 age groups) of Rotifera, Cladocera, Copepoda and Bivalvia were recorded with densities that vary from 62640 indiv./m^3 to 684274 indiv./m^3, depending on sampling site and temperature.

Keywords: *nuclear power plant, Danube River, zooplankton populations, thermal effects.*

1. INTRODUCTION

In 1996 the Nuclear Power Plant Cernavoda (NPP) Cernavoda began the operational activities with one CANDU reactor and from 2007 it works with two reactors.

The cooling system of the Units 1 and 2 of NPP Cernavoda needs an income flow of about 108 m^3/s water [1] for 100% electrical power. The cooling agent is water provided by the Danube-Black Sea Canal; the water passing through the cooling system of the NPP is discharged into the Danube River, through a canal - a heated effluent that could be an ecological stressing factor for the river ecosystem in the area of its influence, downstream of the thermal canal [2].

Assessment of the eventual perturbations due to the increased temperature from cooling water system implied studies on environmental parameters.

There are some papers which describe this specific area, focus on the main physical, chemical and biological parameters [3], [4].

2. METHODS

For this study, during April, June and August of 2010, water samples were collected from six sites (S1÷S6) which have been chosen to illustrate the influence of thermal discharge of Cernavoda NPP cooling system upon Danube water zooplankton community (Fig. 1):

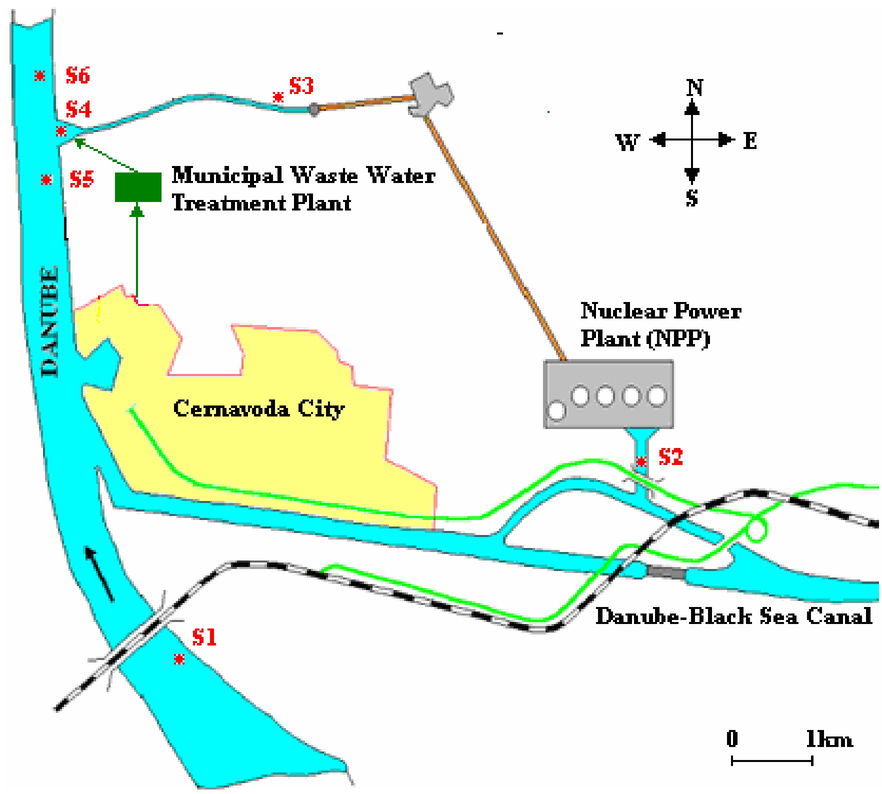

Figure 1. Sampling sites position

S1 – this site is placed on the Danube, 1500 m upstream the confluence with the Danube – Black Sea Canal (DBSC); this is considered a reference station because the ecosystem is not affected by thermal discharge from the NPP Cernavoda or by the waste waters of the town.

S2 – is represented by the income water basin of NPP; here the water is coming from DBSC, but due to the low flow this area could be assimilated as a limnic ecosystem.

S3 – is a site situated on the effluent discharge canal of NPP, upstream the aeration fall; here the temperature of the water is expected to reach the maximum values.

S4 – is a site placed downstream the aeration fall of the NPP discharge canal, but 100 m upstream the confluence between this canal and the Danube River. The effluent from municipal wastewater treatment plant is discharged in this area too.

S5 – is situated on the Danube, 300 m upstream the confluence between the NPP discharge canal and the river, downstream the harbour area.

S6 – this site is placed on the Danube in the mixing zone, 500 m downstream the confluence between NPP discharge canal and the river; here the water is expected to reflect the influence of the thermal discharge of the Danube aquatic ecosystem.

The quantitative samples were collected using a Schindler – Patalas zooplankton trap, and an 80 μm mesh size net. For a better characterisation of the taxa, 10 l of water from different depths were taken, in steps of 1 m, in each sampling site. Thus we obtained a spatial distribution (by depth) of zooplankton characteristics. The final data were calculated as the mean value of these samples.

Zooplankton samples collected in the field were preserved in 4% buffered formaldehyde.

Commonly used methods were applied for zooplankton investigations [5], [6], [7], [8], [9], [10] and for counting the main ecological parameters [11].

3. RESULTS AND DISCUSSIONS

Zooplankton associations from the studied area had a high specific diversity, consisting in 38 rotifers taxa, 12 taxa of Cladocera, 4 species and 3 age groups of Copapoda and Bivalvia larvae. From total taxa, 18 were found in all six key stations, and others 20 taxa in more than 4 sampling points. Two species were recorded in only 1 station.

The total zooplankton varied from 62,640 indiv./m^3 in June for S5 to 684,274 indiv./m^3 in august in S2 (Fig. 2), with an average values of 288,933 indiv./m^3. Income water basin of NPP (S2) represents the area with the highest density zooplankton, up to 2.5 times more than in the areas situated outside of the thermal discharge effluent (S1 and S5).

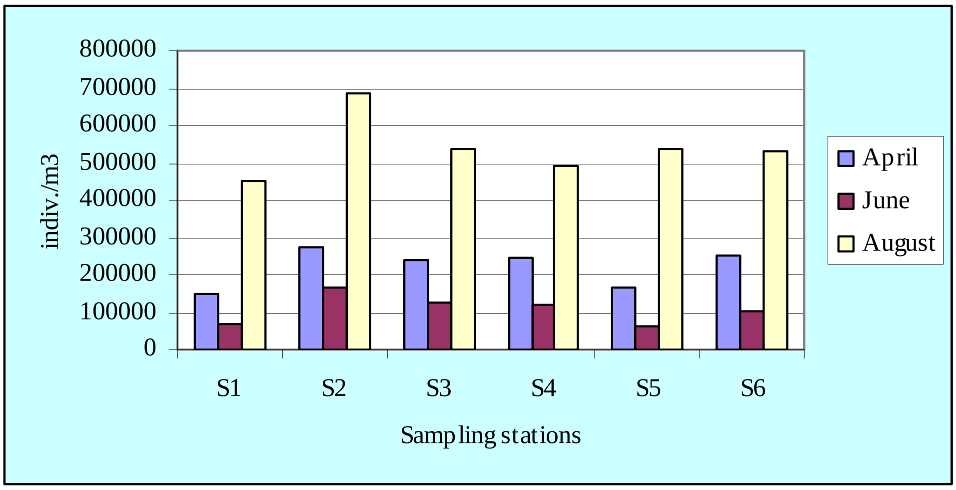

Figure 2. Spatially and temporally distribution of zooplankton density

Rotifera is the dominant group of zooplankton, by diversity and density in all sampling points (Tab. 1) and it represents 55 ÷ 95% from total zooplankton density. The highest number of rotifers (primary and secondary consumers) was found in August on S2 (541,954 indiv./m^3) and the lower in June in S1 (41,000 indiv./m^3).

Bivalvia larvae and cladocerans were recorded with the lowest number in S5 in month of June, with 9,580 indiv./m^3 and 2,500 indiv./m^3, respectively. The highest value for Bivalvia larvae was 67,433 indiv./m^3, recorded in month of August in sampling site S3; in S6 (April) we found the maxim density for cladocerans (24,750 indiv./m^3). Bivalvia represents 6 ÷ 19% from zooplankton density and cladocerans 2 ÷ 7%.

Copepoda numbers varied from 2,700 indiv./m^3 in April in S1, to 111,560 indiv./m^3 in August in S6, with an average value of 40,683 indiv./m^3 and their percentile presence is between 2 ÷ 22% from the total number of zooplankton registered in 2010 in the studied area.

For all three sampling period of time, the zooplankton was registered with the lowest values in the sites situated outside of the thermal influence (S1 and S5). In this situation, the income basin for the cooling water system (sampling site no.2) has a major role; due to the low water velocity, this area creates favourable environmental conditions for an increasing development of the zooplankton.

Tabel 1. Density variation of zooplankton groups (indiv./m^3)

MONTH	SAMPLING SITES	GROUP OF ZOOPLANKTON			
		ROTIFERA	BIVALVIA	CLADOCERA	COPEPODA
APRIL	S1	139700		4700	2700
	S2	246943		15575	11375
	S3	149967	30667	13367	44267
	S4	154125	39825	14050	39975
	S5	156800		4900	4025
	S6	167025	23775	24750	35375
JUNE	S1	41000	14443	2843	11286
	S2	89575	25300	12125	38850
	S3	74000	24533	5700	23267
	S4	72950	21600	4775	22600
	S5	44180	9580	2500	6380
	S6	57300	17220	4700	22120
AUGUST	S1	358350	35100	15718	45075
	S2	541954	45840	20160	76320
	S3	386200	67433	14700	70067
	S4	372020	41880	12820	65440
	S5	428000	30440	14880	61760
	S6	368160	42260	11740	111560

The cooling system has two major effects on zooplankton community structure: thermal and physical. Temperature differences between S2 and S3 were 10.7^{0}C in April, 9.6^{0}C in June and 6.9^{0}C in August.

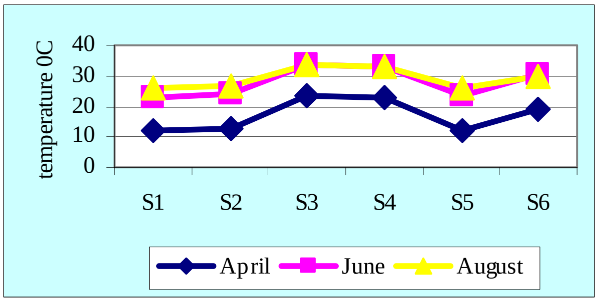

Figure 3. Water temperature on the sampling sites

The water temperatures in the sites S1÷S6 have a similar spatial distribution for all three studies; downstream the confluence between NPP discharge canal and the river (site S6) the values of temperature were higher than in the reference site S1, the range of differences being 3.9÷7.4°C (Fig. 3).

Passing through the pumps and the piping of the cooling system, the zooplankton is subject to the thermal and physical shocks. Total zooplankton density decrease from S2 to S3 with 15% in April, 30% in June and 27% in August. Finally, due the high values of density in the income water basin, in S6 the total zooplankton density is with 24% more than in S1 and with 11% more than in S5, facts observed in the previous studies too[12], [13].

The flow of the Danube River has multiannual average value of about 2390 m^3/s [3] and the maximum flow of the cooling water is 22 times less, which means that the thermal discharge has minor effects after mixing with the Danube water, far downstream on the river.

4. CONCLUSIONS

For all zooplankton species, the transition through the cooling water system of NPP - Crenavoda represents a thermal and mechanical shock, proved by the lower values of concentration in S3 than in S2. In S3 and S4 the values are almost the same; this fact suggests that the negative effects on zooplankton take places only inside the water cooling system. Not the higher temperature is the main factor, but the quick transition of about 10 degrees in a short period of time when the zooplankton individuals are passing through the cooling system.

In S6 could be observed the effect of mixing the Danube water with the effluent. Mainly, the density of the zooplankton is determined by the density in the thermal effluent. But there are also influences from the river water (the S5 water characteristics), which could be observed on the data in S6 August when the values were higher than in S3 and S4, but lower than in S5, that proves a mixing effect between the two water fluxes.

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COMPARATIVE STUDY TO IMPROVE THE MECHANICAL CHARACTERISTICS ON IMPACT ON PLATES MADE OF FIBBERS REINFORCED GLASS

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ABSTRACT

Fibberglass reinforced polyester (GRP) is the most used composite material in ship building industry and required a careful study when we talk about the mechanical characteristics and theie resistance to fatigue. A common field of their application between others is the ship building industry. The use of composite materials in this branch is justified by the ship owners' desire to replace steel or other metallic materials used so far. Therefore, the most used composite material in ship building industry is the fibberglass reinforced polyester known as GRP. This paper proposes to study the static and the dynamic behaviour of GRP plates and the importance of the framework arrangement for three type of panels.

Keywords: *Composite Materials, Fatigue, Mechanical Characteristics, Fatigue - Variable Load.*

1. INTRODUCTION

By definition, composite materials are made of two or more components. Their mechanical properties complete each other, this leading to a material that has superior mechanical properties comparing to its components. Composite materials are the first ones of which structure are conceived entirely by the human hand, not only in their molecular structure but in every way that their destination requires.

These materials have programmable properties and this way they have replaced traditional materials and have penetrated in many top industrial branches such as: aerospace engineering, automobile manufacturing industry and electronics industry.

A common field of their application is the ship building industry. The use of composite materials in this branch is justified by the ship owners' desire to replace steel or other metallic materials used so far. Therefore, the most used composite material in ship building industry is the glass reinforced polyester known as GRP. Due to the fact that composite materials are diamagnetic, they are successfully used in building one particular type of ship, the war craft, and figure 1.

Figure 1. War Craft and Yachts

Having low density, of only 3000 kg/m^3 and special mechanical properties are just perfect for building entire hulls for yachts and small crafts , with lengths ranging from 10 to 47 m. This paper proposes to study the static and the dynamic behaviors of GRP plates and the importance of the framework arrangement for this type of panels. In the following, the three analyses plane panels are presented figure 2, 3 and 4.

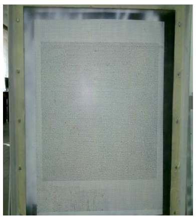


Figure 2. Simple plate (case I)

Figure 3. Plate with stiffness in one direction (case II)

Figure 4. Plate with stiffness in two direction (case III)

2. MATERIAL DESCRIPTION

This study involved two unidirectional hand lay-up composites manufactured in Spat company from Galati.
As we know the fibbers orientation of composite materials can be: one-way, two-ways or three-ways. We used two way fibbers orientation, figure 1.a, and the percentage of glass fibber in mass composite was 62%. As we know if the percentage of glass fibber increases automatically increases the material characteristics.

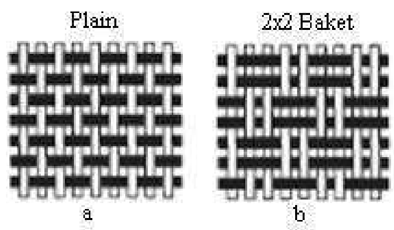


Figure 5. Fibbers Orientation

Composite materials reinforced with fiberglass for shipping industry are divided in two categories called "E" and "S" and is depending on which is made the fibber.

Material type „E" are the most commonly used in construction plates, especially because of good water resistance properties.

Table 1. The characteristics of fibbers

Type	Fibber diameter (μm-10^{-6} m)
C	4.57
D	5.84
DE	6.35
E	7.11
G	9.65
H	10.57

The „E" type material is the most commonly used in construction plates, especially because of good water resistance properties.

3. STATIC ANALYSIS ON GRP PLATES

Static analysis was performed in order to verify the accuracy of numerical modelling using FEM. A correct static modelling can lead to a correct dynamic modelling.

One of the most popular experimental methods with remarkable results in determining stresses and displacements in static conditions is the strain gauge method. This method has advantages like: reduced expenses, high efficiency and good productivity. Using the strain gauge method, we determined the stresses and strains on the experimental models. We've established measuring points where the strain gauges were applied. We used Hottinger 1-LY11-10/120 strain gauges of which electrical resistance is approximately 120 Ω. The results were gathered using a tensometric bridge, SPIDER 8, produced by Hottinger. The elements of the workbench are presented in figure 6.

Tensometric bridge SPIDER 8 (1), laptop with the soft-ware Catman Express 3.1. (2), plane GRP plate (3), strain gauges (4), load (5) and electrical wires (6). In the experiment we used a number of 6 strain gauges for the simple GRP plate and 5 strain gauges for the reinforced plate in order to identify as many points as possible regarding the maximum stress of the loaded plate.

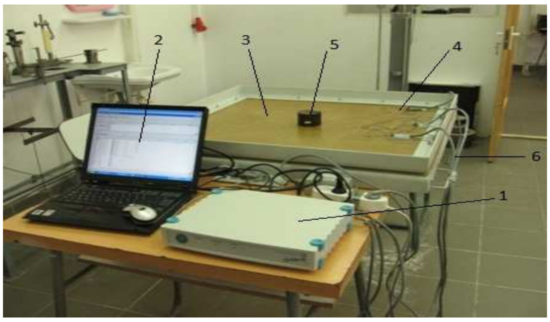


Figure 6. Workbench

2.1 Experimental analysis

In this case the strain gauges were lay-out as presented in figure 7.

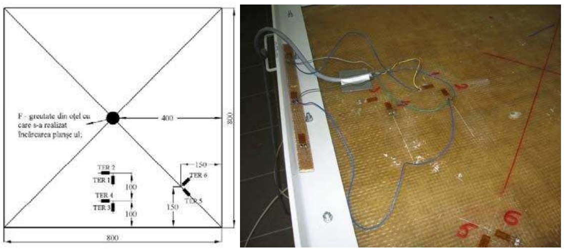


Figure 7. Simple GRP plate

Prior to the placement of the strain gauges, the application points were mechanically prepared (surface polishing), followed by the surface degreasing. After the surface was ready the strain gauges were glued to the plate using specific industrial glue. The static load was performed using weights which were applied in the centre of the plates. The loads were gradually applied from 0 to 122.5 N and then backwards from 122.5 N to 0 N. After obtaining the unit deformations we determined the normal stresses using a mathematical formula and knowing the longitudinal elastic modulus $E=1.8844 \cdot 10^9$ [Pa] (determined also experimentally for our specimen in the laboratory). Same experiment was done for plate case II, III (see fig. 2, 3, 4). For experimental and numerical modelling were considered, all cases, the points where the transducers were located 1, 2, 3, 4 (see figure 7).

2.2 Numerical analysis

Regarding the numerical analysis using FEM (Finite Element Method), the plate structure was analyzed using the soft-ware SolidWorkCosmos/M. The model was meshed using SHELL4T plate elements (thick membrane) with 4 nodes and 3 DOF (degrees of freedom) per node (two rotations and one translation). The mesh for case I for example contains 3200 elements and 1681 nodes. In all three cases, the numerical analysis was performed, in similar conditions with the experimental analysis.

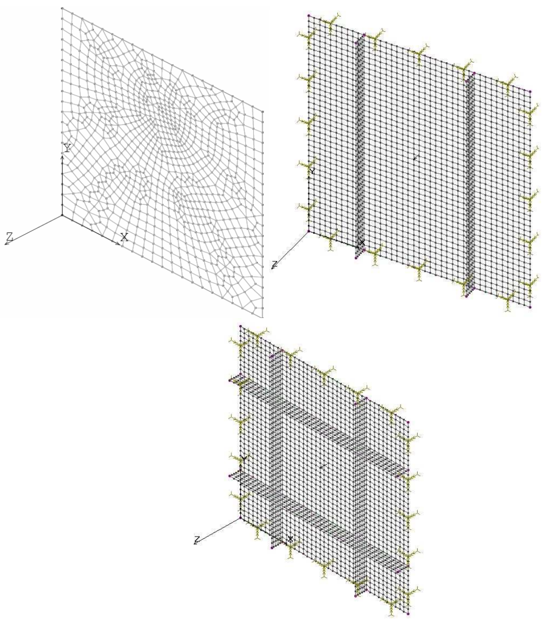


Figure 8. Mesh of the plane

The GRP plates were constrained on their four sides and were loaded with a constant normal force of 65 N applied in their geometrical centre. In the figure 8 the mesh of the plane GRP plate is presented among with the foreseen loads. This mesh was used also in dynamic analysis.

The results obtained of the numerical analysis for areas where placed strain a gauge is presented in table 2 was:

Table 2. (E-experimental results; N-numerical results)

Force 65 (N)		Stress at gauge 1 areas	Stress at gauge 2 areas	Stress at gauge 3 areas	Stress at gauge 4 areas
Case		(Pa)	(Pa)	(Pa)	(Pa)
I	E	160170	150709	199153	171356
	N	170700	161400	213100	183900
Diff %		6.1	6.6	6.5	6.8
II	E	130230	126301	157370	146391
	N	139800	132900	167900	153200
Diff %		6.8	4.9	6.2	4.4
III	E	111218	105891	135012	120049
	N	120500	112100	141200	129200
Diff %		7.7	5.5	4.4	7.1

As is possible to see in table 1 the difference in percent is around 6 %. This means the model chose for experimental and numerical analysis is good, and will be used in dynamic analysis also.

3. DYNAMIC ANALYSIS

3.1 Experimental

In order to perform a dynamic analysis regarding the behaviours of the stressed plane GRP plates we used the gear provided by the German firm GOM, Aramis HS. It is an optical measurement system, which uses no physical contact, to determine unit deformations and normal stresses that are prone to appear in the stressed piece. Aramis recognizes the tested object's surface using two high-speed cameras and assigns coordinates to each image pixel. The hardware's operating mode is very simple and consists of two big phases:

- *recording the first image:* known as "zero point" image because it shows the unreformed plate surface, right before the impact. This single frame is very important because all the following images will be compared to it for all the determinations.
- *recording the rest of the images:* recording the deformed surface of the plate during the dynamic load and assigning coordinates to each and every one of them allows the device to calculate the displacement of every point from the surface of the plate by referring to the first image

The Aramis HS system has a various field of applications such as: material testing, strength assessment, component dimensioning, verification of Finite Element models, and analysis of the behaviour of homogeneous and inhomogeneous material during deformation, strain computation.

In the present study, the hardware was used not only to verify the viability of a computational model but also to determine the unit deformations of the GRP plates and finally to calculate the internal stresses. This experiment is very useful for small crafts and yachts built from GRP plates because it can predict the behaviour of this material in the case of impact with a solid body during navigation.

The experiment needs to be prepared from two points of view:

1) Specimen preparation for the test by applying a series of black dots on the tested surface using a pattern. The dots dimensions are approximately 1 mm in diameter. The surface preparation is very important because, first of all, the sensor calibration depends on it and second because the pixels distribution and the distance between them is predicted on the basis of these dots positions.

2) Sensors (the two high-speed cameras) calibration is a measuring process during which the measuring system is adjusted with the help of calibration objects. For the Aramis measuring system, two different calibration objects are used, figure 9. The biggest one is used for 2000x2000 mm specimen (model) and smaller one for 1000x1000 mm specimen. For our model it was used the calibration object. Calibration stage is very important because now is established the dimension of facets (see figure 13).

Finally, after the sensor calibration and the specimen preparation are over, the workbench looks like in figure 10.

Figure 9. Different calibration objects

Figure 10. Aramis System

3.1.1 Measurements

The dynamic load was made by a simple system made of: a spherical weight of 4.07 kg, and a rigid wire with a length of 900 mm, just in figure 11. In figure 12 is presented the back of plate case III with spherical weight and accelerometer (own designed).

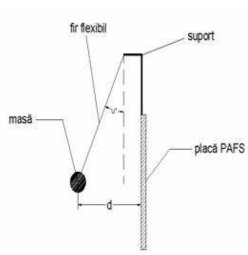


Figure 11. Simple system

Figure 12. plate case III

The three panels were stressed identically specially to point out the influence of the framing regarding the structural integrity of the plate. Two types of loads were performed for each case, depending on the "d" distance horizontally measured between the surface of the panels and the releasing point of the spherical weight. The resulted impact force (witch is necessary for numerical model) was determined each time using an accelerometer (figure 12) which was attached on the surface of the plates. The initial loading data is presented in table 3.

Table 3. The initial loading data

Plate type	Simple GRP plate	
d [mm]	200	400
u°	12.83	26.38
Impact force [N]	35.85	122.5
Impact time [s]	0.0575	0.0575
Mass [kg]	4.07	4.07
Wire length [mm]	900	900

The actual dynamic analysis consisted in the recording of the plate's behaviour before and after the impact, with the two high speed cameras. The measurement of unit deformations and the displacement on all three directions was performed analyzing the recorded data with the Aramis software system. The base of displacements calculation is presented in figure 13.

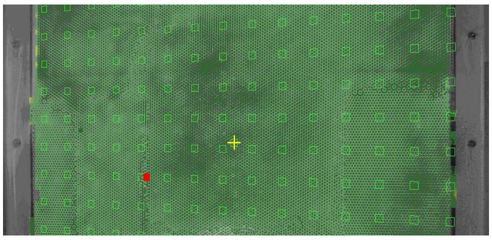
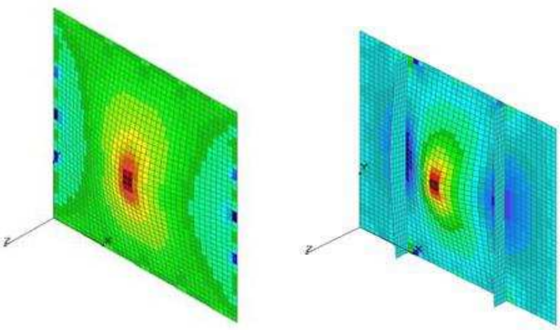


Figure 13. The Aramis base of displacements

The experiment was recorded at speed of a 400 frames/s, and the shutter time was set at one second this way the cameras recorded 400 images.

The results (Aramis give the table of displacements) that were obtained after the dynamic analysis for each loading case and for the case I, II, III are presented in the figure 14.



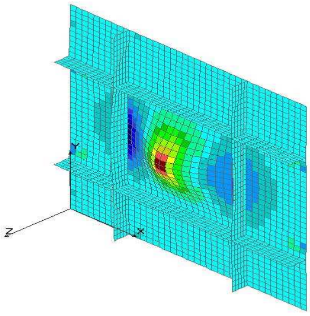


Figure 14. Displacement for case I

In figure 14 are present a parallel between the three types of plates in the moment of impact and the moment of maximum displacements.

The variation of displacements for case I, is presented in figure 15.

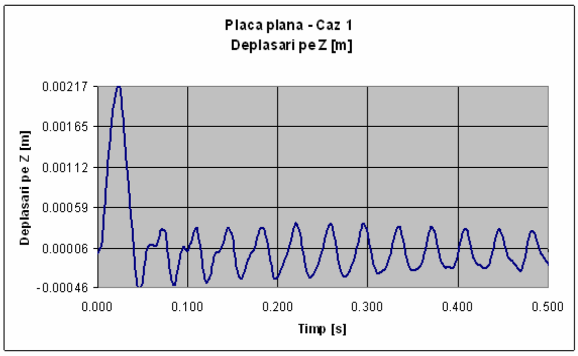


Figure 15. Chart displacement for case I

The values we obtained are very relevant regarding the purpose of this study:

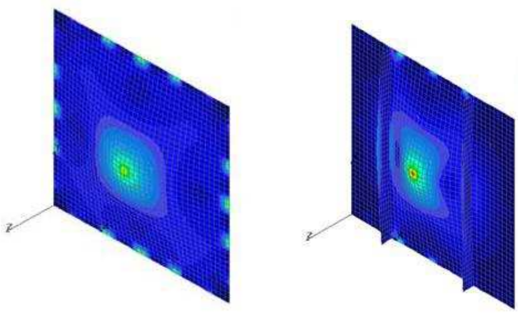
- Maximum displacement for case I is d_{max}= 7.6 mm;
- Maximum displacement for case II is d_{max}= 5.1 mm;
- Maximum displacement for the reinforced GRP plate is d_{max}= 3.7 mm.

3.2 Numerical

The mesh of the plates case I, II and III is presented in figure 8. It was used for meshed SHELL4T elements. The force was applied in middle of the plates.

Loading was applied varying in time from zero to final value in 0.5 sec, for each case. The maximum value (for d = 400 mm) of dynamic force was established using accelerometer and percussion theory.

Stress variation is presented in figure 16.



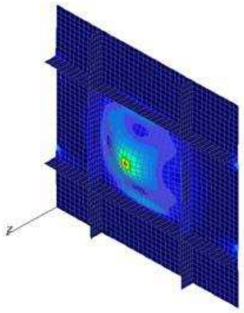


Figure 16. Displacement distributions

The values we obtained are very relevant regarding the purpose of this study:

- Maximum displacement for case I is d_{max}= 8.2 mm;
- Maximum displacement for case II is d_{max}= 5.7 mm;
- Maximum displacement for the reinforced GRP plate is d_{max}= 4.1 mm.

A comparison between the variations of displacement in case I (GRP simple plate) is presented (by overlapping), see figure 17 (a, b, c).

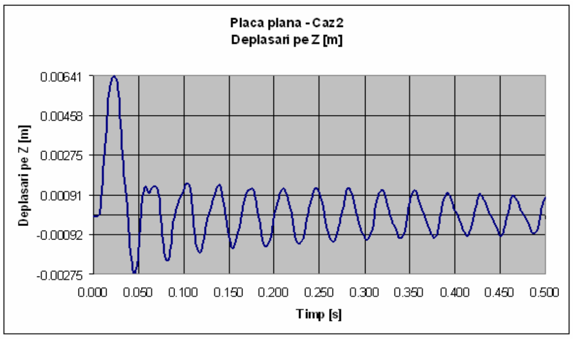


Figure 17.a Experimental displacements

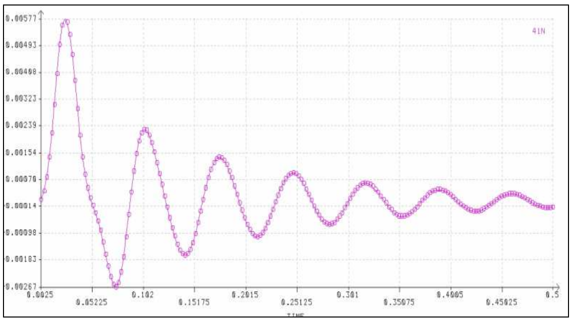


Figure 17. b FEM displacements

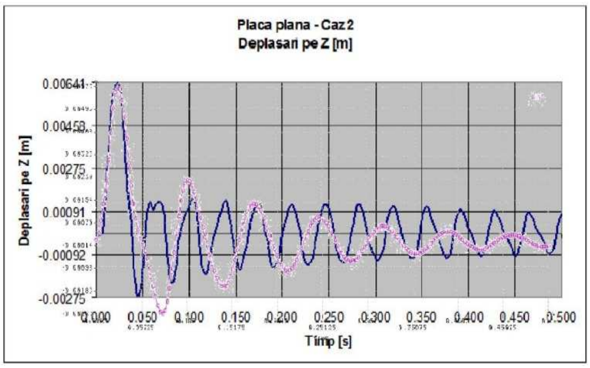


Figure 17.c. Overlapping displacement

4. CONCLUSIONS

4.1 Static analysis

The errors of almost 6% are acceptable from the point of view of a viable experiment. Differences between the experiment and the computational analysis are due to the fact that the numerical method cannot consider and analyze the GRP material as a inhomogeneous material (made from several layers).

4.2 Dynamic analysis

The results of the dynamic analysis bring forward the importance of the transversal and longitudinal framework in shipbuilding. This skeleton which is situated on the inner side of the GRP plates provides a structural strength way bigger than the structural strength of the simple GRP plates, as the following table shows:

Table 3. The results of the dynamic analysis

Panel type case	Maximum displacement for d = 400 mm (mm)		
	Experimental	Numerical	Differences (%)
I	7,6	8,2	7,3
II	5,1	5,7	10,5
III	3,7	4,1	9,7

As can be seen from Table 1, differences are appeared within 11%.

These differences can be interpreted as being due to:

- The way to account the connections to experimental and numerical modeling
- Any imperfections in the manufacturing of the panels;
- Different ways of damping the experimental model and numerical model.

The differences appear are acceptable to this type of structure.

4.3 Final conclusions

From the analysis of measured overlap displacement variation determined experimentally and numerically fig (overlapping displacement) it see that these variations are same for time of 0.05 s, that would correspond to the impact. The behavior for times greater than 0.05 seconds is different for the two modeling, causes above presented (see 4.2). The reinforcements present reduced the displacements and stresses, removing the possibility of delaminating in the case of the impact of boat with various bodies (the accosting, etc.).

The results are successfully used by manufacturers of sports boats of GRP from Romania (SPAT Galati) in their construction.

In this work paper established a method for determining the structural damping coefficient for cases I, II and III with the experimental data.

5. ACKNOWLEDGEMENTS

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A BRIEF SYNTHESIS OF NONCIRCULAR GEARS

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ABSTRACT

In applications that require variable rotational motion, noncircular gears have become a competitive alternative to cams, linkages and even electrical motors. A curiosity in old gear industry, the noncircular gears are quite popular nowadays due to developments in computational modeling and technologies. The paper is focused on a brief presentation of the noncircular gears, i.e. their output transmission functions and recent approaches for gear design and possibilities of manufacture are summarized along with the authors original contribution to the noncircular gear modeling process.

Keywords: *noncircular gears, pitch curve synthesis, teeth generation*

1. INTRODUCTION

What makes noncircular gears a simple, compact and accurate solution for applications that require predesigned variable motions is the fact that they are able to generate the same motions that cams or linkages do, but with better characteristics. In the gear industry past, the main obstacles in using noncircular gears for various applications were the difficulty and the cost of manufacture; nowadays, the latest computational software and technological developments facilitate the noncircular gear design and manufacture.

The earliest design of noncircular gears is proposed by Leonardo da Vinci in his collection "Codex Madrid I". Later, in the 17-18th century, noncircular gears are met in applications like astronomical devices, musical instruments, clockworks and other mechanical toys. At the beginning of the 20th century, noncircular gears were mentioned in technical schools, by Franz Reuleux who studied their kinematics [1].

Noncircular gears have special characteristics and purposes such as gear ratio variation and predesigned motion laws. Consequently, noncircular gears can be divided into several categories: gears with variable speed, gears with constant speed segments, gears that combine rotation with translation and gears with stop-and-dwell motion. Being of various shapes, the mating noncircular gears should respect the main geometrical condition, i.e. the constancy of the center distance.

The most common variable speed gears are the elliptical gears, in unillobal or billobal versions. Unillobal gears must be identical and they rotate around their focus, providing a variable speed ratio, a speed increase and decrease, respectively, during one gear revolution. Unillobal elliptical gears are used in manufacturing processes, like sealing heads, rotary cutoff knives and quick return mechanisms for assembly lines. Doege et al. proposed a new press concept [2] for precision forging in automotive industry using noncircular gears in the drive mechanism for improving the manufacturing quality (Fig. 1). Liu et al. improved a polishing mechanism for optical fibre by using a pair of unillobal elliptical gears (Fig. 2), driven by a pair of different noncircular gears [3]. Billobal gears known as are similar to unillobal gears, but they rotate around their geometric centre and generate a variable output speed with four periods per revolution.

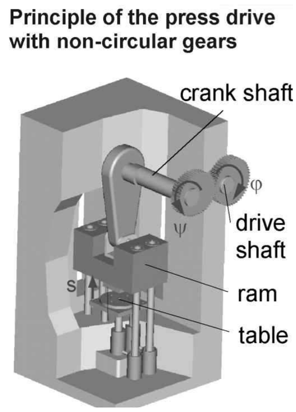


Figure 1 New press concept with noncircular gears [2]

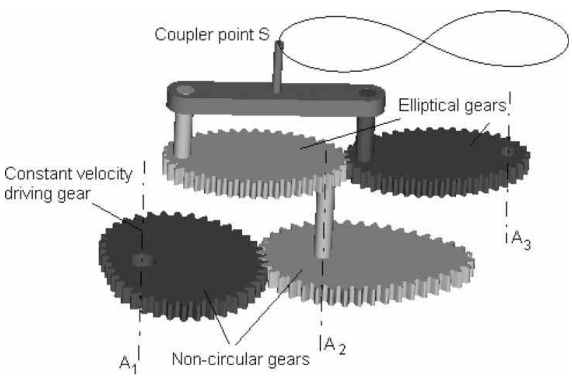


Figure 2 Polishing mechanism [3]

A particular case of billobal elliptical gears is represented by oval gears, very common in industry, used especially in flow meters (Fig. 3). Freudenstein and Chen proposed the use of oval gears in mechanical transmissions like bicycles, band drives, tape drives and timing belts [4]. Quintero et al. proposed a pair of oval gears to be used with a modified crank-slider mechanism of an internal combustion engine, intended to improve the performance of the engine by adjusting the speed of the piston [5]. Emura and Arakawa developed a way to use oval gears in a steering mechanism for turning a carrier of a small radius, idea to be implemented in the robotics industry – such as carrier robots used in the production lines [6].

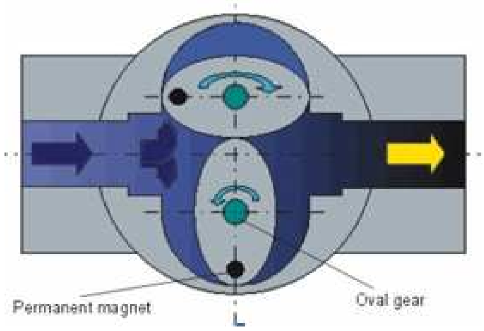


Figure 3 Flowmeter [http://burkert.com/COM/301.html]

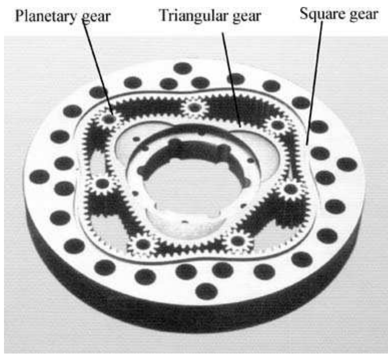


Figure 4 Hydraulic circulating engine [7]

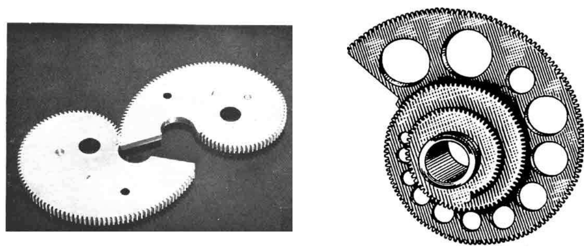
Figure 5 Stop-and-dwell mechanism [8]

Similar to the previous types of noncircular gears are the triangular ones (three-lobed gears), that generate variable output speed with six periods of increase/ decrease per revolution, and square gears (four-lobed gears) that generate eight periods of increase/decrease per revolution. These gears are used in a hydraulic circulating engine (Fig. 4).

Another category of noncircular gears is represented by multispeed gears. Created to provide constant speed segments of the output shaft, with a perfect transition between different speeds, these gears are specially shaped being able to produce a wide range of velocity and acceleration characteristics.

In order to generate a stop-and-dwell (intermittent) motion for the output shaft, noncircular gears are used in combination with circular and differential gears. An example for such a motion was proposed by Freudenstein who replaced the classical Geneva mechanism (or Maltese Cross) with a compact and accurate noncircular gears mechanism, using a combination of two pairs of gears (Fig. 5).

Beside the previous mentioned noncircular gears, there are also gears with opened centrodes (Fig. 6a), that rotate only for a portion, and twisted gears, able to perform an angle $\theta > 2\pi$ and a displacement of the axes (Fig. 6b). These gears are generally used in fine mechanics, computer devices etc.



a) b)

Figure 6 Noncircular gears with open centrodes (a) and twisted centrodes (b) [8,9]

2. PITCH CURVES SYNTHESIS

Noncircular gears modelling is a two phase process, involving: i) the modelling of the conjugate pitch curves, based on a required transmission ratio function/ displacement law or a desired geometry for the driving centrode, and ii) the generation of tooth profiles.

2.1. Pitch curves generation based on transmission ratio variation

Several approaches are reported as regards the pitch curves modelling, based on the hypothesis of transmission ratio or displacement law. Quintero et al. used Bezier (eq. 1) and B-Spline (eq. 2) nonparametric curves to design displacement laws, specific to further design of N-lobe noncircular gears [10].

$$b(u) = \sum_{i=0}^{n} b_i \frac{n!}{i!(n-i)!} u^i (1-u)^{n-i}, i = 0,...n \tag{1}$$

where the n+1 coefficients b_i are the Bezier ordinates

$$p(u) = \sum_{i=1}^{n+1} d_i \frac{u-u_i}{u_{i+k-1}-u_i} N_i^{k-1}(u) + \\ + \frac{u_{i+k}-u}{u_{i+k}-u_{i+1}} N_{i+1}^{k-1}(u) \tag{2}$$

$$k = 2,...,m, \;\; i = 1,...,(n+1+m)-k$$

$$N_i^1(u) = \begin{cases} 1, if \;\; n_i \le n \le n_{i+1} \\ 0, otherwise \end{cases}$$

where N_i^m is the polynomial basis and the n+1 coefficients di are the ordinates of the control points or Greville abscissas ξ_i:

$$\xi i = \frac{1}{m-1}(u_{i+1} + ... + u_{i+m-1})$$

u_i being the terms of a knot vector that satisfies the relation $u_i \leq u_{i+1}$.

In an application in which noncircular gears were used together with a five-bar mechanism, in order to guide a coupler point along a prescribed planar trajectory, Mundo and Gatti generated noncircular centrodes using the inverse kinematic analysis of the linkage and the Aronhold-Kennedy theorem [11]. After they had identified the configuration of the system for each segment of the prescribed path, the instantaneous centre of the relative motion between the cranks of the linkage was located and the pitch curves were thus determined.

$$\bar{\tau}(\phi_{in}) = c_1 + 2c_2\phi_{in} + 3c_3\phi_{in}^2 + 4c_4\phi_{in}^3 + 5c_5\phi_{in}^4 \qquad (3)$$
$$\phi_{in,1} \leq \phi_{in} \leq \phi_{in,2}$$

where φin is the angular position of the input gear and cj

(j = 0, …, 5) are the polynome coefficients.

Based on defined angular displacement position, Liu and Chen obtained the pitch curves of noncircular gears, using Fourier series (Eq. 4) for the angular displacement function [12].

$$m_{12}(\phi_1) = A_0 + 2\sum_{n=1}^{M} A_n \cos\left(\frac{2n\pi}{T}\phi_1\right) + \\ + 2\sum_{n=1}^{M} B_n \sin\left(\frac{2n\pi}{T}\phi_1\right) \qquad (4)$$

where A_0 = 1 and A_n, B_n are the coefficients of the Fourier series.

Litvin et al. proposed a new approach to the generation of function using a drive formed by multiple noncircular gear pairs (eq. 5) [13].

$$\psi(\alpha) = g_n(g_{n-1}(g_{n-2}(...g_1(\alpha)))) \qquad (5)$$
$$g_k(\varepsilon) \neq g_{k-1}(\alpha)$$

where each function g_k (k = 1,…, n) is generated by a pair of conjugated centrodes and α is the angle of rotation of the first centrode.

The authors determined the pitch curves starting from defined motion functions and proposed tandem designs for double-crank linkages, crank-slider linkages and Scoth-Yoke mechanisms.

2.1. Pitch curves generation based on the driving centrode geometry

Tong and Yang developed an algorithm which was used to obtain identical noncircular pitch curves with almost unlimited profile varieties and any number of lobes [14].

$$r_1(\theta_1) = f(\theta_1) \qquad (6)$$

where f is monotonically increasing function with C1 continuity and φ1+φ2=π/2 when f=l/2.

When applied to noncircular gears, the definitions of a base circle and its involute can lead to multiple interpretations and because of this, Lozzi generated base and involute curves of noncircular centrodes. After obtaining the base outlines, by fixing the pressure angle and by terminating the conjugate line, the involutes were generated using the principle of unrolling a hypothetical cord from the base outline and by tracing a point moving along the conjugate line [15]. Figliolini and Angeles followed the same direction, but they generated the base curves for both right and left involute tooth profiles, in the case of N-lobed elliptical gears, through the formulation of the pitch curves and their evolutes [16]. Using a reshaping algorithm on general monotonic functions, Yan et al. generated noncircular multilobe internal pitch curves [17]. This was done by introducing a modifier on a desirable monotonic function, in order to satisfy the kinematic relationship between the pitch curve and the number of lobes.

$$r_1(\theta_1) = \alpha\, r_{1o}(\theta_1) + (1-\alpha)l \qquad (7)$$

where α is the modifier, r_{1o} is a desired monotonic function and l is the center distance.

Andrei and Vasie generated noncircular pitch curves using the supershape equation (Eq. 8), in an attempt to generalyze the noncircular gear design [18].

$$r_1(\theta_1) = \left[\left|\frac{1}{a}\cdot\cos\frac{n\theta_1}{4}\right|^{n_2} + \left|\frac{1}{b}\cdot\sin\frac{n\theta_1}{4}\right|^{n_3}\right]^{-\frac{1}{n_1}} \qquad (8)$$

where a,b are nonzero, real numbers, that determine the length of the traditional ellipse; n – real number, that introduces a rotational symmetry. The curves are repeated on sections of the circle, corresponding to an angle $2\pi/n$. The curve is closed for both integer values of parameter n and rational values, provided that angle ϕ is extended to a multiple of 2π; n_1, n_2, n_3 – real numbers. By various combinations of the exponents, circular or rectangular, symmetrical or asymmetrical, close or open shapes are created.

3. TOOTH PROFILE GENERATION

After the pitch lines have been synthesized, the tooth profiles of the noncircular gears can be obtained either by directly cutting the gear blank with a numerically controlled machine tool or by obtaining the mathematical model/CAD model, followed by the gear manufacture. The most common tools used for the gear manufacture are the rack cutters, shapers, hobs and wire EDM. Using virtual instruments, the tooth profile could be generated by different approaches, as mentioned in literature.

3.1. Mathematical generation of tooth profile

Danieli generated noncircular gear tooth profiles, with constant pressure angle (fig 7), based on the integration of a differential equation that describes the meshing between the gear and tool centrodes [19]:

$$\frac{dy}{d\theta_1} = \cos^2(\alpha)\left[R_1(\theta_1) - \frac{dR_1}{d\theta_1}\tan(\alpha)\right] \tag{9}$$

After the mathematical model was obtained, the gears were cut using a numerically controlled milling machine. In order to increase the contact ratio, Danieli and Mundo generated tooth profiles with a new methodology that uses a constant pressure angle for any given tooth, but variable from one to the next (Fig. 8) [20]. Tooth profiles for the noncircular gears, comprising a planetary gear train (Fig. 9), were generated by Mundo with the same numerical approach used by Danieli [21]. Based on the singularities that can occur, the author investigated non-interference conditions during the generation process.

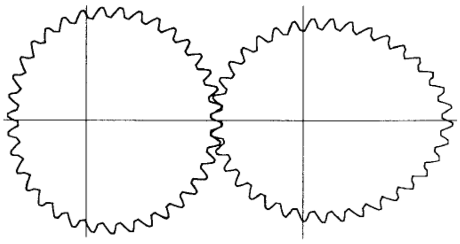


Figure 7 Noncircular gears generated by Danieli [19]

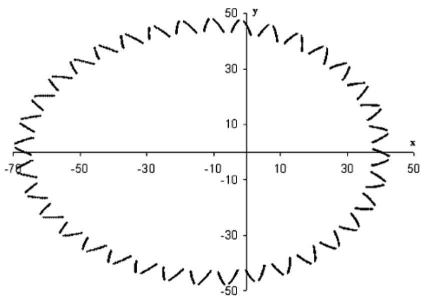


Figure 8 Noncircular gear teeth generated by Danieli and Mundo [20]

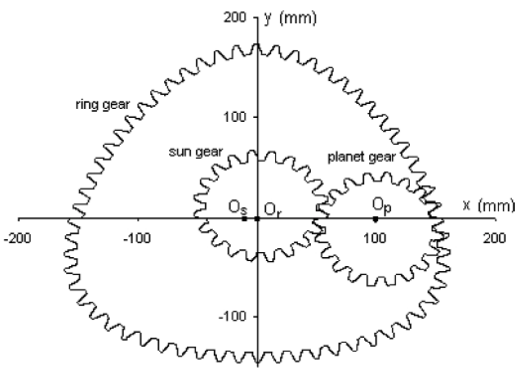


Figure 9 Noncircular gears generated by Mundo [21]

3.2. The enveloping method

The traditional method for the enveloping surfaces, also called the contact line method, is based on the pure rolling of the tool's pitch curve over the pitch curve of the gear, considering a specific kinematics; the tooth profiles are generated by the same tools used for normal gears.

Chang and Tsay generated the tooth profile using the contact line method (fig. 10) [22]. This method considers both the cutting tool locus (in this case, a shaper cutter) in the gear's coordinate system and the meshing equation. Tooth profiles of elliptical gears were generated by Bair with a generation algorithm that uses a hob cutter and meets the theory of gearing [23]. Based on the method proposed by Chang and Tsay, Figliolini and Angeles synthesized tooth profiles for elliptical gears and their rack [24]. In another study and with the same generation algorithm (but wit a rack cutter instead of a hob), Bair generated circular-arc tooth profiles for elliptical gears [25]. Tsay and Fong developed generalized equations of tooth profiles, based on the cutting process with a rack cutter (fig. 11), and imposed some design limits [26].

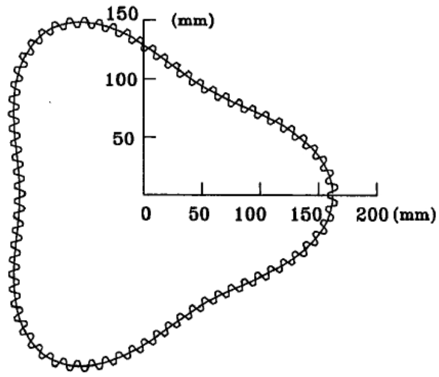


Figure 10 Noncircular gear generated by Chang and Tsay [22]

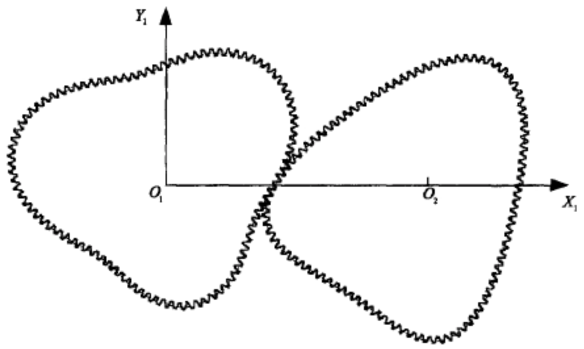


Figure 11 Noncircular gears generated by Tsay and Fong [26]

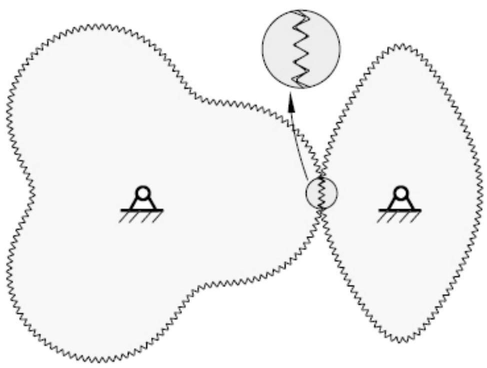
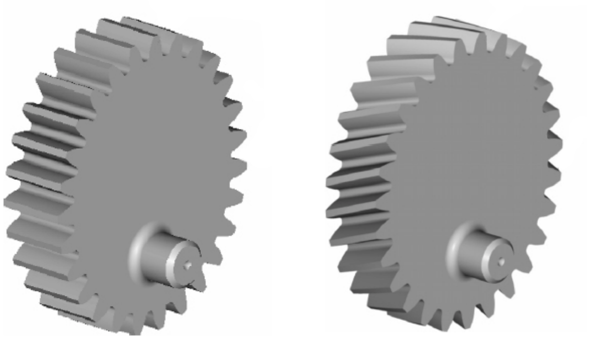


Figure 12 Noncircular gears generated by Quintero et al. [27]

Quintero et al. also used the contact line method to generate tooth profiles for noncircular gears (fig. 12)

[27]. The process was based on two conjugate rack cutters that were meshed with their conjugate gears, in such a way that all elements remained in tangency during the cutting. Litvin et al. used a matrix approach for the equation of meshing used to obtain the generated surfaces of elliptical gears (Fig. 13) by enveloping process [28].



a) b)

Figure 13 Elliptical gears with straight teeth (a) and hellical teeth (b) generated by Litvin et al. [28]

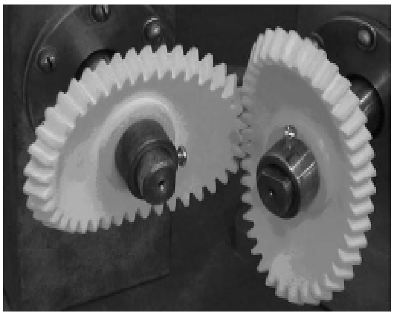


Figure 14 Noncircular gear with intersecting axes [30]

Based on the theory of gearing and on a generation algorithm, Bair et al. simulated the manufacturing process of elliptical gears by convex and concave circular-arc shaper cutters [29]. Xia et al. obtained tooth profiles of bevel noncircular gears with intersecting axes (Fig. 20), by means of geometry principles for spherical engagement [30]. Jing introduced a method that uses a pressure angle function in the angular displacement of gears for the description of the geometry and geometric characteristics of tooth profiles [31].

3.3. The simulation of the cutting process

Li et al. generated the tooth profiles of noncircular gears using a method that reproduces the real gear shaping process (fig. 15), rather than deducing and solving complicated meshing equations [7].

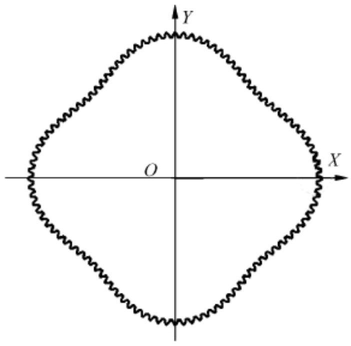


Figure 15 Noncircular gear generated by Li et al. [7]

Vasie and Andrei simulated the cutting process of the noncircular gear by rolling, using a rack cutter or a shaper for convex (Fig. 16a) and convex-concave pitch curves (Fig. 16b), respectively [32].

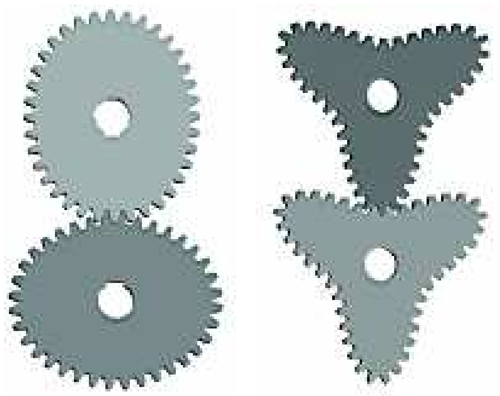


Figure 16 Noncircular gear generated by Vasie [32]

4. CONCLUSIONS

Noncircular gears are still not so popular in the gear industry. Even if it has been shown that noncircular gears are the most direct, compact and versatile solution for the applications that require a variable transmission law, there is still some inertia through the scientist, limited by the lack of a standard design. On the other hand, the development of computer-controlled machines and software enabled the scientist to developed complex studies on noncircular gears. The paper briefly introduces and recommends this special category of geared transmission to the industrial and teaching environments. Types of noncircular gears and their old or new applications are mentioned. Different approaches are summarized regarding the noncircular gear generation, i.e. pitch curves modelling and tooth profiling, according to the initial design requirements: the motion law or the gear pitch curve shape.

5. ACKNOWLEDGMENTS

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SECTION III
ELECTRONICAL ENGINEERING AND COMPUTER SCIENCE

HARMONIC CURRENTS AND THEIR EFFECTS

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ABSTRACT

Harmonic currents are generated by nonlinear loads. We refer to harmonics in power plants mainly because harmonic currents arising due to currents and most of the harm is due to these currents. You can not draw useful conclusions without knowing the current harmonic spectrum, but is usually the only factor to determine total harmonic distortion (Total harmonic distortion - THD). When harmonics propagate through the distribution system, the network edges not crossed by harmonic currents, they are royal as tensions.

Keywords: *harmonic currents, the fundamental sinusoidal, power factor correction.*

1. INTRODUCTION

1.1 Causes Harmonics

Harmonic frequencies are integer multiples of the fundamental frequency power. For a frequency of 50 Hz three harmonic will be frequency of 150 Hz and five harmonic will have frequency of 250 Hz. In Figure 1 are the fundamental and harmonic sinusoidal three and five ranking.

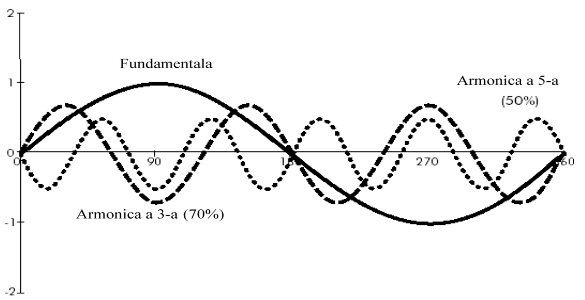

Figure 1 Fundamental harmonic with harmonics of rank three and five

Fundamental sinusoidal superimposed over the harmonic three with an amplitude of 70% of the fundamental and five harmonic with a amplitude to 50% of the fundamental is shown in Figure 2. Distorted current curve will be much more complex than the example, including many more harmonics and with different phase shift.

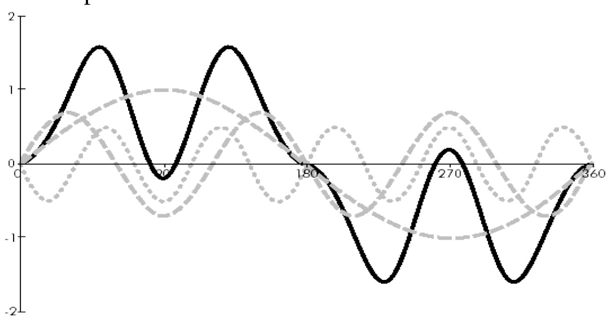

Figure 2 Curve distorted current

There are six zero crossing points over a period instead of two, so that any equipment that uses zero crossing as a reference will malfunction. Curve contains the fundamental frequencies. Harmonics in power plants means mainly because harmonic currents arising due to currents and most of the harm is due to these currents. Current harmonic spectrum should be known in order to conclude and is also useful to determine only typical total harmonic distortion factor (Total harmonic distortion - THD). When harmonics propagate through the distribution network in the sides of which are crossed by harmonic currents, it is found that tension. The values of harmonic voltages should be measured and the currents and values must be specified explicitly defined as voltages and currents. Conventionally, current distortion factor includes the suffix I, for example, 35% THDI, that includes the suffix U voltage distortion, for example, 4% THDU.

Harmonic currents are present in the electricity supply system.

They may be caused by mercury arc rectifiers used to provide AC voltage to DC conversion for track and DC drives with variable speed in the industry. But class types and number of units of equipment that produces harmonics greatly increased and will continue to grow, so we should take due account of harmonics and their effects.

Are presented as three aspects of how and why harmonics are generated, how the presence of harmonics affects power system and equipment and how to minimize these effects.

1.2. *Types of equipments that generate harmonics*

Harmonic currents are generated by nonlinear loads which include:

a) Single-phase loads:

♦ Switching power source (Switched mode power supplies − SMPS);

♦ Electronic ballasts for fluorescent lamps;

♦Small units uninterruptible power (Uninterruptible power supplies − UPS).

b) Three-phase loads:

♦ Variable speed drives;

♦ Large units UPS.

1.3 Single-phase loads

1.4 Switching power source

Buck transformer and rectifier are replaced with a direct recovery controlled power to charge a capacitor, which is DC load to obtain a suitable method to output terminals, voltage and current required value. The advantage is that the size, cost and unit weight are significantly reduced and energy can be made virtually any form factor required.

The disadvantage is that instead of continuous current source absorbs from the mains a current form of current pulses containing a large amount of harmonic three and older and high frequency harmonic components (Fig. 3).

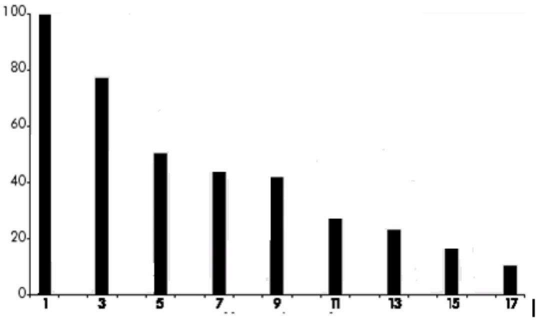

Figure 3 Harmonic spectrum of a typical personal computer

It provides an input filter to drive down high frequency components of the current phase and neutral, but it has no effect on the harmonic currents that propagate back to the supply.

For high power units are made equipments of power factor correction (Corrector Power factor - PFC) that are designed to make the supply load appears fed a resistive load so that current drawn to appear sinusoidal and in phase with applied voltage . Absorbed current can have a triangular high frequency which is then mediated through a filter to form sinusoidal input.

1.5. Electronic ballasts for fluorescent lamps

Electronic ballasts for fluorescent lamps are used to increase efficiency. They are less efficient than magnetic ballasts and the greatest results gained in the fluorescent lamp are more efficient when operated at high frequency than the electronic ballast itself.

Their main advantage is that the light level can be maintained for a longer life than the control currents of the lamp, but the practice leads to a decrease in overall efficiency.

The main disadvantage is that it generates harmonics in mains lamps called "the power factor correction" have a higher efficiency and the low power circuits are not provided with correction.

Spectrum harmonic currents generated by these lamps are shown in Figure 4. These lamps replace incandescent lamps in the household sector and particularly in hotels frequently occurring problems due to harmonics.

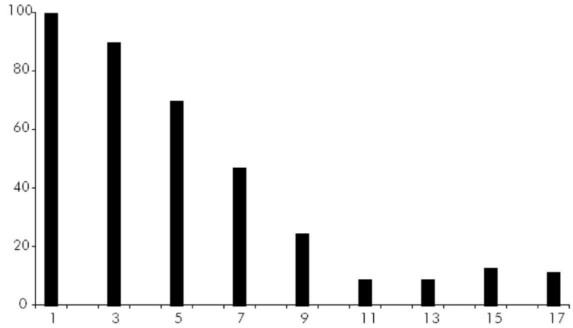

Figure 4 Harmonic spectrum of a typical compact fluorescent lamps

1.6. Three-phase loads

Variable speed drives UPS units and DC converters are typically powered by a three-phase bridge (Fig. 5), also called 6-pulse bridge because the period is six pulses (one half of the period and phase) in the current continuous output.

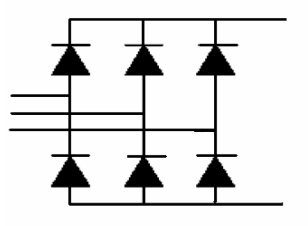

Figure 5 Three-phase bridge, or bridge with six pulses

A 6-pulse bridge generates harmonic of rank 6n ± 1, with a more or less to any multiple of 6. In theory, the amplitude of each harmonic is inversely proportional to the harmonic rank. For example 20% for five rank harmonic and 9% for eleven rank harmonic etc. Figure 6 presents a typical harmonic spectrum.

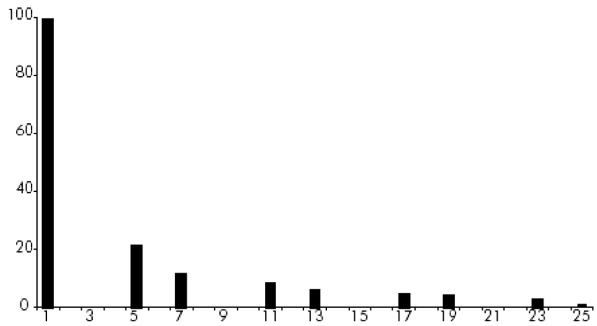

Figure 6 Spectrum of harmonics caused by a typical 6-pulse bridge

Harmonic amplitude is significantly reduced when using a bridge with 12 pulses. In fact there are two six-pulse bridges, provided from the secondary windings connected in star and delta of a transformer, causing phase shift of 30 ° between the applied voltage.

1.7. How harmonics are generated

In an ideal power system voltage waveforms and power are perfectly sinusoidal. Non-sinusoidal currents occur if the load is nonlinear in relation to the applied voltage. For a simple circuit with only linear resistive load, the inductive or capacitive current is proportional to the voltage running (at a certain frequency), so that sine voltage is applied to a sinusoidal current flow, as illustrated in Figure 7.

Load characteristic is given by the relationship between applied voltage and the current resulting in pregnancy. The case illustrated in Figure 7 corresponds to a linear load. If the circuit is a reactive element, it will cause a phase shift between voltage curve and current, power factor is low, but may still be linear circuit.

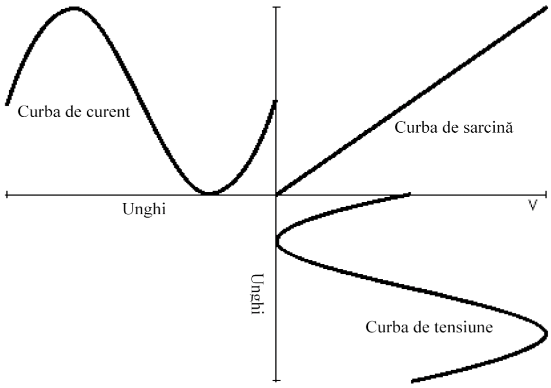

Figure 7 Power waveform in a linear load

Pregnancy consists of a rectifier and a capacitor as a typical power switching entry (SMPS). In this case, current flows only when power will exceed the voltage at the terminals of the capacitor, such point near the maximum power curve, which is observed on the load characteristic.

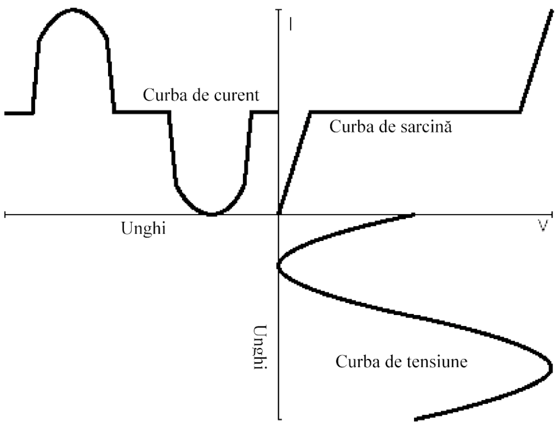

Figure 8 Electric current waveform in a nonlinear load

All regular curves can be decomposed into sinusoidal curves of the fundamental frequency sine curve plus a number of harmonic frequencies. Distorted current curve shown in Figure 8 can also be represented by the fundamental harmonic input two, input harmonic three and so on, possibly up to harmonic 13. For symmetrical curves - positive and negative semi-period the same size and same shape - even harmonic are zero. Harmonic hair are now relatively rare, they normally appear when using the old rectifier.

1.8. Effects of harmonics on transformers

Transformers are affected in two ways by harmonics. First, eddy current losses, normally representing 10% of rated load losses increase with the square harmonic rank. In practice, a transformer operating at rated load and supplying computer equipment including (IT), total losses will be twice higher than for a linear load supply. The result is a much higher temperature leading to a corresponding reduction in life. In fact, in these circumstances life is reduced from about 40 years to about 40 days. Fewer transformers are loaded to full load, but the effect should be considered when selecting plant.

The second effect refers to multiple of three rank harmonics. They occur in all phases of a transformer winding connection triangle, since they have a circular route in the windings. Currents with multiple of three rank harmonics are effectively absorbed by the wound and spread to supply, so delta wound transformers are useful as isolation transformers. Note that other harmonics, which have multiple of three rank pass through the wound. Current movement, which is closed between windings, should be taken into account when sizing the transformer.

1.9 Skin effect in conductors

AC tends to move the conductor surface. This phenomenon is known as skin effect and is more pronounced at high frequencies. Skin effect is normally ignored because it has a very low supply at nominal frequency, but over 350 Hz, namely the harmonic 7, skin effect becomes important, causing additional losses and heating. Where harmonic currents exist, designers should take into account skin effect and land cables in accordance with it. The use wire or cable rolled bars contributes to solving this problem. Assembly and installation of laminated beams must be designed so as to avoid mechanical resonance at harmonic frequencies.

1.10 Induction motors

The harmonic voltages produce in induction motors increased eddy current losses in the same manner as for transformers. Moreover, additional losses occur due to the generation of harmonic fields in the stator, each of which tends to rotate the engine with a different speed, in one sense or another. High frequency currents induced in the rotor leads to further increase of the losses.

1.11 Disturbance to the zero crossing of curves

Many electronic devices detect the point where the supply voltage passes through zero, to determine the coupling of load. This is because the coupling of a task does not generate reactive zero-voltage transients, reducing electromagnetic interference and requests that the static switches. If there are harmonics or transients in the supply, increase the number of troughs leading to failure. In fact, some troughs may be a half period.

2. CONCLUSIONS

If local transformers are installed, they should be chosen with an internal impedance low enough and with sufficient capacity to exhaust extra heat, an oversized transformer properly.

It is not recommended choosing a transformer whose capacity increase is achieved through forced ventilation because high temperatures will persist in the machinery, reducing the duration of life. Forced cooling is indicated only for backup systems (intervention) and will not ever be used in normal operating. Where the harmonic voltage motors are, they must be downloaded to take account of additional losses.

When a harmonic current is absorbed from the power supply, it causes a voltage drop proportional to the harmonic source impedance point of common coupling (PCC) and current. As the main is usually inductive, there will be higher impedance at higher frequencies. Voltage at the PCC is distorted by harmonic currents produced by other consumers and the distortion inherent in transformers and each contributes to additional customer.

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THE INFLUENCE OF DUCTS VENTILATION ON THE DISTRIBUTION OF AIR GAP MAGNETIC FLUX DENSITY AT ELECTRIC MACHINES

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ABSTRACT

For high performance operation (high efficiency, low loss, stability, instauration, etc.), usually in electric machines is necessary to obtain first of all an optimal distribution of magnetic flux density in various parts of machine. Actual construction of the machine requires inevitably some important constructive interventions which will first effect of distorting the magnetic field: slots, yoke, ventilation ducts, etc. This work paper presents the influence of ventilation ducts on the air gap magnetic flux density computed with Schwartz-Christoffel mapping. The knowledge of this aspect is an important one because it intervenes decisive in the design stage when are establish the sheets packages length with immediate consequences on the determination of the main geometric dimensions, and heat transfer that determines the lifetime of the machine.

Keywords: *ventilation ducts, Schwartz –Christoffel mapping, air gap magnetic flux density*

1. INTRODUCTION

AC electric machines are found today in various sectors as: power generation (conventional and the unconventional plants), industrial electric drives, special applications, etc. Machine design is made in accordance with specific application in which will be integrated [4], through design theme are imposed specific data (rated power, rated frequency, number of pairs of poles / speed etc.), and additional data depending on the nature of the application in which the machine will be integrated.

Energy transfer between both armatures (stator and rotor) is accomplished through the electromagnetic field [8]. The physics support of current and voltage are electric windings, while for electromagnetic field is ferromagnetic core. An integrated design must take into account that the electric machine is a complex physical system as: electromagnetic, mechanical, thermal, acoustic, etc. Life of the machine is mainly related to the choice of optimal heat transfer rates that are registered in vital machine parts (windings, core, insulation, etc.) in order to maintain acceptable temperature [9]. For this reason it is necessary to perform ventilation ducts for heat removal [11].

In the case of conventional electrical machines, air gap magnetic induction in important both for the quality of energy accumulated at air gap level (through spatial and temporal distribution) and for distribution analyze of air gap flux density in specific different parts of machine (so the distribution of magnetic voltage, accounted through saturation factor). For this reason, in many tests (electrical, magnetical, thermal, etc) air gap magnetic flux density is considered a reference feature measure.

Air gap magnetic flux density knowledge behaves an immediately practical and theoretical aspect. Therefore, in research and industrial problems, it is abundantly important to determine the real causes which influence it, in order to take steps to priori eliminate these drawbacks since the design phase of machine [4]. Since the electric machine is a complex multi physics system, there must be taken into account a large number of practical considerations: sheet parameters (quality - by specific losses, thickness and insulation), the nature of heat cooling (air, etc.) etc.

2. ANALYTICAL DETERMINATION OF REDUCTION FACTORS OF AIR GAP MAGNETIC FLUX DENSITY

In order to ensure proper ventilation, conventional electric machines are providing with ventilation ducts to eliminate the overheating which is registered in various parts of the machine [9]. This are usually divided into several categories compared with their position against the magnetic flux path (which radial is considered a reference one) radial, axial, mixed, moved ducts, etc. In this paper is considerate the case of most often encountered in practice, the radial ducts one. A longitudinal section of an isotropic machine (stator and rotor reactance of both axes are equal) was presented in Fig. 1.

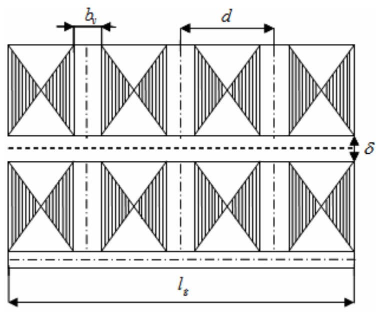

Figure 1. Longitudinal section through an electric machine

Thus, have been revealed a some significant geometric dimensions which must be established in the starting procedure of machine design : l_g - geometric length of the stator (depending on the rated power and factor architecture factor, respectively, on ventilation ducts through their number and width), δ - machine air gap (usually dependent on machine rated power, b_v - ventilation ducts width (in current practice especially at

10 and 15$[mm]$). Sheets were divided into packets of laminations which are insulated each other by various insulating materials (paper, lacquer, ceramics, etc.).

The algorithm to determine the influence of ventilation ducts based on Schwartz-Christoffel mapping [5] follows the same steps as the one used for the determining of Carter factor [6].

Note that a line taken from the middle of air gap is an equipotential line.

In Fig. 2 is considered a mid-air gap on the developed framework and comprising a ventilation duct, which was attached to the plane z

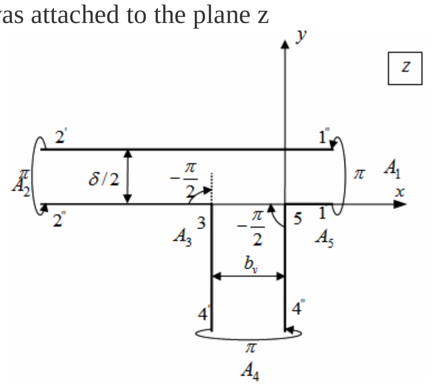

Figure 2. The outline plan $\underline{z}$

Applying Schwartz-Christoffel mapping the plan $\underline{z}$ (figure 2) will be conformal transformed according to plan $\underline{\zeta}$ (fig. 3).

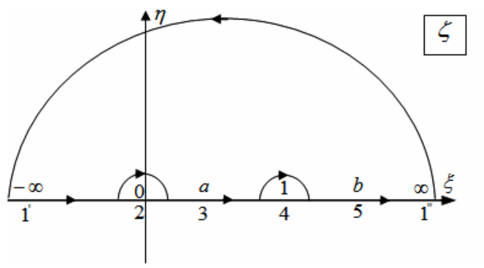

Figure 3. The outline plan $\underline{\zeta}$

Correspondence between the two plans is presented on table 1. Also here were presented the angles too necessary for transformation.

Table 1. Correspondence between planes $\underline{z}$ and $\underline{\zeta}$

A_k	z_k	θ_k	ζ_k
A_1	∞	π	$\pm\infty$
A_2	$-\infty + j\delta/2$	π	0
A_3	$-b_v$	$-\pi/2$	a
A_4	$-b_v - j\infty$	π	1
A_5	0	$-\pi/2$	b

where zero magnetic potential was assigned for equipotential lines drawen by the middle of air gap (point 2), and one for the value of point 4 (bottom ventilation duct).

Analytical expression of Schwartz-Cristoffel mapping is given by:

$$z = \underline{A}\int(\underline{\zeta}-0)^{-1}(\underline{\zeta}-a)^{\frac{1}{2}}(\underline{\zeta}-1)^{-1}(\underline{\zeta}-b)^{\frac{1}{2}}d\zeta + \underline{B} \quad (1)$$

In the order to determine the constant of integration, a correspondence between positions in both plans in point 1 is made :

$$d_1 = j\pi\underline{A};\ j\frac{\delta}{2} = j\pi\underline{A} \quad (2)$$

Hence, the complex constant value is:

$$\underline{A} = \frac{\delta}{2\pi} \quad (3)$$

The dependencies between positions of points a and b become:

$$-j\frac{\delta}{2} = -j\pi A\frac{\sqrt{(0-a)(0-b)}}{0-1} \quad (4)$$

It results the from:

$$\sqrt{ab} = -2;\ ab = 4 \quad (5)$$

Equation transformation is:

$$\underline{z} = \frac{\delta}{2\pi}\int\frac{\sqrt{(\underline{\zeta}-a)(\underline{\zeta}-b)}}{\underline{\zeta}}d\underline{\zeta} + \underline{B} \quad (6)$$

By elementary calculations is obtain:

$$\underline{z} = \frac{\delta}{2\pi}(2\ln\frac{\sqrt{b\underline{\zeta}-b^2}+\sqrt{b\underline{\zeta}-1}}{\sqrt{b\underline{\zeta}-b^2}+b\sqrt{b\underline{\zeta}-1}} + \ldots$$

$$\ldots\ln(b\underline{\zeta}) - 2\frac{b-1}{\sqrt{b}}arctg\sqrt{\frac{\underline{\zeta}-b}{b\underline{\zeta}-1}} + \underline{B} \quad (7)$$

Because the point 5 $\underline{z}_5 = 0$ leads to $\underline{\zeta}_5 = a$ is obtain:

$$\underline{B} = 0 \quad (8)$$

And the point 5 $\underline{z}_5 = 0$ leads to $\underline{\zeta}_5 = a$, result:

$$\frac{b-1}{\sqrt{b}} = \frac{2b_v}{\delta} \quad (9)$$

Because the side $1'' - 2'$ is assigned with value zero of potential, the potential complex will be now determinate the relationship [10]:

$$\underline{W} = \frac{j}{\pi} V_m \ln \frac{1}{\underline{\zeta}} \tag{10}$$

It results the from:

$$\underline{\zeta} = e^{j\frac{\pi \underline{W}}{V_m}} \tag{11}$$

Complex conjugated air gap magnetic flux density is determined by relationship:

$$\underline{B}^* = -\mu_0 \frac{d\underline{W}}{d\underline{z}} = -\mu_0 \frac{d\underline{W}}{d\underline{\zeta}} \cdot \frac{d\underline{\zeta}}{d\underline{z}} \tag{12}$$

where:

$$\frac{d\underline{W}}{d\underline{z}} = -\frac{j}{\pi} \cdot \frac{V_m}{\underline{\zeta}} \tag{13}$$

$$\frac{d\underline{z}}{d\underline{\zeta}} = \frac{\delta}{2\pi} \cdot \frac{\sqrt{(\underline{\zeta}-a)(\underline{\zeta}-b)}}{\underline{\zeta}(\underline{\zeta}-1)} \tag{14}$$

Complex air gap magnetic flux density, become:

$$\underline{B} = j\mu_0 \frac{2V_m}{\delta} \cdot \frac{\underline{\zeta}-1}{\sqrt{(\underline{\zeta}-a)(\underline{\zeta}-b)}} \tag{15}$$

Maximal induction is obtained in point 2, which is founded at an infinite distance from the duct that which distorts the field:

$$\underline{B}_m = j\mu_0 \frac{V_m}{\delta} \cdot \frac{\underline{\zeta}-1}{\sqrt{(\underline{\zeta}-a)(\underline{\zeta}-b)}} \tag{16}$$

The complex reduction factor is defined by:

$$\underline{f} = \frac{\underline{B}}{\underline{B}_m} = \frac{\underline{\zeta}-1}{\sqrt{(\underline{\zeta}-a)(\underline{\zeta}-b)}} \tag{17}$$

Its minimum point is found in a extreme one:

$$\frac{d\underline{f}}{d\underline{\zeta}} = -\frac{(b-1)^2}{2b} \cdot \frac{\underline{\zeta}-1}{[(\underline{\zeta}-a)(\underline{\zeta}-b)]^{3/2}} = 0 \tag{18}$$

which is obtained $\underline{\zeta} = -1$

Minimum factor is:

$$\underline{f}_{\min} = \frac{\underline{B}_{\min}}{\underline{B}_m} = \frac{1}{\sqrt{\left(\frac{b}{2\delta}\right)^2 + 1}} \tag{19}$$

Reduction of flux per unit of length in machine is determining the relationship:

$$\Delta\phi = \int_{-\infty}^{\infty} (B_m - B)dx = B_m \int_{-\infty}^{\infty} (1 - f)dx \tag{20}$$

A specific factor λ is defined by:

$$\lambda = \frac{\Delta\phi}{b_m B_m} = \frac{2}{\pi}\left(arctg\frac{d}{\delta} - \frac{\delta}{2d}\ln\left(1 + \left(\frac{b_v}{\delta}\right)^2\right)\right) \tag{21}$$

Finally, the reduction factor of air gap magnetic flux density is determined by relationship:

$$k_v = \frac{d}{d - \lambda b_v} \tag{22}$$

3. COMPUTATION OF REDUCTION FACTOR DEPENDING ON THE QUALITY AND NATURE OF PLATE COOLANT

Electric machines with radial ventilation ducts have laminations core divided into packets. Packages are composed of sheets from various thicknesses, isolated with different insulating materials (usually paper or lake) in order to reduce eddy current losses.

The ratio l/l_0 between length of a package of some laminations l and reference package length l_0 ($p_{10} = 3[W/kg]$, thickness $0.5[mm]$ and cooled with H_2), is presented in tabel 2 [12].

Table 2. Ratio l/l_0 [12]

Sheet thickness $[mm]$			0.5		0.35		
insulation	Sort tabla	p_{10} $[W/kg]$	3	2.3	1.7	1.3	1.0
Paper $\Delta_i = 0.03mm$		air	1	1.13	1.29	1.28	1.43
		H_2	1.11	1.25	1.44	1.43	1.59
lacquer $\Delta_i = 0.03mm$		air	1.38	1.56	1.75	1.74	1.95
		H_2	1.75	1.96	2.19	2.18	2.37

Considering an electric machine with both armatures slotted (induction machine), which will have an air gap of $\delta = 0.5[cm]$ and a length of stator laminations at $l_0 = 100[mm]$ - which will be considered by reference.

The other packet lengths are presented in table 3.

Table 3. Laminations packet lengths

Sheet thickness $[mm]$			0.5		0.35		
insulation	Sort table	p_{10} $[W/kg]$	3	2.3	1.7	1.3	1.0
Paper $\Delta_i = 0.03mm$		air	100	113	129	128	143
		H_2	111	125	144	143	159
Lac $\Delta_i = 0.03mm$		air	138	156	175	174	195
		H_2	175	196	219	218	237

From technological reasons, the radial ventilation ducts and not moved are executed in two variants: with width $b_v = 10[mm]$ and $b_v = 15[mm]$.

For the first case ($b_v = 10[mm]$), the factor λ is presented in table 4.

Table 4. Factor λ for $b_v = 10[mm]$

Sheet thickness $[mm]$			0.5		0.35		
Insulation	Sheet sort	p_{10} $[W/kg]$	3	2.3	1.7	1.3	1.0
Paper $\Delta_i = 0.03mm$		air	0.1106	0.0989	0.0875	0.0882	0.0795
		H_2	0.1006	0.0901	0.0790	0.0795	0.0720
Lacquer $\Delta_i = 0.03mm$		air	0.0822	0.0733	0.0658	0.0661	0.0594
		H_2	0.0658	0.0591	0.0531	0.0534	0.0493

The reduction factor is this case become:

Table 5. Factor k_v for $b_v = 10[mm]$

Sheet thickness $[mm]$			0.5		0.35		
Insulation	Sheet sort	p_{10} $[W/kg]$	3	2.3	1.7	1.3	1.0
Paper $\Delta_i = 0.03mm$		air	1.0102	1.0081	1.0063	1.0064	1.0052
		H_2	1.0139	1.0112	1.0086	1.0087	1.0043
Lacquer $\Delta_i = 0.03mm$		air	1.0093	1.0074	1.0059	1.0060	1.0029
		H_2	1.0036	1.0029	1.0023	1.0023	1.0020

Repeating the analysis for $b_v = 15[mm]$ we have:

Table 6. Factor λ for $b_v = 15[mm]$

Sheet thickness $[mm]$			0.5		0.35		
insulation	Sort table	p_{10} $[W/kg]$	3	2.3	1.7	1.3	1.0
Paper $\Delta_i = 0.03mm$		air	0.1387	0.1246	0.1108	0.1116	0.1010
		H_2	0.1266	0.1139	0.1003	0.1010	0.0917
Lacquer $\Delta_i = 0.03mm$		air	0.1043	0.0933	0.0840	0.0844	0.0760
		H_2	0.0840	0.0756	0.0682	0.0685	0.0633

Table 7. Factor k_v for $b_v = 15[mm]$

Sheet thickness $[mm]$			0.5		0.35		
insulation	Sort table	p_{10} $[W/kg]$	3	2.3	1.7	1.3	1.0
Paper $\Delta_i = 0.03mm$		air	1.0184	1.0148	1.0117	1.0118	1.0097
		H_2	1.0153	1.0124	1.0096	1.0097	1.0080
Lacquer $\Delta_i = 0.03mm$		air	1.0153	1.0124	1.0059	1.0060	1.0055
		H_2	1.0067	1.0054	1.0044	1.0044	1.0038

In terms of the air gap induction machine, it is desirable to obtain biggest lengths sheet packet for reduction factor k_v at a smallest value (1.0020 for ducts with width $10[mm]$, respectively 1.0038 for ducts with width $20[mm]$) for sheet with thickness $0.35[mm]$ and active power specific losses $p_{10} = 1.0[W/kg]$. But in practical terms (technological one) is the agreed the version with minimal length, that is corresponding of reference sheet package. Often, can be opt for a compromise solution based on specific application in that the machine will be integrated.

4. CONCLUSIONS

The analytic factor of radial ventilation ducts influence on the air-gap magnetic induction computed with Schwartz-Christoffel mapping has been determinate.

Based on recommendations of literature survey, the reduction of air gap magnetic induction flux density factor in machine was determined taking into account both the cooling medium used (air, respectively, hydrogen) and the nature of tooth insulation sheets for various types of metal (various qualities and thicknesses). The most convenient reduction factor is obtained for the longest sheet package, but there arise achievement technological difficulties, respectively, the design of the cooling system. In the current design phase, when the main geometric dimensions of the machine are establish, there must be take into account the distorting effects of ventilation ducts.

Therefore, through an adequate analysis the conditions of ventilation, respectively, the air gap magnetic induction flux density deformation can be simultaneously fulfilled, which will achieve a harmonious operation of the machine.

5. ACKNOWLEDGMENTS

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BRIDGE OSCILLATOR WITH CURRENT CONVEYORS AND CURRENT SOURCE ORDERED IN VOLTAGE

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ABSTRACT

The paper proposes two circuits of oscillators made with current conveyors, a simple method of determining the oscillation frequency and of the relation that must exist between the passive elements of the network for the generation and maintaining of sinusoidal oscillation.

Keywords: *Oscillator, current-conveyor, current-voltage converter.*

1. INTRODUCTION

If we have a network with two useful outputs, the structure of the oscillator which I suggest it to be realised is formed out of a basic amplifier and a network for which the control of the network is done in the current and the one of the amplifier in the voltage. The paper presents a simple method of analysis of these types of oscillators

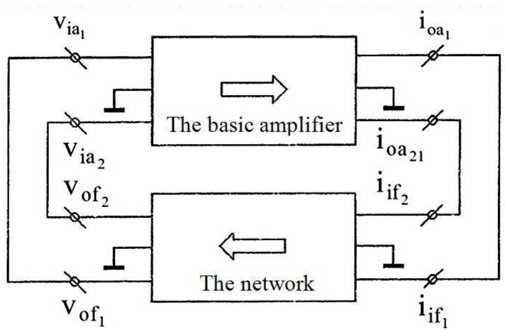

Figure 1 Bridge oscillator with the basic amplifier of the current source type ordered in voltage.

2. MODELS FOR THE AMPLIFIER AND THE NETWORK

If we consider the structure of an oscillator like the one represented in Fig. 1, the models for the basic amplifier and feedback network are the ones from Figure 2 for which the relation of definition of the models are provided in the equations below (1) out of which results the system of equations (2).

$$\begin{cases} v_{ia_1} = v_{of_1} \\ v_{ia_2} = v_{of_2} \\ i_{oa_1} + i_{if_1} = 0 \\ i_{oa_2} + i_{if_2} = 0 \end{cases} \tag{1}$$

$$\begin{cases} Y_{T_{11}} \cdot v_{ia_1} + Y_{T_{12}} \cdot v_{ia_2} - i_{oa_1} + 0 = 0 \\ Y_{T_{21}} \cdot v_{ia_1} + Y_{T_{22}} \cdot v_{ia_2} + 0 - i_{oa_2} = 0 \\ v_{ia_1} + 0 + Z_{T_{11}} \cdot i_{oa_1} + Z_{T_{12}} \cdot i_{oa_2} = 0 \\ 0 + v_{ia_2} + Z_{T_{21}} \cdot i_{oa_1} + Z_{T_{22}} \cdot i_{oa_2} = 0 \end{cases} \tag{2}$$

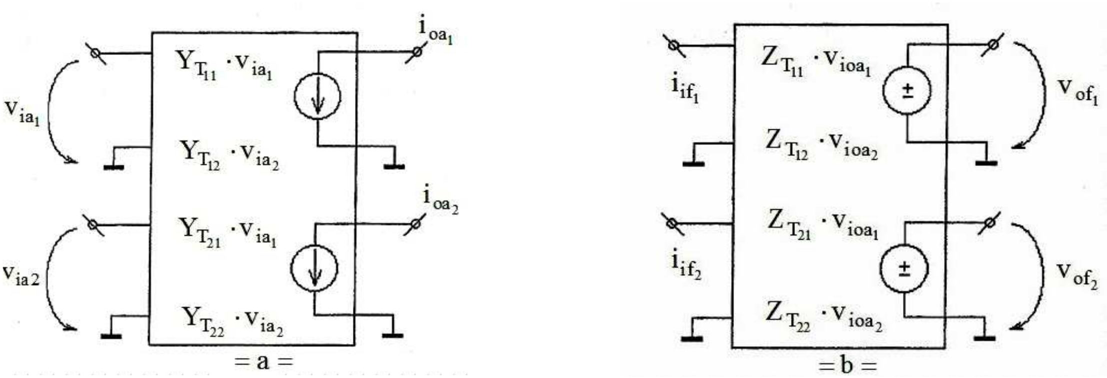

Figure 2 a) The model of the basic amplifier, b) The model of the network

The oscillation condition obtained out of the condition that the system has a different solution than the null one generates relation (3)

$$\det\begin{bmatrix} Y_{T_{11}} & Y_{T_{12}} & -1 & 0 \\ Y_{T_{21}} & Y_{T_{22}} & 0 & -1 \\ 1 & 0 & Z_{T_{11}} & Z_{T_{12}} \\ 0 & 1 & Z_{T_{21}} & Z_{T_{22}} \end{bmatrix} = 0 \tag{3}$$

Which in the case of the network with separate arms for the network and of the symmetric amplifier becomes (4)

$$Z_{T_{11}} \cdot Z_{T_{22}} \cdot \left(Y_{T_{11}}^2 - Y_{T_{21}}^2\right) + Y_{T_{11}}\left(Z_{T_{11}} - Z_{T_{22}}\right) + 1 = 0 \quad (4)$$

3. THE BUILDING OF THE OSCILLATOR WITH CURRENT-CONVEYOR CONVERTER

The current-voltage converter with current-conveyors looks like in Figure 3. Due to the repeated effect in voltage on the X input it can be noticed that the voltage between the Y inputs of the two current conveyors can be found on the R_1 resistance, through the current flows:

$$i_1 = \frac{v_{in}}{R_1} \quad (5)$$

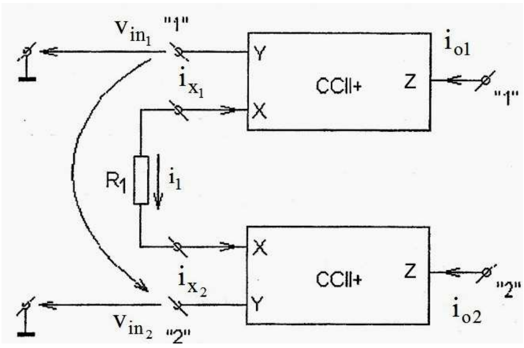

Figure 3 Current-voltage converter realized with current-conveyors

Because $v_{in} = -v_{22}$, and considering that $i_{X_1} = -i_1$ and $i_{X_2} = i_1$, it results in the output of each of the current-conveyors.

$$i_{01}^{'} = -\frac{v_i}{R_1},\ i_{02}^{'} = \frac{v_i}{R_1} \quad (6)$$

and the output currents obtained through linking the conveyors as in Figure 3 are provided by the relations (7)

$$\begin{cases} i_{o_1} = -\dfrac{1}{R_1} \cdot v_{i_1} + \dfrac{1}{R_1} \cdot v_{i_2} \\ i_{o_2} = \dfrac{1}{R_1} \cdot v_{i_1} - \dfrac{1}{R_1} \cdot v_{i_2} \end{cases} \quad (7)$$

by which through identification with the model previously presented determines the admittances

$$Y_{T_{11}} = -\frac{1}{R_1},\ Y_{T_{12}} = \frac{1}{R_1} \quad (8)$$

$$Y_{T_{21}} = \frac{1}{R_1},\ Y_{T_{22}} = -\frac{1}{R_1} \quad (9)$$

Then the linking relation between impedances becomes:

$$1 + \frac{1}{R_1} \cdot \left(-Z_{T_{11}} + Z_{T_{22}}\right) = 0 \quad (10)$$

In the case of the oscillator from Figure 4, an oscillator with a network with independent branches, the value of the pulsation of oscillation and of the relation between passive elements which provide the amplification necessary to produce the oscillation, it is thus determined

$$R_{24} = \frac{R_2 \cdot R_4}{R_2 + R_3 + R_4},$$
$$Z_{13} = \frac{R \cdot R}{R + R + \dfrac{1-\omega^2 LC}{j\omega C}} = \frac{j\omega CR}{(1-\omega^2 LC) + 2j\omega CR} \quad (11)$$

R_{24} and Z_{13} were written by applying the conversion relations star-triangle for each of the independent branches, the purely resistive one, as well as the one which covers a side of LC series circuit type.

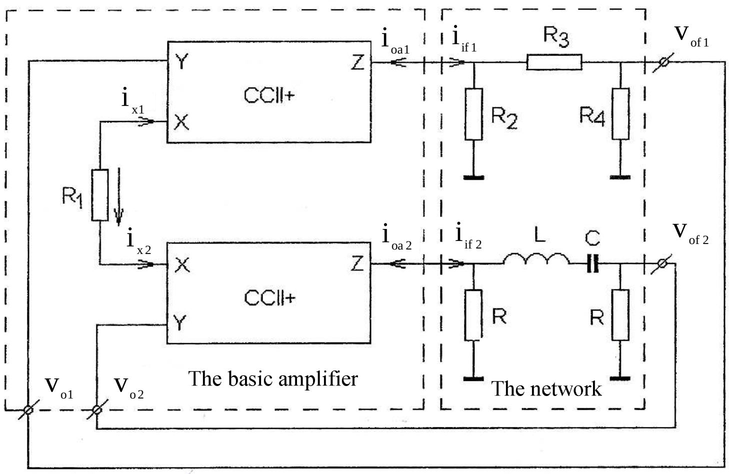

Figure 4 The oscillator with independent branches R

The output voltages for the two branches of the network are given by system (12) out of which we deduce the values of $Z_{T_{11}}$ and $Z_{T_{22}}$ by identification with the definition relations:

$$\begin{cases} v_{of_1} = \dfrac{R_2 \cdot R_1}{R_2 + R_3 + R_4} \cdot i_{if_1} \\ v_{of_2} = \dfrac{j\omega CR^2}{(1-\omega^2 LC) + 2j\omega CR} \cdot i_{if_2} \end{cases} \quad (12)$$

out of which we deduce the values of $Z_{T_{11}}, Z_{T_{22}}$ by identification with the definition relations

$$1 + \frac{1}{R_1} \cdot \left(\frac{j\omega CR^2}{(1-\omega^2 LC) + 2j\omega CR} - \frac{R_2 R_4}{R_2 + R_3 + R_4} \right) = 0 \quad (13)$$

Performing the calculations and separing the real parts and the imaginary ones we obtain:

$$\begin{aligned} &R_1(1-\omega^2 LC) \cdot [R_1(R_2 + R_3 + R_4) - R_2 R_4] + \\ &j\omega CRR_1 \cdot [2R_1 \cdot (R_2 + R_3 + R_4) - 2R_2 R_4 + \\ &+ R(R_2 + R_3 + R_4)] = 0 \end{aligned} \quad (14)$$

$$1 - \omega^2 LC = 0, \ \omega_{osc}^2 = \frac{1}{LC} \quad (15)$$

ω_{osc} represents the pulsation of oscillation with the help of which we compute the oscillation frequency $f_{osc} = \dfrac{\omega_{osc}}{2\pi}$. Equaling with zero the imaginary part of the (14) relation we obtain:

$$R_1(1-\omega^2 LC) \cdot [R_1(R_2 + R_3 + R_4) - R_2 R_2] = 0 \quad (16)$$

$$\begin{aligned} &2R_1 R_2 \left(1 + \frac{R_3 + R_4}{R_2}\right) - R_2 R_4 + \\ &+ RR_2 \left(1 + \frac{R_3 + R_4}{R_2}\right) = 0 \end{aligned} \quad (17)$$

$$\left(1 + \frac{R_3 + R_4}{R_2}\right) \cdot (2R_1 R_2 + RR_2) - 2R_2 R_4 = 0 \quad (18)$$

$$\left(1 + \frac{R_3 + R_4}{R_2}\right) \cdot (2R_1 + R) - 2R_4 = 0 \quad (19)$$

$$2R_1 \left(1 + \frac{R}{2R_1}\right) \cdot \left(1 + \frac{R_3 + R_4}{R_2}\right) = 2R_4 \quad (20)$$

Relation (20) represents the link between the passive elements of the circuit, necessary for the generation and the maintaining of the sinusoidal oscillation.

Should the branches of the network be identical, one can only obtain a parasitic oscillation as a result of the pole represented by the current-conveyors that is in control of terminal Y.

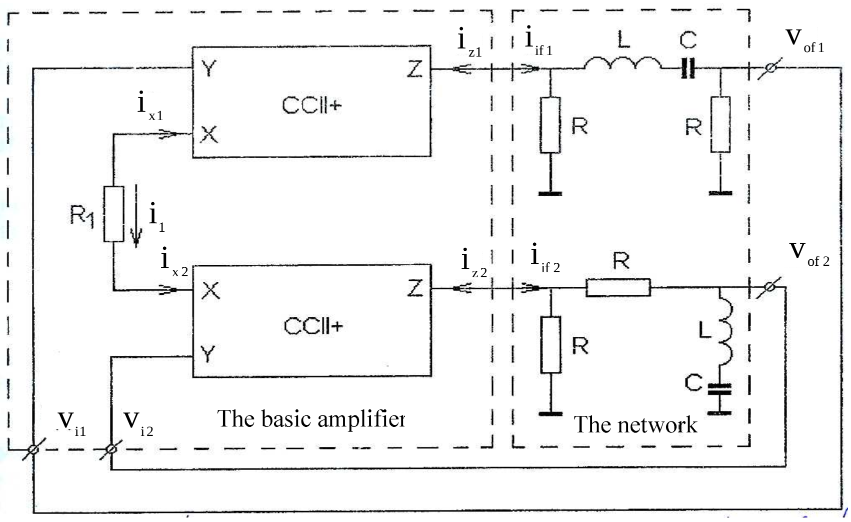

Figure 5 The oscillator with independent branches LC

In the case of the oscillator from Figure 5, $Z_{T_{11}}$ and $Z_{T_{22}}$ becomes

$$Z_{T_{11}} = \frac{j\omega CR^2}{(1-\omega^2 LC) + 2j\omega CR} \quad (21)$$

$$Z_{T_{22}} = \frac{R(1-\omega^2 LC)}{(1-\omega^2 LC) + 2j\omega CR} \quad (22)$$

and the oscillation condition obtained is:

$$1+\frac{1}{R}\left[-\frac{j\omega CR^2}{(1-\omega^2 LC)+2j\omega CR}+\right.$$
$$\left.+\frac{R(1-\omega^2 LC)}{(1-\omega^2 LC)+2j\omega CR}\right]=0 \quad (23)$$

After performing the calculus and separating the imaginary and real components, we get the pulsation oscillation as well as the relation between the passive components that is needed to produce and maintain the sinusoidal oscillation.

$$R_1(1-\omega^2 LC)+2j\omega CRR_1-j\omega CR^2+$$
$$+R(1-\omega^2 LC)=0 \quad (24)$$

$$(1-\omega^2 LC)\cdot(R_1+R)+j\omega CR(2R_1-R)=0 \quad (25)$$

$$1-\omega^2 LC=0 \quad , \omega_{osc}=\frac{1}{\sqrt{LC}} \quad (26)$$

$$2R_1-R=0\text{, } R=2R_1 \quad (27)$$

4. CONCLUSIONS

The proposed method for the analysis of oscillators may consider the limitations of the devices and makes no use of the interruption of the feedback loops. This way we can say that the method is simple and precise.

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FACTOR IDENTIFICATION OF ROMANIAN PHYSICIAN MIGRATION. COMPARATIVE ANALYSIS

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ABSTRACT

The way in which working, or having a job in today's society is seen tells a lot about it, and about the people it includes. Generally speaking, Romanians, but also people from other countries see work as a defining component**Error! Reference source not found.**. Exactly from that need to work and live a decent life it has been observed that the physician migration phenomenon in Romania has escalated, with remarkable performance from the number of people involved, from their results and methods of migration. The present study, which are based to the comparative analysis, it propose to identify the reasons of the physician emigration and to find the modality to stop that.

Keywords: - *migration, globalization, physicians, analysis, identification, factors*

1. INTRODUCTION

The globalization, as an ongoing process during the last two decades, has led to a powerful dilution of the territorial borders concept and to the continuous increase of Romanian mobility, expressed through the expansion of their relocation possibilities [1]. Commonly defined as migration, this process has become increasingly considered during these last years as a way to achieve success in other countries, first from a professional point of view, but also from a familial perspective. However, this sword is a double-edged one, being responsible for problems inside the respective families. Families fallen apart, children left without proper care because of their parent's lack of time or long periods away from home, adjustment issues outside the borders are just a few of the general consequences related to migration. The doctors, governed both by the PULL – attraction factors, such as attractive incomes and better work conditions presented by other countries, but also by the PUSH-rejection factors, such as the lack of support from the Romanian medical system in regards to motivating a local career, cumulated with the globalization effect, become a critical party in the migration of highly qualified workforce migration. Their material needs, combined with their desire to work in better conditions, to work with modern equipment and fulfill their career often push them to take this step.The number of young Romanian emigrants has grown considerably after the revolution, fact which led to the pronounced aging of the population and the need to receive and integrate a large number of immigrants. We can talk about a type of "social transition through migration", which only had a short-term success, with risks and further implications in the society, appearing in the medium and long term perspectives 0. The medical sector has a registered a drop in workforce due to migration. A rise in the average of the doctor's ages has also occurred. This drop in workforce can be solved only through a comeback migration, through immigration or the professional forming of new doctors in the country. The conditions for keeping or attracting the medical staff can be split into three parameters: the salary, the relative cost of life, the quality of public institutions and services from the country of origin **Error! Reference source not found.**, [3], [5]. Starting with the year 2007, the doctor's diplomas have been recognized in the EU space and the Ministry of Public Health started releasing on-demand certificates for the recognition or medical staff [6].

The romanian physicians' reasons for migration are commonly known, however there isn't a real database or specialized works to clearly point the determinant factors for Romanian physicians decision for leaving their native country. This paper will present a comparative analysis of data collected in interviews and questionnaires with managers, recruiters and Romanian doctors who want to work abroad . The objective is to indentify the real reasons for emigration.

2. IDENTIFICATION THE FACTORS EMIGRATION

Along with the widening of migration possibilities for doctors we can see a rising interest from the young people to take up medical careers. The number of doctors has risen during 1999-2007 [2], but the number of private hospitals has also recorded a growth period compared to the state ones, exactly because of the doctor's opening towards the practiced in the West. Both positive and negative effects can be seen as a result of migration at an individual level. These effects depend on the country of origin, on the respective person, on its personality and the emigrant's and its family ability to adapt.

The negative effects related to the migration of doctors at an individual levels are: family alienation of loss through divorce (if the host country does not offer the family the possibility to leave and adapt), difficulties in the adaptation process (language, culture), the traveling costs, the loss of professional status and the tendency of emigrant to be discriminated both at work and in the society. Concerning this last effect, studies have shown that there are countries that are oriented towards recognizing the same work rights for both their citizens and emigrants (Bosnia, Sweden, Denmark, Andorra, Norway), but also countries that tend to prioritize their own citizens (East Germany, Turkey, Portugal, Iceland) and countries that consider that their workplaces should only be given to their citizens (Lithuania, Malta, Slovakia, Croatia, Hungary). According to this criteria, Romania is the 19th out of 49, so more in the area of countries with an over the average rejection. Discrimination is an ethical problem that occurs with migration. In this case, emigrants/immigrants from/to Romania can have employment or promotion problems if they compete with the local doctors. This problem must be known from the start by the person that migrates, he/she assuming this risk.

There are also a series of positive factors at individual level: motivating salary, continuous education[3], the access to advanced technology, quicker promotion possibilities, better living conditions for the doctors and his/her family (advanced equipment, risk free workplace). These positive effects depend on the country to which the migration is done. Not all countries offer decent or any living conditions for the emigrant's family, even if one of the migration conditions is family protection. This problem creates a series of expenses for that country related to family integration. This is something all countries have to do, but not all can afford to. The positive migration effects can be explained by the PULL factors that draw doctors to more developed countries [7], [8]. Common methods for recruiting Romanian doctors are the internet ads, the job fairs, newspaper advertisements, and the access to financial support during the study (research internships).

Most romanian cities are organizing job fairs to recruit doctors. Most Human Resources companies, at the job fairs we participate, were recruiters for private hospitals in Belgium, Germany, France and public hospitals in Sweden.

Countries of interest to our study are France, Belgium and England and in this respect we've conduct interviews and applied questionnaires to a job fair in Iasi. A total of 50 doctors attending the fair answered our questionnaires. Subsequently, interviews were held with the recruiting teams. Also, focused on the same subject, we had the chance to interview some hospital managers in Iasi. We consider this to be only a preliminary study because of the small number of subjects. Although the managers interviewed were few (only 4), we were able to see a correlation in their responses.

The analysis is both qualitative and quantitative, comparing the results for finding if there is the same point of view in regard to the migration reasons and to disseminate the most wanted medical specializations as well as those areas showing a lack of medical specialists. As an output of all data gathered during our study, some ways to reduce the migration are also proposed in the end of this paper.

Questionnaires for the medical specialists were processed in SPSS 19 and this article is based on their results. Interviews with the recruiters were interpreted and responses correlated. Questions posed directly to recruiters attending the job fairs revealed following facts:

-HR companies recruiting for Ireland and England were searching for specialists in the fields of emergency, aenesthesia, general surgery, pediatrics, obstetrics/gynecology, psychiatry, oncology, internal medicine and dentist specialities.

-Companies representing other countries were recruiting specialists in all fields of medicine.

By same recruiters, it seems that main reasons for the physicians' migration are: attractive remuneration package and better working environment.

Next, we will present the results of a second study, based on questionnaires applied to physicians attending the job fair.

Table 1 shows that medical personnel attending the fair was of different specializations, fact reiterated by above mentioned interviews.

Table 1. The physicians specializations

Specialization	Frequency
anesthesia and intensive care	2
psychiatry	3
surgeon	4
dentist	3
pediatrics	1
GP	2
internal	9
radiology	2
residents	4
neurologist	2
orthopedics	1

The average age, arising from questionnaires, is between 25-30 years, which shows that young people are more interested to go abroad permanently or just for specialization.

When asked "What are the reasons you want to emigrate? " the surveyed doctors said:

1. A better financial situation - Yes - 33 No - 13
2. For professional reasons - Yes -30, No - 16
3. For professional development by working in good conditions, with new technologies - Yes - 31 No - 15
4. Better opportunities for their families Yes-22, not -24
5. For acquaintances / friends in that country, Yes-4, No-42

From the responses of those surveyed we can draw the conclusion that top reasons for migration are related first to better earnings, then to achieving a higher professional level and after that the opportunities presented to their own families. So the material reasons are prevailing when taking the decision to leave their native country, fact also revealed by the recruiters.

Data gathered during interviews held with hospital managers are refering to level II hospitals in Moldavia district. After discussions with this managers we were able to identifiy that some specialists who have a stable job and a good settlement in Romania are not necesarily interested for going abroad permanently, but rather to be envolved in a temporary departure for further specialization. Generally, earnings of this doctors may reach such amount that motivates them to stay in Romania. We are taking into account here all extra allowences added to the basic wage as: overtime hours, personal medical projects, professorship, etc...

Even though this seems to not be a major reason, the marital status as revealed from our research may encourage romanian specialists to migrate in some other countries. 26 respondents out of 46 were not married, 3 were divorced and the rest of 17 were married, but most of them with no children. Such marital situation may lead to a greater mobility and freedom for the respondents. Not being highly relevant for this study, we found some particular cases indicating as a main reason for migration the very need to leave everything behind, after a divorce.

All managers surveyed said that doctors who emigrate are young residents who do not find a suitable position, according to their dream of professional development. Even if they agree to undergo their apprenticeship in romanian hospitals as part of university's curriculum, then they are forced to leave at the end of the internship because there is no suitable position in any hospital for them to be succesfully integrated. "From 30 or 40 residents we commonly train each year in our hospital at the end their internship it is five or six who get hired" – said one of the managers we interviewed.

When asked "How justified is the decision for a specialist to leave the country?" a manager said such personal decision it is mainly based on financial grounds, otherwise Romania is offering the same freedom of acces to specialized information as Western Europe itself and, in some cases, acces to comparable high technology. Further personal professional development it is possible in Romania as well, but one may regard as difficult to start his own career and personal life based on an income as a resident doctor and so taking into account to migrate. The only problem the manager was pointing was the financial side, though. Generally, doctors who are not so attracted to the idea of emigrating are those who have already a good status in their own country, meaning they already have reached a higher proffesional level and, in many cases, combining their work with teaching medicine in universities.

A general conclusion of this section is that the results of the three above mentioned analyzes are pointing to the same answers. Migrants can be classified according to their reasons to migrate as follows: there is a group of specialists leaving for higher salaries; there are doctors leaving to offer themselves and their families and children a better living and working/learning environment; there are doctors wishing to practice their profession in better conditions using high-tech technology.

3. METHODS FOR REDUCING THE ROMANIANS PHYSICIANS EMIGRATION

Although strongly influenced by social, economical and political conditions, medical specialists' emigration is, at last, a result of a personal decision in a space dominated by freedom of choice. As there are no other restrictions than those imposed by common european legislation, every individual may freely choose to work and live where there it seems to be best for himself. But problem arise when there is a considerable out-flow of specialists, this indicating that the system itself is not effectively tuned to keep them.

Therefore, for an effective result, it is much easier for national authorities to take control of migratory movements by adopting collective framework conditions, rather than focus on each individual migrant situation. Solving migration problem lies with the concerned authorities, but some guidelines may be drawn from the answers we got during our study.

We asked the following question: „What will determine yourself not to migrate?"

Answers were: a better salary package – 18, a better working environment – 14, facilities for achieving a higher proffesional level. Better salary is the most important motivation for doctors. Managers say authorities may involve themselves in reducing migration by offering scholarships, supporting young residents durinf their internship and providind decent accomodation for them during first years of their careers. Thus, physicians will be motivated to practice their profession in our country. This will prevent the „brain-drain". On the other hand, an inteligent and fair system should provide a homogenous ratio „doctor income per pacient", leading to an optimised relation.

Another idea to reduce the migration, which derives from interviews with decision makers, is that of offering the college entrance examination to such number of places equal to the number of vacancies in the health system. Number of medicine graduates Romania is presently higher than the number of vacancies in the system, which causes the surplus to leave abroad, is search of a job.

A program of internship exchange should provide opportunities for both romanian and foreign specialists to work abroad. Motivating foreign specialists to come in Romania will provide our medical system with needed expertise as both parties may mutually benefit.

An important part of that infrastructure tends to be the telemedicine developed through projects. For the moment, it has only been developed at a national level, its extension to an international level being not too far away. This allows doctors to keep their in-country clients depending on their illness, if a proper surveillance and remote consultation allows that. The next question would be if telemedicine has any effect on migration. Keeping the list of patients allows the doctor to stay in contact with the patient at a new, virtual level. Through the patient's agreement to be involved in remote monitoring and reporting systems, the doctor's emigrant status changes to that of social emigrant person. We are not analyzing that phenomenon though. We can only state the fact that telemedicine brings medical staff back to the country [9], [10], [11], [12].

Comparing responses with those of physicians in general converge to the same methods Result makers to reduce immigration.

4. CONCLUSIONS

In the health systems from the source countries, as is the case of Romania, migration can be a major wear-down and reduction of workforce that can lead to the dissolution of a type of service when the people involved emigrate, when the teaching level is lost due to the teacher-doctors leave or when the work quality of those remaining in the country drops, their desire to emigrate being amplified. The countries of origin lose the investment in the education of medical staff

In Romania's case, there are no bilateral agreements signed for the training of medical staff, but there are recruitment companies that train doctors according to the specifications for the destination countries. They are trained in high level schools because of the continuous contact between the doctors who have emigrated and those that have remained in the country. The emigrant doctors bring back advanced work materials, organize sessions, workshops and conferences to raise the level of knowledge the doctors in Romania have. New teaching materials are created and new projects are established between emigrants and the doctors that remained in the country. This is an important effect, beneficial to Romania as a result of migration. From an ethical point of view, the doctors formed in a poor country have the right to emigrate in a more developed country, but they also have moral obligations towards the country that formed them as specialists and towards their own citizens as patients. Restricting a doctor's freedom of circulation is unethical and would be a violation of individual freedom, more so in a time when globalization is promoted and acclaimed.

Another beneficial effect for the source country is the financial investments done by emigrants and their families. That money is invested especially in real estate, but also in private clinics and offices with the highest technology available. This automatically insures a growth and re-qualification of the medical infrastructure, be it even in the private sector.

5. ACKNOWLEDGMENTS

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This paper doesn't obligatory represent the official opinion of European Union or Romanian Government

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ADAPTIVE CONTROL ALGORITHMS FOR SMART ANTENNA SYSTEMS

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ABSTRACT

Smart antenna systems are used in a wide range of fixed and mobile communication applications. Generally smart antennas are made of antenna arrays and signal processors. The antenna array can have any kind of shape, from linear to circular or rectangular. For simplicity considerations in this paper we studied the linear antenna array. The main characteristic of a smart antenna system is the digital signal processing feature. The system processes the signals in order to obtain a desired radiation pattern. In this paper we will describe some of the most significant algorithms used for processing the signal received by every element of the array along with some of the advantages and disadvantages for each of them. The algorithms described are the LMS (Least Mean Squares), the RLS (Recursive Least Squares) and CMA (Constant Modulus Algorithm).

Keywords: *Smart antenna systems, beam forming, adaptive algorithms, Least Mean Squares, Constant Modulus*

1. INTRODUCTION

The smart/adaptive antenna technology finds its applicability in areas like mobile communications, radar and even medicine. For example such a system can be very efficient in detecting and locating underwater signal sources eliminating the use of active sonar. The ability to point the main beam of the radiation pattern in a specific direction makes this technology very useful in medicine. Also this technology is very useful in anti-jamming applications.

The smart antenna system consists of an antenna array and a signal processor unit. This processing unit can evaluate and manipulate the signals received by each of the antenna array elements using certain processing algorithms in order to obtain the desired radiation pattern. Smart antenna systems are used to direct the energy of the main beam in certain predefined directions and create nulls in the direction of interfering signal sources.

The antenna arrays that make up the antenna systems can have different shapes. To simplify the equations in this present paper we consider a linear antenna array.

The signals received by each element of the array propagate from the signal source to the specific elements on different paths. The phases and amplitudes are different for each signal received by each antenna element. To create the desired radiation pattern, the signals will be processed in such a way that the pattern will have maximum and minimum values in particular directions defined by the user.

The adaptive algorithms operate on the received signals by multiplying them with certain weights. These weights are complex quantities.

With an antenna array of L elements we can create L-1 shapes for the radiation pattern with a theoretical maximum in the direction of the desired signal and nulls in the direction of the interfering signals.

The adaptive algorithms are generally referred to as being part of to main categories. The first category consists of algorithms that use a training sequence in order to achieve adaptation. The LMS and RLS algorithms are part of this category that needs the training sequence with the help of which the mean squared error is minimized. The algorithms from the second category do not need the use of a training sequence in order to achieve adaptation. The CMA algorithm is part of this category.

The radiation pattern in case of a linear antenna array with equally spaced elements can be expressed mathematically as an L-1 rank polynomial with variable coefficients [3]. The first coefficient being equal to a unit we can define the radiation pattern as in the following equation:

$$D(\theta) = W_L (z - b_1)(z - b_2)(z - b_3).....(z - b_{L-1}) \quad (1)$$

2. ADAPTIVE/SMART ANTENNA MODEL

The signals received by the antenna array elements that will be processed in order to obtain the desired radiation pattern have certain particularities that we will describe in the following chapters.

2.1 The linear antenna array and the received signal characteristics:

Let's presume that the antenna array part of the antenna system is linear and it's disposed in the far field. The wave front in this case will be plane. We also take into consideration the presumption that the propagation medium is homogenous. The array is made up of omni-directional elements. In the ideal case of non dispersive propagation and distortion less elements, the propagation from the source to the element is a matter of time delay [3].

As we can see in figure 1, we consider the origin of the coordinate system, the time reference. The time in which a wave front will arrive from the k-th source in direction (Φ_k, θ_k) measured from element l to the origin is given by the equation:

$$\tau_l(\Phi_k, \theta_k) = \frac{r_l \, \hat{v}(\Phi_k, \theta_k)}{c} \quad (2)$$

, where r_l is the position vector for element l, $\hat{v}(\Phi_k, \theta_k)$ is the unit vector in the (Φ_k, θ_k) direction and c is the propagation speed for the wave front. For a linear array with equally spaced elements, oriented along the x axis and d the distance between them, the time is:

$$\tau_l(\theta_k) = \frac{d}{c}(l-1)\cos\theta_k \quad (3)$$

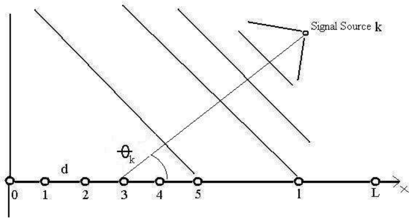

Figure 1. Linear antenna array with equally spaced elements

In figure 1 we considered a linear array with equally spaced elements, the signal source k, the elements of the array with the distance d between them and the angle that defines the direction of the signal source.

When the signal source is situated somewhere perpendicular to the array axis, at an angle $\theta_k = 90^0$ from (3) we can see that $\tau_l(\theta_k) = 0$, for any of the elements l. We can conclude that the wave front reaches all the elements at the same time and the signals induced by the source k at all the elements of the array are equal. For $\theta_k = 0^0$, the wave front reaches element l before it reaches the element in the origin of the coordinate system. The delay can be expressed as in the following equation:

$$\tau_l(\theta_k) = \frac{d}{c}(l-1) \quad 4)$$

On the other hand, for $\theta_k = 180^0$, the delay becomes:

$$\tau_l(\theta_k) = -\frac{d}{c}(l-1) \quad (5)$$

The minus sign in front of the equation is due to τ_l. This quantity represents the propagation time in which the wave front travels the distance between element l and the origin. The negative sign indicates the fact that the wave front gets to the origin before it gets to element l, and the signal induced at element l reaches this element later then the one induced at the element in the origin. The signal induced at the reference element by signal source k can be expressed as [6]:

$m_k(t)e^{j2\pi f_0 t}$, where $m_k(t)$ represents the complex modulation function and f_0 is the carrier frequency. Different modulation schemes are used in different communication systems. As an example, in a FDMA (Frequency Division Multiple Access) system, the modulating function is $m_k(t) = A_k e^{j\xi_k(t)}$, where A_k is the amplitude and $\xi_k(t)$ is the message. In case of a TDMA (Time Division Multiple Access) system, the modulation function is $m_k(t) = \sum_n d_k(n)p(t-n\Delta)$, where p(t) represents the sampling signal, $d_k(n)$ represents the message. and Δ is the sampling period.

For a CDMA (Code Division Multiple Access) system, the modulation function is $m_k(t) = d_k(t)g(t)$, where $d_k(t)$ represents the signal sequence and g(t) is a binary pseudo-random code sequence and its values are +1 or -1. Generally a modulation function describes a complex process with zero mean and a variance equal to p_k, measured at the reference element. As we presume that the wave front reaches element l delayed with $\tau_l(\Phi_k, \theta_k)$, the signal induced by the signal source k at element l can be expressed as: $m_k(t)e^{j2\pi f_0(t+\tau_l(\Phi_k,\theta_k))}$.

This expression is valid in case the signals received by the array are narrowband signals and the dimensions of the array are sufficiently small so that the modulation function theoretically remains constant throughout the $\tau_l(\Phi_k, \theta_k)$ period. In this case the following approximation is viable: $m_k(t) \cong m_k(t+\tau_l(\Phi_k, \theta_k))$.

The term adaptive antenna is used in case of a phased antenna array, when the weight for each element is computed dynamically. The weights corresponding to each element don't have fixed values, predefined in the stage of system development. The weights are computed by the system when the signal processing is employed.

In case of adaptive antennas, conventional concepts like main beam radiation angle, main or secondary lobes are not used as the weights are computed in order to satisfy performance criterions, like output SNR (Signal to Noise Ratio) maximization [5].

The smart antenna term refers to all the situations in which a system uses an antenna array and its radiation pattern is adjusted dynamically by the system in order to satisfy some desired output. In other words a system that utilizes a smart antenna processes the signals received by its sensors. In figure 2 we can see a basic design of smart antenna system.

The type of sensors used and the additional information supplied to the processor depends on the application. As an example we can say that a communication system uses antennas as sensors and some signal particularities as additional information. The processor uses this information in order to differentiate between the useful signal and the interference.

The signals received by the sensors arrive at the processor who uses the useful signals direction as additional information. It computes the weights that are to be used along the communication channel.

The weights can be written as vectors like in the following equation:

$$w = [w_1, w_2, \dots, w_L]^T \quad (6)$$

The signals received by the antenna elements are:

$$x(t) = [x_1(t), x_2(t), \dots \dots, x_L(t)]^T \quad (7)$$

The output signals will be:

$$y(t) = w^H x(t) \quad (8)$$

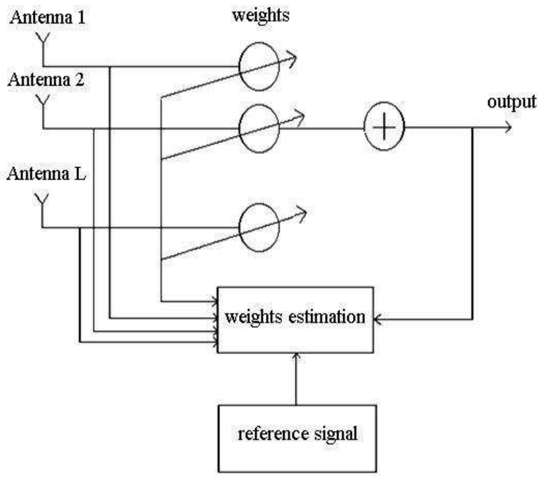

Figure 2. Basic Smart Antenna System

In figure 2 a generic example of a smart antenna system is represented. The main features of such a system are the antenna array and the signal processor depicted as the weights estimation block. The reference signal as we will see later is an optional feature. Some algorithms use it in order compare it to the same sequence sent by the emitter.

The output signal of the smart antenna system will be:

$$y(t) = \sum_{l=1}^{L} w_l^* x_l(t) \qquad (9)$$

where * represents the conjugate transpose.

2.2 Adaptive algorithms:

As we discussed there are two main categories of adaptive algorithms. There are the algorithms that need a training sequence in order to achieve adaptation and the ones who don't need the training sequence called blind equalization algorithms. In figure 3 there is a generic example of a combined scheme in which a specific block called a decision factor can choose between using one of these two types of algorithms based on a certain performance criterion.

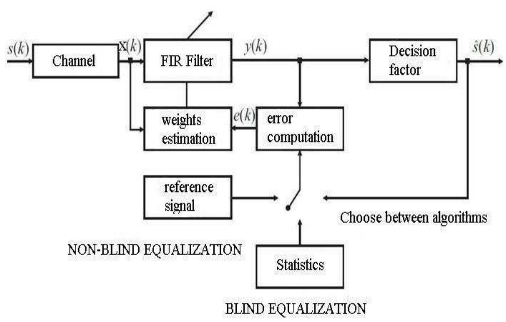

Figure 3. Choosing the proper adaptive algorithm for a specific application

As we established earlier, one of the main objectives of a non blind equalization algorithm is to minimize the mean square error. This is done by comparing an already known training sequence sent by an emitter that reaches the receiver along with the interference to the same sequence undistorted present at the same receiver. An error that has to be minimized is obtained. A blind equalization algorithm doesn't need the training sequence. The algorithm exploits some signal characteristics. For example in case of the CMA algorithm, an algorithm that obtains good performance when signals with modulations like QPSK (Quadature Phase Shift Keying) or BPSK (Binary Phase Shift Keying) are sent over the communication channel, the characteristic exploited is the constant modulus of the signals[7]. The magnitude of their envelope remains the same while the phase varies. So we can say that the decision factor will take into consideration the type of signal the system will receive, but it is not the only thing.

2.3 Minimum mean square error:

A very important decision factor, the mean square error has to be minimized. The result is the computed weights that can be written in form of a vector as in the following equation [3]:

$$w^T(k) = [w_0(k) \;\; w_1(k) \;\; \dots \;\; w_{(L_w-1)}(k)] \qquad (10)$$

The input signal for the adaptive filter is:

$$x(k) = [r_0(k) \;\; r_1(k) \;\; \dots \;\; r_{(L_w-1)}(k)]^T = [r_0(k) \;\; r_0(k-1) \;\; \dots \;\; r_{(0)}(k - L_w + 1)]^T \qquad (11)$$

The output of a L_w length adaptive filter will be:

$$y(k) = \sum_{i=0}^{L_w-1} w_i(k) x_0(k-i) = w^T(k)x(k) \qquad (12)$$

The error is:

$$e(k) = d(k) - y(k) = d(k) - w^T(k)x(k) \qquad (13)$$

, where d(k) is the desired signal.

Minimizing the mean square error implies the minimization of a function of the following form, called a cost function in technical literature:

$$J^{MSE} = E\{e^2(k)\} = E\{d^2(k) - 2d(k)y(k) + y^2(k)\} = E\{d^2(k)\} - 2E\{d(k)w^T(k)x(k)\} + E\{w^T(k)x(k)x^T(k)w(k)\} \qquad (14)$$

When the values for the filter coefficients are fixed, the function can be written as follows:

$$J^{MSE} = E\{d^2(k)\} - 2Ew^T E\{d(k)x(k)\} + w^T E\{x(k)w^T(k)\}w = E\{d^2(k)\} - 2w^T p + w^T R w \qquad (15)$$

, and $p = E\{d(k)x(k)\}$ and $R = E\{x(k)w^T(k)\}$ (16)

,where p is the cross correlation vector and R is the correlation matrix corresponding to the input signal.

The gradient applied to the function is:

$$\nabla_w J^{MSE} = \frac{\partial J^{MSE}}{\partial w} = \left[\frac{\partial J^{MSE}}{\partial w_0} \;\; \frac{\partial J^{MSE}}{\partial w_1} \;\; \dots \;\; \frac{\partial J^{MSE}}{\partial w_{L_w-1}}\right] = -2p + 2Rw \qquad (17)$$

The optimum weights are obtained minimizing the mean square error by setting the value of the gradient to zero. So, these optimum weights will have the following values:

$$2Rw_0 - 2p = 0 \Rightarrow w_0 = R^{-1}p \qquad (18)$$

The mean square error becomes:

$$\xi_{min} = E\{d^2(k)\} - 2w_0^T p + w^T R w_0 = E\{d^2(k)\} - 2[R^{-1}p]^T p + [R^{-1}p]^T R[R^{-1}p]^T = E\{d^2(k)\} - 2p^T R^{-1} p + p^T R^{-1} p = E\{d^2(k)\} - p^T R^{-1} p \qquad (19)$$

This method of minimizing the mean square error is not used often because the amount of time necessary to analyze the cost function is very high. In practice other more efficient methods of analyzing the cost function are employed. The results are estimated so the amount of time needed for computation is optimized.

2.4 Steepest descent method:

The steepest descent method is a gradient search algorithm that leads to weight adjustment for negative values of this gradient [11].

The weights will be computed iteratively from the previous weights as in the following equation:

$$w(k+1) = w(k) + \mu(-\nabla_w J^{MSE}) \quad (20)$$

where μ is the step size that controls the convergence speed and the precision of the algorithm. For convergence reasons we choose:

$$0 < \mu < \frac{1}{\lambda_{max}} \quad (21)$$

where λ_{max} is a maximum value of R.

2.5 Least Mean Squares Algorithm

The LMS algorithm simplifies the gradient search by using instantaneous values instead of expected values. Estimates of the correlation vector and also the correlation matrix will be used.

$$\hat{R} = x(k)x^T(k) \quad (22)$$

$$\hat{p} = d(k)x(k) \quad (23)$$

Using these estimates, the gradient becomes:

$$\nabla_w J^{LMS} = -2\hat{p} + 2\hat{R}w(k) = -2\big(d(k)x(k)\big) + 2\big(x(k)x^T(k)\big)w(k) = -2x(k)\big(d(k) - x^T(k)w(k)\big) -2e(k)x(k) \quad (24)$$

The weights will be computed as in the following equation:

$$w(k+1) = w(k) + \mu(-\nabla_w J^{LMS}) = w(k) + \mu e(k)x(k) \quad (25)$$

The LMS algorithm is the most common non blind equalization algorithm. Other LMS variants have been developed in order to improve the old algorithm.

2.6 Recursive Least Squares Algorithm

Given the fact that the convergence speed of the LMS algorithm depends on the values of the correlation matrix which imposes a limit in case the system uses low performance processing units, the RLS (Recursive Least Squares) algorithm was developed. The step size μ will be replaced with a matrix $\hat{R}^{-1}(k)$ at the k-th iteration. The weights will be computed as the following equation states:

$$w(k) = w(k-1) - \hat{R}^{-1}(k)x(k)\varepsilon^*\big(w(k-1)\big) \quad (26)$$

, where

$$\hat{R}(k) = \delta_0\hat{R}(k-1) + x(k)x^H(k) = \sum_{n=0}^{k} \delta_0^{k-n} x(n)x^H(n) \quad (27)$$

The RLS algorithm computes the inverse of the correlation matrix using the previous inverse and present signal samples. The inverse has the following form:

$$\hat{R}^{-1}(k) = \frac{1}{\delta_0}\left[\hat{R}^{-1}(k-1) - \frac{\hat{R}^{-1}(k-1)x(k)x^H(k)\hat{R}^{-1}(k-1)}{\delta_0 + x^H(k)\hat{R}^{-1}(k-1)x(k)}\right] \quad (28)$$

The matrix is initialized with the value:

$$\hat{R}^{-1}(0) = \frac{1}{\varepsilon_0} I, \varepsilon_0 \neq 0 \quad (29)$$

The RLS algorithm minimizes the cumulated squared error.

$$J(n) = \sum_{n=0}^{k} \delta_0^{k-n} |\varepsilon(n)|^2 \quad (30)$$

2.7 The SATO algorithm:

One of the first blind equalization algorithms developed was the SATO algorithm. The improved version of this algorithm called GSA (Generalized Sato Algorithm) uses the following relation in order to compute the weights:

$$w(k+1) = w(k) + \mu\big(\mathrm{csgn}\big(y(k)\big)\varsigma - y(k)\big)x^*(k) \quad (31)$$

, where

$-\nabla_w J^{GSA} = \mathrm{csgn}\big(y(k)\big)\varsigma - y(k) = e^{GSA}(k)$ (32), and

, csgn(.) represents the complex operator and ς is a constant depending on the signal source.

2.7 The Constant Modulus Algorithm

This may be the best known blind equalization algorithm. This algorithm exploits a feature of transmitted signals like PSK and FSK. This feature is the constant magnitude of their envelope.

The weights are of the following form [14]:

$$w(k+1) = w(k) + \mu y(k)(\varsigma^2 - |y(k)|^2)x^*(k) \quad (33)$$

, where $-\nabla_w J^{CMA} = e^{CMA}(k)$ (34).

3. COMPARISSON BETWEEN THE ADAPTIVE ALGORITHMS DESCRIBED ABOVE

In order to compare the performance of the algorithms presented in the above chapters, we simulate their behavior in the MATLAB environment.

For LMS we considered the static case in which we have a signal source at 50 degrees. The angle is measured with the linear array plane. We consider a number of 8 elements for the linear array. We've chosen the 2.4 GHz frequency for our simulations, which is the most common frequency used in wireless communication applications. We also considered 4 sources of interference, positioned at 25, 80, 130 and 155 degrees. The sources are in fixed positions. We ran the algorithm 200 iterations for a step size $\mu = 0.01$. The results are presented in figure 4 and figure 5.

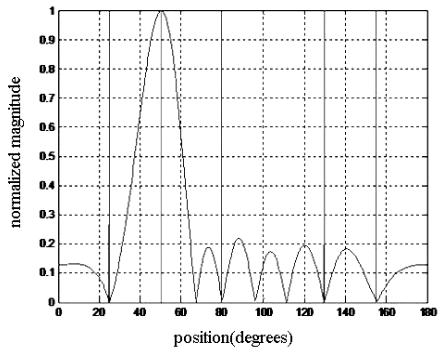

Figure 4. The radiation pattern in rectangular coordinates for μ=0.01 and signal source at 50 degrees

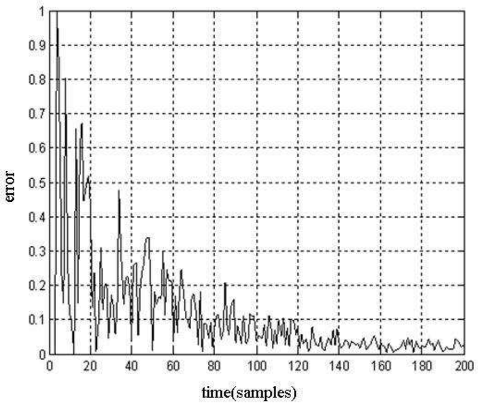

Figure 5. The error obtained for μ=0.01

We can see form figure 4 that after 200 iterations the algorithm achieves a good performance. The main lobe is pointed towards the signal source and zeros are created in the radiation pattern at angles corresponding to the interference sources.

In figure 5 we can see the fact that the error becomes smaller with the increase of the number of iterations.

Simulations have been made for a number of values for the step size μ. For μ=0.01 the convergence is achieved after 140 iterations. The magnitude of the secondary lobes is -15 dB, below the level of the main lobe. The nulls are at the -35 dB level. As the step size is increased superior performances are obtained for the time in which the convergence takes place. Also the magnitude of the secondary lobes decreases.

Although the behavior of the algorithm gets better when increasing the step size there is still a limit to which it can be increased. Also the algorithm reaches an optimum stage, above which its performance cannot be improved. With the decrease of the step size the algorithm reaches convergence slower, and the performance remains unchanged. The simulations were made for a value of 20 dB assigned to the SNR (Signal to Noise Ratio). The SNR influences the error after convergence has been established. For low SNR values the convergence time gets higher. Knowing the value for the SNR is important in establishing values for other parameters involved in the adaptation process.

We plot the results obtained using the LMS algorithm in figure 6 and the results obtained using the RLS algorithm in figure 7. We assume that the signal source is at 120 degrees and the interference is at 30 degrees. We can observe the fact that the RLS algorithm converges faster and is more precise at eliminating the interference signal.

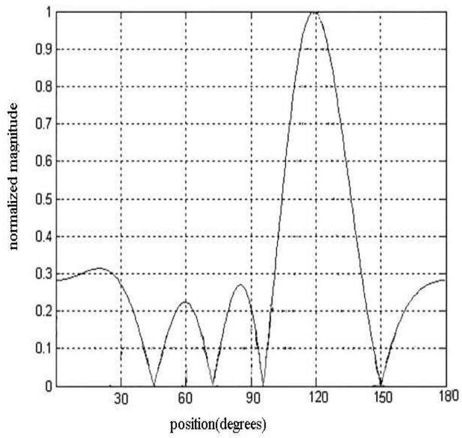

Figure 6. The radiation pattern in rectangular coordinates for LMS algorithm, μ=0.01 and signal source at 120 degrees

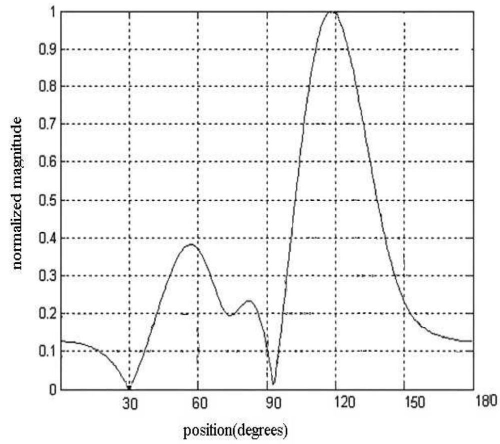

Figure 7. The radiation pattern in rectangular coordinates for RLS algorithm, μ=0.01 and signal source at 120 degrees

From simulating the CMA algorithm we can denote the results obtained for the error, for different values of the step size and number of iterations.

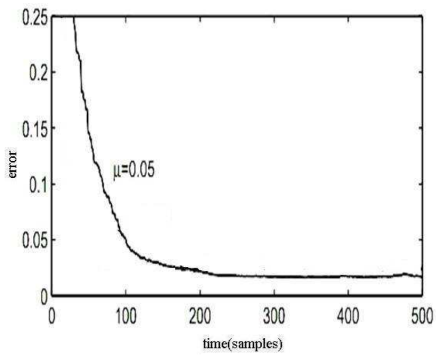

Figure 8. Error obtained in case of CMA for an array of 8 elements and μ=0.01

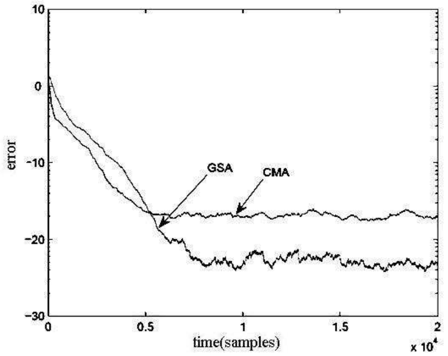

Figure 9. Comparison between GSA and CMA

Comparing the error obtained from using different algorithms we can say that the error in case of using CMA algorithm is smaller compared to the error obtained from using the SATO algorithm. The error in case of using the GSA algorithm is smaller than the error obtained from using CMA for the same number of iterations. The error obtained using CMA and LMS algorithms are comparable for a number of iterations that surpasses 200.

4. CONCLUSIONS

The LMS algorithm is the most used non blind equalization algorithm, due to its simplicity and acceptable performance. Because it's an iterative algorithm it can be used in strong varying signal environments. Its performance is rather stable in different environment conditions. Its convergence speed is lower compared to other algorithms, like for example the RLS algorithm. In most situations, the traffic conditions employ changes in the position of the signal source as well as interference sources in time. The weights in this case don't have time to converge if the adaptation is done at a constant rate. The solution comes from varying the step size μ in accordance with the traffic conditions variation. Other improved variants of LMS were proposed over the years in order to satisfy this principle. As an example, the NLMS (Normalized LMS) algorithm uses a variable step size. By this it avoids the use of estimates of the correlation matrix or its trace in order to compute the maximum allowed step size. Normally the algorithm improves convergence compared to the LMS algorithm.

The convergence speed in dynamic environments is improved. Another way to improve the LMS algorithm is to use block processing. In this case, the so called Block LMS divides the input signal in blocks, weights being computed at block level. As a conclusion we can say that LMS is easy to implement, doesn't need pre-modelling, but the convergence speed is low. This is due to the step size and the dispersion of the correlation's matrix values. With a higher step size we obtain a faster convergence. On the other hand precision has to suffer. Similarly if the dispersion of the values for the correlation matrix R_{xx} is low, the convergence speed raises.

In a specific environment for which we obtain a correlation matrix with a high degree of value dispersion, the standard LMS algorithm converges with a low speed. This matter is overcome with the use of the RLS algorithm. The algorithm uses a matrix instead of the step size at the n-th iteration. The RLS algorithm obtains better performance than the LMS algorithm in flat fading channels.

The CMA algorithm is useful in order to eliminate the correlated interference signals and has a good performance when it is used in digital communication systems that work with signals that have a constant envelope like GMSK or QPSK. The algorithm is not suitable for CDMA systems though, because of the need for power control. Another used variant of this algorithm is named differential constant modulus whose convergence is achieved slower compared to the CMA algorithm but is more stable and can be improved by using information regarding the direction of arrival for the signal source.

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NETWORK COMMUNICATION SOLUTION IN INDUSTRIAL ENVIRONMENTS

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ABSTRACT

This paper describes communication solution for fast data acquisition systems in a large distributed network, with data recovery, who using a central communication server. In welding plants, the automation systems send data with a large frame rate. The data acquisition controllers send data at small time intervals, and the size of data blocks can be very large. In large welding plants, with a big numbers of controllers (starting from about 100 controllers) this can be a problem. In their network (in conformity with IEEE-802.3) can appear a data packet storm or/and the destination server can be locked. In this case we can have loosing of data packets. The solution proposed describes a data revival mechanism, for prevent loosing of packets. This solution is implemented at application level of TCP/IP stack, on both sides (server and controller). The solution is implemented in Marathon Weld's APAS (Arc Process Analysis System) data acquisition system.

Keywords: *data communication software, network protocols.*

1. INTRODUCTION

APAS (Arc Process Analysis System) is a high reliable solution for welding analysis systems. The system is consists of one server (Fig. 1) and APAS controllers connected with welding signals through sensors (current, voltage, gas pressure i.e.). In small work plants data communication is not a problem, in large work plants (about hundreds of controllers) where controllers working simultaneous factor is greater than 0.8 (80%) data transfer Fig. 1. APAS Server between controllers and server can be a problem. In intervals when controllers send data at every 0.1 second data traffic can be overflowed.

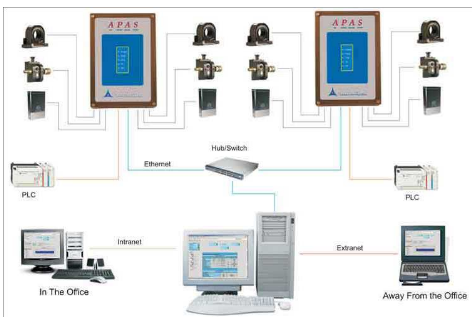

Figure 1 Industrial Data Communication Infrastructure

2. NETWORK PROTOCOL

For obtaining a fast data transfer between controller and server we choose UDP (User Datagram Protocol) packets in place of TCP (Transmission Control Protocol) packets. The UDP packet will be delivered immediately in place of TCP packets (TCP packets must have a TCP connection before data communication begin). Because we haven't acknowledged of UDP packet receiving on transport layer level, this protocol isn't so reliable than TCP packet protocol. Because the network layer isn't locked when UDP packet is sent to an unknown destination, or destination isn't answer consists another advantage for this solution.

To solve the great disadvantage of missing data packet, which not arrived on server, we choose to solve this problem on this intermediate layer. Solution is simple: we create intermediate communication layer between the application and the TCP/IP communication stack - APAS Net Layer - (Fig. 2). This layer will create a reliable data communication solution.

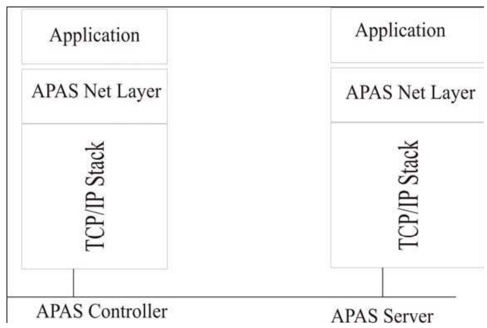

Figure 2 Industrial Data Communication Layer

2.1 APAS Network Layer. Controller's Side:

This layer is responsible with testing packet communication delivery and also this layer will resend loosed packets.

For implementing of APAS Net Layer we choose a three thread solution in a single task (see Fig. 3). The first thread (ADT - APAS Delivery Thread, see Fig. 3) is responsible with data sending to APAS Server, through TCP/IP stack. Also all sending packets are stored in a local database. The other thread (ACKT - APAS Acknowledge Thread, Fig. 3) will listen on a UDP port; acknowledge received packets, sent by APAS Server. If acknowledge is received the sent UDP packet from database will be removed.

For implementing of this protocol, each UDP data packet sent by ADT thread has attached an APAS_PACK_ID identifier. On receiving, each UDP sent by APAS server contains only the APAS_PACK_ID identifier.

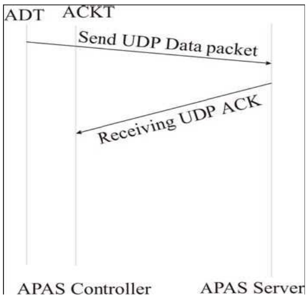

Figure 3 APAS Acknowledge Thread

If UDP sent packets by ADT doesn't receive acknowledge they remain in database, as unsent packets.

One simple solution is to trying to resend packets using the same solution via UDP communication port. This solution isn't so good because loading too much data communication layout and can create a UDP packet storm in local network.

Our solution is to create a third thread (ARUPT - APAS Recovery Unsent Packet Thread). This thread is TCP listener. He listens on TCP port server's request. If server is request a TCP connection this thread will be activated and will manage sending unsent data packets to the APAS server, over TCP connection. After data was sending, the TCP connection will be released, and local unsent packets database is empty.

2.2 APAS Network Layer. Server's Side:

On server this layer is create from a dual thread task. The first thread (ADR -APAS Data Receiver) is responsible for receiving of UDP data packets sent by APAS controller. If packet is received corectly, the thread inform the sending controller that data are received, by sending a acknowledge packet (this packet contains ACK_PACK_ID). And in the same time the packet will be delivered to server application layer.

The other thread is a TCP thread

(ARUD - APAS Received Unsent Data Thread). This thread is activated by scheduler event. When data communication thread ADR is in suspended state, no data delivered, this thread is activated and will check every controller about their unsent database packets (Fig. 4). The thread will receive the packets and will deliver them to application layer. The activation scheduler is depending by:

1. local database size;
2. the maximum frame rate determined by the welding unit;
3. the number of APAS controllers in the local network, who can send data simultaneous.

3. UNSEND PACKETS DATABASE

This database is created on APAS controller side, at APAS Net Layer level. The database contains each undelivered packet and his APAS_PACK_ID identifier.

When a packet is send the same package is saved in this database by ADT thread. If acknowledge is received for a packet, by ACKT thread, the packet is removed from database. If all is ok the database must be empty.

Periodic (at APAS server request) the ARUPT thread is checking the database and empty this database by sending all records to the server.

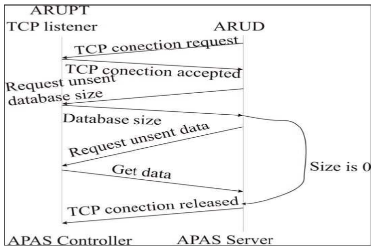

Figure 4 APAS Receive Unsent Data

If database is filled with packets, the older packets will be removed, and newer packets are stored in database.

The status of this database is monitored by class methods. When database achieved 85% from maximum size, a UDP signal will be sent, from APAS Controller to APAS Server, and announce server that unsent packet database achieve warning level. The APAS server must force staring of ARUD thread, for retrieving unsent packets. If database reach top level (it is full) another UDP signal will be sent to server announce that top level is rich and the unsent message database will start overwriting older records. From this time we can consider the system can loose packets.

There are a lot of solutions to don't reach at this point:

1. increase database maximum records count;
2. decrease the APAS server scheduler time constant;
3. analyze congestions in our network.

4. APPLICATION LAYER

This layer is remaining unchanged for main application and data connection between APAS server and controllers.

5. CONCLUSIONS

In welding plants, the automation systems send data with a large frame rate. The data acquisition controllers send data at small time intervals, and the size of data blocks can be very large. In large welding plants, with a big numbers of controllers (starting from about 100 controllers) this can be a problem. In their network (in conformity with IEEE-802.3) can appear a data packet storm or/and the destination server can be locked. In this case we can have loosing of data packets.

The solution proposed describes a data revival mechanism, for prevent loosing of packets. This solution is implemented at application level of TCP/IP stack, on both sides (server and controller). The solution is implemented in Marathon Weld's APAS (Arc Process Analysis System) data acquisition system.

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SATELLITE DATA COMMUNICATION CHANNEL SIMULATOR

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ABSTRACT

This paper describes Inmarsat Satellite data communication infrastructure for a simulator. This communication channel implements GMDSS (Global Maritime Distress and Safety System) and data transfer functions between INMARSAT-C compatible terminal and a Land Earth Station (LES). Thrane & Thrane compatible software, installed on embedded controller is used for simulation of Inmarsat terminal. This controller transfer data to simulated Inmarsat satellite using a wireless network. The satellite functions are implemented into another embedded controller. This satellite communication controller is linked with Inmarsat terminal via wireless network and with another land earth station using a secondary wireless channel. The land earth station is software implemented in a PC linked with simulated satellite using a wireless network. This center is able to manage messages received from Inmarsat terminal, via simulated satellite, and convert them into short text messages, automatically delivered to local network workstations, in faxes format or mail messages. The system can be consists as base for a GMDSS simulator

Keywords: *satellite communications, maritime data communications.*

1. INTRODUCTION

In debugging process of GMDSS (Global Maritime Distress and Safety System) radio terminal we need to test messaging and DSC (distress call alert) message passing between Inmarsat-C terminal and terrestrial operator. For solving this problem we implement a tool for testing delivery of messages from Inmarsat-C terminal to a terrestrial end-point without connection with satellite communication channel.

Also this tool can be used as infrastructure for a GMDSS message passing simulator. The system is able to manage 15 Inmarsat-C compatible terminals, one LES (Land Earth Station) center, and one simulated satellite system.

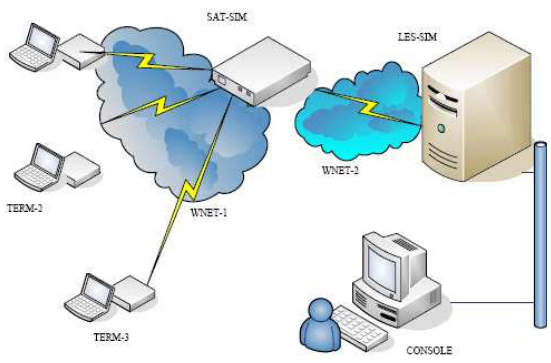

Figure 1. System Architecture

The structure of system is presented in figure Fig. 1 it is consists of three levels:

1. first level is represented by INMARSAT-C terminals, connected with communication controller (notated with TERM-1.. .TERM-3 in figure Fig. 1).
2. second level is represented by Inmarsat-C simulated satellite (SAT-SIM notation in Fig. 1).
3. and the third level is represented by simulated LES system (LES-SIM notation in Fig. 1) and the operator console connected to LES computer.

Between levels we have wireless connections. First wireless connection (WNET-1 notation in Fig. 1) is a small network communication controllers (TERM-1...TERM-3) and simulated Inmarsat satellite (SAT-SIM). This wireless network uses same frequency channel for all connections (433.1580 MHz). The second wireless connection (WNET-2) is a wireless direct link between the simulated satellite (SAT-SIM) and LES system (LES-SIM). This second network use another frequency channel (433.3020 MHz). The each wireless network doesn't disturb communication of the other one (the communication channels are aliens).

2. SYSTEM COMMUNICATION PROTOCOL

The simulated network protocol is nearby Inmarsat communication protocol. The both networks use a Token-Ring / ALOHA like communication protocol. Each network is consists of ring communication protocol. The protocol is controlled by LES center. The LES centers initiate a token in his network (WNET-2), named TOKEN-0. The token will be delivered by satellite simulator (SAT-SIM) into the second network (WNET-1) (see Fig. 2). Each communication controller

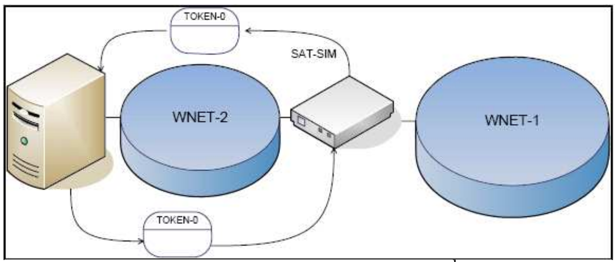

Figure 2. Token transfer over the 2nd network

listen the frequency channel (in his network). If no controller will request to communicate with satellite, after a time the satellite will reply to LES center with same token TOKEN-0. In this manner the ring will be closed. If a communication controller need to login on satellite, after receiving the token TOKEN-0, the controller will send in his network a request channel frame named RQ-TOKEN (Fig. 3). The satellite will process this request and forward it to LES center.

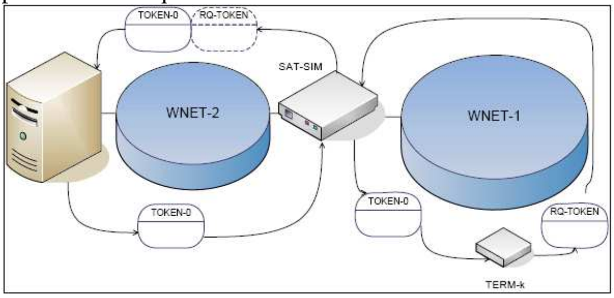

Figure 3. Data Request Protocol

The LES centre will insert a new communication token in his chain. On receiving of this token the communication controller will be able to send data to LES centre. For disconnecting of communication controller from his network, the controller must send a RQ-LOGOUT, or if where τ is period of token TOKEN-0 to travel the ring (at LES communication interface level).

3. SYSTEM STRUCTURE

The system structure is composed from:

1. communication controllers (TERM-1 ... TERM-3),
2. simulated satellite subsystem (SAT-SIM),
3. simulated LES system (LES-SIM).

3.1. Communication Controller

The hearth of communication controller is a microcontroller (TERM_k in Fig. 1) with two serial compatible RS232 interfaces. One serial communication interface will be connected with Inmarsat-C terminal (which is consists of a CAPSAT software installed on a embedded 386SX CPU board) - this serial will be notated with ConCom- and the other one is connected with a wireless serial data radio module -notated with NetCom-. The serial radio module is configured to work in 433.1580 MHz (frequency adopted for WNET-1 network).

The communication controller software is consists of two threads:

- one is responsible with network communication (NetworkThread) and
- the other one is responsible with terminal communication (CommThread). The implementations of these threads are:

```
NetworkThread () {
    if (Event'Timmer [Schedule_for_Testing_Satellite_Time_Out]) {
        Satellite.Status = 0;
    }
    if (Event'NetCom.Rx) {
        switch (NetCom.Rx.Type) { // any token
            case TOKEN-0:
                if (! NetCom.IsLink && Satellite.LogonRq) {
                    NetComSend(RQTOKEN);
                    Satellite.LogonRq = 0;
                }
            break;
            case TOKEN-1:
                if (Satelite.Data.Size)
                    NetComSend (Satellite.Data);
        break;}
    Satellite.Status = 1;}
CommThread () {
    if (Event'ConCom.Rx) {
        switch (message = ConCom_Read()) {
            case 'LogonRequest':
                Satellite.LogonRq = 1;
            break;
            case 'LogoffRequest':
            case 'Data':
                if (Satellite.Status)
                    Satellite.Data = message;
            break;
```

3.2 Simulated satellite subsystem

The base of simulated satellite subsystem is a microcontroller with two RS232 compatible serial interfaces (SAT-SIM in Fig. 1). Both serial channels will be connected to data radio modules. First RS232 serial interface, is named NetlCom, and will be linked with a radio module, on WNET-1 network - radio module is configured to work on 433.1580 MHz. The secondary communication interface is named Net2Com and will be linked with another data radio module, configured to work on 433.3020 MHz, in WNET-2 network.

The simulated subsystem is managed by a single thread SatelliteThread described below:

```
SatelliteThread () {
    if (Event'Timmer [Schedule_Testing_Time_Out]) {
        LES.Online = FALSE;
        for each TERM_k do {
            TERMk.Online = FALSE;}}
    if (Event'Net2Com.Rx) {
        switch (message = Net2Com_Get ()) {
            case 'TOKEN0': case 'TOKENk':
                NetCom_Send (message);
                LES.Online = TRUE;
            break;
        case data:
                k = message.to;
                if (TERMk.Online) {
                    Net1Com_Send (message);
    if (Event'Net1Com.Rx) {
        switch (message = Net1Com_Get ()) {
        case 'TOKENk':
                    k = message.from;
                    TERMk.Online = TRUE;
        case 'TOKEN0':
                    Net2Com_Send (message);
            break;
        case data:
                if (LES.Online) {
                    Net2Com_Send (message)}
```

3.3 Simulated LES system

This system (LES-SIM in Fig. 1) is implemented on a compatible PC-AT, with a Windows XP/2000/NT operating system installed on it. The computer has a serial RS232 interface installed on it (on board or via a USB bus system) - this interface is notated with SERCOM device -. Using this interface the system is linked with WNET-2 network, via a data radio module (programmed to work on 433.3020 MHz frequency channel). Also the system has Ethernet network card plug, for connection with a local are network. The LES functions are implemented in a windows task named LesCenter. The algorithm of this task is described below:

```
LesCenter () {
    static integer LastStation = 0;

    if (Event'Timer [TokenSchedule]) {
        k = LastStation;
        if (LastStation == 0) {
            Satellite.IsOnline = FALSE;
            SerComSend ('TOKENJ));}
         else if (Station[k].IsOnline) {
            SerComSend ('TOKENk');}
        LastStation ++;}
    if (Event'SerCom.Rx) {
        switch (message = SerComGet ()) {
            // something received from serial
            case 'TOKEN0':
                    Sattelite.IsOnline = TRUE;
                break;
            case 'TOKEN_k':
            case message.IsLogon:
                    // Logon Request
                    k = message.from;
                    Station[k].IsOnline = TRUE;
                break;
            case message.IsLogoff:
                    // Logoff Request
                    k = message.from;
                    Station[k].IsOnline = FALSE;
                break;
            case message.DSC:
                    // distress call received
                    k = message.from;
                    log ("DSC message from station k");
                    for each k from Station[1..n-k].IsOnline
                    SerComSend (DSC for station k);
                    eMail ("les@localhost", "DSC for
                    station k");
                break;
            case data:
                    // normal message received
                    log (message);
                    if (message.to is 'INMARSAT Station') {
                        SerCom_Send( message,
                            message.to);
                    } else {
                        eMail (message.to, message);}
                break;
```

4. CONCLUSIONS

This kind of centre is able to manage messages received from Inmarsat terminal, via simulated satellite, and convert them into short text messages, automatically delivered to local network workstations, in fax format or mail messages. The system can be considered as base for a GMDSS simulator.

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SECTION IV
MATHEMATICAL SCIENCES AND PHYSICS

DESCARTES' RULE OF SIGNS

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ABSTRACT

In this paper we show a method of finding the number of positive and negative roots of a polynomial and alternative methods of finding the roots of a polynomial using the programs "Matlab", "Maple" and "Mathematica".

Keywords: *Descartes, positive roots, negative roots.*

1. INTRODUCTION

Despite its intuitive plausibility, Descartes' Rule of signs was not directly proven until over a century after its original statement in 1637. Issac Newton restated the theorem in 1707, but apparently considered it too obvious to merit proof. DeGua is considered the first mathematician who publish an adequate proof in 1740.

Descartes' rule of signs can tell us how many positive and how many negative real roots the polynomial has. Descartes' rule of signs states that the number of positive roots of a polynomial $P(X)$ with real coefficients does not exceed the number of sign changes of the nonzero coefficients of $P(X)$.

2. THEORY

Theorem 1. The sign variation in the sequence $(a_n, a_{n-1}, \ldots, a_1, a_0)$ of coefficients of the polynomial $P(X) = \sum_{k=0}^{n} a_k X^k$ is more than the number of positive real roots of $P(X)$ by some non-negative even number.

Proof: We observe that if $a_0 < 0$ then the number of variation in the sequence $(a_n, a_{n-1}, \ldots, a_1, a_0)$ is odd, end if $a_0 > 0$ then the number of variation is even.

We suppose that $a_n > 0$ and we note with $Var(Q(X))$ the number of sign variation in sequence of coefficient of Q.

We observe that if $\alpha > 0$, then $(X-\alpha)Q(X)$, where $Q(X) \in R[X]$, then the number of sign variation in the sequence of coefficients of $(X-\alpha)Q(X)$ differs from the variations in the sequence of coefficients of Q with an odd number. Indeed, for example, if $b_0 = Q(0) < 0$, then $Var(Q(X))$ is a odd number and the free term of $(X-\alpha)Q(X)$ is $-\alpha b_0 > 0$, so $Var((X-\alpha)Q(X))$ is a even number. Therefore, the difference of the two variations is odd number.

Let $P(X) = (X-\alpha)Q(X)$, where $\alpha > 0$. According to previous reasoning, $Var(P(X)) - Var(Q(X))$ is even number. We proceed by induction on the number of positive roots of P.

We need to prove that, in general, if $\alpha > 0$, then $Var((X-\alpha)Q(X)) > Var(Q(X))$ for all $Q(X) \in R[X]$. But this statement follows immediately if we observe that any sign variation in the sequence of coefficients of $Q(X)$ induce a variation in the sequence of coefficients of $(X-\alpha)Q(X)$ and the difference $Var((X-\alpha)Q(X)) - -Var(Q(X))$ is odd number.

For the negative roots of P, we do so.

It is clear that $\alpha < 0$ is strictly negative root of P if and only if is strictly positive root of $P(-X)$.

But $P(-X) = (-1)^n a_n X^n + \ldots + (-1) a_1 X + a_0$.

It is clear that in (a_k, a_{k-1}) we have a sign change if and only if in $((-1)^k a_k, (-1)^{k-1} a_{k-1})$ we do not have a sign change.

Theorem 2. The number of positive roots of a polynomial $P(X)$ with real coefficients does not exceed the number of changes of its coefficients. A zero coefficient is not counted as a sign change.

Proof. We proceed by induction on the number of positive roots of P(X). If P(X) has no positive roots, the result is immediate. Suppose now that it holds true for less than k positive roots and that we have a polynomial P(X) with k positive roots. Then, for any root $\alpha > 0$, $P(X) = (X-\alpha)Q(X)$, for some polynomial $Q(X)$ with $k-1$ positive roots. By induction, $Q(X)$ has at least $k-1$ sign changes. Therefore, $P(X)$ has at least $(k-1)+1 = k$ sign changes.

Proposition 1. If a polynomial P(X) has no positive roots then its coefficients have an even number of sign changes.

Proposition 2. If all the coefficients of P(X) are positive, then P(X) has no positive roots.

Corollary 2. If all the coefficients of P(X) are nonzero and alternate in sign, then P(X) has no negative roots.

Proposition 3. If a polynomial P(X) of degree n has n positive roots, then its coefficients are all nonzero and the signs of the coefficients of P(X) alternate.

Proof. We proceed by induction on n.

For $n = 0$ are no roots and no sign changes.
For $n = 1$, there is one sign alternation and the coefficients of $P_1 X - P_0$ are nonzero.
Suppose now that $n > 1$ and the proposition holds for polynomials of degree up to $n-1$ and consider a polynomial of degree n having n positive roots. By induction it may be written as the product

$$(X-\alpha)\sum_{k=0}^{n-1}(-1)^{n-1-k} P_k X^k$$

with α and all P_k positive.
Expanding, we get:

$$(-1)^n \alpha P_0 + \sum_{k=1}^{n-1}[(-1)^{n-k}\alpha P_k + (-1)^{n-k-2} P_{k-1}]X^k +$$

$$+P_{n-1}X^n = (-1)^n \alpha P_0 + \sum_{k=1}^{n-1}(-1)^{n-k}(\alpha P_k + P_{k-1})X^k +$$

$$+P_{n-1}X^n$$

which also has nonzero coefficients with alternating signs.

Corollary 3. If a polynomial of degree n has n negative roots, then its coefficients are all nonzero and the signs of the coefficients of P(X) all agree.

Proposition 4. If a polynomial Q(X) with real coefficients exhibits m sign changes, then for any $\alpha > 0$, the polynomial $P(X) = (X-\alpha)Q(X)$ exhibits at least m+1 sign changes.

Proof. Let the degree of Q(X) be n. Then forming $P(X) = (X-\alpha)Q(X)$ we get:

$$P(X) = -\alpha Q_0 + \sum_{k=1}^{n}(Q_{k-1} - \alpha Q_k)X^k + Q_n X^{n+1}$$

This says that $P_{n+1} = Q_n = 1$ and hence has the same sign. Furthermore, as we scan from $k = n$ down to $k = 1$ have that at every sign transition between Q_k and Q_{k-1} the value of $P_k = P_{k-1} - \alpha Q_k$ has the same sign as Q_{k-1}. Thus, starting with P_{n+1}, there is a subsequence Q_{kj-1} of coefficients of Q(X). Since the number of sign changes in the full sequence P_k is no less than the number of sign changes in any subsequence, we have accounted for at least m sign changes in P(X). Finally, $P(0)$ has a sign opposite to that of $Q(0)$ and hence opposite to that of P_{km}. Therefore P(X) has at least m+1 sign changes.

Theorem 3. If in $P(X)$ the first negative coefficient is preceded by k coefficients which are positive or zero, and if Q denotes the greatest of the magnitudes of the negative coefficients, then P(X) is always positive for $X \geq 1 + \sqrt[j]{Q/P_n}$ and so all real roots are less than that value.

Proof. We zero out all but the first of the leading k nonnegative coefficients and replace all following coefficients with –Q. Then, for $X > 1$ we have:

$$P(X) \geq P_n X^n - Q\sum_{k=0}^{n-j} X^k$$

$$> P_n X^{j-1}(X^{n-j+1} - 1) - Q\frac{X^{n-j+1}-1}{X-1}$$

$$> \frac{X^{n-j+1}-1}{X-1}(P_n(X-1)^j - Q)$$

Thus P(X) is positive for $X - 1 \geq \sqrt[j]{Q/P_n}$ and all real roots must be less than $1 + \sqrt[j]{Q/P_n}$.

Proposition 5.. If there is one sign change in the coefficients of P(X), then it has exactly one positive root.

Proof. Let $\alpha > 0$ be the smallest and form the polynomial $Q(X) = \alpha^{-n}P(\alpha X)$. The coefficients of this new polynomial have the same signs as the original and the smallest positive root is shifted to $X = 1$. We show that Q is positive for $X > 1$ and that $X = 1$ is a simple root.

Splitting the positive and negative terms out, we write $Q(X) = S(X) - R(X)$, where the coefficients of S and R are nonnegative, and let j be as in *Theorem 4.* so that S has j coefficients. Factoring we have

$$Q(X) = Q(X) - Q(1)$$

$$= \sum_{k=n-j+1}^{n} S_k(X^k - 1) - \sum_{k=0}^{n-j} R_k(X^k - 1)$$

$$= (X-1)\left[\sum_{k=n-j+1}^{n} S_k\theta_k(X) - \sum_{k=0}^{n-j} R_k\theta_k(X)\right]$$

$$= (X-1)T(X)$$

Note that the $k = 0$ terms in the second term is identically zero. Writing $0 = R_0 - R_0$, we now show that $T(X)$ is positive for $X \geq 1$, and thus $X = 1$ is a simple root and $Q(X)$ is positive for $X > 1$.

$$T(X) \geq \theta_{n-j+1}(X)\left[R_0 + \sum_{k=n-j+1}^{n} S_k - \sum_{k=0}^{n-j} R_k\right]$$

$$\geq \theta_{n-j+1}(1)[R_0 + Q(1)]$$

$$= (n-j+1)\cdot R_0 > 0$$

We conclude therefore that $Q(X)$ and $P(X)$ has exactly one positive root.

Corollary 4. The number of negative roots of P(X) does not exceed the number of sign series separated by an even number of missing terms added to the number of sign changes separated by an odd number of missing terms in P(X).

Corollary 5. The number of complex roots of P(X) exceeds by a nonnegative even integer the number of missing terms plus the number of sign series separated by an odd number of terms less the number of sign changes separated by an odd number of missing terms.

3. EXAMPLES

Example 1. Apply Descartes' rule of signs to the following polynomials:

a) $P(X) = X^3 + 5X^2 - 34$

In the sequence of coefficients of P(X) is a sign change, so the polynomial has a positive real root.

$$P(-X) = (-X)^3 + 5(-X)^2 - 34 = -X^3 + 5X^2 - 34$$

In the sequence of coefficients of $P(-X)$ are two sign changes, so the polynomial has two or zero negative real roots.

Positive roots	Negative roots	Complex roots
1	2	0
1	0	2

b) $P(X) = X^5 - 3X^3 + 7X - 4$

In the sequence of coefficients of P(X) are three sign changes, so the polynomial has three positive real roots or one positive real root.

$$P(-X) = -X^5 + 3X^3 - 7X - 4$$

In the sequence of coefficients of $P(-X)$ are two sign changes, so the polynomial has two or zero negative real roots.

Positive roots	Negative roots	Complex roots
3	2	0
3	0	2
1	2	2
1	0	4

The roots number of a polynomial can be found using different programs, for example, we can use the programs "Matlab", "Mathematica" or "Maple", so we can found and the roots of polynomial.

Example 2. Apply the programs "Mathematica", "Matlab" or "Maple" to found the roots of polynomials

a) $P(X) = X^6 + 2X^4 - 1$.

With "Matlab", using instruction:

```
>> c=[1 0 2 0 0 0 -1];
>> roots(c)
```

we get:

```
ans=
   -0.7862
    0.0000+1.2720i
    0.0000-1.2720i
    0.0000+1.0000i
    0.0000-1.0000i
    0.7862
```

With "Maple", using instruction:

```
> ec1:= x^6+2*x^4-1
> solve(ec1, x)
```

we get:

```
I, -I, -(1/2)*sqrt(-2+2*sqrt(5)) ,
(1/2)*sqrt(-2+2*sqrt(5)) ,
-(1/2*I)*sqrt(2+2*sqrt(5)) ,
(1/2*I)*sqrt(2+2*sqrt(5)) .
```

With "Mathematica", using instruction:

```
Solve[x^6+2x^4-1==0, x]
```

we get:

```
{{x->-\[ImaginaryI]},{x->\[ImaginaryI]},
{x->-Sqrt[-1/2+Sqrt[5]/2]},
{x->Sqrt[-1/2+Sqrt[5]/2]},
{x->-\[ImaginaryI]Sqrt[1/2 (1+Sqrt[5])]},
{x->\[ImaginaryI]Sqrt[1/2 (1+Sqrt[5])]}}.
```

b) $P(X) = X^8 + X^4 + 1$

With "Matlab", using instruction:

```
>> c=[1 0 0 0 1 0 0 0 1];

>> roots(c)
```

we get:

```
ans=
   -0.8660+0.5000i
   -0.8660-0.5000i
   -0.5000+0.8660i
   -0.5000-0.8660i
    0.5000+0.8660i
```

$0.5000 - 0.8660i$
$0.8660 + 0.5000i$
$0.8660 - 0.5000i$

With “Maple”, using instruction:

```
> ec1 := x^8 + x^4 + 1
> solve(ec1, x)
```

we get:

$$-\frac{1}{2}+\frac{1}{2}I\sqrt{3},\quad -\frac{1}{2}-\frac{1}{2}I\sqrt{3},\quad \frac{1}{2}+\frac{1}{2}I\sqrt{3},\quad \frac{1}{2}-\frac{1}{2}I\sqrt{3},$$
$$-\frac{1}{2}\sqrt{2+2I\sqrt{3}},\quad \frac{1}{2}\sqrt{2+2I\sqrt{3}},\quad -\frac{1}{2}\sqrt{2-2I\sqrt{3}},$$
$$\frac{1}{2}\sqrt{2-2I\sqrt{3}}$$

With “Mathematica”, using instruction:

```
Solve[x^8 + x^4 + 1 == 0, x]
```

we get:

$$\{\{x \to -(-1)^{1/6}\},\quad \{x \to (-1)^{1/6}\},\quad \{x \to -(-1)^{1/3}\},$$
$$\{x \to (-1)^{1/3}\},\quad \{x \to -(-1)^{2/3}\},\quad \{x \to (-1)^{2/3}\},$$
$$\{x \to -(-1)^{5/6}\},\ \{x \to (-1)^{5/6}\}\}$$

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CONCERNING THE BEHAVIOR OF THE HARMONICALLY FORCED DOUBLE PENDULUM

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ABSTRACT

The goal of the paper it was to study a simple double pendulum driven by an harmonically external force acting on the outer bob. We have interested on the influence of the direction and magnitude of the external force on the double pendulum's motion. First the physical system was introduced and the equations of motion are derived. Then we have solved numerically these equations for three cases: unforced pendulum, horizontal and vertical harmonically forced pendulum, respectively. For every case we have computed some tools for regularity and chaos (time series curves, phase plane, Poincare section of surface, largest Lyapunov exponent, fast Lyapunov indicator and smaller alignment index). Because of the excellent agreement between all these indicators, we could derive firm conclusions about the behavior of harmonically forced double pendulum.

Keywords: *Forced double pendulum, indicators of quasiperiodic and chaotic modes of behavior.*

1. INTRODUCTION

The pendulum is a tool that scientists have been using for many centuries to understand motion [1]. Although the pendulum has been studied for such a long period of time it is still able to surprise many with its remarkable properties. In mechanics and physics investigations of single and coupled pendulums are widely applied. There is no doubt that the pendulum is one of the objects that have deserved more attention in modelling all kind of phenomena related to oscillations, bifurcations and chaos [2-5]. On the other hand, many oscillatory problems may be reduced in some way to the equation of the pendulum. One could argue that, as a kind of oscillatory unit, it may be found everywhere where oscillations occur [6, 7].

Variants of the simple double pendulum have been considered, including an asymmetrical version and a configuration in which the inner mass is displaced along the rod. The dynamics of the general symmetric compound double pendulum has also been investigated, including a proof that it is a chaotic system. Other studies have referred to the analysis of forces in the double pendulum and their time development [8] or to the parametric double pendulum which is driven by a oscillating support motion in the vertical direction [9].

In the present work, we have studied a simple double pendulum driven by an external force acting on the outer bob. We have interested on the influence of the direction and magnitude of the external force on the double pendulum's motion. The scheme of the paper is as follows: In Section 2 we derived the equations of motion using Newton's law. In Section 3 we briefly discussed standard methods of evaluation in relation to periodic, quasiperiodic and chaotic modes of behaviour. The equations of motion are solved numerically in Section 4 for three cases: unforced pendulum, horizontal and vertical harmonically forced pendulum, respectively. In Section 5, we conclude by summarizing our discussions.

2. EQUATIONS OF MOTION

The simple double pendulum consists of one pendulum fixed to the end of another pendulum. The inner pendulum is modeled as a massless rod of length l_1 with a mass m_1 on the end. The outer pendulum is attached to the mass of the inner pendulum and is similarly a massless rod of length l_2 and a mass m_2. A periodic force $F = F_0 \cos \omega t$, making an angle α with the vertical has been applied to B, as seen in Figure 1.

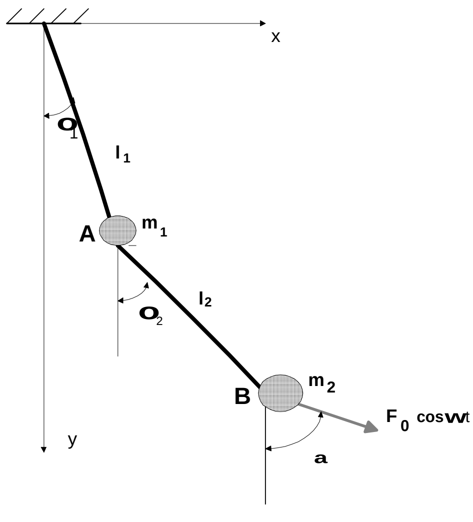


Figure 1 Forced double pendulum

Using the Newton equation of motion for a material point, $M \ddot{\vec{r}} = \sum \vec{F}$, we can derive the equations of motion for the double pendulum by initially defining the positions of the first and second mass:

$$\vec{r}_A = l_1 \sin\theta_1 \vec{i} + l_1 \cos\theta_1 \vec{j} \quad (1a)$$

$$\vec{r}_B = \left(l_1 \sin\theta_1 + l_2 \sin\theta_2\right)\vec{i} + \left(l_1 \cos\theta_1 + l_2 \cos\theta_2\right)\vec{j} \quad (1b)$$

where θ_1 and θ_2 are the displaced angles.

The velocity vectors of A and B are the derivative with respect to time *t* of the position vectors:

$$\vec{v}_A = \dot{\vec{r}}_A = \left(l_1 \cos\theta_1 \,\vec{i} - l_1 \sin\theta_1 \,\vec{j}\right)\cdot \dot{\theta}_1 \qquad (2a)$$

$$\vec{v}_B = \dot{\vec{r}}_B = \left(l_1 \dot{\theta}_1 \cos\theta_1 + l_2 \dot{\theta}_2 \cos\,\theta_2\right)\cdot \vec{i} - \qquad (2b)$$

$$-\left(l_1 \dot{\theta}_1 \sin\theta_1 + l_2 \dot{\theta}_2 \sin\,\theta_2\right)\cdot \vec{j}$$

The acceleration vectors of A and B are the derivative with respect to time of the velocity vectors:

$$\vec{a}_A = \dot{\vec{v}}_A = \left(l_1 \ddot{\theta}_1 \cos\theta_1 - l_1 \dot{\theta}_1^2 \sin\theta_1\right)\vec{i} -$$

$$-\left(l_1 \ddot{\theta}_1 \sin\theta_1 + l_1 \dot{\theta}_1^2 \cos\theta_1\right)\vec{j} \qquad (3a)$$

$$\vec{a}_B = \dot{\vec{v}}_B = \left[l_1\left(\ddot{\theta}_1 \cos\theta_1 - \dot{\theta}_1^2 \sin\theta_1\right) + \right.$$

$$\left. + l_2\left(\ddot{\theta}_2 \cos\theta_2 - \dot{\theta}_2^2 \sin\theta_2\right)\right]\vec{i} - \left[l_1\left(\ddot{\theta}_1 \sin\theta_1 + \dot{\theta}_1^2 \cos\theta_1\right)\right.$$

$$\left. + l_2\left(\ddot{\theta}_2 \sin\theta_2 + \dot{\theta}_2^2 \cos\theta_2\right)\right]\vec{j} \qquad (3b)$$

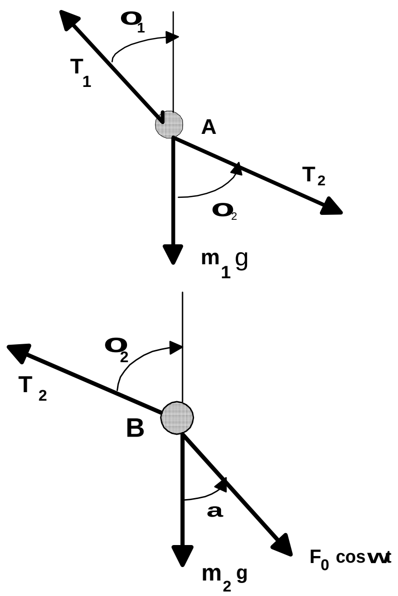


Figure 2 Forces on double-pendulum system

The Newton equation is written for each mass:

$$m_1 \vec{a}_A = \vec{T}_1 + \vec{T}_2 + m_1 \vec{g} \qquad (4a)$$

$$m_2 \vec{a}_B = -\vec{T}_2 + \vec{F} + m_2 \vec{g} \qquad (4b)$$

where $\vec{T}_1$ and $\vec{T}_2$ are tension forces along the rod. In projection on x-y axis, the equations (4) become:

$$m_1 l_1\left(\ddot{\theta}_1 \cos\theta_1 - \dot{\theta}_1^2 \sin\theta_1\right) = -T_1 \sin\theta_1 + T_2 \sin\theta_2$$

$$-m_1 l_1\left(\ddot{\theta}_1 \sin\theta_1 + \dot{\theta}_1^2 \cos\theta_1\right) = -T_1 \cos\theta_1 + T_2 \cos\theta_2 + m_2 g$$

$$m_2 l_1\left(\ddot{\theta}_1 \cos\theta_1 - \dot{\theta}_1^2 \sin\theta_1\right) + m_2 l_2\left(\ddot{\theta}_2 \cos\theta_2 - \dot{\theta}_2^2 \sin\theta_2\right) =$$

$$= -T_2 \sin\theta_2 + F_0 \cos\omega t \sin\alpha \qquad (5)$$

$$-m_2 l_1\left(\ddot{\theta}_1 \sin\theta_1 + \dot{\theta}_1^2 \cos\theta_1\right) - m_2 l_2\left(\ddot{\theta}_2 \sin\theta_2 + \dot{\theta}_2^2 \cos\theta_2\right) =$$

$$= -T_2 \cos\theta_2 + F_0 \cos\omega t \cos\alpha + m_2 g$$

The equations of motion for double pendulum are obtained by eliminating T_1 and T_2 in eqs (5). They represent two nonlinear differential equations. After some algebra we get

$$(m_1 + m_2) l_1 \ddot{\theta}_1 + m_2 l_2 \ddot{\theta}_2 \cos(\theta_2 - \theta_1) - m_2 l_2 \dot{\theta}_2^2 \sin(\theta_2 - \theta_1) +$$

$$+(m_1 + m_2) g \sin\theta_1 = F_0 \cos\omega t \sin(\alpha - \theta_1) \qquad (6a)$$

$$m_2 l_1 \ddot{\theta}_1 \cos(\theta_2 - \theta_1) + m_2 l_2 \ddot{\theta}_2 + m_2 l_1 \dot{\theta}_1^2 \sin(\theta_2 - \theta_1) +$$

$$+m_2 g \sin\theta_2 = F_0 \cos\omega t \sin(\alpha - \theta_2) \qquad (6b)$$

If we use the variables

$$w_1 = \theta_1 \;,\; w_2 = \dot{\theta}_1 \;,\; w_3 = \theta_2 \;,\; w_4 = \dot{\theta}_2 \qquad (7)$$

and the substitutions

$$a = (m_1 + m_2) l_1 \,,\, b = m_2 l_2 \cos(w_1 - w_3),$$

$$c = m_2 l_1 \cos(w_1 - w_3),\, d = m_2 l_2,$$

$$e_1 = -m_2 l_2 w_4^2 \sin(w_1 - w_3) - (m_1 + m_2) g \sin w_1 \qquad (8)$$

$$f_1 = -m_2 l_1 w_2^2 \sin(w_1 - w_3) - m_2 g \sin w_1,$$

$$e_2 = F_0 \cos\omega t \sin(\alpha - w_1),\, e = e_1 + e_2\,,$$

$$f_2 = F_0 \cos\omega t \sin(\alpha - w_3),\; f = f_1 + f_2$$

the system (6) becomes a first order ODE system:

$$\frac{dw_1}{dt} = w_2,\; \frac{dw_2}{dt} = \frac{ed - bf}{ad - be},\; \frac{dw_3}{dt} = w_4,\; \frac{dw_4}{dt} = \frac{af - ce}{ad - be}$$

Before closing this section, let point out that the kinetic (T) and potential (V) energies are given by

$$T = \frac{1}{2}(m_1 + m_2) l_1^2 \dot{\theta}_1^2 + \frac{1}{2} m_2 l_2^2 \dot{\theta}_2^2 + m_2 l_1 l_2 \dot{\theta}_1 \dot{\theta}_2 \cos(\theta_1 - \theta_2)$$

$$V = (m_1 + m_2) g l_1 (1 - \cos\theta_1) + m_2 g l_2 (1 - \cos\theta_2) \qquad (9)$$

3. TOOLS FOR REGULARITY AND CHAOS

3.1 Time series curves

This method is easiest one and it is a visual method. The state variables of the system are observed in time and if they exhibit irregular or unpredictable behaviour, then it is called chaotic. Otherwise (fixed point, periodic and quasi-periodic) it is called regular. In our study, we'll represent the position of the two arms versus time, $\theta_{1,2} = \theta_{1,2}(t)$.

3.2 Phase plane

Phase plane is a two-dimensional projection of the phase space. It represents each of the state variable's instantaneous state to each other. The different motions of the dynamical system can be easy distinguished visually from each other. So, a fixed point solution is a point in the phase plane. A periodic solution is a closed curve, while a quasi-periodic solution is a curve on a torus. In the end, chaotic solutions are distinct and complicated curves in phase plane.

In the next section, we'll plot as an example of a phase plane the motion of the outer bob $y_B = y_B(x_B)$, and the dependence $\theta_2 = \theta_2(\theta_1)$.

3.3 Poincare section

It is a method of displaying the character of a particular trajectory without examining its complete time development, in which the trajectory is sampled periodically, and the rate of change of a quantity under study is plotted against the value of that quantity at the beginning of each period. In fact, the different types of motions appear as finite number of points for periodic orbits, curve filling points for quasi-periodic motions and area filling points for chaotic trajectories. For a better understanding, we'll plot the two-dimensional Poincare section (w_1, w_2), where the two conditions $w_3 = 0$ and $w_2 \cos w_1 > 0$ are fulfilled.

3.4 Largest Lyapunov exponent

The Lyapunov characteristic Exponents (LCEs) are asymptotic measures characterizing the average rate of growth (or shrinking) of small perturbations to the solutions of a dynamical system. The value of the Largest Lyapunov Exponent is an indicator of the chaotic and regular nature of orbits, while the whole spectrum of LCEs is related to entropy and dimension-like quantities that characterize the underlying dynamics. For a chaotic orbit at least one LCE is positive, implying exponential divergence of nearby orbits, while in the case of regular orbits all LCEs are negative. Usually the computation of only the Largest Lyapunov Exponent is sufficient for determining the nature of an orbit, because if it is positive then the orbit is chaotic. The method to calculate the Largest Lyapunov Exponent is to first plot the natural logarithm of the separation between the two closely launched trajectories against time and then find the slope of the region where it is increasing.

3.5 Largest Lyapunov indicator (FLI)

The FLI is defined as follows:

Starting with a m-dimensional basis $V_m(0) = (v_1(0), v_2(0), ..., v_m(0))$ embedded in an n-dimensional space with an initial condition $(x_1(0), x_2(0), ..., x_n(0))$ we take at each iteration the largest amongst the vectors of the evolving basis. Thus, the FLI is defined as:

$$FLI = \sup \|v_j\|,\ j = 1,2,..,m \tag{10}$$

Froeschle has shown that FLI increases exponentially for chaotic orbits and decreases to zero or present a linear variation for a regular orbit [10, 11].

3.6 Smaller Alignment Index (SALI)

This indicator was introduced by Skokos in 2001 as follows:

Let us consider a n-dimensional phase space of a dynamical system and an orbit in that space with initial condition $(x_1(0)\ x_2(0)...x_n(0))$. In order to determine if this orbit is ordered or chaotic we follow the evolution in time of two different initial deviation vectors $\xi_1(0), \xi_2(0)$. In every time step, we compute the parallel alignment index (ALI):

$$d_-(t) = \left\| \frac{\xi_1(t)}{\|\xi_1(t)\|} - \frac{\xi_2(t)}{\|\xi_2(t)\|} \right\| \tag{11}$$

and the antiparalel ALI

$$d_+(t) = \left\| \frac{\xi_1(t)}{\|\xi_1(t)\|} + \frac{\xi_2(t)}{\|\xi_2(t)\|} \right\| \tag{12}$$

where $\| \ \|$ denotes the Euclidian norm of a vector.

The smaller alignment index (SALI) is defined as the minimum value of the above alignment indices at any point in time

$$SALI(t) = \min(d_-(t), d_+(t)) \tag{13}$$

Skokos shows that for systems of *n*-dimensional phase space, the two deviation vectors tend to coincide or become opposite for chaotic orbits, i.e. the SALI tends to zero (because the deviation vectors tends to coincide with the direction of the most unstable nearby manifold). For ordered orbits, which lie on a torus, the two deviation vectors eventually become tangent to the torus, but in general converge to different directions, so the SALI does not tend to zero. Its values fluctuate around a positive value [12].

4. NUMERICAL RESULTS

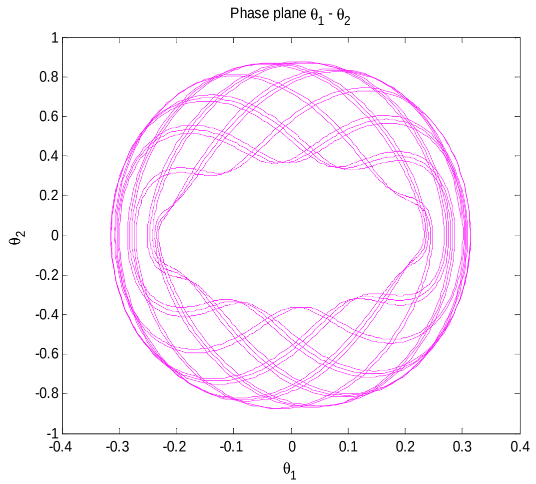
Throughout our numerical study, the next values remain fixed:

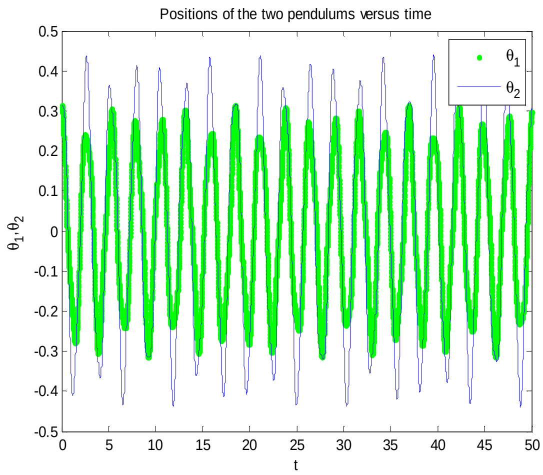
$$m_1 = m_2 = l_1 = l_2 = 1,\ g = 9.8$$

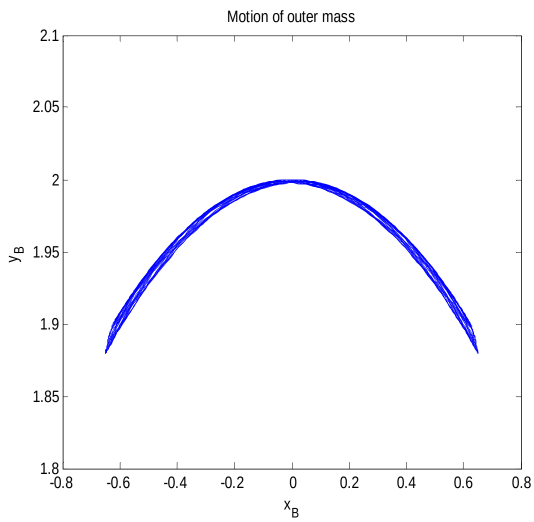
$$\left(\theta_1(0), \dot{\theta}_1(0), \theta_2(0), \dot{\theta}_2(0)\right) = (\pi/10, 0, \pi/10, 0)$$

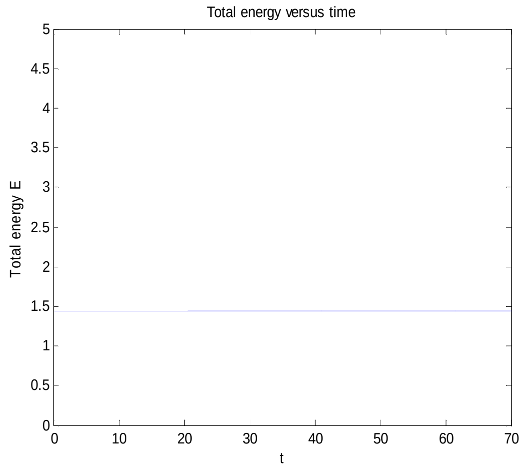
Case I: Unforced double pendulum ($F_0 = 0$)

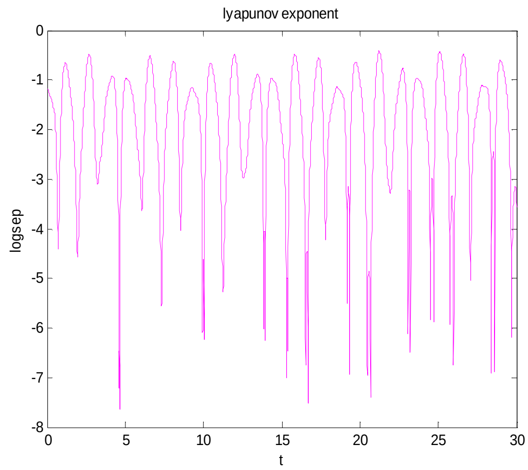
The motion of the double pendulum is quasi-periodic. The phase-plane $(\theta_1 - \theta_2)$ reinforces the previous observation (Figure 3a). Figure 3b shows the position of the two arms versus time while Figure 3c presents the motion of outer bob. The total energy $E = T + V$ is constant during the evolution (Figure 3d) and equal to 1.45 J (indicating a conservative mechanical system). The largest Lyapunov exponent is negative (Figure 3e). The 2-D Poincare section $\left(\theta_1, \dot{\theta}_1\right)$ is represented in Figure 3f and looks like a painted egg. As Skokos and Froeschle said, the SALI fluctuates around a positive value (about 1.07) and lg(FLI) presents a linear variation (Figures 3 g, h).

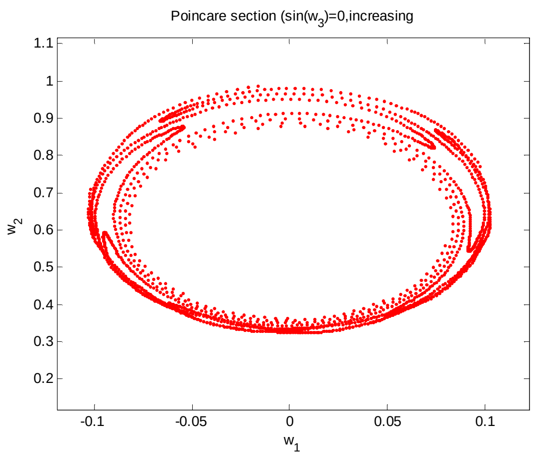


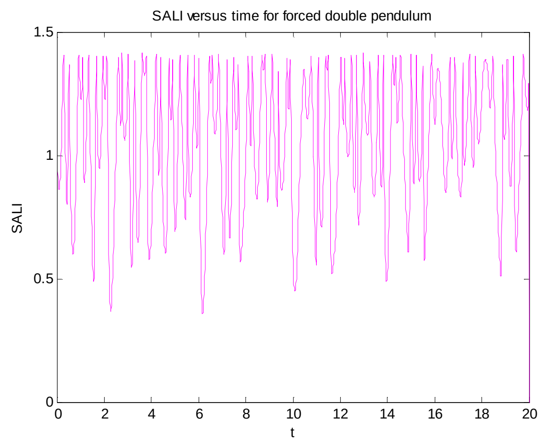












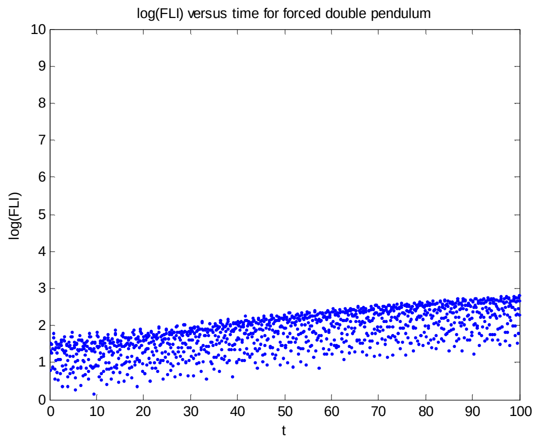
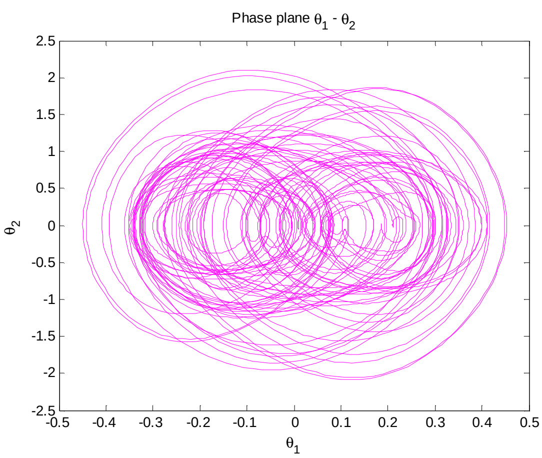
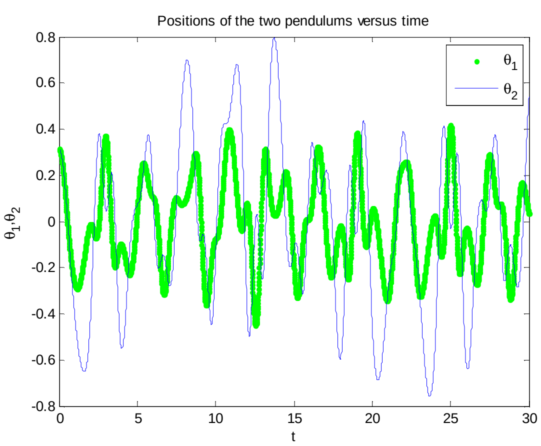


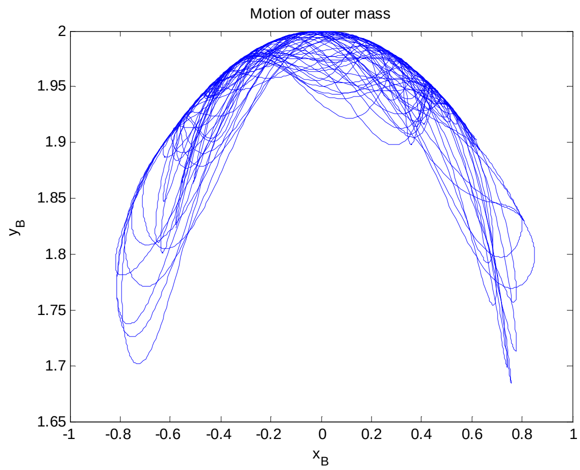
Figure 3: Tools for regularity and chaos in the case of unforced double pendulum

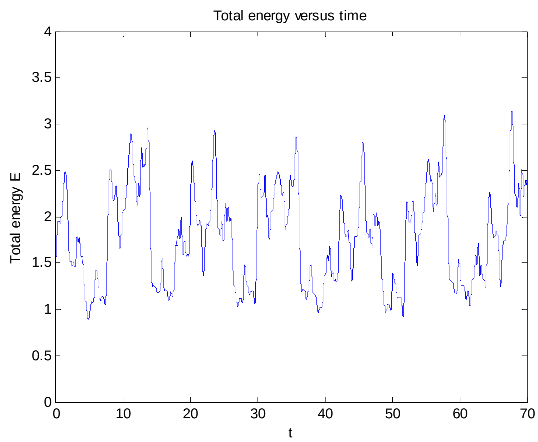
Case II: Vetical forcing ($F_0 = 6.5\ N, \omega = 2\ rad/s$)

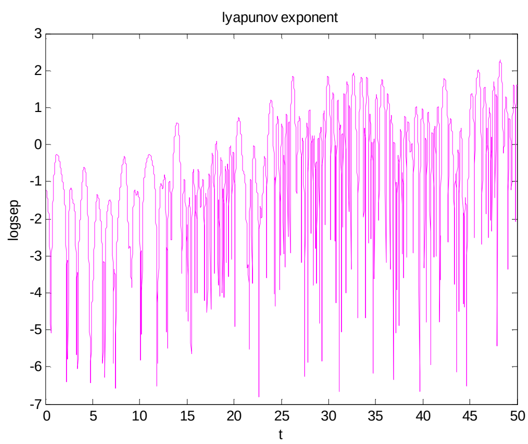
The motion becomes chaotic but the previously seen behaviour is roughly preserved (Figures 4 a-c). The total energy ceases to be constant and fluctuates about mean value E=1.9 J (Figure 4d). The largest Lyapunov exponent starts being negative but after 15 s becomes positive and continues to grow (Figure 4e). The Poincare section is area filling (Figure 4f). SALI vanishes after 125 s (Figure 4g) while *lg(FLI)* increases linearly but with a slope slightly higher than in Case I (Figure 4h).

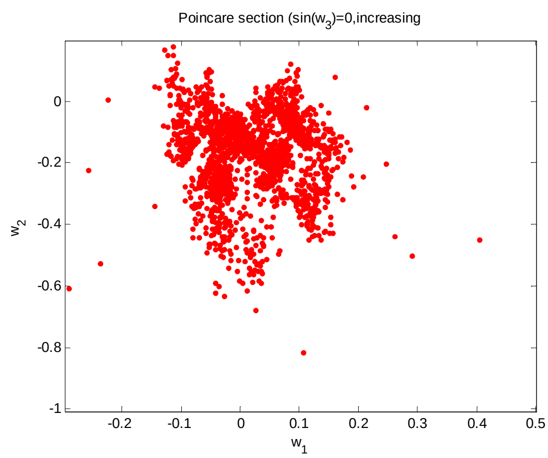












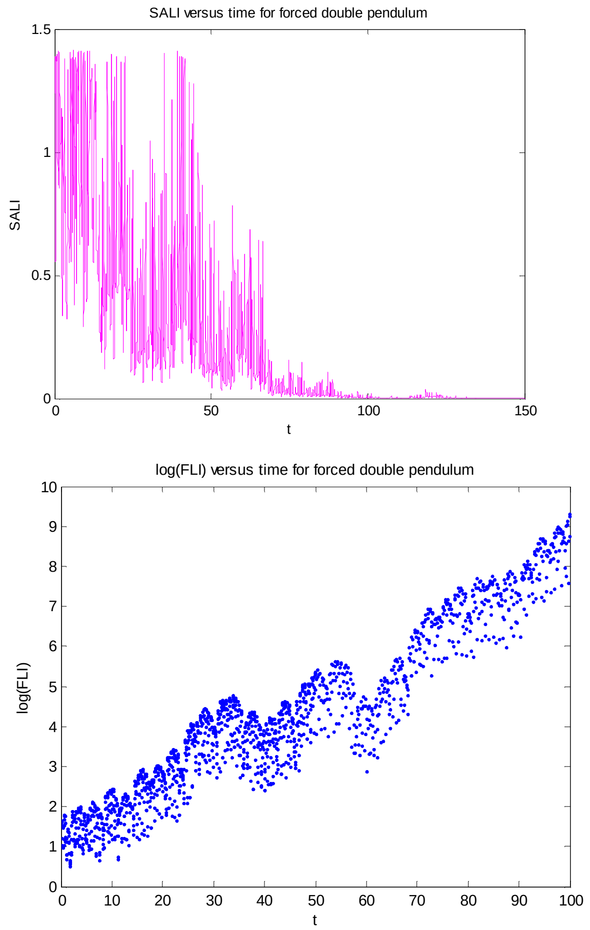
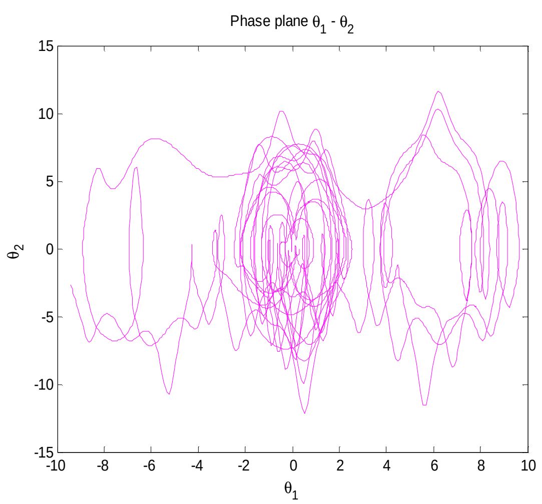
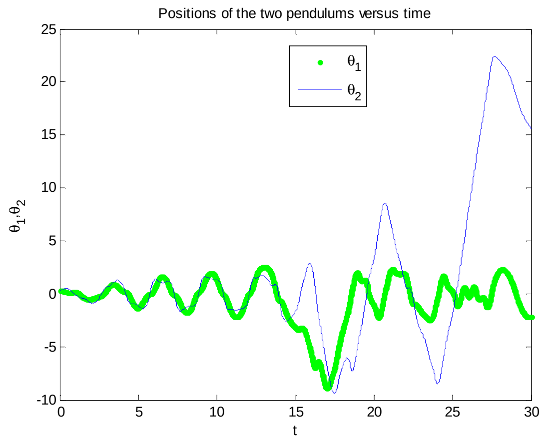


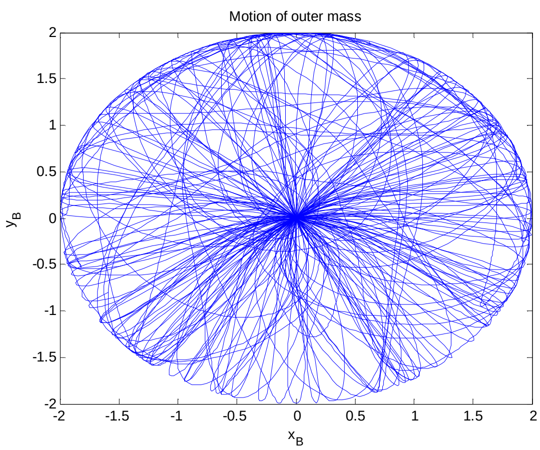
Figure 4: Tools for regularity and chaos in the case of vertical forcing

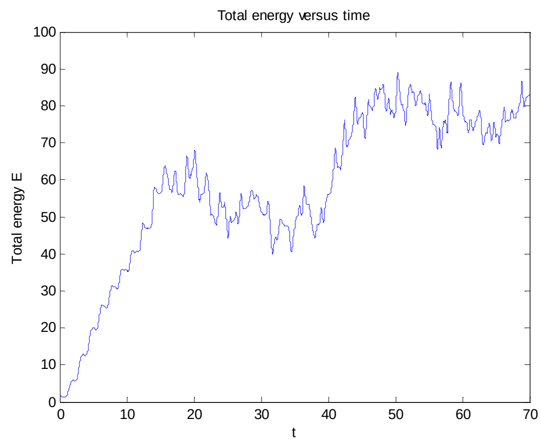
Case III: Horizontal forcing ($F_0 = 4\,N, \omega = 2\,rad/s$)

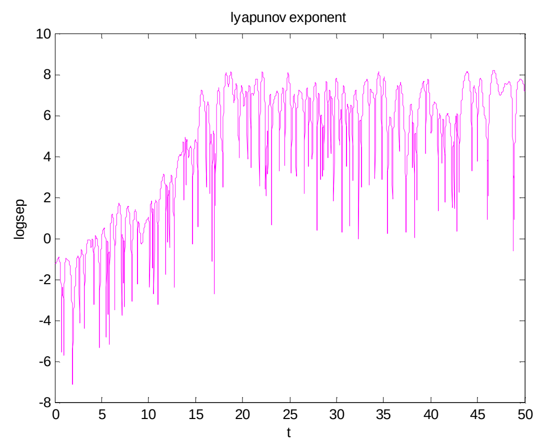
We have a well-developed chaos (Figures 5a-c). The motion is unpredictable and there are a lot of time intervals in which the two pendulums behave as rotors. The energy intake in the system is substantially higher than in previous case and continues to grow during the motion (Figure 5d). The Lyapunov exponent is strong positive (Figure 5e) and Poincare section is area filling (Figure 5f). SALI tends to zero very quickly (in 17 s) while FLI increases exponentially (Figures 5 g, h).











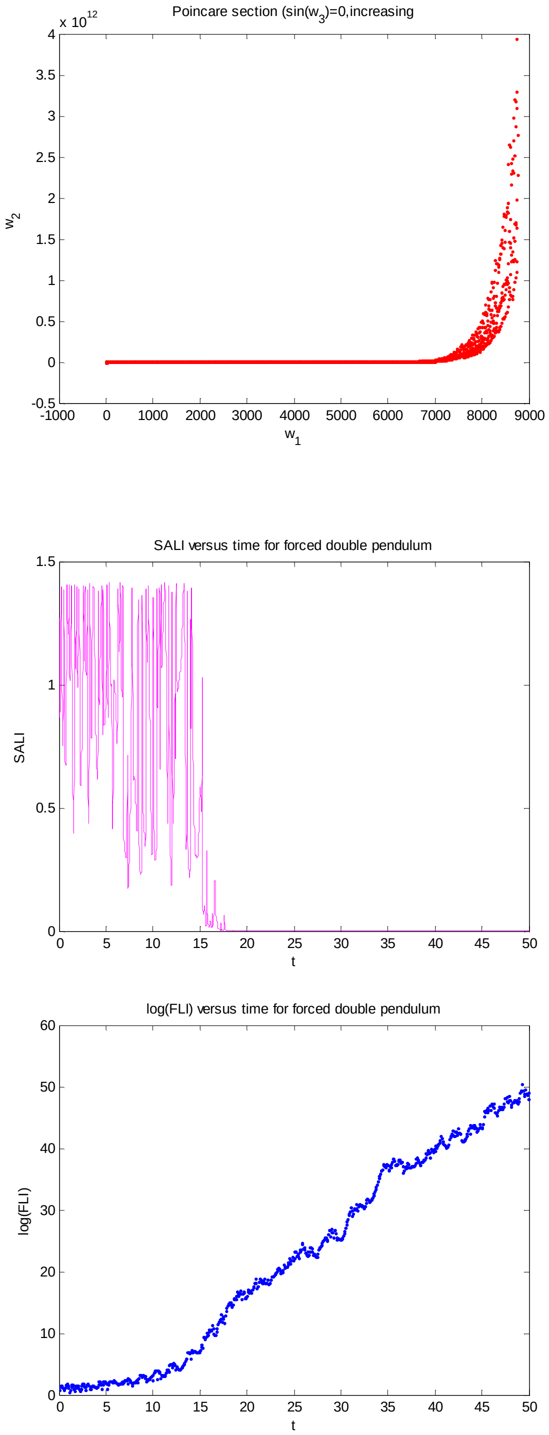


Figure 5: Tools for regularity and chaos in the case of horizontal forcing

5. CONCLUSIONS

In the paper we have numerically investigated the dynamics of the simple double pendulum driven by an harmonically external force acting on the outer bob. Our purpose was to determine the influence of the magnitude and direction of the external force on the system's behavior. We started with an unforced double pendulum which motion is quasiperiodic. Keeping the same initial conditions, we firstly applied to the outer bob an external harmonic force acting on the vertical direction and then in the horizontal direction. In both cases the double pendulum has a chaotic behavior. We have observed that the onset of chaos occurs at a significantly lower magnitude of external force when it acts in horizontal direction (at the same frequency of the exciting force). To make the distinction between the three cases, classic and modern tools to identify regular and chaotic behavior have been used. We think that other numerical studies are necessary for a better understanding of the behavior of the harmonically forced double pendulum.

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SOME MODELS TO MEASUREMENT THE EFFIENCY AND A REVIEW OF LITERATURE ON DATA ENVELOPMENT ANALYSIS

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ABSTRACT

This paper present a model of data envelopmet analysis, the topics of other alternative models and a set of papers who presents bibliography and taxonomy of DEA.

Keywords: *data envelopment analysis , efficiency, productivity, models, bibliography, taxonomy, .*

1. INTRODUCTION

Data Envelopment Analysis is a nonparametric approach [1] to benchmarking the relative efficiency of decision making units (DMUo) that use multiple inputs to produce multiple outputs.

DEA is a linear programming-based methodology and evaluates the efficiency of each DMU relative to an estimated production possibility frontier determined by all DMUs.

DEA methodology does not require any assumption concerning the internal operations of DMU.

For each DMU we tried to analyze the productivity as a ratio between output and input:

$$\text{Productivity} = \frac{output}{input},$$

and compare one DMU to another. This ratio is a commonly used measure of efficiency.

Data Envelopment Analysis uses mathematical programming to transform the ratio measure of efficiency, who is a fractional program (FP), to a linear program (LP)

2. THE BASIC CCR-MODEL.

The model was proposed by Charnes, Cooper and Rhodes in 1978 [2] and is the seminal work to this field of Operation Research/Management Science.

For each DMUo they formed a virtual input (x_{mo}) and output (y_{so}) by weight v_m and u_s :

$$virtual\_input_o = (\mathrm{v}_1\mathrm{x}_{1o} + ... + \mathrm{v}_m\mathrm{x}_{mo})$$

$$virtual\_output_o = (\mathrm{u}_1 y_{1o} + ... + \mathrm{u}_s y_{so})$$

The goal is to determine the weight using a linear programming and to maximize:

$$\frac{virtual\_output_o}{virtual\_input_o}$$

The model measures the efficiency of each DMU and is a fractional program (FPo):

$$\text{(FPo)} \max_{\mathrm{v,u}} \theta = \frac{\mathrm{u}_1\mathrm{y}_{1\mathrm{o}} + \mathrm{u}_1\mathrm{y}_{1\mathrm{o}}. + .. + \mathrm{u}_1\mathrm{y}_{1\mathrm{o}}}{\mathrm{v}_1\mathrm{x}_{1o} + \mathrm{v}_1\mathrm{x}_{1o}. + .. + \mathrm{v}_m\mathrm{x}_{mo}} \quad (1)$$

Subject to:

$$\frac{\mathrm{u}_1\mathrm{y}_{1j} + \mathrm{u}_2\mathrm{y}_{2j}. + .. + \mathrm{u}_s\mathrm{y}_{sj}}{\mathrm{v}_1\mathrm{x}_{1j} + \mathrm{v}_2\mathrm{x}_{2j}. + .. + \mathrm{v}_m\mathrm{x}_{mj}} \le 1,$$

(j=1…n)

$$v_1, v_2, \ldots, v_m \ge 0$$

$$u_1, u_2, \ldots., u_s \ge 0$$

With the Charnes – Cooper transformation[2], we replace the (FPo) into a linear program (LPo):

(LP):

$$\max_{\mu,\nu} \theta = \mu_1\mathrm{y}_{1\mathrm{o}} + ... + \mu_s\mathrm{y}_{s\mathrm{o}} \quad (2)$$

Subject to:

$$\mathrm{v}_1\mathrm{x}_{1j} + \mathrm{v}_2\mathrm{x}_{2j}. + .. + \mathrm{v}_m\mathrm{x}_{mj} = 1$$

$$\mu_1\mathrm{y}_{1\mathrm{o}} + ... + \mu_s\mathrm{y}_{s\mathrm{o}} \le \mathrm{v}_1\mathrm{x}_{1j} + \mathrm{v}_2\mathrm{x}_{2j}. + .. + \mathrm{v}_m\mathrm{x}_{mj}$$

(j = 1,2, … , n 0

There are two important theorems [3]:

Theorem 1. The fractional program (FPo) is equivalent to (LPo).

Theorem 2 (unit invariance theorem) The optimal values of max θ in (1) and (2) are independent of the units in which the inputs ad outputs are measured provided these units are the same for every DMU.

The (LPo) problem can be solved by the simplex method of linear programming or can be obtained from the dual problem of (LPo).

We have an optimal solution of (LPo) who is: (θ^*, ν^*, μ^*). We can identify who is DMU efficiency as follows:

Definition 1 . (CCR-Efficiency) .

1. DMUo ic CCR efficient if θ^*=1 and there exists at least one optimal (ν^*, μ^*) , with ν^*>0 and μ^*>0.

2. Otherwise , DMUo is CCR-inefficient.

Definition 2. Pareto Koopmans Efficiency [4]. A DMU is to be considered fully (100%) efficient if and only if it is not possible to improve any input or output without worsening some other input or output.

Definition 3. (Relative Efficiency). A DMU is to be rated as fully (100%) efficient on the basis of available evidence if and only if the performances of other DMUs do not show that some of its input or outputs can be improved without worsening some of its other inputs or outputs.

CCR-inefficiency means that :

(a) θ^* = 1 and al least one element of (ν^*, μ^*) is zero for every optimal solution of (LPo), or

(b) θ^* <1.

In (b) case, there must be at least one constraint, or DMU, for which the weight (ν^*, μ^*) produces equality between the left and right sides; let the set of such k ∈ {1,2, ..K} :

$$E_o^{'} = \{ k : \sum_{r=1}^{s} \mu_r^* \; y_{rk} = \sum_{i=1}^{m} v_i^* \; x_{ik} \}$$

The subset E_o of $E_o^{'}$, is called the **reference set** or the **peer group** to the DMUo; the set spanned by E_o is called the **efficient frontier of DMUo**.

The goal is to classify and characterize efficiency and inefficiency of selected DMU.

The optimal solution for (LPo) results in a set of optimal weights for the DMUo. The ratio is:

$$\theta^* = \frac{\sum_{r=1}^{s} \mu_r^* \times y_{ro}}{\sum_{i=1}^{m} v_i^* \times x_{io}} \quad (3)$$

The set (ν^*, μ^*) are most favourable weights for the DMUo in the sense of maximizing the ratio; v_i^* is the optimal weight for the input i and μ_r^* is the optimal weight for the output r.

In figure 1, the DMU (B) is on the efficient frontier and is in the reference set of all the other DMU. The DMU (d) will bring onto efficient frontier by reducing its input :

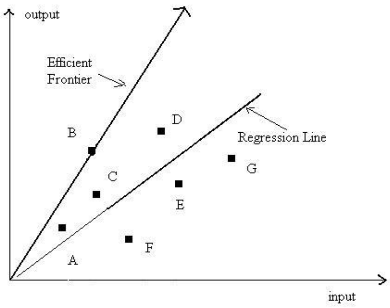

Figure 1 One input, one output. Efficient Frontier and Regression line.

One input two output case:

Figure 2 shows one input and two output case: the DMU(d, e ,f) are inefficient and their efficiency can be evaluated by referring to the frontier lines.

The production possibility set is the region bounded by the axes and the frontier line.

The DMU (a, b ,c ,g) are efficient.

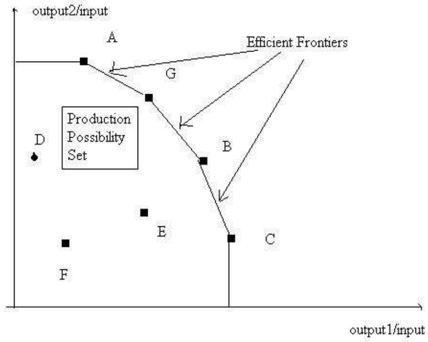

Figure 2. One input and two output case: efficient frontiers and production possibility set

3. ALTERNATIVE MODELS

There are many models and extension of Data Envelopment Analyses [3], [5].

Some of these are:

- CCR model (presented at 2);
- BCC (Banker-Charnes-Cooper) model. The model has its production frontiers spanned by the convex hull of the existing DMU. [6];
- Additive models [7];
- Multiplicative Models;
- Assurance Region DEA Models;
- Cone-ratio Model;
- Allocation models [8];
- SBM – Slack Based Models;
- Chance constrained DEA[9];
- FDH (free disposal hull) Models;
- Non-convex models;
- Non-radial DEA Models;
- Non-controllable Variable Models;
- Non-discretionary Variables Models [10];
- Categorical models [11];
- DEA with Preference Structure;
- Context-dependent DEA;
- Super-efficiency DEA Models;
- DEA with judgments value;
- Dynamic Data Envelopment Analysis;
- Integer DEA Models;
- Fuzzy data envelopment analysis.

4. SOME ASPECTS OF DEA MODELS

The topics for advanced fields in Data Envelopment Analysis literature are:

- Congestion,
- Stability and sensitivity.
- Return to scale
- Most Productive Scale Size
- Qualitative Data in DEA
- Variables with negative values;
- Feasibility and Infeasibility
- Simultaneous data change (in input and/or output);
- Computational aspects
- Distance functions on DEA.

5. UPDATE BIBLIOGRAPHY AND TAXONOMY FOR DATA ENVELOPMENT ANALYSIS

For a comprehensive study, there are some authors who made a bibliography of journal papers, book, principal authors, and the field when the DEA is applied.

Laurence Seiford published in 2005 [12] a bibliography (covers the years 1978-2005), who accompanies the textbook ‘Introduction to data Envelopment Analysis and its uses’; in that bibliography working paper and technical report were excluded. The same author in 1997, in [13] published another papers about the DEA bibliography.

A comprehensive bibliography who covers the years 1951-2001 was published in Socio-Economic Planning Sciences [14].

A dedicated site www.deabib.org shows a bibliography about productivity and efficiency; this database is updated on 2012 journal paper.

Gabriel Tavares [15] writes a bibliography and some statistics about DEA:

- publication number by type, by year, by author,
- a top of authors in several periods, keyword statistics and
-a statistics about DEA publications number by university.

In 2008 has appeared another study [16] with interesting statistics and more thhan 4000 articles published in journals and book chapters.

The statistics are:

-top 20 journals that have published the greatest number of DEA. The first ten are: EJOR – European Journal of Operational Research), JPA – Journal of Productivity Analysis, JORS – Journal of the Operational Research Society, Applied Economics and Annals of Operations Research, Management Science, Omega, Applied Mathematics and computation, Socio-Economic Planning Sciences and International Journal of Production Economics.

- statistics involving publications by authors. The top authors are: Charnes, A, Cooper, W, Seiford, L, Cook, W, Fare, R, Grosskopf, S, Lovell, C.A.K, Thanassoulis, E, Sueyoshi T, Tone, K , Zhu J, Rhodes E, Banker R., Sengupta, J..

- a list of the most popular keywords by number of publication.

Said Gattoufi published a study [17] about taxonomy for data envelopment analysis. This study present a scheme for classifying Data Envelopment Analysis literature.

DEA literature is first classified on four basic factors: data (the source of the data used and the degree of imprecision in the data), envelopment (who is subdivided in six domains characterizing the frontier and the mathematical model used), analysis (subdivided into six domains identifying the different options in the analysis) and nature of the study and methodology it uses.

The methodology combining DEA with other fields is variety:

- methodology combining DEA with Economic Theory (production theory, firm theory), with Game Theory , with Econometrics Theory.
- methodology combining DEA with other OR/MS technique (goal programming, multi criteria decision making, multi objective linear programming, fuzzy sets theory, queuing theory, stochastic programming,).
- methodology combining DEA with statistics (discriminant analysis, cluster amalysis, statistical testing, bootstrapping technique)

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A SURVEY ON FRONTIER ANALYSIS

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ABSTRACT

Measurement of efficiency or inefficiency in economic theory is one of the main topics in literature; this paper shows a parametric technique to estimate the production frontier and is a useful guide to literature in stochastic frontier analysis

Keywords: *Efficiency, Stochastic frontier,Production function,Parametric frontier.*

1. INTRODUCTION

In real economy, the objective is to produce maximum output using minimum cost of some given inputs (or, the dual problem: how is the minimum cost to obtain a given output ?).

One of the most important topics of economy literature is efficiency, the utilization of resource; the ability of a decision-making unit to produce an output using the lowest possible of inputs (input orientation) or output orientation: to obtain the maximum output from a set of inputs.

The productivity can be measured by a ratio of its weight outputs to its weight inputs. The analysis of efficiency means a comparison between optimal values of outputs and inputs and observed values.

The seminal work of Farrel [1] proposed two components of efficiency of a firm: technical/overall efficiency (the ability of a firm to obtain maximal output from set of inputs) and allocative/price efficiency (the ability of a firm to use the inputs in optimal proportions, given the production technology and their respective prices):

$$TE = \frac{observed - output}{potential - output\ (\max - imum)}$$

Where:

TE = Technical efficiency, $0 \le TE \le 1$.

Profit maximization requires a firm to be allocative efficient (by producing the right mix of outputs or using the right mix of inputs given their relative price) and technical efficient (by producing the maximum output given the level of inputs).

In real life, producers are not fully productive efficient and the difference can be explained in terms of technical and allocative inefficiencies.

The estimating of efficiency or inefficiency is one of the main tools of economic analysis.

The production frontier is the maximum output attainable by given sets of inputs and using the technologies; the measure of inefficiency is the deviation from the frontier.

The production functions is a process of transformation of a set of inputs, x into a set(s) of outputs, y.

2. PRODUCTION FRONTIER MODELS

A production frontier model (with cross-sectional data) can be written as:

$$y_i = \mathrm{f}(x_i;\beta) \times TE_i \tag{1}$$

where we have N quantities of inputs to produce a single output, for I producers.

y_i is the scalar output of producer i, i= 1 … I,

x_i is a vector of N inputs used by producer I,

$\mathrm{f}(x_i;\beta)$ is the production frontier,

β is a vector of technology parameters to be estimated.

From (1) , technical efficiency is a ratio of observed output to maximum feasible output:

$$TE_i = \frac{y_i}{\mathrm{f}(x_i;\beta)} \tag{2}$$

For TE_i <1, provides a measure of shortfall of observed output, from maximum feasible output.

In equation (1), $\mathrm{f}(x_i;\beta)$ is deterministic, so the entire shortfall of observed output y_i from the maximum output is attributed to technical inefficiency.

In real economy we have random shocks that are not under control of producer; to incorporate them into analysis we rewrite (1) as a stochastic production frontier:

$$y_i = \mathrm{f}(x_i;\beta) \times \exp\{v_i\} \times TE_i \tag{3}$$

Where:

$\mathrm{f}(x_i;\beta) \times \exp\{v_i\}$ is the stochastic production frontier, and contains two parts: a determinist part: $\mathrm{f}(x_i;\beta)$ and a producer specific part, random-shocks of each producer: $\exp\{v_i\}$.

Technical efficiency becomes:

$$TE_i = \frac{y_i}{\mathrm{f}(x_i;\beta) \times \exp\{v_i\}} \tag{4}$$

The main problem is to estimate TE_i and β.

3. DETERMINIST FRONTIER.

We can rewrite (1) as:

$$y_i = \mathrm{f}(x_i;\beta)\times\exp\{u_i\} \quad (5)$$

where: $TE_i = \exp\{u_i\}$, and $u_i \geq 0$.

We assuming that $\mathrm{f}(x_i;\beta)$ takes log-linear Cobb-Douglas form, then model (5) becomes:

$$\ln y_i = \beta_o + \sum_n \beta_n \ln x_{ni} - u_i \quad (6)$$

Aigner and Chu**[2]** showed that the model (6) can be converted to mathematical programming model: the first model is linear and calculate a parameter vector β with::

$$\text{Min } \sum_i u_i$$

$$\text{Subject to: } \left[\beta_o + \sum_n \beta_n \ln x_{ni}\right] \geq \ln y_i \text{ , i=1…N} \quad (7)$$

The second model is a quadratic programming , and the model is:

$$\text{Min } \sum_i u_i^2$$

$$\text{Subjet to: } \left[\beta_o + \sum_n \beta_n \ln x_{ni}\right] \geq \ln y_i \text{ , i=1…N} \quad (8)$$

The major problem is that the parameters are calculated and not estimated (using regression techniques),and complicated statistical inference about the calculated parameter values.

Schmidt P.[3] shows that the mathematical programming (7) and (8) could have a statistical interpretation if a distribution assumption is imposed on u_i :

The ‘estimates’ of (7) are maximum likelihood estimares of the parameters of the determinist production frontier if the $u_i \geq 0$ follow an exponential distribution :

$$f(u) = \frac{1}{\sigma_u}\exp\left\{-\frac{u}{\sigma_u}\right\} \quad (9)$$

The ‘estimates’ of (8) are maximum likelihood estimates of the parameters of determinist production frontier if the $u_i \geq 0$ follow a half normal distribution:

$$f(u) = \frac{2}{\sqrt{2\pi}\sigma_u}\exp\left\{-\frac{u^2}{2\sigma_u^2}\right\} \quad (10)$$

Greene [4] suggested an alternative model in whichs u_i follows a gamma distibution, and which satisfies conditions for obtaining asymptotic properties of the maximum likelihood estimators.

Other techniques are:

-COLS (correstec ordinary least squares) and

-MOLS (modified ordinary least squares), proposed by Afriat[5].

4. STOHASTIC PRODUCTION FRONTIERES

Stohastic production frontier models was developed by AIGNER, D., LOVELL, C.A.K., SCHMIDT, P. [6] , MEEUSEN, W., van DEN BROECK, J [7], Battese and Corra [8], and AIGNER, D.J., AMEMIYA, T., POIRER, D.,J. [9] and they are made up of three components: the determinist production function, randomness(statistical noise) and technical inefficiency.

For the Cobb-Douglas case, in logarithmic terms, the model can be represented as:

$$\ln y_i = \beta_o + \sum_n \beta_n \ln x_{ni} + v_i - u_i \quad (11)$$

where v_i is the two-sided ‘noise’, component and u_i is the nonnegative technical inefficiency component; the noise component is assumed to be distributed independently of u_i ; the term: $e_i = v_i - u_i$ is a composed error term.

The main problem is: how to define the composite error, how to estimate them and how is the best predictor.

At least four different models can be found in the literature on stochastic frontier model: the Normal-Half Normal, Normal Exponential, Normal Truncated Normal and Normal Gamma.

Normal-Gamma Model

Normal Gamma model (from Greene [10]), makes the distributional assumptions:

(i) v_i is $\mathrm{N}(0,\sigma_v^2)$

(ii) u_i is gamma distribution

(iii) v_i and u_i are distributed independently of each other, and of the regressor.

The joint density function of u and $\varepsilon = v - u$ is:

$$f(u,\varepsilon) = \frac{u^m}{\Gamma(m+1)\sigma_u^{m+1}\sqrt{2\pi}\sigma_u}\times \exp\left\{-\frac{u}{\sigma_u} - \frac{(\varepsilon+u)^2}{2\sigma_v^2}\right\} \quad (12)$$

The marginal density of function ε is:

$$f(\varepsilon) = \int_0^\infty f(u,\varepsilon)du \quad (13)$$

To obtain estimates of the technical efficiency we need the conditional distribution $f(u/\varepsilon)$; this is given by:

$$f(u/\varepsilon) = \frac{f(u,\varepsilon)}{f(\varepsilon)} \quad (13)$$

The mean can be approximated numerically:

$$E(u_i/\varepsilon_i) \quad (14)$$

5. BAYESIAN APPROACH

In Bayesian stochastic frontier literature, KOOP, G, OSIEWALSKI, J., STEEL, M [11], ATKINSON, S., DORFMAN, J., [12], we distinguish these main models:
Bayesian fixed effects models:
- standards individual effects model, and
- marginally independent efficiency distribution model
Bayesian random effects models:
-varying efficiency distribution model and:
-common efficiency distribution model.

6. TOPICS ON STOHASTIC FRONTIERES

The main topics on stochastic frontiers analysis are:
- decomposition and estimation of technical efficiency, with time-invariant and time-varying technical efficiency, cross-sectional and data panel models;
- decomposition and estimation of cost efficiency, cross-sectional and data panel models;
- decomposition and estimation of profit efficiency, cross-sectional and data panel models;
- shadow price approach to the decomposition and estimation of economic efficiency;
- heterogeneity in stochastic frontier models;
- analysis of heteroskedasticity of v_i, u_i, or both, in cross-sectional models, panel-data models with time-invariant or time-varying technical efficiency. .

7. COMPUTER SOFTWARE.

There are two main integrated software who provide program and routines for frontiers and efficiency analysis: LIMDEP/NLOGIT and STATA; .

The freeware program, FRONTIER 4.1 by Tim Coelli can be used for some stochastic frontier model.

8. GUIDE TO LITERATURE

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A good introductory book is edited by COELLI, T., RAO, P., O'DONNELL, C, BATTESE, G. in 2005 **[16];** introductory surveys are: KALIRAJAN, K.P., SHAND, R.T., [17], MURILLO-ZAMORANO, L.R, [18].

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ASYMPTOTIC SPECTRAL MEASURES

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ABSTRACT

We review the subject matter of asymptotic spectral measures from the perspective of asymptotic equivalence relation and discuss the properties of elements of an asymptotic equivalence class. Furthermore, we study a particular case of asymptotic spectral measure ($\{A_h^a\}_{h\in(0,1]}$, given by $A_h^a(b) = A_h(a\cap b)$, when $\{A_h\}_{h\in(0,1]}$ is an asymptotic spectral measure).

Keywords: *asymptotic spectral measure, positive operator –valued measure, support, spectrum, asymptotic equivalence.*

1. INTRODUCTION

In [1], Martinez and Trout introduced the concept of *asymptotic spectral measure* associated to a measurable space (Definition 3.1). Additionally, there is defined the (asymptotic) equivalence of two asymptotic spectral measures, i.e. two asymptotic spectral measures $\{A_h\},\{B_h\}_{h\in(0,1]}:\Sigma\to B(H)$ on (X, Σ) are said to be *(asymptotically) equivalent* if for each measurable set $\Delta\in\Sigma$, we have

$$lim_{h\to 0}\|A_h(\Delta)-B_h(\Delta)\|=0.$$

In this paper, we study the properties of elements of an asymptotic equivalence class. From these, we emphasis the following result:

Theorem: Let $\{A_h\},\{B_h\}_{h\in(0,1]}:\Sigma_X\to B(H)$ be two asymptotic spectral measures asymptotically equivalent. Then

$$spec(\{A_h\})=spec(\{B_h\}),$$

where

$$spec(\{A_h\})=X\setminus\bigcup\{a\subset X \mid a\ deschisă\ și\ lim_{h\to 0}\|A_h(a)\|=0\}$$

In addition, as an example of asymptotic spectral measure, we define $\{A_h^a\}:B\to B(H)$, parameterized by $h\in(0,1]$, given by

$$A_h^a(b)=A_h(a\cap b),\ \forall b\in B,\ \forall h\in(0,1],$$

and we show that $\{A_h^a\}$ is an asymptotic spectral measure. Furthermore, the following property has taken place:

$$spec(A_h^a)\subset\bar{a}\cap spec(A_h),\ \forall h\in(0,1] \text{ and } \forall a\in B.$$

2. POSITIVE OPERATOR – VALUED MEASURES

Let H be a separable Hilbert space. Let X be a set equipped with a σ-algebra Σ of measurable subsets of X.

Definition 2.1. A *positive operator-valued measure* on the measurable space (X, Σ) is a mapping $A:\Sigma\to B(H)$ which satisfies the following properties:

i) $A(\emptyset)=0$;

ii) $A(\Delta)\geq 0$, $\forall\Delta\in\Sigma$;

iii) $A(\bigcup_{n=1}^{\infty}\Delta_n)=\sum_{n=1}^{\infty}A(\Delta_n)$, for disjoint measurable sets $(\Delta_n)_{n=1}^{\infty}\subset\Sigma$, where the series converges in weak operator topology.

Remark 2.2. i) $0\leq A(\Delta)\leq A(X)\leq\|A(X)\|<\infty$, $\forall\Delta\in\Sigma$;

ii) We say that A is normalized if $A(X)=I_H$;

iii) If each $A(\Delta)$ is a projection in $B(H)$, i.e.

$$A(\Delta)^2=A(\Delta)=A(\Delta)^*,$$

then we call A a *projection-valued measure* or *spectral measure*. This is equivalent with the condition:

$$A(\Delta_1\cap\Delta_2)=A(\Delta_1)A(\Delta_2),\ \forall\Delta1,\Delta2\in\Sigma,$$

From now on, let X denote a locally compact Hausedorff topological space with Borel □-algebra □.

Definition 2.3. Let *A* be a Borel positive operator-valued measure on *X*. The *cospectrum* of *A* is defined as the set

$$cospec(A)=\bigcup\{U\subset X \mid U \text{ is open and } A(U)=0\}.$$

The *spectrum* of *A* is the complement, i.e.

$$spec(A)=X\setminus cospec(A).$$

Definition 2.4. Let *A* be a Borel positive operator-valued measure on *X*. *A* is said to be *compact* if $spec(A)$ is a compact subset of *X*.

Lemma 2.5. Let A be a Borel positive operator-valued measure on X. Then $A(K) = 0$, for any compact set $K \subset cospec(A)$.

Proof: Let $K \subset cospec(A)$ be a compact set. Thus each point of K belongs to an open set on which A vanishes. Since K is compact, it follows there are the open sets $(U_i)_1^n \subset X$ such that $K \subset U_1 \cup ... \cup U_n$. Therefore

$$A(K) \leq A(U_1) + \cdots + A(U_n) = 0.$$

Theorem 2.6. Let A be a Borel positive operator-valued measure on X. Then

$$A(spec(A)) = A(X).$$

Proof: Since $cospec(A)$ is the largest open set on which A vanishes, it follows $A(cospec(A)) = 0$. As A is a Borel positive operator-valued measure, we have

$$A(X) = A(cospec(A) + spec(A)) = A(cospec(A)) + A(spec(A))$$

$$\Rightarrow A(spec(A)) = A(X).$$

Corollary 2.7. Let A be a Borel positive operator-valued measure. The $spec(A) = \emptyset$ if and only if $A = 0$.

Proof: Since $spec(A) = \emptyset$, if results from the precedent theorem that $A(X) = 0$. Since A is monotone, it follows $A \equiv 0$.
Reciprocal. If $A \equiv 0$, then $A(X) = 0$. Therefore,

$$X \subset cospec(A).$$

By definition, it results that $spec(A) = \emptyset$.

3. ASYMPTOTIC SPECTRAL MEASURES

Let (X, Σ) be a measurable space and H a separable Hilbert space. Let $\varepsilon \subset \Sigma$ be a fixed collection of measurable sets.

Definition 3.1. An *asymptotic spectral measure* on (X, Σ, ε) is a family of maps $\{A_h\}_{h\in(0,1]}: \Sigma \to B(H)$, such that the following hold:

i) Each A_h is a positive operator-valued measure having property $lim_{h\to 0}\|A_h(X)\| \leq 1$;

ii) The map $h \mapsto A_h(\Delta): (0,1] \to B(H)$ is continuous for any $\Delta \in \varepsilon$;

iii) For each $\Delta 1, \Delta 2 \in \varepsilon$ we have $lim_{h\to 0}\|A_h(\Delta_1 \cap \Delta_2) - A_h(\Delta_1)A_h(\Delta_2)\| = 0$.

The triple (X, Σ, ε) will be called *asymptotic measure space*.
If $\varepsilon = \Sigma$, then $\{A_h\}$ will be called *total asymptotic spectral measure* on (X, Σ).

If each A_h is normalized, i.e. $A_h(X) = I_H$, then $\{A_h\}$ will be called *normalized*. (Definition 3.1. [1])
If $\lim_{h\to 0}\|A_h(X) - I_H\| = 0$, then $\{A_h\}$ will be called *asymptotically normalized.*

Remark 3.2.
a) A spectral measure $E: \Sigma \to B(H)$ determines the "constant" total asymptotic spectral measures $\{E_h\}$ given by the assignment

$$E_h = E, \forall h \in (0,1];$$

b) Any continuous family $\{E_h\}$ of spectral measures determines an asymptotic spectral measure on (X, Σ, ε);
c) For each $\Delta 1, \Delta 2 \in \varepsilon$ we have

$$lim_{h\to 0}\|A_h(\Delta_2)A_h(\Delta_1) - A_h(\Delta_1)A_h(\Delta_2)\| = 0.$$

d) For each $\Delta \in \varepsilon$ we have

$$lim_{h\to 0}\|A_h(\Delta) - A_h(\Delta)^2\| = 0.$$

e) For each $\Delta \in \varepsilon$ we have

$$lim_{h\to 0}\|A_h(\Delta) - A_h(\Delta)^n\| = 0, \forall n \in \mathbb{N}.$$

f) If $\{A_h\}$ is asymptotically normalized, i.e.

$lim_{h\to 0}\|A_h(X) - I_H\| = 0$, then $lim_{h\to 0}\|A_h(X)\| = 1$.

g) $lim_{h\to 0}\|A_h(\Delta)\| \leq 1$, $\forall \Delta \in \varepsilon$.

Additionally,
$lim_{h\to 0}\|A_h(\Delta)^n\| \leq 1$, $\forall \Delta \in \varepsilon$ and $\forall n \in \mathbb{N}$.

h) If $\{A_h\}$ is asymptotically normalized, then

$lim_{h\to 0}\|A_h(\Delta)\| \leq 1$, $\forall \Delta \in \varepsilon$.

i) If $\{A_h\}$ is normalized, then

$\|A_h(\Delta)\| \leq 1$, $\forall \Delta \in \varepsilon$ and $\forall h \in (0,1]$.

Proposition 3.3. Let $\{A_h\}$, $\{B_h\}$ be two asymptotic spectral measures such that

$lim_{h\to 0}\|A_h(\Delta_1)B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)\| = 0$,

$\forall \Delta 1, \Delta 2 \in \varepsilon$. Then

$lim_{h\to 0}\|A_h(\Delta_1)^n B_h(\Delta_2)^m - B_h(\Delta_2)^m A_h(\Delta_1)^n\| = 0$,

$\forall n, m \in \mathbb{N}$ and $\forall \Delta 1, \Delta 2 \in \varepsilon$.

Proof:

$$\lim_{h\to 0}\|A_h(\Delta_1)^2B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^2\| = \lim_{h\to 0}\|A_h(\Delta_1)^2B_h(\Delta_2) - A_h(\Delta_1)B_h(\Delta_2) + A_h(\Delta_1)B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1) + B_h(\Delta_2)A_h(\Delta_1) - B_h(\Delta_2)A_h(\Delta_1)^2\| \le \lim_{h\to 0}\|A_h(\Delta_1)^2B_h(\Delta_2) - A_h(\Delta_1)B_h(\Delta_2)\| + \lim_{h\to 0}\|A_h(\Delta_1)B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)\| + \lim_{h\to 0}\|B_h(\Delta_2)A_h(\Delta_1) - B_h(\Delta_2)A_h(\Delta_1)^2\| \le \lim_{h\to 0}\|A_h(\Delta_1)^2 - A_h(\Delta_1)\|\|B_h(\Delta_2)\| + \lim_{h\to 0}\|A_h(\Delta_1)B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)\| + \lim_{h\to 0}\|B_h(\Delta_2)\|\|A_h(\Delta_1) - A_h(\Delta_1)^2\| \le 0$$

thus:

$\lim_{h\to 0}\|A_h(\Delta_1)^2B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^2\| = 0,$

$\forall \Delta 1, \Delta 2 \in \varepsilon$.

By induction, we show that if

$$\lim_{h\to 0}\|A_h(\Delta_1)^nB_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^n\| = 0,$$

for each Δ1,Δ2 ∈ε, then

$$\lim_{h\to 0}\|A_h(\Delta_1)^{n+1}B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^{n+1}\| = 0,$$

for each Δ1, Δ2 ∈ ε.

$$\lim_{h\to 0}\|A_h(\Delta_1)^{n+1}B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^{n+1}\| = \lim_{h\to 0}\|A_h(\Delta_1)^{n+1}B_h(\Delta_2) - A_h(\Delta_1)^nB_h(\Delta_2) + A_h(\Delta_1)^nB_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^n + B_h(\Delta_2)A_h(\Delta_1)^n - B_h(\Delta_2)A_h(\Delta_1)^{n+1}\| \le \lim_{h\to 0}\|A_h(\Delta_1)^{n+1}B_h(\Delta_2) - A_h(\Delta_1)^nB_h(\Delta_2)\| + \lim_{h\to 0}\|A_h(\Delta_1)^nB_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^n\| + \lim_{h\to 0}\|B_h(\Delta_2)A_h(\Delta_1)^n - B_h(\Delta_2)A_h(\Delta_1)^{n+1}\| \le \lim_{h\to 0}\|A_h(\Delta_1)^2 - A_h(\Delta_1)\|\|B_h(\Delta_2)\|\|A_h(\Delta_1)^{n-1}\| + \lim_{h\to 0}\|A_h(\Delta_1)^nB_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^n\| + \lim_{h\to 0}\|B_h(\Delta_2)\|\|A_h(\Delta_1)^{n-1}\|\|A_h(\Delta_1) - A_h(\Delta_1)^2\| \le 0$$

thus

$$\lim_{h\to 0}\|A_h(\Delta_1)^nB_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)^n\| = 0,$$

for any $n \in \mathbb{N}$ and Δ1, Δ2 ∈ ε.
Analogously, we can prove that

$$\lim_{h\to 0}\|A_h(\Delta_1)^nB_h(\Delta_2)^m - B_h(\Delta_2)^mA_h(\Delta_1)^n\| = 0,$$

$\forall m \in \mathbb{N}$ and ∀Δ1, Δ2 ∈ ε.

Definition 3.4. Two asymptotic spectral measures $\{A_h\},\{B_h\}_{h\in(0,1]}:\Sigma \to B(H)$ on (X, Σ, ε) are said to be *(asymptotically) equivalent* if for each measurable set *Δ* ∈ ε,
we have

$$lim_{h\to 0}\|A_h(\Delta) - B_h(\Delta)\| = 0.$$

If this hold for ε = Σ, we will call them fully equivalent. (Definition 3.2. [1])

This equivalence relation could be associated with the asymptotic equivalence of two families of linear bounded operators on a Hilbert space, i.e. two families of operators $\{S_h\},\{T_h\} \subset B(H)$, parameterized by $h \in (0,1]$, are called to be *asymptotically equivalent* if

$$lim_{h\to 0}\|S_h - T_h\| = 0.$$

Therefore, we can say that two asymptotic spectral measures $\{A_h\},\{B_h\}_{h\in(0,1]}:\Sigma \to B(H)$ on (X, Σ) are said to be *(asymptotically) equivalent* if for each measurable set Δ∈□, the families of operators $\{A_h(\Delta)\},\{B_h(\Delta)\} \subset B(H)$ are asymptotically equivalent.

Remark: The asymptotic equivalence is reflexive, symmetric and transitive.
Proposition 3.5. Let $\{A_h\}$, $\{B_h\}$ be two asymptotic spectral measures on (X, Σ, ε). If $\{A_h\}$, $\{B_h\}$ are asymptotically equivalent, then
$\{A_h\}$ is asymptotically normalized if and only if $\{B_h\}$ is asymptotically normalized;
If $\{A_h\}$ is normalized, then $\{B_h\}$ is asymptotically normalized.

Proof: i)

$$\lim_{h\to 0}\|B_h(X) - I_H\| = \lim_{h\to 0}\|B_h(X) - A_h(X) + A_h(X) - I_H\| \le \lim_{h\to 0}\|B_h(X) - A_h(X)\| + \lim_{h\to 0}\|A_h(X) - I_H\| = 0$$

Reciprocal. Analog.
ii) Since $\{A_h\}$ is normalized, i.e. $A_h(X) = I_H$, $\forall h \in (0,1]$, and

$$\lim_{h\to 0}\|B_h(X) - A_h(X)\| = 0,$$

thus

$$\lim_{h\to 0}\|B_h(X) - I_H\| = 0.$$

Proposition 3.6. Let $\{A_h\},\{B_h\}$ be two asymptotic spectral measures on (X, Σ, ε). If $\{A_h\},\{B_h\}$ are asymptotically equivalent, then

a)

$lim_{h\to 0}\|A_h(\Delta_1)B_h(\Delta_2) - B_h(\Delta_2)A_h(\Delta_1)\| = 0$ ∀Δ1, Δ2 ∈ε. Also, ∀Δ ∈ ε we have

$$lim_{h\to 0}\|A_h(\Delta)B_h(\Delta) - B_h(\Delta)A_h(\Delta)\| = 0.$$

b)

$lim_{h\to 0}\|A_h(\Delta_1)^nB_h(\Delta_2)^m - B_h(\Delta_2)^mA_h(\Delta_1)^n\| = 0,$ $\forall n, m \in \mathbb{N}$ and ∀Δ1, Δ2 ∈ ε.

c) $lim_{h\to 0}\|A_h(\Delta)^n - B_h(\Delta)^n\| = 0$, $\forall n \in \mathbb{N}$ and ∀Δ∈ ε.

Proof:
a)

$\lim_{h\to 0}\|A_h(\Delta_1)B_h(\Delta_2)-B_h(\Delta_2)A_h(\Delta_1)\| = \lim_{h\to 0}\|A_h(\Delta_1)B_h(\Delta_2)-A_h(\Delta_1)A_h(\Delta_2)+A_h(\Delta_1)A_h(\Delta_2)-B_h(\Delta_2)A_h(\Delta_1)+A_h(\Delta_2)A_h(\Delta_1)-A_h(\Delta_2)A_h(\Delta_1)\| \le \lim_{h\to 0}\|A_h(\Delta_1)B_h(\Delta_2)-A_h(\Delta_1)A_h(\Delta_2)\| + \lim_{h\to 0}\|A_h(\Delta_1)A_h(\Delta_2)-A_h(\Delta_2)A_h(\Delta_1)\| + \lim_{h\to 0}\|B_h(\Delta_2)A_h(\Delta_1)-A_h(\Delta_2)A_h(\Delta_1)\| \le 2\lim_{h\to 0}\|A_h(\Delta_1)\|\|B_h(\Delta_2)-A_h(\Delta_2)\| \le 0$

Taking $\Delta_1=\Delta_2=\Delta$ in a), we obtain

$$\lim_{h\to 0}\|A_h(\Delta)B_h(\Delta)-B_h(\Delta)A_h(\Delta)\| = 0.$$

b) Having in view a) and applying Proposition 3.3., it follows

$$\lim_{h\to 0}\|A_h(\Delta_1)^n B_h(\Delta_2)^m - B_h(\Delta_2)^m A_h(\Delta_1)^n\| = 0.$$

c) Since $\{A_h\}, \{B_h\}$ are asymptotically equivalent, we have

$\lim_{h\to 0}\|A_h(\Delta)^2-B_h(\Delta)^2\| = \lim_{h\to 0}\|A_h(\Delta)^2 - A_h(\Delta)+A_h(\Delta)-B_h(\Delta)+B_h(\Delta)-B_h(\Delta)^2\| \le \lim_{h\to 0}\|A_h(\Delta)^2-A_h(\Delta)\| + \lim_{h\to 0}\|A_h(\Delta)-B_h(\Delta)\| + \lim_{h\to 0}\|B_h(\Delta)-B_h(\Delta)^2\| = 0$

for each $\Delta\in\varepsilon$.
By induction, we will show if

$\lim_{h\to 0}\|A_h(\Delta)^n-B_h(\Delta)^n\| = 0$, $\forall\Delta\in\varepsilon$,
then
$\lim_{h\to 0}\|A_h(\Delta)^{n+1}-B_h(\Delta)^{n+1}\| = 0$, $\forall\Delta\in\varepsilon$.

$\lim_{h\to 0}\|A_h(\Delta)^{n+1}-B_h(\Delta)^{n+1}\| = \lim_{h\to 0}\|A_h(\Delta)^{n+1} - A_h(\Delta)^n + A_h(\Delta)^n - B_h(\Delta)^n + B_h(\Delta)^n - B_h(\Delta)^{n+1}\| \le \lim_{h\to 0}\|A_h(\Delta)^{n+1}-A_h(\Delta)^n\| + \lim_{h\to 0}\|A_h(\Delta)^n-B_h(\Delta)^n\| + \lim_{h\to 0}\|B_h(\Delta)^n - B_h(\Delta)^{n+1}\| \le \lim_{h\to 0}\|A_h(\Delta)^{n-1}\|\|A_h(\Delta)^2-A_h(\Delta)\| + \lim_{h\to 0}\|A_h(\Delta)^n-B_h(\Delta)^n\| + \lim_{h\to 0}\|A_h(\Delta)^{n-1}\|\|B_h(\Delta)-B_h(\Delta)^2\| = 0$

Proposition 3.8. Let $\{A_h\}, \{B_h\}$ be two asymptotic spectral measures on (X, Σ, ε). If $\{A_h\}, \{B_h\}$ are asymptotically equivalent, then

$lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^{[n]}\| = lim_{h\to 0}\|(B_h(\Delta)-A_h(\Delta))^{[n]}\| = 0$

$\forall n\in\mathbb{N}$ and $\forall\Delta\in\varepsilon$, where

$(A-B)^{[n]} = \sum_{k=0}^{n}(-1)^{n-k}C_k^n A^k B^{n-k}, \forall A,B\in B(H)$.

Proof: We show that

$(A-B)^{[n+1]} = A(A-B)^{[n]} - (A-B)^{[n]}B$,

$\forall n\in\mathbb{N}$.

$$A(A-B)^{[n]} - (A-B)^{[n]}B =$$
$$= A\sum_{i=0}^{n}(-1)^{n-i}C_i^n A^i B^{n-i} - \left(\sum_{j=0}^{n}(-1)^{n-j}C_j^n A^j B^{n-j}\right)B =$$
$$= A^{n+1} + \sum_{k=1}^{n}(-1)^{n+1-k}[C_k^n + C_{k-1}^n]A^k B^{n+1-k} + (-1)^{n+1}B^{n+1} =$$
$$= (A-B)^{[n+1]}.$$

Taking into above relation $n=2$, it results

$\lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^{[2]}\| = \lim_{h\to 0}\|A_h(\Delta)(A_h(\Delta)-B_h(\Delta)) - (A_h(\Delta)-B_h(\Delta))B_h(\Delta)\| \le \lim_{h\to 0}\|A_h(\Delta)(A_h(\Delta)-B_h(\Delta))\| + \lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))B_h(\Delta)\| \le \lim_{h\to 0}\|A_h(\Delta)\|\|(A_h(\Delta)-B_h(\Delta))\| + \lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))\|\|B_h(\Delta)\| \le 0$

By induction, we show if

$\lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^{[n]}\| = 0$, $\forall\ \Delta\in\varepsilon$,
then
$\lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^{[n+1]}\| = 0$, $\forall\ \Delta\in\varepsilon$.

$\lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^{[n+1]}\| = \lim_{h\to 0}\|A_h(\Delta)(A_h(\Delta)-B_h(\Delta))^{[n]} - (A_h(\Delta)-B_h(\Delta))^{[n]}B_h(\Delta)\| \le \lim_{h\to 0}\|A_h(\Delta)(A_h(\Delta)-B_h(\Delta))^{[n]}\| + \lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^{[n]}B_h(\Delta)\| \le \lim_{h\to 0}\|A_h(\Delta)\|\|(A_h(\Delta)-B_h(\Delta))^{[n]}\| + \lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^{[n]}\|\|B_h(\Delta)\| \le 0$

Analogously we can prove that

$\lim_{h\to 0}\|(B_h(\Delta)-A_h(\Delta))^{[n]}\| = 0$, $\forall n\in\mathbb{N}$ and $\forall\Delta\in\varepsilon$.

Proposition 3.9. Let $\{A_h\}, \{B_h\}$ be two asymptotic spectral measures on (X, Σ, ε). If $\{A_h\}, \{B_h\}$ are asymptotically equivalent, then

$lim_{h\to 0}\|(A_h(\Delta)-B_h(\Delta))^n\| = lim_{h\to 0}\|(B_h(\Delta)-A_h(\Delta))^n\| = 0$

$\forall n\in\mathbb{N}$ and $\forall\Delta\in\varepsilon$.

Proof: The proof is similar to the proof of Proposition 3.8, taking into account the remark

$(A-B)^{n+1} = A(A-B)^n - B(A-B)^n$,

$\forall n\in\mathbb{N}$ and $\forall$ A,B∈B(H).

From now on, let X denote a locally compact Hausedorff topological space with Borel □-algebra B.

Proposition 3.10. Let $\{A_h\}$ be a full asymptotic spectral measure on (X, B) and $a \in B$. Then $\{A_h^a\}: B \to B(H)$, parameterized by $h \in (0,1]$, given by

$A_h^a(b) = A_h(a \cap b)$, $\forall b \in B$ and $\forall h \in (0,1]$,

is an asymptotic spectral measure.

Proof: By definition of $\{A_h^a\}$, we have

$A_h^a(\emptyset) = A_h(a \cap \emptyset) = A_h(\emptyset) = 0$, $\forall h \in (0,1]$
and
$\lim_{h\to 0}\|A_h^a(X)\| = \lim_{h\to 0}\|A_h(a \cap X)\| =$
$\lim_{h\to 0}\|A_h(a)\| \le \lim_{h\to 0}\|A_h(X)\| \le 1$

Let $(b_n)_{n\in\mathbb{N}} \subset B$ be a family of disjoint sets. Thus $(a \cap b_n)_{n\in\mathbb{N}} \subset B$ is also a family of disjoint sets. Since A_h is numerable additive, $\forall h \in (0,1]$, it results

$$A_h^a\left(\bigcup_{n\in N} b_n\right) = A_h\left(\bigcup_{n\in N}(a \cap b_n)\right) =$$
$$= \sum_{n\in N} A_h(a \cap b_n) = \sum_{n\in N} A_h^a(b_n),\ \forall h \in (0,1].$$

As the map $(0,1] \to B(H): h \to A_h(a \cap b)$ is continuous $\forall$ $b \in B$, then the map is also continuous $\forall$ e $b \in B$.
Let $b_1, b_2 \in B$. Thus

$$\lim_{h\to 0}\|A_h^a(b_1 \cap b_2) - A_h^a(b_1)A_h^a(b_2)\| =$$
$$= \lim_{h\to 0}\|A_h(a \cap b_1 \cap b_2) - A_h(a \cap b_1)A_h(a \cap b_2)\| =$$
$$= \lim_{h\to 0}\|A_h((a \cap b_1)\cap(a \cap b_2)) - A_h(a \cap b_1)A_h(a \cap b_2)\| =$$
$$= 0, \forall h \in (0,1].$$

Therefore, $\{A_h^a\}: B \to B(H)$ is a full asymptotic spectral measure.

Proposition 3.11. Let $\{A_h\}$ be a full asymptotic spectral measure on (X, B). Then
i) $A_h^a(\emptyset) = 0$, $\forall h \in (0,1]$;
ii) $A_h^a(\mathbb{C}) = A_h(a)$, $\forall h \in (0,1]$;
iii) $A_h^a(\{x\}) = \chi_a(x)A_h(\{x\})$, $\forall x \in X$ and $\forall h \in (0,1]$;
iv) $A_h^a(a) = A_h(a)$, $\forall h \in (0,1]$;
v) $A_h^a(b) = A_h^b(a)$, $\forall a, b \in B$ and $\forall h \in (0,1]$;
vi) $A_h^a(b) = A_h(a)$, $\forall a, b \in B$ such that $a \subset b$ and $\forall h \in (0,1]$;
vii) $A_h^a(b) = A_h(b)$, $\forall a, b \in B$ such that $b \subset a$ and $\forall h \in (0,1]$;
viii) $A_h^a(b) = 0$, $\forall a, b \in B$ such that $a \cap b = \emptyset$ and $\forall h \in (0,1]$;
ix) $A_h^a(a \cap b) = A_h(a \cap b)$, $\forall a, b \in B$ and $\forall h \in (0,1]$;
x) $A_h^{a\cup b}(c) = A_h^a(c) + A_h^b(c)$, $\forall a, b, c \in B$ and $\forall h \in (0,1]$;

Proposition 3.12. Two full asymptotic spectral measures on (X, B) $\{A_h\}$, $\{B_h\}$ are asymptotically equivalent if and only if $\{A_h^a\}, \{B_h^a\}: B \to B(H)$, given by $A_h^a(b) = A_h(a \cap b)$ and $B_h^a(b) = B_h(a \cap b)$, $\forall b \in B$, $\forall h \in (0,1]$, are asymptotically equivalent $\forall a \in B$.

Proof: Let $a \in B$ be fixed. Since $\{A_h\}$, $\{B_h\}$ are asymptotically equivalent, thus

$\lim_{h\to 0}\|A_h(a \cap b) - B_h(a \cap b)\| = 0$, $\forall b \in B$.

It follows that

$\lim_{h\to 0}\|A_h^a(b) - B_h^a(b)\| = 0$, $\forall b \in B$.

Reciprocal. Since $\{A_h^a\}, \{B_h^a\}$ are asymptotically equivalent $\forall$ $a \in B$ and moreover

$A_h^a(a) = A_h(a)$ and $B_h^a(a) = B_h(a)$,
it results
$\lim_{h\to 0}\|A_h(a) - B_h(a)\| =$
$= \lim_{h\to 0}\|A_h^a(a) - B_h^a(a)\| = 0, \forall a \in B$.

Therefore, $\{A_h\}$, $\{B_h\}$ are asymptotically equivalent.

Proposition 3.13. Let $\{A_h\}$ be a full asymptotic spectral measure on (X, B). Then

$A_h(spec(A_h)) = A_h(X)$, $\forall h \in (0,1]$.

Proof: Analog with the proof of Theorem 2.5.

Remark: If $\{A_h\}$ is a normalized asymptotic spectral measure on (X, B), then

$A_h(spec(A_h)) = I_H$, $\forall h \in (0,1]$.

Proposition 3.14. Let $\{A_h\}$ be a full asymptotic spectral measure on (X, B) and $\{A_h^a\}: B \to B(H)$, parameterized by $h \in (0,1]$, given by $A_h^a(b) = A_h(a \cap b)$, $\forall b \in B$ and $\forall h \in (0,1]$. Then

$spec(A_h^a) \subset \bar{a} \cap spec(A_h)$, $\forall h \in (0,1]$.

Proof: Let b be a compact set such that $b \subset \mathbb{C} \setminus \bar{a}$. Thus $a \cap b = \emptyset$. By this relation we have

$A_h^a(b) = A_h(a \cap b) = A_h(\emptyset) = 0$, $\forall h \in (0,1]$.

hence

$b \subset cospec(A_h^a) \Rightarrow \mathbb{C} \setminus \bar{a} \subset cospec(A_h^a)$, $\forall h \in (0,1]$

(by regularity property of measures A_h). Therefore

$spec(A_h^a) \subset \bar{a}$, $\forall h \in (0,1]$.

Let b be a compact set such that $b \subset \mathbb{C} \setminus spec(A_h)$. Thus there is a family of open sets $(b_i)_{i=\overline{1,n}}$ such that

$b \subset \bigcup_{i=1}^{n} b_i,\ b_i \subset \mathbb{C} \setminus spec(A_h) \Rightarrow A_h(b_i) = 0$.

Since each A_h is additive, we have

$A_h(b) \le A_h(\bigcup_{i=1}^{n} b_n) = \sum_{i=1}^{n} A_h(b_i) = 0$.

Taking into account the following relation

$A_h^a(b) = A_h(a \cap b) \le \sum_{i=1}^{n} A_h(a \cap b_i) \le \sum_{i=1}^{n} A_h(b_i) = 0$

it results
$b \subset \mathbb{C} \setminus spec(A_h^a)$,

for any compact set b such that $b \subset \mathbb{C} \setminus spec(A_h)$. Since each A_h is regular, it follows

$\mathbb{C} \setminus spec(A_h) \subset \mathbb{C} \setminus spec(A_h)$, $\forall h \in (0,1]$,

Therefore
$spec(A_h^a) \subset spec(A_h)$, $\forall h \in (0,1]$.

Definition 3.15. An asymptotic spectral measure $\{A_h\}$ on X will be said compact if there is a compact subset K of X such that $spec(A_h) \subset K$, $\forall h \in (0,1]$. (Definition 3.4 [1])

Remark: i) A_h is compact, $\forall h \in (0,1]$, if and only if $\{A_h\}$ is compact;
ii) If $\{A_h\}$ is compact, then

$A_h(spec(A_h)) = A_h(K) = A_h(X)$, $\forall h \in (0,1]$;

iii) If $a \in B$ is a pre-compact open set, then $\{A_h^a\}$ is a compact asymptotic spectral measure (even $\{A_h\}$ is not a compact asymptotic spectral measure);
iv) If $\{A_h\}$ is a a compact asymptotic spectral measure, then $\{A_h^a\}$ is a a compact asymptotic spectral measure, $\forall a \in B$.

Definition 3.16. Let $\{A_h\}_{h\in(0,1]} : \Sigma_X \to B(H)$ be an asymptotic spectral measure. The cospectrum [1] of $\{A_h\}$ is defined as the set

$cospec(\{A_h\}) = \bigcup\{a \subset X | a \text{ deschisă și } lim_{h\to 0}\|A_h(a)\| = 0\}$

The spectrum of $\{A_h\}$ is the complement of $cospec(\{A_h\})$, i.e.

$spec(\{A_h\}) = X \setminus cospec(\{A_h\})$.

Remark 3.17.
i) $spec(\{A_h\}) \subseteq \bigcup_{h\in(0,1]} spec(A_h)$
and $\bigcap_{h\in(0,1]} cospec(A_h) \subseteq cospec(\{A_h\})$.

ii) If $\{A_h\}$ is compact, then $spec(\{A_h\})$ is also a compact set.

Proof: i) Let $a \subset \bigcap_{h\in(0,1]} cospec(A_h)$ be an open set. Thus
$A_h(a) = 0$, $\forall h \in (0,1]$
and
$\lim_{h\to 0}\|A_h(a)\| = 0$.
Therefore

$a \subset cospec(\{A_h\})$, $\forall a \subset \bigcap_{h\in(0,1]} cospec(A_h)$.

It results

$$\bigcap_{h\in(0,1]} cospec(A_h) \subseteq cospec(\{A_h\})$$

and, taking the complement we have

$spec(\{A_h\}) \subseteq \bigcup_{h\in(0,1]} spec(A_h)$.

ii) Let $\{A_h\}$ be a compact set. Thus there is a compact subset K of X such that $spec(A_h) \subset K$, $\forall h \in (0,1]$.
By i), it follows

$spec(\{A_h\}) \subseteq \bigcup_{h\in(0,1]} spec(A_h) \subset K$.

Lemma 3.18. Let $\{A_h\}_{h\in(0,1]} : \Sigma_X \to B(H)$ be an asymptotic spectral measure. Then

$lim_{h\to 0}\|A_h(K)\| = 0$,

for each compact subset K of $cospec(\{A_h\})$.

Prof: Let K be a compact subset of $cospec(\{A_h\})$. Thus each element of K belongs to an open set a having property $\lim_{h\to 0}\|A_h(a)\| = 0$. Since K is a compact set, hence there is a family of open set $(a_i)_1^n \subset X$ such that $K \subset a_1 \cup \ldots \cup a_n$. Therefore

$A(K) \le A(a_1) + \cdots + A(a_n) = 0$
and
$\lim_{h\to 0}\|A_h(K)\| \le \lim_{h\to 0}\|A_h(a_1)\| + \cdots + \lim_{h\to 0}\|A_h(a_n)\| = 0$

Proposition 3.19. Let be an asymptotic spectral measure. Then

$lim_{h\to 0}\|A_h(X)\| = lim_{h\to 0}\|A_h(spec(\{A_h\}))\|$.

Proof: We show that

$\lim_{h\to 0}\|A_h(cospec(\{A_h\}))\| = 0$.

Let K be a compact subset of $cospec(\{A_h\})$. By Lemma 3.18, it follows that

$\lim_{h\to 0}\|A_h(K)\| = 0$.

Since A_h is regular, for any $h \in (0,1]$, by above relation, it results that

$\lim_{h\to 0}\|A_h(cospec(\{A_h\}))\| = 0$.

Because

$spec(\{A_h\}) = X\backslash cospec(\{A_h\})$,

we have that

$$\lim_{h\to 0}\|A_h(X)\| = \lim_{h\to 0}\|A_h(spec(\{A_h\})) + A_h(cospec(\{A_h\}))\| \le \lim_{h\to 0}\|A_h(spec(\{A_h\}))\| + \lim_{h\to 0}\|A_h(cospec(\{A_h\}))\| = \lim_{h\to 0}\|A_h(spec(\{A_h\}))\|$$

In addition, we have that

$$\lim_{h\to 0}\|A_h(spec(\{A_h\}))\| = \lim_{h\to 0}\|A_h(spec(\{A_h\})) + A_h(cospec(\{A_h\})) - A_h(cospec(\{A_h\}))\| \le \lim_{h\to 0}\|A_h(cospec(\{A_h\}))\| + \lim_{h\to 0}\|A_h(cospec(\{A_h\})) + A_h(spec(\{A_h\}))\| \le \lim_{h\to 0}\|A_h(X)\|$$

By two precedent relations, it follows that

$$\lim_{h\to 0}\|A_h(X)\| = \lim_{h\to 0}\|A_h(spec(\{A_h\}))\|.$$

Corollary 3.10. If an asymptotic spectral measure $\{A_h\}$ is asymptotically normalized (respectively normalized), then the following assertions hold:

i) $\lim_{h\to 0}\|A_h(spec(\{A_h\}))\| = 1$;

ii) $\lim_{h\to 0}\|A_h(spec(\{A_h\})) - I\| = 0$.

Proof: If $\{A_h\}$ is an asymptotic spectral measure asymptotically normalized, then, by Remark 2.2. f), we have that

$\lim_{h\to 0}\|A_h(X)\| = 1$.

By Proposition 3.19, it follows that

$\lim_{h\to 0}\|A_h(spec(\{A_h\}))\| = 1$.

We show that

$\lim_{h\to 0}\|A_h(spec(\{A_h\})) - I\| = 0$.

Since $\{A_h\}$ is asymptotically normalized, i.e.

$\lim_{h\to 0}\|A_h(X) - I\| = 0$,

it results

$$\lim_{h\to 0}\|A_h(spec(\{A_h\})) - I\| = \lim_{h\to 0}\|A_h(spec(\{A_h\})) - A_h(X) + A_h(X) - I\| \le \lim_{h\to 0}\|A_h(spec(\{A_h\})) - A_h(X)\| + \lim_{h\to 0}\|A_h(X) - I\| \le \lim_{h\to 0}\|A_h(spec(\{A_h\})) - I + I - A_h(X)\| \le \lim_{h\to 0}\|A_h(spec(\{A_h\})) - I\| + \lim_{h\to 0}\|A_h(X) - I\| = \lim_{h\to 0}\|A_h(spec(\{A_h\})) - I\|$$

Therefore:

$$\lim_{h\to 0}\|A_h(spec(\{A_h\})) - I\| = \lim_{h\to 0}\|A_h(spec(\{A_h\})) - A_h(X)\| = \lim_{h\to 0}\|A_h(cospec(\{A_h\}))\| = 0$$

Remark: 3.21.

i) $\lim_{h\to 0}\|A_h(cospec(\{A_h\})) - I\| = 1$.

ii) For each open set $a \subset cospec(\{A_h\})$, we have

$\lim_{h\to 0}\|A_h(a) - I\| = 1$.

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Proof: i) Since

$1 = \|I\| \le \|A_h(cospec(\{A_h\})) - I\| + \|A_h(cospec(\{A_h\}))\|$,

$\forall h \in (0,1]$, taking limit by h, we obtain

$$1 \le \lim_{h\to 0}\|A_h(cospec(\{A_h\})) - I\| + \lim_{h\to 0}\|A_h(cospec(\{A_h\}))\| \le \lim_{h\to 0}\|A_h(cospec(\{A_h\})) - I\| \le \lim_{h\to 0}\|A_h(cospec(\{A_h\}))\| + 1 = 1$$

ii) Analog.

Theorem 3.22. Let $\{A_h\}, \{B_h\}_{h\in(0,1]}: \Sigma_X \to B(H)$ be two asymptotic spectral measures. If $\{A_h\}$, $\{B_h\}$ are asymptotically equivalent, then

$spec(\{A_h\}) = spec(\{B_h\})$.

Proof: Let be an open set $a \subset cospec(\{A_h\})$. Thus

$\lim_{h\to 0}\|A_h(a)\| = 0$.

Since $\{A_h\}, \{B_h\}$ are asymptotically equivalent, it results that

$\lim_{h\to 0}\|A_h(a) - B_h(a)\| = 0$.

By two precedent relations, we have that

$\lim_{h\to 0}\|B_h(a)\| = \lim_{h\to 0}\|A_h(a)\| = 0$.

Thus $a \subset cospec(\{B_h\})$, $\forall a \subset cospec(\{A_h\})$ open. Therefore

$spec(\{B_h\}) \subset spec(\{A_h\})$.

Reciprocal. Analog

Remerk 3.23. Let $\{A_h\}$, $\{B_h\}$ be two asymptotic spectral measures on (X, Σ). If $\{A_h\}$, $\{B_h\}$ are asymptotically equivalent, then $\{A_h\}$ is compact if and only if $\{B_h\}$ is compact.

Proof: By precedent Proposition, for each compact subset K of X, we have $spec(\{A_h\}) \subset K$ if and only if $spec(\{B_h\}) \subset K$.

5. CONCLUSIONS

In conclusion, we have recalled the concept of asymptotic spectral measure, as introduced by Martinez and Trout in [1], and studied the properties of asymptotic spectral measures from an asymptotic equivalence class. As example of asymptotic spectral measure, we defined and analysed the behaviour, in relation to asymptotic equivalence, of asymptotic spectral measure $\{A_h^a\}_{h\in(0,1]}$, given by $A_h^a(b) = A_h(a \cap b)$, when $\{A_h\}_{h\in(0,1]}$ is an asymptotic spectral measure.

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POSITIVE ASYMPTOTIC MORFISMS

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ABSTRACT

We show the relationship between support of a positive asymptotic morphism and its spectrum, using the concept of a positive asymptotic morphism as it was introduced by Martinez and Trout [1], and prove that a positive asymptotic morphism has o a regularity property.

Keywords: *asymptotic morphism, positive morphism, support, spectrum, regularity property.*

1. INTRODUCTION

Connes and Higson [1] introduced the concept of asymptotic morphism:
A *asymptotic morphism* from a C* - algebra *A* to C* - algebra *B* is a family of applications $\{\varphi_t\}$ from *A* to *B*, parameterized by $t \in [1,\infty)$, such that:
1) the map $t \to \varphi_t(a) \in B$ is continuous for each $a \in A$;
2) for all $a_1, a_2 \in A$ and $\lambda \in \mathbb{C}$, the following hold:

$$\lim_{t\to\infty} \|\varphi_t(a_1) + \lambda\varphi_t(a_2) - \varphi_t(a_1 + \lambda a_2)\| = 0$$
$$\lim_{t\to\infty} \|\varphi_t(a_1)\varphi_t(a_2) - \varphi_t(a_1 a_2)\| = 0$$
$$\lim_{t\to\infty} \|\varphi_t(a_1{}^*) - \varphi_t(a_1)^*\| = 0$$

Martinez and Trout [3] introduced the positive asymptotic morphism, defined as:
A *positive asymptotic morphism* from a C* - algebra *A* to a C* - algebra *B* is a family of maps $\{Q_h\}_{h\in(0,1]}: A \to B$, parameterized by $h \in (0,1]$, such that the following hold:

a) Each Q_h is a positive linear map;

b) The map $h \mapsto Q_h(f): (0,1] \to B(H)$ is continuous for any $f \in A$;

c) For all $f, g \in A$ we have
$$\lim_{h\to 0}\|Q_h(fg) - Q_h(f)Q_h(g)\| = 0.$$

Let A and B be C* - algebras. An linear operator Q : A → B is positive if $Q(f) \geq 0$ for any $f \geq 0$.
Let H be a separable Hilbert space and $B(H)$ be the C* - algebra of all bounded linear operators on H . Let X be a set equipped with a □-algebra Σ_X of measurable sets and let $C_X \subset \Sigma_X$ denote the collection of all pre-compact open subsets of X. Define $B_0(X)$ to be the C* - subalgebra of $B_b(X)$ (C* - algebra of all bounded Borel functions on *X*) generated by $\{\chi_U | U \in C_X\}$, where χ_U denotes the characteristic function of $U \subseteq X$. If *X* is also σ – compact, then let $C_0(X)$ be the set of all continuous functions which vanish at infinity on *X* .

We call support of a morphism Q: $C_0(X) \to B(H)$ the set

$$supp(Q) = \cap \{F \subset X | F \text{ închisă și } Q(f) = 0, \forall f \text{ cu } supp(f) \subset X \setminus F\}$$

A morphism $Q: C_0(X) \to B(H)$ will be said to have compact support if there is a compact subset K of X such that $supp(Q) \subset$ K.

In this paper, having in view the concept of the support of morphism, we define the *support of an asymptotic morphism* as being the set

$$supp(\{Q_h\}) = \\ = \cap\left\{F \text{ închisă} | \lim_{h\to 0}\|Q_h(f)\| = 0, \forall f \in B_b(X) \text{ a.î. } supp(f) \cap F = \emptyset\right\}$$

and we show that for a asymptotic positive morphism with property $lim_{h\to 0}\|Q_h(1) - I\| = 0$, we have

$$Sp(\{Q_h(f)\}) \subseteq f(supp(\{Q_h\})), \forall f \in B_b(X),$$

where $Sp(\{Q_h(f)\})$ represent the spectrum of a family of linear bounded operators, as introduced by [5].

We call the *spectrum* of a family of operators $\{S_h\} \subset L(X)$ the set

$$Sp(\{S_h\}) = \mathbb{C} \setminus r(\{S_h\}),$$

where the set

$$r(\{S_h\}) = \left\{\lambda \in \mathbb{C} | \exists \{\mathcal{R}(\lambda, S_h)\} \subset L(X), \lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda, S_h) - I\| = \lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)(\lambda I - S_h) - I\| = 0\right\}$$

is the *resolvent set* of a family of operators$\{S_h\} \subset L(X)$.

Two positive asymptotic morphisms $\{Q_h\}, \{P_h\}_{h\in(0,1]}: A \to B$ are called *asymptotic equivalent* if for all $f \in A$ we have that $lim_{h\to 0}\|Q_h(f) - P_h(f)\| = 0$ (Definition 2.2. [3]).

In this paper, we also show that two positive asymptotic morphisms $\{Q_h\}, \{P_h\}_{h\in(0,1]}: B_b(X) \to B(H)$, having property $lim_{h\to 0}\|Q_h(1) - I\| = 0$ and

$lim_{h\to 0}\|P_h(1)-I\|=0$ are asymptotic equivalent if and only if

$$lim_{h\to 0}\|Q_h(id)-P_h(id)\|=0.$$

A direct consequence of this result is a regularity property of a positive asymptotic morphism, i.e. $\{Q_h\}_{h\in(0,1]}: B_b(X)\to B(H)$ being a positive asymptotic morphism such that $lim_{h\to 0}\|Q_h(1)-I\|=0$ and $\{T_h\}\subset B(H)$ a bounded family of linear continuous operators ($\lim\sup_{h\to 0}\|T_h\|<\infty$), then the following affirmations are equivalent:

i) $lim_{h\to 0}\|T_hQ_h(f)-Q_h(f)T_h\|=0, \forall f\in B_b(X)$;

ii) $lim_{h\to 0}\|T_hQ_h(id)-Q_h(id)T_h\|=0$.

2. ASYMPTOTIC EQUIVALENCE

Defini□ia 2.1. We say that two families of operators $\{S_h\},\{T_h\}\subset L(X)$, parameterized by $h\in(0,1]$, are *asymptotic equivalent* if

$$lim_{h\to 0}\|S_h-T_h\|=0.$$

Proposition 2.2. The asymptotic equivalence between two families of operators $\{S_h\},\{T_h\}\subset L(X)$ is an equivalence relation (i.e. reflexive, symmetric and transitive) on $L(X)$.

Proof: It is evidently that the asymptotic equivalence is reflexive and symmetric.
Let $\{S_h\},\{T_h\},\{U_h\}\subset L(X)$ be families of linear bounded operators such that $\{S_h\},\{T_h\}$ and $\{U_h\},\{T_h\}$ are respectively asymptotic equivalent. Then

$$\lim_{h\to 0}\|S_h-U_h\|=\lim_{h\to 0}\|S_h-T_h+T_h-U_h\|\le\lim_{h\to 0}\|S_h-T_h\|+\lim_{h\to 0}\|T_h-U_h\|=0$$

Proposition 2.3. Let $\{S_h\},\{T_h\}\subset L(X)$ be asymptotic equivalent.
i) If $\{S_h\}$ is a bounded family of operators, then $\{T_h\}$ is also bounded and conversely;
ii) $\{S_h\},\{T_h\}$ are asymptotic commuting (i.e. $lim_{h\to 0}\|S_hT_h-T_hS_h\|=0$);
iii) Let $\{U_h\}\subset L(X)$ be a bounded family of operators such that $lim_{h\to 0}\|S_hU_h-U_hS_h\|=0$. Then $lim_{h\to 0}\|U_hT_h-T_hU_h\|=0$;

Proof: i) If $\{S_h\}$ is a bounded family of operators, then there is $\lim\sup_{h\to 0}\|S_h\|<\infty$. Since

$$\lim_{h\to 0}\|S_h-T_h\|=0,$$

it follows that

$$\lim\sup_{h\to 0}\|T_h\|=\lim\sup_{h\to 0}\|T_h-S_h+S_h\|\le\lim_{h\to 0}\|S_h-T_h\|+\lim\sup_{h\to 0}\|S_h\|<\infty$$

Therefore $\{T_h\}$ is a bounded family of operators. Analogously we can prove that if $\{T_h\}$ is a bounded family of operators, than $\{S_h\}$ is a bounded family of operators.
ii)

$$\lim_{h\to 0}\|S_hT_h-T_hS_h\|=\lim_{h\to 0}\|S_hT_h-S_h{}^2+S_h{}^2-T_hS_h\|\le\lim_{h\to 0}\|S_h(S_h-T_h)\|+\lim_{h\to 0}\|(S_h-T_h)S_h\|\le 2\lim_{h\to 0}\|S_h\|\|S_h-T_h\|\le 0$$

iii) $\lim_{h\to 0}\|T_hU_h-U_hT_h\|=$

$$=\lim_{h\to 0}\|T_hU_h-S_hU_h+S_hU_h-U_hS_h+U_hS_h-U_hT_h\|$$
$$\le\lim_{h\to 0}\|T_hU_h-S_hU_h\|+\lim_{h\to 0}\|S_hU_h-U_hS_h\|+$$
$$+\lim_{h\to 0}\|U_hS_h-U_hT_h\|\le 2\lim_{h\to 0}\|U_h\|\|T_h-S_h\|$$

Since $\{U_h\}$ is a bounded family of operators, then there is $\lim\sup_{h\to 0}\|U_h\|<\infty$. So

$$\lim_{h\to 0}\|U_hT_h-T_hU_h\|=0.$$

Proposition 2.4. Let $\{S_h\},\{T_h\}\subset L(X)$ be two bounded families of operators such that $lim_{h\to 0}\|S_hT_h-T_hS_h\|=0$. Then
i) $lim_{h\to 0}\|S_h^nT_h^m-T_h^mS_h^n\|=0$, for any $n,m\in\mathbb{N}$;
ii) $lim_{h\to 0}\|(S_h-T_h)^{[n]}\|=lim_{h\to 0}\|(S_h-T_h)^n\|$, for any $n\in\mathbb{N}$;
iii) $lim_{h\to 0}\|(S_hT_h)^n-S_h^nT_h^n\|=0$, for any $n\in\mathbb{N}$;

Proof: i) We prove that $\lim_{h\to 0}\|S_h^nT_h-T_hS_h^n\|=0$, for any $n\in\mathbb{N}$.
For $n=2$ we have

$$\lim_{h\to 0}\|S_h^2T_h-T_hS_h^2\|=\lim_{h\to 0}\|S_h(S_hT_h)-S_h(T_hS_h)+(S_hT_h)S_h-(T_hS_h)S_h\|\le 2\lim_{h\to 0}\|(S_hT_h)-(T_hS_h)\|\|S_h\|=0$$

For $n=3$ we have

$$\lim_{h\to 0}\|S_h^3T_h-T_hS_h^3\|=\lim_{h\to 0}\|S_h(S_h^2T_h)-S_h(T_hS_h^2)+(S_hT_h)S_h^2-(T_hS_h)S_h^2\|\le\lim_{h\to 0}\|S_h^2T_h-T_hS_h^2\|\|S_h\|+\lim_{h\to 0}\|S_hT_h-T_hS_h\|\|S_h^2\|=0$$

Considering relation $\lim_{h\to 0}\|S_h^nT_h-T_hS_h^n\|=0$ true we prove that $\lim_{h\to 0}\|S_h^{n+1}T_h-T_hS_h^{n+1}\|=0$.

$$\lim_{h\to 0}\|S_h^{n+1}T_h-T_hS_h^{n+1}\|\lim_{h\to 0}\|S_h(S_h^nT_h)-S_h(T_hS_h^n)+(S_hT_h)S_h^n-(T_hS_h)S_h^n\|\le\lim_{h\to 0}\|S_h^nT_h-T_hS_h^n\|\|S_h\|+\lim_{h\to 0}\|S_hT_h-T_hS_h\|\|S_h^n\|=0$$

Applying above relation to S_h^n □i T_h, it follows that

$$\lim_{h\to 0}\|S_h^n T_h^m - T_h^m S_h^n\| = 0,$$

for every $n, m \in \mathbb{N}$.
ii) and iii) can be proved analogously i).

3. SPECTRUM OF A FAMILY OF OPERATORS

Definition 3.1. We call the *resolvent set* of a family of operators $\{S_h\} \subset L(X)$ the set

$$r(\{S_h\}) = \Big\{\lambda \in \mathbb{C} \,|\, \exists \{\mathcal{R}(\lambda, S_h)\} \subset L(X),\ \lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda, S_h) - I\| = \lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)(\lambda I - S_h) - I\| = 0\Big\}$$

We call the *spectrum* of a family of operators $\{S_h\} \subset L(X)$ the set

$$Sp(\{S_h\}) = \mathbb{C} \setminus r(\{S_h\}).$$

Proposition 3.2. i) If $\lambda \in r(S_h)$ for any $h \in (0,1]$, Then $\lambda \in r(\{S_h\})$. Therefore $\bigcap_{h\in(0,1]} r(S_h) \subseteq r(\{S_h\})$;
ii) If $\lambda \in Sp(\{S_h\})$, then

$$|\lambda| \leq \lim\ \sup_{n\to\infty} \lim_{h\to 0}\|S_h{}^n\|^{\frac{1}{n}};$$

iii) If $\|S_h\| < |\lambda|$ for any $h \in (0,1]$, then $\lambda \in r(\{S_h\})$;
iv) If $\{S_h\}$ is bounded, then $\{\mathcal{R}(\lambda, S_h)\}$ is also bounded, for every $\lambda \in r(\{S_h\})$;
v) If $\{S_h\}$ is bounded, then $\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\| \neq 0$, for every $\lambda \in r(\{S_h\})$;
vi) $r(\{S_h\})$ is an open set of $\mathbb{C}$. If $\{S_h\}$ is a bounded family, then $Sp(\{S_h\})$ is a compact set of $\mathbb{C}$.

Proof: i) Trivial.
ii) The functions defined by

$$f_h(\lambda) = \sum_{n=0}^{\infty} \frac{S_h^n}{\lambda^{n+1}},$$

for any $h \in (0,1]$, have as convergence domain the sets $D_h = \Big\{\lambda \,|\, |\lambda| > \lim\ \sup_{n\to\infty}\|S_h{}^n\|^{\frac{1}{n}}\Big\}$, for any $h \in (0,1]$ ([4] III.14.).
If we put $D = \Big\{\lambda \,|\, |\lambda| > \lim\ \sup_{n\to\infty} \lim_{h\to 0}\|S_h{}^n\|^{\frac{1}{n}}\Big\}$, then $D \subseteq D_h$, for any $h \in (0,1]$.
Let us show that

$$\lim_{h\to 0}\|(\lambda I - S_h)f_h(\lambda) - I\| = \lim_{h\to 0}\|f_h(\lambda)(\lambda I - S_h) - I\| = 0$$

for any $\lambda \in D$.
Let $\lambda \in D$. Then

$$\lim_{h\to 0}\|(\lambda I - S_h)f_h(\lambda) - I\| = \lim_{h\to 0}\left\|(\lambda I - S_h)\sum_{n=0}^{\infty}\frac{S_h^n}{\lambda^{n+1}} - I\right\| = \lim_{h\to 0}\left\|\sum_{n=0}^{\infty}\frac{S_h^n}{\lambda^{n+1}}(\lambda I - S_h) - I\right\| = \lim_{h\to 0}\left\|\sum_{n=0}^{\infty}\left(\frac{S_h^n}{\lambda^n} - \frac{S_h^{n+1}}{\lambda^{n+1}}\right) - I\right\| = 0$$

Similarly, we prove that $\lim_{h\to 0}\|f_h(\lambda)(\lambda I - S_h) - I\| = 0$.
Therefore $\lambda \in r(\{S_h\})$, for every $\lambda \in D$, so

$$Sp(\{S_h\}) \subseteq \mathbb{C} \setminus D = \Big\{\lambda \,|\, |\lambda| \leq \lim\ \sup_{n\to\infty} \lim_{h\to 0}\|S_h{}^n\|^{\frac{1}{n}}\Big\}$$

iii) It immediately results by ii).
iv) If $\{S_h\}$ is bounded, then $\lim\ \sup_{h\to 0}\|S_h\| = M < \infty$. Let $\lambda \in r(\{S_h\})$. According to Definition 3.1., follows that there is $\{\mathcal{R}(\lambda, S_h)\} \subset L(X)$ such that

$$\lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda, S_h) - I\| = \lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)(\lambda I - S_h) - I\| = 0$$

From the last relation it results

$$\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\| = \frac{1}{|\lambda|}\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)(\lambda I - S_h) - I + \mathcal{R}(\lambda, S_h)S_h + I\| \leq \frac{1}{|\lambda|}\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)(\lambda I - S_h) - I\| + \frac{1}{|\lambda|}\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)S_h\| + \frac{1}{|\lambda|} \leq \frac{1}{|\lambda|}\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\|\|S_h\| + \frac{1}{|\lambda|} = \frac{1}{|\lambda|}M\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\| + \frac{1}{|\lambda|}$$

and having in view ii) we obtain

$$\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\| \leq \frac{1}{|\lambda| - M}.$$

v) Let $\lambda \in r(\{S_h\})$. From Definition 3.1., it follows that there is $\{\mathcal{R}(\lambda, S_h)\} \subset L(X)$ such that

$$\lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda, S_h) - I\| = \lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)(\lambda I - S_h) - I\| = 0$$

We suppose that $\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\| = 0$. Since

$$1 = \|I\| \leq \|(\lambda I - S_h)\mathcal{R}(\lambda, S_h) - I\| + \|(\lambda I - S_h)\mathcal{R}(\lambda, S_h)\|$$

it follows

$$1 \leq \lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda, S_h) - I\| + \lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda, S_h)\| \leq \lim_{h\to 0}\|\lambda I - S_h\|\|\mathcal{R}(\lambda, S_h)\| \leq 0$$

contradiction.

vi) Let $\lambda \in r(\{S_h\})$. From Definition 3.1., it follows that there is $\{\mathcal{R}(\lambda, S_h)\} \subset L(X)$ such that

$$\lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda, S_h) - I\| = \lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)(\lambda I - S_h) - I\| = 0$$

Let $\mu \in D(\lambda, \frac{1}{\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\|})$. So

$$|\lambda - \mu| < \frac{1}{\lim_{h\to 0}\|\mathcal{R}(\lambda, S_h)\|}.$$

According to ii), it follows $1 \in r(\{(\lambda-\mu)\mathcal{R}(\lambda, S_h)\})$, therefore there is $\{\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h))\} \subset L(X)$ such that

$$\lim_{h\to 0}\|(I-(\lambda-\mu)\mathcal{R}(\lambda,S_h))\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - I\| = \lim_{h\to 0}\|\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h))(I-(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - I\| = 0$$

In addition, from iv) we obtain $\{\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h))\}$ is a bounded family.
Having in view the above relation, it results

$$\lim_{h\to 0}\|(\mu I - S_h)\mathcal{R}(\lambda,S_h)\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - I\|$$
$$= \lim_{h\to 0}\|(\lambda I - S_h)\mathcal{R}(\lambda,S_h)\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - (\lambda-\mu)\mathcal{R}(\lambda,S_h)\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - I\| =$$
$$\lim_{h\to 0}\|((\lambda I - S_h)\mathcal{R}(\lambda,S_h) - I)\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) + \mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - (\lambda-\mu)\mathcal{R}(\lambda,S_h)\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - I\| \le$$
$$\lim_{h\to 0}\|((\lambda I - S_h)\mathcal{R}(\lambda,S_h) - I)\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h))\| + \lim_{h\to 0}\|\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - (\lambda-\mu)\mathcal{R}(\lambda,S_h)\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - I\| \le \lim_{h\to 0}\|((\lambda I - S_h)\mathcal{R}(\lambda,S_h) - I)\|\|\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h))\| +$$
$$\lim_{h\to 0}\|(I-(\lambda-\mu)\mathcal{R}(\lambda,S_h))\mathcal{R}(1,(\lambda-\mu)\mathcal{R}(\lambda,S_h)) - I\| = 0$$

so $\mu \in r(\{S_h\})$, for every $\mu \in D(\lambda, \frac{1}{\lim_{h\to 0}\|\mathcal{R}(\lambda,S_h)\|})$.
Therefore, for any $\lambda \in r(\{S_h\})$, there is an open disk $D(\lambda, \frac{1}{\lim_{h\to 0}\|\mathcal{R}(\lambda,S_h)\|})$ such that

$$D(\lambda, \frac{1}{\lim_{h\to 0}\|\mathcal{R}(\lambda,S_h)\|}) \subset r(\{S_h\}).$$

If $\{S_h\}$ is a bounded family, from ii) we have

$$|\lambda| \le \lim\sup_{h\to 0}\|S_h\| < \infty,$$

for any $\lambda \in Sp(\{S_h\})$, so $Sp(\{S_h\})$ is a compact set.

4. POSITIVE ASYMPTOTIC MORPHISMS

Let A and B be two C* - algebras.

Definition 4.1. A *positive asymptotic morphism* from A to B is a family of maps $\{Q_h\}_{h\in(0,1]}: A \to B$, parameterized by $h \in (0,1]$, such that the following hold:

a) Each Q_h is a positive linear map;

b) The map $h \mapsto Q_h(f): (0,1] \to B(H)$ is continuous for any $f \in A$;

c) For all $f, g \in A$ we have

$$\lim_{h\to 0}\|Q_h(fg) - Q_h(f)Q_h(g)\| = 0.$$

(Definition 2.1. [3])

Remark: a) Any *-homomorphism $Q: A \to B$ determines a constant positive asymptotic morphism $\{Q_h\}_{h\in(0,1]}: A \to B$ defined by $Q_h = Q$, $\forall h \in (0,1]$.

b) For any $f \in A$ we have

$$\lim_{h\to 0}\|Q_h(f)\| \le \|f\|.$$

(Sect. 2. – [4]. Remark 3.2)

c) If A is a commutative C* - algebra, then for any $f, g \in A$ we have

$$\lim_{h\to 0}\|Q_h(f)Q_h(g) - Q_h(g)Q_h(f)\| = 0$$

Definition 4.2. Two positive asymptotic morphisms $\{Q_h\}, \{P_h\}_{h\in(0,1]}: A \to B$ are called *asymptotic equivalent* if for all $f \in A$ we have that

$\lim_{h\to 0}\|Q_h(f) - P_h(f)\| = 0$. (Definition 2.2. [3])

Remark: The asymptotic equivalence relation of two positive asymptotic morphisms is a equivalence relation (i.e. symmetric, reflexive and transitive).

Let H be a separable Hilbert space and $B(H)$ C* - algebra of all bounded linear operators on H . Let X be a set equipped with a □-algebra Σ_X of measurable sets and let $C_X \subset \Sigma_X$ denote the collection of all pre-compact open subsets of X. Define $B_0(X)$ to be the C* - subalgebra of $B_b(X)$ (C* - algebra of all bounded Borel functions on X) generated by $\{\chi_U | U \in C_X\}$, where χ_U denotes the characteristic function of $U \subseteq X$. If X is also σ – compact, then let $C_0(X)$ be the set of all continuous functions which vanish at infinity on X .

Definition 4.3. A positive asymptotic morphism $\{Q_h\}_{h\in(0,1]}: B_b(X) \to B(H)$ will be said to have *compact* support if there is a compact subset K of X such that $supp(Q_h) \subset$ K, $\forall h \in (0,1]$.

Remark 4.4. a) $X \setminus supp(Q_h)$ is the largest open set on it Q_h is vanished.

b) If $supp(Q_h) \cap supp(f) = \emptyset$, then $Q_h(f) = 0$.

Definition 4.5. Let $\{Q_h\}_{h\in(0,1]}: B_b(X) \to B(H)$ be a positive asymptotic morphism. The *support of* $\{Q_h\}$ is defined as the set

$supp(\{Q_h\}) = \cap \{F \text{ închisă} | \, lim_{h\to 0}\|Q_h(f)\| = 0, \forall f \in B_b(X) \text{ a.î. } supp(f) \cap F = \emptyset \}$

Theorem 4.6. Let $\{Q_h\}_{h\in(0,1]}: B_b(X) \to B(H)$ be a positive asymptotic morphism having the property $lim_{h\to 0}\|Q_h(1) - I\| = 0$. Then

$$Sp(\{Q_h(f)\}) \subseteq f(supp(\{Q_h\})), \forall f \in B_b(X).$$

Proof: Let $f \in B_b(X)$ and $\lambda \notin f(supp(\{Q_h\}))$. Thus $\lambda - f(x) \neq 0$, $\forall x \in supp(\{Q_h\})$. Hence, there is an open set $G \supset supp(\{Q_h\})$ such that $\lambda - f(x) \neq 0$, $\forall x \in G$. It follows $g(x) = 1 / (f(x) - \lambda) \in C(G)$ and

$$g(x)(f(x) - \lambda) = (f(x) - \lambda)g(x) = 1, \forall x \in G.$$

Having in view the above relation and since $\lim_{h\to 0}\|Q_h(1) - I\| = 0$, it results

$$\begin{aligned}&\lim_{h\to 0}\|Q_h(g)(\lambda - Q_h(f)) - I\| = \\ &\lim_{h\to 0}\|Q_h(g)(\lambda - Q_h(f)) - Q_h(g)Q_h(\lambda - f) + Q_h(g)Q_h(\lambda - f) - Q_h(g(\lambda - f)) + Q_h(g(\lambda - f)) - Q_h(1) + Q_h(1) - I\| \leq \\ &\lim_{h\to 0}\|Q_h(g)(\lambda - Q_h(f)) - Q_h(g)Q_h(\lambda - f)\| + \lim_{h\to 0}\|Q_h(g)Q_h(\lambda - f) - Q_h(g(\lambda - f))\| + \lim_{h\to 0}\|Q_h(g(\lambda - f)) - Q_h(1)\| + \lim_{h\to 0}\|Q_h(1) - I\| = 0\end{aligned}$$

Analogously we prove that

$$\lim_{h\to 0}\|(\lambda - Q_h(f))Q_h(g) - I\| = 0.$$

Thus $\lambda \in r(\{Q_h(f)\})$. Therefore

$$Sp(\{Q_h(f)\}) \subseteq f(supp(\{Q_h\})), \forall f \in B_b(X).$$

Corollary 4.7. Let $\{Q_h\}_{h\in(0,1]}: B_b(X) \to B(H)$ be a positive asymptotic morphism such that $lim_{h\to 0}\|Q_h(1) - I\| = 0$. Then

$$Sp(\{Q_h(id)\}) \subseteq supp(\{Q_h\}).$$

Theorem 4.8. Let $\{Q_h\}, \{P_h\}_{h\in(0,1]}: B_b(X) \to B(H)$ be two positive asymptotic morphisms such that $lim_{h\to 0}\|Q_h(1) - I\| = 0$ and $lim_{h\to 0}\|P_h(1) - I\| = 0$. Then $\{Q_h\}, \{P_h\}$ are asymptotic equivalent if and only if $\{Q_h(id)\}, \{P_h(id)\}_{h\in(0,1]}$ are asymptotic equivalent (i.e. $lim_{h\to 0}\|Q_h(id) - P_h(id)\| = 0$).

Proof: If $\{Q_h\}, \{P_h\}$ are asymptotic equivalent, i.e.

$$\lim_{h\to 0}\|Q_h(f) - P_h(f)\| = 0, \forall f \in B_b(X),$$

then

$$\lim_{h\to 0}\|Q_h(id) - P_h(id)\| = 0.$$

Reciprocal: Let $f \in B_b(X)$ and $g \in C_c(X)$ such that $g = 1$ on a neighborhood of $supp(f)$. Then, by Weierstrass – Stone Theorem, it results there is a net $(p_n)_{n\in\mathbb{N}}$ by polynomials with two variables and real coefficients such that

$$\lim_{n\to\infty} p_n g = fg.$$

When $Q_h(id) \geq 0$, it follows $Q_h(id)$ is self-adjoint, so

$$Q_h(id) = Q_h(id)^* = Q_h(\overline{id}).$$

Taking into account that

$$\lim_{h\to 0}\|Q_h(id) - P_h(id)\| = 0$$

$$lim_{h\to 0}\|Q_h(1) - I\| = 0 \text{ and } lim_{h\to 0}\|P_h(1) - I\| = 0,$$

we have

$$\lim_{h\to 0}\|Q_h(p_n g) - P_h(p_n g)\| = 0.$$

Thus

$$\begin{aligned}&\lim_{h\to 0}\|Q_h(f) - P_h(f)\| = \lim_{h\to 0}\|Q_h(fg) - P_h(fg)\| = \lim_{h\to 0}\|Q_h(\lim_{n\to\infty} p_n g) - P_h(\lim_{n\to\infty} p_n g)\| = \\ &\lim_{h\to 0}\|\lim_{n\to\infty}(Q_h(p_n g) - P_h(p_n g))\| \leq \\ &\lim_{n\to\infty}\lim_{h\to 0}\|Q_h(p_n g) - P_h(p_n g)\| = 0\end{aligned}$$

Theorem 4.9. Let $\{Q_h\}_{h\in(0,1]}: B_b(X) \to B(H)$ be a positive asymptotic morphism such that $lim_{h\to 0}\|Q_h(1) - I\| = 0$ and $\{T_h\} \subset B(H)$ a bounded family of linear continuous operators ($\lim\sup_{h\to 0}\|T_h\| < \infty$). Then the following affirmations are equivalent:

i) $lim_{h\to 0}\|T_h Q_h(f) - Q_h(f)T_h\| = 0$, for any $f \in B_b(X)$;

ii) $lim_{h\to 0}\|T_h Q_h(id) - Q_h(id)T_h\| = 0$.

Proof: i) □ ii) Trivial.

ii) □ i) : Let $f \in B_b(X)$ and $g \in C_c(X)$ such that $g = 1$ on a neighborhood of $supp(f)$. Then, by Weierstrass – Stone Theorem, it results there is a net $(p_n)_{n\in\mathbb{N}}$ by polynomials with two variables and real coefficients such that

$$\lim_{n\to\infty} p_n g = fg.$$

When $Q_h(id) \geq 0$, it follows $Q_h(id)$ is self-adjoint, so

$$Q_h(id) = Q_h(id)^* = Q_h(\overline{id}).$$

Taking into account that

$$\lim_{h\to 0}\|T_h Q_h(id) - Q_h(id)T_h\| = 0$$

$$lim_{h\to 0}\|Q_h(1) - I\| = 0 \text{ and } lim_{h\to 0}\|P_h(1) - I\| = 0$$

we have

$$\lim_{h\to 0}\|T_h Q_h(p_n g) - Q_h(p_n g)T_h\| = 0.$$

Thus

$$\lim_{h\to 0}\|T_hQ_h(f)-Q_h(f)T_h\| =$$
$$\lim_{h\to 0}\|T_hQ_h(fg)-Q_h(fg)T_h\| =$$
$$\lim_{h\to 0}\|T_hQ_h(\lim_{n\to\infty} p_ng) -$$
$$Q_h(\lim_{n\to\infty} p_ng)T_h\| =$$
$$\lim_{h\to 0}\left\|\lim_{n\to\infty}(T_hQ_h(p_ng)-Q_h(p_ng)T_h)\right\| \le$$
$$\lim_{h\to 0}\lim_{n\to\infty}\|T_hQ_h(p_ng)-Q_h(p_ng)T_h\| =$$
$$\lim_{n\to\infty}\lim_{h\to 0}\|T_hQ_h(p_ng)-Q_h(p_ng)T_h\| = 0$$

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STUDENT'S MOBILITIES, AN INSPIRATIONAL MARKETING TOOL. CASE STUDY:ROMANIA

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ABSTRACT

Used wisely, Erasmus programme can significantly accelerate the modernization and reform in higher education. As the Ministers responsible for higher education in the countries participating in the Bologna Process, met in Budapest and Vienna on March 2010, appreciated in their common declaration, higher education institutions, students and staff are "engaged in a series of reforms to build a European Higher Education Area based on trust, cooperation and respect for the diversity of cultures, languages, and higher education systems ". The Erasmus programme is maybe the most helpful tool in building this bridge. Our analysis aims to underline the relevant aspects concerning the selection process for an Erasmus mobility: study mobilities (SMS) and placement mobilities (SMP) in Romania; to identify the main difficulties experienced by final beneficiaries undertaking Erasmus mobilities and to assess the impact of participation in the Erasmus programme upon students, teachers and institutions. We want to see if there are best practices and lessons learned at national level and our main instrument will be a survey conducted in seven universities, at national level.

Keywords: *Erasmus, mobilities, best practices, recognition, ECTS*

1. INTRODUCTION

When you say "mobilities", you say ERASMUS. When you say ERASMUS, you say higher education institutions working together through intensive programmes, networks and multilateral projects; you say innovation throughout Europe.
Thanks to all these actions, ERASMUS has become a driver in the modernisation of higher education institutions and systems in Europe and, in particular, has inspired the establishment of the Bologna Process.

Used wisely, Erasmus programme can significantly accelerate the modernization and reform in higher education. As the Ministers responsible for higher education in the countries participating in the Bologna Process, met in Budapest and Vienna on March 2010, appreciated in their common declaration, higher education institutions, students and staff are "engaged in a series of reforms to build a European Higher Education Area based on trust, cooperation and respect for the diversity of cultures, languages, and higher education systems ". The Erasmus programme is maybe the most helpful tool in building this bridge.

Our analysis aims to underline the relevant aspects concerning the selection process for an Erasmus mobility: study mobilities (SMS) and placement mobilities (SMP) in Romania; to identify the main difficulties experienced by final beneficiaries undertaking Erasmus mobilities and to assess the impact of participation in the Erasmus programme upon students, teachers and institutions. We want to see if there are best practices and lessons learned at national level. We consider this analysis work in progress because we think it will be more relevant to collect information from more universities, giving the fact that in Romania, in 2010, there are 65 universities which applied for Erasmus Students Mobilities for studies (SMS) and 44 universities which applied for placement mobilities (SMP).

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2. RELEVANT ASPECT CONCERNING THE SELECTION PROCESS FOR AN ERASMUS MOBILITY: SMS, SMP IN ROMANIA

Beginning with the academic year 2005-2006 the new way of organizing education in cycles, as a consequence of the Bologna process, affected the Erasmus programme. This happened, primarily, in connection with the mobility of 1st cycle students. The duration of 4 years (240 ECTS) of undergraduate studies established by the 2004 law in Romania for technical higher education, although from our point of view is an acceptable compromise to the realities, generated mobility difficulties both with universities which have adopted a first 3-year cycle (almost all universities in Italy, Belgium, Netherlands and most of those in Germany, etc.) and with the Grandes Ecoles in France which continue to provide integrated programmes of 5 years.

In 2010 a number of 65 universities applied for Erasmus Students Mobilities for studies, which means 3 institutions more than in 2009. According to statistical data shows there is an increase of 10.82% in terms of number of student months requested in 2010, compared to 2009. The same trend was maintained when speaking about the level of the HEIs demand in terms of number of student mobilities which remained unrealistic: 7107 requests in 2009, 7894 requests in 2010 which represents a 11,7% increase, compared to only 3129 student mobilities performed in 2009. Thus, in order to distribute the funds to the Romanian universities the NA continued to take into account the "past performance" regarding the number of student months achieved in the academic year N-2 and also the particular criteria for new comers: intermediary report (year N-1) and / or request (in terms of number of students`months, outgoing and incoming) depending on the first year of participation in the Erasmus Programme.

In order to reach the target of 3000000 Erasmus students, starting with 2011, our National Agency (NA) will distribute the funds by replacing the number of student months with the number of students. Also, taking into account the recommendation made by the Commission, the NA will set a minimum of 275 EURO/month/student instead of 300 EURO/month/student in 2010.

Also NA took into account the number of months spent by the incoming students during the previous academic year in that particular institution. In addition, because of the national economic context especially in a year of crisis (i.e. the scarcity of cofinancing sources), the NA continued to set a minimum of 300 EURO/month/student, which limits somehow an increase to a larger extent of the total number of students beneficiaries.

Despite the efforts aimed at identifying sources for co-financing student mobilities, insufficient funds available to the students engaged in mobilities abroad is still identified as a main challenge by the participating universities. Another issue that comes often in the signals received by the agency is linked to the recognition of studies and the assimilation of credits abroad.

We want to have more Erasmus students but, in the same time, it is not possible to transform Erasmus into a programme accessible only for students coming from wealthy families. Therefore, each university do its best in order to keep a balance between those two constraints.

There is a completely different problem with Erasmus students placements. At national level, in 2010 a number of 44 universities applied for decentralized actions for Erasmus Students Mobilities (placements), meaning 5 institutions more than in 2009. The statistics form our National Agency shows an increase of 38.5% in terms of number of student months for placements requested in 2010 (1531), compared to 2009 (1105).

Public universities were ones that answered positively to this challenge. An explanation consists in the fact that the public universities used to have Leonardo da Vinci projects in the past and therefore they have the necessary background/know-how in organising this type of mobility.

In order to distribute the funds to the Romanian universities the NA continued to take into account the "past performance" in terms of number of mobility months in the academic year N-2 and also the particular criteria for new comers: intermediary report (year N-1) and / or request (in terms of number of students` months, outgoing and incoming) depending on the first year of participation in Erasmus. The NA did also take into account the number of months spent by the incoming students during the previous academic year in that particular institution.

In order to reach the target of 3,000,000 Erasmus students starting with 2011, the NA will distribute the funds by replacing the number of student months with the number of students. Following the Commission recommendations, the NA will decrease the minimum grant level to 325 EURO/month/student, instead of 375 EURO/month/student in 2010.

Even though there is still a discrepancy between the number of institutions that applied for SMS and the number of applicant institutions for SMP, we still have to notice the positive trend.

We need to mention that Romania has no tradition in close cooperation between universities and enterprises, and thus each university take every opportunity to disseminate the good practice examples in placements.

There is no compact period of 3 months in the students' calendar, except for those in the last semester of master study programmes, so that efforts were required to condense the examination period for the students that applied for a SPM mobility.

Companies became more receptive to demands of accepting students for practical placement stages; subsequent years will ensure a greater number of mobility stages.

We should also add that the curriculum of all the HEIs in Romania does not foresee more than 3 weeks of practical activities over the 3 years cycle.As a consequence it is very difficult to make an equivalence of the Erasmus placement period, of a minimum of 3 months, with the compulsory study period, although the placement activities are awarded transferable credits (up to a maximum of 60 credits for one year placement).

So, we appreciate the number of institutions that applied for placements as being still "weak".

3. THE MAIN DIFFICULTIES EXPERIENCED BY FINAL BENEFICIARIES UNDERTAKING ERASMUS MOBILITIES

The most difficult problem that all universities pointed out is related to the financial payment amount. Some of the universities mentioned the northern countries, where the students have to pay for the courses they attend and the living costs are generally high.

Some universities mentioned differences in awarding the credits and problems concerning the equivalence of the courses. The curricula is signalled not to be aligned, nor even compatible. This resulted in difficulties regarding the recognition of the results in the sending universities.

Other issue concerned accommodation and the costs of accommodation in case of SMS and SMP beneficiaries. There are universities that do not offer the students accommodation at all and do not offer any solutions.

We can mention that the periods of practice in some universities are shorter than the minimum required for the placement mobility.

In the same time, identifying European partner enterprises continues to represent a challenge.

Some universities which have inter-institutional agreements with german universities mentioned the fact that the German language, especially the medical German language is still a barrier even if students have proficiency knowledge certificates and B2 or A2 level, they are treated like Germans and no courses of English are organised in German institutions.

Late arrival of the Transcript of records in case of several SMS beneficiaries, due to specific procedures in host universities and to the extension of the examination period until late of September. Thus involved difficulties in finalizing the recognition of the results in our university.

Finding accommodation and the costs of accommodation in case of SMP beneficiaries, if the stage was run in a company.

There are universities that require aminimum of six months and there are faculties within our university that can not allow the students to perform an Erasmus mobility for more than three months because the curricula of our university doesn`t fit the curricula from the host university.

4. THE EXTENT IMPACT OF PARTICIPATION IN THE ERASMUS PROGRAMME UPON STUDENTS, TEACHERS AND INSTITUTIONS

Despite all these difficulties the Erasmus programme has a huge impact on the Romanian academic community. The participation in any form of the Erasmus programme can only be beneficial to all involved parties, as it lays ground for future cooperation, facilitates integration and accelerates information and cultural sharing. Students can find jobs easier and teachers are able to improve the teaching methods and content of study plans or disciplines.

There is no doubt that the impact on the students is an extended one. Many students witnessed that Erasmus has been “a life changing experience” for them. They have managed to be independent and to successfully integrate in a new social group. There is unanimous feedback on Erasmus seen as a great way of broadening their horizon of study, and creating interest for continuing some sort of cross-boundaries collaboration, as well as for following a master degree.

A large majority have expressed their desire to further an international career, in the study field of their current studies, feeling well-trained and educated for. According to their statements, they considered the experience extremely beneficial, enjoyable and would remake it in a form of a second mobility during the current degree studies or at a more advanced level.

Among the advantages we can underline a smoother insertion into the labour market; develop students’ transversal/generic competences; build awareness of European citizenship and intercultural diversity; individual growth on an academic and personal level.

According to recent years, three main directions have been identified that affect the requests of registered university graduates. (knowledge society, changes in labour market structure and the internationalization and globalization of product markets and labour markets and their impact on higher education). Directions above create new indicators on the skills that people should be equipped with: Innovation and knowledge management, Professional expertise, Functional flexibility, Mobilizing Human Resources, International orientation.

Overall a very positive impact through improving knowledge, getting a new experience, creating opportunity for cooperation, changing the mindset etc. The students enjoy experiencing different cultural patterns and study systems.

Erasmus beneficiaries (teachers) have appreciated the outcomes of the mobilities, have acquired new knowledge and skills, have upgraded and harmonized curricula and they are more involved when teaching Erasmus incoming/ outgoing students. Some plan to develop new programmes based upon joint curriculum harmonization or joint modules, or joint thesis.

The institution is more and more committed and acquires more experience in institutional building, achieves international and European exposure and visibility at home and abroad. Broad exchange opportunities are playing a considerable role in international students recruitment. ERASMUS represents an open door to mobility and cooperation; boost reputation and increase visibility of the institution; enrich the teaching offer and services through comparisons and exchange of quality procedures and standards; achieve institutional awareness of intercultural diversity.

The impact of Erasmus is generally enhanced through the dissemination of the experience achieved by the former Erasmus students towards future beneficiaries, during meetings organized by the home universities. They have also involved themselves in the Erasmus Students Network in different cities, described their experience on the Erasmus platform and eventually launched new student associations and websites.

5. PRELIMINARY CONCLUSIONS

One preliminary conclusion that we can draw may consist in improving the grants conditions (amount and timely payment) and the overall “quality” of the mobility experience (timely information, adequate preparation and due recognition).

Romanian universities need to find a better balance between incoming and outgoing students, which calls for efforts aimed at attracting students to particular places, as well as at convincing students of the value-added of mobility. The latter is likely to become a strong determinant of ERASMUS’ future success: the benefits of an ERASMUS learn-in-Europe experience will no longer be taken for granted by a sufficient number of students and will have to be demonstrated on the basis of its academic and/or professional value-added. Mobility will increasingly be seen as a means to achieve a variety of goals, rather than as an aim in itself .

In Romania, we have to mention the most notable evolution during the year 2010 which was the reform of the educational system. The legislation proposed by the Government was subject to extended consultations and debates at national level, that involved a wide range of social and professional categories affected by the law's effects. The end of 2010 marked the adoption of the new Romanian Law of national education. Notably, it mentions the internationalization of higher education as a priority.

We consider the new law is in favor of the Erasmus programme, the possibility of undergoing study or placement periods in Europe Union being mentioned explicitly. A substantial improvement in the quality of undergraduate and postgraduate education is expected after the implementation of the National Qualifications Framework in Higher Education - which is part of the new law.

At national level, is anticipated a positive impact on the quality of Erasmus students' mobilities, with respect to the recognition of competences acquired abroad and the issuing of Diploma supplements in a more appropriate way.

As we alredy said, used wisely, Erasmus programme can significantly accelerate the modernization and reform in higher education. Seeing what and how others do, in other European universities, working together on courses, seminars, workshops, projects, is an ideal opportunity for their own progress (where "own" have to be found both at institutional and personal level).

A teacher or staff member can take high profit both from teaching and from training mobility. You can see, discover, understand, try, validate methods and content, attitudes and results. It is a live facing with the new educational approach, based on skills and competences, of the student- centred education. Students from foreign universities, to whom the teacher has the chance to teach during the Erasmus mobility, do not forgive and do not accept outdated procedures, passive attitude, reject the arid contents that does not answer to their own interests and aspirations of professional training. Teaching in a foreign university accelerates progress in Romanian universities.

For upgrading infrastructure, for policies based on materials and service management in the university area, mobility for staff training, is a great motivation and an opportunity to study advanced models implemented in universities across Europe.

Regarding the attitude of former Erasmus students with respect to the educational process, essential changes are outlined during the mobility period, manifested by more maturity in their behaviour within the academic area, more commitment to learn thoroughly, more curiosity and interest for novelty items, much more cultural openness and capacity to understand, accept and foster multiculturalism.

It is also apparent from former Erasmus students a stronger desire to engage themselves in educational process, to propose topics and educational activities, to become partners with the teachers in the education process. Partnership aspect of student (s) - teacher (s) is clearly stronger when Erasmus students were back among their colleagues, namely when the stage was not performed in the final period of study.

Certainly, the Romanian higher education becomes healthier, more energetic and vigorous, more European, more flexible and open, because it is forced to do it by its Erasmus beneficiaries themselves.

The questions that universities had to answer and that we choose to present in our anaysis were:

- Please analyze the results of the selection process round 2010_SMS;
- Please analyze the results of the selection process round 2010_SMP;
- Please provide up to 3 concrete examples of the main difficulties experienced by final beneficiaries undertaking Erasmus mobilities SMS and SMP;
- Please describe the extent of impact of participation in the Erasmus programme upon students, teachers and institution?

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