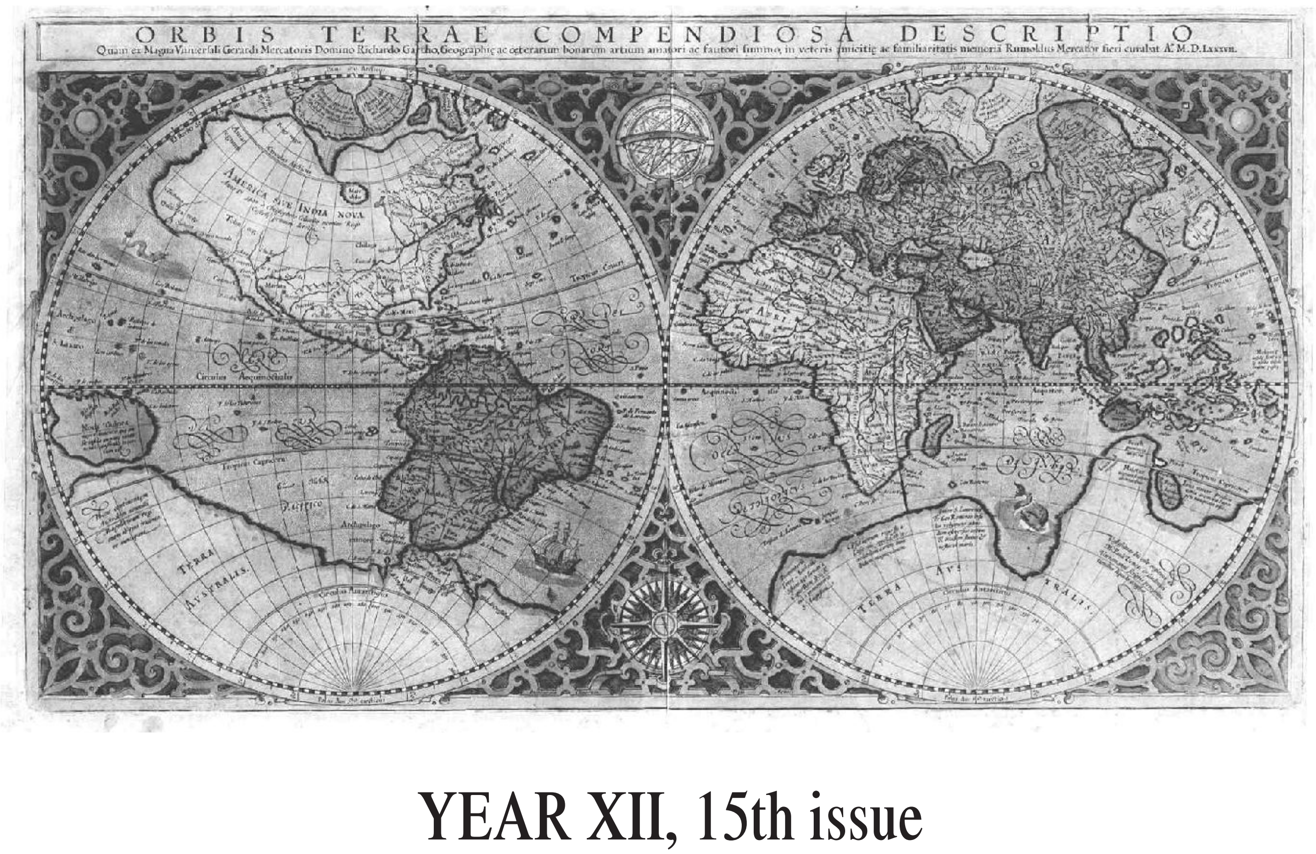
UNIVERSITATEA MARITIMA CONSTANȚA

CONSTANTA MARITIME UNIVERSITY

ANNALS



YEAR XII, 15th issue

Editura NAUTICA

CONSTANŢA 2011

CONTENTS

SECTION I

NAVIGATION AND MARITIME TRANSPORT

SMUGGLING ON MARITIME AND RIVER WATERWAYS

[1]ANECHITOAE CONSTANTIN, [2]GRIGORUT CORNEL,
[3]GRIGORUT LAVINIA-MARIA

[1,2,]*University "Ovidius", Constanta,* [3]*National Institute of Economic Research "Costin Kirițescu", Bucuresti, Romania*

ABSTRACT

Ty a recent paper, Constantin Tanase appreciates that on maritime and river waterways, i.e. in shipping, smuggling has always found an environment conducive to its development and prosperity. Being a fraud connected to the activities of trade, it is easy to spot "the opportunities" offered to this phenomenon by the travel by sea or rivers from a port to another, from one country to another.

Keywords: *Maritime smuggling, war contraband.*

1. PORT AND MARITIME CUSTOMS AREA

Port and maritime customs area is the port area and the sea strip than stretch along the coast, where the coastal State exercises its rights to customs control and suit. It is extended over the "territorial sea", where the coastal State has sovereign rights, and over the contiguous zone, which varies in width from State to State. With the exception of Poland, the European States have a maritime customs area which coincides to the "territorial sea" width, i.e. 12 miles, under the UN Convention on the Law of the Sea, signed at Montego Bay (Jamaica) on 10th December 1982, ratified by Romania by Law no. 110 of 10th October, 1996. Poland, whose territorial sea has a width of three miles, established a customs contiguous zone of 12 miles. Chile has a customs contiguous area of 100 km, the U.S. customs control area is of 12 miles and about 35 countries have customs control zones with the width between 3-12 miles. In port and maritime customs area the sovereign State can control, track and even confiscate the vessel for breaking its customs laws.

1.1. Customs Authority

Numerous and more and more complex, multilateral commercial and customs agreements and treaties among countries have imposed the existence of international law principles and customary practices that are applied and respected in more extensive areas of the planet [1].

Besides the main task to collect taxes under tariff prescriptions, customs had always had the task to control goods and documents, the means of transport and to find law violations.

The first modern customs laws were including procedure regulations addressed to the activities of customs clearance of goods and vessels [2]. Law no. 9 / 1949 on Customs reserves section § 2 of Chapter II to *"Vessel Customs Police"* (art.9-12). This law is in force today, but, in common vocabulary, reference is made to the term "port customs police", meaning "customs authority" of ports, the customs office of arrival/departure, import/export etc.

According to art. 13 section (1) of Law no. 86/2006 on the Romanian Customs Code, the authorized customs officials, in order to perform customs control under the law, are entitled to board on any vessel, including the military ones, in maritime or inland ports, and in roadsteads.

In transport by sea or river, the master, owner or agent of the vessel carrying the cargo to be unloaded or transshipped, shall submit to the customs, within 24 hours of landing, the original of *cargo manifest* [3] and a copy of it.

Pér ă contrario, if there are not carried out operations of cargo unloading or transshipment, it is not necessary to bring a copy of the cargo manifest.

Vessel agents are required to write, in Romanian, on the copy of the cargo manifest, the name of the cargo.

For vessels loaded with mass goods, in the absence of the cargo manifest, the vessel master, owner or agent may submit a notice showing the identification data of the respective goods.

Customs Police receives from the vessel master the *customs manifest* [4] of the loaded vessel and the customs declarations of the crew. It carries out checks in order to verify the truth of the statements made. It establishes and situates under the customs law the cargo and the goods of the crew. It perceives customs fees or applies customs exempts and asks for the "Clearance Inward" [5].

When there are found deviations from the law in force, fines can be imposed or the port police can be notified.

2. SMUGGLING ON SEA AND RIVER WATERWAYS

Smuggling is the unauthorized border crossing, established under the portuary regime, of prohibited goods or avoiding the customs control of certain goods [6]. Smuggling can be either a contravention or a criminal action. Customs offense is punishable by fine when the offender's good faith is proven (inaccurate entries in the manifest, inconsistencies found while discharging, regarding the quantities provided for on the manifest etc.), or by fine and confiscation of objects, when the offender is of bad faith but when the amount of smuggling is relatively insignificant. Customs offense involves the offender's fraudulent intent and the volume of smuggling is relatively high. It is punished according to criminal laws, by fine, the confiscation of objects and even by custodial sentences. Most States sanction even the attempt of smuggling.

Thus, if undeclared objects are found on board, even if not hidden, they are considered smuggling. The vessel is liable to customs for any contraband found on board or which - ascertained outboard - could be attributed to the vessel [7].

The Romanian Customs Code of 10/04/2006, Title XII entitled "Penalties", Section 1 entitled "Crimes", art. 270, defines and penalizes the crime of smuggling. Thus, the entry into or the exist out of the country, by any means, of goods or cargo, at places other than those established for customs control, is the crime of smuggling and shall be punished with imprisonment for 2-7 years and with the interdiction of certain rights. Also, art. 271. C. v. provides that the introduction into or the exist out of the country, without any right, of weapons, ammunition, explosives, drugs, residues, nuclear or other radioactive substances, toxic substances, waste, hazardous waste or chemical materials constitute the crime of qualified smuggling and shall be punished with imprisonment from 3 to 12 years and with the interdiction of certain rights, if the criminal law provides for a greater punishment.

3. THE CONTRABAND OF WAR

The Contraband of War can consist of the goods of neutral States found on vessels inspected or visited on the high seas or in the territorial waters of one of the belligerents or in ports, which, by their nature, can help the land, air or naval military operations of the enemy, or are about to help these operations. The classifications proposed by Hugo Grotius were used in international conferences: a) the absolute contraband, which includes the essential items necessary to war development, such as weapons and ammunition; b) the conditional and occasional contraband, such as supplies, money, railroad materials and transportation equipment, machinery, tractors, horses etc. The articles in this category may be subject to confiscation if it is found that they are destined to the military or naval forces of the enemy or to a “military theater” occupied by enemy forces. In total war, the above made classification is not taken into account. Hugo Grotius argues however, that in a just war, "the captured objects of enemies should be returned at their cessation of hostilities"[8].

4. REFERENCES

[1] MLADEN, C., *Drept vamal românesc şi comunitar*, Ed. Economică, Bucureşti, 2003, p. 13.
[2] The General Law of Customs of 15th June 1874.
[3] *The Shipping manifest* is the list indicating the cargo transported (including the bill of lading, cargo name, tonnage, weight, volume), the sender and the recipient and the cost of the freight. It is written by the ship's agent and it informs the naval authorities of the relevant aspects that must to determined in order to establish the customs duties.
[4] *The Cargo Manifest* is the list indicating the number of the bill of lading or of the inland waterway bill of lading or of the receipt storage list, but also general provisions such as: marks and identification numbers of packages, name, quantity and, where applicable, weight, package and the provider name and the name of the beneficiary.
[5] Clearance Inward – Procedure of Custom Clearance on arrival. Arrival statement submitted by the ship to the customs and the port captain, followed by the liquidation of all formalities required by port authorities. This is generally done by portuary agencies. See BIBICESCU, G., TUDORICĂ, A., SCURTU, G., CHIRIȚĂ, M. *Lexicon maritim englez roman, cu termini corespondeti in limbile franceza, germane, sapniola, rusa.* Bucuresti, Ed. Stiintifica, 1971. pag. 140.
[6] See Gheorghe Bibicescu, Andrei Tudorică, Gheorghe Scurtu, M. Chiriță, op. cit. p. 159.
[7] TĂNASE, C., *Contrabanda pe căile maritime şi fluviale*, Ed. Arionda, Galați, 2004, p. 19.
[8] Hugo, Grotius, *Despre Dreptul Războiului şi al Păcii*, Editura Ştiințifică, Bucureşti, 1968, p. 746.
[9] GRIGORUT, C., ANECHITOAE, C., et alii, *Management issues for the safe operation of ships and for pollution prevention,* In: RIZZUTO, E., *Sustainable Maritime Transportation and Exploitation of Sea Resources,* CRC Press A BALKEMA BOOK, Italia, 2011, pp. 941-944
.

RULES REGARDING THE NAVIGATION ON THE TERRITORIAL SEA AND IN ROMANIAN PORTS

[1]ANECHITOAE CONSTANTIN, [2]GRIGORUT CORNEL, [3]BRASOVEANU FLORICA
[4]GRIGORUT LAVINIA-MARIA

[1,2,3]*University "Ovidius", Constanta,* [4]*National Institute of Economic Research "Costin Kirițescu", Bucuresti, Romania*

ABSTRACT

The rules of navigation in the territorial sea and ports are set by the Romanian State in shipping, in accordance to national regulations and international agreements and conventions to which Romania is party. The supervision and control of navigation on roadsteads and Romanian sea ports are exercised by the Romanian Naval Authority by port captains. The access of maritime and inland waterway vessels, whatever flag they fly, in the Romanian ports and inland waterways is free and non-discriminatory [art. 17 of Ordinance no. 42 / 1997 (r)].

Keywords: *Navigation, the right to visit, vessels in danger.*

1. THE ARRIVAL OF CIVIL FOREIGN VESSELS IN PORTS

The arrival of civil foreign vessels in ports is allowed under the terms established by the practices of each port. The right of innocent passage, which includes stopping and anchoring in cases of force majeure or distress or for helping people, endangered or damaged vessels or aircraft, is considered an exception extended to the right to enter the port.

In order to prevent, reduce and control marine environment pollution, States can impose special conditions for the arrival of foreign vessels in their ports.

The situation of vessels in danger is provided by all maritime codes, where there are introduced mandatory provisions according to which port authorities have to take the operational and urgent measures needed for their salvation [1].

The hypothesis taken under consideration regards those vessels which are either underway in or towards a port and which are in an access pass or in a roadstead.

2. THE RIGHT TO VISIT

The right to visit, inspect, intervene and conduct research on board of a vessel in Romanian ports or roadsteads is exercised under the Romanian law, and in accordance to the international conditions to which Romania is party, taking into accounts the following considerations:

- Except emergency situations, threatening the safety of navigation and port facilities, any visit of public authority representatives on board of a vessel will be made only in the presence of the vessel's agent, and, for vessels without an agent, in the presence of the vessel master;
- Any visit, inspection or research on board of a vessel in ports, roadsteads or in national navigable waters, conducted by public authorities other than the NRA, shall be under the assistance of the port captain [2] or of his representative.

3. GENERAL NAVIGATION RULES

All maritime and inland waterway vessels, whatever flag they fly, sailing or stationary in Romanian national navigable waters and in Romanian ports, are required to comply with the national legislation and with the international agreements and conventions to which Romania is party [art. 15 of Ordinance no. 42 / 1997 (r)].

The vessel must have the name and the registration port clearly entered on it. They should not be deleted and covered.

The vessel must bear the IMO number so that it is visible from any point on the water and air.

Every vessel must have the certificates required by national regulations and those set out in international conventions to which Romania or the flag State is party. They must be submitted to the port captain and they can be accessed by other competent authorities, at their request, if the situation requires it.

Vessels from any category, regardless of their flag, entering the Romanian roadsteads or ports, are bound by the provisions on entry and navigation on national waters, and by the provisions regarding their stay, operation and departure [3], under the national rules in force and the Regulation for the portuary operation of Romanian sea ports.

All vessels, from their arrival and to their departure from the access channel must have, at the bow and stern, available ropes, long and strong enough in order to be used immediately for assistance, in case of failure of the propulsion or steering equipment.

During their navigation on national waterways and to their departure from the Romanian ports, all vessels shall carry on board the minimum staff provided for in the safety certificate.

4. THE OBLIGATIONS OF THE VESSEL MASTER/PILOT

GEO no. 74/2006, for amending and completing the Government Ordinance no. 42/1997 amended, art. 59 entitled *"The crew hierarchy"* provided for the management of maritime vessels the position of

"Master" and for the management of inland navigation vessels the position of *"pilot"*.

The Master / Pilot [4] of the vessel exercises the command of the people on board under the authority he is vested with and perform the tasks incumbent under law and international conventions.

The command of non-propelled vessels belongs to the tugboat or pusher master who handles them.

The non-propelled vessels in ports that are not under the assistance of a tug or pusher are under the responsibility of the owner, their operators or their agent.

The command of river vessels and other non-propelled inland navigation vessels which do not have officers on board is exercised by the pilot.

Vessel masters are required to immediately bring to the attention of harbor masters, in VHF 67 channel, the occurrence of all events on vessels while in Romanian seaports, in their roadsteads or during maneuvers, such as collision, damage, fire, drowning, acts of indiscipline etc.

The written report on these events will be made by the vessel master to the harbor master no later than 24 hours after the event.

5. REFERENCES

[1] Robert Rézénthel, *Accesul în port al navelor în pericol*, în Revista română de drept maritim, anul IV, nr. 2/2002, pp. 15-24.

[2] Harbor master (Fr.Commandant du Capitaine du port or port, Ger. Hafenkapitän, Hafenmeister, Sp. Capitan del Puerto, Russian Kanumah nopma). The chief of the harbor master, responsible for the execution of police attributions and port navigation attributions and control of crew and vessel certificates; he cooperates with the port administration for the settlement of berths; he keeps the inventory of navigators and registration numbers of ships in the respective port; he receives sea protests and verifies them; he names the experts and monitors the implementation or portuary regulations and the observance of port practices and international conventions on navigation safety. If there are no port practices or corresponding provisions in transport agreements, the harbor master settles the necessary period for the operation of ships. In some ports, he also makes notary acts. See: Gheorghe Bibicescu, Andrei Tudorică, Gheorghe Scurtu, M. Chiriță, *Lexicon maritim englez roman, cu termini corespondeti in limbile franceza, germane, sapniola, rusa.* Bucuresti, Ed. Stiintifica, 1971. p. 315.

[3] On ships' departure from harbours in some countries a certificate of dissolution is issued. This document is used in harbours in Great Britain, issued by the "Board of Trade" to ships that make trips abroad. The "A. A" certificate shows the performance of departure formalities and that the crew was on board in compliance with the legal forms; the "B.B" certificate shows the performance of arrival formalities, and that the role of crew and the logbook were deposited in the office. See: Gheorghe Bibicescu, Andrei Tudorică, Gheorghe Scurtu, M. Chiriță, op. cit. p. 140.

[4] Any ship or floating material, with the exception of a pushed convoy other than pushers, must be under the autority of a person with the necessary qualification for this purpose. This person is named pilot. Art. 1.02 of the Navigation Regulations on Danube in the Romanian sector, between 1.075 and Sulina berth, Published in the Official Gazette no. 672 bis of 92/10/2007

.

SAFETY IN PORT AND ON INLAND WATERWAYS

[1]ANECHITOAE CONSTANTIN, [2]GRIGORUT CORNEL,
[3]GRIGORUT LAVINIA-MARIA

[1,2,]University "Ovidius", Constanta, [3]National Institute of Economic Research "Costin Kirițescu", Bucuresti, Romania

ABSTRACT

The coordination, supervision and management of vessels in the traffic control area are carried out by the Port Control. Since their entry into the traffic control area, vessels are required to comply with Port Control directives. Port Control directives take precedence over any other provision and they are binding on all vessels in the traffic control area. The restriction or the prohibition of navigation in certain areas will be communicated in due time by notice to navigators. The maneuvers in seaports are performed only with the approval of harbor masters.

Keywords: *Port Control, arrival to and departure from ports, maritime vessels*

1. SECURITY SERVICES

Security services in ports and on inland waterways are activities related to shipping activities, which, according to art. 19 para. (1). b, Section 1 of Ordinance no. 22/1999 (r1), are referred to as *safety services,* and include: vessels' pilotage into and out of ports, from the berths of the same port and on waterways, towage maneuver of vessels in ports. Security services are services of national interest and are conducted under State control, by the ministry [art. 41 of Ordinance no. 22/1999 (r1)].

The specific rules on how to perform maneuvers in each seaport are set out in Part B of the Regulation on the operation of Romanian Ports *"Specific rules and norms for the operation of Romanian seaports "* [1].

The vessel is required to supervise any maneuver of a vessel, carried out around it, and provide the necessary help when requested.

Vessel masters must ensure and take all the necessary measures in order to be ready to act at any time at the occurrence of events likely to endanger the safety of their vessels, port facilities and other vessels nearby.

The assistance and rescue [2] of vessels in distress at sea or on national navigable waters, of goods, cargo and persons on board is carried out according to national legislation and the international agreements and conventions to which Romania is party.

The access of persons to maritime and river ports is made on the basis of entrance cards (specifying the number of the access gate), issued by port operators or on the basis of the sailor card or passport. Beachcombers [3], scrap iron or waste grain thieves are sanctioned and punished by the port police.

2. PROHIBITIONS APPLIED TO VESSELS IN PORTS

Vessels in ports or roadsteads are prohibited to perform work underwater and other activities likely to endanger the safety of navigation, without the approval of harbor masters. Within Romanian maritime ports, in their access canals and roadsteads, except in cases of force majeure, it is prohibited:

- vessels' maneuvering, with anchors in water, except maneuvers on strong wind;
- vessels' anchoring near the places where the ban is indicated;
- vessels' anchoring in maneuver roadsteads and in the access channel.

According to art. 34 of Ordinance no. 22/1999 (r1), port administrations are entitled to prohibit or stop the loading / unloading of vessels if it finds that:

a) vessels have water holes in the hull;

b) the loading / unloading of vessels endangers the security of port facilities and equipment;

c) the vessel's draft exceeds the maximum allowable draft in the operation berth or in any other cases where it is found that the security of the port infrastructure is endangered;

d) danger of pollution.

3. ARRIVAL AND DEPARTURE OF VESSELS IN PORTS

Until obtaining the permission for the arrival of maritime navigation vessels, granted by the harbor master, the vessel will stay in the outer port roadstead, in the sector corresponding to its category and to the transported goods, as indicated by the Port Control.

Inland waterway vessels, irrespective of the flag they fly, can arrive / depart from Romanian port only after obtaining the arrival/ departure permit issued by the Captain / office of the captain of the respective port [art. 3. (1) - (3) of MTCT Order no.2473/2006].

In order to obtain the permit for the arrival in a Romanian port, inland waterway vessels, irrespective of the flag they fly, will send to the harbor master / the office of the captain the following documents:

a) general statement;

b) crew list;

c) passenger list, where appropriate;

d) the departure permit from last port or any other official document which replaces this document and / or documents accompanying the goods, as appropriate.

In order to obtain the permit for the departure from a Romanian port, inland waterway vessels, irrespective of the flag they fly, will send to the harbor master / office of the captain the following documents:

a) notice of departure;
b) crew list;
c) list of passengers and / or documents accompanying the goods, as appropriate.

3.1. Vessels' arrival in ports

Port administrations allocate the berths where vessels are to operate and issue the permit for mooring at these berths based on the acceptance of their arrival into the port, issued by the harbor master [art. 32 para. (1) of Ordinance no. 22/1999 (r1)].

The vessels' arrival in ports is made with the prior special authorization of the harbor master and of the port administration in the following cases:

 when the vessel is in danger of sinking;

 when there is fire on board, a fire is suspected on board or when there is no assurance that, once the fire started, it can be extinguished;

 when, due to their construction, the vessel can threaten the port superstructure or infrastructure;

 when the vessel has sick people on board or persons susceptible to diseases requiring quarantine; this situation will be reported to the Port Control with at least 6 hours before the entry into the traffic control area;

 when the vessel has toxic, radioactive or explosive waste on board or other substances which can endanger lives and public safety; this situation will be reported to the Port Control within at least 24 hours before the vessel enters the traffic control area, and if the vessel has or will have radioactive cargo on board it will require the arrival approval within at least 30 days before the date of the arrival in port;

 when, because of its load or otherwise, it constitutes a danger to public order and safety;

 for the repair, modification or dismantling outside port shipyards;

 when they enter the port for shelter, stay or other activities outside port operations;

 nuclear-powered vessels can enter the port only with the approval of the State authority in the field of shipping; in this case, the date and time of the arrival and the required stay period will be announced at least 30 days before.

At their arrival to the Romanian seaports, vessels are required to use the traffic separation device, according to the navigators' notices.

Any anchorage maneuver, change of anchorage or departure from anchorage, arrival to or departure from the port, as well as the exit to the open sea from the respective area will be made only after obtaining the approval given by the harbor master.

No vessel, irrespective of its flag, can stay or anchor outside the roadstead limits, or in the territorial waters without the approval of the harbor master, except in cases of force majeure, situation which shall be communicated to the harbor master and the border police, as soon as possible.

3.1.1. The order of vessels' arrival in ports or berths

The decision of ordering the vessels' arrival in ports and the assignment of berths are made according to the demands of the economic agents engaged in shipping activities, in ports [art. 32 section (1) of G.O. no. 22/1999 (r1)].

The arrival of vessels in ports and berths is decided by the Commission which coordinates the vessels' arrival, departure and maneuvering. The vessels' agents will submit to the specialty service in port administration, providing for the Committee Secretariat, the document certifying the vessel within at least 24 before its arrival.

The vessels' arrival in ports and berths will be communicated by the Port Control and under the monitoring of the harbor master.

For the vessels' arrival and departure maneuvers or berth change, the vessel agents will necessarily draw up the pilotage card in three copies, which will be approved by the representatives of the harbor master and of the port administration within the daily meetings of the committee coordinating the vessels' movement.

In special cases of general interest or danger for the vessels inside roadsteads, the harbor master may order the entry of vessels in port, even if they are not scheduled for landing.

The vessels arriving into the port leave free access to those which leave the port.

The simultaneous arrival and departure of several vessels in the red light-green light area is prohibited.

4. REFERENCES

[1] Approved by the Order of Minister nr. 956 din 23/06/2003 for the approval of the Regulation for the portuary operation of Romanian maritime ports, Published in the Official Gazette nr. 470 of 01/07/2003.

[2] HAISAN, M., is the only Romanian woman that occupied the position of ship master. She commands a rescue and intervention ship (Albatros vesswl), which deals mostly with resue operations and participates in interventions in case of ships that require SOS. PREDESCU, F., Evenimentul Zilei, nr. 4251 (October 22, 2005), p. 14.

[3] See BIBICESCU, G., TUDORICĂ, A., SCURTU, G., CHIRIȚĂ, M. *Lexicon maritim englez roman, cu termini corespondeti in limbile franceza, germane, sapniola, rusa.* Bucuresti, Ed. Stiintifica, 1971. pag. 63, Beachcomber, unemployed individual, wandering through the ports, earning his/her living from collecting fish debris left on the beach or in fishing piers, and from other expedients

.

QUANTIFIED INVESTIGATION OF NAVIGATION OFFICERS' FATIGUE RELATED ERRORS ON SHIPS

[1]BAL ELIF, [2]ARSLAN ÖZCAN

[1,2]Maritime Transportation and Management Engineering Department, ITU Maritime Faculty, Turkey

ABSTRACT

Maritime industry is still a human-centered industry in spite of latest technologies which has developed for reducing marine accidents. Human based errors cause marine accidents more than equipment based problems do. These accidents cause catastrophic consequences about human life and marine environment. Fatigue of navigation officers plays effective role on these human-based errors and marine accidents. There are several factors that effect navigation officers' fatigue. In this study, relationship between fatigue of navigation officers and marine accidents will be examined; factors which are affecting fatigue of navigation officers determined with SWOT (strength, weaknesses, opportunities and threats) analysis method and weighting of the factors determined by using AHP (Analytic Hierarchy Process) Method. With this analysis, strategic action plans were developed for minimizing fatigue related human errors on-board taking into account this SWOT factors and the weighting factors.

Keywords: *SWOT-AHP, Fatigue, Navigation Safety*

1. INTRODUCTION

Fatigue can be defined as temporary loss of strength and energy resulting from hard physical or mental work. Fatigued people usually experienced difficulties in maintaining task performance at an adequate level. This can have major consequences. There are several studies available which are about link between fatigue, human performance and human errors .[1,2,3] There are two types of fatigue: physical and psychological (mental). Psychological fatigue is the result of effort/reward imbalance [4]. Human based errors are causing marine accidents more than equipment based problems. According to the many of research studies, it has been recognized that almost 70 to 80% of maritime incidents are caused by human errors[5]. Violation of rules, mistakes, slips and lapses are causing accidents. Fatigue is playing important role on especially these slips and lapses. According to a research, 23% of cases that fatigue were a contributory cause among 98 ship casualty reports [6].

SWOT analysis method is used in this study to analyze factors which affect fatigue level of navigation officers in order to make strategy formulation for reducing human errors and maritime causalities respectively. The present investigation is attempted to examine the strengths and weaknesses affecting fatigue level of navigation officers, as well as the opportunities and threats in the external working environment for ships and her officers who are in charge of the navigation. The intention of this study is to develop strategy of action plan for ship management companies and seafarers through SWOT analysis and AHP with a view to make safer navigational operations for the prevention of marine casualties.

2. METHODS USED IN THIS STUDY

2.1. SWOT Analysis

Every program and system has its strengths, weaknesses, opportunities and threats. SWOT is an acronym for these factors. Considering these internal factors: strengths, weaknesses and external factors: opportunities and threats (SWOT); strategies, which will convert the threats into opportunities and off-setting the weaknesses against the strengths will be produced [7]. SWOT analysis is designed to be used in the preliminary stages of decision-making and strategic management. The SWOT approach involves systematic thinking and comprehensive diagnosis of factors relating to a new product, technology, management, or planning [8].

2.2. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) as a decision analysis tool is used in this study with SWOT Analysis method which is a mathematical method for analyzing complex decision problems with multiple criteria[9]. AHP can deal with qualitative attributes as well as quantitative ones. It is a useful decision analysis technique which can be used during strategic planning. AHP is used in many fields such as planning, selecting the best alternative, resolving conflicts, optimization problems with other techniques such as linear programming, fuzzy logic, quality function deployment etc. [10] By utilizing AHP, linguistic variables can be quantified.

2.3. Aim and Method of SWOT Cascaded with AHP

SWOT analysis is a qualitative analysis method and has no means of determining the importance or intensity of SWOT factors analytically. SWOT analysis has become insufficient due to this factor. The AHP is a mathematical method for analyzing complex decision problems with multiple criteria, and can deal with qualitative attributes as well as quantitative. By utilizing the AHP in SWOT analysis, SWOT factors can be weighted and rated quantitatively [11]. When SWOT and AHP used in combination, the SWOT approach can provide a quantitative measure of the importance of each factor in decision making[12].

Consequently, AHP and SWOT are both simple and widely used methods, and they are relatively easy to understand.

3. METHODOLOGIES FOR SWOT-AHP APPLICATION

In this study, negative factors as weaknesses and threats which are causing and increasing fatigue level of navigation officers were observed by considering seafarers', crewing department of shipping companies' and lecturers' opinions and experiences (See Fig.1). Then positive factors as opportunities and strengths which can reduce the fatigue level of navigation officers were observed (See Fig.2). Then the factors were clustered. The pair wise comparisons are carried out within SWOT factors by the ship masters (5 persons) who are actively working as master on ocean-going ships, operation manager and crewing manager of shipping company (3 persons) who are working at least for five years on same position, lecturers at Istanbul Technical University Maritime Faculty (2 persons), ratings (3 persons) and Maritime Faculty students (2 persons) whom are completed their 12 months sea period.

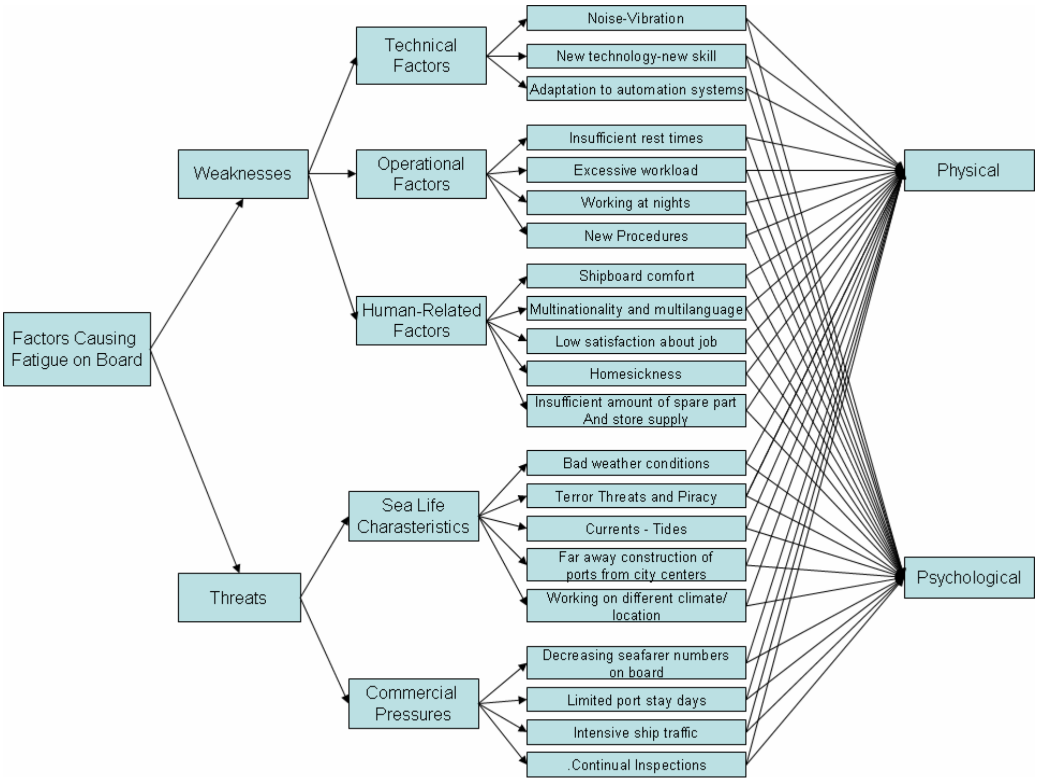


Figure 1. Classification of factors that are causing fatigue of navigation officers

Positive factors (strengths and opportunities) and negative factors (weaknesses and threats) are weighted separately so that the sum of the weighting of negative factors is 1.0 and the sum of positive factors is 1.0 also.

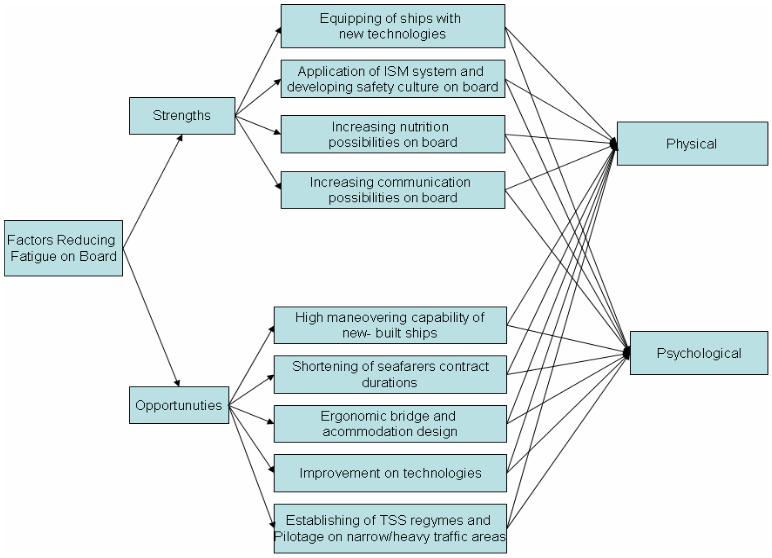


Figure 2. Classification of factors which are reducing fatigue of navigation officers

Pair wise comparisons have done among each factors shown in Fig.3. 'Super Decisions' software (www.superdecisions.com) is used for computing the priority of precautions by utilizing the results of pair-wise comparison intensities.

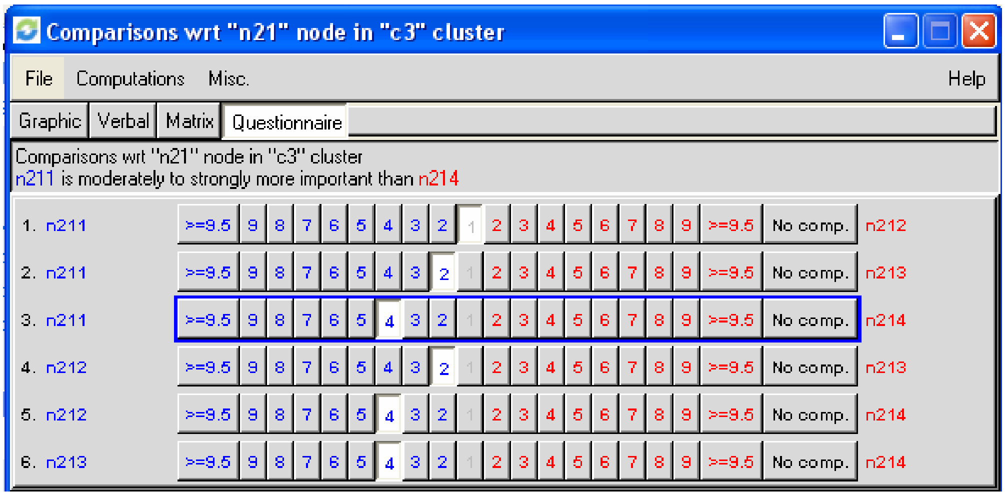


Figure 3. Pair-wise Comparisons between Factors

4. SWOT FACTORS THAT AFFECTING FATIGUE LEVEL OF NAVIGATION OFFICERS

4.1. The Probable Strengths for Reducing Fatigue Related Human Errors:

- *Equipping of ships with new technologies:* New innovations or technologies such as ECDIS and AIS reduce navigation officers' workload and they have been developed to lighten considerably the navigation workload with enforcing reduced human errors. Automated control of loading/discharging systems especially on tankers and machinery area reduce officers' and other ratings' workloads and they have been developed to lighten considerably the port operation workload with enforcing reduced human errors.
- *Application of ISM system and increasing safety culture on board:* Safety on board has become a critical issue in the last decades. Application of ISM system regularly reduced vvorkloads of seafarers and increased safety culture on board [13].
- *Increasing communication facilities:* Being far away from family is the most common problem for seafarers on board [14].This reality increases seafarer's psychological fatigue level on board. Increasing communication facilities on board reduces psychological fatigue on board.
- *Increasing nutrition possibilities on board:* Regular and sufficient nutrition reduces fatigue level. Nutrition possibilities and quality of nutrition were increased on ships compared with before.

4.2. The Probable Weaknesses which are Increasing Fatigue Related Human Errors:

4.2.1. Technical Factors

Technical factors can be shortly described as the factors which are directly related with the nature of ship. These factors are:

- *Noise – vibration:* According to the nature of job, ships are moving from one port to another. Because of this movement and ship's engine, there is a continuous noise and vibration on board.
- *New technology needs new skills and educations:* Every new technology which is considered to increase navigational safety has brought new skills and new compulsory training such as ARPA Radar and ECDIS training.
- *Adaptation to automation systems:* All automation systems such as automated engine room or automated controlled loading/discharging systems need adaptation period for officers.

4.2.2. Operational Factors

Operational factors are directly related with the nature of job. These factors are:

- *Insufficient rest times:* Due to the watchkeeping periods and heavy duties, navigation officers can not find rest times enough. Sleeping less than seven hours a day causes poorer health and fatigue level. Quality of sleep is one another factor which increases fatigue level of seafarers. Insufficient rest between work periods increases navigation officers' fatigue level [15]
- *Excessive workload:* Watckeeping, maintenance, maneuvering, port operations, preparing ship for inspections and paper works about procedures are consisting of main body of navigation officers' workloads.
- *Working at nights:* Watchkeeping, port operations and maneuvering are the main purposes of working at nights.
- *New procedures bring more paper work on board:* New procedures which though to increase ship safety and such as ISM and ISPS procedures, they naturally have brings extra workload for navigation officers.

4.2.3. Human Related Factors

Human related factors are directly related with the nature of human being. These factors are:

- *Shipboard comfort:* Shipboard comfort is related with the comfort of cabinets, messrooms, nutrition and communication facilities, stability of ship and other social facilities on board.
- *Multinationality and multilanguage*: On several ships, crew's nationalities are different than others. These factors affect the satisfaction of navigation officers.
- *Low satisfaction of seafarers about their occupation:* Crew members who display care and loyalty are less likely to produce claims. Ship owners and operators can achieve a high level of continuity and competence by providing crew with secure employment and by taking into account the factors such as recruitment, health, training and general awareness of shipboard best practice and by monitoring satisfaction in terms of monitoring expectation of crew members [14].
- *Homesickness:* According to latest surveys, homesickness is one of the most important factor which is reducing satisfaction level of seafarers [14].
- *Insufficient amount of spare part and store supply:* Because of the nature of the job, officers can not get any spare part, store supply or any other needs.

4.3. The Probable Opportunities for Reducing Fatigue Related Human Errors:

- *High maneuvering capability of new building ships and new maneuvering equipments:* Word merchant fleet is renewing and new-built ships have high maneuvering capabilities when compared with the last decade built ships. This reality reduces maneuvering times of ships.
- *Shortening of seafarer's contract durations:* The seafarers' durations of contracts are shortened especially in world's leading ship management companies. This situation reduces chronic fatigue of seafarers taking into account the fatigue clause of STCW Code [16].
- *Ergonomic bridge and accommodation design of new-building ships:* Ergonomic issues have become more popular in ship-building sector. Ergonomic bridge design arranges safe look out and reduces workload of masters and navigation officers. Ergonomic design of accommodation places also increases seafarers' satisfaction and arranges acceptable living conditions [17,18].
- *Improvements on technologies:* New technologies about navigation or ship construction reduce navigation officer's workloads. They are assisting tools for them to enable efficient maneuvering and offering more comfortable navigation infrastructure.
- *Establishing of TSS regimes, VTS systems and Pilotage on narrow/heavy traffic areas:* Established Traffic Separation Scheme (TSS) and Vessel Traffic Service (VTS) Stations arrange safer navigations for ships and ships can make efficient decisions by the help of VTS centers [17].

4.4. The Probable Threats which are Increasing Fatigue Related Human Errors

4.5.

4.4.1. Sea Life Characteristics

These factors which are directly related with the nature of sea life can be described as following:

- *Bad weather conditions:* Bad weather conditions such as gales and dense fog situations increase workload of navigation officers and master. Also, seasickness is a factor that increases mental and physical fatigue which directly reduces job satisfaction [17].

- *Terror threats, piracy and ISPS application:* Terror threats for ships and related ISPS application tasks restrict seafarers' social life during stay at port.
- *Currents, tides, and darkness:* Currents and darkness are the two dominant factors causing marine casualties especially in coastal traffic area and narrow channels [18].
- *Construction of new ports far away from city centers:* New-constructed ports and terminals are generally constructed far away from city centers. On restricted port days, seafarers cannot go outside from ship for relaxing.
- *Working on different climate/location:* Because of the movement of ships from one port to another, officers' working environment continuously changes, therefore, climate conditions, weather conditions and time zones continuously change too.

4.4.2. Commercial Pressures

- *Intensive ship traffic:* There are around 52000 ships in service at sea, and number of ships is increasing regularly per annum. Increasing number of ships and new-built faster ships cause collision risks. Watch conditions are closely related with ship traffic. In intensive traffic conditions, an extra watchman should look out in Navigation Bridge [18].
- *Trend of decreasing seafarer number on board:* One another commercial pressure appears as decreasing number of seafarers to minimum standards as it is mentioned in the Minimum Safe Manning Certificate of ship. This reality increases workload and fatigue of navigation officers.
- *Limited port stay days:* The time period when ships spend while lying in ports are decreased due to the developed cargo handling facilities.
- *Continual inspections on restricted port days:* Port state and flag state inspections and oil major companies' vetting inspections are increased on restricted port days. Shortened port days and increased inspections directly cause seafarers' fatigue and response.

5. RESULTS OF AHP APPLICATION, CONSIDERATIONS AND DERIVED STRATEGIES FROM SWOT – AHP APPLICATION

Table 1 Priorities of Negative SWOT Factors that are Causing Fatigue on Navigation Officers

GROUP	SWOT Factors	Overall Priority
Weaknesses	**Weaknesses**	**0,76905**
	Technical Factors	**0,07972**
	Noise-Vibration	0,04806
	New technology-new skill	0,01822
	Adaptation to automation systems	0,01344
	Operational Factors	**0,24626**
	Insufficient rest times	0,13229
	Excessive workload	0,07018
	Working at nights	0,01072
	New Procedures	0,03307
	Human-Related Factors	**0,44307**
	Shipboard comfort	0,09591
	Multinationality and multilanguage	0,08549
	Low satisfaction about job	0,07941
	Homesickness	0,07042
	Insufficient amount of spare part and store supply	0,11184
Threats	**Threats**	**0,23095**
	Sea life characteristics	**0,09792**
	Bad weather conditions	0,03338
	Terror threats and piracy	0,00856
	Currents – tides	0,00431
	Far away construction of ports from city centers	0,03994
	Working on different climate/location	0,01173
	Commercial pressures	**0,13303**
	Decreasing seafarer numbers on board	0,04640
	Limited port stay days	0,05278
	Intensive ship traffic	0,00702
	Continual Inspections	0,02684
Weaknesses – Threats	**Physical**	**0,45560**
Weaknesses - Threats	**Psychological**	**0,54440**

Pair-wise comparisons have been done by utilizing AHP. Priorities and weighting factors which cause fatigue on navigation officers is shown in Table 1. When the results are considered, internal negative factors (weaknesses) play more important role on fatigue of navigation officers than external negative factors (threats) do. When weaknesses are considered, human related factors are most important factors on navigation officer's fatigue. Commercial pressures on ship and navigation officers are most important external factor that causing fatigue on navigation officers. Priorities and weighting factors which can reduce fatigue on navigation officers are shown in Table 2.

Table 2 Priorities of Positive SWOT Factors that are Reducing Fatigue on Navigation Officers

GROUP	SWOT Factors	Overall Priority
	Strengths	0,60000
	Equipping of ships with new technologies	0,21200
	Application of ISM system and developing safety culture on board	0,21544
Strengths	Increasing nutrition possibilities on board	0,12771
	Increasing communication possibilities on board	0,04486
	Opportunities	0,40000
Opportunities	High maneuvering capability of new - built ships	0,04058
	Shortening of seafarers contract durations	0,13640
	Ergonomic bridge and accommodation design	0,07754
	Improvement on technologies	0,08558
	Establishing of TSS regimes and Pilotage on narrow/heavy traffic areas	0,05991
Strengths - Opportunities	**Physical**	0,50071
Strengths - Opportunities	**Psychological**	0,49929

Internal factors (strengths) have more important role for reducing fatigue of navigation officers than external factors (opportunuties) have. Developing safety culture on board and equipping ships with new technologies are two dominant factors which are reducing fatigue of navigation officers. Graphical results of pair-wise comparisons of SWOT groups and factors are shown in Figure 4. There is not any pair-wise comparison done between positive and negative factors, so the sum of the weighting factor of positive quadrants (strengths and opportunuties) is 1, 0. The sum of the weighting factors of negative factors (weaknesses and threats) is also 1, 0.

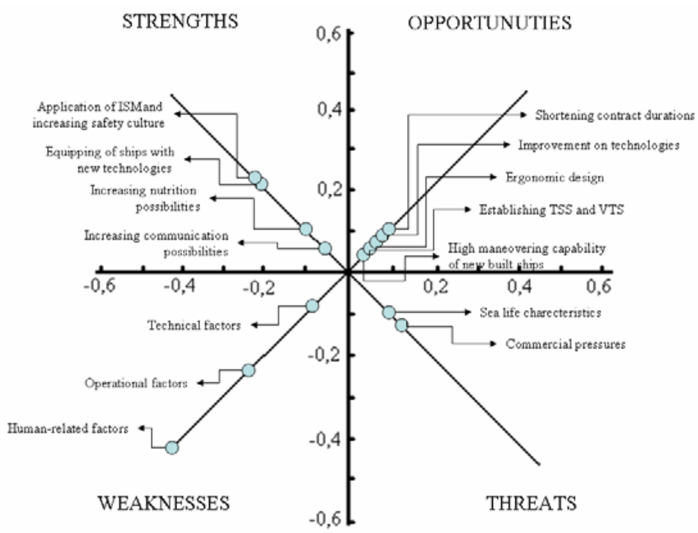


Figure 4. Graphical results of pair-wise comparisons of SWOT groups and factors

Psychological factors are as important as physical factors on fatigue. Factors which cause fatigue and which reduce fatigue of navigation officers are both physical and Psychological. The number positive and negative factors and their Psychological and physical weights are summarized in Figure 5.

While considering the overall factors of strengths, weaknesses, opportunities and threats mentioned in the section 4 and section 5 of this study, the following strategies will be defined: Besides the risk assessment of each process can easily be handled if the threats or weaknesses are properly identified. It should also be taken into account that a human factor has a great significant impact on threats or weaknesses as it is identified in section 5 of this study. When the overall contribution of SWOT analysis is examined, the following comments can be interpreted for reducing fatigue level of seafarers and fatigue related human errors on board. Workload management should be applied on board because of fatigue plays important role on human errors. Precautions which will increase seafarer's satisfactions should be taken by ship management companies. Loyalty of seafarers should be provided by ship management companies by taking several precautions. On board procedures should be shortened that officers will need less time for paper works. New training programs about new technologies should be developed. New rules should bring into force for reducing fatigue of seafarers. Sea and sea life must be encouraged. Social facilities about seafarers at port should be developed. Navigation bridges and accommodation places should be designed by taking into account ergonomic aspect too. Widespread use and equipping new technologies such as ECDIS and automated loading-discharging systems on board should be maintained.

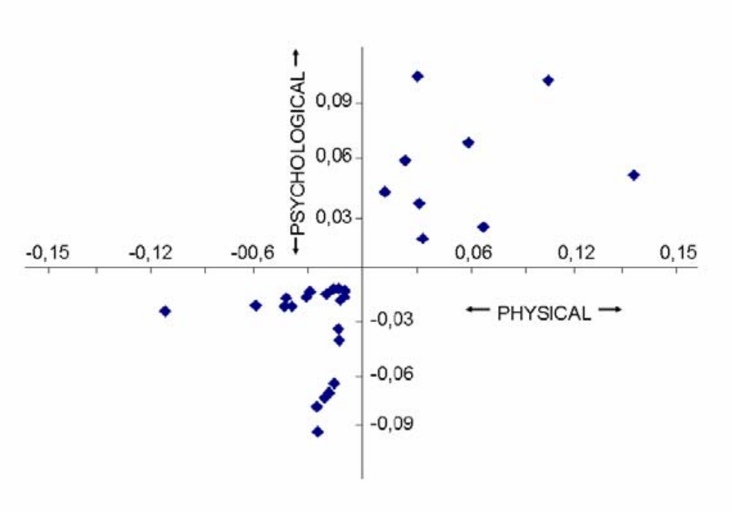


Figure 5. Weighting of SWOT factors and their psychological and physical weights

6. CONCLUSIONS

In maritime industry, human errors are have been still causing accident and incidents in spite of presence of latest navigational technologies and fatigue is playing important role on these errors. In this study, it is aimed to identify the positive and negative factors which affecting the fatigue level of seafarers by applying SWOT (Strength, Weakness, Opportunities and Threats.) analysis and weighting these factors by applying Analytic Hieararchy Process (AHP). Taking into account above mentioned strengths, weaknesses, opportunities and threats and the priorities of weighting factors, several practical solutions are suggested in order to reduce fatigue related human errors on shipboard operations.

This study originally suggests the main management tool which is specifically applied for reducing fatigue of seafarers and consequently enhancement of safety and ship management performance to prevent accidents and casualties in maritime transportation.

7. REFERENCES

[1] CAMPAGNE, A., PEBAYLE, T., MUZET, A., 2004. *Correlation between driving errors and vigilance level: influence of the driver's age*. Physiol. Behav. 80, 515–524.

[2] TORSWALL, L., AKERSTEDT, T., 1987. *Sleepiness on the job: continuously measured EEG changes in train drivers.* Electroencephalog. Clin. Neurophysiol. 66-6, 502–511.

[3] KECKLUND, G., AKERSTEDT, T., 1993. *Sleepiness in long distance truck driving: an ambulatory EEG study of night driving*. Ergonomics 36, 1007–1017.

[4] BOKSEM, M., MEIJMAN, T., LORIST M., 2006. *Mental fatigue, motivation and action monitoring,* Biol. Psychol. 72, 123–132.

[5] SHEA, I. P., GRADY, N., 1998. *Shipboard Organisational Culture in the Merchant Marine Industry*, Proceedings ofthe Safe Navigation Beyond, Gdynia.

[6] RABY, M., MCCALLUM, M. C., 1997. *Procedures for investigation and reporting fatigue contributions to marine casualties,* Proceedings of the Human Factors and Ergonmics Society 41st Annual meeting, September 22–26, New Mexico.

[7] SAATY, R. W., 1987. *The analytic hierarchy process and SWOT analysis- what it is and how it is used*. Math. Model 9, 161 - 178.

[8] BRADSHAW, J. M., Boose, J. H., 1990. *Decision analysis techniques for knowledge acquisition:*

combining information and preferences using Aquinas and Axotl SWOT. Int. J. of Man-Machine Studies 32, 121–186.
[9] SAATY, T. L., 1980. *The Analytic Hierarchy Process*. McGraw-Hill, New York.
[10] VAIDYA, S. O., KUMAR, S., 2006. *Analytic hierarchy process: An overview of applications*, Eur. J. Oper. Res. 169, 1–29.
[11] PESONEN, M., KURTTILA, M., KANGAS, J., KAJANUS, M., HEINONEN, P., 2000. *Assessing the priorities using SWOT among resource management strategies at the Finish Forest and Park Service*. Forest Sci. 47 -4, 534–541.
[12] KURTTILA, M., PESONEN, M., KANGAS, J., KAJANUS, M., 2000. *Utilizing the analytic hierarchy process AHP in SWOT analysis – a hybrid method and its application to a forestcertification case.* Forest Policy Econ. 1, 41–52.
[13] ER, D., 2000. *Integration of Quality Based Management Standards into International Maritime Training and Education*, International Association of Maritime Universities Journal, 1, 45-53.
[14] ARSLAN, O., 2006. *Human Resources Management for Turkish Seafarers*. MSc Thesis, Istanbul Technical University, Istanbul.
[15] SEAFARER FATIGUE: *Cardiff University Research Programme*, Cardiff, 2006.
[16] STCW, 1995. *Seafarers Training, Certification and Watchkeeping (STCW) Code* - Part A - Mandatory Standards Regarding Provisions of the Annex to the STCW Convention - Chapter VIII - Standards Regarding Watchkeeping - Section A-VIII/1 Fitness for duty, London.
[17] ARSLAN, O., ER, I. D., 2008. *A SWOT Analysis for Successful Bridge Team Organization and Safer Marine Operations,* Process Saf. Prog. 27-1, 21-28.
[18] AKTEN, N., 2004. *Analysis of Shipping Causalties in the Bosphorus*, J. Navigation 57, 345–356.

CONSIDERATIONS ON THE FINANCIAL RISKS IN THE SHIPPING INDUSTRY

[1]BATRINCA GHIORGHE, [2]BURCA ANA-MARIA

[1,2]Constanta Maritime University, Romania

ABSTRACT

In general, business-risk management is concerned with the possible decline in the value of a shipping company due to an event, or a change, in any of the factors that affect its value. Fundamentally, the value of a company depends on the expected net cash flows from its operations. Therefore, any factor that may have a negative impact on the expected net cash flows is identified as a risk. Due to the capital-intensive nature of shipping and the fact that most vessel acquisitions are financed through term loans priced on a floating-rate basis, unanticipated changes in interest rates may have an adverse impact on the assets and liabilities of a company and can lead to severe liquidity problems and cash-flow mismatch, especially given the business-cycle dynamics of shipping markets. Consequently, interest-rate risk measurement and mitigation is an indispensable aspect of shipping risk management.

Keywords: *risk management, hedging, forward-rate agreement, interest-rate futures, interest-rate swaps, interest-rate options*

1. INTRODUCTION

Risks are embedded in any business activity. For a shipowner, the decision to invest in a vessel may signify his belief that freight rates will go up, earning him a return on his investment that is higher than the risk-free interest rate. His decision to invest creates at the same time a natural exposure to freight rates, accepting the risk that freight rates may in fact go down. Risks are simply unavoidable in any profit-taking activity.

In addition to fluctuations of freight rates, bunker prices and asset prices, unanticipated interest rate changes justify a substantial fraction of the shipping risk management function. Unanticipated changes in interest rates may create cash flow and liquidity problems for companies which may no longer be able to service their debt obligations. Vast amounts of capital are required for the financing needs of shipping companies, the majority of which are provided through loans via international commercial banks. Shipping finance structure has changed as the industry evolves and becomes more mature, with sophisticated financial instruments and well-informed market participants. Interest-rate risk is directly related to the individual debt structure of the company, since the elevated gearing ratios of shipping companies involve liabilities susceptible to interest-rate instability. Furthermore, most shipping loans are quoted in US dollars. If debt and revenues are denominated in different currencies, this exposes the borrower to exchange-rate risk. Hence, shipping companies face another aspect of risk, namely currency risk, which is directly related to interest-rate exposure, since each currency is linked with a different interest rate yield curve. These facts provide evidence that interest-rate risk measurement and mitigation is an indispensable aspect of shipping risk management.

2. RISK MANAGEMENT IN SHIPPING

There is a wide misconception among practitioners who consider risk management as synonymous to hedging. This is an oversimplification and does not reflect the true dimension of risk management. In fact, risk management is a three-step process: risk modelling which implies identifying the underlying risk factors and modelling their dynamics, risk measurement which implies quantifying the impact of risk factors on financial results and risk management which implies controlling risk with risk-informed decision making.

Risk management does not necessarily imply risk reduction. In fact, the objective of risk management is not to reduce risk, but more importantly to quantify and control risk. Most of the times, the intention is not to eliminate risk, but rather to alter our risk profile according to the prevailing market conditions, our risk preferences, and potential regulatory or contractual requirements. In this context, hedging is just one possible alternative for the active management of risk.

There are two components of our inability to be able to precisely predict what the future holds: these are variability and uncertainty. Risk management can do very little to reduce variability (markets will continue to fluctuate no matter how advanced risk management gets), but can be very effective in reducing uncertainty for those involved in risk-taking decisions.

Most industries can distinguish between business risks and market risks. Other industries cannot distinguish between business risks and market risks. Shipping can be said to belong to the industries that cannot distinguish between business risks and market risks. Financial results in shipping are directly affected by movements in the world's freight rate markets. Freight rates have historically been very volatile. The impact of unforeseen geo-political events and the slow speed of adjusting supply to demand have often resulted in dramatic fluctuations in the level of freight rates. Fluctuations in freight rates directly affect fleet cash flow and cash flow performance is the topmost concern in shipping, both from an owner and a lender perspective. So, what really matters when measuring freight market risk is the impact of freight rate variability on cash flow performance. Shipowners are in effect in the business of managing shipping risk affecting a portfolio of physical assets, rather than simply managing a fleet of vessels.

Risk management in shipping is also justified by various industry inefficiencies. Regarding the capital needs, shipping is a capital intensive industry with significant funding needs for fleet expansion and replacement purposes. Yet, it has very limited opportunities to diversify its sources of funding, as most of its financing comes in the form of bank debt. Secondly, regarding the bond between asset and liability, asset economic life is usually much longer than the term of debt financing, variable revenues meet fixed debt obligations and there is a high positive correlation between freight rates and vessel values, leading to a situation of low collateral support when default is most likely. Finally, many banks tend to be influenced by the general sentiment of shipping markets: they appear more willing to lend when the market (and vessel prices) is high, despite the fact that the market will eventually revert back to lower levels; in contrast, they appear rather hesitant to extend credit at a period of low freight rates, although these are likely to rise to more sustainable levels.

3. TYPE OF LOANS

The majority of ship finance is carried out through plain vanilla term loans. These loans are financial products of international commercial banks and refer to a specified amount of money, called drawdown, for a specific maturity (usually above three years) depending on the qualitative and quantitative characteristics of the asset to be financed, such as whether it is a newbuilding or a second-hand vessel, the vessel's age or market conditions. The borrower makes periodic interest payments plus repayments of capital according to a pre-specified amortization schedule. The most common reference rate is either the three-, six-, and 12-month LIBOR rates and is reset at regular intervals, every three or six or 12 months, respectively. In addition to LIBOR rates, borrowers pay a spread of usually 0.5 per cent to 3 per cent over the floating rate which reflects the creditworthiness, terms of credit, general business and financial risk as well as the bank's profit margin.

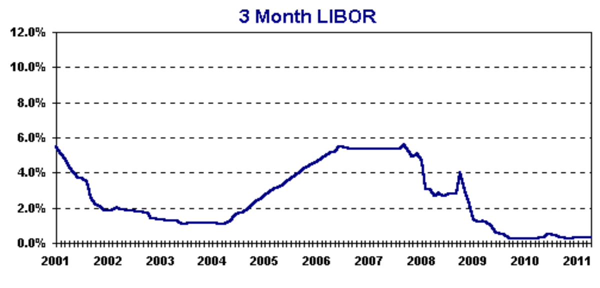


Figure 1 The evolution of 3 Month LIBOR

The contractual structure of term loans is negotiated on the basis of the creditworthiness of the shipping company and the financier's confidence in the company's corporate management and investment plan. The financial status of the potential borrower is cautiously examined, because the probability of default of the candidate company will determine the decision and the terms of funding. Term loans are flexible and the repayment schedule can be arranged to meet the demands of the borrower. A fixed-rate loan has a uniform interest rate until maturity, whereas a floating-rate loan has an interest rate reset at predetermined time intervals. We can note that fixed-rate loans are beneficial for borrowers if interest rates in the market increase above the fixed rate; similarly, fixed-rate loans are beneficial for lenders if interest rates in the market decrease below the fixed rate level. Regarding the floating-rate loans, borrowers can benefit from falling LIBOR rates, but if interest rates increase they will be exposed to higher interest payments.

A common repayment plan involves equal instalments, consisting of constant payments. Each payment includes an amount of the principal plus the accrued interest on the unpaid balance. A more frequent repayment schedule is to assume unequal instalments because yields on shipping loans are attached to the benchmark LIBOR. Moreover, a balloon repayment may be arranged which involves a large lump-sum payment of the outstanding capital due at or near the maturity date of the loan. The main purpose of the balloon payment is to reduce substantially the size of the periodic payments, whereas the balloon payment will usually be covered by the resale or scrap value of the vessel. Obviously, this strategy generates residual value risk and as an alternative, if market expectations permit, it is not uncommon to spread out the balloon payment by refinancing and/or restructuring the loan. If the balloon repayment refers to the payment of the entire capital upon maturity, this payment is known as bullet repayment. However, due to the capital-intensive nature of the shipping industry, bullet payments are not common. Other clauses may include a moratorium, where the lender is authorized to permit suspension of capital repayments for a period known as grace or holiday period, which may often last one or two years immediately following the commencement of the loan agreement.

4. METHODS OF REDUCING THE FINANCIAL RISK

In finance, hedging is the strategy of mitigating risk exposure by establishing an offsetting position in the derivates market. Derivate markets allow market agents to minimize their exposure to risk by reducing the variance of their portfolio. Hence risk-management tools and their effectiveness in terms of hedging are of utmost importance. The hedging techniques and instruments used to hedge interest rate risk include interest-rate forwards, called "forward rate agreements", interest-rate futures, interest-rate swaps and interest-rate options.

A forward-rate agreement is a bilateral contract to exchange interest-rate payments on a notional amount, at a certain future date, over a specified time interval. The underlying asset for the FRA contracts is usually a LIBOR rate with a specified maturity, but other reference rates can be agreed as well. FRA contracts are over-the-counter cash-settled contracts on the difference between the interest rate stipulated in the contract and the prevailing interest rate at maturity. Hence, FRAs are off-balance-sheet transactions; there are no up-front margin requirements and they are not marked-to-market. A wide range of maturities is available, starting from a few days up to terms of several years. However, three, six, nine and 12 months are usually more liquid. Each payment on the differential between FRA rate and current spot rate is settled at the beginning of each period. Because interest payments accrue from the loan's commencement date and are not due until maturity, each payment should be discounted accordingly.

Regarding the mechanism of FRAs, if interest rates rise above the agreed rate then the seller of the FRA pays the buyer the increased interest expense. Similarly, if interest rates fall below the agreed rate the buyer of the FRA pays the seller the increased-rate cost. Because a FRA contract is used to hedge a single-period interest payment, usually a strip of FRAs is required to fully hedge a term loan. A portfolio of FRAs is equivalent to a plain vanilla swap.

Futures contracts on interest rates are extremely liquid, with high traded volumes and open interest, because interest-rate volatility affects a wide range of market participants. Interest-rate futures are standardized contracts, traded in organized exchanges and thus do not incorporate credit risk as do over-the counter derivatives contracts.

Futures contracts on interest rates are quoted as 100 minus the implied interest rate or yield. Therefore, when interest rates increase, interest rate futures decrease and vice-versa. Consequently, borrowers in the market wishing to hedge their interest-rate risk will be sellers of futures and lenders will be buyers. Hedging with interest-rate futures works in the same way as it does with FRA contracts. The main advantage compared to the FRA market is that because the contracts are exchange-traded, credit risk is reduced. On the other hand, FRA contracts do not require any cash outflows prior to maturity whereas for futures contracts both initial-margin requirements and daily marking-to-market have to be considered because they may cause liquidity problems if the participant cannot meet margin call payments.

Because a single-maturity FRA contract can only hedge a single reset period, a strip of FRAs is required to fully hedge a term loan. In this case, it is common to bundle this strip of FRAs as a single contract with a common price across all maturities. Such a contract is called an interest-rate swap. An interest-rate swap is a bilateral OTC contractual agreement to exchange streams of interest payments for a specific maturity, called the tenor, based on a notional principal. The notional principal is only used for the purposes of calculating interest payments and is not exchanged between the two parties. In its basic form, also called a plain vanilla swap, the contract involves the exchange of a fixed-for-floating interest payment. However, floating-for-floating swaps, called basis swaps, are also possible.

Swap transactions involve intermediaries, usually banks that get commission and brokerage fees for their services. It should be noted that usually for a shipping company, the swap will be arranged directly through the lending bank and in most cases, the shipowner will simply be paying the fixed rate instead of paying or receiving the offsetting cash flows.

Valuation of financial derivatives is vital from a risk-management perspective and any portfolio of derivatives contracts should be valued on a daily basis. At the initiation of the swap agreement, the value of the contract will have zero market value; this is a no-arbitrage condition and implies that in order for the deal to be fairly priced, the present values of the expected floating and fixed stream of payments should be equal. The value of the swap today describes how much the swap is worth today and thus the amount of money the counter-parties have to pay or receive in order to terminate the contract early. Calculating the value of the swap is important because it enables companies to mark-to-market their positions and also calculate their counter-party exposure for each swap transaction. Although not all swaps can be settled prior to expiry, they can change hands under the approval of the swap facilitator who has to verify the creditworthiness of the new counter-parties. A common alternative way to unwind the swap is to neutralize the swap payments by reversing the position and agreeing another offsetting swap contract. Nowadays, cancellable swaps exist, but the embedded option to cancel makes these transactions more complex and more expensive.

Swaps are very useful hedging tools and provide an effective hedge against fluctuations in interest rates. However, a borrower is locked into a fixed rate and cannot take advantage of any decrease in the level of interest rates in the market. Interest-rate options provide a more flexible alternative.

"Caplets" and "floorlets" are risk-management tools, designed to provide insurance by setting a maximum (cap) and a minimum (floor) floating rate respectively for a certain interest-rate period. A caplet is defined as a long position on a single call option on an underlying interest rate. An interest rate caplet gives its holder the opportunity to limit any possible future losses due to an increase in interest rates. The purchase of the call option compensates the floating-rate borrower in the case of an interest-rate rise and provides an upper bound on the spot interest-rate payment which the borrower has to pay at expiry. A floorlet, on the other hand, is defined as a long position on a single put option on an underlying asset. An interest-rate floorlet gives its holder the opportunity to limit any possible future losses due to a drop in interest rates. The purchase of the put option compensates the floating-rate lender/investor in the case of an interest-rate fall and provides a lower bound on the spot interest-rate payment that the investor receives at expiry. Caps and floors are structured on the basis of a specific reference rate, for example, three-month LIBOR, which is reset at regular intervals. A caplet (long call) pays at expiry an amount equal to the difference between the spot interest rate and the strike rate, if this amount is positive, and zero otherwise. In the same way, a floorlet (long put) pays at expiry an amount equal to the difference between the strike rate and spot interest rate, if this amount is positive, and zero otherwise.

Caplets and floorlets are used to hedge interest-rate risk over a single reset period. In practice, in order to hedge a term loan with multiple resets, we require multiple caplets that cover successive interest-rate periods. A "cap" is a portfolio of two or more caplets with the same exercise price but different maturity dates, while a "floor" is a portfolio of two or more floorlets with the same exercise price but different maturities. Therefore, both pricing and hedging techniques for caps and floors are the same as those used in the case of caplets and floorlets.

Collars are very effective risk-management instruments designed to confine the gains and losses of the potential holder of the instrument within certain limits. Collars are a combination of caps and floors, which allow the profit/loss of the investor to be limited to a maximum (cap) and minimum (floor). For example, a shipowner who plans to borrow a certain amount of capital in the future can buy an interest-rate call option (cap) and sell an interest-rate put option (floor) with a notional principal equal to the amount of the loan and expiration dates that match the tenor of the loan. If the shipowner is borrowing money at a floating LIBOR rate, the cap will limit any possible future losses due to an increase in interest rates by compensating the borrower at each reset. For this insurance, the shipowner will pay a cap premium. A way to offset the higher premium is to sell a put option for the same maturity but lower strike and receive the floor premium. However, by doing so, potential profits are limited if interest rates fall. The purpose of collars is to limit the effective borrowing cost by setting upper and lower bounds.

A forward swap is a bilateral contractual agreement whereby two counter-parties enter into a swap agreement on a notional specified capital commencing on a pre-determined future date, at a specified swap rate; in other words, it is an interest-rate swap with a forward start date. Forward swaps are useful for securing the future level of swap rates and can also be used for speculation on the future value of the underlying reference rates. On the other hand, in a forward swap, the purchaser has the obligation – rather than the right – to enter into a specified swap agreement with the issuer on a specified future date. It is for this reason that forward swaps are usually traded with embedded options that provide flexibility with respect to exercising the forward swap. These instruments are called "swaptions" (swaps with an option).

A swaption is an OTC contract which gives the purchaser the right – but not the obligation – to enter into a specified swap agreement with the issuer, on or by a specified future date, either as a fixed-rate payer and floating-rate receiver, called a "payer swaption", or as a fixed-rate receiver and floating-rate payer, called a "receiver swaption". Therefore, a payer swaption is exercised when interest rates increase and a receiver swaption when the opposite occurs; in other words, a payer swaption is a call option on a forward swap and a receiver swaption is a put option on a forward swap. Swaptions are also used to offset the payments on an existing swap in later years.

In shipping markets, most cash inflows and outflows are US-dollar denominated. For instance, freight rates and bunker prices are quoted in US dollars, while most shipping loans are issued in US dollars in Eurocurrency markets. However, there are also cases where shipping companies undertake debt issued in currencies other than US dollars. In these cases the corporate management is interested in matching the interest-rate payments to the same currency as their revenues, that is, US dollars. Such an exposure can be managed using currency swaps. A currency swap is a bilateral OTC contractual agreement to exchange the principal and streams of interest payments from one currency to another for a specified time horizon. Unlike interest-rate swaps, the principal actually changes hands, both at the inception and redemption of the deal. Since the cash flows of the two parties are not in the same currency, the counter-parties' respective payments are made in full.

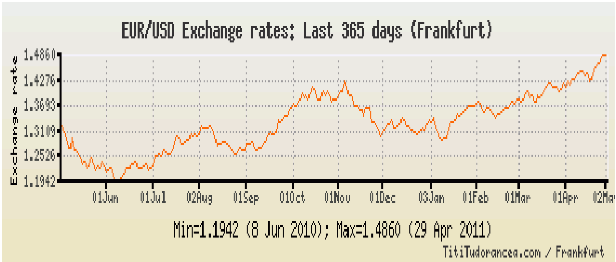


Figure 2 EURO/USD exchange rates historical evolution

5. CONCLUSIONS

The shipping markets are becoming increasingly risky as fluctuations in freight rates and ship prices have increased substantially. This calls for prudent control of not only freight rates and ship prices, but also a range of other financial risks. Therefore, high volatility and cyclicality in rates and prices make risk management a vital issue which takes a central role in the effective strategic management of business.

These risks, if managed effectively, can stabilize cash-flows, with positive repercussions for business in a number of directions. Shipping derivatives have been developed in order to manage risks, emanating from fluctuations in freight rates, bunker prices, vessel prices, scrap prices, interest rates and foreign exchange rates, more effectively, in a cheaper and more flexible manner.

6. REFERENCES

[1] ALIZADEH, A.H., NOMIKOS, N.K., *Shipping Derivatives and Risk Management*, Faculty of Finance, Cass Business School, City University, London 2009

[2] CHRISTOFFERSEN, P.F., *Elements of Financial Risk Management*, London, New York: Academic Press, 2003

[3] CUTHBERTSON, K., NITZSCHE, D., *Financial Engineering: Derivatives and Risk Management*, 1st edition, Chichester: John Wiley & Sons, 2001

[4] HARRINGTON, S.E., NIEHAUS, G.R., *Risk Management and Insurance*, 2nd edition, New York: McGraw Hill, 2003

[5] Laboratory for Maritime Transport, National Technical University of Athens: www.martrans.org .

EXPERIMENT AND THEORY REGARDING THE PIVOT POINT

[1]BUTUSINA PAUL, [2]DINU DUMITRU

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

The purpose of this paper is to find, in open sea, where is the pivot point (as being well established in rigid body mechanics and in ship's manoeuvring theory). It is trying to find evolution of pivot point for a classical turning under current and swell influence. Main target of the work is to correct pivot point theory as it is presented in seafarers books.

Keywords: *Pivot Point, manoeuvering ship, current, swell.*

1. INTRODUCTION

Pivot point of the ship turning is defined in seafarers' publications more or less accurately as follows.

Pivot point is the point which trace the turning curve of a ship. It is located in the fore section of the ship, aftwards of the stem at 1/6-1/3 of ship's length [3].

In general, position of the pivot point is located:

a) – in the horizontal plane of the drifting center, on the vertical line of gravity center of the vessel, when:
- the vessel is stationary with rudder zero, she has speed through the water and zero speed over the ground (at anchor in current);
- vessel is moving straight forward or backward, with rudder midship;
- the vessel has speed over the ground and zero speed through the water (ship is dead in the water, she is drifted by current in calm water);
- position of the pivot point depends of the position of drifting center and this depends of the movement and its sense.

The vertical of the pivot point is the axis in respect with, during turning manoeuvre (or altering the course), the forces which act on the vessel induce the turning moments. The magnitude of these moments depends of the magnitude of the forces and the distances between positions of the application points of them and the axis of the pivot point.

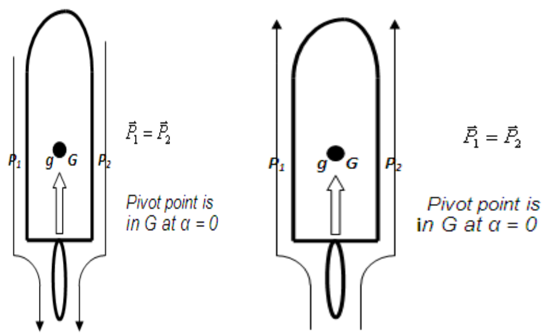
Usually, it (the pivot point) is moving forward when the vessel is moving ahead and aftwards during astern moving and it is stabilizing at about 25% of ship's length or ¼ of ship's length from stem or stern [9].

For a stopped (without movement in respect with the water) at zero trim, in calm water and in absence of the wind, the pivot point coincides with gravity center of the vessel. Under propulsion force and the resistance of the water, the pivot point moves forward. One can consider
with certain approximation, that at a stable speed, the pivot point is at 25% or 1/4L from fore. During astern moving, the pivot point will be stabilized at about 25% or 1/4L from aft. Although not intended, some publications may give the impression that the pivot point moves right aft with sternway. This is clearly not correct and can sometimes be misleading. It should also be stressed that other factors such as acceleration, shape of hull and speed may all affect the position of the pivot point [24].

The pivot point is defined also: that position aboard the vessel about which the ship rotates when turning. In conventional vessels, the pivot point was approximately one third (1/3) of the ship's length, measured from forward, when moving ahead.

It should be noted that when the vessel goes to anchor the pivot point moves right forward and effectively holds the bow in one position. Any forces acting on the hull, such as from wind or current, would cause the vessel to move about the hawse pipe position [14].

As a rule, close to the pivot point is placed the navigation bridge. The position of this point is determinate by ship's gravity center position G and application point C of the rudder resistance, during moving of the vessel ahead or astern. Moving ahead, the pivot point is forward in respect with gravity center and moves more forward with the increasing speed; moving astern, it is behind gravity center and moves aftwards as the speed increase astern [30].



A. Vessel moves forward, rudder midship's

B. The vessel moves astern, rudder midship's

Figure 1(A,B). Wrong positioning of the pivot point

As you will see later, the quotes given before (including fig.1 A and B) from impressing works and which are not random errors of expressing or editing, they are not so real as they are declared and there are necessary important corrections in order to achieve the goal for which they were introduced in seafarers training.

The phenomenon of pivot point existence in ship manoeuvring is well known to navigators, though there is unclearly statement regarding qualitatively and quantitatively its location on a ship during various modes of operation. The available literature on ship manoeuvring and handling does not cover all aspects of pivot point in a systematic way [7].

The pivot point (PP) is the point in diametrical plan of the vessel or in the prolongation of this plan, around which the vessel swings on the tajectory which she describes.This trajectory can be a circle arch with its own center of rotation on the curve (momentary center of rotation). From PP, fore and aft of the vessel can be seen swinging with the same angular speed, even if PP is out of ship's shape.

PP (or tactical point of turning) is located in the point of intersection between ship's diametrical plan and the perpendicular from momentary center of rotation.In PP, ship's tangential speed on the trajectory is ship's speed recorded on board.

PP is important for ships' operators because it gives some indications regarding equilibrium of the forces acting on the vessel, by its indication regarding space swept during turning and by possibility to predict ship's orientation.

If PP is not close to *1/2L*, when space swept by the vessel is $\pi L^2/4$ and it is located fore or aft, necessary space for turning is 4 times larger (πL^2).

Obviously PP will exist only when the vessel is in turning movement and to predict its position is not easy in all cases. In deed, for a stabilized turning on calm sea without current, PP is situated fore or aft, function of sense of movement in fore or aft area as it is presented in the most of publications, at 1/5-1/3L from fore or aft.

PP is defined as a point at distance Xp, measured from the center of gravity of the ship that satisfies the relationship [7]:

$$v + Xp \cdot r = 0 \qquad (1)$$

Where:
v - is sway speed at the center of gravity of the ship;
r - is the yaw rate.
It follows, from Eq.(1) that:

$$Xp = -v/r \qquad (2)$$

Equation (2) is ill defined when the yaw rate is zero, which corresponds to a straight line motion. When the vessel movies on a straight line ahead or astern or she is in a pure sway motion, it is reasonable to consider PP at infinity [7]. In other words saying, *when the vessel moves along axe X-X' or she drifts along axe Y-Y', there are not a PP and it is unfair to declare that PP is fore or aft function of direction of ship's movement, as it is used in present.*

2. WATER RESISTANCE AND PIVOT POINT OF A VESSEL STOPPED

Considering a stopped ship, without movement through the water and rudder mid ship's, we can find a point situated about at its mid length, from where if a tug will push with a force F (Fig.2), fore and aft extremities of the ship are moving with V1= V2. The force F is applied on the same support as water-resistance force WR. Its center of application is Center of Water/Lateral Resistance, CWR. Arm lever of F and WR is zero.

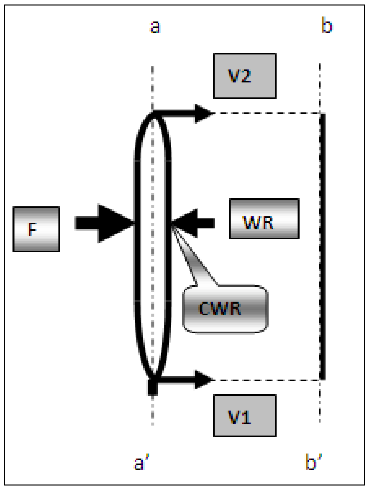


Figure 2 Vessel stopped

The ship will be translated from axis a-a' to b-b' (a-a' II b-b'). In this case there is not rotation, nor PP, or it is situated at infinity.

If the force is applied closer to mid length but more to one side of the considered ship, let to say aft (Fig.3), the arm lever of forces F and WR will be "d"

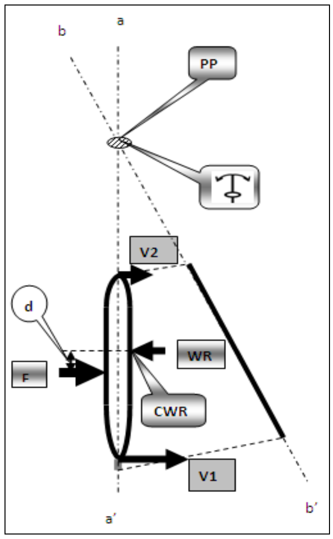


Figure 3 Vessel anchored

and the ship will record a side movement and a rotation (V1>V2). The axis a-a' will be intersected by b-b' in PP. If the ship would be anchored, PP would be where the anchor chain will leave sea bottom or close to that point. *In this case PP is outside of ship's shape.*

Outside ship shape PP is of special interest for 4 points mooring vessels when they deploy or recover anchors in current or strong winds when very interesting phenomena are recorded, sometimes putting ships in impossibility to manoeuvre.

If the tug will push with force F closer to aft (Fig.4), the arm lever of F and WR , d1 > d (from fig.3) and rotation of the ship will be faster (V1>>V2) and PP will be located inside of ship's shape close to application point of WR in ship fore part. During action of F, it appears a water flow (WF) around the bow which creates low pressure (LP) responsible for a slight forward movement of the vessel.

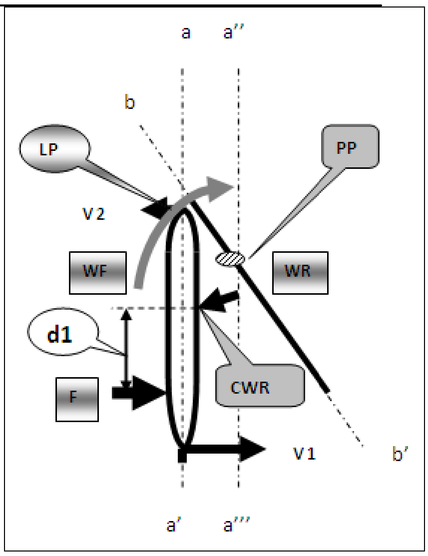


Figure 4 Force *F* applied close to aft

3. WATER RESISTANCE AND PIVOT POINT OF A MOVING VESSEL

If the ship will start to move ahead keeping her rudder mid ship's (fig.5), due to drifting movement with speed *D*, vessel will move on the resultant of propulsion speed *P* and *D*, respectively with speed *P1* on its direction. Water resistance force WR increases and it will shift forward. The result is a shift of PP forward in the direction of movement.

Arm lever of *F* and *WR*, *d2 > d1* and in consequence *V1 >> V2*, it means the vessel will turn more quickly. Even with a kick ahead, this increasing of rotation speed can be seen. This phenomenon is valid for astern movement if the tug acts forward. In such case, due to short distance between *WF* application point and PP, in practice, by ship handlers, it is used to consider PP as reference point for *WR* application point. In reality application point of *WR* depend of underwater shape of the vessel.

4. METHOD

To find PP position (fig.6) it was used bridge ships equipment, two marine portable GPS, watches and cameras. The two portable GPS were placed at fore and aft extremities of an offshore multipurpose vessel (fore GPS above of fore perpendicular). During ship evolution it was made movies fore and aft to record time and GPS

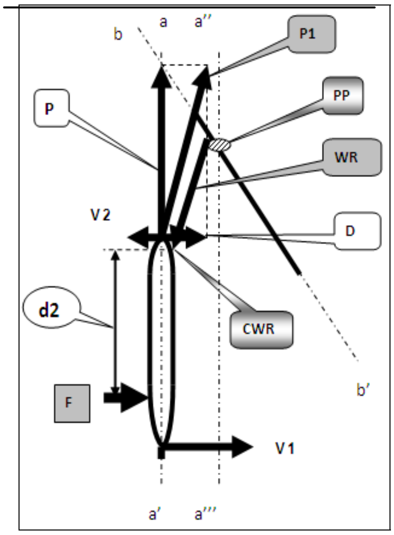


Figure 5 Vessel moves forward

screens and pictures with bridge navigation information were taken at about each change of 10^0 of ship's heading. After extracting of data from movies and pictures, position of fore and aft GPS were represented with connected linear speed. Using principles of mechanics, at intersection of perpendiculars on these speeds it was found instantaneous centre of rotation *Ci* around which the movement of the vessel is producing . *Sa GPSa Ci = Sf GPSf Ci = 90^0*. GPS tangentialspeeds (*Sa and Sf*) were decomposed on direction of ship's centre line (*Sfl and Sal*) and on a perpendicular on the centre line (*Sat and Sft*). Transversal components Sat and Sft gives swinging movement of the vessel.Joining transversal components of GPS speeds Sat and Sft, which correspond with angular rotation speed, at

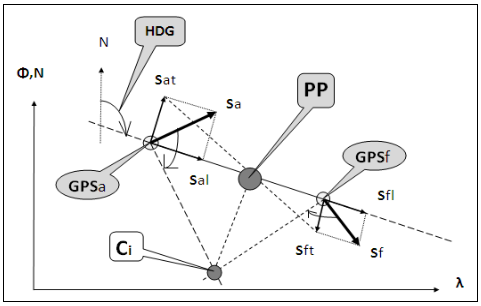


Figure 6 Method of finding PP position

intersection with centre line it will be found the pivot point, PP, as it is defined in ship's handling (as point from where fore and aft are rotating with same speed). The origin of pivot points measurements is fore perpendicular which in our case correspond with ship's stem. PP abscissa *Xpp,* are negative inside of ship's shape. PP position can be get also at intersection of diametrical plan (or center line) with a perpendicular from *Ci*.

There were performed few tests on real vessel and same tests on virtual ship (close as possible with particularities of real vessel), on Constanta Maritime University manoeuvring simulator. In this work we present a single test only due to limited space. Measurements done can be seen on figure 7.

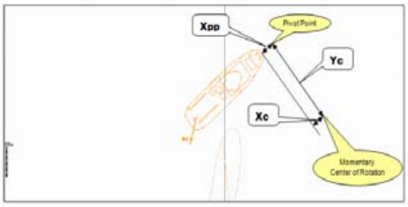


Figure 7 Coordinates of momentary center of rotation and PP as they are indicated by manoeuvring simulator.

To see the effect of the current on position of PP (fig. 8) one can consider a ship with rudder at a certain angle to starboard, moving with speed through water *V*, recorded in her center of gravity *G*. Speed *V* can be decompose longitudinally and transversally in *u* and *v*. The vessel swings around PP with angular speed *r*. PP, defined before, describes turning curve *T*, on which she moves with speed *V'*. The trajectory *T* has the momentary center of rotation *Ci*.It is considering the current *W* having opposite sense with ship's bow swinging sense.

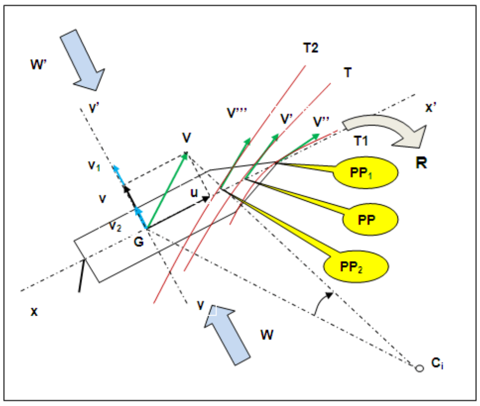


Figure 8 Changing of PP position in current

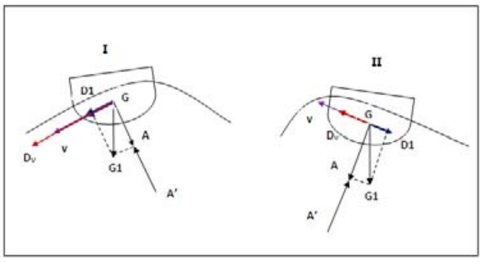


Figure 9 Swell effect over sway speed

Acting on axis y-y', current speed will sum with sway speed *v* resulting new sway speed v_1. To this new sway speed correspond a new PP_1, placed more forward ($Xp = -v/r < Xp1 = -v_1/r$), which will moves along trajectory T_1 with speed *V''*. For the case of current of the same sense with bow swing speed, sway speed will be reduced by current speed, resulting sway speed $v_2 < v$. New PP_2 will be located towards *G* and it will moves with speed *V''' on the trajectory* T_2 (the momentary radius, RT2 > RT > RT1).

To study the effect of the swell on the position of PP (fig.9), we consider a vessel turning with sway speed *v*, having swinging sense to port. The swell comes from starboard. During rising and falling of the ship on swell wave, displacement force acting in G_1 will be decomposed in a plan parallel with floating plan, D_1 and in a plan perpendicular on floating plan, *A*, which is canceled by Archimedes buoyant force *A'*. Depending of the slope of the swell wave on which is the vessel situated, the component D_1 will be composed with the sway speed *v*, resulting a new sway speed *DV*. This new sway speed can be greater (fig.9.I) or smaller (fig.9.II) than old sway speed, depending of the sense of *DV* which will be same or opposite with sway speed before arriving swell wave. Sway speed being involved in definition of PP position, it results that, during passing from one slope to the other of the swell wave, PP will have a "jump" in respect with its position before to arrive the swell wave.

The target of the test regarding PP was the evolution of its position in open sea, in real environment conditions and how this evolution can affect manoevring versus PP theory as it is presented in marine universities. Athough here it is presented a simple turning manoeuvre in open sea, the tests were performed in various conditions and their results are presented in a separate research report. Special attention was paid for current effect.

Abscissa PP *(Xpp)* was measured from fore perpendicular, where one GPS was placed and it is positive forward and negative aftward.

Ordinate of momentary center of rotation *(Yc)* was measured from the diametrical plan of the ship and its sign is positive when momentary center of rotation is on the side of rotation of ship's bow.

Angle (Tc-Tw) between ship's head and coming current (its direction, by navigation definition, is outgoing) has maximum value 180°, measured from the bow and being positive on the port side.

5. VESSELS PARTICULARITIES

5.1 True vessel - Offshore Supply Vessel (SV)

L_{WL} = 56.37 m; B = 14.60 m;
h = 5.50 m; d = 4.75 m;
D = 1500 tdw; 2 engines 2 x 1641 Kw;
2 fix propellers in Kort nozzles;
2 balanced rudders; Bow thruster = 5 mt;
Max. speed = 13 knts; Height of eye = 15.25 m.

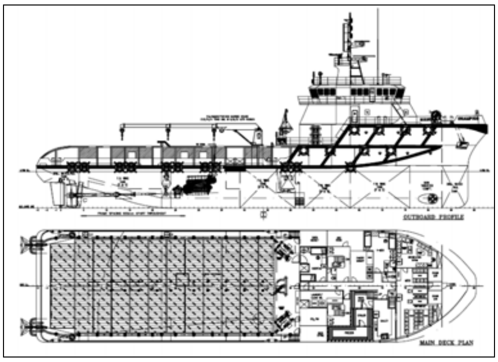


Figure 10 General plan of the reference vessel

5.2 Simulation vessel (S_1)

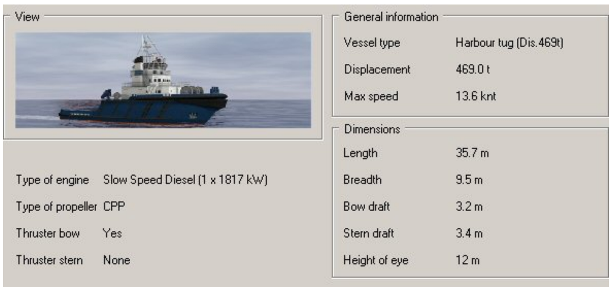


Figure 11 Virtual vessel

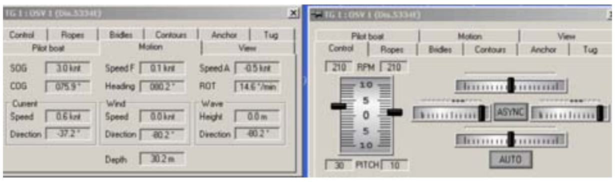


Figure 12 Controls and recording data during simulation

Abbreviations used in this work are:

Time - time of the record
HDG/Hdg - true course (through water)
Spd - true speed (through water)
COG - course over ground
SOG/Vt - speed over ground
Lat - latitude
Long - longitude
Xpp - abscissa PP from fore perpendicular (Ppv)
Yc - momentary center of rotation ordinate
Ci - momentary center of rotation
PP - pivot point

6. THE EXPERIMENT

6.1 The test with reference vessel (SV) was a complete turning circle to starboard (fig.13), engine at minimum revolutions, in following conditions:

Port engine680 rpm ahead;
Bow thruster stop
Total drift 321°/1,1 nd;
Apparent wind 0 nd;
Swell 220°/0,5-1 m/6-8 sec.
Remark the boat landing on starboard
Rudder 35° Starboard

Table 1. Test data

The results were recorded in table 1 from which were extracted the graphs presented in fig.13-17.

Variation of PP abscissa in respect with ship's head is presented in fig.14 and its variation in respect with the angle between ship's head and current in fig.15.

Analyzing positions of PP (fig. 14) one can see that ship being all the time in ahead moving, PP approaches of stern and a good part of evolution it is out of the ship shape forward. Studing relation between PP position and incidence angle, ship-current (fig.15) one can observe that the highest values of the *Xpp*, positive or negative are placed to an angle of incidence between vessel and current of 70°-130°, the greatest positive value being recorded at 119,5° (tab.1), the highest negative at 90°-100° and the lowest values close to incidence angle 0° or 180°.This confirm mathematical definition of PP, when the current acts perpendicular on the vessel, drifting (sway) speed increases, value of the ratio *v/r* increases because angular speed of swinging does not record a proportional increasing.

From fig. 16 one can observe that the momentary centers of rotation (*Ci*) are grouped, this mean that the turning swept little space although momentary centers ordinates are of quite high values (ship's trajectory is composed of large circle arches).

Momentary fluctuation, both for PP and Ci are induced, at the slow speed of the vessel, besides the current, by the swell too, this increasing or decreasing ship's sway or yaw rate.

Momentary center of rotation abscissa were not recorded, theoretically being of the same value as PP abscissa although during their measurements, it was observed that these two kind of abscissa are not equals, probably due to summoning of all errors of devices and graphic work precision.

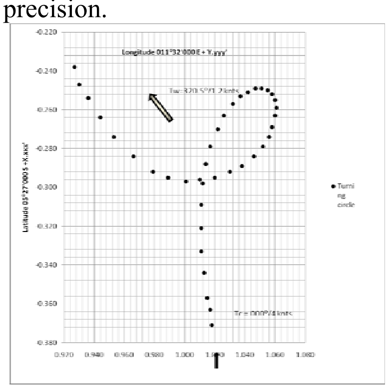


Figure 13 Ship's trajectory during the test

NR	TIME	COMANDA (BRIDGE)					PROVA (FORE)				PUPA (AFT)				Xpp DE LA PROVA [m]	Yc [m]	Tc-Tw [°]	ROT [°/min]
		ΔT	HDG	COG	LATITUDINE -05°27.000' +	LONGITUDINE 011°32.000' +	COG	SOG	LATITUDINE -05°27.000' +	LONGITUDINE 011°32.000' +	COG	SOG	LATITUDINE -05°27.000' +	LONGITUDINE 011°32.000' +				
A	15.58.53	00.16	2.0	2.0	-0.363	1.017	347	2.42	-0.356	1.018	337	2.52	-0.381	1.017	∞		41.0	
B	58.57	00.20	3.5	4.0	-0.357	1.015	353.0	2.42	-0.348	1.017	342	2.52	-0.327	1.002	39.59	106.73	42.5	24.0
1	6.00.20	1.42	71.0	69.6	-0.270	1.022	39.0	1.23	-0.267	1.033	13	1.85	-0.277	1.006	39.82	56.03	110.0	54.0
2	00.30	1.52	80.5	83.2	-0.263	1.026	46.0	1.18	-0.264	1.036	29	1.59	-0.267	1.010	66.21	96.31	119.5	60.0
3	00.40	2.02	91.0	90.0	-0.257	1.032	53.0	1.23	-0.258	1.042	31	1.75	-0.258	1.014	50.93	56.49	130.0	66.0
4	00.50	2.12	100.0	103.0	-0.253	1.037	65.0	0.98	-0.257	1.047	36	1.65	-0.251	1.021	37.50	37.97	139.0	54.0
5	6.01.00	2.22	110.0	107.8	-0.251	1.042	82.0	0.82	-0.256	1.053	48	1.49	-0.247	1.025	31.95	40.29	149.0	60.0
6	01.10	2.32	119.0	120.7	-0.249	1.047	90.0	0.67	-0.256	1.055	64	1.34	-0.241	1.030	30.56	61.58	158.0	54.0
7	01.20	2.42	130.0	129.5	-0.249	1.051	99.0	0.67	-0.258	1.059	54	1.54	-0.239	1.036	38.89	15.75	169.0	66.0
8	01.30	2.52	140.0	139.5	-0.250	1.055	146.0	0.72	-0.260	1.061	83	1.13	-0.238	1.042	-4.63	35.42	179.0	60.0
9	01.40	3.02	151.0	149.2	-0.252	1.058	170.0	0.93	-0.262	1.062	113	1.03	-0.237	1.047	-16.67	48.43	-170.0	66.0
10	01.50	3.12	162.0	151.0	-0.255	1.060	174.0	0.77	-0.264	1.066	121	1.03	-0.239	1.052	-12.04	50.47	-159.0	66.0
11	6.02.00	3.22	173.0	175.8	-0.259	1.061	192.0	0.72	-0.269	1.060	121	0.82	-0.243	1.058	-13.43	33.62	-148.0	66.0
12	02.10	3.30	180.0	187.3	-0.263	1.060	205.0	1.03	-0.274	1.058	149	1.03	-0.247	1.061	-26.39	51.40	-141.0	42.0
13	02.20	3.42	192.0	193.7	-0.269	1.058	216.0	1.08	-0.281	1.055	173	1.13	-0.253	1.062	-28.71	68.99	-129.0	72.0
14	02.30	3.52	201.0	212.0	-0.274	1.056	225.0	1.54	-0.284	1.052	187	1.44	-0.257	1.061	-37.04	77.79	-120.0	54.0
15	02.40	4.02	212.0	211.2	-0.279	1.052	234.0	1.65	-0.287	1.044	201	1.65	-0.263	1.059	-35.19	90.75	-109.0	66.0
16	02.50	4.12	221.0	222.0	-0.284	1.046	249.0	1.54	-0.291	1.038	209	1.18	-0.272	1.055	-43.06	72.93	-100.0	54.0
17	6.03.00	4.22	231.0	236.0	-0.289	1.038	258.0	1.59	-0.294	1.027	224	1.34	-0.280	1.048	-42.23	30.79	-90.0	60.0
18	03.10	4.32	242.0	242.4	-0.292	1.030	261.0	1.80	-0.298	1.019	228	1.75	-0.286	1.042	-31.95	91.77	-79.0	66.0
19	03.20	4.42	252.0	254.2	-0.295	1.020	269.0	1.85	-0.297	1.010	242	1.8	-0.290	1.035	-28.24	122.09	-69.0	60.0
20	03.30	4.52	262.0	264.2	-0.296	1.010	273.0	1.85	-0.297	0.999	247	0.93	-0.294	1.028	-30.56	117.98	-59.0	60.0
21	03.40	5.00	270.0	270.0	-0.297	1.001	282.0	2.00	-0.297	0.987	257	2.00	-0.297	1.015	-25.00	123.71	-51.0	48.0
22	03.50	5.12	284.0	280.0	-0.295	0.989	287.0	2.16	-0.291	0.977	262	2.37	-0.296	1.005	-2.78	129.18	-37.0	84.0
23	6.04.00	2.22	294.0	289.8	-0.292	0.979	301.0	2.21	-0.288	0.968	273	2.31	-0.297	0.993	-12.96	107.18	-27.0	60.0
24	04.10	2.32	300.0	298.8	-0.284	0.966	310.0	2.21	-0.279	0.957	281	2.37	-0.295	0.985	-9.26	105.56	-21.0	66.0
25	04.20	2.42	319.3	320.3	-0.274	0.953	317.0	2.26	-0.269	0.949	290	2.42	-0.291	0.967	4.63	101.40	-1.7	115.8
26	04.30	2.52	323.2	323.5	-0.264	0.944	320.0	2.21	-0.261	0.940	298	2.42	-0.284	0.957	7.64	130.57	2.2	24.0
27	04.40	3.02	337.5	337.5	-0.254	0.936	334.0	2.16	-0.250	0.934	308	2.42	-0.277	0.945	8.80	108.34	16.5	84.0
28	04.50	3.12	348.0	348.2	-0.247	0.930	339.0	2.06	-0.241	0.929	313	2.42	-0.269	0.935	19.45	101.17	27.0	66.0
29	6.05.00	3.22	357.0	357.5	-0.238	0.927	345.0	1.85	-0.233	0.927	317	2.42	-0.260	0.928	18.06	86.21	36.0	54.0

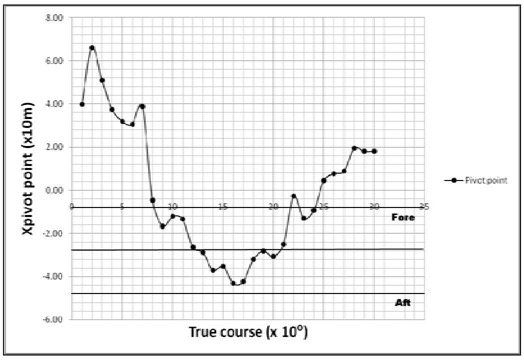


Figure 14 PP abscissa variation during the test

Momentary centers ordinates – Y_C (tab.1) have quite high values and one can observe "jumps" sometimes. Explanation of these jumps is same as for PP, graphic definition of its being close connected with the momentary center of rotation of the vessel.

6.2 Test with virtual vessel (S_1) was performed for the same conditions as for the real vessel. Unfortunately it was not found a virtual vessel with the same particularities as the reference vessel and difference between the two ships is very big $L_{SV} – L_{S1}$ = 21 m, without considering that the vessel S1 has only one propeller but the vessel SV has two in nozzle.Against these differences, the results of the simulation (tab.2) confirm trajectory shape (fig.17),

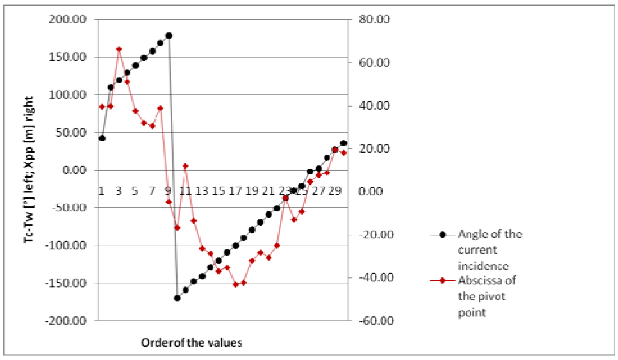


Figure 15 PP in respect with the current

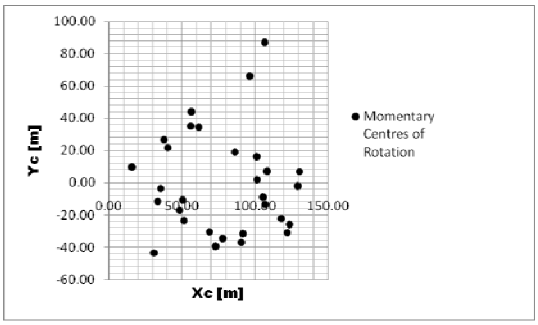


Figure 16 Momentary centers of rotation

Table 2 Simulator test data

Timp	HDG	SPD	COG	SOG	Fore speed	Aft speed	PP from Ppv [m]	Ci Xc	Ci Yc	Tc-Tw [°]	ROT [°/min]
0.20	21.3	3.8	357.2	4.2	-0.2	-3.4	3.00	3.67	43.67	60.3	156.2
0.25	34.9	3.3	4.6	3.9	-0.4	-3.8	4.00	4.33	36.00	73.9	168.4
0.30	48.6	2.8	12.8	3.4	-0.5	-3.7	5.33	6.00	31.33	87.6	161.2
0.35	61.9	2.3	20.8	3.1	-0.5	-3.7	6.67	6.67	26.00	100.9	156.2
0.40	72.2	2.0	28.9	2.7	-0.4	-3.5	4.67	4.00	23.33	111.2	153.8
0.44	84.8	1.7	37.9	2.5	-0.4	-3.4	5.00	5.00	19.38	123.8	148.3
0.49	97.5	1.4	52.8	2.1	0.0	-3.1	-0.67	0.00	17.00	136.5	152.7
0.54	109.5	1.2	57.9	1.9	-0.1	-3.1	0.67	0.00	13.33	148.5	148.2
0.59	122.4	1.1	82.5	1.4	0.4	-2.4	-4.67	-5.00	14.67	161.4	139.9
1.05	136.9	0.9	99.0	1.2	0.8	-2.5	-9.20	-9.33	10.33	175.9	166.3
1.10	149.0	1.0	118.4	1.2	0.7	-2.1	-9.33	-9.67	13.20	-172.0	140.1
1.15	161.8	1.0	157.4	1.0	1.3	-1.7	-16.00	-16.67	11.67	-159.2	148.2
1.20	174.0	1.2	170.4	1.2	1.4	-1.7	-16.00	-15.33	14.33	-147.0	153.8
1.25	186.5	1.3	194.1	1.4	1.6	-1.4	-18.67	-18.33	16.87	-134.5	146.5
1.30	199.0	1.4	216.0	1.5	1.8	-1.2	-21.67	-20.87	17.33	-122.0	149.2
1.35	211.4	1.8	224.7	1.9	1.8	-1.2	-22.33	-22.00	25.33	-109.6	150.2
1.45	236.1	2.1	248.0	2.2	1.8	-1.1	-23.00	-22.33	39.30	-84.9	147.0
1.49	245.9	2.5	257.0	2.6	1.9	-1.1	-23.33	-22.67	30.67	-75.1	147.5
1.54	258.1	2.6	265.0	2.6	1.7	-1.3	-21.67	-22.00	32.47	-62.9	146.3
1.59	270.1	2.8	272.6	2.9	1.5	-1.4	-18.00	-18.00	34.67	-50.9	142.4
2.05	284.6	3.1	285.4	3.1	1.3	-1.4	-17.67	-17.33	40.87	-36.4	135.5
2.10	296.5	3.2	293.1	3.2	1.2	-1.8	-14.80	-16.00	37.47	-24.5	151.1
2.15	307.8	3.2	296.6	3.3	0.7	-2.2	-8.67	-10.13	41.53	-13.2	140.4
2.20	320.1	3.3	309.6	3.3	0.6	-2.0	-8.67	-10.00	45.80	-0.9	128.7
2.25	331.5	3.2	314.4	3.4	0.4	-2.6	-5.33	-6.00	38.80	10.5	153.1
2.30	343.1	3.2	321.4	3.5	0.0	-2.7	0.33	0.67	44.47	22.1	132.3
2.35	355.0	3.0	331.0	3.3	0.0	-2.9	0.00	-0.67	38.87	34.0	142.6
2.40	6.5	3.0	337.3	3.5	-0.4	-3.2	4.33	4.33	38.00	-314.5	142.4
2.43	14.8	2.7	343.2	3.1	-0.3	-3.2	3.67	3.67	34.47	-306.2	142.8

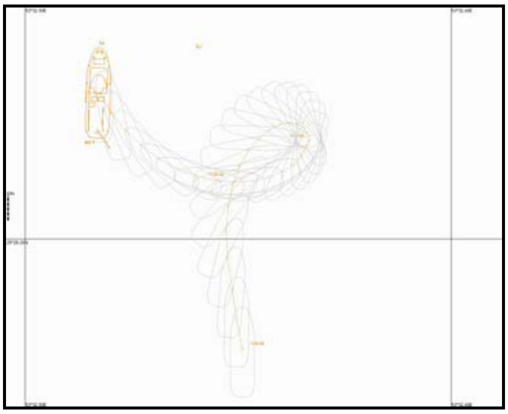


Figure 17 Trajectory of the virtual vessel S1

Graph of PP has almost the same shape as real ship's graph (fig.19).From fig.18 it can be observed evolution of the sway speed and the yaw angle, elements which

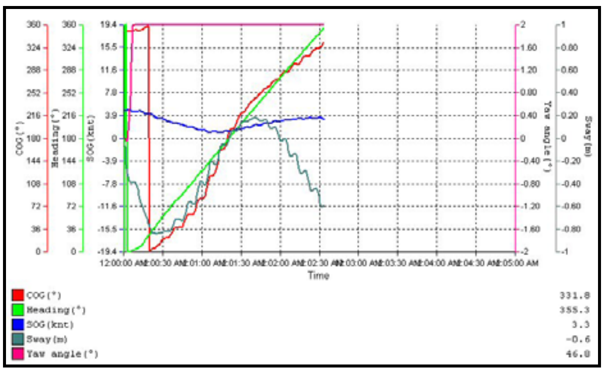


Figure 18 Graphs from simulator for the vessel S1

define PP abscissa (*Xpp*). Explanation of the fluctuation of the values of these elements is the same as for PP.

The comparison between results of the test performed by real vessel and virtual vessel is not

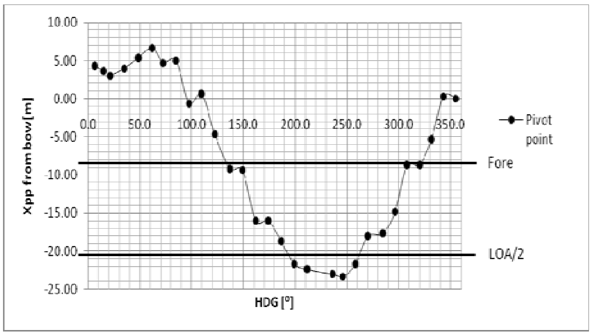


Figure 19 PP in respect with ship's head

relevant because, in fact, they are two different vessels and analyze of the results is in principle. It has not to forget that the virtual vessel has not a boat landing as appendix and her results are not influenced by a supplementary unsymmetrical resistance through water.

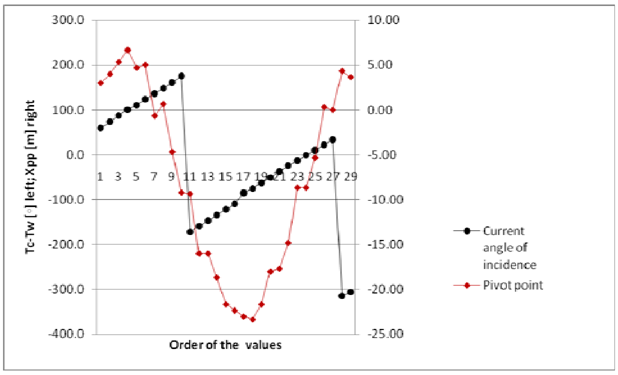


Figure 19 PP in respect with current influence

7. CONCLUSIONS

During documentation for this work it came out that there are a clearly discrepancy between shipbuilding research results and perception of ship operators training system about pivot point of the ship turning. Theory of the pivot point is received only for a stable turning in calm water and it is extended as each interpreter consider, below scientific level, although nowadays there are all facilities to find a complete statement of the question (manoeuvring simulators in large numbers).

This test, among the others unpublished here, was performed with an important appendix fixed on the hull which it affected substantially the results of the test.

In the same time the tests clearly demonstrated the complexity of the factors which affect the evolution of the pivot point during offshore manoeuvres against port manoeuvres and they show obviously that the pivot point can not be treated so simply as it is in the most works in training system of the seafarers, unchanged for almost hundred years.

It is clear that very often the pivot point is located outside of the ship's shape and unknowing very well its position it is not practically to try to calculate forces momentum which act on the vessel in respect with this point. The affirmations regarding moving of the pivot point up 1/5 or 1/4 L from bow has to be completed with specification that it is valid for a stabilized turning manoeuvre in water area with ideal conditions and it is not a general statement as it is understanding from the most works regarding the matter or completely wrong to assert that the pivot point is located in a certain place during streight way ahead or astern.

It was demonstrated, in special for low speed, huge influence of the current and the swell on the p;ivot point abscissa evolution.

Paraphrasing professor Rayleigh who said: "It happens not infrequently that results in the form of 'laws' are put forward as nobelties on the basis of elaborate experiments, which might have been predicted a priori after a few minutes consideration", we can say: the results of the pivot point study which could be enunciated after a few (good) minutes consideration, they needed experiments of which one was presented in this work and may be they will need more experiments on the ship models and manoeuvring simulators and may be even then it will not be sure that the complete theory of the pivot point will be assimilated by the seafarers training books.

8. REFERENCES

[1] Artyszuk Jaroslaw - *Evaluation of uniform current dynamic effect in practical ship manoeuvring,* Szczecin Maritime Academy, *A*nnual of navigation 8/2004

[2] Bertram, Victor - *Practical ship hydrodynamics,* Butterworth Heineman (2000)

[3] Bibicescu Ghe. şi colectiv - *Lexicon maritim englez-român*, Editura ştiinţifică, 1971

[4] Butuşină Paul, Dinu Dumitru – *Water resistance force – pivot point*, Annals of Mechanical, Industrial and Maritime Engineering, vol.XII, Ovidius University Constanţa, 2010

[5] Cauvier, Hugues - *Is the Pivot Point realy a pivot point? A study on the rotation and sideways motion of ships*, sohu@oricom.com (2008)

[6] Chase, G. Andy - *The Moving Pivot Point,* The Northern Mariner/Le Marin du Nord, IX, July (1999);

[7] Ching-Yaw Tzeng - *Analysis of the pivot point for a turning ship*, Journal of Marine Science and Technology, vol.6, no.1 (1998)

[8] Che Wan, Mohd Noor Bin Che, Wan Othman - *Manoeuvring prediction of offshore supply vessel,* Faculty of Mechanical Engineering, Universiti Teknologi Malaysia May 2009

[9] Deboveanu Marin – *Tratat de manevra navei*, ed. Lumina Lex 1999-2003

[10] *Dictionar enciclopedic*, vol.II, Editura enciclopedică,1996

[11] Dinu Dumitru, Popa Dan - *Jet Maneuvering of ROVs. A Mathematical Model***,** Revista Hidraulica Nr.2(24), iulie, 2009, ISSN 1453-73-03

[12] Dinu Dumitru – *Hydraulics and hydraulic machines*, Ed. Sigma Trading Metafora, 1999

[13] Dinu Dumitru – *Mecanica fluidelor pentru navigatori*, ed. Nautica, 2010

[14] House David L. – *Ship Handling*, Butterworth Heinemann, 2007

[15] Journée J.M.J. - *Prediction of Speed and Behaviour of a Ship in a Seaway,* Report 0427-P, Delft University of Technology, Ship Hydromechanics Laboratory, 1976;

[16] Lewis, E. V. - *Principles of Naval Architecture*, SNAME, NJ (1989)

[17] López Eloy, Velasc Francisco J., Moyano Emiliano, Rueda Teresa M. - *Full-scale manoeuvering trials simulation,* Journal of Maritime Research*,* Vol. I. No. 3, pp. 37-50, 2004

[18] Maier Viorel – *Mecanica şi construcţia navei*, Editura Tehnică, 1987

[19] MSC 76/23/Add.1 - S*tandards for ship manoeuvrability* , Resolution MSC.137(76) (2002)

[20]30. Obreja Dan, Crudu Liviu, Păcuraru-Popoiu Sădiţa - *Manevrabilitatea navei*, Galaţi University Press (2008)

[21] Port Ravel Ship Handling Training Center - *Course Manual*, 2010

[22] Rawson, K.J. and Tupper, E.C. - *Basic Ship Theory*, Butterworth Heineman (2001)

[23] Resolution MSC.235(82) - *Adoption of the guidelines for the design and construction of offshore supply vessels*, 1 December 2006

[24] Rowe, R.W. - *The ship handler's guide*, The Nautical Institute, London (1996)

[25] RINA Rules - *Ship manoeuvrability*, MANOVR, 2003

[26] RINA INDUSTRY S.p.A.,TERMINAL ALPI ADRITICO, TERMINALE DI RIGASSIFICAZIONE OFF-SHORE - *Studio di Manovrabilità,* 2008

[27] Schneekluth, H. and Bertram, Volker - *Ship Design for Efficiency and Economy*, Butterworth Heineman (1998)

[28] SOGREAH Consulting Engineering – *Proceedings,* 1-st International Symposium on Ship Approach and Berthing Manoeuvres, Grenoble, 1977

[29] Sogreah - *Port Revel Shiphandling Technical Documentation,* 2009

[30] Universitatea Maritimă Constanţa – *Curs de manevra navei pentru învăţământ cu frecvenţă redusă,* 2007

[31] Volker Bertram – *Practical ships hydrodynamics*, Buttervorth Heinemann, 2000

[32] Zamfir, P.I. and Bartalos Bela - *Manevra navelor cu propulsie mecanică*, note de curs, Institutul de marină „Mircea cel Batrân", 1979.

THE GROUNDING OF TWO CARGO SHIPS NEAR THE ROMANIAN BLACK SEA COAST. METEOROLOGICAL CONDITIONS ANALYSIS

[1]CHIOTOROIU BRINDUSA, [2]CIUCHEA VALENTIN

[1]*Constanta Maritime University,* [2]*The Maritime Hydrographic Office, Constanta, Romania*

ABSTRACT

The aim of this study is to analyze the meteorological conditions at sea level and in the middle troposphere, during a violent storm in December 2009. The analysis is based on pressure and temperature maps, on the meteorological data recorded by the onshore and offshore weather stations and on the outputs of the Alaro simulation model. The grounding of a cargo vessel of 1725 dwt on the submersed beach south of Sulina channel the 16.12.2009 and of another cargo vessel of 3025 dwt, north of Sulina channel the 17.12.2009 occurred during this storm event. The events reconstruction, based on media reports and, partly, on the testimonials of a crew member, emphasizes other causes connected to human nature and the importance of taking measures in order to keep the ship safe during difficult meteorological conditions.

Keywords: *storm, Black Sea, maritime accidents*

1. INTRODUCTION

The storms produced along the Romanian Black sea coasts had negative consequences on the natural environment and economic activities (navigation, tourism, the change related to the places and operation of oil drillings, etc.). The consequences on coastal navigation consisted in small damages to the cargo or to the ship bulb, the body and superstructure, the side shell plating buckles, the loss of the anchor, of the propeller, damage to the hull or deck machinery, affected stability due to cargo loss or even grounding (Chiotoroiu et al., 2009). They also consisted in damages of the barge, pusher, plant and port equipments.

The highest number of accidents on sea occurred during bad weather in winter, with a maximum in January and December.

The snow falls and blizzards from December 2009 had grave consequences on the road, rail, maritime and air traffic in many counties in the south-eastern part of Romania. The main Romanian Black Sea ports (Constanta North and South and Midia) were closed starting with December 17, 2009, 03.45 p.m., after the port operations had been stopped during the morning of that day. According to the Zonal Harbor Master's Office, the barge traffic on the Danube-Black Sea Canal was also restricted (http://www.gandul.info/news/). The Romanian Naval Authority announced that the *Torgut S* ship, with a crew of 14 members was stranded on December 17, 2009, at 03.20 a.m. in the Sulina area, due to unfavourable hydro-meteorological conditions. They also announced that the Jupiter cargo grounded near the Sulina beach on December 16, 2009, at 5.30 a.m. (http://www.gandul.info/news/).

A thorough analysis of this extreme weather event could contribute to a better understanding of similar situations in the future and to the improvement of weather forecast, so implicitly to the reduction of risks associated with these phenomena.

2. STATE-OF-THE-ART

Previous climatological studies on the genesis and evolution of storms produced along the Romanian shore showed that during many of these events, the upper-level atmospheric circulation is characterized by a substantial amplification of the planetary-scale flow waves during the development phase of the Mediterranean cyclones that bring cold air to very low latitudes (Georgescu et al., 2009; Maheras et al., 2001; Chiotoroiu, 1999; Tayanc et al., 1998). Initially cyclones are of mesoscale size (Radinovic, 1987). The mature stage of Black sea lows indicated a northward shift of the Aegean-Black sea double geopotential minima and an intensification of the upper-trough (Trigo, 2002).

The thermal inversion in the south-eastern Romania (cold sea level air and associated ENE winds and warm air at 900-850 hPa and associated SSE winds) was observed by Draghici (1988). The systematic advection of warm air from the Mediterranean was also studied in relation to the genesis of blizzards in the south-east Romania (Draghici et al., 1990; Bogdan et al., 1999; Popa et al., 2002; Cordoneanu, 2004; Georgescu M. et al., 2004; Capsa et al., 2005; Georgescu F. et al., 2009).

3. METHODOLOGY

For the analysis of the distribution of atmospheric pressure at ground level, of the geopotential field 500 hPa and 850 hPa, of temperature distribution at different levels and of the cold and warm advections over the studied region, the NCEP reanalysis maps from the Reanalysis archive are used (available on the website www.wetterzentrale.de).

A surface wind map is also used, from the Alaro model simulations. This is a regional prognosis model with a good resolution and offers the advantage of considering the particularities of the zone for which it works.

Meteorological and hydrological data (on wind speed and direction and sea state) were recorded in two weather stations, belonging to the national weather stations network: Sulina on the coast and Gloria offshore (figure 1). Observations on wind direction and speed are made using the wind vane (10 m from the ground) at Sulina, while at Gloria measurements are realized by anemograph (42 m from the sea level). Wind speed values are mediated on two minutes Observations on the wave characteristics are visual and made every 3 hours.

For the reconstruction of the maritime accidents, media reports have been used as well as the testimonials of one member of the Jupiter crew, who participated to the Jupiter cargo ship voyage as a deck cadet.

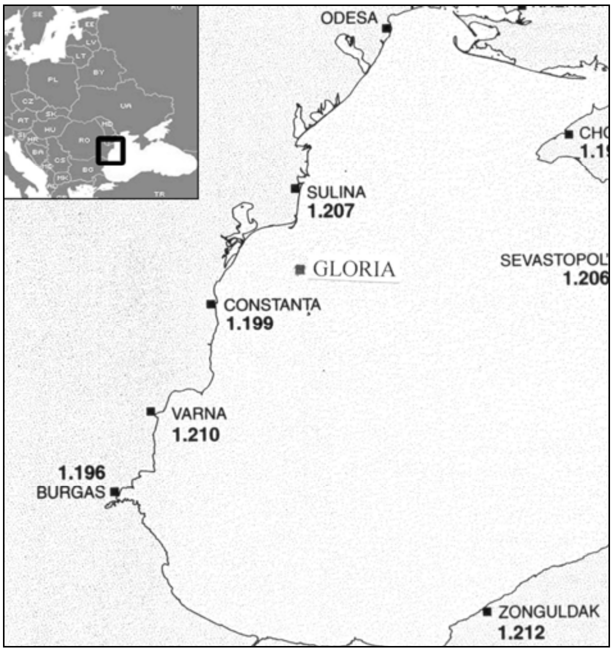


Figure 1. The Romanian weather stations Sulina and Gloria.

4. VESSELS DETAILS AND EVENTS RECONSTRUCTION

The general cargo ship Jupiter, built in1974 had the following characteristics: IMO 7336575, flag Georgia, summer DWT 1725 tons, GRT 1350 tons, NRT 675, length overall 77.83 m, beam 12.4 m, draft 6.7 m, was owned by Tomini Trading company, the manager being Arados Shipping company, both in Constanta, Romania (http://www.shipspotting.com/gallery/photo.php?lid=439735).

On the 14th of December, 2009, the cargo Jupiter left harbor Kroman (Turkey), unloaded, and headed towards Galati harbor. When entering the Bosphorus strait at 11.30 a.m., the 1-st deck officer was informed by radio-telephone that the Black Sea was very rough. During the night (14/15.12.2009), the ship remained in the Bosphorus strait in order to remedy some malfunctions. From the observations made by the deck cadet it follows that: when entering the Black Sea on the 15th of December, 2009, swell was noticed; as the ship was approaching the Constanta harbor at a speed of 10 Nd, it was noticed that the weather worsened and the sea run high; at 11.30 p.m., 10 Nm south from Sulina, on a rough sea, with strong winds exceeding force 8, the vessel was pitching and rolling heavily (Cristofor, 2010). On the 16th of December, 2009 at 2:30 a.m., the ship was at anchor 5 Nm South of Sulina canal, at a considerable distance from the anchorage. During the night, the wind caused the dragging of the anchor so that on 16.12.2009 in the morning (5.30 a.m.), the vessel was put aground, being pushed close to the Sulina beach.

On the 18th of December, 2009, the ship owner sent two trailers to get the ship afloat but the refloting operations having been taken during difficult meteorological conditions, failed. It was revealed that the vessel began to flood in the double bottom and No 3 and 4 holds (figure 2). This fact was transmitted to the port authorities and to the ship owner. The crew consisting of 8 people (the captain of the ship, the steersman and the deck cadet, of Romanian nationality, the chief, the 1st deck officer and two mechanics, of Syrian nationality) remained on board for several weeks during unfavorable meteorological conditions (starting on 18.01.2010 a second blizzard affected the east part of Romania, accompanied by record low temperatures of -24°C).

Figure 2. The cargo ship Jupiter beached on Sulina (Google earth)

On the 20th and 21st of January, 2010, after five weeks of waiting, all the Syrian seafarers abandoned ship and swam the 50 meters to the beach where they were met by the frontier police. On board there were three Romanian seafarers who finally abandoned ship (Cristofor, 2010). At the moment the event is being investigated by the authorities in charge. (http://www.ziare.com/articole/nava+esuata+sulina).
The leader of the Free Union of Seafarers declared that "the ship was sunk into the sand. Moreover, after the refloating operations, the hull of the ship was damaged which made the vessel unmanoeuvrable"

(http://www.telegrafonline.ro/1264197600/articol/109831/navigatori_romani_blocati_pe_o_nava_esuata_la_sulina.html).

During the same storm, another stranding took place, which of the cargo ship Turgut S, also under Georgian flag, with an 8 member crew of Georgian nationality. This cargo ship was built in 1980, its main characteristics were: IMO 7942582, length overall 88 m, beam 13 m, draft 6.7 m, DWT 3025 tons (http://www.marinetraffic.com/ais/ro/shipdetails.aspx?mmsi=213803000).

The ship was on its way towards the Ukrainian harbor Ilichevsk, in ballast and not carrying cargoes). Because of the bad weather conditions, the ship sought a place of refuge in the area intended for anchorage in Sulina and the 17.12.2009, at 00:30, the ship ended the maneuver of anchoring. Due to the unfavorable meteorological conditions the monitoring of the position was determined at short intervals of time. Around 03:30 the weather conditions got worse, the vessel lost the port anchor whereas the starboard anchor began dragging. Despite the captain's and the crew's efforts of maintaining the ship in the safety zone, the ship beached around 4:30, across from Musura isle at a distance of 1 Mm North from the landfall lighthouse: 45° 03' 88N, 29° 45' 93 E and 1750 meters from the Northern dam of the Sulina canal.

No victims, damages to the hull or any leakage were reported. The representatives of Sulina harbor authorities, the customs service the frontier police participated in the evaluation of the situation of the ship. On account of the beaching position of the ship and the difficult meteorological conditions, the owner of the ship gave up on trying to get the ship afloat. One month after the incident, the crew on board requested abandoning it because of the unfit conditions of living. At the moment, the ship no longer exists having been cut and used for iron in the autumn of 2010.

5. METEOROLOGICAL CONDITIONS

The storm from December 2009 can be considered as a type of „storm in low pressure field" (Chiotoroiu, 1999). It cannot be correlated with a large number of damaged ships, comparing to other types of storms that occurred in the area, as for example the „couple anticyclone/ depression, with travelling disturbances from the Mediterranean Sea to the Black Sea" (Chiotoroiu, Ciuchea, 2010).

5.1. Upper-level and sea level circulation

Between the 16th and the 19th of December 2009, a low pressure field (under 1010 hPa) covered the southern parts of Europe, the Mediterranean Sea and extended to the Black Sea. The high pressure system (1030 hPa) covered only the northern parts of Europe (figure 3).

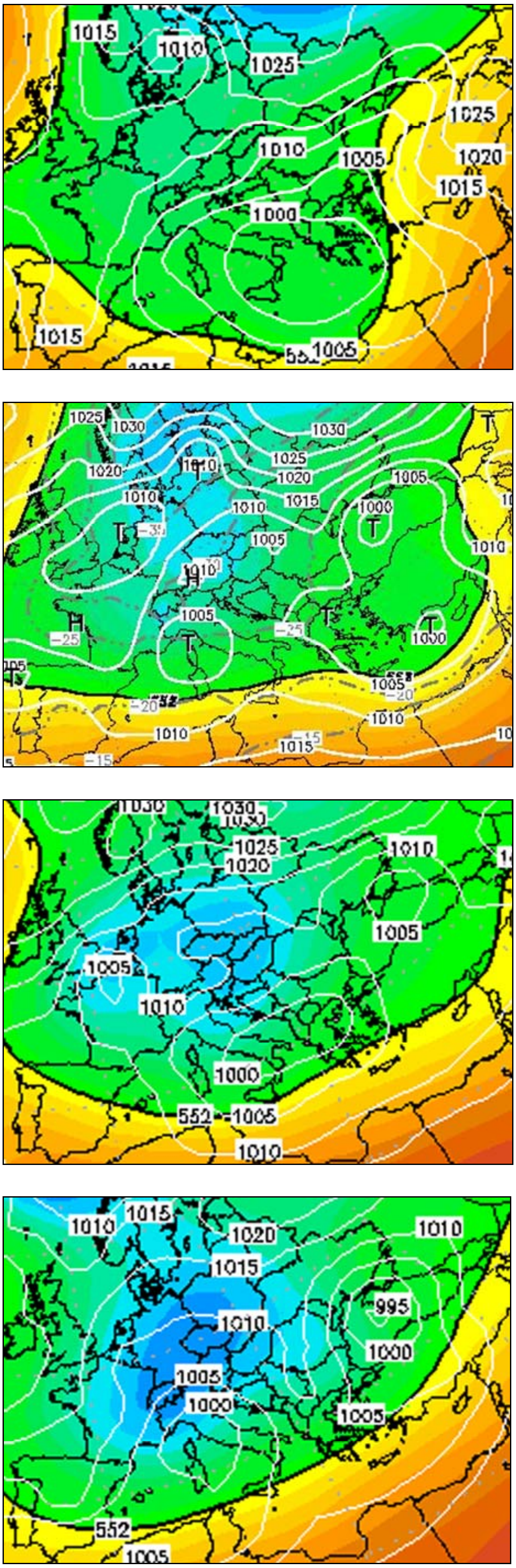


Figure 3. NCEP surface reanalysis for the 16,17,18, 19.12.2009, 00 UTC

The extension of the geopotential low in the middle troposphere towards the Mediterranean and the north of Africa can be observed in figure 3. The trajectories of the Mediterranean cyclones at sea level followed the ascendant part of this thalweg (in figure 3, sea level pressure is represented with curved white lines and the 500 hPa geopotential heights are represented in colours).

During this storm we can observe that at the lower layers the warm and humid maritime air mass in cyclonic twist towards the northwest or west generates a thermal positive anomaly which contributes to the deepening of the surface vortex. Temperatures were about -5°C at Sulina and +5°C over the Black Sea the 17.12.2009, 00 UTC (fig. 4). This warm advection is responsible for the snowfalls in the south-east part of Romania, with a maximum of about 50.0 l/m^2 at Sulina the 16.12.2009.

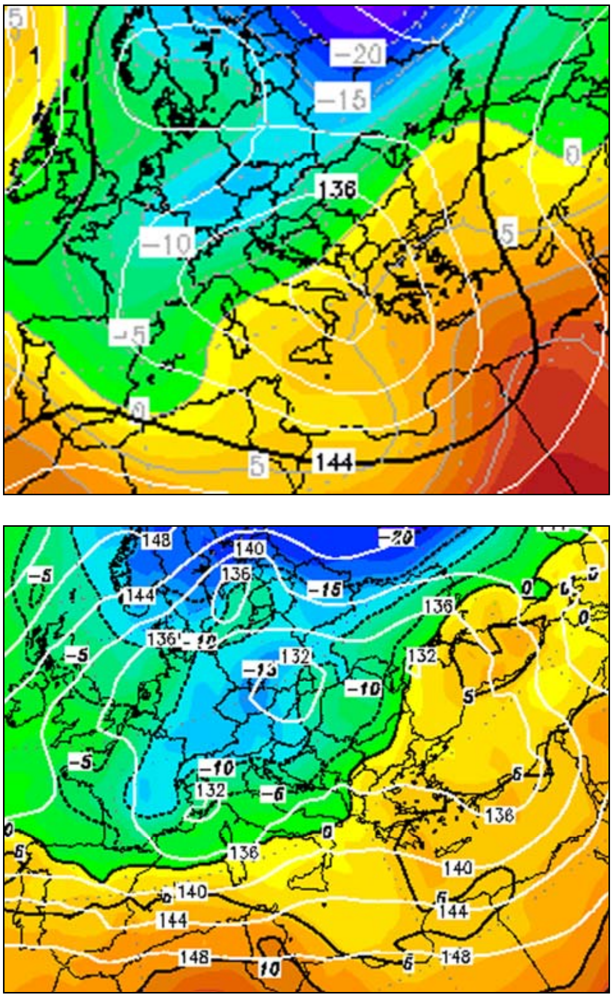


Figure 4. NCEP reanalysis of 850-hPa geopotential heights maps, the 16 and 17.12.2009, 00 UTC. Temperatures are represented in colours.

5.2. Wind speed and sea state variations.

The wind at ground level intensified when the circulation at 850 hPa occurred on the same direction as the circulation at ground level, the 16.12.2009. The climax moment of the storm corresponds to the maximum wind speed and maximum wave heights at the two stations: Sulina and Gloria, figs. 6 and 7.

Wind changed its direction during the passage of the cyclone which reactivated rapidly above the Black sea. Wind direction was ESE during the night between the 15 and the 16.12.2009 and became ENE the 16.12.2009 and then NNW the 16.12.2009 in the evening. Until the 19.12.2009 the wind blew constantly from NNW, as shown in figure 5 (Chiotoroiu, Iancu, 2010).

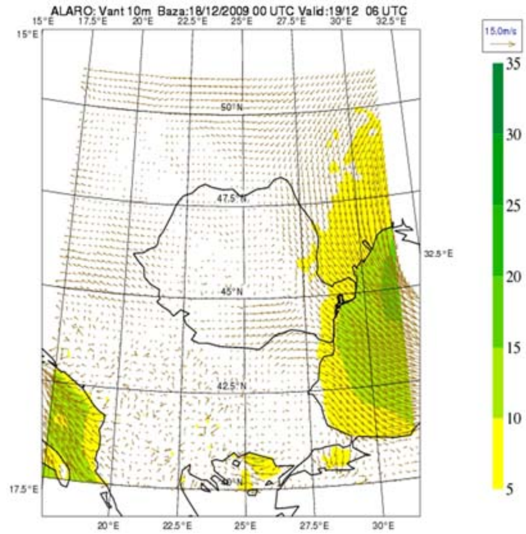


Figure 5. Wind speed and direction from the Alaro model outputs, December 2009

We can therefore observe that the cargo ship Jupiter was put aground, being pushed close to the Sulina beach during the night of 15 of December 2009, when the sea run high under conditions of winds blowing dominantly from East in the open sea and on the coast (at the Gloria platform and at Sulina). Previous studies on wave's height evolution near the Romanian coast as a function of the wind speed for different wind directions have shown that high waves could form during eastern winds, no matter the wind speed (Bondar coord., 1972).

The ship Turgut S also was put aground during the night of 16/17.12.2009, when the wind became stronger the 16.12.2009 in the evening, blowing constantly from NNW. The sea state, recorded by the Sulina weather station was 6 (waves' height of about 5-6 meters). The sea became rough in only several hours (fig. 6).

6. CONCLUSIONS

The heavy snowfalls during the blizzard from December 2009 are due to the humidity potential of the Mediterranean cyclones and had consequences on land transport: national and county roads were blocked, many trains were cancelled, 241 people were evacuated from their cars, snowed up on the national roads, in the south-east of Romania and 80 localities in ten counties were affected by the lack of electric energy.

On sea, two cargo ships rode at anchor and were put aground, north and south of the Sulina channel. They were informed about the weather forecast. Therefore, alongside bad weather, human failure too led in both cases to the grounding.

During this type of storm, the Mediterranean cyclones reach the Black Sea through different "trans-balcanic" trajectories.

Those cyclones preferring the most southern trajectories, above the Aegean Sea have a great humidity potential, a remarkable thermal asymmetry and reactivate rapidly above the Black Sea where they can survive 56 to 72 hours in the western and north-western part of sea (Bordei-Ion, 1983)

.

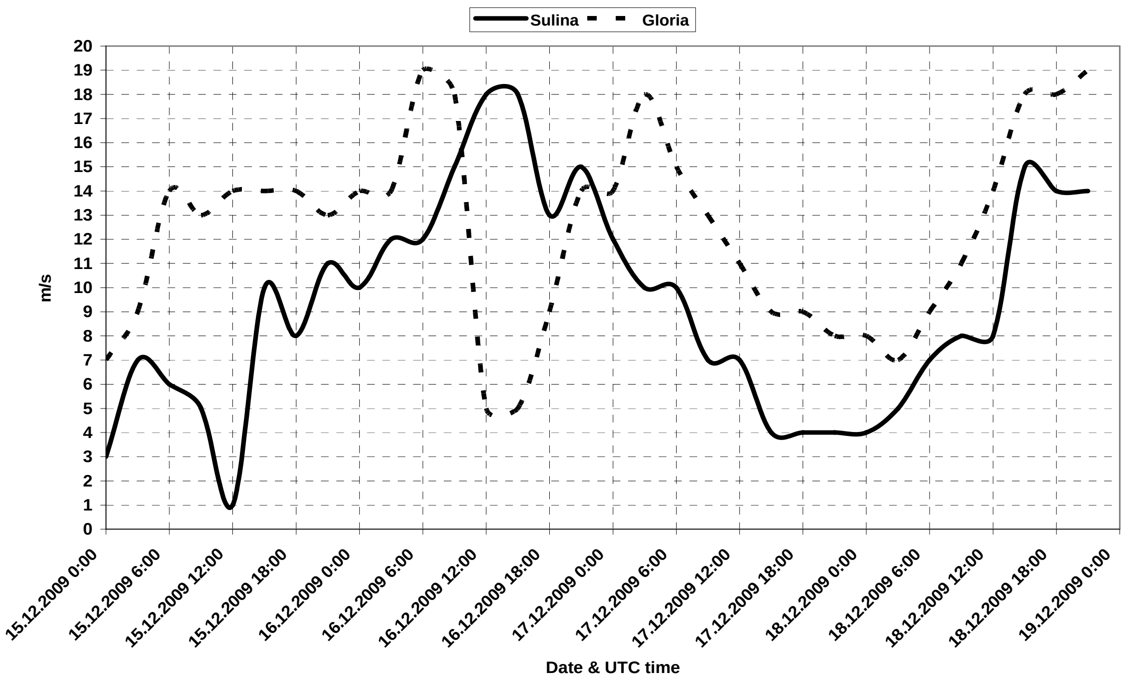


Figure 6. Wind speed at Sulina and Gloria, 15-19.12.2009

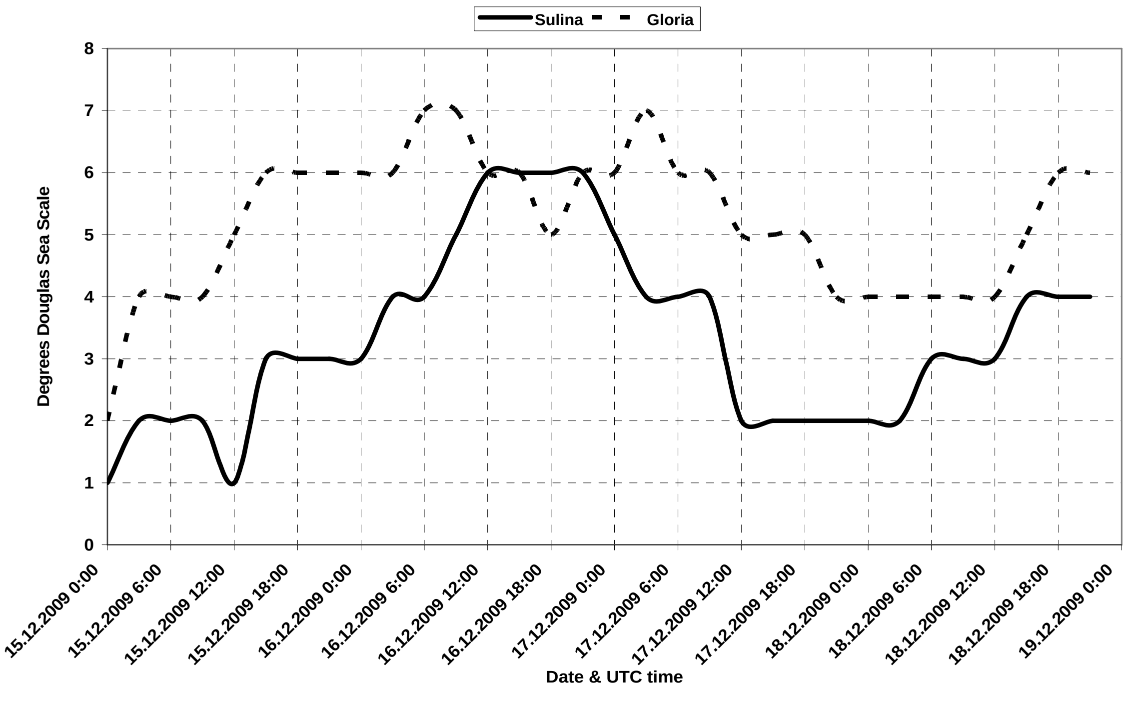


Figure 7. Sea state at Sulina and Gloria, 15-19.12.2009

7. REFERENCES

[1] Bordei-Ion E., 1983: *Rolul lantului alpino-carpatic in evolutia ciclonilor mediteraneeni*, Edit. Academiei, Bucuresti, 136 p.
[2] Bogdan O., Niculescu E., 1999: *Riscurile climatice din România*, Academia Română, Institutul de Geografie, Compania Sega-International, 280 p.
[3] Capsa D., Timofte A., 2005: *Viscolul care a afectat estul Romaniei in perioada 3-5 februarie 2005*, Sesiunea Anuala de Comunicari Stiintifice, Administratia Nationala de Meteorologie, Buc., 28-30 sep. 2005, *CD*, 1678-1701.
[4] Chiotoroiu B., Iancu I., 2010, *Types de circulation à l'origine des tempêtes de neige dans le sud-est de la Roumanie*, Actes du XXIII-ème Colloque de l'Association Internationale de Climatologie, Rennes, France, ISBN 978-2-907696-16-6.
[5] Chiotoroiu B., Ciuchea V., 2009: *Severe weather conditions and maritime accidents along the Romanian Black sea coast*, Proceedings of the XIII International Scientific and Technical Conference on Marine Traffic Engineering – MTE 09, Malmö, Sweden, 2009, edit. L.Gucma, 35-39.
[6] Chiotoroiu B., 1999, *Les tempêtes dans le bassin occidental de la mer Noire*, Presses Universitaires du Septentrion, Lille, France, 224 p.
[7] Cordoneanu E., 2004: *Atmospheric meso-scale phenomena related to the Black Sea proximity*, Proceedings of the International Workshop "Black sea Coastal-Air-Sea Interaction. Phenomena and Related Impacts and Application", May 2004, Constanta, Romania, CD.
[8] Cristofor C., 2010, *Frecvenţa şi influenţa fenomenelor de vreme severă (furtunilor) asupra navigaţiei din bazinul de Vest al Mării Negre, Proiect de diploma,* 45 p., Universitatea Maritima din Constanta, specializarea Navigatie si Transport Maritim si Fluvial, coord. Conf.dr. B. Chiotoroiu
[9] Draghici I., Cordoneanu E., Banciu D., 1990: *Asupra dinamicii crivatului*, Studii si cercetari . Meteorologie, 4, Institutul de Meteorologie si Hidrologie, Bucuresti, 55-72.
[10] Draghici I., 1988, *Dinamica atmosferei*, Editura Tehnica, Bucuresti, 475 p.
[11] Georgescu F., Tascu S., Caian M., Banciu D., 2009: *A severe blizzard event in Romania – a case study*, Natural Hazards and Earth System Sciences, 9, 623-634.
[12] Maheras P., Flocas H.A., Patrikas I., Anagnostopoulou Chr., 2001: *A 40 year objective climatology of surface cyclones in the Mediterranean region: spatial and temporal distribution,* International Journal of Climatology, 21, 109-130.
[13] Radinovic D., 1987: *Mediterranean cyclones and their influence on the weather and climate*, PSMP Report studies, no. 24, WMO, 131 p.
[14] Tayanc M., Karaca M., Dalfes H.N., 1998: *March 1987 cyclone (blizzard) over the eastern Mediterranean and Balkan region associated with blocking,* Monthly Weather Review, 126, 3036-3047.
[15] Trigo F. I., Bigg G.R., Davies D.T., 2002: *Climatology of cyclogenesis mechanisms in the Mediterranean,* Monthly Weather Review, vol. 130, March 2002, 549-569.
[16]****Marea Neagra in zona litoralului romanesc. Monografie Hidrologica*, 1972, Institutul de Metorologie si Hidrologie Bucuresti.
[17]***http://www.shipspotting.com/gallery/photo.php?lid=439735).
[18]***http://www.gandul.info/news/
[19]***http://www.marinetraffic.com/ais/ro/shipdetails.aspx?mmsi=213803000).
[20]***http://www.telegrafonline.ro/1264197600/articol/109831/navigatori_romani_blocati_pe_o_nava_esuata_la_sulina.html).
[21]***http://www.ziare.com/articole/nava+esuata+sulina).
[22]***http://www.wetterzentrale.de/topkarten/

THE INFLUENCE OF THE BLOCK COEFFICIENT ON THE SHIP'S BEHAVIOR ON ITS MANEUVERS IN SHALOW WATERS HAVING NAVIGATION RESTRICTIONS

[1]CUPSA OVIDIU SORIN, ARSENIE C. PAULICA

[1]*Constanţa Maritime University*

ABSTRACT

The ships behave differently to maneuvers in shallow waters, but in general it is accepted that, in this situation, the ship's maneuverability and vitality is affected by the appearance of the bottom effect – the SQUAT effect.

There is an accumulation of factors which influence the behavior of the ship in the studied situation, and the combined influence of these factors usually determines the behavior when the SQUAT phenomenon appears.

The most important of these is the C_b coefficient (block coefficient), which is a constructive characteristic specific to each ship.

The object of the present article is to present the relationship between the value of the bottom coefficient and the way in which the trim of the ship modifies when the SQUAT phenomenon takes place.

Keywords: *block coefficient, squat, maneuvering, shallow water, trim, bow, aft .*

1. INTRODUCTION

Depending on the necessities for which it was built, each ship has constructive characteristics which were assigned with certain purposes beginning with the designing phase.

From the SQUAT effect point of view we are not interested in other characteristics but in those connected with the shape of the ship's.

Generally the hulls are built after taking into account some important aspects:

- the displacement of the ship.
- the type of merchandise for which it is built.
- the speed for which it is designed.
- the possible special conditions which need to correspond in exploitation.

Taking into account all these aspects each series of ships has a specific constructive form.

The size which interests us in determining the SQUAT effect is the block coefficient.

We will see how this coefficient determinate the characteristiscs of the ship in shallow water maneuvring.

2. THE BLOCK COEFFICIENT

The block coefficient is the proportion between the volume of the hull and a parallelepiped having a V equal to:

$$V = L_{pp} B_{med} T_{med}\,, \quad (1)$$

Where:

V – the volume of the parallelepiped,

L_{pp} *– the length between the perpendiculars,*

B_{med} *- the median width (at the dead-flat),*

T_{med} *- the medium draught*

The coefficient - C_b (block coefficient) as a proportion between the volume of the hull and the volume of this parallelepiped, shows us which is the percent from the volume of this parallelepiped which fills the ship's quick work.

If we define the volume of the hull - V_c as being:

$$V_c = \frac{D}{\rho}, \quad (2)$$

Where :

V_c *- the volume of the hull,*

D – the displacement of the ship,

ρ *– the density of the volume of displaced water,*

Then:

$$C_b = \frac{V_c}{L_{pp} B_{med} T_{med}}. \quad (3)$$

It can be seen from the drawing above as well, that C_b is a sub-unitary factor, being divided into units only in the ideal case of a floating pontoon in the shape of a parallelepipedous locker, situation in which V_c fills the entire volume *V*. Meaning if $V_c = V$, atunci $C_b = 1$.

Generally the large transport ships, like oil tankers VLCC or ULCC, have full shapes, which makes it that in their case C_b is sensitively close to the value 1.

In the case of speed boats – passenger ships, container ships, pleasure or military crafts, which have a more elongated form, generally C_b can be 0,7 or even smaller.

Generally the C_b factor influences especially the modification ship's trim towards the bow or towards the stern and we will discuss in the following chapter this problem in order to show in what way this factor manifests itself.

3. THE MODIFICATION OF THE TRIM ACCORDING TO TYPE OF SHIP

The maritime officer must know that every class of ships behaves differently to the maneuvers in shallow waters.

An experimented sailor, who knows his ship and is familiarized with this phenomenon, will understand immediately how his ship will behave in a certain situation, without being needed to hesitate when it is necessary to take a rapid decision in order to prevent this phenomenon or to straighten the ship which can "feel the bottom of the water".

It is admitted in the maritime practice the fact that the maneuver of the water on fairways with a shallow depth is the appanage of the experienced officers.

Even so, the large accumulation of responsibilities on board, the fatigue, the bad weather, the obstacles for navigation, the busy traffic or other conditionings may force the watch officer to deal with a SQUAT type phenomenon at times when it is least expected.

That is why it is very important to know to what category of behavior the ship which he navigates belongs to and the way in which this behavior can influence the vitality and the maneuverability of the ship.

We have shown in chapter 13 that the main factor that is responsible for the modification of the trim of a ship at the maneuver in shallow water conditions is the block coefficient C_b.

Knowing from the previous chapter that C_y is a dependent dimensionless coefficient ρ, v_{nava}, H, T, we can notice easily that for the pre-established ρ, v_{nava}, H, T is a function in the form:

$$F_y \approx Ct. f(C_b). \quad (4)$$

In practice, the hydrodynamic theory and the empiric study of the phenomenon, there are three known types of behaviors of the ships in the moment of the appearance of the SQUAT phenomenon, according to the C_b value:

- Ships that have the tendency to trim by the bow;
- Ships that have the tendency to squat;
- Ships that maintain their trim;

In the below chart we can notice which is the modification tendency of the ship's trim according to the C_b :

a. Ships that have the tendency to trim by the bow:

Generally it is admitted that the full shape ships (VLCC, ULCC, etc) draw in the attack front from the bow a very large quantity of water, which initially accumulates below the body of the ship.

This accumulation of large flow generates a high speed of the water that flows below the bottom of the ship, having as a consequence a very large difference of pressure between the stream of liquid from the front of the ship and the one below the body of the ship:

$$\Delta p_{prova} = p_{prova} - p_c, \quad (5)$$

Where:

Δp_{prova} – the difference of pressure from the bow,

p_c- the pressure of the water flow in front of the ship,

p_{prova}-the pressure below the bottom of the ship, in the bow.

At the same time the direction of the momentum of the pressure force is negative, having the tendency to "suck" the bow towards the bottom of the water.

At this type of ships, in the bow area this difference of pressure (Δp_{pupa}) is much lower. This phenomenon is caused mainly by the following factors:

- The adherence of the liquid layers to the ship's body engages on the entire length of the ship's body the liquid stream, generating a swirl speed, area in which the liquid mass "follows" the ship with a relative speed v_s .
- The loss of an important mass of liquid through the lateral boards leads to the decrease of the flow and therefore of the relative movement speed of the water stream from the bow to the stern, so:

$$v_{pupa} < v_{prova}, \quad (6)$$

Consequently :

$$p_{pupa} > p_{prova}, \quad (7)$$

- The propeller effect creates eddy currents at the stern of the ship and the cavitation phenomenona, which engages the liquid mass from the stern, creating a passage area between the liquid mass from below the stern of the ship and the one from the ship's track.

Therefore because of these factors we will have:

$$\Delta p_{pupa} = p_{siaj} - p_{pupa}, \quad (8)$$

Where:

Δp_{pupa} – the difference of pressure at the stern,

p_s - the pressure of the water stream from the ship's track,

p_{pupa} - the pressure below the bottom of the ship, in the stern area.

This time the direction of the combined momentums of the pressure force is positive, having the tendency to push the stern upwards and the bow downwards.

And as absolute values we will have:

$$\Delta p_{prova} > \Delta p_{pupa} \quad (9)$$

Therefore, as a consequence of these phenomena, this type of ships will have the tendency to trim by the bow, making the maneuver of the ship much more difficult in a considerable amount, as we will see in an ulterior chapter.

b. Ships that have the tendency to squat:

Generally it is admitted that the raking ships, with hydrodynamic shapes (speed boats, military boats, passenger boats, container ships, etc) draw in the attack front from the bow a much smaller quantity of water, having the tendency to "fly" over the water.

This phenomenon generates a relatively reduced accumulation of water that flows below the bottom of the ship in the bow area, having as a consequence a much reduced difference of pressure (Δp_{prova}) between the liquid flow from the front of the ship and the one below the body of the ship:

$$\Delta p_{prova} = p_{prova} - p_c, \quad (10)$$

Where:

Δp_{prova} – the difference of pressure at the bow,

p_c - the pressure of the water stream in front of the ship,

p_{prova} - the pressure below the bottom of the ship in the bow area.

That is why, although at the same time the direction of the momentum of the pressure force from the bow area is negative, having the tendency to "suck" the bow towards the bottom of the water, its value is relatively low, not having any significant effects.

At this type of ships, in the stern area, this difference of pressure (Δp_{pupa}) has the tendency to increase. This phenomenon takes place mainly because of the following factors:

- The adherence of the liquid layers to the ship's body engages the liquid stream on the entire length of the ship's body, leading this time to a accumulation of liquid from the bow to the stern, meaning to the increase of the flow and therefore of the speed of relative movement of the water stream from below the ship's body from the bow to the stern, so:

$$v_{pupa} > v_{prova}, \quad (12)$$

Consequently :

$$p_{pupa} < p_{prova}. \quad (13)$$

The steaming with a high speed of the ship can lead to the expulsion of a large quantity of liquid at the stern.

As a consequence of these factors we will have:

$$\Delta p_{pupa} = p_{siaj} - p_{pupa}, \quad (14)$$

Where:

Δp_{pupa} – the difference of pressure at the stern,

p_s - the pressure of the water stream at the ship's track,

p_{pupa} - the pressure below the bottom of the ship, in the stern area.

And, as absolute values:

$$\Delta p_{pupa} > \Delta p_{prova} \quad (15)$$

Therefore this time the direction of the combined momentums of the pressure force is positive, having the tendency to push the bow upwards and downwards.

So, as a consequence of these phenomena, this type of ships will have the tendency to squat, making the maneuver of the ship more difficult, as we will see in an ulterior chapter.

c. Ships that maintain their trim:

With this type of ships the accumulation of a liquid mass phenomena below the ship's body combined with the adherence of the liquid layers on the ship's body engaged on the entire length of the ship's body liquid stream, lead to a constant of the relative movement speed of the water stream under the ship's body from the bow to the stern, therefore:

$$v_{pupa} = v_{prova}, \quad (16)$$

Consequently :

$$p_{pupa} = p_{prova}. \quad (17)$$

These ships will have the tendency to keep their march trim in the areas with shallow water as well. This is the case of many cargo ships, small bulk carriers, technical ships, etc, that have relatively equilibrated shapes, which lead to a block coefficient (C_b) situated around the value of 0,7.

4. THE CLASIFFICATION OF THE SHIPS ACCORDING THE BLOCK COEFFICIENT

We have defined in a previous chapter the block coefficient - C_b, (block coefficient) as being the proportion between the volume of the bottom and the volume of a parallelepiped of volume $V = L_{pp} B_{med} T_{med}$.

Where:

V – the volume of the parallelepiped,
L_{pp} *–the length between the perpendiculars,*
B_{med} *-the median width (at the dead-flat),*
T_{med} *- the medium draught*

Therefore C_b shows us what is the percent from the volume of this parallelepiped that fills the quick-work of the ship.

We have defined the volume of the bottom - V_c as being:

$$V_c = \frac{D}{\rho}, \quad (18)$$

Where :

V_c *- the volume of the hull,*
D – the movement of the ship,
ρ *–the density of the displaced water volume,*

Then:

$$C_b = \frac{V_c}{L_{pp} B_{med} T_{med}}. \quad (19)$$

We have also shown that C_c is a sub-unitary factor:

$$C_b \leq 1. \quad (20)$$

According to this factor the ships are classified as:

a. Ships with $C_b > 0,7$.

These ships have the tendency to trim when the SQUAT phenomenon appears. We can generally find in this category of ships the transport ships with a high displacement, with full shapes, at which:

$$0,7 < C_b < 1 \quad (21)$$

In this category of ships we can find:

- VLCC (Very Large Crude Carrier) – large tankers
- ULCC (Ultra Large Crude Carrier) –super tankers
- OBO (ore bulk oil) – combined liquid-solid bulk carriers.

The trimming by the bow combined with the appearance of the SQUAT phenomenon raises important problems of the ships' maneuverability.

Out of these, the most important ones are:

- The reduction of the ship's capacity to swing because of the increased resistance which the water opposes to the ship's body in the bow area;
- The decrease of the steering effect, because of the exposure of the helm and the reduction of the bearing surface of it once with the partial or total exit from the liquid mass;
- The decrease of the ship's vitality by reducing the propulsion capacity of the ship, with the exposure of the propeller, phenomenon which can have serious consequences on the ship's propellers.

b. Ships with $C_b = 0,7$.

These types of ships generally have the tendency to keep their trim which they had in march before the appearance of the SQUAT phenomenon.

Generally in the case of these ships we can notice a balanced shape. They are speed ships and of medium capacity, which keep a classical LBT proportion, with functions such as:

- GCD (cargo ships) – general cargo;
- BC (bulk-carrier) – bulk carriers;
- MLP (multipurpose) – multifunctional ships;
- Neo bulk ships such as RO-RO, LO – LO;
- OSV (offshore supply vessel) – supply ships, etc.

These types of ships are characterized by a SQUAT type phenomenon which manifests exclusively through the growth of the draught, keeping all the other limitations of the maneuver: the decrease of the speed, the increase of the turn curve, vibrations of the ship's body, etc.

c. Ships with $C_b < 0{,}7$.

These ships have the tendency to squat when the SQUAT phenomenon appears. In this category of ships we can generally find the high speed transportation ships, with hydrodynamic shapes, at which:

$$0 < C_b < 0{,}7 \quad (22)$$

In this category we can find::

- PAS (Passenger Ship) –passenger ships;
- CN (Cellular Container)- container ships
- SAL (sailing vessel) – recreational sailing ships;
- Military ships, etc.

The squatting caused by the SQUAT phenomenon raises as well important problems to the maneuverability of the ship.

Among these the most important ones are:

- The decrease of the maneuverability of the ship and the loss of its direction control;
- The increase of the deterioration danger of the helm and of the propeller because of the high risk of touching the bottom.

5. CONCLUSIONS

Because of the specific behavior of each ship at the appearance of the SQUAT phenomenon it is very important that the sailor knows very well the characteristics of the ship which he is maneuvering, its constructional dimensions and the behavior that the ship can have at the time of the appearance of the phenomenon.

Generally the tendency of modifying the trim is valid when the ship is on a straight trim. If the ship has already a different trim than a horizontal one, an accentuation phenomenon of that specific trim can appear meaning that:

- If the ship is squatted, the SQUAT phenomenon can accentuate the squatting,
- If the ship is trimmed, the SQUAT phenomenon can accentuate the trimming.

Because of this, in order to reduce the risks that can appear, it is recommended that in areas with shallow waters to enter by ship with a proper speed correspondent to a straight trim, taking into account the block coefficient of the ship when calculating the necessary depths for maneuvers and of the steaming speeds of the ship in shallow waters.

6. REFERENCES

[1] CUPŞA O. S., DINU D. - *Considerations regarding the Use of Distortional Simulation for Studying Long Break-waters*, Constanta Maritime University Annals, Year XI, Vol. 13, 2010.

[2] DINU D. - *Hydraulics and hydraulic machines*, Ed. Sigma Trading Metafora, 1999.

[3] BARRAS, C.B. – *The Phenomenon of Ship Squat*, International Shipbuilding Progress, 1979

[4] ERYUZLU, N.E., HAUSSER, R. – *Experimental Investigation Into Some Aspects of Large Vessel Navigation in Restricted Waterways*, Symposium on Aspects of Navigability, Delft, The Netherlands, 1978.

[5] MILLWARD, A. - *A Preliminary Design Method for the Prediction of Squat in Shallow Water*, Marine Technology, 1990.

[6] TUCK, E.O. – *Shallow Water Flow Past Slender Bodies*, Journal of Fluid Mechanics, 1966.

and during the following 130 seconds, a decreasing variation, still linear, of the equation:

Q = - 10/13 t + 3800/13.

The expresion *f(t)* has the value [2]:

$$f(t) = \frac{4\rho}{\pi r_0^2}\left[\frac{1}{3}k_1 + \frac{2\upsilon}{r_0^2}(k_1 t + k_2) - \sum_{n=1}^{m} e^{-\frac{\upsilon}{r_0^2}\alpha_n^2 t}\frac{k_1 - k_2\frac{\upsilon}{r_0^2}\alpha_n^2}{\alpha_n^2}\right]. \quad (3)$$

By integrating on the length of the pipe, we obtain:

$$p_2 - p_1 = -f(t)(z_2 - z_1) \quad (4)$$

or

$$p_1 - p_2 = f(t)l, \quad (5)$$

l - being the length of the pipe.

In case the lock chamber is being filled, we note with $p_1 = \rho g h_1$ is the hydrostatic pressure from the upland water (which can be considered constant) and h_2 the level of the liquid from the watergate (Fig. 1.), we will have consecutively:

$$p_1 - \rho g h_2 = f(t)l; \quad (6)$$

$$\rho g h_2 = p_1 - f(t)l; \quad (7)$$

$$u(t) = \frac{h_2}{t} = \frac{1}{\rho g t}\left[p_1 - f(t)l\right]. \quad (8)$$

u(t) represents the rising speed of the level of liquid from the watergate.

By replacing *f(t)* and taking into account that the last two terms from the square paranthesis of the ratio (3) – the ones below the sum – they are much low than the first two.

$$\frac{\frac{k_1}{3t}}{\frac{k_1}{t\sum_{n=1}^{m} e^{\frac{\upsilon}{r_0^2}\alpha_n^2 t}}} = \frac{\sum_{n=1}^{m} e^{\frac{\upsilon}{r_0^2}\alpha_n^2 t}}{3} \rangle\rangle 1 \quad (9)$$

and

$$\frac{\frac{2\upsilon k_2}{r_0^2 t}}{\frac{\upsilon k_2}{r_0^2 t\sum_{n=1}^{m} e^{\frac{\upsilon}{r_0^2}\alpha_n^2 t}}} = 2\sum_{n=1}^{m} e^{\frac{\upsilon}{r_0^2}\alpha_n^2 t} \rangle\rangle 1. \quad (10)$$

Because α_n has supra-unitary values, by approximating we can write:

$$u(t) \cong \frac{C_1}{t} + C_2, \quad (11)$$

where:

$$C_1 = \frac{p_1}{\rho g} - \frac{4l}{\pi g r_0^2}\left(\frac{k_1}{3} + \frac{2\upsilon k_2}{r_0^2}\right) \quad (12)$$

and

$$C_2 = \frac{8l\upsilon k_1}{\pi g r_0^4}. \quad (13)$$

A hyperbolic variation in time of the speed of the level of liquid towards the asymptote:

$$u = \frac{8l\upsilon k_1}{\pi g r_0^4}. \quad (14)$$

Observation:

By using the approximate ratio (11), we can determine the variation of the level of liquid, evidently still aproximate, which is a line that looks like this:

h(t) = $C_1 + C_2 t$.

In practice from experimental data we can approximate the variation of the level of liquid from the watergate with a line on the 0-200 seconds portion.

The equation of this line is:

h = 12,5 – 1/25 t .

In case of the drainage of the lock chamber through free fall, assuming that the discharge is being done from the lock chamber in the II pond, we will have:

$$\rho g\frac{h_2 - h_3}{t} = \frac{f(t)}{t}l. \quad (15)$$

h_2 - the fluctuating level of the water from the watergate, h_3 - the constant level of the water from the II pond (Fig. 1).

$$u(t) = \frac{h_2 - h_3}{t} = \frac{l}{\rho g t}f(t); \quad (16)$$

By replacing we notice that:

$$\lim_{t\to 0} u(t) = 0 \text{ and } \lim_{t\to\infty} u(t) = \frac{8l\upsilon k_1}{\pi g r_0^4}. \quad (17)$$

3. DETERMINING THE NECESSARY FLOW FOR A CONSTANT COMPULSORY SPEED OF THE LEVEL OF WATER FROM THE LOCK

For this we will consider a linear variation in time of the pressure gradient:

$$\frac{\partial p}{\partial z} = at , \qquad (18)$$

In which a is a dimensional constant measured in [kg.m^{-2}.s^{-3}].

The ratio (18) can be written in the form:

$$dp = atdz \qquad (19)$$

and we can integrate it on the length of the filling pipe of the lock chamber:

$$p_2 - p_1 = at(z_2 - z_1). \qquad (20)$$

We can write consecutively:

$$\frac{p_1 - p_2}{t} = -al , \qquad (21)$$

$$\rho g \frac{h_1 - h_2}{t} = al . \qquad (22)$$

The constant filling speed will be:

$$u = \frac{h_1 - h_2}{t} . \qquad (23)$$

So:

$$\rho g u = -al , \qquad (24)$$

or

$$u = -\frac{1}{\rho g} al = cons\tan t . \qquad (25)$$

In order to find out the flow we will use the solution for the Navier-Stokes equation in the conditions of a non-permanent flow through the pipes, for a linear variation of the pressure gradient submitted in the reference [4].

For a linear variation of the pressure gradient, $\frac{\partial p}{\partial z} = at$:

$$\frac{\partial v}{\partial t} = -\frac{1}{\rho} at + \nu \left(\frac{\partial^2 v}{\partial t^2} + \frac{1}{r}\frac{\partial v}{\partial r} \right). \qquad (26)$$

Taking into account the (25), we can determine accurately the formula for the necessary flow in order to ensure a filling with a constant speed u of the level of water from the lock chamber of the watergate:

$$Q(t) = \frac{2\pi g u}{l \nu^2} r_0^4 \left(\frac{\nu t}{16} - \frac{r_0^2}{96} - 2 r_0^2 \sum_{n=1}^{m} \frac{e^{-\frac{\nu \alpha_n^2}{r_0^2} t}}{\alpha_n^6} \right). \qquad (27)$$

4. CONCLUSIONS

The mathematic shaping has allowed us to solve a very delicate problem: the variation of the level of liquid from the lock chamber of the watergate in the transition periods, for example the opening of the gate.

The opening of the gate can be done in such a way that the flow has a linear variation.

Our mathematic undertaking has allowed us, by solving the Navier-Stokes equation with the help of the potential vector, to establish the distribution of speeds in the pipe and then the variation speed of the level of water.

This mathematical calculus allows us a even more refined shaping of the filling process of the lock chamber of a watergate in the transition situations, exceeding the practical simplifications of the engineering design.

Approaching the matter in the same way, we could determine the variation speed of the level from the lock chamber of the watergate in the situation of draining it in the II pond.

The problem can be discussed and vice-versa: by establishing a certain constant speed of variation of the level of the water, to determine the necessary flow in order to obtain this speed. In this situation, the pressure gradient has a linear variation $\frac{\partial p}{\partial z} = at$, in which a is a dimensional constant.

By using the solution for the solving of the calculus of the distribution of speeds in case of a pressure gradient which is variable in time, we could highlight the formula for the flow in correlation with the constant imposed value, u, of the speed of the level of water from the lock chamber of the watergate.

Solving these two problems allows us a more precise theoretical approach of the flowing phenomenon through circular pipes, in transitory situations, but also to establish precisely the necessary flow for a certain design requirement- the speed of the level of liquid from the lock chamber.

5. REFERENCES

[1] CIORBEA V., CUPŞA O. S. ş.a., *Canalul Dunăre-Marea Neagră*, Ed. Ex Ponto, 2008.

[2] CUPŞA O. S., *Contribuții la stabilirea mecanismului interacțiunii statice şi dinamice dintre apă şi structurile hidrotehnice*, Teza de doctorat, Universitatea Maritimă Constanța, 2010.

[3] CUPŞA O. S., DINU D., *Considerations regarding the Use of Distortional Simulation for Studying Long Break-waters*, Constanta Maritime University Annals, Year XI, Vol. 13, 2010.

[4] DINU D., *Considerations regarding the Flow through Circular Conduits in the case of Linear Time Variation of Pressure Gradient*, The 5th International Scientific Conference on Naval Technologies TEHNONAV, Constanta, 2006.

[5] DINU D., CUPŞA O. S., *The Velocity of the Lock Water Level at a Linear Variation of the Flow in the Filling (Emptying) Conduit*, Journal of Marine Engineering and Environment, Year III, Vol. 1, 2010.

[6] DINU, D., PETREA F., *Maşini hidraulice şi pneumatice*, Institutul de Marină Civilă, Constanţa, 1993.
[7] WITTFOGEL K. A., *The Hydraulic Civilization: Man's Role in Changing the Earth*, Chicago, IL - University of Chicago Press, 1956.
[8] Institutul de Studii şi Cercetări pentru Îmbunatăţiri Funciare, *Sinteza privind studiile şi cercetările hidraulice în cadrul STE Canal Dunăre - Marea Neagră*, 1975.
[9] I.P.T.A.N.A. - S.A., *Studiu privind morfologia lucrărilor hidrotehnice pe canalele navigabile*, Bucureşti 1994.

IMPROVEMENT OF SERVICES IN PUBLIC ADMINISTRATION THROUGH QUALITY PLANNING

DRAGAN CRISTIAN

Constanța Maritime University, Romania

ABSTRACT

Planning is one of the basic processes of Quality Management. Through this stage, the objectives and the path to be followed in order to achieve them is determined.

In Administration and Public Services, the aim of quality planning is to establish policies, procedures, actions and, ultimately, a system that satisfy citizens their needs and expectations. By necessity we mean the need that is evinced by an individual or collectivity, having the main purpose to satisfy it.

Keywords: *quality management, public services*

1. INTRODUCTION

Planning is one of the basic processes of Quality Management. Through this stage, the objectives and the path to be followed in order to achieve them is determined. The two subsequent processes depend on planning which is an authentical map, and they must be closely related to the objective of quality, which represents nothing else but the organization needs and expectations. Quality planning process is similar to any other process that is resulted from any other activities. The whole organization should be involved and it must include various sectors of the organization. Quality objectives vary in size depending on the hierarchical level for which they are established. That is why, within the organization, the objectives tend to decrease in importance as they descend the hierarchical pyramid.

2. PLANNING WITHIN ADMINISTRATION AND PUBLIC SERVICES

In Administration and Public Services, the aim of quality planning is to establish policies, procedures, actions and, ultimately, a system that satisfy citizens their needs and expectations. By necessity we mean the need that is evinced by an individual or collectivity, having the main purpose to satisfy it.

When the necessity is expressed fully, it becomes a requirement. The term expectancy refers to the subjective probability of an individual to obtain something. In terms of quality is likely to say that probability estimated by the customer on the product (or service) is to satisy the existence of a necessity. The design of a service must be based on customer requests and needs, taking into account the perception that the citizen has about rendered services.

Only when the perception of service equals or exceeds the expectations of the customer will produce customers satisfaction. Also, a mass of people or a segment of citizens to whom public service is addressed to is not the only variable that intervenes in this process.

Society as a whole, interacting with the public administration produce certain basic requirements, in which will be analyzed collective needs. The service design can therefore be conditionated by factors such as availability of resources, incompatibility of interests or impact service. Given the above, you can outline what is called quality of service loop (Figure 1).

In it is illustrated the relationship with the society under whose influence are identified the needs and requirements of citizens. Hence, it describes the service, showing the items to be subjected to quality control.

herefore, the service result is the subject of a triple assessment .

- - First of all, the customer assess over the service; this is the main aspect, given that the citizen is the one who decides at what point it is managed to get real quality: his needs and expectations.
- Secondly, assessment made by the public organism, which will assess the effectiveness of the service delivery process and its efficency, meaning the connection between results and resources used to achieve them.
- Thirdly, the evaluation by other critical factors can be found within the public organism or outside of it. They may be political centers of power authorities, public or private organizations and members of the organization.

When planning policies, including the quality ones, it must taken account of the strategy. The strategy is projected over the policies, serving them as a reference. This applies to all public administrations. For example, the behavior of local corporations towards urbanized land requests. This could be influenced by the idea of development and preservation of environmental quality of the city as a strategic value of the future, which involves various restrictions in land classification of diffrent areas. First of all, policies should take into account needs and requirements of citizens, considering that both aspects are referenced to current problems. However, the public administrations should go further, anticipating future situations. Therefore, it is necessary to develop plans that will make policy planning a form of future dominance.

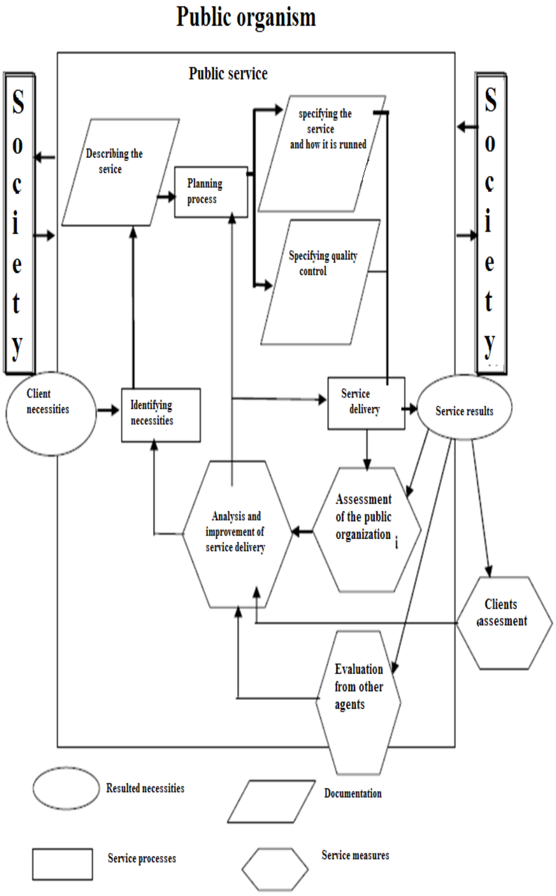


Figure 1 Loop of service quality

3. QUALITY PLANNING PROCESS

The plan should contain, fundamentally, objectives , such as a description of material and human resources and actions needed to achieve them. F. Taylor said that those who prepare the plan and those who run it are diffrent people. Nowadays, it is considered that the plan must be drawn by those who are responsible for its execution.

Dwight Eisenhower, commander of Allied Forces during the 2nd World War and, later, president of the United States, explained this by saying: "Plans are worthless. Planning is the only important aspect." The first and main objective of the planning sector of an organization is not to organize its plan, but to teach all its departments to achive the objectives of their own plan.

Planning is a continuous , permanent process, incorporating knowledge of all those working in the organization, which takes into account a possible change of circumstance or scenario.

The so-called hypothesis of planning shows how the scenario is expected to evolve from the beginning. The product resulted by the plannig is not "the plan", but, “the planning process".

Planning is a process, a set of actions that are successive or simultaneous, leading to a results. At this process must attend all organization members. During the planning process should be taken into account the following:

- Participation. A proper planning can be achieved only when both sides are involved: the ones who need the plan, and also those who are in charge to run the plan This affirmation is supported by several aspects. The first aspect would be, for example, that elements of work that are to be performed are well known by those performing the work daily. The other aspect is that participation practice gives results in a greater understanding between those who must execute assignments and a greater acceptance from those who receive them. Concerning this, participatory cultures are very suitable for the planning process. In public planning, it is shown an increasing interest of the citizen who want to take part of the process through their reprezentatives. Currently , itis disscused a so-called Relational Administration. These practices are the consequence of customer orientation in public administration.
- Continuity. Planning is not a one day or a one year task. On the contrary, is something that should be performed permanently. A plan should be amended, improving continuously. A plan is not changed only in an environment which does not change. The more stabe the environment is, the more easier plans implementation will be each time. When environmental variables change suddenly, planning becomes a complicated process.
- Globality. Planning must refer to the entire organization. It is not coherent to plan some departments or actions and some not. It is necessary that the plan coordinates and integrates all departments, regardless of their position in the organization. Planning Stages are shown in Figure 2. Each of them can be considered as a sub-generator of certain results on products that will serve as input or resource for the next phase

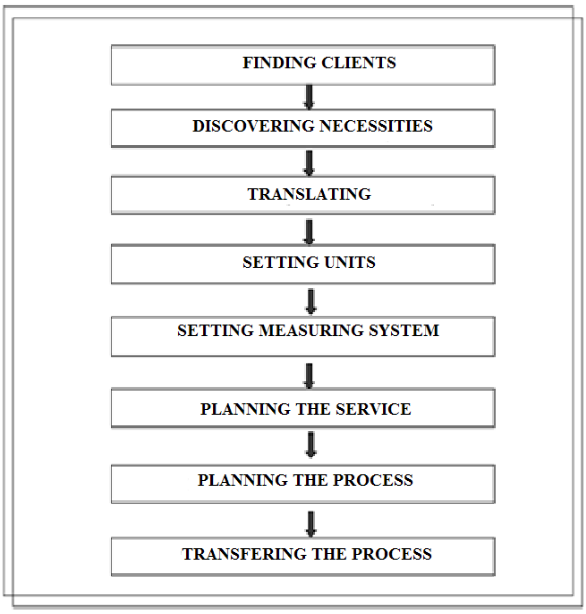


Figure 2 Planning stages

4. REFERENCES

[1] MACHADO Munoz - *La gestion de la calidad total en la administracion publica*, Madrid, 2002

[2] MOLDOVEANU George, DOBRIN Cosmin- *Managementul calității în sectorul public, publishing house: A.S.E.*, 2007

CHARACTERISTICS OF QUALITY IN SERVICES SECTOR

DRAGAN CRISTIAN

Constanța Maritime University, Romania

ABSTRACT

Concerns in the quality of services field are more recent (20-30 years) than those of product quality (over 100 years). Service is unique in its own way. Ideal is that the service could be adapted for customers needs, depending on the level of adaptability of the provider in order to customize his services.

Services can not be stored and preserved for later consumption. Typically, services can be provided only by integrating external factor.

Compared to products, services have some features that Philip Kotler characterized by: „Although the basic service is immaterial, it can be accompanied by a material component”.

Keywords: *quality management, public services*

1. INTRODUCTION

Concerns in the quality of services field are more recent (20-30 years) than those of product quality (over 100 years). Many of the specific problems of the quality of products can be adapted to the particularities of specific services. In support of this statement comes from the series of international quality standards (ISO 9000:2000) from which we can conclude that wherever we use the term "product" we can also find the concept of“service”.

2. DEFINITION OF „SERVICE”

The concept of "service" can be defined in terms of:

- Potential - that is, provider capabilities (knowledge, skill, motivation) that he obtained durring the educational process, which enables him to provide services;
- Process - it is a valuable creative activity made in the clients account; the focus is on simultaneous production and consumption;
- Result - the result identifies the service's provision of material (service = material good).

From the three approaches we shows that services are actions, activities that can be traded on the market and whiich are involving the participation directly or indirectly of the potential provider. This requires the combination of internal and external factors in the provision of activities, in order to obtain positive effects on people or on objects belonging to them.

The service is an intangible product. The notion of product is defined as the result of specific activities and processes. A product can encompass both immaterial and material sides. When the share of an intangible component (so defining for services) of a product increases, it is registred a weight loss of materials composition.

The concept involves the entire service sector of "infrastructure services" as a complex system of activities and interactions that do not end in producing material goods, but is a vital operation for the state economy.

- The concept of "service" has the following meaning in economic practice, namely:
- The sector is the production of intangible goods;
- The products that are sold to the customers go together with material goods or either eparately;
- It is an occupation which refers to the workforce engaged in "nonproductive" activities in all economy sectors ;
- As a function that includes persons involved in service activities. Hence, the service includes a variety of economic sectors characterized by different production processes, different modes of supply, different customers, suppliers and market structures.

3. CHARACTERISTICS OF SERVICES

Compared to products, services have some features that Philip Kotler characterized by:

- Intangibility or imateriality;
- Inseparability between the moment of production and moment of consumption;
- Varability or heterogeneity;
- Perishability.

a) Intangibility:

Services, in their vast majority can not be touched, seen, felt before being purchased ("can not be put in the bag"). Although the basic service is immaterial, it can be accompanied by a material component (Fig. 1.1). For example, in retail trade there is the material part of consumers goods, which is accompanied by service supply, transport, sale - holding a significant share, but less than the material part (actual products).

Hotel services are characterized by a growing share of large intangible component (activities from reception, cleaning, driving, room service, leisure, environment, politeness, etc..) But not to be neglected the material component (rooms with electrical equipment, electronics, textiles, furniture), and those in the common areas, all providing comfort and environment at high levels which is reflected favorably on perceived customer service.

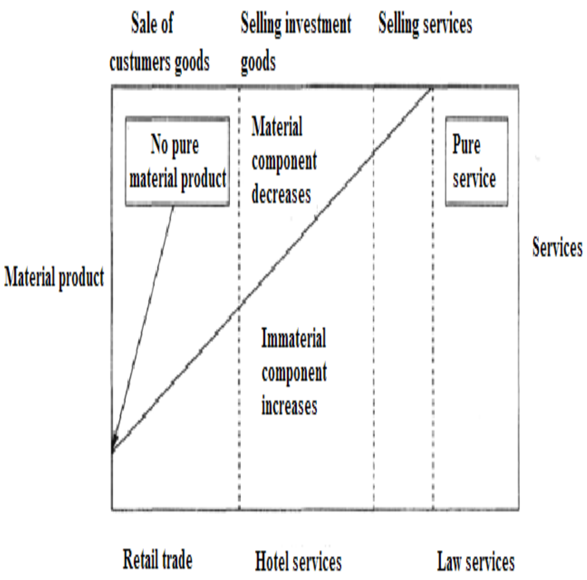


Figure 1 The share of composition of intangible (service) of a product
(Source: Wilhelm Brakhahmn and Ulrike Vogot, ISO 9000 for services. Quick and safe for certification (translation), Ed. Tehnica, Bucharest, 1998.)

Advocacy services have a much smaller material component, related to the office equipment and supplies (paper, toner etc). The share of pure services is relatively small. Here we include consultancy services, information, etc. .

b) Inseparability
It is a specific characteristic of services because, mostly, they are consumed at the time of their occurrence can not be separated in time and space by the provider, nor the client, he is usually involved in that particular process, fact that confirms a provider - client interaction . Therefore, the role of human resources is very important, especially in education, tourism, trade, medical, cultural, sports, where customers perceive the quality of service conecting with the staff: teacher, doctor, actor, athlete, salesman, receptionist, etc. .

c) Variability or heterogeneity
Service is unique in its own way. Therefore, services can not be standardized nor totally copied from one firm to another. Ideal is that the service could be adapted for customers needs, depending on the level of adaptability of the provider in order to customize his services. Services must be designed to meet satisfy customer's highest expectations, so that there will be no significant differences between the "desired quality, expected quality" and "effective quality" perceived by the customer.

d) Perishability
Services can not be stored and preserved for later consumption. If a service is not used when it is available then it is wasted, creating difficulties in matching offer and demand. Typically, services can be provided only by integrating external factor. For example, a student can "consume" service offered by a "course" only if he personally attends to that course.

4. CONCLUSIONS

Service specific features cause difficulty in assessing their quality. If in a "factory of goods" employees may have some wrong attitudes, or dissatisfaction about work, customers will never know about this issues , and thay will not be influenced by the perceived quality of products, unless the dissatisfaction is reflected negatively on activities to achieve performing products, as, indeed, might justify the appearance of defects. If we find in "service factories", such as a banks, hospitals, universities inappropriate attitudes, or staff dissatisfaction , it immediately affects quality which is usually much reduced from what we expect.

5. REFERENCES

[1] DRĂGAN, C., *Managementul procesului de reformă în administrația publică portuară, Lucrările ediției a XVI-a a simpozionului național cu participar internațională Acvadepol*, Editura Nautica, 2009

[2] DRĂGAN, C., *Armonizarea managementului calității serviciilor în administrația publică centrală cu reglementările europene*, Constanța 4-9 mai 2009, Lucrările sesiunii de comunicări ştiințifice a cadrelor didactice, masteranzilor şi studenților Universității Spiru Haret

[3] BRAKHAHMN, Wilhelm and VOGOT, Ulrike, *ISO 9000 For services. Quick and safe for certification (translation),* Ed. Tehnica, Bucharest, 1998.)

SOFTWARE TOOLS FOR QUAY CRANE EXPLOITATION AND TRAINING

[1]DRAGOMIR CRISTINA, [2]BREAZU ALINA

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

One of the objectives of berth crane operations management in ports is productivity maximization of berth cranes, matched with the vessel requirement of minimizing waiting times. This paper presents several management software tools for berth crane operations in ports that are used for aquiring such an objective.

Keywords: *Quay crane, software, simulator, terminal*

1. INTRODUCTION

The increase of worldwide maritime container transport cause ports terminals expansion, next to ship-owners capacities expansion. The great liner ship-owning companies choose central transhipment hubs which are called at by all ships of one service and where all goods are handled and transported. In these ports, more containers are discharged and shipped per port call. This will lead to an increase in feeder traffic.

The representatives of shipping companies pose, among others, the following demands to operators:

- terminal development with shorter idle periods;
- flexible time frames for vessel service;
- minimising of waiting times at the gate and shorter handling times of trucks and trains;
- better handling conditions for feeder traffic;
- increase of planning reliability on the side of the ship-owner through timely notification of investment decisions;

Port authorities will meet demands such as:

- time frames as large as possible for traffic independent from tides;
- amelioration of street and rail links and of access to inland waterway;
- development of feeder ports;
- answers to environmental problems.

In order to obtain at least 200 container movements per hour, most operators will have to almost double the productivity of their facilities. They have to improve organisation and management and use more efficiently innovative technologies such as gantry cranes with several lifting units, automatised transport and stacking equipment and adequate information and communication technology for operational, tactical and strategic planning [1].

After the introduction of containerisation, the seaport terminals have changed by including alterations to the storage area, the introduction of specialised container handling equipment and storage methods. The equipment available to handle containers in the intermodal terminal are of three main types: gantry cranes (rail mounted or rubber tyre); side loaders (forklifts and reachstackers) and straddle carriers (rubber tyre). The choice of equipment will depend on container throughput, operating strategy, physical operating space, track layout and degree of standardisation in container sizes and types. Each type of equipment has different capital cost, land requirements for operating purposes, and pavement strength requirements. Overall transit times, reliability of delivery times and costs are the main factors influencing mode choice in the freight transport sector. Users of intermodal terminals have as their main requirements: reliability of delivery times, container pick-up and delivery cycles which are delay free, and the ability to monitor the progress of their consignments (i.e., real time information regarding container location and estimated arrival times). Whichever technology is applied, it has to be taken into consideration that the container transport system consists of a number of sub-systems, the capacities of which need to be well harmonised in order to prevent bottle-necks within the transport chain. It is absolutely essential to meet this demand, not only with regard to investment in facilities, but also with regard to the operational management [2].

One of the objectives of berth crane operations management in ports is productivity maximization of berth cranes, matched with the vessel requirement of minimizing waiting times.

2. VESSEL OPERATIONS RELATED TO CRANE EXPLOITATION

Vessel entrance depends on formal conditions like agreements between the vessel's shipping line and the port of call for the use of port facilities, as well as operational settings like berth assignment and pilot/tug availability. Once the vessel is berthed, container discharge/loading can be initiated only if additional human and mechanical resources are allocated; if not, the vessel waits in its berth position until resource assignment. In some terminals, discharge and loading operations are performed by rail-mounted gantry cranes called quay cranes placed along the berth. Quay cranes can move 20 and 40 feet containers between the vessel and the berth area (or quayside). As soon as this operations are completed, the vessel requests, and eventually waits for, tug services to un-berth and exit the port.

The ideal situation is for containers to be transferred to the berth before the arrival of the ships to reduce the port time, and then to be stowed on the ships by the shore cranes. If the import containers are not on the top of the ship then the other containers should be unloaded and restowed. Thus, many containers on the dock will causes delays[2].

3. SOFTWARE TOOLS FOR MANAGEMENT OF BERTH CRANE OPERATIONS - ISL'S CRANE OPERATION PLANNING SYSTEM

Many types of software tools are being used for management of berth crane operations.

Institute of Shipping Economics and Logistics advices operators of container terminals worldwide on questions concerning terminal capacity, design of the terminal layout, implementation of equipment, development of a transport network, handling strategies and the design of stacking areas. Crane Operation Planning System, a project developed by Institute of Shipping Economics and Logistics [3], is a prototype of an integrated planning system for an optimal assignment scheduling of ship to shore container cranes for prevention of capacity reserves and optimal assignment scheduling. The scope of this software tool is related to allocation of general and not performance-related information concerning vessel management, overview of expected arrival times and late arrivals regarding vessel planning, berth planning with allocation of vessels to berths and crane deployment planning. This last module assigns schedule of available berths.

According to several empirical studies, berth container cranes are working to about one half up to one third of their capacity due to the fact that terminal operators dimension their devices up to peak-periods. The second reason is that a great amount of planning reserves are hold out. The estimated saving potentials are about 20% and Crane Operation Planning System helps to slash these capacity reserves.

In vessel management module is made the allocation of general and not performance-related information like Vessel ID, ship owner, line, length, width, draft, buttock line and cross section with illustration of single bays, schedules and maximum number of berths which are able to despatch the vessel simultaneously.

In the vessel planning module is made an overview of expected arrival times and late arrivals. The data used in this module is: expected arrival time, planned departure time, number of containers to despatch (import or export), allocation of the containers to bays and bay plan.

Berth planning concerns the allocation of vessels to the berths. The planner assigns vessels to berths at the quayside. Arrival time and the time to despatch are transferred from the module vessel planning. With allocation of vessels to berth the planner receives following information: The ship to shore cranes range of operation, planned vessel at the quay with multiple occupancies or temporally overlappings stands out in terms of color, the number of containers which have to be loaded or discharged, vessel's direction etc. The module berth planning offers to the operation manager the possibility to realise all discrepancies concerning planning and to solve them by relocation the vessels.

Crane planning is used for scheduling assignment of available berths. Basing on the module berth planning the operation manager gets suggestions for resource scheduling of the available cranes. The manager is able to change restrictions (manual allocation of cranes, for example) and to receive a new suggestion from the software tool.

This software tool improves the quality of integrated berth and crane planning, provides planning alternatives and make static evaluations. The use of the tools increase productivity by reduction of planning mistakes, optimal application of the devices, reduction of the planning costs and reduction of the crane deployment costs.

4. DEVICE EMULATORS FOR AUTOMATED SYSTEMS

A device emulator is the reproduction of a real machine or facility with the help of a software-based model. The model works whilst retaining the original software interfaces of the real device. This means the model accepts the same input and produces the same output as the real appliance. Thus, after the modelling phase the model can conduct tests for cost-intensive facilities and machines and adapt the results to real devices. With machines which seem to work too slowly or too quickly for the human mind, the testing phase is shortened by severalfold, since the speed of the model, in contrast to the real facility, may be varied.

The use of a device emulator has, among others, the following advantages: shortening of start-up phase, possiblity to make performance checks without the real device.performance checks spare the material and energy. Also, performance checks are shortened considerably by time lapse and an early exposure of bottlenecks and planning mistakes is obtained [4].

5. MODERN HEAVY LIFT SIMULATORS USED FOR TRAINING

Heavy loads for project cargo or offshore installations are difficult to handle during loading. Cargo loads often reach the limits of the ship's dimensions and load limits. Only experienced crane operators and ship crews can handle these goods without causing damage and expensive accidents.

To prevent accidents and costs caused by human failure a special attention must be set on training, both in the case of a maritime crew that works aboard ship or for employees working in harbour area for a port operator. Training for loading and unloading process of heavy lifting can be successfully accomplished by using simulators.

Rheinmetall Defence Electronics GmbH is one of the leading companies in simulator technology that now develops a new concept of simulators for heavy lifting. The simulator creates an environment in which a trainee can practice in safe virtual world under a variety of realistic conditions. All workplaces are connected and all actions done by one workstation inflict the operation of all other workstations accordingly. This will generate a realistic feeling of interdependency between the team members.

The main simulation components can be subdivided into five parts:

- The visualisation of the workplaces for the Crane Operators, the Bridge Team and the Cargo Loading Officer.

- The simulation of the technical systems for Ballast Systems as well as the systems for Power

-Supply, Anti Heeling and last but not least the Stability Calculation Station.

-The Simulation of the Ship itself including the influence of external forces, like wind.

-The simulation of the crane operation and the crane model.

-The simulation of cargo out of a library of different cargo models and physically realistic collision calculation. [5]. The HLS7 heavy lift simulator from Rheinmetall ensures significantly improved training results [6].

Also, crane simulators from GlobalSim enable practice on dangerous, costly, and challenging crane operations in a safe and cost effective training environment. MasterLift crane and material handling simulators are used for training ship to shore gantry cranes, mobile jib harbor cranes, pedestal cranes, rubber tyred gantry cranes, rail mounted gantry cranes, ship gantry cranes, barge derrick lattice cranes straddle Carriers or reach stackers The MasterLift line of material handling (MHE) and crane simulators from GlobalSim reduces training time, particularly time spent on live, expensive equipment.

With over 120 cranes training and MHE systems world-wide, GlobalSim has emerged as the premier provider of heavy-lift simulators. MasterLift 1000 portable crane training systems are being used by a variety of construction and maritime customers to provide entry-level lift and load management training. The system includes multiple crane models available like ship-to-shore gantry crane, ship pedestal crane, tower crane, RTG crane, hydraulic telescopic crane snd shipboard gantry crane. The software includes all executable software for both scenario creation and trainer operation. These units are designed to be either self-paced or instructor controlled and use the same crane dynamics, collision, environmental effects and cargo models as the full-size MasterLift products [7].

6. SOFTWARE USED FOR OPTIMISATION CALCULUS

Every dynamically loaded metal construction needs to satisfy among other criteria also verification of fatigue damage. Verification of fatigue damage assures that no failure appears during variable loading of the metal construction within a certain period of time, or useful life time. Analysis of stresses in the construction and their transformation in the form most appropriate for calculation of fatigue damage is of the highest importance for the verification.

Simulation models of container quay cranes can be created using software ADAMS (Automatic Dynamic Analysis of Mechanical Systems) and KRASTA (KRAn-STAtik). Software application ADAMS allows monitoring of the dynamics (velocity, acceleration, force etc.) of the system, while KRASTA enables observation of stress, deformations, movements, etc. Fatigue damage in the construction depends on the change of stresses. Calculation of life time is based on a calculation of the fatigue damage in the construction [8].

ADAMS, a Virtual Prototyping Tool was implemented 30 years ago by Mechanical Dynamics Incorporated, formed by researchers who developed the base code at University of Michigan. Original product was ADAMS/Solver, an application that solves nonlinear numerical equations. In the early 90's, ADAMS/View was released, which provided the users a Graphical User Interface in order to build, simulate and examine results in a single environment. Today, industry specific products are being produced, such as: ADAMS/Car, ADAMS/Rail, ADAMS/Engine, ADAMS/Hydraulics, etc. ADAMS/View automatically calculates mass and inertial properties only for three-dimensional rigid bodies and it calculates the total mass and inertia of a part based on the part's density and the volume of its geometry. The application assigns mass and inertial properties to a marker that represents the part's center of mass (cm) and principal axes. It helps to represent data quantified during a simulation, such as: displacement, velocity, or acceleration of a point on a part, forces in a joint, angle between two bodies and other data resulting from a user-defined function. It measures pre-defined measurable characteristics of parts, forces and constraints in a model. The constraints of the application is related to restricts relative movement between parts, it represents idealized joints and it removes rotational and/or translational degrees of freedom from a system [9].

Definition of the moving (displacement) can be done only between two rigid bodies, what is one of the basic problems accompanying work and simulation with ADAMS. If we desire to analyze trolley movement alongside main girders this is limited to the quite short distance because discontinuity of the material in the model.

Software alone enables defining of a great number of parameters, and what should be in a certain way encouraged and emphasised to manufacturers of crane equipment is to give with their products the most possible data (for example, for ropes, engines, etc.) The more parameters of the model correspond to parameters that manufacturers give, the closer is the model to the real construction. The comparison of the simulation models with real constructions can give models and parameters which are, in total, acceptable from the design standpoint. Thus gained experience in an optimization aim can save a lot of money, which is greatly appreciated in present time and in the future [10].

KRASTA is a program for the structural and modal analysis of spatial framework in the fields lifting appliances, plant manufacturing and general steel building. Frameworks or pieces of it can be moved into different calculation positions and proofed independently in the position. KRASTA supports different types of cross section, which can all be used for the calculation of stresses. For thinwalled and parametric cross sections the program calculates the required unit stresses itself. The individual points on the section can be classified for certain standards. Cross sections may be imported from libraries or from other KRASTA systems. The mass case ”permanent mass” is always available. It contains the beam and node masses described at the individual properties. To distinguish certain parts of the mass and for modelling variable mass distributions, further mass cases can be defined and combined. By this means KRASTA makes it possible to manage independent different mass distributions e.g. electrical equipment, counterweight or different positions of the trolley.

Basic loads apply different types of loads on beams or nodes or groups of these, like concentrated loads: forces and moments on beams or nodes, distributed loads: uniform or trapezoidal forces and moments starting and ending at any place on beam, predeformation: concentrated, uniform or trapezoidal displacements and distortion (lowering of supports, imperfections), acceleration: gravity loads translational and rotational acceleration and angular velocity for different mass distributions, wind: drag coefficients and editable wind profiles, temperature: constant or trapezoidal temperature distribution. Basic load cases can be combined to combination and logical load cases. Combination factors can be used to reflect partial safety coefficients or dynamic coefficients. Logic load cases allow the analysis of complex load events. The logical connection between the components can be in such a way that exactly one acts, one or none acts, all act simultaneously, all possible combinations are considered. The logical combination of the acting loads makes sure, that all possible combinations are considered and the worst cases are found.

Force conditions can be used to model ropes, legs and other elements that only transmit forces higher or lower than a limit force.

In the result display of load cases inner forces, deformations and bending lines can be displayed graphically at any time: inner forces as normal forces, lateral forces, torsional and bending moments, beam deformations as displacements, distortions, support forces: scaled linear or logarithmically, bending lines with user defined magnification factor. The following proofs according to standards are possible: proof of stresses elastic-elastic DIN 18800, proof of fatigue DIN 15018, proof of fatigue DIN 22261, proof of fatigue FEM 1.001 2.131/2.132, proof of fatigue ISO 5049-1, proof of fatigue AS 4100. Results can be displayed as text in user defined formats, as color contours with user defined palettes or as border lines across the beam. For elastic systems natural frequencies and eigenvectors can be calculated. The system can deal with rigid body eigenvectors as well[11].

7. CONCLUSIONS

Today challenge is to find technologies that can help to prevent human failures and their consequences. Softweare tools and simulator technology can help approach this challenge as it helps to manage adequately the technical processes, beside training the workers skills and testing the technology in a virtual and safe environment.

8. ACKNOWLEDGMENTS

Some of the ideas presented in the paper are the result of the models developed in the framework of the MIEC2010 bilateral Ro-Md research project, under the supervision of the National Authority for Scientific Research (ANCS), Romania, [12].

9. REFERENCES

[1]http://www.isl.org/services/downloads/ISL_Optimisation_Simulation_English.pdf

[2] KOZAN, E., *Optimising Container Transfers at Multimodal Terminals*, Mathematical and Computer Modelling, Vol.31, p.235-236, Elsevier Science Ltd., 2000

[3] http://www.isl.org/projects/cops/index.php?lang=en

[4] ARENDT, F., HAASIS, H. D., ZACHCIA, M., *Optimisation and Simulation for Ports and Hinterland*, lnstitut für Seeverkehrswirtschaft und Logistik, Bremen, Germany, 2010

[5] OESTERLE, A., *Heavy Lift Simulation*, The Human Element at the Ship/Port Interface, Editors Willi Wittig, Christina Prieser, Proceedings of the 1st International Ship-Port-Interface Conference ISPIC 2008, Bremen, Germany, 19-21 May 2008, p.183-188.

[6]http://www.ship-technology.com/contractors /simulators/rheinmetalldefence/

[7]http://www.globalsim.com/Products/ByPlatform/MasterLift1000/tabid/77/Default.aspx

[8] BOJANIC, G., RALEVIC, N., GEORGIJEVIC, M., *Optimization of Container Quay Crane Life Time Based on Numerical Analysis*, Machine Design, Novi Sad, 2010, ISSN 1821-1259, p. 49

[9] ESQUE, S., *IHA-2700 Hydraulijärjestelmien mallinnus ja simulointi jatkokurssi*, 2005, http://www.iha.tut.fi/education/IHA-2700/lecture_2.pdf

[10] GEORGIJEVIC, M., BOJANIC, V., BOJANIC, G., *Advantages and Problems Concerning Application of Simulations Trough Different Levels of Development Processes*, Advances in Simulation for Production and Logistics Applications, Markus Rabe (ed.) , Fraunhofer IRB Verlag, Stuttgart 2008, p.253-254

[11] http://www.kuehne-bsb.de/

[12] OANTA, E., PANAIT, C., LEPADATU, L., TAMAS, R., CONSTANTINESCU, M., ODAGESCU, I., TAMAS, I., BATRINCA, G., NISTOR, C., MARINA, V., ILIADI, G., SONTEA, V., MARINA, V., BALAN, V. (2010-2012), *Mathematical Models for Inter-Domain Approaches with Applications in Engineering and Economy*, MIEC2010 - Bilateral Romania-Moldavia Scientific Research Project, National Authority for Scientific Research (ANCS), Romania.

BLACK SEA SECURITY ENVIRONMENT AND ITS INFLUENCE OVER THE ROMANIAN NAVAL FORCES PROJECTION

[1]GEORGESCU STEFAN, [2]ZIDARU MARIAN

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

From the ancient time Black Sea area was a transit zone for the economic, politic and strategic interests. To support this statement, there are the caravans and the antique sea lines of communications which created "the silk road," as a linkage between the eastern and western civilizations and the numerous movements of the greatest strategists of the time with their troops from south to north and vice versa.

Keywords: *Black Sea, security, naval forces*

1. INTRODUCTION

From the ancient time Black Sea area was a transit zone for the economic, politic and strategic interests. To support this statement, there are the caravans and the antique sea lines of communications which created "*the silk road,"* as a linkage between the eastern and western civilizations and the numerous movements of the greatest strategists of the time with their troops from south to north and vice versa.

The geopolitical and security developments in the Black Sea area, its geographical location, the existing risks and threats, as well as the advantages offered by the political, economic and military co-operation have focused, more and more, the interest of the European and Trans-Atlantic organizations, generating a more careful approach of the issues related to this area.

Romania's foreign policy, has established among its priorities those concerning the Black Sea area, which are considered to be "*a very important issue, of national interest."*

The Black Sea Region has the greatest density of separatist conflicts, disputes or regional tensions.

These situations bring major concerns for the regional stability and security of the Wider Black Sea Region. The conflicts in Transnistria, Abkhazia, South Ossetia and Nagorno-Karabakh, as well as other disputes, are posing serious threats to regional security. Sometimes, the risk of violent confrontations floats like a toxic cloud. The good news is that the differences between countries are counterbalanced by the common opportunities and challenges facing the Black Sea area. Romania has a keen interest in actively strengthening the stability and security in the Wider Black Sea Region, and promoting the values of democracy, rule of law and human rights.

When we analyze the geopolitical features of the Black Sea area, we must first begin with the recognition of the key obstacles and dilemmas the region faces, on the attempts the countries make to line up their efforts into the systemic and dynamic process, to build the regional security and, as a follow up, the global security. Also, an essential factor to understand the current phenomena is generated by the impact of the transition after the post-communist era over the littoral states, during their adjustment to the new Euro-Atlantic security environment. The last but not the least, the geo-economic analysis of the local regional powers (Russian Federation and Turkey), especially from the point of view of the energy competition and the transit corridors of these resources, connecting the Mediterranean Sea, Black Sea, Caspian Sea and Central Asia, are essential to define the geopolitical perspectives over the short and middle term period.

In this new geo-strategic environment, the influence of the historical evolution is a factor that should be taken into consideration on the configuration of the relationships between this region with NATO and EU and, to prove its increased importance. Thus, centuries ago, the Greeks, Romans, Ottomans, and Russian seamen used the Black Sea for their economic and military purposes. In the past, the large empires extended their control over the Black Sea region due to its richness (grains, minerals, wood, and fish), and because it is geo-strategically important. For this reason, the Black Sea was considered for many times as a buffer zone between civilizations. In the last years, the Black Sea area has turned, at global level, into a transit zone between Central Asia, Middle East and Central and Western Europe.

I have to underline that South-Eastern Europe, including the extended Black Sea area, is the only European area where there are yet *"frozen conflicts",* which are still under international debate.

Compulsory manner, to reassess Romania's national security strategy, with major changes over the role, place and the missions of the Armed Forces in general and, of the Naval Forces in particular. This new status means, besides the national security and stability guaranty, responsibilities to generate European and regional stability and security.

We can anticipate that, subsequent to the European Union integration, Romania will bring its national contribution to the European security, which will increase the tasks and responsibilities assumed as a NATO member state.

The state counselor, General Constantin DEGERATU, has made an assessment over the Black Sea importance, at the annual Black Sea Naval Commanders Committee Meeting, held in Mamaia on May 17th, 2005: "*in our opinion, Black Sea is recognized as an important geo-political area, which* *also covers the countries placed around it and in its closeness. It claims a real Euro-Atlantic strategy with the purpose to ensure the democratic stability, security and prosperity, on one hand and, to properly promote the dynamism of democratic changes process, on the other hand. In order to support such strategy, we have to start from the region's realities, as well as from the ways this area is integrated onto the global processes."*

From this point of view, as well as from the latest statements of the Romanian president, there are at least three specific elements for the Black Sea area.

First of all, all states within the area are united among the same fundamental values and interests, which govern the current development of the international relationships: democracy, human rights, free market economy and fight against terrorism.

From the EU point of view, the littoral countries express more firmly their will for integration; to this respect, there are countries which have signed the adhesion treaty, some will start the negotiations for integration and others develop a very active and dynamic co-operation with EU.

Black Sea area is placed as a central point between two major strategic axes, which have complementary components: the axis of the energy producer and the energy consumer, on one hand and, the axis of the security producer and the security consumer, on the other hand.

Nowadays, there are profound changes of the international environment, which consist of the progress over democracy, to seek and define the security options, as well as a further development regarding the character and nature of regional and global security risks and threats. In this context, Romanian concerns over the international relationships and co-operation are oriented towards an active contribution to the peace, stability and security policy.

The importance of the region, located between two areas with a very high conflict potential (the Balkans and Caucasus) and, located near Eastern Mediterranean area (marked by the Middle East conflicts and by the exacerbated Islamic terrorism), is underlined especially by The importance of the region, located between two areas with a very high conflict potential (the Balkans and Caucasus) and, located near Eastern Mediterranean area (marked by the Middle East conflicts and by the exacerbated Islamic terrorism), is underlined especially by the following factors:

- this is the space where three geopolitical and geo-economical zones interfere; they are considered to be on top of the areas with very high level risks, concerning the security and stability (Southern Europe, Eastern Europe and Middle East);
- this is the exit gate to the Planetary Ocean for Romania, Ukraine, Russian Federation, Georgia and Bulgaria;
- it is crossed by many transportation routes of crude oil and hydrocarbon products, from the Caspian Sea to the Western countries and includes, in the same time, the path of the future energetic highway TRACECA;
- it is a part of the southern border of the Russian Federation and, in the same time, NATO's edge to the south-east;
- includes at least one segment for the drugs trafficking channel, from Central Asia and Middle East to Western countries, for weapons smuggling from the former Soviet Union countries and, even for immigrants trafficking from Central Asia to the West;
- there are numerous marine resources, a large net of ports and port facilities; Black Sea seaside can offer numerous opportunities for trade and tourism co-operation;
- stands for a very good environment for the military co-operation in the framework of PfP program and even for the development of the special partnership between Russia and NATO.

The increased importance of the Black Sea region in the geopolitical context, at the beginning of this new millennium, is given by the necessity to establish the strategic raw materials flow, by the economic and military co-operation and by the increased involvement of the great powers and of the international institutions' contribution to solve major issues of the region.

I think that the geographical position of Romania in the vicinity of the Black Sea and its connection to the Planetary Ocean represents a strategic advantage that must be fully exploited.

As I said before, in the context of Romania's external policy priorities, a special attention is given to the Black Sea issues. This concern is a very important matter, of national interest.

Romania wants to promote its own maritime and river interests, which are sustained by its maritime power, by the access to the sea and by the length of the maritime and river borders (from its length of more than 2500 km, Danube flows in Romania 1075 km)

From this perspective, our country has major interests to support the supply with raw materials through the maritime and river lines of communications, to exploit the sea bed, to develop the submarine exploration and exploitation, to support economic activities at sea and river – naval transportation, tourism, naval building – and to promote its image worldwide, by showing the flag at seas and oceans. Also, the Euro-Atlantic involvement on the extended region of the Black Sea is very important.

The spirit of the maritime power of a state is represented by the possibilities to efficiently use the sea richness and facilities on its own interest and by its capacity to deny the use of the sea by its potential opponents. Romania and its Armed Forces represent reliable partners for the process of cooperation and regional stability. They contribute to broader forms of cooperation development, to effective crisis management and to the prevention of the conventional and non-conventional risks. Romania also promotes the transatlantic values and the security standards, ensures the crises management interoperability throughout the Wider Black Sea Area, the cooperation in border and seashore security and in civil emergencies. Another field of interest would be the assistance given to the neighbouring countries in the reform of the security sector as well as the development of the security programs' reform. The activities of the Romanian Armed Forces and the armed forces of other states in the region for building confidence should also not be ignored.

According to "The Naval Forces Doctrine for Operations", which is an unclassified document, the elements of the maritime power are:

a. The Naval Forces and their means, including those of the Border Police, the Maritime Aviation and the Marines;
b. The commercial fleet;
c. The infrastructure and the logistic resources: naval bases, ports, supply centers and warehouses, naval building yards, naval repair shops, airfields;
d. The naval educational system;
e. The naval leagues and associations;
f. The specialized mass-media components;
g. The naval shipyards and the firms with such profile;
h. The firms, installations and ships specialized in the research and exploitation of the maritime and river resources and of the sea bed;
i. The firms and associations that promote the sea and river tourism, and their means;
j. The research institutes with activities in the water environment researches and their logistics;

The elements of the maritime power come from specific sources of the overall power of the state (a short definition of A. Mahan, at the end of the 19^{th} century).

- *the geographical position*: the physical configuration, the territorial size; the length of the littoral; the existence of the gulfs and of suitable sites to set up ports and to shelter ships on bad weather conditions; the existence of the inland water courses, lakes, rivers and navigable channels;
- *the maritime policy of the Government* : the political and economical external relationships; the maritime policy of the state;
- *the resources and the defense capabilities*: the economy; the natural resources; the inland communications system; the telecommunications and radio communications system; the population; the armed forces, etc;

Considering these, the maritime power can be represented as a coagulated and inseparable system. Thus, we deal with an interconnection, in which the maritime trade influences the maritime resources; the resources determine the state's naval strength, which, also, is transcribed in maritime supremacy, encouraging the commerce.

The economical and political evolution of Romania is tightly linked to the policy regarding the activities on sea. A developed Romania will also mean in the future ROMANIA, AS A MARITIME POWER.

Romanian maritime and river interests are a component part of the national, economical, political and military interests. They evolve in time, in accordance with the maritime power and the political status of the state.

The maritime and river interests are promoted through negotiations and treaties and the protection of the maritime and river interests is accomplished by the Naval Forces, which must be able to project the power in the blue seas, in order to defend the economical objectives and the maritime sea lines of communications wherever is needed by the national or by the Alliance interests.

"The Naval Forces Doctrine for Operations," emphasizes the fact that Romania is vitally interested to: maintain its own territorial integrity within the limits of the land, maritime and river borders; keep the exit of Danube river to the Black Sea unmodified, mainly through its branches and, secondary, through the Danube-Black Sea canal; guarantee the conditions to enforce and keep the maritime areas of interest for the economical use and freedom of action; preserve stability in the area; keep freedom of movement on the maritime and river lines of communication; to protect the river infrastructure; protect the sea, river and delta environment; to participate to the naval events of the Allies and of the partners.

In the conditions of such a complex economical and political situation, especially in the Black Sea area, the existence of the Naval Forces is the sound argument that grants credibility to Romania's policy, on defending its own maritime interests. In this context, the completion of the restructuring and the shift to the new stage of modernization of the Naval Forces is a national priority.

In the same context, there is the co-operation of the Romanian Naval Forces with other national institutions with responsibilities in the domain, to the combating of the naval terrorism and to the prevention of other risks and threats to the security, such as: organized crime, drugs traffic, illegal weapons traffic, and also the illegal exploitation of the maritime resources in the Romanian maritime and river sovereignty.

In case of natural disasters or emergencies on crisis situations, the Romanian Naval Forces can ensure the evacuation of the civilian population and of the non-combatant personnel. Also, the Naval Forces can provide, through its specialized structures, emergency medical treatment, can fix or evacuate the damaged infrastructure, can restore or build bridges and roads. Also for the humanitarian support, the Naval Forces actions can focus on measures for human life saving, such as medical support, water supplies, food, clothing, fuel and also the transportation on sea of the persons affected by the disaster.

I consider that the reconstruction and modernization of the Naval Forces must be related permanently with the following goal:

ON LONG AND MEDIUM TERM, ROMANIA MUST BE ABLE TO PROTECT ITS INTERESTS IN THE BLACK SEA AND IN THE OTHER MARITIME AREAS, ON ITS OWN AND TOGETHER WITH ITS ALLIES.

AS A CONSEQUENCE, ROMANIA MUST BECOME A REGIONAL MARITIME POWER.

In the future, the potential participation of a Romanian naval component, in the permanent structure of the Allied Naval Forces, might be a support factor to place Romanian policy inside the international decisional political organizations.

At the present stage, there have been identified a series of possible threats which might occur within the area of responsibility of the Naval Forces and in the neighboring areas, such as: the escalation of the inter-ethnic and religious conflicts in the vicinity of Romania; the restriction of the freedom of navigation or of those actions guaranteed by the international maritime laws; the violation of the maritime, river or land borders; the conduct of terrorist actions; weapons, ammunitions, drugs and hazardous materials smuggling; the conduct of specific informational and economic actions against both the civilian society and the military organizations; illegal emigration; pollution and, not the least, a potential nuclear accident.

Romania doesn't consider any state as a potential threat to its national security and, as the entire Armed Forces, Naval Forces can bring their contribution to solve sea and river issues, especially through peaceful means, to contribute to the security environment in the region.

Participation at common naval exercises under the auspices of the regional initiatives, such as the Group for Naval Cooperation in the Black Sea – BLACKSEAFOR, consolidates the trust, friendship and relations of good vicinity with all Black Sea littoral states.

The principle from the "Romanian National Security Strategy", according to which the military force acts as the last resort to provide country's security, compels us not to neglect the possibility of a military involvement.

From the analysis of the present risks and threats in the region, results a certain hierarchy, in relation with the probability of occurrence of conflicts and events to which the Naval Forces will have to react. These can be non-military actions of asymmetric type, materialized into actions against organized crime, drugs traffic, smuggling and refugees flow from the sea, against the piracy and terrorist acts at sea and in harbors. These do not exclude the possibility of an outburst of, either a regional armed conflict characterized by the combination of conventional actions with unconventional ones, low to medium intensity on all environments, nor a major armed conflict, consisting on a conventional war, based on means with high maneuvering capacity, precision on hits, multi-dimensional protection of the forces, use of the electronic means and informational warfare.

To all of these we add the natural disasters and ecological incidents which, due to their unpredictable character cannot have hierarchies based on the probability criterion, but have important effects that demand the intervention of the Naval Forces.

2. THE CONTRIBUTION OF THE ROMANIAN NAVAL FORCES TO THE PROVISION OF COOPERATION AND SECURITY IN THE BLACK SEA AREA

The capability to control the maritime space is, at present, one of the main strategic factors, even if, simultaneously, we witness a reduction of the level and a change of the types of the virtual threats. The new element added to this constant strategy – the tendency to consider the Naval Forces as the "operational arm" for peace keeping operations and crisis management – needs, necessarily, a reassessment of the criteria regarding the composition, training and the use of these forces.

Able to operate remotely, without constraints imposed by the national borders or by the limitations of weapons control, the Naval Forces, frequently, are the first forces to operate in the crisis areas. Thus, a naval force may constitute a tool of the external security policy, whose presence often exercise a much more convincing influence, in comparison with the size and costs of its elements.

Although the region is characterized by instability, the relationships between the littoral states of the Black Sea have been drastically modified in the last decade. The main tendency for the Black Sea is that this area will become an area of co-operation, development and regional security. The regional co-operation is a reality with significant results, especially regarding to the level of trust between the littoral states. For the first time in its history, Black Sea is about to become a source of unity, development and stability in this extended geographical area, which has permanently been unstable and represented a border between various political, ideological and religious systems.

The co-operation relationships are focused on the economic development and the prevention and elimination of the risk factors that may generate crisis situations, with harmful effects over the regional stability and security. Thus, there are promoted political, ideological, economic, diplomatic and cultural relations in order to maintain and consolidate the stability and, also, the military co-operation relations in order to increase the trust and security through transparency.

Consequently, the Romanian president, on the occasion of his visit to the USA, in his speech regarding the importance of the Black Sea, in March 2005, stated: "*We are prepared to participate in a mutual fund of the Black Sea, which will be implemented with the financial support of our American partners, USAID and German Marshall Fund, with the participation of the European Union. This mutual fund will seek to support the democratic developments in our vicinity, by the creation of public-private partnerships. Moreover, we will continue to initiate projects under the auspices of the Community of Democracies, in order to join Georgia and the other states to the euro Atlantic community".*

The conservation of a peace and stability climate, desirable in order to achieve the economic and prosperity objectives, must be ensured by an appropriate tool that will guarantee the regional security. Romania's option for the future achievement of the Multipurpose Naval Force, able to fulfill traditional naval missions and, to fight also against the asymmetric threats, is subscribed under and has been determined by the present capacity of the Romanian economy to sustain reduced military structures, by the great diversity of the actions in which the Romanian Naval Forces are engaged, and also by the transition to modern technologies and multifunctional equipments in the naval field.

The existence of a multinational maritime force to which all Black Sea littoral states participate represents a mean to achieve some of the co-operation activities, such as: fighting against the danger at sea, human life and environmental protection. By participating to the activities of the Black Sea Naval Cooperation Task Group BLACKSEAFOR, the Romanian Naval Forces are mainly engaged in the fulfillment of humanitarian and Search and Rescue missions. The contribution of the Romanian Naval Forces to the regional stability can be evaluated also by the adoption of "The Document on Confidence and Security Building Measures in the naval field in the Black Sea", which is the result of the negotiations between the six littoral states.

The domains provided in the "Document on Confidence and security building measures in the naval field in the Black Sea" increase the trust, security and, consequently, to the peace preservation, are:

- cooperation in the naval field;
- reciprocal visits of ships and observers of the littoral states in the naval bases;
- exchange of naval information;
- notification of the forces and the main national naval activities;
- planning and execution of common naval exercises every year.

Starting with 1990, the Romanian Armed Forces began an ample process of reform, whose goal is the interoperability with the armed forces of NATO countries. The Romanian Government supported and will support this costly and long process, so that Romania will hold a military force capable to address any threats to its national security and sovereignty.

In this general context, the Naval Forces passed through a reform process, which led to the transformation of this military service into a more flexible and powerful force, that passes at this moment through a process of conceptual, structural and actional modernization.

The present and the future activity of the Naval Forces is oriented towards the setting up of a new structure of force capable to respond to the threats and risks specific to the new security environment in our region and, in the same time, to be able to be interoperable with the other NATO navies. The main objective of this demarche is to review our concepts, legislation, doctrine, regulations and manuals to ensure the legislative framework for all new missions, to approach the planning system and conduct of military operations from a new perspective, to implement standard procedures on execution of operations together with the Allied and Partners navies, to modernize our fleet, to endow with new military equipment of the latest generation, that will provide the interoperability and carry out all missions with maximum efficiency.

The doctrines, regulations and other internal leading documents have a clear, easy to understand content and easy to apply at all level echelons. The endorsement, within these documents, of the concept of "*centralized leadership and non-centralized execution*" will allow commanders to adapt to the changing conditions.

In the past 15 years, personnel from the Romanian Navy participated, within the Partnership for Peace framework and, in the last year, under NATO command, to the military exercises in the Black Sea and Mediterranean Sea. Multinational exercises we participated, aimed to strengthen the co-operation with the other NATO navies, as well as with the navies from the Partnership for Peace. We can remind here the exercises carried out in the Black Sea, such as COOPERATIVE PARTNER, BLACK SEA PARTNERSHIP, LIVEX with Bulgaria and Turkey and annual training activities, under the BLACKSEAFOR.

For the fully integration into NATO, Romania keeps a firm line to hold a capable fleet that can respond to all requirements of the Alliance. Besides the Mărăşeşti frigate, our country acquired 2 new frigates, in 2004 and 2005, which increases the operational capability of the Romanian Navy. Also, the corvettes and mine hunters received a good appreciation from our partners, due to the success in multinational exercises they participated. The divers unit has an important place within Romanian Navy, due to the special use of this kind of force. These elite divers carry out missions with a high impact in the theater of operations.

Romania continues its consistent policy to impose its maritime interests in Black Sea region and has the objective to become a real partner within the Alliance. Through the Naval Forces, Romania will be capable to respond to any kind of threats to the global and regional stability. Beginning with the participation between 15 October and 15 December of frigate Ferdinand to the Active Endeavor Operation, Naval Forces show their capacity to accomplish the missions of the Alliance and also the possibility to protect the Romanian interests in others maritime theaters of operations. The Naval Forces prove that the fleet has made important steps in the transformation from a coastal force into a new force which can be deployed and sustained in a military theater far away from its maritime bases (a so called blue waters navy).

The Black Sea region and, especially the eastern part represents an area with long periods of instability and insecurity, a source of concerns for the European democracies, but in the same time an important turning point for the world wide energy corridor. From the NATO and UE point of view, there must be taken firm measures to reinforce the safety of commercial routes and pipe lines in the region. Thus, Romanian Navy becomes a core factor which can be used to accomplish these objectives. The responsibilities which Romania will assume in the region, and the means will use, were presented by the president of Romania, Mr. Traian Băsescu: "*Black Sea area is the area of criminality in which Romania must be involved. Not only we have a Navy capable to participate to the control of what happens in the Black Sea, but in the last month, Romanian Navy has got two new frigates, excellent equipped, which together with Mărăşeşti frigate, form three units of a maximum importance, capable to participate to the process of controlling what happens in the Black Sea*".

In order to achieve the recognized maritime picture the successful task accomplishment besides the Naval Forces there is a need to engage other national governmental institution based on special agreement, such as:

a) surveillance and recconaisance aviation and Air Force Operational Command;
b) Naval Border Police

c) Romanian Naval Authority and Constanta Ports Administration
d) Romanian Intelligence Agencies
e) National Custom Autority

In order to successfully monitor the crises and prevent the conflicts at sea, Romania must have the capability to protect its legal and legitimate interests of using the sea on a peaceful manner. To accomplish this aim, Romania needs a Naval Force able to address any situation of crisis or conflict, to have the possibility to act when and where is necessary, a force that, in order to be well balanced, must include elements required to lead under water, surface or air warfare operations.

To cope with all risks and threats against the national security, Naval Forces will pass in the next years, together with the other services, through an adaptation process of its structure and capabilities, to accomplish as well specific missions for high intensity conflict, as non combat missions, which determine the existence of minimal military structures, flexible and quick deployable, able to sustain itself in an area of operations.

Thus, our option refers to the development of a Multipurpose Naval Force, that would be structural, manned, equipped and such trained that, using the same resources, will correspond to the evolution of military phenomenon, in order to easily adapt to the qualitative leap in naval technology and to be based on a highly motivated and qualified human resource.

The Multipurpose Naval Force will be fully interoperable with the other services of the Romanian Armed Forces, with the other partners in joint and combined operations and, high potential to modify the operational capability of forces and their capabilities proportional to the evolution of the situation at the strategic level. The Force will have the capacity to exploit the advantages of the technological level of ships to obtain, in an efficient manner, the success in all undertaken actions.

An efficient and economic Multipurpose Naval Force needs a self sustained logistics system, composed from resources dislocated in permanent bases and own means for replenishment.

The structural reform and the modernization of Multipurpose Naval Force will continue to achieve a force capable to accomplish the role of naval component in combined operations, to accomplish all type of missions, included in Romanian Military Strategy. The requirements that must be accomplished by the naval force which we project are as follows: command and control, a balanced structure of forces, interoperability and infrastructure.

The components of this effective naval force will match each other and, all together, will be able to cover the operational spectrum, in order to respond to the requirements and conditions imposed by the new geo-strategic situation and by the increased importance of force offered to NATO, able to accomplish the whole range of missions.

The composition of the Multipurpose Naval Force is determined by the necessity to balance at least two essential requirements: enough forces to accomplish the missions and the capability to sustain and maintain the forces in the planned operational status.

The strategy for the endowment and development of the Naval Force, on a long and medium term, comprises programs of acquisitions and modernizations whose completion is represented by the creation of a balanced structure of modern capabilities, required in order to accomplish the new missions. The modernization of the equipments is determined not only by the evolution of the security environment and the need to respond to new risks and threats, but also by the progress imposed by the transformation process of the armed forces in general and of the navy, in particular.

The endowment program of the Naval Forces refers to: replacement of the littoral surveillance system with the SCOMAR system; finalizing the program of modernization for frigates and the endowment of these with helicopters and modern warfare systems; replacing the corvettes with new multifunctional corvettes; replacing the mine sweepers with modern mine hunters; revitalizing the submarine and, on a long term, the acquisition of 2 new modern classic submarines; the endowment of the divers with performing equipments and competitive support vessels; providing logistics and support capabilities for the deployed forces in the theaters of operations.

Starting from the present status of the Naval Forces, analyzing the probability of risks and threats' occurrence in the region and, considering the possibilities to financially sustain the development and modernization processes, we can assess that in the present and predictable conditions, the accomplishment of such an endowment of the Multipurpose Naval Force is possible to be accomplished, gradually, on a long and medium term, until the year 2020.

The number of years required to accomplish the Multipurpose Naval Force, is directly dependent on the evolution of the economic progress and on the value of the allocated financial resources. The process can be accelerated by an optimal distribution of the allocated budget of the Ministry of National Defense to the services, in accordance with the most probable risks and threats, as well as the analysis of the acquisition costs for ships and equipments and the costs for their operation and maintenance.

In our opinion, set up of a balanced military fleet is the key for the fulfillment of the national operational and strategic goals.

PROMOTING ROMANIAN MARITIME INTERESTS IN ACTUAL GEOPOLITICAL CONTEXT

[1]GEORGESCU STEFAN, [2]SORESCU FLORIN

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

The subject of this presentation is to emphasize the intrinsic relationship between Romania and Black Sea, taking into consideration geopolitical issues. From this point of view it is presented Romanian interests regarding Black Sea and the extended region of Black Sea, taking into account the fact that it doesn't represent a conjunctural or a historical issue or a consequence of actual geopolitical evolutions. In order to sustain and promote these interests it is much and much stressed the idea that Romania has to become a regional maritime power. This represent a condition for promoting national interests in Black Sea region.

Romanian interests in Black Sea region can be compeled by risky economic, military-political and military factors. Promoting our interests in Black Sea region, Romania becomes a factor of stability in the region, contributing at the same time to a stability and security climat, both in Black Sea region and in the extended region of Black Sea.

Keywords: *Black Sea, security, naval forces*

1. INTRODUCTION

Romania and the Black Sea are two geographical entities inseparable. Without the Black Sea, Romania would be a stretch of land unfulfilled, without Romania, Black Sea would be a boundless and without identity. The importance of the Black Sea to Romania is the concept of addiction to the Black Sea region, it is now vital interests of EU Member easy access to Caspian energy resources, the need to create a stable security environment, predictable and consistent in the immediate vicinity of border common European space.

Wider Black Sea region includes both coastal States and the Republic of Moldova and South Caucasus states of Armenia and Azerbaijan.

Wider Black Sea region represent the area of intersection of two interactive systems: the Euro-Atlantic community, represented by NATO and the EU and CIS consists of OTSC under Russian influence. From the European perspective, three countries are EU member states - Greece, Romania and Bulgaria, a country is a candidate integration EU - Turkey, five partner countries - PEV are Moldova, Ukraine, Georgia, Armenia and Azerbaijan, a country receiving a strategic partnership with EU - Russian Federation.

Romanian Black Sea coast gives of Romania out free in oceans worldwide by the Bosphorus, Dardanelles and then through the Aegean and the Mediterranean through the Straits of Gibraltar from the Atlantic and then in the world. This opening to 71% of the planet has significant consequences on Romania. These relate to:

1) access to unlimited resources of the ocean;
2) a favorable geostrategic position;
3) the possibility of developing coastal cities;
4) the possibility of developing a transmission network;
5) the possibility of developing tourism varied and complex.

In light of this assertion and indivisible unit, Romania is obliged to promote the interests of guaranteeing existence. For this, Romania has to exercise its role of regional maritime power in the context in which this role is achieved, it must be managed by opinionated Security Strategy of Romania. From this point of view, Romania has to assume regional responsibilities in asserting a climate of stability and security in the wider Black Sea.

Regarding Romania's Black Sea interests in the wider Black Sea we can say that:

1) conjuncture is not a problem;
2) these not a historical problem;
3) these not a matter of geopolitical developments.

In a Europe that tends to its own territorial full continental Romania's interests are, in specific proportions of indivisibility strategic interests of the European Union, which Romania is acting upward interest and consistent.

Black Sea one of the oldest European geopolitical system, a special strategic importance for Romania, again a reality after the Cold War Euro-Atlantic community. After the disappearance of Russian Empire and the Ottoman Empire, the geopolitical system was initially divided in the center of the Balkans and Caucasus, then in four, adding the Centre-North Anatolian and Pontic. At present the interests of Turkey and Russia less overlap in the Black Sea area and more Turkish origin-Muslim republics of Central Asia, Turkey's influence means the area is much higher vis-à-vis those of Russia against Turkey.

These advantages offer Romania the role of commercial bearing south-eastern Europe.

2. ROMANIA'S BLACK SEA INTERESTS IN THE WIDER BLACK SEA

Are almost prophetic ideas and Titulescu's theses, which, in August 1934, the full effort to create the Balkan Entente, stress convincing: “Mission of building a Europe free extended will not be complete until the Black Sea countries will not be fully supported by the Euro-Atlantic community. The region boasts its ancient ties with European civilization, as evidenced by increasingly intense historical and archaeological research. The strategic importance of the area was visible from the time of the Greeks and Romans, for this region is at the crossroads of Europe with Asia Minor and the Caucasus. Today we have the opportunity to meet these countries and to include them in the Euro-Atlantic community. In addition, enhancing democracy and stability on the shores of the river history, we can help revive the ancient name Black Sea, making it ever: Pontus Euxinus, «Grand Hospitable»".

XXI century projections back to the fore the great Romanian diplomat. Currently, Romania is engaged in designing, managing and asserting his own interests in the Black Sea and hence the wider Black Sea region.

In this context, the Black Sea, in which Romania promotes its interests, is induced by international geopolitical framework defining its own specific features, such as:

1) foreign involvement of the Black Sea littoral states, in implementing and ensuring democratic stability, economic development and social prosperity in the Great Middle East;
2) providing an additional platform for cooperation between U.S. and EU in a region where their strategic interests, basically, are complementary, which could lead to their successful approaches;
3) empowering NATO to engage in military operations outside the area, most likely in the Great Middle East, and in this case, providing some support from partners outside NATO;
4) positive engagement of Russia, against taking into account the legitimate security interests, which can be more effectively achieved under a stable and prosperous neighborhood than in an unstable environment;
5) encourage the development and ownership of the Black Sea regional identity itself as a partner of the West, which is possible by wise policies pursued by the NATO-EU co-US.

In this geopolitical context, Romania has stated its intention, to be a vector of stability, democracy and the promotion of Euro-Atlantic values in the region. Romania, promoting clear and open and their interests can be a vector of the EU's fundamental interests in the region, stressing the development of international processes, ultimately, the fact that Romania's interests are in Europe.

Romania's national interests can be promoted in the region Black Sea:

1) exploitation of economic opportunities;
2) constructive ownership of cultural opportunities;
3) involvement in education and social development in the region;
4) combating corruption, organized crime and terrorism;
5) transformation of the Black Sea region in a vector of solidarity and cooperation, as determining the social cohesion of Europe.

All this is possible in the context in which Romania will become practically a regional maritime power, General proposed to assert in this direction configuring virtually coordinates national strategic interest to the Black Sea.

3. ROMANIA - REGIONAL MARITIME POWER, ONE OF THE MAJOR NATIONAL INTERESTS

Not only in developing the Black Sea region (in the context of extremely complex and, not infrequently, conflicting beginning of this century) but the very fact that Romania has a coastline (245 km) complains that the assertion of our state regional maritime power in the geopolitical and geostrategic context of this space. The Black Sea region produces flow of strategic materials from the Orient to Europe Union, the region representing an area frequently economic, political and military and geopolitical and geostrategic change produced by an area which causes the active involvement of major international players and bodies Why have the global architecture of international vocation.

Against these considerations, both medium and long term, Romania should be able, alone or with allies, to defend and promote their interests in the Black Sea, but in other maritime areas, requirement can not be accomplished without Romania to become the geopolitical perspective, but geostrategic, a regional maritime power.

4. FACTORS THAT MAY CAUSE CHANGES IN STATE SECURITY AND THE WIDER BLACK SEA

Main risk factors identified in the Black Sea region are:

1) Economic risk factors:
   a. economic disparities between countries in the region and promoting economic strategy inadequate;
   b. economic stake started operation and transport of oil through the Black Sea, which may contribute directly or to the settling of conflicts or the deepening and diversification;
   c. circumvent the rights of States to exploit the natural riches of their territory or maritime economic zone of their own.
2) Risk factors such as political-military:
   a. continuation of deepening conflict and territorial disputes, exacerbated nationalism and separatist tendencies and internal instability of states formed after disintegration of Soviet Union;
   b. the position of Russia's reluctance to extend NATO eastward, including the states bordering the Black Sea and thus the Black Sea basin including the area of responsibility of the southeastern flank of NATO. A further NATO expansion eastward and more aware that Russia sees it as a U.S. intention to make the process of integration into NATO in a control element of the situation in areas "hot", adjacent to the Black Sea, with adverse consequences for her position as isolation and the threat of great power and influence factor in the area;
   c. the struggle for energy resources is yet the most important dimension of the states that have interests in this area. It may contribute directly or to the settling of disputes, either to further or

diversification. Such situations can act as a brake on investment in the area (except the oil from the Caspian Sea area) or may limit the scope of assistance programs created by various European and international institutions necessary for a sustainable regional development. It can be appreciated that in the near future stability will depend considerably on the Black Sea and direct extraction of oil and gas the Caspian Sea area. The commissioning of the Rhine-Main Canal, which connects the North Sea to the Black Sea and Baltic Sea in perspective and through the Main-Elbe canal, the Danube waterway is the main thoroughfare in Europe, enabling the access faster to Asian markets and to the Caspian Sea, to move towards large-scale exploitation of the important existing oil reserves;

d. cross-border crime, organized crime connections, especially on issues relating to trafficking in arms, drugs and people. Thus, in recent years, this area is crossed by several transit routes for drugs from the Middle East and Central Asia, particularly Afghanistan, the consumer markets of the Russian Federation and European countries.

3) Risk factors for military:

a. the existence of ongoing internal military conflicts or military conflicts between states in the area;
b. the disintegration of the armies of federal states and national armies trained subsequently use to obtain political advantages, the new regional economic conditions;
c. changing the ratio of forces through the creation of armed sub-November;
d. development of new military alliances;
e. resizing military potential;
f. the possibility of significant discrepancies regarding the degree of protection of states, the prospect of EU membership, some countries in Eastern and Southeastern Europe will have a triple protection (OSCE, NATO, EU), other dual (OSCE, NATO) and the third category one level of protection (OSCE);
g. the production of military potential gaps between countries in stages to reduce conventional weapons and the military;
h. participate in equal measure to all states to deepen confidence building measures and security arrangements in the area and the open skies;
i. various forms of non-governmental organizations, private companies and mercenaries involved in conflicts or potential.

Black Sea and its littoral states, the overall area of interest is a political, economic and military, a special sensitivity, given the specific risk factors and potential threats to the security of this area, which may occur as a result of poor management of risk.

By geographical location, existing threats and risks and benefits of political cooperation, economic and military, in recent years, the Black Sea has attracted more and more interest in European and transatlantic organizations, but the major powers, resulting in a closer approach to problems facing this area.

Security developments in the Black Sea are directly connected to the transformation of global security, increased stability in the logic of integration opportunities and secondly, increasing the need for risk management and security challenges in the area.

Assessments on the security system can address a broad vision on the Black Sea, since developments in this region are intrinsically linked to the EU and NATO borders, but also changes in the security environment in the Balkans - the former Yugoslavia to Albania and Greece; of Caucasus - in Georgia, Armenia and Azerbaijan, the Middle East and East - from Turkey to Iraq and Iran.

In the future Black Sea region could play a dual role: as a platform for the design of military force to Middle East and Central Asia as a buffer against asymmetric risks for European security. Annihilation factors favoring development of regional risks and threats has been the attention of the Black Sea and European and international bodies. All measures taken, these factors continue to keep risks and threats and even generate new ones.

Complexity of the security situation in the Black Sea countries is the result of summing the effects of separatist conflict, ethnic, religious, illegal trafficking in weapons, drugs, people and other forms of cross-border crime. This fact, coupled with the inefficiency of local authorities in the countries concerned in management situations, is a framework for carrying out actions that could destabilize the regional balance.

On the military situation in the Black Sea basin is characterized by relative stability. Strategic importance of naval forces of neighboring countries tend to change from the traditional role of territorial defense mitigation, achieving the main functions of control, cooperation, risk and asymmetric power projection in the Black Sea and Black Sea outside.

Stimulation predictable multilateral cooperation in the Basin, the bus trans-European waterway contributes significantly to the value of sea and river transport routes across the Black Sea area, including connection to the Caspian basin via the Volga-Don.

Developing trade is still a primary factor of convergence integrating states in the region. The objectives are speeding up preparations for a functional market economy status, encouraging free trade zones, clarifying the status.

Evolution of the strategic east-west and caused economic opening of the European Union and NATO enlargement require clarification of policy issues, which aims to transform the Black Sea into a pole of political stability and economic growth in order to expand the climate of peace and security to the Balkan area and further to the Caucasus and Central Asia.

There are three strategic themes, the process comes into contact with the challenges and opportunities in the Black Sea, namely:

Romania's admission into the North Atlantic Alliance and European Union increased responsibilities for security convincing Romanian state border of southeastern Europe. As Romania's border responsibilities, now part of the European Union, but NATO and are in a position to double the operational assertions with mutual determination: Romania's border security responsibilities north-western Black Sea region are equally and the Alliance, and the European Union, as the active logic of mutual determination, as specified responsibilities of Romania subsumes default on the part of organizations, namely the EU and NATO.

Moreover, building a European deep Romanians, a Euro-Atlantic Romania fully and convincingly, democratic country, safe and prosperous, is generally transmitted desire Romania's National Security Strategy.

5. ROMANIA'S ROLE AND STRATEGIC INTEREST TO ASSERT THAT DYNAMIC VECTOR OF SECURITY AND PROSPERITY IN THE BLACK SEA REGION

Specialized studies estimates that Romania "as the state border of the European Union and NATO member, has major interests of the neighbor countries stable, democratic and prosperous because they are only capable of maintaining peace and understanding between them, creating regional community pluralistic, and have a predictable behavior in security, allocate is that the current geopolitical and geostrategic context, "the building of security and prosperity in the Sea. Black is a direction separate action of this strategy".

In fact, Romania's strategic interest to the Black Sea region and the wider Black Sea region is stable, democratic and prosperous, closely connected to European and Euro-Atlantic structures. Subsumed this interest, the strategic objective - the dynamic array of democratic security, stability and prosperity - is to stimulate greater involvement in European and Euro-Atlantic region.

Arguments Romania's strategic interest to the Black Sea region lies mainly in the following considerations:

1) In terms of security challenges, the region is a faithful mirror of the new risks and threats and a virtual polygon dangerous for their experimentation. Be mentioned among them: international terrorism, proliferation of weapons of mass destruction and their means of delivery, local conflicts, illegal trafficking of arms, munitions and explosives, drug trafficking, illegal migration and human trafficking, government inefficiency, undermined by endemic corruption and organized crime, democratic deficit and failure characterized by the proper exercise of the powers conferred sovereign states;
2) Black Sea region is the richest part of Europe in separatist conflicts, tense situations, disputes and probably one of the densest in the world;
3) Cross-border crime is a reality of the region. Criminal activities of this nature takes place on land and water, have connections with international terrorist groups and regimes are favored by separatist and illegal presence of foreign troops in the new democracies.

Countering these risks and threats is a primary responsibility of the Black Sea littoral states. They must be, first, fully aware of these dangers and are required to develop internal policies, external security and able to neutralize the negative phenomena within their borders and to refrain from supporting in any kind of separatist movements, extremist or terrorist organizations, criminal activities. Black Sea countries must cooperate actively and effectively, to promote measures for increase confidence in the region and fulfill in good faith the obligations on conventional arms reduction and withdrawal of military forces stationed illegally in other states.

6. CONCLUSIONS

The meaning of the claim based on the indivisibility of security in the Euro-Atlantic area, in accordance with the requirements of globalization, the need for equal treatment for all entities that have interests in the area - including NATO and the U.E. Romania believes that the Black Sea region is a geopolitical space open international democratic community, where the allied, partner and friend states can fully manifest.

In accordance with this aim, Romania promotes actively the necessity of a Euro-Atlantic strategy for the Black Sea region, taking into account the experience of NATO-EU in the stabilization process of Southeastern Europe and need a balance capable of promoting democratic option of states, to prevent worsening risks and threats and to contribute effectively to resolve conflicts and tensions. Enlargement of EU responsibilities in stabilizing and rebuilding the region, strengthening the presence and contribution of NATO and PfP programmer at the processes of promoting democracy, peace and security, and presence in the region some operational capabilities of U.S., are factors capable to contribute for substantiate such a strategy.

7. REFERENCES

[1]. ANECHITOAE, C., *Geopolitica sistemelor maritime – note de curs,[Geopolitics marine systems - course notes]*, Editura Militară, [Military Publishing House], Bucureşti, 2008.

[2]. VICOL, S., *Geopolitică şi geostrategie în Regiunea Extinsă a Mării Negre [Geopolitics and geostrategy in the wider Black Sea]*, Editura CTEA [Publisher CTEA], Bucureşti, 2008.

[3]. *** *Doctrina pentru operații a Forțelor Navale – S.M.F.N. [Doctrine for Operations of the Navy]*, Editura Statului Major al Forțelor Navale [Publishing of Navy Staff], Constanța, 2007.

[4]. Recomandarea 65/2002 a Adunării Băncii de Dezvoltare şi Comerț a Mării Negre [Recommendation 65/2002 of the Assembly Commerce and Development Bank of the Black Sea]

[5]. Raportul Consiliului Suprem de Apărare a țării privind activitatea desfăşurată în anul 2007, în Şedința CSAT din 17 aprilie 2007 - Hotărârea nr.62, [Report of Supreme Defense Council on activities of the country in 2007. Document adopted in theCSAT meeting on 17 April 2007, Case High School 62].

THE ACCESS OF FOREIGN MILITARY VESSELS IN TERRITORIAL AND PORTUARY WATERS OR IN COMMERCIAL PORTS

[1]GRIGORUT CORNEL, [2]ANECHITOAE CONSTANTIN, [3] GRIGORUT LAVINIA-MARIA

[1,2,]*University "Ovidius", Constanta,* [3]*National Institute of Economic Research "Costin Kirițescu", Bucuresti, Romania*

ABSTRACT

According to art. 19 of Law no. 17/1990 regarding the legal status of inland and marine waters, the territorial sea, the contiguous zone and the exclusive economic zone of Romania, in the territorial sea, the inland and marine waters and ports of Romania, the access of any vessel, which has nuclear, chemical weapons on board or other weapons of mass destruction or which carry such weapons or ammunition for them and any other goods or products prohibited by Romanian laws, of is banned. According to art. 20 of the same Law, the foreign nuclear-powered vessels can enter ports or roadsteads only with the prior approval of the competent Romanian authorities, which will be requested at least 30 days before their arrival.

Keywords: *Territorial waters, maritime and river ports, civil and military vessels.*

1. PORT WATERS

The international rules govern legal national and international relations between countries, on the use of national and international non-maritime waters (rivers, lakes and canals) [1]. A national water course watercourse is the watercourse composed of inland non-maritime waters and inland maritime waters [2]. Inland non-maritime waters include: water courses (rivers, streams), lakes and canals, except those under international regimes (international channels). Inland maritime waters include: inland seas, bays and baths, water ports, port roadsteads; maritime waters between the shoreline and the territorial sea baseline.

1.1. The harbour approach channel

The harbour approach channel is more or less determined by geography, local conditions and circumstances. If there are more possible variations of the route, the one which allows a smooth sailing is chosen.

In practice, the choice of the route leads to a compromise between the hydraulic and navigational aspects and the technical equipment on land and on the vessel, necessary to the vessels' guidance. The entrance runway must be oriented so that the wind blows on the vessel's bow and that the vessel is not obliged to return, to reach the wind broadside or to dock with the wind blowing from the stern.

The route should be as straight as possible; a single curve is preferred to a succession of curves at small intervals. The fairway will follow the mainstream direction and, in case of rising sea levels, when large vessels arrive, it is advisable to meet frontal currents.

When passing under bridges etc., the fairway will have a clearly marked route on a straight length of at least 5 vessel lengths on each side of the crossing vessel. The minimum waterway width can not be reduced.

The interior access construction must be aligned with the navigation fairway shaft.

We must avoid locating the lock or the access to the roadstead at the middle of the landing front because this reduces the useful length; in the access area, buildings will be provided with rounded corners, protected with shock absorbers.

On the route or in ports, accidents can occur, leading to traffic breaks or to collision risks. For each fairway there is a *"critical point"* from which the vessel can not stop, turn or evacuate the fairway.

1.2. The Port Manhole

The Port manhole is used for the arrival and departure of vessels in and out of ports and it is the most difficult area that a vessel covers on its access route to the port [3]. It must be wide enough to create favorable conditions for the safe movement of vessels in all weather conditions and water surface agitation.

In order to ensure the maneuver capacity, the access speed of the vessel will be 15-20 km/h [4]. An increase in vessel speed would provide for more stability but it has the disadvantage that it leads to a longer stopping length, affecting the interior design of the port. At the same time, the manhole must have a width as small as possible, in order to limit the propagation of waves, silt and ice.

Ports have usually one manhole. In large ports, depending on the traffic size and extent of the coastal zone, two or three entries may be taken. This solution may be necessary in order to facilitate the vessels' maneuvering if the waves and the wind have frequent direction changes. The manholes have different orientations and the vessels can use them depending on the storm propagation direction. The existence of several manholes facilitates both the access and the entrance of silt in the port.

2. TERRITORIAL WATERS

The territorial waters are a sea portion which extends along the shores of a State and over which the coastal State exercises its sovereignty. The coastal State sovereignty is extended both over territorial waters and on the soil and subsoil covered by them and over the air space above them. The width of territorial waters is established by the coastal State law, taking into account its economic interests and those concerning the protection of its security; in general, the breadth of the territorial sea, fixed by different States, ranges from 3 to 12 nautical miles. The Romanian territorial waters expand over 12 nautical miles (22.24 m), from the seashore to the sea. The sovereignty right over the territorial waters of the coastal State was established by the rules of international law and the national legislation of a large number of States. This principle was confirmed by an international convention concluded in 1958 in Geneva, at the conference for encoding the Law of the Sea, convened by the United Nations; under its sovereignty, the coastal State has the exclusive right to fish in the territorial waters, to exploit the natural riches of their soil and subsoil, to exercise customs and health control, police rights etc. The UN Convention on the Law of the Sea signed at Montego Bay (Jamaica) on 10 December 1982 integrates the previous provisions, leaving the right to the sovereign State to set the inner sea width which shall not exceed 12 nautical miles, measured from baselines (Article 1, section 1 in conjunction with art. 3). Within the territorial waters, there are applied the laws and regulations of the coastal State and its jurisdiction.

2.1. The access of foreign warships in territorial waters

Foreign trade vessels are allowed to pass through territorial waters, provided that the coastal State law on the harmless passage is observed.

Warships can not pass through the territorial waters of a foreign State without its prior authorization. There are exempted only the cases of force majeure, when the entrance of a foreign warship in the territorial waters is necessary because of damage or storm berthing. Foreign warships which have been permitted to enter the territorial waters are bound to observe the coastal State laws and may be forced to leave the territorial waters in case of law infringement. However, foreign warships have immunity from the civil and criminal jurisdiction to the coastal State. Foreign submarine ships can navigate only at the surface.

2.2. The access of foreign military vessels in port waters and ports

Military vessels can enter only under the prior authorization of the State port, which may impose restrictions on the number of vessels and on their stay. Military vessels can still enter without authorization in case of force majeure (storm, damage etc.) or if the head of their State or the diplomatic representative accredited in the country of respective port is on board.

Military vessels shall enjoy immunity from criminal and civil jurisdiction; they can not be seized, confiscated or requisitioned. Therefore, offenses committed on board, between crew members, shall be punished according to the laws of the State which the vessel belongs to. If a criminal takes refuge on shore, he must be delivered to the vessel master. The jurisdiction immunity of the vessel extends to the members of State crew when they are ashore, in uniform and under their official titles (during service or in connection to it). In case of desertion, crew members can not be arrested by the vessel master; deserters' remission is not obligatory for the State of residence.

Warships which have been permitted to enter the port waters of a foreign State enjoy immunity from both civil and criminal jurisdiction. These vessels can not be seized, confiscated or requisitioned.

The offences committed by crew members are punishable under the laws of the State which the military vessel belongs to. The vessels in the port waters of a foreign State are bound to observe the regulations of the coastal State. Foreign private commercial vessels are subject to the civil and criminal jurisdiction of the coastal State. However, the order on board is governed under the laws of the State whose flag the vessel flies, and the coastal State shall exercise criminal jurisdiction over the crew of a foreign vessel in its ports only if the offense committed harms the public order of the coastal State or if the vessel master called on the support of local authorities. According to international law, state-owned commercial vessels in foreign port waters enjoy immunity from civil jurisdiction, i.e. they can not be seized, requisitioned or followed for the execution of civil obligations.

State vessels assigned to non-commercial purposes (sanitary vessels, customs control vessels, vessels for scientific research etc.) are generally treated as warships as regards their regime in the water of foreign ports.

3. REFERENCES

[1] We consider appropriate to use the word national or international rivers, although, etymologically, it would be more appropriate to talk about national or international non-maritime waters, as the lakes and channels are not rivers or, *stricto sensu,* watercourses. Also, the international river law includes river groundwaters.

[2] SCĂUNAŞ, S., *Drept internaţional public*, C. H. Beck, Bucureşti 2007, p. 244.

[3] „The Manhole" of Port Tomis has the width of 65 m, oriented towards South-East.

[4] CIORTAN, R., *Amenajări portuare*, „Ovidius" University Press – Constanţa, 2001. p. 226.

[5] GRIGORUT, C., ANECHITOAE, C., et alii, *Management issues for the safe operation of ships and for pollution prevention,* In: RIZZUTO, E., *Sustainable Maritime Transportation and Exploitation of Sea Resources,* CRC Press A BALKEMA BOOK, Italia, 2011, pp. 941-944.

PORT PRACTICES

[1] GRIGORUT CORNEL, [2]ANECHITOAE CONSTANTIN, [3] GRIGORUT LAVINIA-MARIA

[1,2]*University "Ovidius", Constanta,* [3]*National Institute of Economic Research "Costin Kirițescu", Bucuresti, Romania*

ABSTRACT

Commercial practices are practices or rules applicable to contractual relations between the participants to international trade activities. Commercial practices require a determined objective element of a particular practice, attitude or behavior. They are characterized by: continuity, consistency and uniformity and require duration, repeatability and stability. Depending on how many partners apply them, practices differ from the habits established between certain contracting parties.

Keywords: *Port practices, conventional practices, normative practices.*

1. DEFINITION OF PRACTICES

The practice represents a long practice (attitudes, behavior), which has some degree of experience, repeatability and stability, applied to an indefinite number of traders, which may or may not have the character of a source of law [1]. In laws where the practice is maintained as a source of law, next to the commercial written law, there is no problem of interpretation. In the absence of written provisions, the practice will be applied, just as the written law, with the same binding power. In some legislations (Italian law), these general, local or special practices appear under the formula of *"use"* [2]; in Romanian law, the term is mistaken for that of *"custom"* [3], and in international trade law, the term used is "*practice*"[4]. Regardless of terminology, these practices have:

- a general, collective, impersonal and repeated nature, applying to an indeterminate number of traders, on a given territory, or on a particular product category. By means of their general, collective, impersonal and repeatable nature, practices are similar to legal rules but, unlike them, they cannot be sanctioned by the State. Practices are rules of conduct, created by traders in their commercial practice;
- an objective nature, meaning that they are reflected in legal documents and material facts (positive, negative), which were applied repeatedly over a longer period of time. The age, the continuity, is the essence of practices.

2. CLASSIFICATION OF PRACTICES

Commercial and maritime practices are divided according to their legal force in:

- normative practices (legal, customary law), in international practice and
- conventional practices (interpretative, of fact) [5].

Another criterion for the classification of practices refers to the extent of their application in space; from this perspective, practices can be:

- **local,** when applied to a specific commercial market, port etc.;
- **particular** those relating to a particular industry, or products (wood, cereals, fruits);
- g**eneral,** when applying to all commercial relations.

2.1. Normative practices

The particularities of normative practices are expressed by: generality, impersonality and obligation. These practices represent a source of law and are applied as a legal norm. They determine the rights and obligations of parties, governing social relations, yet not covered by law, or interpreting the provisions of law; in some cases, practices are applied against a legal disposition, which is not of public order. Trade practices and rules made at trade fairs, especially in maritime trade, have been incorporated into collections. Among them most important are the *Roles d'Oleron,* which include maritime practices applied in the Atlantic Ocean, *Consulat de la Mer* or *The Tables from Amalfi,* which include maritime practices in the Mediterranean Sea, *The Collection from Wisby,* comprising commercial practices applied in Nordic markets; *Guidon de la Mer,* which include provisions relating to maritime insurance [6].

2.1.1. The scope of the normative practices

The scope of normative practices is both contractual and extra-contractual *(eg. Port practices or scholarship practices).* The normative practices, where recognized, have the value of non-imperative legal rules. Parties may decline to apply normative practices by establishing clauses contrary to their content, within the contract. In terms of proof, normative practices are presumed to be known just as the law, being applied by the judge, even ex officio.

3. PORT PRACTICES

Port practices have a uniform nature; when applied continuously, by the mutual consent of parties, they gain local law value over time [7].

The arrival of vessels in roadsteads, their stopping at the anchor, their entering and leaving the port – are made under the rules and regulations established [8] by each country, for all ports (with or without implementing them regionally or internationally), or differently, for categories of ports, or by special rules applicable to a single port [9]. In order to be recognized, port practices must meet certain conditions:

 are well defined and uniformly applied in order to allow a certain and safe interpretation of the charter party, and in order to be used equally, in all situations;

 are fair, in order to be considered valid and recognized by courts in case of disputes, unless the party which made the complaint knew this practice and it is proven that it had accepted it, even tacitly;

 are consistent with the principles of law, because circumstances may arise when the "port practices" come in conflict with these principles, or even with some local rules and can not get an applicable general nature.

Foreign laws can not affect "port practices". In the absence of a contrary agreement (C / P), the laws of a State regarding the establishment of fines for cargo embankment delays can not be applied in a foreign port, whose practices provide other rules. *"Port practices"* refer particularly to:

 the legal holidays of the State, that are mandatory for any vessel;

 the means of introducing the vessel into the port and docking it to the operating berths;

 the means of establishing the fines for cargo embankment delays and for establishing the details of loading and unloading of vessels;

 the official office hours and work hours in ports;

 the number of the exchanges of working crews;

 the working hours;

 the obligation of using crane operators and time keepers;

 the means for interpreting contract provisions or trade terms;

 the means for taking delivery of goods;

the means for vessels' bunkering;

 the means for applying port taxes - sometimes, depending on the nature of the vessel's tonnage certificate.

"The port practice" is a constant source of dispute between the vessel and the charterers, receivers or loaders. Thus, in some ports, according to the practice:

 the unloading is done on the quays, or in port warehouses, under the supervision of local time keepers; the goods remain under customs control;

 the proof of delivery of goods (of the vessel) is not signed yet and, contrary to the terms of the bill of lading, or of Hague Rules of 1924, the complaints about defaults or damaged goods are presented long after the vessel departure.

Therefore, clocking is not made in contradiction to the vessel. If the discharge of goods is made in warehouses, the risks during their transportation to dry land can come to the vessel, under "the port practice", contrary to the terms specified in the bills of lading and Hague Rules, which state that the risk for the vessel stops once with the passage of goods across the vessel's over-side. Also, according to the port practice, and especially in English ports, the rules for loading or unloading shall be subject to a number of factors which make it impossible to collect the demurrage. *"The port practice"* varies from one port to another, even across the same country. Thus, in some English ports, practices do not refer to the rapidity, or norm, wherewith vessels should be loaded or unloaded, but covers only the means for delivering or taking delivery of goods; despite the principles of law, local courts gave numerous decrees against vessels when only the interested party imposed the enforcement of "the port practice", in contradiction to the provisions of the bill of lading [10]. "The port practice" can not go before the clauses in the charter party.

In other ports like Antwerp - Belgium and Kotka – Finland, the practices interpret the "F.O.B." Clause, i.e. the goods are stored "somewhere on the shore", near the vessel and not on the vessel, and sometimes the "alongside" clause (v), i.e. the goods can be delivered to the vessel at a greater distance than the one reached by the derrick; the reach "under the garnet" is made on behalf of the vessel.

In some English ports, and especially in London, the "alongside" clause implies that the vessel is not forced to dock at a certain loading berth, but, in the lack of an operational berth, it may remain on the river, where shippers are bound to bring the goods in barges etc. and to load them on the vessel. In most English ports, at Anvers and in the main Greek ports etc., port practices require the vessel to use port bailiffs.

In English ports, port fees are reduced by 20% if the vessel uses an English tonnage certificate. The clause "under the port practice" is not favorable to vessels.

Regarding the category of normative practices, it is known that, in the interwar period, they had the force of law. Under them, the court could decide outside contractual provisions. Later, however, it was adopted the view that port practices were designed to interpret or supplement the terms of contracts of carriage by sea, with a sense of (interpretative) "conventional practices".

4. REFERENCES

[1] SNGHENI, S., VOLONCIU, M., STOICA, C., *Drept comercial*, Ed. Universitară, Bucureşti, 2004, p. 21.

[2] Vivante, C., *Principii de drept comercial,* Ed. Cartea Românească, Bucureşti, 1928, p. 19.

[3] CĂRPENARU, S. D., *Drept comercial român*, Ediția a IV-a, Ed. All Beck, Bucureşti, 2002, pp. 16-17.

[4] CĂRPENARU, S. D., *Dreptul comerțului internațional,* vol. l, Ed. Actami, Bucureşti, 1995, pp. 98-99.

[5] VOICU, M., VERIOTTI, M., *Uzurile maritime şi portuare. Regulamentele uzurilor în porturile româneşti Brăila, Constanța şi Galați* - din anii 30, Ed. EX PONTO, Constanța, 1999, pp. 315-380.

[6] MACOVEI, I., *Instituții în dreptul comerțului internațional*, Ed. Junimea, Iaşi, 1987, p. 26.

[7] BIBICESCU, G., et. Alii, pp. 173-174. (eng. Custom of The; Fr. Usage du port; Ger. Gebräuche des Hafen, Gewohr heitsrecht; Sp. Costumbres del puerto).

[8] MIRCEA, T., *Exploatarea comercială a navelor şi porturilor maritime***,** Ed. Didactică şi Pedagogică, Bucureşti, 1978, p. 151.

[9] ANECHITOAE, C., *Introducere în drept portuar*, Ed. Bren, Bucureşti, 2007, p. 45.

[10] PANDELE, A. L., *Conosamentul*. Bucureşti, Ed. C. H. Beck, 2006, p. 22

.

THE SYSTEMATIZATION OF MARITIME AND PORT LEGISLATION

[1]GRIGORUT CORNEL, [2]ANECHITOAE CONSTANTIN, [3]GRIGORUT LAVINIA-MARIA

[1,2]*University "Ovidius", Constanta,* [3]*National Institute of Economic Research "Costin Kirițescu", Bucuresti, Romania*

ABSTRACT

Professors I. Ceterechi şi M. Luburici stated that, in general, a classification of law systems according to the criterion of law is a historic and fundamental classification and it represents the key to understanding the law in its historical evolution. A significant influence on the formation of the legal systems of Western countries had some of the oldest systems – the religious systems and "the canon law". Following Antony Brunetti's systematization, in terms of historical evolution and of the influence more or less exercised by the French Code of 1807, the maritime legislation is grouped into three categories.

Keywords: *The Anglo-American system, the Roman-Germanic system.*

1. INTRODUCTION

The present document contains the instruction for writing the papers published in the Constanta Maritime University Annals. The file has been realized with the use of Microsoft Word, the 2003 version, according to the editing instructions which will be presented as follows. For this reason you can edit your paper in two ways: either you create a new file and then you format it according to the present rules, or you use the commands copy-paste and insert the text of your paper directly into this file. The papers sent to the journal secretariat for publishing will be edited in DOC format. Editing board will convert the Word files in PDF format.

2. THE ANGLO-AMERICAN SYSTEM

The Common-Law is the third largest contemporary legal system and it is a legal system that governs vast territories that go far beyond the limits of Great Britain [1].

The *common-law* system does not cover the entire United Kingdom and Northern Ireland, since, at least in the case of the Scottish law, it is based on principles completely different from the English ones . Likewise, the U.S. law or the Canadian one is not integrally part of the *common-law,* Quebec and Louisiana being important exceptions. The *Common-law* is not fully implemented in Orkney and Shetland Islands. The Isle of Man is governed by an old custom, from the eighth century, while the islands of Jersey and Guernsey, in the English Channel, are subject to several laws of French origin. A characteristic feature of the *common-law* system is also the inexistence of the concept of branch of law [2]. Unlike the German and Roman legal systems, in the English law, the main rules are of jurisprudence origin. By means of the consecration of the judicial precedent, the Anglo-Saxon system knows no division into branches of law. *Common-law* means common law, *and* the State *Law* refers to those acts adopted by the Parliament [3]. The most original aspect of the Common-law is the coexistence of three normative subsystems, which are autonomous and parallel.

2.1. The Common-Law Subsystem

The Common-Law (narrowly understood) contains the rules established by judicial rulings, i.e. rules which are pronounced by courts and which become binding for lower courts in similar cases.

2.2. The Equity Subsystem

Equity is a corrective element brought to common-law rules; it is an attempt of the English law to keep pace with changes in society, with the natural evolution of legal institutions. The Common-Law became, since medieval times, a brake in the emancipation of law. The equity, by means of its terminological essence, expresses the admirable idea that in case of an unjust law, the ordinary citizen can appeal to the king; in fact, the complaints were not solved by the king but by the royal house official, named Chancellor. However, over the centuries, the equity brought essential improvements and additions to several common-law institutions. A fundamental principle which had been introduced was providing that "the violation of law can not remain without punishment" and that equity means equality between the parties to the process.

2.3. The Statutary Law Subsystem

The Statutary law is the third branch which consists of rules of law created by written law. A feature of this branch arises from the fact that the English law knows neither the implied repeal nor the desuetude: this explains why many laws remain in force, laws which have never been repealed and which date for centuries. In constitutional matters, Britain has no constitution, in the sense of a fundamental unique act, in order to regulate its political organization. The Constitution consists of several categories of legal rules that are found in Statutary-Law, the common-law, the constitutional practice (the unwritten law, made up of practices). In this matter, the Statutary-Law has a privileged position, consisting of:

- **Magna Charta Libertatum, enforced** to King John **Lackland**, in 1215, by the rebelled nobles and town people, who secured their privileges, limiting the royal authority.

- **Habeas Corpus Act,** edited in 1679, 20 years after Cromwell's death, asserting the principle of separation of powers (parliament, magistrates and King).

- The **Bill of rights,** developed in 1689, by means of which the Parliament acquired legislative power.

The tripartite division described above, typical to the Anglo-Saxon system, has nothing to do with the Latin division of the branches of law. In *common-law,* in *equity* and in *statute law* there are rules which, in the conception of continental jurists, would be of public law and others which would be of private law [4].

Consequently, the Anglo-American legal system (Common-Law), the laws of the Anglo-Saxon communion, have characteristics influenced by customary rules. This is because within the Anglo-American group of countries there was felt the lack of private law and customary law codifications, crystallized, provided in classic collections of written law. As already mentioned, some written laws, the "State Law" or special laws, have a great importance; they influenced the maritime law, their principles being adopted in international conferences as a "legal basis for the unification of certain institutions of maritime law". Starting from the fourteenth century, the Merchant Law has been recognized as part of the common law of the kingdom. Over time, special merchant courts were replaced by *common-law* courts *and* the commercial right was integrated into the general law. The incorporation of the customary rules of the commercial law configured the commercialization of the *common-law system.*

For England and its Dominions, there are worth noting: the written law – the "State Law" – the Merchant Vesselping Act, of the Merchant Marine Act of 1854, often amended, the 1894 text being in effect today; special laws: the Marine Insurance Act of 1906 amended 1909; the Bill of Lading Act of 1855, the Maritime Convention Act of 1911; the Pilotage Act of 1913, Merchant Shipping; the Carriage of Qoodes by the Sea Act of 1924, which reproduces the Hague Rules of 1921-1922, the Water's Carragee Act for Canada, Australia, New Zealand.

In the United States of North America: the Harter Act of 1893, on the sea carrier's liability; the Pomerene Act of 1916 on the loading policy; the Merchant Seamen's Act of 1915 [6]; the Merchant Marine Act of 1920 known as the "Jones Act" or Bill Jones, amended on May 22, 1928, when it was renamed the Jones-White Act and the "Merchant Marine Act of 1936" [5].

In countries that rely on common law, the judges' verdicts given during the trial of cases *("precedents")* represent an important source of maritime law. The laws made by judges are a fundamental feature of the legal system, in these countries, and the verdicts given in previous cases are seen as a guide for future decision making processes. What is important is that through a case on trial which was given a verdict, it was decided on the ways in which a contractual provision or a statute has to be understood, and what rule should be applied where the statute or the contract is tacit. The essence of the doctrine of the "precedent", as a Supreme Court decision, is binding on other courts, which are located below in the hierarchy, where facts are similar.

The highest authority in making decisions clearly belongs to the courts that are at the top of the hierarchical structure of courts in the countries based on Common law (e.g. the House of Lords in the United Kingdom).

3. THE MARITIME AND PORTUARY SYSTEM OF THE EUROPEAN COMMUNITY

In countries outside the European Community, the decisions of higher courts are only indicative and not binding; in other words, the lower courts are not bound to follow the previous decisions of some courts, situated higher in the hierarchy. Accordingly, a court decision in these countries is seen as a source of maritime law. In Europe, two systems of law have been developed for centuries, systems which have not influenced each other: the continental law and the law of the British Isles. In EU countries there are several systems of law, including the Roman-Germanic law [6] and the English C*ommon Law* - known as the law of the judicial precedent, which are the most popular. The *Common Law* is the work of judges belonging to higher courts and not to the legislator.

Every State that joined the European Community agrees to apply community laws, which annulled the conflict provisions of national laws. The European Economic Community has its own legislation on shipping, under the form of EEC regulations, which once made up, pass directly into the legislation of any Member State, without being adopted by any implementing legislation. These rules are thus the primary sources of maritime and portuary laws for Member States.

4. REFERENCES

[1] *The Common-law* (the term comes from the common ley – the common law) has its origins in the customs used in the context of the Norman Conquest and were maintained thereafter, as a statement of William the Conqueror. ZLĂTESCU, V. D., *Geografie Juridică Contemporană*, Ed. Didactică şi pedagogică, Bucureşti, 1981, p. 124.

[2] The pragmatic spirit that characterizes the English doctrinal law has led to the extinction of differences between different fields of law, that are artificially constructed by the Romano-Germanic civil law system.

[3] MACOVEI, I., *Instituții în dreptul comerțului internațional*, Ed. Junimea, Iaşi, 1987, p. 28.

[4] The full name of the "Seaman's Act" is the "Act to Promote the Welfare of American Seamen in the Merchant Marine of the United States" (Act of March 4, 1915, ch. 153, 38 Stat. 1164).

[5] Kilmarx, R. A., ed. *America's Maritime Legacy: A History of the U.S. Merchant Marine and Shipbuilding Industry Since Colonial Times.* Boulder, Colo.: Westview Press, 1979, p. 9.

[6] The words "civil law" or "Roman-Germanic law" means the great contemporary European legal system which includes first and foremost the French and German systems, then those inspired by them in Italy, Spain, Holland and other states on the continent.

LOCAL HORIZON ENVIRONMENTAL KNOWLEDGE IN CONSTANTA CITY BY PRACTICAL APPLICATIONS ON THE BLACK SEA SHORE

[1]NECULA LILIANA, [2]BOSTINA ALINA

[1]*"Traian" High School Constanta;* [2]*Constanta Maritime University, Romania*

ABSTRACT

A special importance in the study of geography is on the local horizonenvironmental knowledge, the surrounding reality, as human and natural potential socio-economic offer important resources which support the teacher and students but by their direct observation and analysis, can be easily integrated and exemplifiedin the geography lesson. Nature is the medium closest to the student's familiarity with the geographical space..
Students are eager to know more about how develops the local environment and the near horizon environment.

In this paper we proposed to familiarize students with the geography of the near horizon, as well as capacity building, skills: orientation, observation, analysis.

Keywords: *local horizon, practical application, knowledge, landscape.*

1. INTRODUCTION

Didactic teaching extracurricular activities are versatile, designed and organized by the teacher as travel distance and in some places, with a limited duration.

These activities are great ways to:

- Meaningful and educational use of leisure time;
- Training and educating the whole personality;
- Ensure learning and deepening directly, actively and consciously knowledge;
- Training of skills and abilities necessary for their integration into life;
- Dynamics of scientific curiosity, the spirit of investigation, imagination and creative thinking;
- Body hardening and physical development;
- Training of team spirit;
- Fostering courage and initiative;
- Developing the love and respect for natural beauty and man;
- To establish an active attitude to protect and maintain an environment as good (especially the local horizon).

2. TYPES OF ACTIVITIES:

After the form of organization, there are these types of activities:

2.1. Walking- is a journey on foot, at your leisure, in parks, botanical gardens, zoological gardens, in the city to recreate, get the air, to see, discover and explore, for 1-2 hours. The teacher can organize a walk during hours (lessons), after hours or on weekends. The teacher's semestrial activity project include walking, setting operational objectives of the parade, the route, the goals will be considered ready for discussion with students plan, which will lead to the observation questions. Students must know the operational objectives of the parade, the route and rules that must follow.

Sample trips can be made to:

- Archaeological Park
- Park Tanning

2.2. Visiting - is a journey lasting more than one day, in order to meet immediate locality, economic unit exhibits in a museum, a monument of nature or history. Visits can be organized during the time of geography, after classes, weekends or holidays. The teacher must set the goal to visit, to include visits to semestrial activity project, establish operational objectives of the visit, to document the objective of visiting. The teacher should inform students that will be visited on the objective, the operational objectives targeted by this activity will specify the place and time of departure and return, during the visit, will indicate the equipment, protective measures and rules that students must meet. During the visit, students observe, write down observations in their notebooks, ask questions, take pictures, etc.. After the visit, the data will be processed by the teacher and the students form of essays, reviews, discussions, debates, etc..

Thus, you can visit the following objectives:

- Wastewater Treatment Plant "Constanta - north"
- Constanta weather station
- Museum of National History and Archaeology

2.3. Hiking - is a journey lasting more than one day, without means of transport for short distances on foot and aims recreation, physical and psychological recovery in nature, the collection of information by direct observation, immediate knowledge of a natural monument, a natural reserve, landscapes, a lake, a cave, and a man-made target. To make a trip with students, the teacher must establish objective and targeted operational objectives include hiking in semestrial activity project, to establish the route to be covered, to document the target and the route. The teacher must inform students about the goal that will be visited on operational objectives pursued, of course. The teacher will set a date and time of departure and return, will indicate where the meeting will recommend necessary equipment and food (depending on season), and environmental protection standards of the person.

In the studied area can be hiking in the area:

- Beaches of Constanta, Modern beach starting from the head until the Fishery Cape
- From over the sand-belt that stretches Mamaia

2.4. Trip - is a journey outside the city of residence, duration of at least one day a means of transport and aims recreation, visiting, information, study. The teacher sets the goals to be achieved according to the excursion, the route chosen, the goals will be visited, set size and structure of the group includes a trip to the annual or semestrial activity project. The route must include varying objectives to arouse and maintain student interest, provide them with pleasant emotions through the beauty of the landscape, through its uniqueness.

For example, mention trips in the area of natural reserves of:

- Fantanita - Murfatlar
- Valu lui Traian
- Agigea

2.5. Expedition - is a journey of study and research, with a duration of 10-14 days, which is preferably done during the summer outside the city of residence and includes students with interests in targeting the expedition theme: geology, geography, biology, history, ethnography, folklore.

2.6. *Practical applications in local horizon on the black sea shore*

Local horizon features favors the development of practical applications of analysis and interpretation. He is an inexhaustible treasure for applications, observations and research. The local horizon usually means an area determined as the tension surrounding the city of residence.

We must first distinguish the local horizon wich is reduced to very near the school or the entire city where the school is. Then comes the closest local horizon wich can be extended curse of 5-10 km, enough to be crossed on foot round trip for one day without needing overnight accommodations. Over 15 km away is the local horizon which can not be limited in practice than the outside of vehicles. Some authors delimit the local horizon based on scientific, geographic criteria whatever the degree of accessibility and travel possibilities. Thus, Mrs. Professor V. Velcea defines it as "a conventional area or well-defined territorial unit by certain criteria, in which global or detailed research enables the identification of mechanisms for phenomena and processes, dynamics and directions of evolution."

Applied lessons are the foundation of geographical concepts of conscious properties, of their fixation; we can generate in students an attachment to their native places. Visits and trips to the local horizon leading to acquiring thorough knowledge on the formation of correct scientific concepts and representations, the formation of work habits and civilized behavior. In these activities, students can develop their skills of observation, analysis and interpretation of phenomena and processes, causes, how they conduct and the effects of these phenomena.

Also, students are awakening the interest for study, research, the wish to know more, to know, to be informed.

To achieve all goals, the teacher must study sites first and then to extract the characteristic features of different routes of practical applications.

As an example of how the lessons can take place , trip with students to know the local horizon we will present some possible practical applications can be made on the coast between Constanta and Navodari, and in the region nearby.

1. In the **local horizon relief** direct investigation involves:

- Mapping of specific phenomena: for example, degradation processes and modeling of self seawall and beach silt accumulation on the streets of the city after every heavy rain, etc.
- Photographing and interpreting photographic documentation of phenomena with a greater degree of spectacle;
- Achieving some direct measurements (this is especially true for the slopes with gravitational processes);
- Achieving geomorphologic profiles;
- Completion of geomorphological chips;
- Achieving some sketches and maps;

Practical applications on a quality embossed lead to accurate and easy notions about the forms of relief, especially to the coast, the action of external agents on the earth's crust, etc..

Observations on the relief of local horizon can be made, for example, on the coast between Casino of Constanta and Perla Hotel in Mamaia.

1. From the cliffs (35-40 m) high coast is observed almost linear. Morphologically, Dobrogea region is complex maritime coast carried out two sectors joined the East-West:

- The cliff - a sector level, currently emersion, which formed in the geological past area ongoing processes marine transgression and regression, but which now dominates the aerial modeling process ;
- The continental shelf (self) - immersive, but temporarily dry in the past (the Quaternary), where the accumulation and erosion processes predominate underwater.

The interaction of land – modeling agent have resulted in a number of forms and processes of degradation and modeling of self seawall and beach.

Through observations and discussions directed students can highlight the main geomorphological processes and forms, namely:

- Processes and marine forms: abrasion - due to currents and waves, more powerful in the south of the coast, and precipitating - extensive beaches, especially north of the Fishery Cape.
- Processes and forms of gravity: easily observed in the south coast due to slope inclination, the loess property falls off prismatic columns and

groundwater occurrence impermeable clay horizon of the loess. There are frequent subsidence, slumps, landslides, piping.

- Anthropogenic processes and forms: visible through out the sector under observation - consolidation of banks, development projects and defense of the cliff, protection dikes, breakwaters, etc..

It can also do exercises with the guidance map, map of confrontation with reality on the ground, you can take pictures, panoramic drawings can be done.

2. **At the beach** you can follow, using a column stratigraphic geology of the area and found that the Sarmatian formations, represented by limestones and calcareous sandstones, outcrop, being trapped in anticlines and synclines wide undulating system oriented almost shore line.

It can perform measurements of the thickness of rock layers, taking samples of rocks, indicating the importance of sedimentary layers for measuring time and the documents underlying the research (fossils and layers thickness). Thus, over the Sarmatian limestones can be observed gips-clay layers, followed by thick sandy clay and loess formations then, about 20 meters thick.

Opinion can be questioned on the origin of C. Bratescu opinion about the four loess horizons corresponding to the four phases of glacial and fossil soil horizons, corresponding to interglacial stages.

Also on the beach can make determinations of particle size and chemical composition of the sand.

North of Fishery Cape, is seen the sand-belt enclosing lagoon Siutghiol (Mamaia), where the resort of Mamaia was built. Students will explain and observe that the old Black Sea coast, a high shore, with cliffs, is located on the western shore of Lake Siutghiol.

3. Knowing the **local climate horizon** is very important for the organization of human social activity. Items that are useful for understanding local climate horizon refers to:

- Genetic factors;
- Climate factors (mean annual temperature, warmest month temperature, etc..) And the existence of local weather phenomena (frost, drizzle, frost, mist, hail, thunderstorms, fog);
- Topoclimatic and microclimatic differentiation;
- On these outstanding results plus the observation of empirical phenomena.

Information about the elements that define the local climate horizon is based on measurements made at meteorological station situated in Constanta, on the extrapolation of data and on some scientific or empirical observations (with the help of simple tools).

To better understand how to obtain data on air temperature (average monthly and annual absolute maximum, absolute minimum, the number of days with temperatures above 30 ° C, etc..) Is a visit to the meteorological station of Constanta. There, students learn about weather characteristics of the plant, equipment with various measurement devices (thermometers, barometers, pluviometres, psychrometers, the device for measuring direction and wind speed).

In terms of empirical observation as the students observed in this area is low rainfall, the predominant circulation of air masses from the east and north-east (the chill wind, a dry summer and frosty winter wind). Students also noted that because the Black Sea, foggy periods are more frequent than other areas of Dobrogea, and in their proximity, humidity is higher, the temperature is less excessive daytime; freezing takes about 76 days per year and there are also over 100 days of summer.

4. Applications to study the **hydrographic components** are watching the Black Sea coast, the estuary and lagoon-type lakes.

Since the city borders the Black Sea, students are familiar with the notions of seaside promenade, beach, waves, currents, etc.. Greater focus on concepts related to land interaction - modeling agent, and the unique aspects that make the Black Sea, namely in terms of biotic stratification (related to the absence of vertical currents) and in terms of salinity (due to exchange Mediterranean Sea water).

On water clarity and color, stands out about the weather, flora exist in seawater, with alluvium brought by the rivers flowing into the Black Sea and not of last row, with discharges from anthropogenic activities. In summer, certain periods, closely linked to sea water temperature, currents and the direction of oxygen in the water level is apparent and the development of different types of seaweed.

In the winter of 2006, due to very low air temperatures, students could observe the phenomenon of frost on the Black Sea, rare and spectacular. Also, closely related to air circulation, over the year, have seen various degree of agitation of the sea and how it influences the movement of ships.

Analysis of standing water body to identify the type of basin, identifying changing water levels under natural conditions, the use of lake waters, the observation of phenomena related to pollution, frost, vegetation and fauna wet environments, and the realization of a bathymetric profile graphic representation , knowledge and learning how to measure the depths of execution, etc.. To do this, students can travel to the lakes: Tabacarie, Siutghiol, Tasaul.

5. The analysis of the **local horizon biotic** enjoys special attention from students. The trips are group reservations Fantanita – Murfatlar and Valu lui Traian, observing the specific vegetation and fauna of forest and grassland, as well as human interventions on the aftermath of the coating were not quick to defend.

Thus, practical application in forest Fantanita - Murfatlar is to: observation of natural vegetation, soil type correlation with elements of vegetation, observation of human interventions and natural changes on vegetation.

Deployment of the application consists of:

- Determining the locations where observations will be made (in the forest, to 10 m inside the forest, to 20 m inside the forest);
- The types of observations that will make students (and the influence of light from inside

the forest edge, the edge temperature variation in the interior; appearance of forest vegetation)

Practical Reserve Valu lui Traian, emphasizes characteristic formation of steppe vegetation, with a particular interest to enjoy this land tortoise, submediteranean element. In these trips can be observed and other specific elements of wildlife, such as ferret, the bustard, snakes.

Students see both the positive aspects of human intervention on the natural environment, endless vineyards such as vine varieties Murfatlar superior, but also negative ones such as high levels of pollution resulting from forest visitors. Students can print their desire to participate in an action of greening the area.

6. Hiking means also the observation of the **types of soils** and their characteristic profiles, the use and transformation underscores the correlation between soil, vegetation and fauna.

Thus, observing the light color of the soil in our area (the study of a soil profile in the cliff north of Constanta), have students explain the notion of chernozem steppe, which are plants that can grow on it. It highlights the fact that this type of soil fertility decreases (because of porosity) in the absence of rainfall, so irrigation is required as necessary. Also observed in coastal psamosoils developed on sandy substrate. You can make comparisons between the steppe lands covered in the past and use today and those in most modified by human actions (tillage, terraces, irrigation, fertilizers, pesticides).

7. Applications on **population and settlements** are slightly accomplish in Constanta city by visiting the most important objectives. Students can be divided into two teams to investigate the past, and the other the present in the history of this city. Students can study the town-monography and can talk to older people can go to city hall to obtain the latest census data on mortality, birth, nationality, etc. Based on statistical data obtained we can calculate the natural balance.

They explain the concepts of the built-in, the metropolitan area, the movement of people (come and go) for the city of Constanta, because its function is a port and tourist attraction for people from many parts of the country.

Students can collect data about economic activity on the branches of the economy and the products made.

Also, students can collect data about tourist-activity in the town, so the statistical service of the mayor and the county tourist information center, on which to make charts on the evolution of tourist activity in the last three years.

3. CONCLUSIONS

It can be said that the applications made, geography becomes a concrete object, easily accessible to students, developing their sense of observation, assessment and interpretation of natural phenomena and social relations between them, logical thinking, love and care from their native places.

Can also be concluded that:

- Regardless of the venue of the lesson, this is the basic form of transmission of knowledge and learning.
- Regardless of the type of lesson (communication of new knowledge, practical skills training, fixing, checking and control, etc.) Must establish goals and techniques work most effectively, leading to best results for students.
- New knowledge must be reported and is always related to prior knowledge.
- Lesson content must have a strong scientific without being charged or heavy.
- Learning methods and means must be as varied in order to maintain students' interest in knowledge always awake. Emphasis must be placed on practical activities, personal discovery, which stimulates creative thinking
- Contents lessons must be continually updated.

The teacher must work with students in the learning process. The teacher should be the leader of the activity, process coordinator, it's protagonist. Nature is the medium closest to the student's familiarity with the geographical space. Students are eager to know more about how evolves the local environment and the near horizon.

4. REFERENCES

[1] Dragan, M., (2002), *Constanta si imprejurimile ei - ghid turistic*, Ed. Ex Ponto, Constanta;

[2] Dulama, M., E., (2001), *Elemente din didactica geografiei*, Ed. Clusium, Cluj-Napoca;

[3] Ilinca, N., (2006), *Elemente de didactica aplicata a geografiei*, Ed. CD Press, Bucuresti;

[4] Iancu, M., (1966), *Consideratii fizico-geografice asupra Dobrogei maritime,* in Dobrogea maritima, S.S.N.G, Bibl. Geogr., 4;

[5] Zotta, B., (1995), *Geografia municipiului Constanta*, Ed. Muntenia, Constanta

THE SOCIO-ECONOMIC IMPACT GENERATED BY THE IMPROVEMENT OF NAVIGATION CONDITION ON THE ROMANIAN - BULGARIAN COMMON SECTOR OF THE DANUBE

NEDEA PETRONELA-SONIA

Faculty of Touristic and Commercial Management, "Dimitrie Cantemir" Christian University, Bucharest, Romania

ABSTRACT

The Danube River in Romania and Bulgaria is an important section of the Pan-European Transport Corridor number VII. The river connects the Black Sea with the hinterland from Romania and Bulgaria to Hungary, Austria, Germany, etc. However, in the periods of summer–autumn, the water flows are decreasing considerably on this river section, resulting in difficult navigation conditions. In the main branch of the Danube, the minimum depth for navigation is not met everywhere, resulting in dangerous navigational conditions and economic uncertainty about this transport route. The reasons for this very unfavourable situation for navigation are mainly related to morphological and hydrological phenomena. The project named "Technical Assistance for Improvement of Navigation Conditions on the Romanian – Bulgarian common sector of the Danube and accompanying studies" is part of the more global Danube navigability project in order to improve the Pan-European Corridor no. VII as it aims to improve the navigability of the Danube River in such a way that it will answer to the needs of the national transport policy of Romania as well as the countries' international commitments. The impact on the socio-economic environment will be analysed for the following section on the Danube River: Iron Gate II to Romanian/Bulgarian border at Calarasi – Silistra, where previous studies have identified a number of specific navigational constraints. After completing the investment works in the sites from critical sectors for navigation, the impact will be positively, both from economic and social point of view. Positive effects begin to occur during the construction period when the works are finalized in each site. Carrying out the proposed works contribute to fulfil the obligation from the Convention on navigation regime on the Danube, which provides the commitment of the Danube states to maintain their sectors on the Danube, under navigability conditions for inland ships, and to execute the works necessary to ensure and improve the navigation conditions.

Keywords: *Pan-European Transport Corridor no. VII, navigation improvement works, the impact on the socio-economic environment*

1. INTRODUCTION

Project name - ISPA 2005/RO/16/P/PA-002/01 "Technical assistance for the improvement of the navigation conditions on the Romanian-Bulgarian common sector of the Danube and accompaniyng studies". Section 1: Iron Gates II - Silistra (rkm 863 - 375).

Initiator of the project - On May 3td 2007, the Ministry of Transports in Romania awarded the contract "Technical Assistance for Improvement of Navigation Conditions on the Romanian – Bulgarian common sector of the Danube and accompanying studies". The European Commission endorses the contract for co-financing in accordance with the limits of the Financing Memorandum ISPA measure 2005/RO/16/P/PA/002.

Aim of the project. This project is part of the more global Danube navigability project in order to improve the Pan-European Corridor no. VII as it aims to improve the navigability of the Danube River in such a way that it will answer to the needs of the national transport policy of Romania as well as the countries' international commitments. To meet these requirements the project covers the following areas:

- Section I: Iron Gate II to Romanian/Bulgarian border at Calarasi – Silistra, where previous studies have identified a number of specific navigational constraints; for Section 1, the project is carried out with the purpose the ensure the necessary parameters of the navigable channel on the Danube (Fig. 1), especially in zones with islands and alluvial deposition.
- Section II: The port of Tulcea sector between Ceatal Ismail – Braila to Ceatal Sf. Gheorghe – Sulina Channel, where navigation conditions are hampered by sedimentation of the harbour and a curve (R=700m) with limited navigation width;
- Section III: Danube – Black Sea Canal and the Port Alba – Midia Navodari Canal, where poor design/construction has resulted in stability and erosion problems of the high embankments / escarpments defining the channels and where canal infrastructure needs improvement;
- Section IV: Detail Design, Works Tender Documents and Cohesion Fund Application for the extension of Calafat Port Infrastructure and systematization of the Port rail device.

Timing of the project. The execution period of the planned works is estimated to start in the year 2012. The works will be carried out one by one, during several years. The designer has considered the execution of water constructional works within two stages. Works provided within the second stage are estimated to begin in the year 2018, and will be completed in 2022.

2. SCOPE OF THE PROJECT

The project has the purpose to propose works that are within the category of successively taken measures, starting from before the year 1900, for maintaining the navigation channel which allows ship access and transport of goods along the Danube between the Black Sea and the Danubian ports, to Central Europe and Western Europe.

The specification of a technical solution within the project is necessary for continuing to provide adequate navigation conditions along the Romanian – Bulgarian common sector of the Danube and access among Danubian riparian countries and the Black Sea. The project contributes to maintain river channel stability on some stretches, which is important for maintaining the necessary conditions in the navigable channel.

Also, the project is in line with European policy to improve navigation on inland waters, as a measure towards sustainable development. Continuing the present activities (zero alternative), without other measures, has negative direct or indirect effects on economic activities.

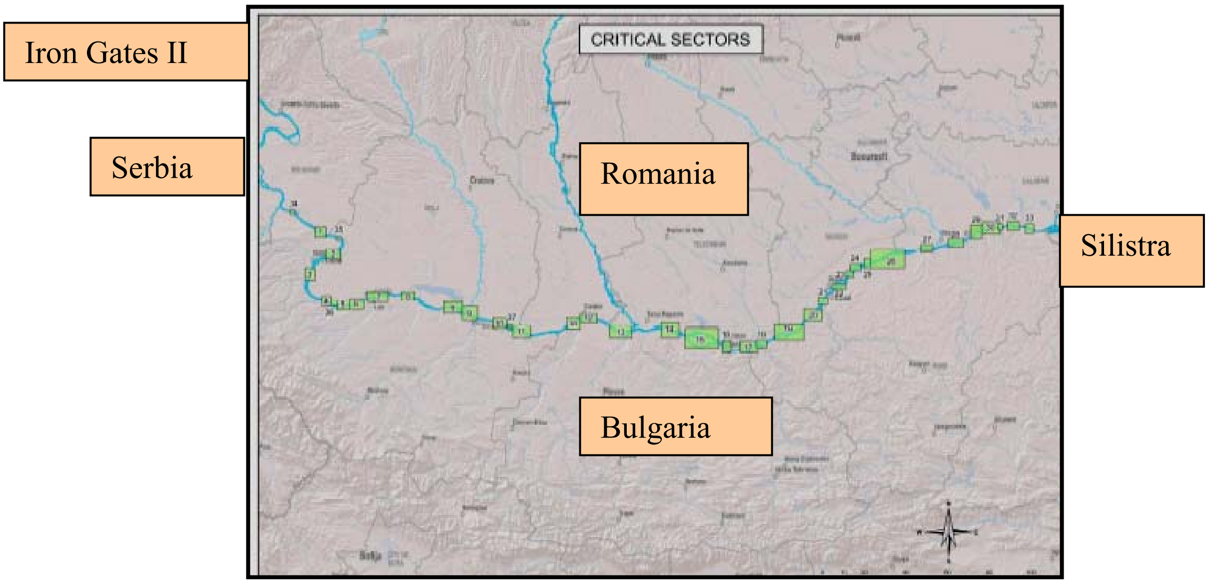


Figure 1. The Romanian - Bulgarian sector of the Danube (source: E.I.A., Technical assistance for the improvement of navigation conditions on the Romanian -Bulgarian common sector of the Danube and accompanying studies, Ministry of Transports of Romania, dec., 2009)

The cumulated effects of this project with other proposed projects on the Lower Danube, like the project regarding the Calafat port improvement works, the project for improvement of the navigation conditions on the Calarasi - Braila sector (ISPA 1), the project of proposed works for the Danube - Blak Sea Canal, contribute to continue navigation in more adequate conditions.

Due to the contributions of these projects, naval navigation can be performed over a longer period of time under normal circumstances and conditions. Following this improvement works Danube can become a more efficient means of trade.

The proposed project is part of the actions taken for finding common solutions to answer both to requirements of navigation or other uses, and to ecological requirements, taking into account the European Union legislations and the international conventions.

2. POTENTIAL IMPACT ON THE SOCIO-ECONOMICAL ENVIRONMENT AND MEASURES TO REDUCE IT

The critical sectors for navigation are located along the whole common Romanian – Bulgarian sector of the Danube (Section 1 of the project – which means Iron Gate II – Calarasi-Silistra).

Impact prognosis. The impact on the socio-economic environment due to the project works has been assessed on the basis of the following criteria: *during contruction* - impact on the population (socio-economic conditions, environmental conditions), impact on river transport, impact on fishing and recreation, impact on pumping stations (water intake and discharges), impact on other infrastructure - and the socio-economic impact *during the operational period.*

2.1. Impact during the construction period

The impact during the construction period is temporary and it will be both positive and negative. New working places will be provided for local population during the development of site works. Land potential impact generated by construction activities is insignificant because the works proposed to be carried out are located within the minor channel (groins and bottom sills) or on the banks of Danube River (bank protection works). Negative impact is produced by noise and emissions generated by operation of work equipment, transport vehicles and construction activities.

2.1.1. Potential impact on population

The project creates jobs for execution of works and for supply with a large volume of local construction materials, and also for activities in building site organizations (placed in harbour zones). This positive impact has a relatively long duration, till the finalization of the capital dredging works and of the constructions. So, it is recommended that the necessary personnel for performing the activities in the sites be employed from the local population in a number as large as possible, and also be qualified if necessary.

Noise and emissions might have an impact on the population that is located within the working front area. Most localities are more than 2 km away from the left Danube bank, thus the impact on population from riparian counties is insignificant.

Industrial areas from Calafat, Turnu Măgurele, Zimnicea and Giurgiu are the closest to the Danube bank, or even in its vicinity. So the impact on these industrial areas can be significant. Dredging activities for the navigable channel will be carried out in vicinity of the industrial areas.

Critical navigation sectors that are closest to localities on the left bank

- *Critical navigation sector of Basarabi.*

Description of the present situation:

The navigation is on the left branch of the Kutovo Island (on Romanian bank). At this location the navigation channel is between 100-150 m, which makes difficult the crossing of convoys (the recommended width is 180 m). The end of Kutovo Island is having significant erosion at present.

The construction of a new bridge (Calafat – Vidin) started at rkm 796 in 2008. The Port of Calafat is located at rkm 795 and is an important for passing the Danube towards Bulgaria, being the shortest route between West and East; here is a continuous traffic of passengers, vehicles of any type, trucks. The potential impact of works on activities from this area is insignificant because works proposed to be executed occur at the upstream end of Kutovo Island, on the right Danube bank and at aprox. 4 and 5 km distance from the site of the new bridge and of Calafat Port. Impact generated by the execution of works proposed within this critical sector, on population from the town of Calafat, will be insignificant due to the long distance from the town and low dredging volume.

- *Critical navigation sector of Corabia – Băloiu branch*

Within the critical navigation sector of Corabia – Băloiu branch, the following works are proposed to be executed in the vicinity of industrial area belonging to Corabia town: dredging the navigable channel located on the Romanian bank, in all the study versions, a groin and two arch groins and one groin that are located on the Bulgarian bank of the Danube.

The impact of construction activities on this area will be insignificant, due to distance of these groins from the industrial and residential area of Corabia town. Impact of noise and emissions, generated by dredging activities is insignificant because areas in which dredging works are executed (low amount of dredged material) are located at a high distance from the industrial and residential area of Corabia town.

In Bulgaria, no negative impacts or deterioration of the socio-economic conditions are anticipated in the populated areas around Danube.

2.1.2. Potential impact on river transport

Construction and development activities that are carried out on the joint Romanian-Bulgarian Danube sector, within the working front area, may lead to perturbations on the river transport development.

Danube economic importance has risen lately, after the river has been connected to Main and Rhin by the Rhin – Main – Danube Channel. An arterial shipping canal thoroughfare of 2 850 km (1075 km through Romania) was created which lays from the North Sea to the Black Sea, at its extremities having two ports of exceptional importance: Rotterdam in the west corridor and Constanta at the eastern extremity. This navigable thoroughfare crosses many European countries: Netherlands, Germany, Austria, Czech Republic, Slovakia, Hungary, Serbia, Romania and Bulgaria.

The Rhine - Main - Danube channel directly promotes the development of trade within the abovementioned countries, in general, and also the international trade, and it substantially reduces the shipping distance; the Rotterdam - Constanta route can be traveled by a motor boat within 10 days, from going, and within 16 days, to returning, and a train of pushed barges can travel on the same route, within 13 and 18 days, respectively.

Potential impact generated by construction and development activities, on river transport is temporary and may be:

- potential impact from insignificant to moderate because groins, bottom sills and bank protection works are not carried out within the navigable channel;
- moderate potential impact due to the transport along the Danube, of construction materials and construction equipment activities within the work area;
- potential impact from moderate to significant generated by dredging activities within the navigable channel.

2.1.3. Potential impact on fishing and recreational areas

Construction and facilities activity can also generate a temporary potential impact on recreational areas, commercial and recreational fishing on the Danube. Fishing has a long tradition in Romania, due to large water areas. The Danube River, together with the overflow meadow and the Danube Delta has determined the fishing to be the most important activity for the inhabitants of these areas, up to the middle of last century. A broad action of embankment works for areas covered by water began in early 1950s, in order to use them for agricultural activities, this leading to the decline of fisheries within inland waters (decrease of captures and jobs).

Commercial fishing within inland waters shall be carried out in natural water basins that represent the national public field: Danube, Danube Delta, the lacustrine complex of Razim-Sinoe, reservoirs, etc. Fishing within inland waters is carried out based on a license and a fishing permit.

According to data provided by the Registry of Ships and Boats that is managed within the National Agency for Fisheries and Aquaculture, a number of 2 256 boats, are present in the Danube delta and Danube (1333 in the Danube area and 923 in the Danube Delta area).

Fishing is practiced with fixed or mobile fishing tools, using small fishing boats, made up of wood. Capture fishing is not mechanized within inland waters. At the end of 2005, the share of people involved in commercial fishing within inland waters, of the total sector, was 37.16 % (2531 persons), out of which, 97.98 % men and 2.02 % women.

While fishing within inland waters is an important activity, landing facilities are old and insufficient in the Danube delta, but particularly along the Danube and reservoirs. Places for fish conditioning and storage up to selling process, have begun to be built and modernized, lately. Fishermen have no transportation means for fish on land and water, these services are mainly provided by the beneficiaries.

Construction, facility and dredging activities may generate a moderate to significant impact on fishery in the critical field under work, due to the increased water turbidity and noise produced by construction or dredging equipment. This impact is temporary (during the work period and up to water turbidity decrease) and it occurs on limited areas (work area and downstream it, where the turbidity is higher). Fishing potential impact might be:

- negligible for the Danube area locate upstream of sectors in which construction and facility works are executed;
- minor, if the working volume is low and carried out within short time periods;
- moderate in the neighborhood of the sites, even leading to fishing interruption during works execution, if the working volume is important and carried out on a long period of time.

Construction and facility works may also have a temporary potential impact on recreational areas from the Danube bank. Recreation areas are set up within riparian towns of the Danube. Critical navigation sectors in which certain works are proposed are not present within riparian town areas, and the impact on recreational areas might be:

- insignificant, when works are executed at high distance, upstream or downstream of them;
- moderate to significant, when works are executed at small distances, upstream of them, by an increase of water turbidity, equipment noise and discomfort created by the presence of workers.

2.1.4. Potential impact on water intakes and discharges from drainage pumping stations

The Danube River is an important water supply source of certain localities (Calafat, Zimnicea Oltenita) and irrigation systems in the south of Romania. The execution of construction and planning works can have a negative potential impact on water quality due to increased turbidity and eventually due to silting-up of areas downstream of the groins and of the guiding walls. Alluvial deposition can grow in time up to the groin top level along a downstream distance of about twice the groin length. Lower alluvial deposition occur a long a downstream distance of to 6-7 times the groin length. Process evolution and duration depend on the local configuration of the channel, groin top level, hydrological conditions and alluvial transport.

Increased water turbidity during execution of the works can cause disruption of water treatment system for drinking water: an increase of settling period within the treatment plant, high amounts of sediments (sludge) in settlers from this plant, these leading to higher costs of water. Increased water turbidity at the intake outlet may also lead to stopping the treatment plant, therefore, stopping the city water supply.

Potential impact of the dredging and construction works is negligible when the works upstream the water intake or upstream the discharge point from drainage are at a sufficiently long distance so that water turbidity in the area of the respective intake or discharge point and stream pattern are not influenced. Potential impact of bank protection works can be minor if these constructions will be executed so that to not disturb the functioning water intakes or discharges that exists within the bank protection line.

Potential impact of groins can be moderate or major if groins or guiding walls are placed at a small or very small distance upstream of the water intake canals of the pumping stations and of discharges from pumping stations for drainage (removal of excess water). It is expected silting-up of the river channel at the left bank in the respective points due to alluvial deposition in the groin influence zone.

2.1.5. Potential impact on other infrastructure elements

The necessary ship traffic for carrying out dredging and construction works proposed in the project will respect the existing navigation regulations. This way, effects on existing infrastructure elements on the Danube will be avoided and it will not result any impact of the needed traffic during the construction period on infrastructure. The construction works that are proposed within the project are not located in port facilities zones and do not result in negative effect on them.

2.2. Impact during the operational period

After completing the investment works in the sites from critical sectors for navigation, the impact will be positively, both from economic and social point of view. Positive effects begin to occur during the construction period when the works are finalized in each site. Carrying out the proposed works contribute to fulfil the obligation from the Convention on navigation regime on the Danube, which provides the commitment of the Danube states to maintain their sectors on the Danube, under navigability conditions for inland ships, and to execute the works necessary to ensure and improve the navigation conditions. The following aspects will be obtained by these investment works:

- ➢ to improve navigation conditions on the navigable channel of the common Romanian-Bulgarian Danube sector;
- ➢ commercial and touristic river traffic, with good conditions for navigation, will have a positive effect on the economic development of the riparian Danube counties and also commercial and touristic river traffic will lead to development of new jobs in port towns of the Danube.

Other important aspects are:

- ➢ to improve the access of commercial and touristic ships from Danube riparian countries to the Black Sea, by the Danube-Black Sea Channel or Sulina Channel;
- ➢ to improve access connections to Europe, up to Rotterdam, of people from Central and Eastern Europe;
- ➢ Create conditions for development of village systems and tourism;
- ➢ Increase the information flow towards the population around Danube about the environmental problems related to thit region and the solution to these problems;
- ➢ New cultural-historical monuments might be discovered and turned into tourist attraction.

3. CONCLUSIONS

The evaluation of the impact on the socio-economic environment can be summarised as follows:

- ➢ The *impact on the socio-economic conditions of the population during construction* can be considered as positive, as jobs will be created both in the construction activities and the supply and trapsortation of materials. The impact will be more positive if more works are carried out. Also, dredging activities are supposed to generate fewer jobs than construction activities;

- ➢ The *impact on the environmental conditions of the population during construction* will likely be very limited, as most construction sites are located far away from major population centers and construction and transportation will as much as possible be done from the water rather than from the land. Potential impacts on the population in the towns of Calafat and Corobia can be expected to be low. Impact on the environmental conditions of the population will likely be less important still for dredging activities than for construction activities;

- ➢ The *impact on river transport during the construction activities* will be insignificant to moderate as far as the engineering construction works are concerned. The river transportation associated with those construction works will also only have a moderate impact. Impact of dredging activities on river transport can however be moderate to significant. As a result, alternatives that require a lot of dredging will potentially have a more important impact on river transport than the other alternatives. Overall, the impact on river navigaton is expected to be relatively minor if the mitigation measures are applied;
- ➢ The *impact on fishing* may be moderate to significant as a result of construction, facility and dredging activities, due to the increased water turbidity and noise produced by construction or dredging equipment. The *impact on recreational activitties* (e.g. use of the beaches) will likewise be affected by the construction activities. It can be expected that large-scale construction activities will have a more important impact than dredging activities on both fishing and other forms of recreation;
- ➢ The *impact* of bank protection works *on water intakes and discharges* can easily be avoided by proper design of the bank protection works taking into account the presence of the intakes or discharges. Groins on the other hand affect downstream sedimentation patters, which could cause disturbance of inlets and discharges. The problem is obviously less vital for discharges than for intakes. For the latter, sedimentation can affect the quality of the water and hence both the functioning of the installations and the quality (and thus use) of the water.

As a general conclusion we can say that the investment works will have a clearly positive impact on the socio-economic conditions of the population, as a result of the employment they generate. They do however have a slight negative impact on environmental conditions of the population and on river transportation, and a clear negative impact on fishing, recreation and some pumping stations.

This conclusion is reinforced by the observation that the investment works are better at lowering inland navigation costs and thus inducing extra traffic, resulting in more economic benefits for the riparian countries.

4. REFERENCES

[1]. BUTTON K., *Transport, the Environment and Economic Policy*, Edward Elgar Publishing, UK, 1993

[2]. GHINEA D., *Geographic Enciclopedy of Romania*, Enciclopedic Publishing House, Bucharest, 2002

[3]. **Harris F. R.**, *Danube River Development Strategy*, Final Report, WL Delft, Iptana, Bucharest, 1999

[4] SOBARU A. C.,NĂSTASE G. I., AVĂDANEI C., *Danube – Main – Rhin arterial shipping canal*, Economic Publishing House, Bucharest, 1998

[5]******* *Geographic Enciclopedy of Romania*, Scientific and Enciclopedic Publishing House, Bucharest, 1982

[6]******* *Geography of Romania*, Publishing House of Romanian Academy, Bucharest, 2005

[7]******* *Reports on the state of environment in the year 2007 in the Counties Dolj, Olt, Teleorman, Giurgiu and Calarasi* (from Environmental Protection Agencies)

[8]******* *Pan-Eurostar. Pan-European Transport Corridors and Areas Status Report*, Final Report, HB-

Verkehrsconsult GmbH, Germany, VTT Technical Research Centre of Finland, 31 Jan, 2007
[9]*** *Trans-European Networks: Toward and integrated approach*, Commission Staff Working Document, Commission of the European Communities, Brussels, March 21th, 2007
[10]*** *Romanian Statistical Yearbook 2005, 2008* (National Institute of Statistics)

THE ROLE OF MOBBING IN GENERATING HUMAN ERRORS IN MARITIME INDUSTRY

ÖCEL HATEM

Karabük University, Turkey

ABSTRACT

Bullying in the workplace is a serious problem for many workers, employers and totally for organizations. It prevails in both private and public organizations, and finds its victims among men and women as well as among managers and workers alike.

Keywords: *bullying, human error, psychological problems, working climate*

1. INTRODUCTION

Bullying in the workplace is a serious problem for many workers, employers and totaly for organizations. It prevails in both private and public organizations, and finds its victims among men and women as well as among managers and workers alike.

Workplace bullying refers to a situation where a person or a group of persons repeatedly and regularly harasses, offends, socially excludes or negatively affects an employee's work task over a period of time (Einarsen, Hoel, Zapf and Cooper, 2003). The interest in workplace bullying has been motivated by its links to job related strain experienced by the target of bullying that leads to adverse consequences for both the target and the organization. Many investigators have reported that to be a target of bullying lowers self-esteem (Mathiesen and Einarsen, 2007; Vartia, 2003) and job satisfaction (Einarsen et al.,1998) and produce psychological problems such as fear, anxiety, helplessness, depression and post-traumatic stress disorder (Mathiesen and Einarsen, 2004; Mikkelsen and Einarsen, 2002). It has also been reported that victims of bullying display less organizational citizenship (Constantino, Domingez and Galan, 2006) and more counterproductive work behavior (Einarsen et al., 2003).

There is no general agreement on the definition of workplace 'bullying',and several other terms have been used interchangeably. One of these is 'mobbing', which derives from the English word 'mob', originally used to describe animal aggression and herd behaviour. At the present day, 'mobbing' is also widely used in German-speaking countries and in the Netherlands. Other concepts close in meaning to workplace bullying are harassment or work harassment, non-sexual harassment, psychological harassment, victimization, psychological terror, scapegoating and petty tyranny. Concepts such as abusive behavior or emotional abuse, generalized nonsexual workplace harassment, workplace trauma, and workplace aggression have been used in the USA to describe hostile behaviours relevant to workplace bullying.

Leymann, mobbing/psychological terror:

Leymann has regarded bullying as in working life involves hostile and unethical communication, which is directed in a systematic way by one or a few individuals mainly towards one individual who, due to mobbing, is pushed into a helpless and defenceless position, being held there by means of continuing mobbing activities (Leymann, 1990).

Einarsen & Skogstad called aggressive behavior as Bullying:

"To label something bullying it has to occur repeatedly over a period of time, and the person confronted has to have difficulties defending himself/herself. It is not bullying if two parties of approximately equal 'strength' are in conflict or the incident is an isolated event. In other words there are two important characteristics of workplace bullying which are continuance and frequency" (Einarsen & Skogstad 1996). Other concepts close in meaning to workplace bullying are work harassment (Björkqvist, Österman & Hjelt-Bäck 1994), non-sexual harassment (Zapf & Einarsen 2001), victimization (Einarsen & Raknes 1997), psychological terror (Leymann 1990), scapegoating (Thylefors 1987) and petty tyranny (Ashforth 1994).

There are five significant discriminative features of the workplace bullying:

First of all bullying involves negative or hostile behaviours occurring regularly, repeatedly and over time. A one-off incident is not regarded as bullying. The negative behaviour involved is usually the kind of behaviour that is common to everybody in everyday working life, but it becomes bullying when it is systematically repeated (Vartia, 2003).

Vartia (2003) said that the second features of bullying is defencelessness of the victim. In another words victim feel the difficulty in trying to defend him/herself against the negative actions. This implies an imbalance of power between the target of the bullying and the bully. Niedl (1995) emphasize that a person will be victimized only if he/she perceives him/ herself as helpless to defend himself/herself. It is not bullying if two equally strong parties are in conflict. The feeling of defencelessness may be due to an imbalance of power (e.g., the hierarchical position between an employee and a superior), or it may be an indirect consequence of a bullying incident itself or of a previous interpersonal conflict situation (Einarsen 2000).

It has been taught bullying as an interpersonal phenomenon that occurs between two individuals, between one/several individual/s and a group, or towards a group of people. This is the third characteristics of the phenomenon. Mostly, both superiors and co-workers are seen as potential bullies. However, some authors consider that bullying is a situation between an employee and his/her superior/manager, arising from the characteristics or motivation of the superior (Vartia, 2003). Although bullying is usually regarded as a conflict between co-workers or supervisors and subordinates, people outside the workplace, e.g., clients, patients and pupils, have also been identified as bullies(Hoel & Cooper, 2000).

Fourth features of bullying is intentionality (Björkqvist, Österman & Lagerspetz 1994). Björkqvist et al. (1994) said that the perpetrator assesses the relation between the effect of the intended strategy and the dangers involved whether they be, physical, psychological or social. According to them the aggressor will try to maximize the effects and minimize the risks.

The last features of the workplace bullying is includes various kinds of negative acts. These are
1) manuplation of the victim's reputation,
2) manuplation of the victim's performance of work tasks,
3) manuplation of the victim's communication with co-workers,
4) manuplation of the victim's social life,
5) manuplation of physical assaults, or the threat of physical violence (Mikkelsen & Einarsen, 2001).

Causes of The Workplace Bullying

Several factors have been identified as correlates of workplace bullying. These factors can be divided into two broad sources: factors related to the work environment and individual characteristics of victims and perpetrators. Researchers have documented a number of organisational stressors typically associated with the occurrence of workplace bullying. For example, Einarsen et al. (1994) reported work characteristics such as "weak" leadership, role conflict and lack of work control as the most important variables for predicting bullying. Zapf, Knorz and Kulla (1996) also found job content and the social environment to be significant determinants of harassment at work. Furthermore, some authors argue that certain changes in the organisation or in the economy, such as a downsizing, a recession or an economic crisis, may increase the risk of bullying (Baron & Neuman 1998; Salin 2003).

As a results we can say in short both environmental factors and characteristics of the victim and the bully are assumed to contribute to the onset of a bullying situation.

On the environmental side:

Many research has shown that it is correlated with many features of the work environment, including;

a heavy work load,
high stress,
organizational problems,
experienced role conflicts,
organizational restructuring,
change of management,
work control,
low satisfaction with leadership or 'negative' management styles,
the social or organizational climate and unsatisfactory relationships at work,
conflicts in general in the work unit,
as well as difficulties in talking about problems in the working group (Einarsen, Raknes & Matthiesen 1994; Hoel & Cooper 2000; Zapf 1999).

On the personality view:

For the personality view is important of the characteristics of the victim, the bully, or to both.

The victim

Coyne et al. (2000) said that the role of the victim's personality has been emphasized somewhat differently by different authors, and a hypothesis has been put forward conserning the specific personality traits that are connected with victimization in bullying. He suggested that some personality traits may make people more vulnerable than others to bullying in general, or in specific situations (Coyne et al. 2000). Vartia (2003) said that "victims of bullying are in many cases different in some respects from the others in the work unit. A bullying victim may be different from others in many ways; e.g., he/she may represent a minority in terms of gender, race or religion, education or occupation in the work unit".

Vartia (2003) pointed out that victim may be different from others in terms of; e.g., gender, race or religion, education or occupation in the work unit. Einarsen and Raknes said that some people are more vulnerable than others to bullying because they are low on self-assertiveness, have low self-esteem and are unable to defend themselves, is very common and has been supported in some cross-sectional studies (Einarsen & Raknes 1991). Research on individual factors in bullying has found that victims score lower on selfesteem than non-victims (Aydın & Öcel, 2009). Victims have also been found to be anxious in social settings. In a study comprising bullying victims and their non-bullied co-workers, the victims tended to be less independent and extrovert than the non-victims (Einarsen & Raknes 1991).

A study using MMPI-2 (the Minnesota Multiphasic Personality Inventory) showed that a specific personality profile for victims of bullying: they were oversensitive, suspicious and depressive, and had a tendency to convert psychological distress into psychosomatic symptoms (Mathiesen & Einarsen 2001).

The bully

Zapf and Einarsen have suggested three main types of bullying related to
The personality of the bully
1) self-regulatory processes with regard to threatened selfesteem,
2) lack of social competence, and

3) bullying as a result of micropolitical behaviour.

A traditional view has regarded low self-esteem as a powerful and dangerous cause of violence. Thus, violence may appear to be a result of threatened egotism. Some studies shown that bullies have described themselves as low on social competence and self-esteem, and high on social anxiety and aggressiveness (Einarsen, Raknes, Matthiesen & Hellesoy 1994).

Zapf &Einarsen (2003) put forward to bullies display social competences, lack of emotional control, as well as a lack of self-reflection and perspective taking. Bullies may not be aware of what they are doing or of how their behaviour affects others. According to Zapf &Einarsen (2003) they normally do not admit the bullying, probably because aggressive behaviour is not socially acceptable.

Some Example of Workplace Bullying Behaviors

- Someone withholding necessary information so that your works get complicated.
- Ridicule or insulting teasing
- Ordered to do work below your level of competence
- Gossip or rumors about you
- Physical abuse or physical abuse threat
- Neglect of your opinions or views (Einarsen and Raknes, 1997)

Type of the organization (to be more common in the public than in the private sector) (Hoel & Cooper, 2000). Bullying very common in some occupations such as graphical workers, hotel and restaurant workers, in the teaching profession, education and health, in transport and communication, in the prison service, among post and telecommunications workers, and in the dancing profession (Hoel & Cooper, 2000). Several studies have found that men and women perceive themselves as being bullied equally often although some have shown an overrepresentation of women among the victims (Einarsen & Skogstad 1996). Age and ethnic background are also important in the workplace bullying. Some studies showed that young employees were slightly more at risk of bullying than others and Asian peoples are more likely to be bullied than white (Hoel & Cooper 2000).

Measurement of the Workplace Bullying

Devastating effect of bullying on the target and on the organization has lead to efforts to determine its causes and prevalence. From the beginning, one of the major concern of these efforts has been how to assess it (Jiminez et al., 2007). Some researchers have used a strategy based on definitions of bullying. Respondents have been asked if they have been a victim of bullying, according to the definition, during the previous 6 or 12 months, for example, and they have decided whether or not to label themselves victims of bullying. Some researchers have directly asked “Have you been bullied during the last 6 months?” without defining bullying. A number of observational techniques and self-report questionnaires assessing exposure to bullying have been developed. The Leymann Inventory for Psychological Terrorization, LIPT (Leymann 1989), the Negative Acts Questionnaire, NAQ (Einarsen & Raknes 1997), and the Work Harassment Scale, WHS (Björkqvist, Österman & Hjelt-Bäck 1992) have been used for this purpose. Among the self-report questionnaires the Negative Acts Questionnaire (NAQ) developed by Einarsen and Raknes (1997) has been one the most widely used instrument.

Consequences of Workplace Bullying

The interest in workplace bullying has been motivated by its links to job related strain experienced by the target of bullying that leads to adverse consequences for both the target and the organization. Many investigators have reported that to be a target of bullying lowers self-esteem (Mathiesen and Einarsen, 2007; Vartia, 2003; Aydın & Öcel, 2009) and job satisfaction (Einarsen et al.,1998). It has also been reported that victims of bullying display less organizational citizenship (Constantino, Domingez and Galan, 2006) and more counterproductive work behavior (Einarsen et al., 2003; Öcel, 2009) and turnover intention (Öcel, inpress).

When working with victims of long-term bullying, what strikes one the most is the intense and pervasive health problems they display. Exposure to systematic bullying at work causes a host of negative health effects in the target (Einarsen & Mikkelsen, 2003). Several studies have shown connections between workplace bullying and ill health in the form of psychosomatic symptoms and severe psychological stress symptoms (Einarsen, Raknes, Matthiesen & Hellesøy, 1996; Einarsen & Raknes 1997; Messeguer, Soler, Saez ve Garcia, 2008; Mikkelsen & Einarsen, 2002), physical illness symptoms (Öcel, inpress). Symptoms of post-traumatic stress disorder (PTSD), state-trait anxiety (Aydın & Öcel 2009) and general anxiety disorders have also been identified in bully victims (Björkqvist et al.,1994). Bullying can even affect a victim’s desire to continuing living his/her life. Leymann (1990) estimated that between 100 and 300 individuals of those who committed suicide in Sweden during one year had a history of experiencing workplace bullying.

2. REFERENCES

[1] ASHFORTH, B. (1994*). Petty tyranny in organizations. Human Relations*, 47(7), 755–778.
[2] AYDIN, O. ve ÖCEL, H. (2009). *“The negative acts questionaire: The study of validity and relaibility”* Turkish Psychological Articles*,*12, 94-103.
[3] BJÖRKQVIST, K., ÖSTERMAN, K. & HJELT-BäCK, M. (1992). *‘The Work Harassment Scale’.* Vasa, Åbo Akademi University.
[4] BJÖRKQVIST, K., ÖSTERMAN, K. & HJELT BäCK, M. (1994). *Aggression among university employees.* Aggressive Behavior, 20, 173-184.
[5] COYNE, I., SEIGNE, E. & RANDALL P. (2000). *Predicting workplace victim status from personality.* European Journal of Work and Organizational Psychology, 9, 335–349.
[6] CONSTANTINO, G.T., DOMINGEZ, J. F.M. veGALAN, J.A.G. (2006) *A coso laboral: Relaciones conla cultura organizacional y los resultados*

personates. Psicothema, 18, 776-771. (İngilizce abstract PsyINFO Database record (c) 2008, APA.
[7] EINARSEN, S. (2000). *Harassment and bullying at work; A review of the Scandinavian approach Aggression and Violent Behavior*, 5(4), 379–401.
[8] EINARSEN, S., HOEL, H., ZAPF, D. & COOPER, C. L. (2003). *The concept of bullying at work: The European tradition.* In S. Einarsen, H. Hoel, D. Zapf & C. L. Cooper, *Bullying and emotional abuse in the workplace. International perspectives in research and practice* (pp. 3-30). London: Taylor & Francis.
[9] EINARSEN, S., MATHIESEN S. B. & SKOKSTAD, A. (1998). *Bullying, burnout and well-being among assistant nurses.* Journal of Occupational Health and Safety, 14, 263-268.
[10] EINARSEN, S. & MIKKELSEN, E. G. (2003). *Individual effects of exposure to bullying at work.* In S. Einarsen, H. Hoel, D. Zapf & C. L. Cooper (Eds.), *Bullying and emotional abuse in the workplace. International perspectives in research and practice* (pp. 127-144). London: Taylor & Francis.
[11] EINARSEN, S. & RAKNES, B.I. (1991). *Mobbing i arbeidslivet. En undersokelse av forekomst og helsemessige konsekvenser av mobbing på norske arbeidsplasser. (Bullyingat work. A study on the occurence and consequences of bullying at Norwegian workplaces)*. Forskningssenter for Arbeidsmiljo, Helse of Sikkerhet FAHS, Universiteteti Bergen.
[12] EINARSEN, S. & RAKNES, B.I. (1997). Harassment in the workplace and the victimization of men. *Violence and Victims*, 12, 247-263.
[13] EINARSEN, S. & RAKNES, B.I, MATTHIESSEN, S.B. & HELLESOY, O.H. (1994). *Mobbing ogharde personkonflikter: Helsefarlig samspil på arbeidsplassen (Bullying and harsh personalized conflicts: Unhealthy interaction at work*). Bergen, Norway: Sigma Forlag.
[14] EINARSEN, S. & RAKNES, B.I, MATTHIESSEN, S.B. & HELLESOY, O.H (1996). *Helsemessige aspekter ved mobbing i arbeidslivet. Modererende effekter av sosial stotte og personlighet.(Bullying at work and its relationships with health complaints. Moderating effects of social support and personality).* Nordisk Psykologi, 48(2), 116–137.
[15] EINARSEN, S. & RAKNES, B.I, MATTHIESSEN, B.S.. (1994*). Bullying and harassment at work and their relationships to work environment quality: an exploratory study*. European Work and Organizational Psychologist, 4(4), 381–401.
[16] EINARSEN S. & SKOGSTAD A. (1996*). Bullying at work: Epidemiological findings in public and private organizations*. European Journal of Work and Organizational Psychology,5(2), 185–201.
[17] HOEL, H. & COOPER, C.L. (2000). *Destructive Conflict and Bullying at Work*. Manchester School of Management, University of Manchester Institute of Science and Technology(UMIST).
[18] JIMENEZ, B.M., MUNOZ, A.R., GAMARRA, M.M. ve HERRER, M.G. (2007). *Assessing workplace bullying: Spanish validation of a reduced version of the negative act questionnaire.* The Spanish Journal of Psychology*, 10,449-457.*
[19] LEYMANN, H. (1989*). Presentation ov LIPT-formuläret: konstruction, validering, utfall.Violen.*
[20] LEYMANN, H. (1990). *Mobbing and psychological terror at workplace.* Violence and Victims*,* 5, 119-126.
[21] MATTHIESSEN, S.B. & EINARSEN, S. (2001). MMPI*-2 configurations among victims of bullying at work*. European Journal of Work and Organizational Psychology, 10(4), 467–484.
[22] MATTHIESSEN, S.B. & EINARSEN, S (2004). *Psychiatric distress and symptoms of PTSD among victims of bullying at work.* British Journal of Guidance & Counselling*,32,335-356.*
[23] MATTHIESSEN, S.B. & EINARSEN, S (2007). *Perpetrators and targets of bullying at work: Role stres and individual differences.* Violence and Victims, 22, 735-753.
[24] MIKKELSEN, E.G. & EINARSEN, S. (2001). *Bullying in Danish work-life: Prevalence and health correlates.* European Journal of Work and Organizational Psychology, 10(4),393–413.
[25] MIKKELSEN, E.G. & EINARSEN, S (2002). *Basic assumption and post-traumatic stress among the victims of workplace bullying.* European Journal of Work and Organizational Psychology 11, 87-111.
[26] NIEDL, K. (1995). *Mobbing/Bullying am Arbeitsplatz. (Bullying at a workplace).* Munich:Rainer Hampp Verlag.
[27] ÖCEL, H. (2009). *Çalışanların örgütsel vatandaşlık ve üretim karşıtı iş davranışlarının nedenlerine ilişkin bir model önerisi.* (Yayınlanmamış Doktora Tezi). Ankara: Ankara Üniversitesi. (*A Model Proposal of Antecednts About Organizational Citizenship Behaviors and Counterproductive Work Behaviors of Workers*, Unpublished PhD Thesis).
[28] ÖCEL H. (In press) *Belief in a just world as a moderator of the relationships between workplace bullying and physical illness symptoms*. Turkish Journal of Psychology.
[29] ÖCEL H.(Reviewing). *Workplace bullying and turnover intention among blue-collar workers in Turkey: The moderating effect of belief in a just world.*
[30] SALIN, D. (2003). *Bullying and organisational politics in competitive and rapidly changing work environments.* International Journal of Management and Decision Making, *4*, 35-46.
[31] THYLEFORS, I. (1987). SYNDABOCKAR. *Om utstötning och mobbning i arbetslivet. (Scapegoats. Exlusion and bullying in worklife)*. Stockholm: Natur och Kultur.
[32] VARTIA, M. (2003). *Workplace bullying: A study on the environment, well-being and health.* These de doctorat non publiee. Universite d'Helsinki, Helsinki, Finlande.
[33]ZAPF, D. & EINARSEN, S. (2001). *Bullying in the workplace: Recent trend in research and practice – an introduction*. European Journal of Work and Organizational Psychology, 10(4), 369–373.
[34] ZAPF, D. & EINARSEN, S. (2003*). Individual antecedents of bullying. Victims and perpetrators*. In S. Einarsen, H. Hoel, D. Zapf and C. Cooper (eds) Bullying and emotional abuse in the workplace: International perspectives in research and practice. London, New York: Taylor & Francis Books Ltd, pp. 165–184.

THE OPERATIONAL SCIENTIFIC RESEARCH. THE TESTING OF SPECIFIC PHYSICAL TRAINING OF THE NAVAL STUDENTS AND THE STATISTICAL PROCESSING OF THE RECORDED RESULTS

OPRISAN NAIE-GILLES

Naval Academy „Mircea cel Batran” Constanta, Romania

ABSTRACT

The present work briefly shows, the results of a larger research we made on the naval students who followed an experimental methodological plan for their specific physical training, in order to increase the level of their efficiency and their performances according to the physical and psycho-motional requests aboard ships, during good weather as well as when bad, stormy weather over the seas. The results we obtained are presented here in their short form, because we do not have room enough, showed that the improving experimental intervention proved to be extremely positive, modifying all previous concepts expressed so far, in the methodology of the naval students physical and pshycho-motional training.

Keywords: *Specific physical training, specific training, applicative swimming, testing, professional-applicative performance*, pulling the rope while swimming, rowing in a single person boat, statistical processing, etc.

1. INTRODUCTION[1]

T The professional experience of the last 30 years in the superior educational system of the Naval Forces, added to the experience got directly aboard school ships during many voyages, after so many years of teaching and training the students on Mamaia lake waters (using different types of boats in different weather conditions) we considered necessary to rebuild the general process of practical training, in order to improve the training ways and methods of the future young navigators. For all that, the intervention of improving experiments was necessary, inside the students training schedules. Part of this operational scientific action and some of the results we obtained, are to be presented in this paper.

2. THE GOAL OF THE RESEARCH

Was to investigate closely and as objective as we could be, the level and the specificity of the physical and psyco-motional effort in the navigators activity. Then, we are to ellaborate a new optimal training system in order to to prepare better and more complexthe navigating personnel and the naval students, according to the real requests aboard ships. Stepping aboard schoolships together with the naval students helped us to gather a larger experience inside the real navigators' life and activity. This way we enlarged our efficiency in specific training of the generation to follow.

3. THE TASKS OF THE RESEARCH

The main task of the operational experimental research presented in short in this paper, was to establish new methods of specific training of the naval students and the navigating personnel, which to be able to answer to the real requests of physical and psycho motional specific effort of the the navigators, no matter the weather conditions.

4. THE TASKS OF THE RESEARCH

They were really very many. We presented their details in many previous reports. In order not to reiterate, we'll refer here only to the final phase of the scientific experimental research on the naval students. **We**'ll present more details of the ***statistical processing*** and ***co-relative analysis*** of the investigated parameters.

The way to use the statistical mathematical method of investigation analysis, of processing and interpreting **the data.**

In the rationalizing process of the research methods, we selected from the various possibilities offered by the *mathematical statistics*, only those procedures of statistical processing and interpreting offering the most accurate results to rech the goal of our research.

The statistical processing and interpreting of the investigated parameters of our scientific experimental investigation, were done using the *Microsoft excel* programme. This way we ensured a maximum of objectivity of the results in order to avoid any subjective involvement.

5. THE TASKS OF THE RESEARCH

We'll present her briefly only the models of cybernetized statistical processing, absolutely objective of some of the investigated parameters inside the operational research we made. We'll also presentthe results recorded in two of the tests and their statistical processing.

[1] We have to mention the col. (rs.) psihologist ***Dan Nicolau***, who had a role in supporting the realising of this paper.

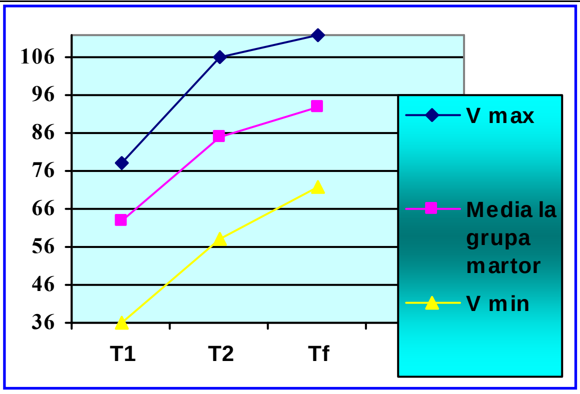
5. a. The results we note at the end of our statistical processings.

Generally speaking all the investigated parameters in *the initial test*(T1)a wide dispersion of values of the statistical indicators (Vmax-Vmin). We expected when doing the intermediary testing (T2) and the final testing(Tf) this dispersion to reach a smaller value by standardizing step by step the training level of the experimentel group members. They came voluntarily by the others, as parallel subjects in our experimental action, leading to a challenging stimulation of the experimental group members.

.

Table No. 1

THE COMPARATIVE STATISTICAL ANALYSIS AND THE INTERPRETATION OF THE FINAL DATA OF THE TESTS (Example no.1) The testing of the specific physical training: *pulling the rope while swimming*						
Number of the subjects	**Innitial testing (T1)**		**Intermediary testing (T2)**		**Final testing (Tf)**	
	Witness Group	**Experimental Group**	**Witness Group**	**Experimental Group**	**Witness Group**	**Experimental Group**
1	42,00	38,00	64,00	96,00	75,00	122,00
2	36,00	44,00	58,00	78,00	72,00	114,00
3	55,00	90,00	72,00	136,00	86,00	177,00
4	70,00	78,00	103,00	100,00	109,00	142,00
5	66,00	67,00	90,00	99,00	98,00	133,00
6	68,00	68,00	92,00	89,00	100,00	136,00
7	59,00	75,00	77,00	106,00	86,00	140,00
8	72,00	54,00	102,00	99,00	108,00	130,00
9	78,00	58,00	104,00	105,00	110,00	145,00
10	66,00	62,00	84,00	128,00	90,00	158,00
11	70,00	66,00	73,00	114,00	85,00	142,00
12	69,00	73,00	74,00	106,00	80,00	124,00
13	61,00	78,00	90,00	112,00	86,00	130,00
14	77,00	64,00	106,00	106,00	112,00	134,00
15	56,00	60,00	88,00	102,00	96,00	128,00
STATISTICAL PROCESSING OF THE DATA						
$\overline{X}$	**63,00**	**65,00**	**85,13**	**105,07**	**92,87**	**137,00**
Vmax (maximal value)	78,00	90,00	106,00	136,00	112,00	177,00
Vmin (minimal value)	36,00	38,00	58,00	78,00	72,00	114,00



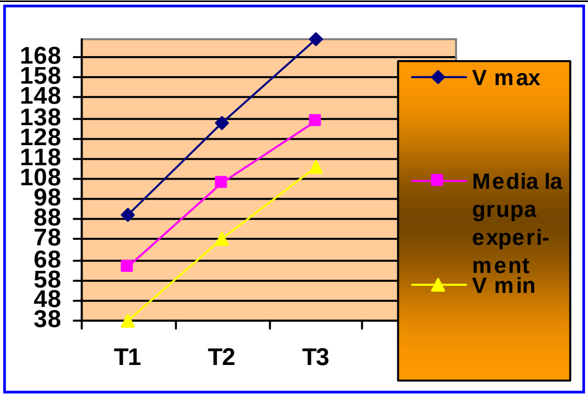
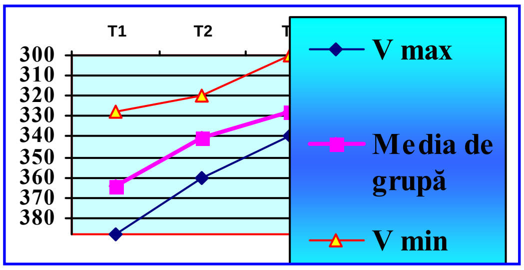


Diagram 1 (Witness Group) The expression of the diagram marks the differencebetween the maximal and minimal values of the results obtained by the subjects during the three tests: the innitial one (T1), the intermediary one (T2) and the final one (Tf)	Diagram 2 Experimental Group The expression of the diagram marks the differencebetween the maximal and minimal values of the results obtained by the subjects during the three tests: the innitial one (T1), the intermediary one (T2) and the final one (Tf)

This, materialized in the maintaining almost constant of the values differences between the first and the last recorded times in every test, as well as the changes noticed from a test to another. So, the firsts in a test weren't the first in other tests. But we noticed the studets were deeply interested, provide the challanging atmosphere between them, during our experimental action. In the tables no.1 and no.2 as well as in the diagrams 1-4 we present the figures recorded. In our paper the examples refers only to two tests*:"Pulling the rope while swimming"*and *„Rowing in a single preson boat" (baby boat)*

Table No. 2

THE COMPARATIVE STATISTICAL ANALYSIS AND THE INTERPRETATION OF THE FINAL DATA OF THE TESTS (Example no.2) The testing of the specific physical training: *Rowing in a single person boat*						
Number of the subjects	**Initial testing (T1)**		**Intermediary testing (T2)**		**Final testing (Tf)**	
	Witness Group	**Experimental Group**	**Witness Group**	**Experimental Group**	**Witness Group**	**Experimen tal Group**
1	370,00	367,00	350,00	246,00	331,00	235,00
2	366,00	390,00	345,00	380,00	330,00	344,00
3	352,00	348,00	340,00	235,00	328,00	228,00
4	344,00	388,00	335,00	300,00	322,00	262,00
5	328,00	372,00	320,00	290,00	316,00	230,00
6	373,00	355,00	349,00	240,00	340,00	215,00
7	385,00	360,00	360,00	242,00	334,00	215,00
8	369,00	347,00	336,00	251,00	331,00	233,00
9	378,00	377,00	350,00	312,00	340,00	283,00
10	388,00	342,00	345,00	250,00	338,00	226,00
11	359,00	367,00	330,00	280,00	321,00	261,00
12	364,00	379,00	335,00	280,00	320,00	267,00
13	358,00	384,00	334,00	300,00	300,00	256,00
14	363,00	363,00	340,00	270,00	336,00	265,00
15	364,00	366,00	336,00	250,00	332,00	233,00
STATISTICAL PROCESSING OF THE DATA						
$\overline{X}$	**364,07**	**367,00**	**340,33**	**275,07**	**327,93**	**250,20**
Vmax (maximal value)	388,00	390,00	360,00	380,00	340,00	344,00
Vmin (minimal value)	328,00	342,00	320,00	235,00	300,00	215,00



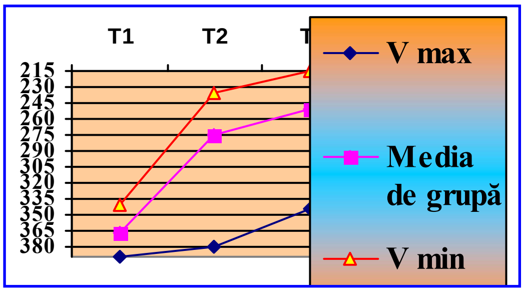


Diagram 3 (Witness Group) The expression of the diagram marks the differencebetween the maximal and minimal values of the results obtained by the subjects during the three tests: the innitial one (T1), the intermediary one (T2) and the final one (Tf)	Diagram 4 Experimental Group The expression of the diagram marks the differencebetween the maximal and minimal values of the results obtained by the subjects during the three tests: the innitial one (T1), the intermediary one (T2) and the final one (Tf)

6. THE TASKS OF THE RESEARCH

During our experiments on the naval and marine students we stressed most *the specific physical training* and *the specific psycho motional trainig*

In the same time we did not forget their time off, the way they had fun using the ways of *the general physical training*. Moreover, we noticed tht, by introducing the specific physical and psycho motional training we matched the requests aboard ship and influenced almost simultaneously. even the general physical training. (In the final phase of the research, the experimental Group recorded superior and improved values at seven from the nine investigated parameters concerning *general physical training*, the difference between the medium results of the groups being a *„very significant one”*, according to the Table of Fischer, at a statistic significance threshold „p”<0,001 and n-1.)

Concerning **the specific physical training**, the recorded parameters evolution in the final phase demonstrated our programme , induced aboard ship is completely justified and true. Statistic calculation results (we miss the necessary room to present)showed the experimental Group reached „very significant statistic„ levels at a significance threshold of p=0.01 and n-1. The objectivity, expressed by the figures noed as results, the mathematical modelling of the training level, together with the statistical mathematical interpretation, showed that the goal of our scientific methodical research in the experiment, was positively reached.

7. METHODICALPRACTICAL RECOMMENDATIONS

The results we obtained by optimizing the structure and the contents of the specific physical and psycho motional training of the naval and marine students, demonstrated how necessary is to generalize the new system of the training, extending it to be applied to all the navigating personnel. Therfore it is very necessary to do a practical training, to get a rythm of all this training of the navigating personnel, in order to support the physical capabilities and a real capacity to fulfill the specific psycho motional acts, necessary in the navigation activities, no matter the conditions.

The new methodical installed way, scientifically motivated, as well as the significant statistical mathematical results obtained along this pedagogical experiment on students and professional navigators, as well, deeply confirmed the hypotesis we had from the very beginning, and the goal and tasks and methodology also. The leading of this training methodical scientifical has to be applied during the learning period in the Institute, during also the period the student are training aboard school ships, and eventually during al their lives as long as they are navigators.

7. REFERENCES

[1]. ANGHELACHE, C. – *„General Statistics, theory and application”*, Economic Publishing House, Bucharest, 1999.

[2]. DUMITRESCU, G. - *„Statistical mathematical methods in sports”*, I. E. F. S., Bucharest, 1991.

[3]. EPURAN, M. – *„The body activities research methodology”*, Vol. I and II, A.N.E.F.S., Bucharest, 1992.

[4]. ERNEST, W. Maglischo – *„Let’s swim faster”*, (Translation) M.T.S., C.C.P.S., F.R.N., Vol.II, Bucharest, 1992.

[5]. GOLU, M. **-** *A Statistics Course* **–** Bucharest University, 1996

[6]. KURT, E**. – „***A standard test to determine the effort capacit”*, C.N.E.F.S., Bucharest, 1996.

[7]. MUSTER, D. – **„***The research methodology in the physical training and sports*”. Litterary Publishing House, 1985.

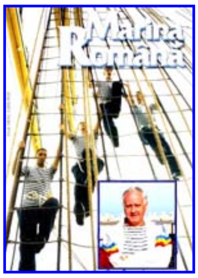
[8]. OPRISAN, N. – *„The application of the mathematical modelling and programmed training in order to prepare the rowing competitions”*. C.N.E.F.S. Publishing House, in „ Physical training and Sports” Magazine, No. 11/1982, p.26-32.

[9]. OPRISAN, N. - *„The mathematical model of the World competition in boating- the improving of the competition model in rowing”,* C.N.E.F.S. Publishing house Bucharest, „Physical training and Sports” Magazine, No. 6/1983, p.30-41.

[10]. OPRISAN, N. – *„Requests of the selection process concerning the psycho motional capacityof the young man involved in naval and marine education”*. – Paper published by the Education Ministry in Forum Magazine, No. 3-4/1992, p.89-101.

[11]. OPRISAN, N. – **„**The *physical and psycho motional training of the young future navigators”*- Paper published by the Education Ministry and the Foreign publishing House „România”, în FORUM magazine, No.11-12/1993, p.19-23.

[12]. OPRISAN, N. - *„Practical training of the naval students aboard ship, a good opportunity to strongly form the psycho motional features necessary in achieving <the ships roles>*-Paper presented at the „International Conference on naval and marine education”(ROMANIAN NAVAL ACDEMY’S 130 th ANNIVERSARY) Constanta, 14-16 Nov. 2002; paper published in the volume of A.N.M.B., pag. 444-449.



SCIENTIFIC APPLIED RESEARCH. A PATTERN OF A CORRELATIVE ANALYSIS OF THE PHYSICAL TRAINING PARAMETERS TESTED ON NAVAL AND MARINE STUDENTS

OPRISAN NAIE-GILLES

Naval Academy „Mircea cel Batran" Constanta, Romania

ABSTRACT

The applied scientific activity in the field of the pedagogical experiments on naval and marine students were widely extended and very complex. In our paper we'll reffer only to the final part of our scientifical investigation action, mainly to the correlative analysis of the investigated data, as a result of our pedagogical intervention in order to complete the general education and training of the young navigators to be. So, we'll present here *the analysis of their longitudinal evolution and the statistical indicators of their correlation - analysed in different moments of their phases of the research - the correlative analysis between the statistical investigated indicators inside the final testing on experimental group, as well as the correlative analysis between the group of tests applied on the witness and experimental students' groups.* We consider these directions presented here are quite sufficient to show the complexity of our scientific action.

Keywords: *Statistical correlation, scientific investigation parameters,co-relation coeficient, longitudinal evolution, value uniformity, appreciation scale, co-relative matrix, statistical signification, etc.*

1. INTRODUCTION[1]

Usually, at the end of the researches having as object the evolution of some phenomenon as a result of an experimental improving interventions, a processing of the data and results is done, then the correlative calculations between the influence of different parameters we used, is also realised. As the hypotesis, the target the methods ad the the steps involved in our experimenton the naval and marine students were widely presented during many other speeches we'll only present here - because we do not have room enough - a correlative analysis of the parameters included in the scientific investigation.

2. THE GOAL OF THE RESEARCH

Our research goal in this specific domain, not very often accessible, was to put into effect an improving action of a new adequate training programme, according to the real requests of the physical and psycho motional needs aboard ships.

3. THE RESEARCH METHOD

They were really very many. We started from the study of the specific litterature, from the critical analysis of the educational programmes involving the improving experimental intervention, then, we statistically processed the investigated data and got the realistic conclusions due to realise a new, more adequate programme to answer the real conditions imposed by the navigation activities. The last part, that of the correlative analysis of the investigated parameters wil bee widely and thoroughly presented in this paper.

[1] In the end we mention the contribution in achieving this work of mr. col. (rs.) psihologist ***Dan NICOLAU***.

4. THE RESEARCH RESULTS ACCORDING TO CORRELATIVE ANALYSIS OF THE INVESTIGATED PARAMETERS PRINCIPLES

The innitial study of the mathematical statistics

We havw to note here that, in order to calculate the *statistic correlation co-eficient* between the involved parameters and the groups of new tests, we used the formula of *ranking method - SPEARMAN.*

The formula we used to calculate the statistical correlation coeficient by the ranking method - SPEARMAN.	The formula we used to calculate the statistical correlation coeficient by the method - PEARSON.
$r^1 = 1 - \frac{6 \cdot \sum D^2}{n \cdot (n^2 - 1)}$	$r = \frac{\sum d_x \cdot d_y}{(n-1) \cdot S_x \cdot S_y}$

The correlative study was orientated towards the three following directions:

A. The longitudinal evolution analysis of the correlation of the investigated statistical indicators in differnt phases of the research

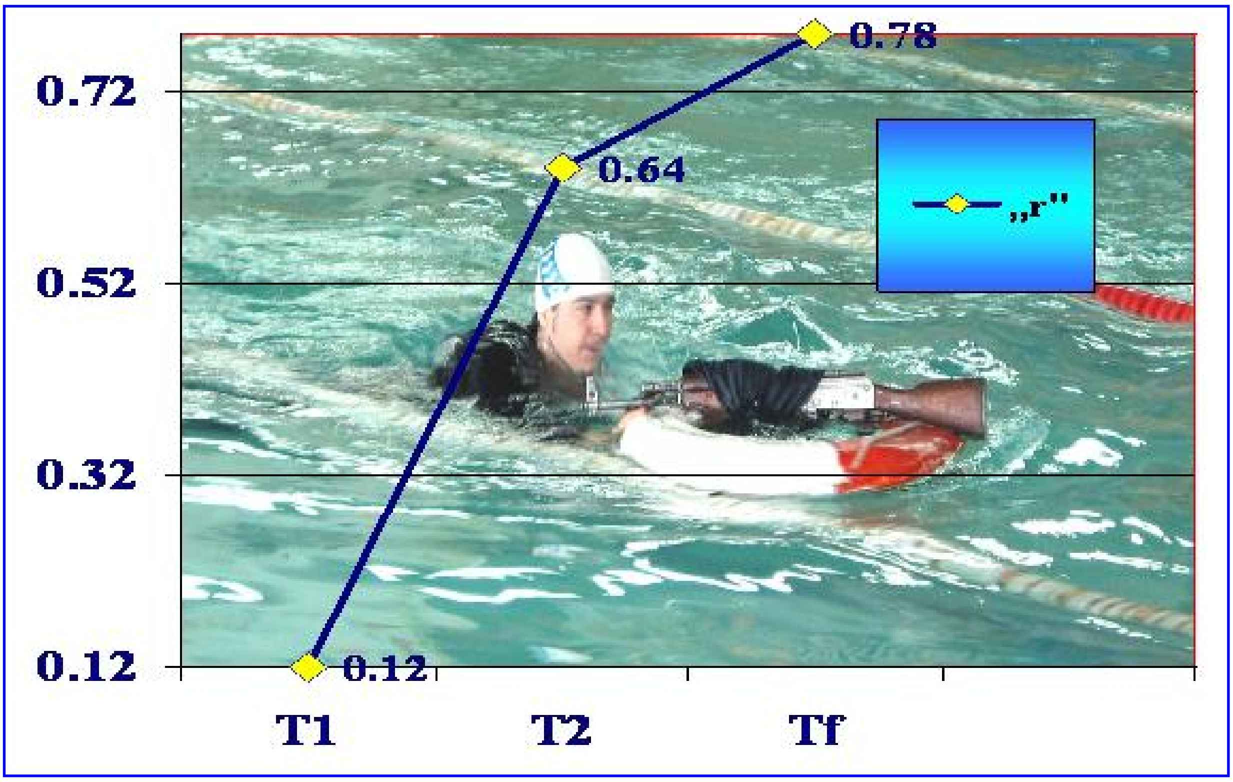
As the analysis is larger than we can afford to include in this paper, as a whole, we'll present here only the most significant general conclusions of the study we made, followed, of course by an example, the one showed in table no. 1 and in diagram no.1.

Table no. 1

The significant presentation of the longitudinal evolution of the correlation coeficient („r”) between two *specific physical training* parameters along all three tests: T_1, T_2. and T_f.							
Ord no.	**Correlated parameters**	**T_1**		**T_2**		**T_f**	
		1	**2**	**1**	**2**	**1**	**2**
1	**Swimming dressed 50 m. (t-shirt and trousers)**		**0,12**		**0,64**		**0,78**
2	**Carrying during swimming of the round life buoy, of the rifle and the equipment**						
Legend							
r < 0,52; p < 0,05;			**0,52 ≤ r ≤ 0,66**			**r > 0,66; p = 0,01.**	

Diagram no.1

The longitudinal evolution of the correlation coeficient („r”) between two *specific physical training* parameters along all three tests: T_1, T_2. and T_f.



Some tests included in our research showed the *correlation coeficients („r”) recorded statistical significant increasing values.* This showed us in figures on the one hand that such an innitial uniformity of values of the students groups included in the pedagogical experiment is missing, and, on the other hand, their uniformization from this point of view all along our improving intervention and specific training. We concluded this way that the entire improving intervention process of the specific training of the navigators is positivel in their benefit. The final results demonstrated this fact. The experimental intervention using a new model of physical and specific psycho motional training of the naval amarine students lead them to better results some of them outstanding in the final tests. This reflected in a higher level of the quality of their intervention in rescue actions in the open sea storms.

B. The co-relative analysis between the statistical indicators we investigated in the final testing on the experimental group of students.

We have to remind you that we used the previously mentioned formula of *„ranking method - SPEARMAN”* and respected the evaluation scale of the official statistics recognized by the whole scientific world and presented here in the table no.2. We contributed this way to an absolute objectivization of our research and evaluation procedures.

Table 2

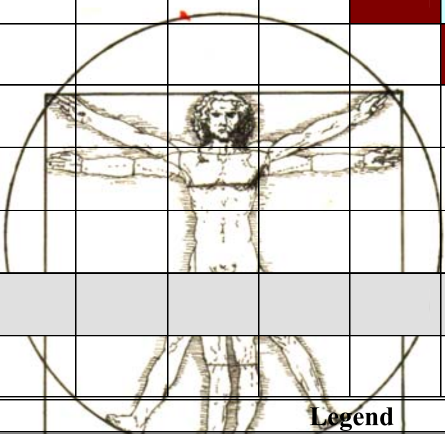
The appreciation and interpretation scale of the statistical correlation coeficient („r”).			
The value of the statistical correlation coeficient („r”)		**Interpretation**	**The value of the statistical significance threshold („p”)**
r > 0,66	**0,68,…etc.**	**The statistical very significant correlation**	**p = 0,01**
	0,67		
r ≥ 0,52; r ≤ 0,66.	**0,66**	**The statistical significant correlation**	**p = 0,05**
	0,65		
	0,64		
	0,63		
	0,62		
	0,61		
	0,60		
	0,59		
	0,58		
	0,57		
	0,56		
	0,55		
	0,54		
	0,53		
	0,52		
r < 0,52	**0,51**	**The statistical non-significant correlation**	**p < 0,05**

B.a. The correlative analysis of the morphological development parameters

We present in the table no.3, below the situation

Table 3

The correlative matrix and the correlation coeficients of the *morphological development* parametersat the students of the experimental group (E) in the final testing (T_f) of the research												
Ord. No.	**Investigated parameters**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	Height		0,75	0,97	0,99	0,87	0,92	0,97	0,83	0,91	0,97	0,92
2	Weight			0,70	0,66	0,52	0,68	0,69	0,42	0,58	0,63	0,55
3	Height when lying on the back				0,96	0,85	0,90	0,96	0,84	0,91	0,97	0,93
4	Arms amplitude					0,88	0,88	0,96	0,80	0,89	0,96	0,91
5	Body height up to the shoulders						0,84	0,91	0,82	0,89	0,89	0,88
6	Legs lenght							0,88	0,84	0,96	0,95	0,88
7	Shoulders width								0,84	0,90	0,95	0,92
8	The excedent when coiled up									0,94	0,92	0,82
9	Specific amplitude										0,97	0,89
10	**I.M.Ma. (Σ 3-9)**											0,93
11	Pool width											
Legend												
r < 0,52; p < 0,05;			**0,52 ≤ r ≤ 0,66**				**r > 0,66; p = 0,01.**					



(I.M.Ma. (Σ 3-9) = Morphological Indicator of the navigator.)

When analyzing the correlative matrix with the morphological parameters we notice statistically signifiant values of the correlation coeficient „r” between all morphological parameters at the statisticalsignificance threshold (0,05) but mostly the p=0,01, which means very clearly there’s a nomal balanced proportionality of the body and limbs measures in the experimental group of students, over 21. More than that, the indicator I.M.Ma is an additional one in characterizing globally the morphology considering the value of an indicator raises in the same direction. As you can see in table no.33 we have only one exception, the correlation between *specific amplitude* and *body weight*, but not being in any relation (r = 0,42 < 0,52 at p < 0,05).

B.b. The correlative analysis between the active parameters of the breathing apparatus.

Table 4

The correlative matrix containing the correlation coeficients of the *breathing apparatus* parameters gathered from the students of the experimental group (E) in the final test (T_f)				
Ord. no.	**Correlated parameters**	**1**	**2**	**3**
1	Respiratory frequency (F.R.)		0,16	0,11
2	Vital capacity (C.V.)			**0,91**
3	Apnoea time (T.Ap.)			
Legend				
r < 0,52; p < 0,05;		**0,52 ≤ r ≤ 0,66**		**r > 0,66; p = 0,01.**

B.c. ***The correlative analysis othe physical training parameters***

The correlative matrix is shown in the table below (5)

Table 5

The correlative matrix including the correlation coeficients of the *general physical training*, at the students of the experimental group (E) in the final test (T_f)									
Ord no.	**Correlated parameters**	**1**	**2**	**3**	**5**	**6**	**7**	**8**	**9**
1.	Arm pullings		0,22	- 0,15	0,21	0,25	0,34	**0,84**	0,09
2.	Abdominal flexions			0,25	- 0,67	0,45	0,46	0,02	0,60
3.	The standing jump				0,14	0,16	- 0,01	- 0,38	**0,57**
4.	Long distance run on 4000 m					**0,89**	0,04	- 0,27	0,44
5.	Free style swimming for 30’						0,18	- 0,29	0,50
6.	Sprint on 50 m							- 0,009	0,19
7.	Freestyle swimming on 50 m								- 0,25
8.	Specific balance								
Legend									
r < 0,52; p < 0,05;			**0,52 ≤ r ≤ 0,66**			**r > 0,66; p = 0,01.**			

As can be seen, from the correlative matrix we recorded values of the statistically significant correlation coeficient between the *tests of pulling in arms* and *freestyle swimming 50 m* (r = 0,84 at p = 0.01), as well as between the *long distance run 4,000 m* and *freestyle long distance swimming 30’* (r = 0,89 at p = 0.01).

The experience showed us the best sprinters on the ground (50 m) are not the best, or fastest sprinters when swimming the 50 m distance. In spite these two tests are focused on the same 50 m. Distance testing the motional capacity, the speed, the structure of the motional acts is totally different, r = - 0,009 at p < 0,05.

This fact is of greatest importance demonstrating ***the need to guide, and lead the navigator’s training to the specific effective workin contact with the water, as the best sportsmen on the ground are not at al the best when swimming or rowing in boats !***

B.d. The correlative analysis of the specific physical training parameters

Concerning the specific physical training (see table no. 6) We can notice statistically significant correlations between the results obtained at pulling the rope in orthostatic position (standing) and rowing a single person boat, r = 056 at p = 0,05.

Table 6

The correlative matrix of correlation coeficients of the specific physical training of the students in the experimental group (E) in the final test (T_f) of the research							
Ord. no.	**Correlated parameters**	**1**	**2**	**3**	**4**	**5**	**6**
1	Pulling the rope (1) in orthostatic position (standing)		**0,56**	0,15	**0,995**	-0,02	0,28
2	Rowing in a single person boat			0,34	0,18	0,28	0,13
3	Swimming dressed 50 m (t-shirt and trousers)				0,39	**0,78**	-0,1
4	Pulling the rope (2) while swimming					0,10	0,03
5	Carrying while swimming, the circle (round) lifebuoy, the rifle and the equipment pack						-0,1
6	Exercise ittinerary for rapid run and obstacles aboard ship						
Legend							
r < 0,52; p < 0,05;		**0,52 ≤ r ≤ 0,66**			**r > 0,66; p = 0,01.**		

We also noticed significant and visible correlations between th results of the students of the experimental group in the final test at: *pulling the rope in orthostatic position* and *pulling the rope while swimming,* r = 0,995 at p = 0,01 and between the *swimming test dressed* and the *test of swimming vith the rifle , the equipment pack and the lifebuoy*, r = 0,78 at p = 0,01.

B.e. The correlative analysis of the specific psycho motional training parameters

When analyzing the correlative matrix together with the specific psychomotional parameters (shown in the table no. 46)we may notice a correlation between the results of the two variants of „Oprişan test", r=086 at p=0,01, a very significant correlation from statistical point of view, meaning both variants of the test are completing each other and form the specific features and qualities the activities aboard ship request. Therefore the improvement of the results at one of the variants guides to the increasing the specific medium capability of the group to realise the other one in best (optimal) conditions.

Table 7

The correlative matrix with the correlation coeficients of specific psycho motional parameters, we collected from the experimental group students (E) in the final tests (T_f).			
Ord. no.	**Correlated parameters**	**1**	**2**
1	***„Oprişan"* test. First variant**		**0,86**
2	***„Oprişan"* test. Second variant**		
Legend			
r < 0,52; p < 0,05;	**0,52 ≤ r ≤ 0,66; p = 0,05**	**r > 0,66; p = 0,01.**	

The general conclusion we may get is, practically we still can create some other variants of the ittinerary, larger or smaller, according to the specific physical and psycho motional posibilities of the crew the man is working whithin, for attending a higer level of the psycho motional experience, more and different developped in order to face the difficulties the activities on the ship request. Each member of the crew has to have a most appropriate answer to help the general succes of the crew.

The results get at the final psychomotional testing as well as the correlation level of the two variants of the psycho motional specific test (*„Oprişan"*) applied in our experimenal research we present to you make us aware to conclude our unique pedagogical experiment with the naval and marine students and the general methodology, fully reached the target they expected.

Generally speaking, we recorded at the level of all the investigated parameters in *innitial test* (T_1) a large scale of values of statistical indicators (Vmax-Vmin). We expected in the intermediary test (T_2) and final test (T_f) this scale to record a lower value by uniformization in training of the experimental group members. It didn't happen.

Developping our tests aboard a ship we attired attention and interest of the crew members, and, surprise! they wanted to take part in our experimental action. Of course, their participation stimulated, challanged the members of the experimental group. So, they maintainened constant the values of the differences between the first and the last in the courses timing. More than that, we noticed some important changes because the first in some tests came down the top in other tests. The most important thing we consider to have been gained was from far the interest the students involved in the experiment, their devotion, their challenging attitude.

C. The correlative analysis between the groups of tests

This analyse includes to calculate the statistical correlation coeficients, between the average of the values rankings of the tests inside the experimental group for each one of the eight groups of tests applied. As can be seen in table 47 we recorded correlation coeficients statistically significant, between most of thegroup of tests.

Table 8

The correlative matrix to the correlation coeficients, between the group of tests applied to the experimental group members (E) in our final test (T_f)

Ord. no.	The correlated parameters	1	2	3	4	5	6	7	8
1	The morphological development		0,72	0,27	0,52	0,59	0,38	-0,14	0,58
2	Breathing apparatus			0,54	0,49	0,72	0,52	0,62	0,27
3	Cardiovascular apparatus				0,61	0,63	0,60	0,59	-0,02
4	Physiological indicators					0,76	0,81	0,51	0,47
5	General physical training						0,86	0,69	0,64
6	Specific physical training							0,78	0,47
7	Specific psycho motional training								0,51
8	The psychosocial integration level								

Legend: r < 0,52; p < 0,05; r ≥ 0,52; p = 0,05; r > 0,66; p = 0,01.

5. GENERAL CONCLUSIONS

As seen, the **morphological parameters** of the second experimental stage did not have a significant evolution either, showing the statistical significance threshold at p = 0,05 and freedom degree n-1. This demostrates again the evolutive processes in the anthropometric line are somehow closed at this age and the specific training only helps to come to maturity. What is left to be perfectible ? The parameters characterizing the joints mobility !

Concerning the final tests in order to determinethe evolution of the **functional capacity** we notice the experimental group recorded a positive evolution and astatistically significant difference at the level of all investigated parameters concerning the functional capacity of the **breathing apparatus**, as well as the functional capacity of the **cardiovascular apparatus.**

The positive evolution in improved direction of the investigated functional parameters at the experimental group level showed an excelant capacity to adaptation to efficiently support the physical effort. This demonstrates our new vision over the programming the education and specific physical training is positively useful according to the requests of the navigators activities aboard ships.

Even if we stressed a little more the activities to ensure a **specific physical training** and a **specific psiho motional training** of the naval and marine students inside our pedagogical experiment, we did not avoid to pay attention to the free time of the students, to help them have fun using the methods of the physical training.

More than that, we concluded that, by introducing specific and rationalized physical and psychomotional training according to the requests aboard ships we influenced in the same time the general physical training level.

In the final phase of the research the experimental group recorded superior values in the improved sense at seven from the nine investigated parameters in general physical training, the difference between the averages of the groups being „*very significant from statistical point of view*", according to Fischer's table, at a statisttical significance threshold of „p"<0,001 and n-1.

Concerning **specific physical training**, the evolution of the recorded parameters in the final phase of the research fully demonsrated our programme is covering the training needs aboard ships.

The statistical calculation results revealed that the experimental group recorded at the level of the most investigated parameters "*very significant from statistical point of view*" differences at the significant threshold of p = 0,01 and n-1

The objectivity by expressing only the figures representing our results, the mathematical modelling of the desired training level, together with the statistical and mathematical processing and interpreting of the results showed the target of the methodical-scientific research inside our experiment weas fully reached.

The results obtained at the final testing from the experimental second stagedemonstrated the same thing concerning the **specific psycho motional training**.

In both variants of specific psychomotional test („Oprişan" test), at the final test, the experimental group is included into the effort needs aboard ship, the average of the group being far better than the one of the witness group, „t" = 9,44 and 9,40, differences *„very significant from statistical point of view"* at p = 0,001 and n-1.

Concerning the **psycho temperamental testing** and the final one, the results of the Guilford - Zimermann test showed the students group we worked with are fully satisfying the requests the navigation security raises to the crews. They are not problems in this respect, no statistically significant differences between the experimental and witness group were noticed.

Concerning the **psychosocial integration capacity (the communicative emergency level)**, the results of the final test in the second experimental stage with the test *„MAK-KROSSKI”* showed an important superiority of the experimental group compared to the witness group „t” = 8,84, *„a very statistically significant”* difference at p = 0,001 and n-1.

This shows the specific and psychosocial integration emergency comunication parameters are influenced positively, are prfectible by introducing the new optimal system with its operational objectives of the specific physical and psycho motiomal training introduced in the practical training of the naval and marine students.

6. FINAL CONCLUSIONS

1. At the end of our study we concluded that the specific physical and psycho motional training, **in naval education is insuffcent found in the litterature**.

The authors dealing withnavalspecific issues, are usually reffering mostly to the necessity of the psychological education in the field. They also recognize the real place the physical education has to have in a complete education of the future navigators, for its roleplay in the regulation of integrative function and the psycho motional capacities in the activities aboard ship.

2. Analyzing the **educational plans**, programmes and the other **planning documents** in the Navy we noticed the **small numbers of hours dedicated to the physical training** of the **naval and marine students**, no matter if civilians or military. The total amount was raising to the level of the time dedicated to study litterature, philosophyor...theology, totally incorrect for their future professional activities across the seas.

We also have to mention that until the start of our research, the hours included in the general planning in the field was orientated mostly to the general physical training, avoiding the specific psycho motional training, far from the needs of the students and the naval activity.

3. Analyzing **the results of the sociological investigation questionnaire** we concluded the specilists are aware of the necessity of enlarging the number of hours dedicated to specific physical training and guiding them correctly to thei future occupation.

The same thing was understood after **analyzing the laws and the rules designed** to regulate the navigation activities, they also being unefficient and not able to organize the putting into practice of the theoretical studies. There ,s a need to induce a new vision and methodical scientific way to replace the old traditional training system as to be able to be more practical in applying the established rules.

4. In order to follow the goal we suggested in our research we used a n important part of the **traditional tests** taken fom the litterature in the field but we also dared to introduce new **tests and parameters very specific** to the activity we were studying. This way we became practical and concrete supported by the results seen in the figures we presented.

5. The results we obtained in the second experimental stage were absolutely relevant, demonstrating that ***the proposed optimal model applied in the specific physical and psycho motional training of the naval and marine students*** was in their benefit. The specific methods in testing checking the results were according tothe real requests in the navigation activitiesand they reached al the concrete parameters able to give us a correct answer to our questions concerning the physical activity, the specific needs of the effort in the navigation.

This way we elaborated ***„the model of the navigator”*** having figures-parameters in all directions we are going to test the navigator, a model never realised before.

7. METHODICAL – PRACTICAL RECOMMENDATIONS

1. The results obtained by optimizing the structures and the contents of specific physical and psycho motional contents of the naval and marine students demonstrated the veracity of our research we did as well as the necessity to generalize the new optimal system of training applying on the entire navigator personnel.

2. The structure the professional activities are organized aboard ships must include compulsory the specific education and training in order to develop at highest level all activities included in the navigators life in best weather condition as well as in stormy conditions of the open sea. So it is obviously important to execute practical exercises in practical cases of „**The Roles of the Ship**” *(„man or men over board”,fire on board” „flood in the tanks”, „abbandon ship”, „ salvation and surviving in case of wreckage”,* etc.)

Therefore, the practical permanent training is absolutely and compulsory for every member of the crew in order to form and to maintain the physical qualities and a best capacity to react in any case to solve the bursting out problems.

3. The specific training algorythms and the optimal model to put into a structure wel organized all the practical elements we suggested are considered to be very flexible and adaptable to any kind of a ship.

The way we worked and oriented towards forming and keeping the psycho motional qualities specific to the navigators activities can be adopted also by the aviators, miners and other cathegories with good results.

4. The new line we suggest, very we;ll supported scientifically, as well as the results we obtained (verysignificant from the statistical mathematical point of view, obtained in our pedagogical experiment together with our groups of naval and marine students (even together with members of the crew!) fully confirmed the hypotesis previously established as wel as the goal, the tasks and the methodology we used.

5. The methodical-scientific guiding of the specific professional training has to be applied both inside the educational process and in the practical applications in the school, as well as all along the life and activities of the navigating pesonnel. The methodical line and the direction we mention is already in use in many navigation companies.

8. REFERENCES

[1]. BEJU, Iulian - *„The evolution of the educational system in the last few years. The stage andthe directions for the reform to be continued”*. „Forum” Magazine, no. 3-4/1993, pag. 10-12.

[2]. HARJOABA, Ioan - *„The new structure of the superior education- an important element of the reform”*, „Forum” magazine, no. 1-2/1993, pag.2-4.

[3] ION, L., BRATU, I., MIHAILESCU, C., BEJAN, A., - *„The physical training and the sport in the training of the military students”*, „Demnitatea Națională” Publishing House, Bucharest, 1996.

[4]. ION, L., ENE, V., - *„Organizing leading and the physical training legislation”*, A.N.M.B. Publishing House, Constanta, 2001.

[5]. OPRISAN, Naie - *„Some rules and recommendations in the nautical sportive activity”*, „Educatie Fizică şi Sport” magazine, C.N.E.F.S. Publishing House, Bucharest, no.3/1987,pag.17-22.

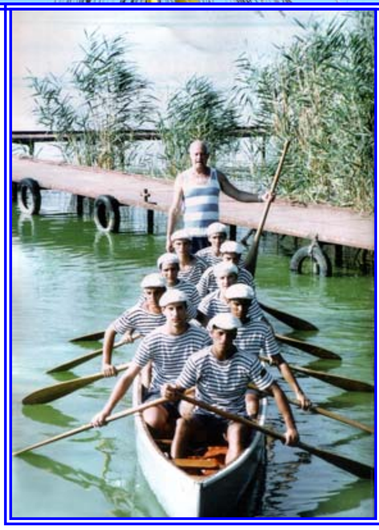
[6]. OPRISAN, Naie - *„Selection requests concerning the physical and psicho motional capacity for the young peoplewanting to follow naval and marine courses”*, „Forum” magazine, no.3-4/1992, pag. 98-101.

[7]. OPRISAN, Naie - *„Physical and psycho motional training for the navigators to be”*, „Forum „ magazine. No.11-12/1993, pag.19-23.

[8]. OPRISAN, Naie - *„The development of the physical and psycho motional specific features of the naval and marine students aswell as navigators by the methods of the applicative swimming”*, Paper presented at a High International Session on the anniversary of 10 years from the moment of Physical Education Institute from Chishinew, Republic of Moldova, V-th edition 1-3 nov. 2001.

[9]. OPRISAN, Naie - *„Practical activities of naval and marine students aboard ships, a neccesary opportunity to form psycho motional features in order to accomplish the missions aboard”* - Paper presented at, *INTERNATIONAL CONFERENCE ON NAVAL AND MARINE EDUCATION” („ROMANIAN NAVAL ACDEMI'S 130 th ANNIVERSARY”)*, Constanta, 14-16 nov, 2002. (published in the volume edited by A.N.M.B., pag. 444-449 included on the CD of the book).

[10]. POPESCU, Mircea - *„Concerns for the health level of the young students”*, „Forum” magazine,no.7-8-9.1992, pag49-52.



RISK ASSESSMENT

POPA LILIANA-VIORICA

Maritime University Constanta, Romania

ABSTRACT

Employers are required to ensure the health and safety of workers and other persons so far as possible, by the application of certain principles, including the evaluation of unavoidable risks and the taking of action to reduce them. Employers must ensure that measures are taken to ensure an improvement in the safety and health of workers and other persons in respect of those risks identified by the assessment. Employers must review the assessment when there is reason to believe that it is no longer valid, and make any necessary changes. Workers must be informed of any significant findings of the assessment and measures for their protection, and of any subsequent revisions made. The Company is also required to ensure that anyone working on the ship, whether or not they are directly employed by the Company, is aware of the findings of the Company’s risk assessment and of the measures taken for their protection.

Keywords: *Employers, risks, workers, company, measures, assessment*

1. INTRODUCTION

Every year, millions of people in the EU are injured at work, or have their health seriously harmed in the workplace. That is why risk assessment is so important, as the key to healthy workplaces. Risk assessment is a dynamic process that allows enterprises and organizations to put in place a proactive policy of managing workplace risks. For these reasons, it is important that all types and sizes of enterprise carry out regular assessments. Proper risk assessment includes, among others things, making sure that all relevant risks are taken into account (not only the immediate or obvious ones), checking the efficiency of the safety measures adopted, documenting the outcomes of the assessment and reviewing the assessment regularly to keep it updated. The most important piece of European legislation relevant to risk assessment is the Framework Directive 89/391. This Directive has been transposed into national legislation. Member States, however, have the right to introduce more stringent provisions to protect their workers.

2. PURPOSE OF RISK ASSESSMENT

Employers in each workplace have a general duty to ensure the safety and health of workers in every aspect related to their work. The purpose of carrying out a risk assessment is to enable the employer to take the measures necessary for the safety and health protection of workers.

These measures include:

- prevention of occupational risks;
- providing information to workers;
- providing training to workers;
- providing the organization and means to implement the necessary measures.

Whilst the purpose of risk assessment includes the prevention of occupational risks, and this should always be goal, it will not always be achievable in practice. Where elimination of risks is not possible, the risks should be reduced and the residual risk controlled. At a later stage, as part of a review program, such residual risk will be reassessed and the possibility of elimination of the risk, perhaps in the light of new knowledge, can be reconsidered.

The risk assessment should be structured and applied so as to help employers to:

- identify the hazards created at work and evaluate the risks associated with these hazards, to determine what measures they should take to protect the health and safety of their employees and other workers, having due regard to legislative requirements;
- evaluate the risks in order to make the best informed selection of work equipment, chemical substances or preparations used, the fitting out of the workplace, and the organization of work;
- check whether the measures in place are adequate;
- prioritize action if further measures are found to be necessary as a result of the assessment;
- demonstrate to themselves, the competent authorities, workers and their representatives that all factors pertinent to the work have been considered, and that an informed valid judgment has been made about the risks and the measures necessary to safeguard health and safety;
- ensure that the preventive measures and the working and production methods, which are considered to be necessary and implemented following a risk assessment, provide an improvement in the level of worker protection.

3. RISK ASSESSMENT TOOLS

There are many risk assessment tools and methodologies available to help enterprises and organizations assess their risks. The choice of method will depend on workplace conditions, for example the number of workers, the type of work activities and equipment, the particular features of the workplace and any specific risks.

The most common risk assessment tools are checklists, which are a useful tool to help identify hazards. Other kinds of risk assessment tools include: guides, guidance documents, handbooks, brochures, questionnaires, and “interactive tools” (free interactive software, including downloadable applications which are usually sector-specific).

These tools can be either generic or branch/risk-specific. The Agency has developed a risk assessment tools database with tools from all over Europe. These tools are free and available online. The database is regularly updated with new tools.

4. HOW TO CARRY OUT A RISK ASSESSMENT

At EU-level there are not fixed rules about how risk assessments should be undertaken (you should check the specific legislation relating to risk assessment in your country). However, there are two principles which should always be borne in mind when approaching a risk assessment:

- to structure the assessment to ensure that all relevant hazards and risks are addressed (e.g. not to overlook tasks, such as cleaning, that might take place out of normal working hours, or ancillary departments such as waste compacting);
- when a risk is identified, to begin assessment from first principles by asking whether the risk can be eliminated.

A stepwise approach to risk assessment

The European Guidance on risk assessment at work proposes an approach based on a number of different steps. This is not the only method of carrying out a risk assessment; there are a variety of methodologies for achieving the same objective. There is no single “right” way to do a risk assessment and different approaches can work in different circumstances.

The risk assessment procedure (incorporating elements of risk management) can be broken down into a series of steps.

1. Establish a program of risk assessment at work
2. Structure the assessment (decide on the approach: geographical/ functional/ process/ flow)
3. Collect information
4. Identify hazards
5. Identify those at risk
6. Identify patterns of exposure among those at risk
7. Evaluate the risks (the probability of harm/severity of harm in actual circumstances)
8. Investigate options for eliminating or controlling risks
9. Prioritize action and decide on control measures
10. Implement controls
11. Record the assessment
12. Measure the effectiveness of action
13. Review (if changes are introduced, or periodically)
14. Monitor the program of risk assessment.

For most businesses, especially small and medium-sized enterprises, a straightforward five-step approach (incorporating elements of risk management) such as the one presented below should work well.

Step 1. Identifying hazards and those at risk
Looking for those things at work that have the potential to cause harm, and identifying workers who may be exposed to the hazards.
Step 2. Evaluating and prioritizing risks
Estimating the existing risks (the severity and probability of possible harm) and prioritizing them in order of importance.
Step 3. Deciding on preventive action
Identifying the appropriate measures to eliminate or control the risks.
Step 4. Taking actions
Putting in place the preventive and protective measures through a prioritization plan.
Step 5. Monitoring and receiving

The assessment should be reviewed at regular intervals to ensure that it remains up to date.

However, it is important to know that there are other methods that work equally well, particularly for more complex risks and circumstances. Which approach to assessment is applied will depend upon:

- the nature of the workplace (e.g. a fixed establishment, or a transitory one)
- the type of process (e.g. repeated operations, developing/changing processes, work on demand)
- the task performed (e.g. repetitive, occasional or high risk)
- technical complexity.

In some cases a single exercise covering all risks in a workplace or activity may be appropriate. In other cases, different approaches may be appropriate to different parts of a workplace.

Step 1. Identifying hazards and those at risk

The identification of the hazards in all aspects of work should be approached by:

- walking around the workplace and looking at what could cause harm.
- consulting workers and/or their representatives about any problems they have encountered. Often the quickest and surest way to identify the details of what really happens is to ask the workers involved in the activity being assessed. They will know what process steps they follow, whether there are any short cuts, or ways of getting over a difficult task, and what precautionary actions they take.
- examining systematically all aspects of the work, that is:

- looking at what actually happens in the workplace or during the work activity (actual practice may differ from the works manual)

- thinking about non-routine and intermittent operations (e.g. maintenance operations, changes in production cycles)
- taking account of unplanned but foreseeable events such as interruptions to the work activity
- considering long-term hazards to health, such as high levels of noise or exposure to harmful substances, as well as more complex or less obvious risks such as psychosocial or work organizational risk factors
- looking at company accident and ill-health records
- seeking information from other sources such as:
  - manufacturers' and suppliers' instruction manuals or data sheets
  - occupational safety and health websites national bodies, trade associations or trade unions
  - legal regulations and technical standards.

The identification of all those who might be exposed to the hazards. For each hazard it is important to be clear about who could be harmed; it will help in identifying the best way of managing the risk. Account should be taken of workers interacting with the hazards whether directly or indirectly, e.g. a worker painting a surface is directly exposed to solvents, while others workers in the vicinity, engaged in other activities, are inadvertently and indirectly exposed.

This doesn't mean listing everyone by name, but identifying groups of people such as 'people working in the storeroom' or 'passers-by'. Cleaners, contractors and members of the public may also be at risk.

Particular attention should be paid to:
- gender issues
- groups of workers who may be at increased risk or have particular requirements:
- workers with disabilities
- migrant workers
- young and old workers
- pregnant women and nursing mothers
- untrained or inexperienced staff
- temporary and part-time workers

It is important to identify how these people might be harmed, i.e. what type of injury or ill health may occur.

Step 2. Evaluating and prioritizing risks

The next step is to evaluate the risk arising from each hazard. This can be done by considering:

- how likely it is that a hazard will cause harm (e.g. whether it is improbable, possible but not very likely, probable, or inevitable over time)
- how serious that harm is likely to be (e.g. resulting in minor damage, a non-injury incident, a minor injury (bruise, laceration), a serious injury (fracture, amputation, chronic ill-health), a fatality, or a multiple-fatality)
- how often (and how many) workers are exposed.

A straightforward process based on judgment and requiring no specialist skills or complicated techniques could be sufficient for many workplace hazards or activities. These include activities with hazards of low concern, or workplaces where risks are well known or readily identified and where a means of control is readily available. This is probably the case for most businesses. In some other cases it may not be possible to identify the hazards and evaluate risks without professional knowledge, support and advice. This may arise in respect of the more complex processes and technologies in the workplace, or hazards, such as those related to health, which may not be readily or easily identifiable, and may require analysis and measurements.

Step 3. Deciding on preventive action

Having evaluated the risks, the next step is to put in place preventive and protective measures. Among the things to be considered at this stage are:

1. Whether risks are preventable or avoidable. Is it possible to get rid of the risk? This can be done, for instance, by:
- considering whether the task or job is necessary,
- removing the hazard,
- using different substances or work processes.
2. If risks are not avoidable or preventable, how risks could be reduced to a level at which the health and safety of those exposed is not compromised. When determining a strategy to reduce and control risks, employers should be made aware of the following additional general principles of prevention:
- combating the risk at source.
- adapting the work to the individual, especially as regards the design of work places, the choice of work equipment and the choice of working and production methods, with a view, in particular, to alleviating monotonous work and work at a predetermined work-rate and to reducing their effect on health.
- adapting to technical progress.
- substituting the dangerous by the non-dangerous or the less dangerous (replacing the machine or material or other feature that introduces the hazard by an alternative)
- developing a coherent overall prevention policy which covers technology, organization of work, working conditions, social relationships and the influence of factors related to the working environment.
- giving collective protective measures priority over individual protective measures (e.g. controlling exposure to fumes through local exhaust ventilation rather than personal respirators).
- giving appropriate instruction to workers.

For guidance on the control of risk through these measures employers should be referred to specifications, in national legislation, national standards, published guidance and other such criteria, published by national authorities.

A further important general principle of which employers need to be aware is that they should not transfer risks. That is to say that in providing a solution to one problem, another problem should not be created.

For instance, it would be of doubtful benefit to provide double-glazing to office windows in order to reduce noise from outside, unless provision was made for adequate ventilation.

4.5 Step 4. Taking action

After the most appropriate preventive and protective measures have been identified, the next step is to put them in place effectively.
Effective implementation involves the development of a plan specifying:

- the measures to be implemented
- the means allocated (time, expenses etc)
- who does what and when
- when actions are to be completed, and
- a date for reviewing the control measures.

It is important to involve workers and their representatives in the process:

- to inform them about the measures implemented, about how they will be implemented, and who will the person in charge of implementing them
- to train or instruct them about the measures or procedures that will be implemented.

Step 5 Monitoring and reviewing

Arrangements for monitoring and reviewing the protective and preventive measures should be introduced following the risk assessment to ensure that the effectiveness of these measures is maintained, and the risks controlled.

The information generated by monitoring activities should be used to inform the review and revision of the risk assessment.

Risk assessment should not be a once-and-for-all activity. The assessment needs to be reviewed and revised, as necessary, for a number of reasons, including:

- the degree of change likely in the work activity
- changes which might alter the perception of risk in the workplace, such as a new process, new equipment or materials, change of work organization, and new work situations including new workshops or other premises
- once the new measures have been introduced following the assessment, the new working conditions should be assessed in order to review the consequences of the change. It is essential that the risk is not transferred, that is to say that in providing a solution to one problem, another problem should not be created
- the assessment no longer being applicable because the data or information on which it is based is no longer valid
- the preventive and protective measures currently in place being insufficient or no longer adequate, e.g. because new information is available regarding particular control measures
- as a result of the findings of an accident or “near miss” (a near miss is an unplanned event that did not result in injury, illness, or damage - but had the potential to do so)

5. DOCUMENTING THE RISK ASSESSMENT

A record of the results of risk assessments at work should be kept. Such a record can be used as a basis for:

- information to be passed to the persons concerned
- monitoring to assess whether necessary measures have been introduced
- evidence to be produced for supervisory authorities
- any revision if circumstances changes.

A record of at least the following details is recommended:

- name and function of the person(s) carrying out the examination
- the hazards and risks that were identified
- the groups of workers who face particular risks
- the necessary protection measures
- details of the introduction of the measures, such as the name of the person responsible and date
- details of subsequent monitoring and reviewing arrangements, including dates and the people involved
- details of the involvement of workers and their representatives in the risk assessment process.

The records of assessments should be drawn up with the consultation and participation of workers and/or their representatives and made available to them for information. The workers concerned should, in any case, be informed of the outcome of each assessment that relates to their work station, and the action to be taken as a result of the assessment.

6. EMPLOYERS’ ROLES AND RESPONSIBILITIES

Employers should carefully prepare what they are going to do in order to meet their responsibilities to make a risk assessment, and put in place the measures necessary for the safety and health of workers. It is recommended that they do this through an action plan for the elimination or control of risks.

The action plan should include:

- commissioning, organizing and coordinating the assessment
- appointing competent people to make the assessments

- the person carrying out the risk assessment can be:
  - the employers themselves
  - employees designated by the employers
  - external assessors and service providers if there is a lack of competent personnel in the workplace
- people can demonstrate their competence by showing that they have the following abilities:
  - an understanding of the general approach to risk assessment
  - the capacity to apply this understanding to the workplace

- the ability to identify situations where they would be unable to adequately assess the risk without help, and be able to advise on the need for further assistance

- consulting workers' representatives on arrangements for the appointment of those who will make the assessments
- providing the necessary information, training, resources and support to assessors who are the employer's own employees
- ensuring adequate coordination between assessors (where relevant)
- involving management and encouraging the participation of the workforce
- determining the arrangements to be made for reviewing and revising the risk assessment
- ensuring that the preventive and protective measures take account of the results of the assessment
- ensuring that the risk assessment is documented
- monitoring the protective and preventive measures to ensure that their effectiveness is maintained
- informing workers and/or their representatives of the results of the assessment and of the measures introduced (making the records available to them).

7. WORKERS' ROLES AND RESPONSIBILITIES

It is important that workers participate in the risk assessment. They know the problems and the details of what really happens when they perform their tasks or activities, so they should be involved in the assessment. Their practical knowledge or competence is also often needed to develop workable preventive measures. Workers' participation is not only a right, it is fundamental to make the employers' occupational health and safety management effective and efficient.

Workers and/or their representatives have the right/duty to:

- be consulted on arrangements for the organization of the risk assessment and for the appointment of those undertaking the task
- participate in the risk assessment
- alert their supervisors or employers regarding perceived risks
- report any changes in the workplace
- be informed of the risks to their safety and health and of the measures necessary to eliminate or reduce these risks
- be involved in the process of deciding on the preventive and protective measures to be put in place
- ask the employer to put in place appropriate measures and to submit proposals to minimize hazards or to remove the danger at source
- cooperate to help the employer to ensure that the working environment is safe
- be trained/receive instructions on the measures to be put in place
- take care as far as possible of their safety and health and that of others persons affected by their acts in accordance with the training and the instructions given by the employer

In addition, it is important workers representatives are trained so that they understand risk assessment and their role in it.

8. CONCLUSIONS

Persons carrying out risk assessments at work should have knowledge of and/or information on:

- hazards and risks which are already known to exist, and the way that they arise
- the materials, equipment and technology used at work
- working procedures and organization and interaction of workers with the materials used
- the type, likelihood, frequency, and duration of exposure to the hazards. In some cases this may mean the application of modern, validated techniques of measurement
- the relation between exposure to a hazard and its effect
- the legal standards and requirements relevant to the risks present in the workplace
- what is regarded as good practice in areas where there are no specific legal standards.

Employers should make sure that whoever is making the risk assessment, whether an employee or an external consultant, speaks to the employees, or other people such as contractors who actually carry out the work.

Where employees of different employers work in the same workplace, assessors may need to share information about risks and the health and safety measures in place to address those risks. Facilitating this is a matter for the employer to arrange.

9. REFERENCES

[1] HMSO, *Report of Lord Donaldson's inquiry into the Prevention of Pollution from merchant Shipping,* HMSO, 1994

[2] Department for Environment, Transport and Regions, *Guidelines for Environmental Risk Assessment and Management,* Crown, London, 2000

[3] Queensland Transport and GBRMPA, *Oil Spill Risk Assessment for Coastal Waters of Queensland and the Great Barrier Reef Marine Park,* 2000

[4] Port of London Authority, *Operational Risk Assessment of Port of London 1999-2001,* Marine and Risk Consultants Limited, 2001

[5] Anatec, *UK & European Ship Routeing – Voluntary Observing Ships* (Technical Note), Department for Transport, 2003

[6] TWT/WWF, *Implementing the recommendations of the Sea Empress Environmental Evaluation Committee: A Review of Progress*. The Wildlife Trusts and WWF, 1999

[7] Safetec UK, *Identification of the Environmental High Risk Areas (MEHRA's) in the UK*, Department for Environment, Transport and Regions, 1999

[8] Owen, J., *Risk Assessment of shipping in environmentally sensitive areas*, Cardiff University, 1999

FUTURE DEVELOPMENTS ON OIL AND GAS TRANSPORT IN THE BLACK SEA REGION

STANCA COSTEL

Constanta Maritime University, Romania

ABSTRACT

The Black Sea region lies at the crossroads of major oil and gas export flows to the world energy markets. Wider Black Sea area is increasingly becoming very important in terms of energy production, transportation and distribution.

Last global tendencies in energy field indicate that the Black Sea region plays an important role in formation of new energy map of the Eurasian continent, which in perspective will contain such aspects, as diversification of oil and gas supplies, new routes of transportation of energy sources to the European markets and ensuring security of these projects. The concept of wider Black Sea region implies along with Russian oil and gas resources an increasing role of the energy sources of the Caspian basin with participation of Trans-Caspian countries – Iran, Kazakhstan and Turkmenistan in regional energy projects. The Black Sea region is a strategically important region as well as for own fossil reserves.

Keywords: *Black Sea, energy, oil and gas transport, pipelines.*

1. INTRODUCTION

In November 2006 the 2nd Energy Ministerial Conference was held under the Baku Initiative sponsored by the European Commission, and a new Energy Road Map was agreed by the European Commission and Governments of Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkey, Ukraine, Uzbekistan and the Russian Federation (as an observer) setting out a plan of action to bridge the gap between the current situation in the energy sector of these countries and the long-term vision for a common energy strategy.

The priority areas identified in the Road Map include supporting to sustainable energy development - including energy efficiency, renewable energy sources and demand side management - and attracting investment into energy projects of common interest.

The Energy Community Treaty, having as main goal to set up a legal and economic framework in relation to Network Energy, entered into force on 1st July 2006, accepted Georgia as observer in December 2007 and was enlarged with Moldova (full member from 1st May 2010) and Ukraine (full member from 1st February 2011) .

The Contracting Parties established to adopt and implement the acquis communautaire on energy, environment, competition and renewables. Turkey has confirmed the intention to engage in formal negotiations to join the Energy Community Treaty.

Figure 1 Map of Black Sea Region

2. PIPELINES IN THE REGION

The *Druzhba pipeline* is the world's longest oil pipeline with 4000 km length reaching Ukraine, Hungary, Poland and Germany. Pipeline was built in 1964 and currently has a capacity of 60–62 million tons per year. There are two project proposals with regard to the further extension of the Druzhba pipeline: extension of the northern branch of pipeline to the German North Sea port of Wilhelmshaven and extension of the pipeline to pass through Hungary and Croatia for reaching Adriatic Sea.

The *Baku–Tbilisi–Ceyhan pipeline* is a 1,768 km long crude oil pipeline from the Azeri-Chirag-Guneshli oil field in the Caspian Sea to the Mediterranean Sea. It connects Baku, the capital of Azerbaijan; Tbilisi, the capital of Georgia; and Ceyhan, a port on the south-eastern Mediterranean coast of Turkey, hence its name. It is operational from 10 May 2006 and is projected to transport 1 million barrels per day.

The *Odessa–Brody pipeline* (also known as *Sarmatia pipeline*) is a crude oil pipeline between the Ukrainian cities Odessa at the Black Sea, and Brody near the Ukrainian-Polish border (674 km). There are plans to expand the pipeline to Płock, and furthermore to Gdańsk in Poland.

Blue Stream is a major trans-Black Sea gas pipeline that carries natural gas from Russia into Turkey. Operating at full capacity delivers 16 bcm per year. The pipeline was built with the intent of diversifying Russian gas delivery routes to Turkey and avoiding third countries. It is planned to build the second leg of pipeline to allow expanding Russian gas export to the south (via Samsun-Ceyhan gas pipeline further to Israel and Lebanon).

South Caucasus Gas Pipeline (Baku-Tbilisi-Erzurum route) is to transport natural gas from the Shah Deniz gas field in the Azerbaijan sector of the Caspian Sea to Turkey. First deliveries of gas started in December 2006.

The pipeline is being constructed in the same corridor as the Baku-Tbilisi-Ceyhan oil pipeline in order to minimize the environmental and social impact. The pipeline is 692-km-long and the annual capacity will be up to 16 bcm, with the potential of being connected to Turkmen and Kazakh producers through the planned Trans-Caspian Pipeline.

The first aim of pipeline is to supply Georgia and Turkey. In longer perspective South Caucasus pipeline will supply Europe with Caspian natural gas, including Iran and Turkmenistan, through the planned NABUCCO project, Turkey-Greece and Greece-Italy pipelines.

NABUCCO is a gas pipeline project connecting the Caspian region, Middle East and Egypt via Turkey, Bulgaria, Romania, and Hungary with Austria and further on with the Central and Western European gas markets. The pipeline planned length is 3.900 km and the transport capacity of pipeline will be 31 bcm per year.

Another proposed route aiming at the transportation of natural gas from Kazakhstan and Turkmenistan to Central Europe is expansion of *Central Asian-Centre* gas pipeline, which runs from Turkmenistan via Uzbekistan and Kazakhstan to Russia.

Burgas-Alexandropoulos oil pipeline (279 km) is a project for transportation of Russian and Caspian oil from the Bulgarian Black Sea port of Burgas to the Greek Aegean port of Alexandroupoli. It would be an alternative route for Russian oil for bypassing the Bosporus and the Dardanelles.

However, in June 2010 it was announced that Bulgaria will not participate in the project to due strong opposition of local population of Burgas and an environmental impact assessment is needed before making a final decision about the project.

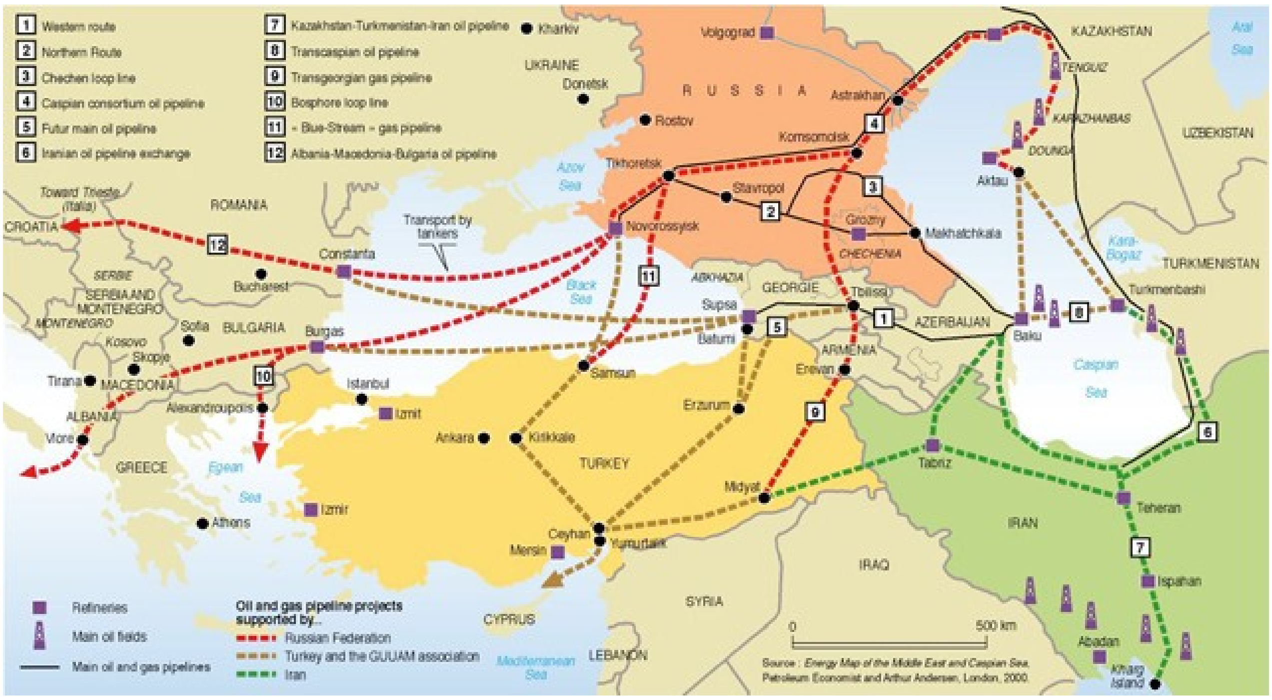


Figure 2 Oil and gas pipelines in the Black Sea Region (Source: http://maps.grida.no)

The *Pan-European Oil Pipeline* is a proposed oil pipeline from Constanța in Romania via Serbia and Croatia to Rijeka and from there through Slovenia to Trieste in Italy (1,856 km).

The aim of the pipeline is to bypass Turkish straits in the transportation of Russian and Caspian oil to Central Europe. In Trieste the pipeline will be connected with the Transalpine Pipeline, running to Austria and Germany.

Trans-Caspian Pipeline project is a proposed submarine pipeline between city of Turkmenbashy in Turkmenistan and Baku in Azerbaijan and considered as a part of the South Caucasus pipeline and NABUCCO project.

Along with South Caucasus and Trans-Caucasus pipelines the *Iran-Turkey gas pipeline* with extension of 2.577 km is the third essential branch of the NABUCCO project. The construction of pipeline was completed in 2001. In Erzurum the Iran-Turkey pipeline is linked to the South Caucasus pipeline.

Iran-Armenia gas pipeline is a 140 km pipeline between two countries running from Tabriz to Iran-Armenia border. The initial capacity of the pipeline is 1.1 bcm annually, which will be increased up to 2.3 bcm by 2019.

The Armenian side plans to lay some more 197 km of the pipe in order to reach the planned amount. The pipeline operation started on December 2006 and was officially inaugurated on 19 March 2007.

AMBO (Trans-Balkan pipeline) project is planned oil pipeline from Bulgarian Black Sea port Burgas via Former Yugoslav Republic of Macedonia (FYROM) to Albanian Adriatic port Vlore. The 894-km pipeline is expected to transport 750 000 barrels of oil per day. Trilateral convention on the AMBO project was signed on 31 January 2007.

3. RENEWABLE ENERGY

In the Black Sea Region each country is distinct in terms of its energy use and potential for renewable energy, but several trends are clear.

First is that renewables are clearly underexploited. Second is that of the renewables sources, hydropower is the best known, but at large scale (and hence questionably 'renewable'); the massive growth in wind power seen globally is beginning to make itself known in the region.

The abundance of oil and gas in the Caspian region has left countries there using that resource for domestic use, as in Azerbaijan, while many other countries continue to rely heavily on fossil fuels that have historically been available at cheaper than market prices, complicating the economic argument for alternatives.

The State Agency of Ukraine for Energy Efficiency and Energy Conservation (SAUEEEC) launched in 2010 a project of which includes the largest European solar power plant (80 MV) in Okhotnykovo, Crimea.

The project aims to produce electric energy from "clean" sources – the sun and the wind – to the amount of 2,000 MW. SAUEEEC expects the production share of alternative energy to make up 30 percent of Ukrainian energy market by 2015.

Ukraine funds its energy saving projects by the profits the government receives from selling CO_2 quota under the Kyoto protocol. In 2009; having traded its CO_2 emission quota to Japan, Ukraine has received almost USD 400 m.

The amount of solar radiation in Ukraine varies between 800 and 1450 W/m² per year and provides an extensive potential market of solar energy projects. As of 2009, Ukraine is the twelfth largest energy market in the world with an installed capacity of 54 GW. Ukraine exports its excess electricity to Hungary, Moldova, Poland, Romania, Russia, and Slovakia.

5. CONCLUSIONS

Most of the Black Sea, both the shelf and the deeper areas, is believed to be prospective for oil and gas. Indeed, numerous discoveries have been made on the shelf of Ukraine (including the Sea of Azov), Romania, and Bulgaria.

Russia excluded, imports of oil and gas are rapidly rising in volume and value, to the extent that they cause considerable foreign trade deficits in some countries, for example Bulgaria.

Previously inaccessible technology is now increasingly available and – except for the Ukraine – all of the countries have improved the terms of access for investors in the petroleum industry in general, in offshore exploration, and in production business in particular.

Similar opportunities may exist offshore of Georgia, Ukraine, and Bulgaria. Similar to the North Sea of 50 years ago, the Black Sea may be on the verge of becoming a major oil and gas producing area.

The opportunities in the area of Black Sea related to oil and gas transport include:

- *New pipelines*

Construction of export pipelines to deliver hydrocarbons to the European markets will improve the access to Caspian resources.

- *Fossil fuel development*

The latest research leads to extension of efforts in development of potential offshore exploitation in the Turkish area. In the Georgian area it is possible to see future developments also. However, transport of fossil energy will lead to increased shipping capacities in connection with further extend of pipeline networks.

- *Regional development*

The new role of the countries in the region (Bulgaria and Romania) as distributors on transportation routes will give them a chance of regional development including creation of work places, new incomes sources etc.

Unfortunatelly there are are also some risks associated to this development in the Black Sea area:

- *Increased oil transport and Bosphorus Strait constrains*

Future developments of the oil export flows from the Caspian region will increase the tankers passage though straits. Proposed projects, which in perspective will bypass Bosphorus Strait, could eliminate the environmental risks and possibility of physical break of energy supply in the region.

- *Environmental damage associated with new energy transport*

New developments in energy transport in the Black sea Region will lead to various environmental impacts and will increase the pollution risk due to ships accidents.

- *Need for effective communication*

The energy cooperation in the region should assure an effective sharing of information in case of an external energy crisis, as well as for assisting the early response and reactions in case of energy threats.

- *Infrastructure development*

Wider investment policy for the improvement and liberalization of investment opportunities in the energy sector is needed for rehabilitation and modernization of existing energy infrastructure and construction of new energy capacities.

Exports of crude oil from Black Sea ports averaging at over 100 million tonnes a year are expected to continue to rise, resulting in continued seaborne transits via the Bosporus and increased use of eastern Mediterranean ports linked to new pipelines intended to bypass the Bosporus.

Novorossiysk is the main export port in the Black Sea, accounting for 70% of oil loaded at Black Sea ports.

The European Commission has started streamlining the various transport cooperation efforts. It has launched exploratory talks with the countries of the region on extension of the trans-European transport networks.

7. REFERENCES

[1] Report on the first year of implementation of the Black Sea Synergy, Commission of the European Communities, Communication from the Commission to the Council and the Puropean Parliament, Brussels, 19.6.2008, COM(2008) 391
[2] Worldwide News Ukraine, www.inogate.org
[3] Wind in Power – 2010 European statistics, The European Wind energy Association, February 2011
[4] The Wider Black Sea Region in the 21st Century, Strategic, Economic and Energy Perspectives, Hamilton D., Mangott G. (eds.), Center for Transatlantic Relations, 2008
[5] The priorities of cooperation between BSEC member states in the field of energy: oil and gas sector, Report adopted by The Thirtieth Plenary session of the PABSEC General Assembly, 20th November 2007
[6] 'Diagnostic Report' to guide improvements to the regular reporting process on the state of the Black Sea environment, Commission on the Protection of Black Sea Against Pollution, 3rd August 2010

DEVELOPMENT OF RIVER INFORMATION SYSTEMS SERVICES FOR LOGISTIC ACTORS THROUGH THE RISING PROJECT

STANCA COSTEL

Project Manager - Romanian Intermodal Association, Romania

ABSTRACT

Started in February 2009 the FP7 project RISING has for objective the development and testing of new River Information Services for the European inland water transport (IWT) sector. In contrast to other RIS projects, RISING focuses exclusively on the current and future needs of the European transport and logistics sector. Through the RISING project the European transport sector is kept informed on RIS and awareness is being raised on the potentials of RIS(ING) services for transport and logistics operations.

IWT has become an integral part of co-modal transport and logistics chains. As such, the IWT sector has to comply with requirements of supply chain management (SCM). Effective transport infrastructure and high-performance intelligent Transport Systems (ITS) must be further developed which will play a key role in this process.

Keywords: *RISING, river information system, inland water transport*

1. INTRODUCTION

Europe`s freight transport system has much room for improvement. Congestion, capacity problems and delays affect mobility and economic competitiveness and are detrimental to the environment and quality of life.

The EU has committed itself to pursue the goal of shifting transport to less energy-intensive, cleaner and safer transport modes. Inland waterway transport is an obvious choice and should play a more prominent role in reaching these targets.

As a result of growing overseas trade and EU enlargement towards Central and Eastern Europe, freight transport volumes in Europe are expected to increase by one third until 2015. Present patterns of transport growth and its reliance on road transport have lead in many regions to congestion and pollution.

Shifts to more environmentally friendly modes must be achieved where appropriate, especially on long distance and in congested corridors. At the same time each transport mode must be optimised.

All modes must become more environmentally friendly, safer and more energy efficient as well as easily compatible in the transfer points. Finally, co-modality, i.e. the efficient use of different modes on their own and in combination, will result in an optimal and sustainable utilisation of resources.

Together with other modes, inland waterway transport can contribute to the sustainability of the transport system, as recommended by the White Paper. In the context of a liberalised inland navigation market, the European Commission aims at promoting and strengthening the competitive position of inland waterway transport, in particular by enhancing its integration into multi-modal supply chains.

The future usage and implementation of the new RIS(ING) services for inland fleets, ports/ terminals and transport-logistics is of strategic interest. This will facilitate the integration of IWT into multimodal transport chains. In order to attract the commercial businesses of the European transport sector to make use of the RISING services, demonstrator cases, regional Industry Forums as well as further multimedia-based dissemination instruments will be carried out along the rivers Rhine/ Scheldt, the Danube and the Elbe/ Weser.

2. RIS SERVICES, BENEFITS AND USERS

River Information Services (RIS) means the harmonised information services to support traffic and transport management in inland navigation, including interfaces to other transport modes. RIS aim at contributing to a safe and efficient transport process and at utilising the inland waterways to their fullest extent. RIS can be distinguished by:

- RIS include interfaces with other transport modes such as sea, roads and railways.
- Rivers in the context of RIS include all types of inland waterways, e.g. canals, lakes and inland and sea ports, too.
- RIS is also the generic term for all individual information services to support inland navigation in a harmonised way.
- RIS collect, process, assess and disseminate fairway, vessel movement, vessel traffic and transport information.
- RIS are not dealing with internal commercial activities between one or more of the involved companies, but RIS are open for interfacing with commercial activities, as far as requested by commercial partners and when the competent authorities are able to provide this information.

Both administrative organisations and commercial enterprises can benefit by making use of River Information Services (RIS). RIS users can be: Skippers, RIS operators, lock/bridge operators, waterway authorities, terminal operators, operators in calamity centres, fleet managers, cargo shippers, consignors, consignees, freight brokers, supply forwarders and other interested organisations & enterprises. However, the main emphasis has been put on serving skippers and authorities so far.

There is an imminent need for information exchange between parties in the inland navigation sector (RIS users) and between parties of different modes of transport (IWT, rail, road, maritime) and between different countries (cross-border). In particular, the exchange of Inland Navigation traffic related information as well as of information regarding the individual vessel (movement information), dealing with safety and efficiency of ship movements, and of transport related information mainly focused on efficiency of the cargo flows, may be of use to actors involved in both types of activities.

During the last decades, a significant number of services and systems, dealing with vessel traffic, fleet and transport management, have been developed and are in the process of being implemented.

For example, RIS is already available in some countries along the river Danube and will become available soon in others. In the near future seven Danube-riparian countries will offer RIS, enabling a cross-border data/information exchange of vessel movement information (e.g. position data of vessels which should be used also for logistics purposes. Position or waypoint data can be obtained via AIS transponders or other technical solutions; depending on the legislation regarding the use of AIS data. Authorities are playing a role in the RISING story in their function of influencing the logistics operation of the total transport chain.

The following potential RIS services for transport-logistics players will be enhanced in the framework of RISING:

- RIS information for **voyage planning** of IWT operators providing data on water level, water depth, maximum height/bridges, berth availability, lock occupation (actual and predictions/forecasts) used for routing, stowage planning, etc.
- RIS information for the **fleet management** of inland navigation including unpropelled inland vessels, by identifying their current position and status of operation
- RIS information facilitating **event management**, i.e. voyage monitoring for IWT operators, freight integrators, inland port operators, sea port operators providing status information, e.g. vessel positions, passing waypoints, missing administrative reports, predictions of problems in continuation of the voyage
- RIS information for both inland/sea **ports and terminals management** by providing Estimated Time of Arrival (ETA) updates for e. g. transhipment operations, management of terminal resources and of pre- and post-haulages.

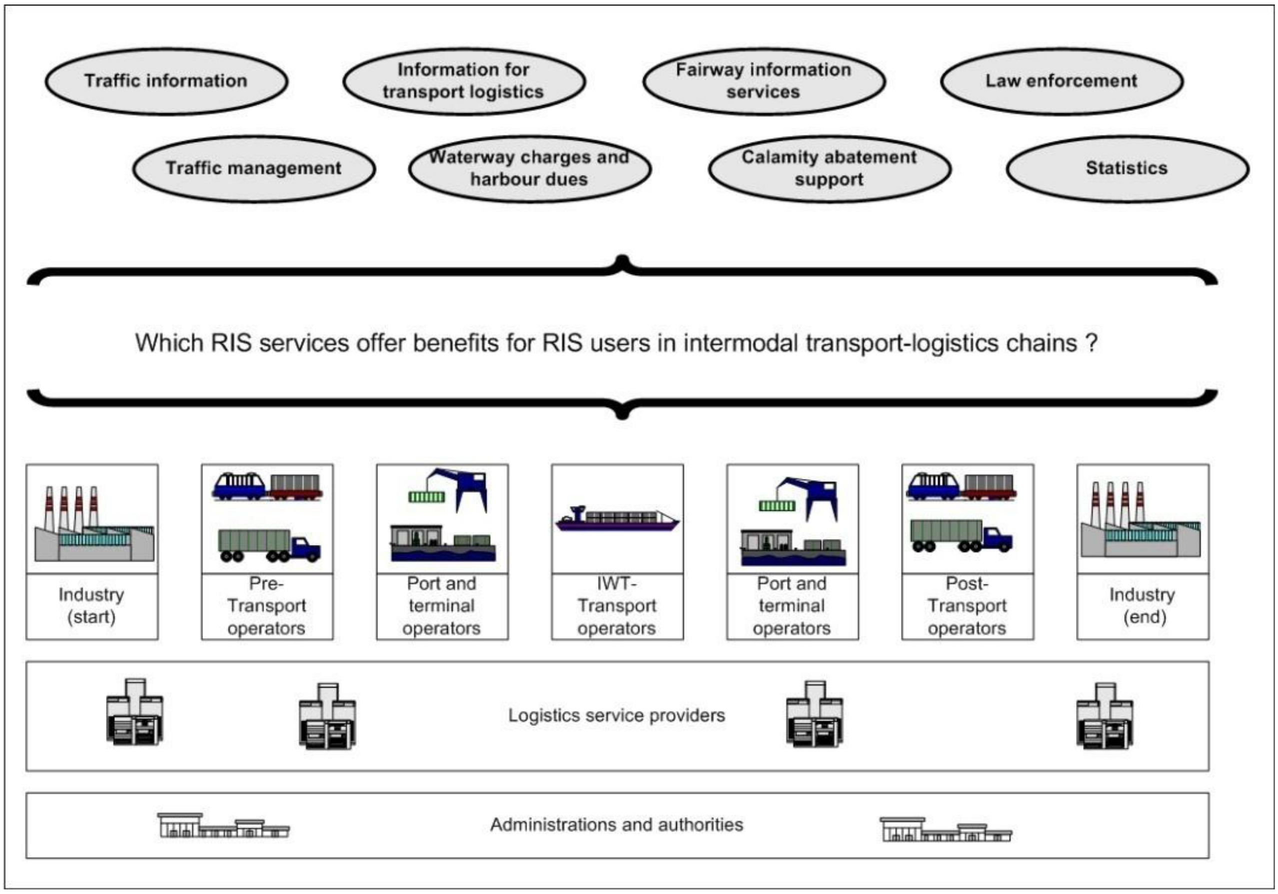


Figure 1 RIS services and users

3. RIS DIFFERENT APPROACHES AND IWT INTERGRATION IN THE TRANSPORT CHAINS

There are different philosophies and strategies e.g. concerning RIS implementation in the different Member States of the European Union. These differences have to be addressed in order to arrive at and to ensure a common strategy and implementation path. Examples are:

- RIS experts and transport management/logistics experts are looking on the same subject (inland vessels) from totally different angles with different objectives
- RIS implementations in Western and Eastern Europe differ in their strategy, e.g. concerning the confidentiality of information collected by the RIS operator (is it allowed to offer value added services based on these data?)
- Different structures in inland waterway transport management: one-person companies (ship owner is master is transport planner and organiser) vs. companies operating a whole fleet of inland vessels where transport planners and supervisors have to optimise the whole fleet
- Well advanced RIS operators vs. starters: RISING can create “appetizers” to demonstrate the benefits and usefulness of advanced RIS services.
- RIS vs. Port Community Systems: can both groups benefit from each other?

RISING Project tries to overcome these differences by joining these “worlds” by proposing harmonised services independently from the organisational structures behind.

The inland waterway transport sector is now faced with the challenge of integrating existing services (e.g. ETA, identification of vessels/barges) into day-to-day commercial operations and defining new services (port services, transport management) offering value added for intermodal transport and logistics operators.

By making use of RIS and Non-RIS technologies (GPRS, GSM, sensors) in the field of Inland Navigation, traffic information will be available also for logistics information systems, which support:

- **planning** processes (e.g. route planning, vessel and barge scheduling, voyage planning, total transport chain planning, fleet optimisation, infrastructure optimisation), and
- **execution and monitoring** processes (e.g. ETA updates, Tracking and tracing, SCEM) processes of commercial actors.

The use of these data for transport and logistics operations is currently under-exploited. Tracking and tracing (T&T) of cargo is only one of several applications providing benefits for transport logistics operators by using traffic information (services) generated out of RIS.

On top of the “historical” T&T applications, new concepts like Supply Chain Event Management (SCEM) creating a more active monitoring of the chain by comparing expected status events with actual ones, offer even more benefits – when supplied with the appropriate data concerning the transport means and the cargo at any time of the trip to forecast problems such as delays in advance – not only if they have occurred.

IWT must be better integrated with other transport modes, e.g. with deep sea shipping and ports when acting as reliable hinterland connection. To facilitate the integration of inland waterway transport in efficient door-to-door transport operation, the RISING project adopted the framework architecture and mode independent information exchange principles laid out in the FREIGHTWISE project.

4. VOYAGE PLANNING THROUGH RISING TOOLS

This RISING Project area aims at developing software on the basis of Inland ECDIS that enables a freight forwarder and inland waterway operator to determine the optimum combination of size of vessel and route as well as the calculation of realistic ETAs and time windows and a method to communicate the details of a voyage plan to the chain manager so that the details of the voyage plan can be used in an SCEM database.

Voyage planning will be able to select for a given point of departure and a given destination the best waterway route as well as the most suitable vessel.

In order to be able to develop a voyage plan the following activities need to be carried out in such a way that reliable predictions, useful for the stakeholders, can be made:

1. Determine which voyage plan standards exist in both IWT and road traffic and use these standards to communicate the voyage plan particulars between chain manager (transport integrator) and transport company. Voyage plan in inland shipping is recently defined by the working group “Voyage plan” of the ERI group. It is very new and never checked with other existing standards. So it seems worthwhile to see what exist in road traffic. Transport integrators are confronted with these two worlds.
2. Identify simple and effective methods to determine the speed of a vessel given its characteristics, including the draft and trim of the vessel, the characteristics of the waterway, the power level and use this information for a realistic ETA calculation; take statutory speed limits into account. At present there are no known methods to determine a vessel´s speed making the ETA calculation very difficult.
3. Determine the effect of wind on highly loaded vessels with containers or other deck cargo and determine whether the resulting rudder angle and drift angle may affect the speed of the vessel. If so, take this effect into account.

4. Employ a number of selected and appropriate vessels with appropriate equipment on board (AIS) to determine the sailing times between a given port of departure and port of destination as a function of ship size, draft, trim and water level testing the theoretical concepts using AIS. At present there is no interaction between the voyage plan and the information from locks. There are lock statistics at present and some standards in AIS to exchange information but nothing is defined to share information about lock planning with the planned voyage of a ship.
5. Compare these measurements with the hydrodynamic calculations on ETA.
6. Develop a stochastic method for the determination of ETAs at waypoints as well in the port of destination with corresponding time windows which are realistic.
7. Collect and standardise lock statistics regarding the passage times of given vessels in a lock as far as they are available.
8. Develop a method to improve lock chamber planning and to estimate the passage time through a lock based on existing information; and make the information available and applicable for direct use by the voyage planner.
9. Collect and then select methods, which enable the voyage planner to get information on the future trend of water levels on the intended network.
10. Put the software ready for use on a portal so that freight forwarders and chain managers are able to use the software. This requires that the software is web based and can be operated through a user-friendly web interface.

5. CONCLUSIONS

The basic procedures in inland waterways transport operation, logistics chain management, inland port operation etc. considered similar in different European countries but this is not true in practice.

Differences in European regions – caused by legal framework and regulations, tradition, etc. do exist. The interesting point in RISING was to compare these processes and to identify similarities and differences.

The set of defined processes reflected all these specialties but should be generic on the other hand. The added value to conduct this research on a European basis is this generic approach, which would not be possible when performing isolated national research activities.

A future successful implementation of River Information Services (RIS) depends on the creation of a number of conditions. The most essential ones are:

- **RIS Legislative Frameworks:** After the finalisation of several preparation activities and projects in the past, the European Directive on River Information Services (RIS) (2005/44/EC) has been put into force providing common standards for future implementations and initiatives (e.g. RIS Guidelines, NAIADES, the revised White Paper, Freight Transport Logistics).
- **RIS Infrastructure:** The set up of the physical and electronic infrastructure of River Information Services (RIS) in EU-Member States, but also in the Candidate Countries (e.g. Croatia) and Third Countries (e.g. Serbia), provides the technical basis for the operation of RIS. Supporting the technical implementation process, selected European initiatives (e.g. IRIS Master Plan, IRIS Europe), mostly co-financed under the TEN-T programme, have been launched.
- **RIS Services:** In order to generate products and services for the market, here the IWT-sector, concrete River Information Services (RIS) are needed. Identified and developed RIS might both address the administrative organisations (e.g. lock operators, RIS operators, authorities, etc.) and/or commercial enterprises (e.g. terminal operators, skippers, fleet operators, etc.).

The RISING project addresses and supports the future River Information Services development, whereas special focus will be put on the RIS Services rather than on the RIS Legislative Frameworks, which deals primarily with transport policy issues, or the RIS Infrastructure, which belongs pre-dominantly to pure infrastructural projects.

Consequently, RISING focuses on the River Information Services, and hereby on such services, which offer primarily benefits for commercial actors located in the IWT and intermodal sector.

6. REFERENCES

[1] Commission Regulation (EC) No 414/2007 of 13 March 2007 concerning the technical guidelines for the planning, implementation and operational use of river information services (RIS) referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community
[2] Study of the Current Situation and Trends in Inland Water Transport in Member Countries, Economic Commission for Europe, ECE/TRANS/SC3/2006
[3] Strenghtening Inland Waterway Transport, Pan-European Co-operation for Progess, European Conference of Ministers of Transport, UNECE, 2006
[4] www.naiades.info
[5] www.rising.eu
[6] www.ria.org.ro

THE ADVANTAGES OF MULTIMODAL INTRA-EUROPEAN TRANSPORT AS OPPOSED TO INLAND TRANSPORT

[1]VARSAMI ANASTASIA, [2]POPESCU CORINA

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

Intra-European transport has severe economic and technological requirements. It needs ports, docking points, handling equipment adapted to the vessel used. It requires a high degree of loading, round trip if it is the case of liner voyage, due to high transport capacity. This requires a regular supply of goods, sufficient workforce to ensure loading, suggesting a national organization, and connections with terrestrial platforms. Transhipment must be quick. This paper discusses how launching a new navigation service is expensive and is often done by big ship owners who create their own supply chains. The conditions of Intra-European transport present some difficulties related to the geographical or social particularities that prevent and restrict competition. These problems such as traffic congestion, blockages of activity due to the possibility of strikes, and the rigid organization of labour duration will also be part of the analysis in this paper.

Keywords: *Multimodal Transport, Intra-European Transport, Inland Transportation.*

1. INTRODUCTION

Traditionally, short sea shipping has the image of a slow, unreliable and obsolete mode of transport which affects the shipper's decision to use this mode. Short sea operators need to alter that image by effectively promoting the advantages of short sea shipping to the shippers and facilitating the cooperation among transportation modes.

Still, positive benefits of transport on short distances come out. European geography is highly favourable to Short Sea Shipping, with more than 67,000km of coastline and very few industrial centres being more than 400 km from the coast. Additionally there are approximately 25,000 km of navigable inland waterways. Short sea shipping supports the development of efficient, integrated transport system in all continents around the world, and can help meet environmental and social goals for sustainable development. From an environmental perspective, shipping tends to have lower environmental and social impact than land transport.

Potential economic advantages from using short sea shipping to moderate surface include reduced costs of maintaining road infrastructure and making the transport of goods more efficient by reducing traffic congestion or directly connecting coastal regions. The expansion of short sea trade could encourage more attractive employment in the maritime sector and could help with the shortage of seafaring officers.

A study by INRET from 2006 shows that, for all types of transport, on average, not even half of the companies with 500-2,000 employees have the power to develop land and sea bases: we speak about agents who are not always interested to use the ports, because some large land carriers are much stronger, with major car parks and so it is preferable to utilize them.

In conclusion, the community network is solid consolidated. In the past decade, there were 72 regular lines along the ocean coastline, including 14 serviced daily and 54 twice a month. Rotterdam serves 63 ports in six EU countries and Anvers has a rich maritime traffic of EVP 668,000 for 8. 8 MT containerized goods.

2. FUNCTIONALITY OF INTRA-EUROPEAN TRANSPORT

For more than a decade the efforts to establish new transport activities on short distance were intensified. Since 1995, the Brussels Commission aims to help projects to develop Intra-European transport. This was relayed by various structures: Association of Peripheral Maritime Regions of Europe, Atlantic Cities Conference, the Association of Atlantic Arc, etc. In the latter, at the end of 1996, the association has been formed eight ports which formed APAA (Arch Atlantic Ports Association) to rebounds the combined transport in order to present a pilot project in Brussels on opening up exciting prospects for Intra-European transport, and provide market support. Then after a meeting in Brest, in 1997, eight subjects were studied for the development of "feeder" along the arc, to which representatives of freight carriers and suppliers have responded positively, saying they are willing to help adapt their routes through ports: a strong awareness in regard to transfer goods to the sea and it is difficult to measure its effects.

In this period occurred various attempts for coast navigation, which were preceded, in 1995, by the CATAM project which is proposing a series of coastal lines to open ocean coasts with five types of routes between Glasgow and also Algeciras and up the Rhine. This proposal has been carefully studied, supported by graphics and forecast investment and profitability calculations for different types of vessels purchased or chartered. The project had the particular merit that has attracted the attention of the marine organizations and proposed directions for reflection, and perhaps action, as of that date, actual operations were launched. In conclusion, those involved have answered to the need for transporting goods from land to sea.

However, some of these experiments have failed so it is very important to eliminate the causes. First, what led to these failures were negative or insufficient responses at specific requirements of various forms of intra-European transport, especially as a small concordance between nature and characteristics of the goods transported and type of vessel chosen, especially in the first phase. Then it is a lack of advertising: the supply of services does not reach a sufficient range of customers in technical or geographical areas. Then it happened that the release date to be poorly chosen, the economic situation was bad (a very serious project could not resist a devaluation of the pound sterling). Finally, there were not so good appreciations of the sites rich in goods, and the nature of these goods, implying inadequacy of methods or means of collecting: it is not enough to know that you have tons of freight nearby, it is necessary to find means to transport them to the ship. This suggests that adaptation to competition from road and rail transport is difficult, but essential for success.

There are successful examples that have been imposed internationally. In particular we recall once again the feeder activity, which has been firmly applied in Western Europe, under three aspects:

- services that belong to large ship owners covering the coasts of Scandinavia to Gibraltar and could reach western France, such as Maersk;
- collecting goods on intra-European transport lines: Bugsier for the delta of the Rhine, Ellerman, Mac Andrew around the British Isles, etc..
- Ultimately the companies that occasionally feeder outside of specialized services, such as Bell Lines, Geest North Sea.

Such campaigns have a well-established place on the transport market: "... even if it takes two days to get from northern France in northern Spain, compared with only one on road, feeder is cheaper by 25% "(per unit load) said Mac Andrew’s company director.

Very well-established line-Vigo to Saint Nazaire traffic capacity of 900 000 tones, is mainly based on the Citroën factory in Rennes, whose clients at first, seemed very small. The structure is the same for all forms of redistribution from a coastal port importantly supplies of petroleum products, animal feed, technical exchanges between refinery and large production units.

Short sea shipping is of paramount importance if the EU wishes to establish a complete and integrated system of intermodal transportation which will be able to guarantee not only free competition but also internal economic and social cohesion. Short sea shipping can offer effective transportation services with low relative cost and with fewer externalities compared to road transport which is considered to be its main competitor.

The importance and functionality of short sea shipping is demonstrated by the fact that in 2007, it represented 61% of the total EU-27 maritime transport of goods (expressed in tonnes). This split between short sea shipping and other seaborne transport (namely “deep sea shipping”) was particularly pronounced in Finland, Malta and Sweden where sea short shipping accounted for 90% of sea transport. Geographical considerations may partly explain such predominance. In contrast, in relatively small countries, such as the Netherlands and Belgium which are home to some big ports concentrated on inter-continental trade, the share of sea short shipping is about 50%.

In terms of commodities moved by short sea shipping, liquid bulk accounted for almost half of the total to/from the EU-27, with 896 million tons. At 364 million tons, dry bulk was the second largest type of cargo. Goods transported in Roll-on/Roll-off (Ro-Ro) units were third (251 million tons), followed by containers (210 million tons). In contrast to bulk cargo, goods in both Ro-Ro units and containers recorded positive growth rates of +5.2% and +8.4%, respectively in 2007. Indeed Ro-Ro ships are particularly suited to European short sea shipping markets and have been technologically developed in recent years.

Iberian nations have an important transport activity on short distances, so it is good to remember them because their Community trade is a major reason why the transit on French territory is overload. According to the Traffic Monitoring by the Franco-Spanish Pyrenees, for 2002, Spain's sea trade with the EU are 51.98 million tons and 14.811 million tons with the rest of Europe. Only for North-East of Europe and Italy, which otherwise would have made transport by heavy trucks transiting France, its amount of 43,888,000 tons, which equates to 2.7 million trucks.

France’s share from all Iberian maritime trade, together with Portugal maritime traffic is 1.526 million tons, including 83.6% of French exports (more than half of petroleum products and a great part for steel products), and with Spain about 4.7 Mt and here predominantly petroleum products and energy products . It is clear that geographical factors are important: Franco-Spanish trade after 1986, the entry date into the European Union, were maintained between 3.5 and 4.5 Mt.

It is also important to point distribution of these fronts in the coastal transport, because it requires a comparison with terrestrial flows arising due to competition. Here's the situation for 2005:

- the cargo loaded in Spain, having the French ports as destination: 1,738,362 t for Mediterranean shores and 962,565 t for the Atlantic ones, and unloaded, the French Mediterranean ports of origin of 464,153 t, and coming from ports in Manche, 823, 641 t. The contribution of each port may be seen in Table 2.3;
- the cargo loaded in Portugal 145, 717 t with the southern French shore as destination and 1,224,797 tons, destined for western and northern shores, and unloaded cargo 195.573t and respectively 54.331t .

These are areas where intra-European transport is already adapted. There are other areas, but they have not been captured yet, but are appealing for new services.

These are the areas where intra-European transport is already adapted. There are other areas which can be favourable to this kind of transport.

We can predict, as a conclusion, a general situation in which intra-European transport activities are presented as a Community trade polymorphic activity already developed. The problem is not to create new forms of short-distance navigation, but to create means of transport of goods at sea, in a proportion much higher than the existing ones and to integrate them in an efficient manner into a transport chain for the wellbeing of all parts implied. To achieve this performance terrestrial flows must be very well known and studied.

Intermodal commodity flows are simply a sequence of separate stages. Intermodal freight transport could be managed more effectively by means of systems that enable smooth transfer of goods between modes and information between all parties (i.e. the sender of goods, the companies moving the goods and receivers). With such systems, the transport chain could be scheduled and managed as a single process over a range of modes and with different providers.

Integration of short sea shipping in logistic chains can therefore be viewed as a process integration problem addressing the interests of the stakeholders involved:

- transport users: Businesses that buy transportation services, who are shippers (including exporters & importers) and freight forwarders acting on behalf of shippers wishing to identify and use sea short shipping or combined transport services most suited for their purpose;
- ship operators: Businesses that provide transportation services wishing to exchange information electronically with all relevant actors through planning, executing and completing transport operations including haulers, operators of trains, inland waterway vessels, terminals and other logistics operators;
- port services providers responsible for managing the transport infrastructure able to facilitate the best possible use with efficient links to hinterland connections and to support transport users by providing relevant information about the available transport infrastructure and how to use it;
- transport regulators: the EU and National Administrations (regulatory authorities, specifically customs, safety & security agencies, police (immigration), animal welfare and associated organizations such as EMSA (European Maritime Safety Agency) responsible for Safe Sea NET wishing to obtain, in the simplest possible way, the required information for monitoring compliance with applicable regulations, and to exchange information with other authorities for collaboration in security and environmental risk management.

The objective of European e-Maritime initiative is to promote “coherent, transparent, efficient and simplified solutions in support of cooperation, interoperability and consistency between member states, sectors, business and systems involved in the European Transport System. This objective is fully compatible with the Lisbon Agenda, the mid-term review of the Transport White Paper, the Blue Book on the integrated maritime policy, the information society and range of other policies inspired from electronic means of communication.

The EU e-Maritime initiative is intended as a broad and embracing initiative in the maritime transport sector aimed at facilitating and supporting the development and take-up of the latest enabling ICT technologies for the improvement of maritime transport services as part of integrated EU Transport System.

E-Maritime is closely related to:

- the “e-freight” action of the EU Freight Logistics Plan which denotes the vision of a paper-free, electronic flow of information associating the physical flow of goods with a paperless trail built by ICT;
- the e-Customs developments aimed at providing a paperless environment for customs and trade by making Member States’ electronic customs systems compatible with each other and creating a single, shared computer portal;
- European Border Surveillance System / EUROSUR related developments.

It should be also mentioned the fact that the passengers transport is often linked with that of goods, and can be a profitable element of the lines.

3. THE NEED FOR INTRA-EUROPEAN PORTS

Ships need port equipment, either for navigation, either for loading / unloading operations. These port devices are not strictly the same regardless of the type of transport. It is advisable to first understand the ports heterogeneousness structures in the EU countries.

There is a frequent need to adapt the equipment to the demands of intra-European transport. There are still a small number of withdrawn ports, others whose locks should be checked and others whose docks no guarantee the only 4 m depth needed for regular short sea shipping vessels. Dissatisfactions of owners and carriers is that a regular tramp vessel spends 50-60% of the time working on shore, and is not efficient in terms of price conditions, delays, starting programs, due to insufficient or unsuitable handling facilities and other equipment, especially destined for multimodal transport.

With the exception of the main hub ports of Rotterdam, Antwerp, Hamburg, Amsterdam and Algeciras, all top 20 ports of Europe had shares of short sea shipping above 50% of total seaborne transport. However, Rotterdam still handled the highest tonnage of short sea shipped goods in 2007. Despite these high percentages it is recognized that many ports in terms of their organization and infrastructure are not always friendly to short sea shipping in Europe.

There are major and medium ports that meet these requirements but it is true that there are on the peninsular southern coasts, and on the islands, a very small number of not so well equipped ports, whose means for investments and maintenance are limited. These ports are too small to be able to develop a normal funds policy. European Community Ship owners' Association, through the Maritime Industries Forum has long suggested a number of measures that should be taken to give ports the opportunity to meet the required services.

A few years ago, during the round table organized by the European Council of Ministers of Transport (ECMT), some opinions have been issued to avoid dispersal of expensive credit funds. Some ports can be encouraged to receive Community aids. Without judging any policy to be followed, or decisions to be taken, resulting from contacts with interested parties some criteria could be taken into account:

- organizations' port capacity to gather together a critical mass of cargo, large enough to supply maritime transport, in this regard, it is often more demanding than land transport, it depends on the type of vessel used, the nature of traffic, the practice shipping line or "tramp", the sequence of ports of calls, etc;
- combinations of goods or cargo profitable enough for the shipowner; after some case studies, for a vessel of 500-600 tpl, they are: steel products, fertilizers, chemicals, wood, while the scrap, coal, sand, gravel and clays are not sufficient or not allowed except in poor economic period. But Iberian import-export traffic has a positive answer to these critical conditions. The same thing happens with Italian trans-Alpine traffic, although the transfer to the ship is more difficult here due to the geographical location of trading partners. But in all these cases, a good equipment of ports led to redirection the transports to navigation.

The EU has included policy measures for the enhancement of short sea shipping. Its program includes legislative, technical and operational initiatives which are aimed at developing short sea shipping at EU, national, regional and industry levels. In addition, the establishment of a „European maritime transport space without barriers" should help to boost short sea services in all maritime regions. This concept would ensure a reduction of the administrative formalities, in particular customs formalities that apply today to the intra-EU seaborne trades and that do not apply to similar road transport services.

4. CONCLUSIONS

Overall, the southern ports are expensive. This is an important aspect of the price equation. They can reach in some cases up to 70% of operating costs of the vessel (according to the Federation of Belgian Companies) and we may note here the years when the transit of a container the price was 40 Euros in Northern Ireland, 75 in southern North Sea, while in Iberian ports was 180 to 200 Euros. In these ports to the service price they are added outstanding wages and social charges, which could be subordinate to other specialized structures (unemployment, welfare, etc.).

There are added to the final price the effects of port unions organized at international level: frequency occurs due to employment termination for reasons that should not directly affect the port. Thus the final price is high. This was the case in December 1991 when the total strike from Spain, Portugal, Italy and Greece to protest against the liberalization of intra-European transport nationwide. This case still prevails in many ports in which social conflicts are multiplying.

Price lists change from one port to another, depending on the policy established or on the different types of goods, their maximum values can be found elsewhere than in southern Europe. But most important to remember are: the multiplicity, the variety, the difficulty of calculating these charges, which increase the administrative delay times and do not encourage their clients or their representatives to practice shipping transport. This situation is not common in rail transport; not even in road transport where a single document meets all requirements. This is a serious handicap for short distance shipping that can be solved by systematic unitization without any doubt by the election and settling a price for general goods transhipment, which are most often penalized due to equipment problems.

If the same cargo can be transported either by sea or land it is necessary to seek to simplify the shipping and port practices such as price harmonization or navigation adapted to intra-European transport, if we want to develop it. This involves a review of facilities and installations.

5. REFERENCES

[1] LEBAHY, Y., *Stratégies de développement pour la facade Atlantique – Les enjeux de navigation*, Ed. Eyrolles, 1996

[2] MARCADON, J., *Fractures et continuitées du littoral français. Cas des ports et transports maritimes*', Ed. Armand Colin, 1999

[3] VIGARIE, A., BENOIT, M., *Transport demarchandises sur les grandes axes européennes - la recherche d'itinéraires alternatifs*, Ed. Economica, 2006.

SECTION II

MECHANICAL ENGINEERING AND ENVIRONMENT

INCREASING THE WEAR RESISTANCE USING THE ELECTRICAL DISCHARGE IMPULSES

BARHALESCU MIHAELA

Constanta Maritime University, Romania

ABSTRACT

The paper shows some theoretical and experimental aspects with respect to superficial hardening of the grey cast irons and carbon steels. The used process for the superficial hardening allows obtaining very high hardness (1100 HV) on the treatment surfaces, without the change of the bulk structure. The micro alloying and deposition with vibrator electrode give the superficial hardening.

Keywords: *deposition, layer, discharges, hardness, wear.*

1. INTRODUCTION

The efficient and rational use of metallic materials is a problem of present interest in most factories. The superior capitalization of metallic materials into products is obtained by application of the most efficient bulk – and / or surface – thermal treatments.

In most cases, the pieces are made by carbon steel, low-alloy steel or rich-alloy steel, and in some cases by iron.

In order to increase the wear resistance and the hardness, major properties of pieces, these are subject to superficial hardening treatments: thermal (superficial chilling), thermo chemical treatments.

For the same purpose of increasing the endurance of pieces (machines organs, tools) intensely subject to wear, in the last time a series of unconventional superficial treatments were imposed. One can remember the thermal treatments with laser beam thermal treatments with electron beams and, last but not the least, the PVD and CVD. All these methods confer very high hardness to superficial layers, yielding to a considerable enhancement of the treated piece lifetime.

2. SPARK MICROALLOYNG

This method is based on the material transfer effect from electrode to the surface of the treated piece during the electrical discharge in the gaseous environment between electrode and piece. The basic requirement is the electrical conductivity of the piece and electrode.

After being subjected to such a treatment, the piece surface will be covered with a layer made by electrode material, named white layer, under which is a diffusion zone formed by the basis material in which the electrode material has diffused.

After discharge, at a certain time, the anode electrode is removed from the cathode piece, switching off the electric circuit; then the process is resumed, finally leading to compositional and structural changes of the superficial layer of the cathode. The characteristics of this layer can vary over large limits as a function of electrodes material, environment composition between the electrodes and parameters of the impulse discharge (the discharge energy and vibration amplitude of the anode electrode).

The process of alloying and deposition by electric spark with vibrating electrode permits the modification of the dimensions and relief of the piece and tool, modification of the chemical composition, delivery state and in final treatment state (hardening and structure and physical, chemical, mechanical and technological properties of the superficial treatment. The method can be used by hand and automatic.

3. EXPERIMENTAL RESULTS

The first series of experiments were done on grey cast iron samples Fc 250, subjected to superficial micro alloying. We utilized electrodes of sintered tungsten and titanium carbides, used for scintillation at different work conditions (discharge current and oscillation frequency).

After the superficial treatment, the samples micro hardness was determined with a PMT – 3 apparatus. The samples type, the work conditions and the measured micro hardness values are given in Table 1 and Table 2.

Table 1 The samples type, the work conditions

No	Sample	Electrode type	Work condition [A]	Layer thickness [µm]
1	Fc 250	WCo8		
		TiCo6	1.2	30
2	Fc 250	WCo8		
		TiCo6	2.0	46
3	Fc 250	WCo8		
		TiCo6	2.8	58

By analyzing the data from Table 1 and Table 2 one notices that micro hardness on layer is greater than on basic structure and enhanced values are obtained using the tungsten carbide electrodes.

The analysis of the phase's composition of the new formed layers was performed by X-ray using a DRON – 3 diffractometer. The radiation was MoK_{α} with the wavelength λ_{Mo}=0.7107Å. The diffraction data are given in Table 3.

Table 2 The measured micro hardness values

No	Sample	Electrode	Micro hardness HV_{50}		
		type	Layer	Transition zone	Basic structue
1	Fc 250	WCo8	1010	480	320
		TiCo6	890	440	330
2	Fc 250	WCo8	990	460	320
		TiCo6	895	440	315
3	Fc 250	WCo8	1000	450	310
		TiCo6	910	420	320

Table 3 The diffraction data from experiments

No	$2\Theta_i$ [deg]	Θ_i [deg]	d_{hkl} computed [Å]	d_{hkl} gauge [Å]	hkl	Phase
1	18.00	9.00	2.270	2.270	(102)	W_2C
2	20.25	10.12	2.020	2.010	(111); (101)	F_α; C_{gr}
3	33.50	16.75	1.233	1.232	(102); (140)	W_2C+ Fe_3C
4	35.60	17.80	1.161	1.160	(233)	Fe_3C
5	39.50	19.75	1.051	1.070	(400)	TiC
6	41.20	20.60	1.009	1.002	(203)	W_2C
7	44.25	22.13	0.943	0.941	(202)	WC
8	48.60	24.30	0.863	0.864	(212)	TiC

The second series of experiments were accomplished on samples of machine steels in tempering – Table 4.

Table 4 Chemical composition of the matrix alloy

Samples	Chemical composition [%]				
	C	Si	Mn	Cr	Mo
OSC 10	0.98	0.28	0.30	0.20	-
45VSiCrW20	0.48	1.05	0.35	1.15	-
57VMoCrNi17	0.58	0.30	0.70	1.12	0.55

Table 4 Continued

Samples	Chemical composition [%]		
	W	V	Ni
OSC 10	-	-	0.25
45VSiCrW20	1.9	0.18	0.25
57VMoCrNi17	-	1.15	1.80

The sample surfaces 15 x20x5 mm were fine restricted and then processed by electric spark using electrodes (Φ = 2 mm) made of sintered carbides WCo8. The impulse discharge regimes were: the 3rd regime with I_{SC} =1.3 A and the 4th regime with I_{SC} = 1.8 A at a discharge energy W_i = 2.1 – 3.4 J, impulse duration of approximately $9 \cdot 10^{-4}$ s and electrode vibrating amplitude of 0.3 mm. Processing 1 cm^2 of the sample's surface was completed in 45 s. Before and after sparking the sample masses were determined. After sparking, the roughness of the treated surface, thickness of the deposited white layer and of the diffusion substrate and the $MHV_{0.1}$ micro hardness were measured.

The results of measuring the geometrical parameters, mass increase, steel samples, in delivery state (a) and after final treatment (b) by spark processing in the 3rd working regime, with hard electrode made of sintered carbides (WCo8), are given in Table 5.

Table 5 Geometrical parameters, mass increase and micro hardness of the obtained layers

Steel	Tratement state	Mass variations [g]	Layer thickness [μm]	
			White	diffusion
OSC 10	a	0.0058	29	12
	b	0.0048	34	21
45VSiCrW20	a	0.0069	30	14
	b	0.0031	32	28
57VMoCrNi17	a	0.0060	28	8
	b	0.0059	44	16

Table 5 Continued

Steel	Tratement state	Microhardness [daN/mm^2]		
		White	Diffusion	Basis
OSC 10	a	1069	587	187
	b	1073	723	511
45VSiCrW20	a	1523	756	244
	b	1573	914	756
57VMoCrNi17	a	1485	707	321
	b	1523	892	502

5. CONCLUSIONS

The method is based on the material transfer effect from electrode to the surface of the treated piece during the electrical discharge in the gaseous environment between electrode and piece.Using of optimal working regimes will lead to achieving some very good quality coatings. The type of coating depends on the electrode speed over the surface of the sample as well. The thickness of the deposited layer can be as high as 100 μm. The wear behaviour of the layers is very good.

6. ACKNOWLEDGMENTS

Some of the ideas presented in the paper are based on the results of the Ph.D. thesis, Research on obtaining and structural analysis of thin layers of corrosion-resistant metal, Technical University Gh Asachi, Iasi, 2007

7. REFERENCES

[1] GHEORGHIES, C., *Controlul structurii fine a metalelor cu radiatii X*, Editura Tehnica Bucuresti, 1990
[2] POPESCU, N., *Tratamente termice neconventionale*, Editura Tehnica, Bucuresti, 1990

DYNAMIC BEHAVIOR OF THE SUPERCHARGER UNITS WITH FREE ROTATION OF SUPERCHARGED INTERNAL COMBUSTION ENGINES

BURCIU MUGUREL

Faculty of Mechanical Engineering , Department of Thermal Systems and Environmental Engineering
Lower Danube University of Galati, Romania

ABSTRACT

The paper deals with the differential equation expressing the dynamic behavior of free rotation supercharger units used turbocharging internal combustion engines.

The mathematical model is based on knowledge of the operating characteristics of the supercharge unit to stationary regimes and their vicinity. Transfer functions are determinated, functions that are used for achieving and adjusting automatic regulators which controls the operation of the system under consideration.

Keywords: *supercharged engine, transfer function, dynamic behavior, unsteady working conditions*

1. INTRODUCTION

Technical and economic indices of supercharged diesel engines and functioning of the unit of charge with free rotation are substantially influenced by the unsteady gasothermodynamic and mechanical processes taking place in the turbocharger.

Order to study joint operation of the engine and the turbocharger unit, so to determine the dynamic behavior of turbocharged diesel engine, it is necessary to establish before the dynamic behavior of the aggregate of the charge.

The paper shows the differential equation expressing the dynamic behavior of free rotation supercharger units used turbocharging internal combustion engines.

Based on knowledge of the operating characteristics of the supercharge unit to stationary regimes and their vicinity, we simulate the dynamic behavior and calculate transfer functions of the charge units to specific signals.

These transfer functions are used for achieving and adjusting automatic regulators which controls the operation of the system under consideration.

2. MODELING THE DYNAMIC BEHAVIOR OF THE SUPERCHARGE UNIT WITH FREE ROTATION

Dynamic behavior of the charge unit considered a mechanical system consisting of turbine and compressor is given by differential equation:

$$J_{TK} \cdot \frac{d\ \omega_{TK}}{dt} = M_{teT} - \left|M_{teK}\right| \quad (1)$$

Considering quasi-operational regimes, close to the stationary, groups of equations can be written [1], [3]:

$$M_{teT} = \frac{\dot{m}_T \cdot l_{tsT} \cdot \eta_T}{\omega_T} \quad (2)$$

$$\left|M_{teK}\right| = \frac{\dot{m}_K \cdot \left|l_{tsK}\right|}{\omega_K \cdot \eta_K}; \omega_T = \omega_K = \omega_{TK} \quad (3)$$

$$l_{tsT} = \frac{k_T}{k_T - 1} \cdot R_T \cdot T_T \cdot \left(1 - \left(\frac{1}{\pi_T}\right)^{\frac{k_T - 1}{k_T}}\right) \quad (4)$$

$$\left|l_{tsK}\right| = \frac{k_K}{k_K - 1} \cdot R_K \cdot T_0 \cdot \left(\pi_K^{\frac{k_K - 1}{k_K}} - 1\right) \quad (5)$$

$$\eta_T = f_{\pi_T}\left(\overline{\dot{m}_T}, \overline{\omega_T}, \overline{h_T}\right) \quad (6)$$

$$\pi_T = \frac{p_T}{p_0'} = \left(\overline{\dot{m}_T}, \overline{\omega_T}, \overline{h_T}\right) \quad (7)$$

$$\eta_K = f_{\pi_K}\left(\overline{\dot{m}_K}, \overline{\omega_K}, \overline{h_K}\right) \quad (8)$$

$$\pi_K = \frac{p_K}{p_0} = \left(\overline{\dot{m}_K}, \overline{\omega_K}, \overline{h_K}\right) \quad (9)$$

$$\dot{m}_T = \dot{m}_k\left(1 + \frac{1}{L_{um}}\right) \quad (10)$$

$$\dot{m}_K = i \cdot z \cdot n \cdot V_s \cdot \eta_v \cdot \rho \cdot c_b \quad (11)$$

$$\overline{\dot{m}_T} = \frac{\dot{m}_T \cdot \sqrt{T_T}}{p_T} \quad (12)$$

$$\overline{\omega_T} = \frac{\omega_{TK}}{\sqrt{T_T}}; \overline{h_T} = \frac{h_T}{h_{Tnom}} \quad (13)$$

$$\overline{\dot{m}_K} = \frac{\dot{m}_K \cdot \sqrt{T_0}}{p_0} \quad (14)$$

$$\overline{\omega_K} = \frac{\omega_{TK}}{\sqrt{T_0}}; \overline{h_K} = \frac{h_K}{h_{Knom}} \quad (15)$$

where :

J_{TK} (kgm^2) - mechanical moment of inertia of the rotating mechanical turbocharger components, reduced to its revolution axis:

ω_{TK} (s^{-1}) - common speed of the compressor and turbine;

ω_K (s^{-1}) - compressor angular speed;

ω_T (s^{-1}) - turbine angular speed;

T_0(K) - fluid temperature at the entrance of the compressor;

T_k(K) - fluid temperature at the exit of the compressor;

T_T(K) - gas temperature at the entrance of gas turbine;

$\dot{m}_k$ (kg/s) - compressor mass flow rate;

$\dot{m}_T$ (kg/s) - gas turbine mass flow rate;

M_{teT} (Nm) - turbine shaft torque;

M_{teK} (Nm) - compressor shaft torque;

l_{tsT} (J/kg) - specific isentropic turbine shaft work;

$|l_{tsK}|$ (J/kg) - absolute value of the specific isentropic compressor shaft work;

η_T - effective efficiency of gas turbine;

η_K - effective efficiency of compressor;

k_K - compressor fluid adiabatic coefficient;

k_T - gas turbine fluid adiabatic coefficient;

h_T - turbine control body position;

h_K - compressor control body position;

L_{um} [kg air/kg fuel] - real quantity of moist air from the fuel mixture;

i – number of cylinders;

z(cycle/rotation) – rhythmicity of engine;

n (rpm) – engine crankshaft speed;

V_s(m^3) – cylinder volume;

η_v - cylinder filling coefficient;

c_b - scavenging coefficient;

R_T(J/kgK) - specific gas constant for gas turbine;

R_K(J/kg*K) - specific gas constant for the fluid that evolves into compressor;

p_T(N/m^2) - gas pressure in the turbine entry;

p_0 (N/m^2) - gas pressure at the exit of gas turbine;

p_K(N/m^2) - fluid pressure at the compressor exit;

p_0(N/m^2) - fluid pressure at the compressor entry;

t(s) – time;

Considering the nonstationary regime, but nearest the stationary operating mode, write [3], [6]:

$$\omega_{TK} = \omega_{TK0} + \Delta\omega_{TK} \quad (16)$$

$$M_{teT} = M_{teT0} + \Delta M_{teT} \quad (17)$$

$$M_{teK} = M_{teK0} + \Delta M_{teK} \quad (18)$$

ω_{TK0} (s^{-1}) - common speed of the compressor and turbine at stationary running;

M_{teT0} (Nm) - turbine shaft torque at stationary running;

M_{teK0} (Nm) - compressor shaft torque at stationary running;

Where for the steady operating mode:

$$M_{teT0} = M_{teK0} \quad (19)$$

Based on these mathematical expressions, equation (1) becomes:

$$J_{TK} \cdot \frac{d(\Delta\omega_{TK})}{dt} = \Delta M_{teT} - \Delta|M_{teK}| \quad (20)$$

If we consider known for stationary operation regimes, these experimental characteristics [1], [3], [7]:

$$M_{teT} = M_{teT}(p_T, \omega_{TK}, c_{cycle}, h_T) \quad (21)$$

$$M_{teK} = M_{teK}(p_k, \omega_{TK}, h_K) \quad (22)$$

Equation (20) becomes:

$$T_{TK}\frac{d(\Delta\omega^*_{TK})}{dt} + K_{TK}.\Delta\omega^*_{TK} = \Delta p^*_T + \theta_{cycle}\Delta c^*_{cycle} - \theta_{p_K}\Delta p^*_K + \theta_{h_T}\Delta h^*_T - \theta_{h_K}\Delta h^*_K \quad (23)$$

Where:

$$T_{TK} = \frac{J_{TK}\cdot\omega_{TK0}}{\left(\frac{\partial M_{teT}}{\partial p_T}\right)\cdot p_{T0}} \quad (24)$$

$$\Delta\omega^*_{TK} = \frac{\Delta\omega_{TK}}{\omega_{TK0}} \quad (25)$$

$$p_T = p_{T,0} + \Delta p_T \quad (26)$$

$$\Delta p^*_T = \frac{\Delta p_T}{p_{T0}} \quad (27)$$

$$c_{cycle} = c_{cycle,0} + \Delta c_{cycle} \quad (28)$$

$$\Delta c^*{}_{cycle} = \frac{\Delta c_{cycle}}{c_{cycle,0}} \quad (29)$$

$$p_K = p_{K,0} + \Delta p_K \quad (30)$$

$$\Delta p^*_K = \frac{\Delta p_K}{p_{K0}} \quad (31)$$

$$h_T = h_{T,0} + \Delta h_T \quad (32)$$

$$\Delta h^*{}_T = \frac{\Delta h_T}{h_{T0}} \quad (33)$$

$$h_K = h_{K,0} + \Delta h_K \quad (34)$$

$$\Delta h^*{}_K = \frac{\Delta h_K}{h_{K0}} \quad (35)$$

$$F_{stTK} = \left(\frac{\partial M_{teK}}{\partial\omega_{TK}}\right) - \left(\frac{\partial M_{teT}}{\partial\omega_{TK}}\right) \quad (36)$$

$$K_{TK} = \frac{F_{stTK}\cdot\omega_{TK0}}{\left(\frac{\partial M_{teT}}{\partial p_T}\right)\cdot p_{T0}} \quad (37)$$

$$\theta_{cycle} = \frac{\left(\frac{\partial M_{teT}}{\partial c_{cycle}}\right)\cdot c_{cycle,0}}{\left(\frac{\partial M_{teT}}{\partial p_T}\right)\cdot p_{T0}} \quad (38)$$

$$\theta_{p_K} = \frac{\left(\frac{\partial M_{teK}}{\partial p_K}\right)\cdot p_{K,0}}{\left(\frac{\partial M_{teT}}{\partial p_T}\right)\cdot p_{T0}} \quad (39)$$

$$\theta_{h_T} = \frac{\left(\frac{\partial M_{teT}}{\partial h_T}\right)\cdot h_{T,0}}{\left(\frac{\partial M_{teT}}{\partial p_T}\right)\cdot p_{T0}} \quad (40)$$

$$\theta_{h_K} = \frac{\left(\frac{\partial M_{teK}}{\partial h_K}\right)\cdot h_{K,0}}{\left(\frac{\partial M_{teT}}{\partial p_T}\right)\cdot p_{T0}} \quad (41)$$

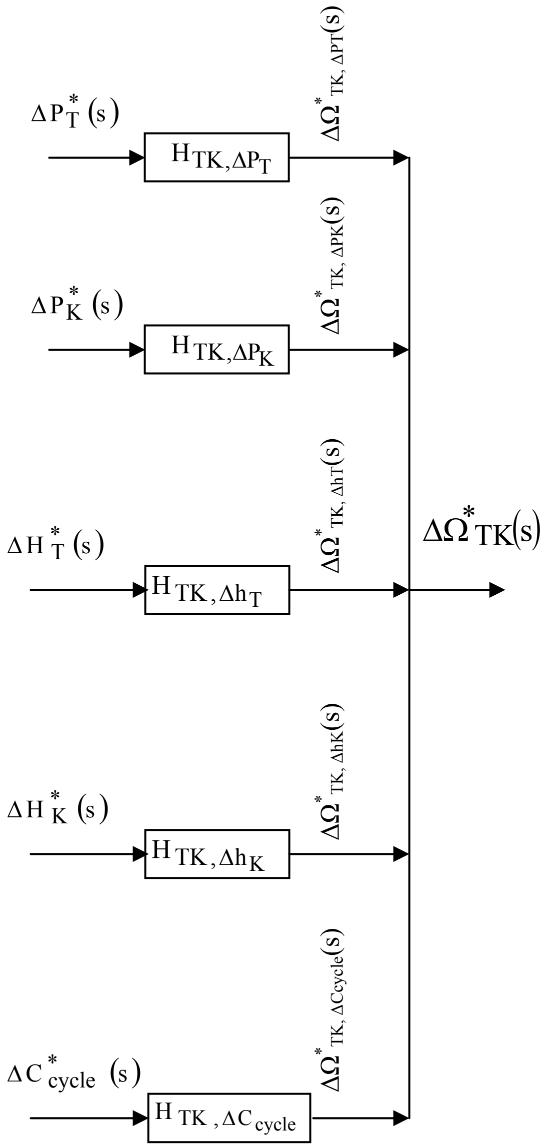


Figure 1 Structural diagram for supercharger unit with free rotation

Where:

p_{T0}(N/m^2) - gas pressure in the turbine entry at stationary running;

p_{K0}(N/m^2) - fluid pressure at the compressor exit at stationary running;

h_{T0} - turbine control body position, at stationary running;

h_{K0} - compressor control body position at stationary running;

c_{cycle}(kg fuel/cycle) – fuel consumption on cycle;

$c_{cycle,0}$(kg fuel/cycle) – fuel consumption on cycle at stationary running;

$\Delta\omega_{TK}, \Delta c_{cycle}, \Delta p_T, \Delta p_K, \Delta h_T, \Delta h_K$ - variations of this measurements in the nonstationary regime compared to those of steady-state operation.

Differential equations (23) expressing the dynamic behavior of the turbocharger to signals Δp_T, Δp_K, Δh_T, Δh_K, Δc_{cycle}.

Using experimental characteristics (21), (22), necessary derivatives can be calculated for each direction so that order differential equation (23) can be solved using numerical methods.

3. TRANSFER FUNCTIONS OF THE SUPERCHARGE UNIT WITH FREE ROTATION

Applying the Laplace transform directly to equation (23), zero initial conditions, resulting the transfer functions of supercharger units at specified signals [3], [1]:

$$(T_{TK}\cdot s + K_{TK})\cdot\Delta\Omega^*_{TK}(s) = \Delta P^*_T(s) + \theta_{c_{cycle}}\cdot\Delta C^*_{cycle}(s) - \theta_{p_K}\cdot\Delta P^*_K(s) + \theta_{h_T}\cdot\Delta H^*_T(s) - \theta_{h_K}\cdot\Delta H^*_K(s) \quad (42)$$

Considering:

$$H_{TK,\Delta P_T} = \frac{1}{(T_{TK}\cdot s + K_{TK})} \quad (43)$$

$$H_{TK,\Delta C_{cycle}} = \frac{\theta_{c_{cycle}}}{(T_{TK}\cdot s + K_{TK})} \quad (44)$$

$$H_{TK,\Delta P_K} = \frac{-\theta_{p_K}}{(T_{TK}\cdot s + K_{TK})} \quad (45)$$

$$H_{TK,\Delta h_K} = \frac{-\theta_{h_K}}{(T_{TK}\cdot s + K_{TK})} \quad (46)$$

$$H_{TK,\Delta h_T} = \frac{\theta_{h_T}}{(T_{TK}\cdot s + K_{TK})} \quad (47)$$

Result:

$$\Delta\Omega^*_{TK}(s) = H_{TK,\Delta P_T}\cdot\Delta P^*_T(s) + H_{TK,\Delta C_{cycle}}\cdot\Delta C^*_{cycle}(s) + H_{TK,\Delta P_K}\cdot\Delta P^*_K(s) + H_{TK,\Delta h_T}\cdot\Delta H^*_T(s) + H_{TK,\Delta h_K}\cdot\Delta H^*_K(s) \quad (48)$$

Transfer functions for $\Delta p_T, \Delta p_K, \Delta h_T, \Delta h_K, \Delta c_{cycle}$ signals (43)-(47) are used for achieving and adjusting automatic regulators which controls the operation of the system. Based on transfer functions (43)-(47) resulting structural scheme (Figure 1) for supercharger unit with free rotation.

4. CONCLUSIONS

Mathematical model presented, together with the calculation processes of internal combustion engine itself, allowing the study of thermo and mechanical processes of turbocharged engines.

Based on known characteristics, using interpolation functions of two and three variables we can evaluatewith a good approximation the characteristics of the turbine and compressor. Using the equations (23) recommended in the paper it is possible to calculate the terms from differential equation of rotative mechanical system motion, solve the equation and establishing with a good approximation the working conditions of turbocharger.

Also use relationships (43)-(47) can be determined transfer functions that are used for achieving and adjusting automatic regulators which controls the operation of turbocharger.

If we know these different working conditions for turbocharger and the different working conditions of internal combustion engines with big probability, we establish the operating conditions in common of internal combustion engine and turbocharger.

5. REFERENCES

[1] BURCIU M., Thesis Ph.D., *Contributions to the study of nonstationary processes in the internal combustion engine overloading turbo-compressors*, University of Galatzi, Faculty of Mechanical Engineering, Department of Internal Combustion Engines, 2000

[2] BURCIU M., *Internal Combustion Engines*, Europlus, Galati, 2006

[3] DUMITRU GH., *A physical-mathematical nonlinear model for gas-thermodynamical changeable unsteady processes from internal combustion engines*, National Institut for Thermal Machines, Bucharest, 24-25 November 1978

[4] DUMITRU GH.,BURCIU M., *Program for the approximation of real functions with two or three independent variables using Spline functions*, “Dunarea de Jos” University, Galati, Scientific Session, 1993

[5] MICULA GH., *Spline functions and applications*, Technical Publishing, Bucharest 1978

[6] SCHIOP A. I., *The analysis of some discreditation methods*, Academic Publishing , Bucharest 1978

[7] EARL LOGAN JR., *Handbook of Turbomachinery*, Arizona University, 1995

MATRIX TRANSFER METHOD IN STUDYING THE DYNAMIC BEHAVIOUR OF THE HIGH POWER ENGINE SHAFTING SYSTEMS

[1]BUZBUCHI NICOLAE, [2]STAN LIVIU-CONSTANTIN

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

It is already known that the dynamic behaviour of the internal combustion engine shafting system is more complicated as usually, due to its complicated shape and to its important inertias. Several models have been developed in this purpose, but they more unrealistic as they normally consider the resonant engine rate only. The present method is an attempt to the engine behaviour at any speed, using the Matrix Transfer Method (MTM).

Keywords: *Marine engine, torsional vibration, matrix transfer method.*

1. INTRODUCTION

The purpose of the present study is to describe the dynamic behaviour of marine diesel engines shafting system on the basis of the Matrix Transfer Method (MTM). With this end in view, a computer code was developed, being liable to present the torsional amplitude variation with respect to the time (crank angle).

The MTM application suppose the following data:

- the dynamic equivalent oscillating system;
- the natural frequencies of torsional free vibration;
- the harmonic analysis of the torsional excitation,

as known data (see [1], [2]). The computer program is able to show the dynamic behaviour of the shafting system in any of its points and for any engine speed.

2. THEORETICAL BACKGROUND

The motion equation of the equivalent oscillating system (figure 1) may be written as follows:

$$[J]\{\ddot{\varphi}\}+[\xi]\{\dot{\varphi}\}+[C]\{\varphi\}=\{M\} \qquad (1)$$

where:

- [J] - the diagonal matrix of the mechanical moment of inertia relative to the crankshaft axis;
- [ξ] - the band matrix of the shafting damping coefficients
- [C] - the matrix of the massless shafts located between two discs of the oscillating system;

{M} - the vector of the torque excitation;

- {ϕ} - the torsional amplitude vector.

According to the figure 2, we may isolate the j-th disc with its adjacent massless shaft segment and to write the empirical formulae for the damping coefficients corresponding to the piston-cylinder group, to the crankjournal, to the flywheel (due to the friction in the air) and to the propeller, respectively:

$$r_{ccyl} = 0.01 \qquad \omega_{0_\gamma} J_{cyl} \qquad (2)$$

$$\xi_{journ_k} = \frac{0.2bk + 0.6}{100}\omega_{0_\gamma} J_{cyl} \qquad (3)$$

$$r_{fl} = \frac{0.001}{k}\omega_{0_\gamma} J_{fl} \qquad (4)$$

$$r_{prop} = 30\frac{M_{prop}}{n_{prop}}, \qquad (5)$$

In (2)...(5), $\omega_{0\gamma}$ [s^{-1}] is the known natural frequency for the γ - th torsional vibration degree (usually, γ = I, II, III), J_{cyl} [Nms^2] is the mechanical moment of inertia corresponding to one engine mechanism, b=0.5 for the crankshafts fitted with counterweights, J_{fl} the moment of mechanical inertia of the flywheel, M_{prop} [Nm] is the torque required by the propeller and n_{prop} [r.p.m] its angular speed, k being the harmonic order.

The excitation torque acting on the j - th disc has the following form [3]:

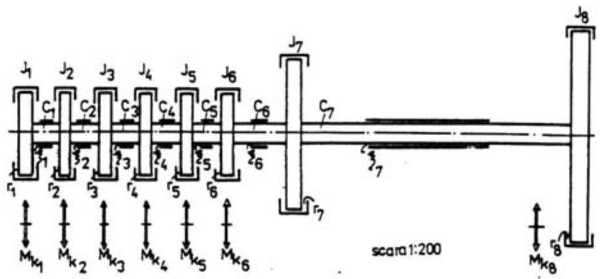


Figure 1. The equivalent oscillating system for a 6 inline low-speed engine

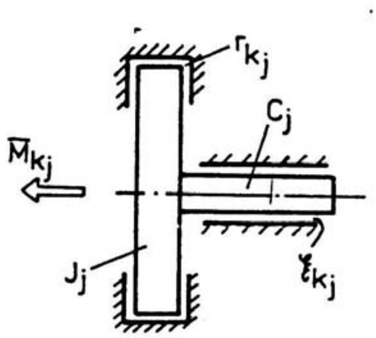


Figure 2. Torsional disc-element

$$M_{k_j} = A_{p_{k_j}} \cos k(\alpha - n_j\delta) + \left(B_{p_{k_j}} + B_{ik}\right)\sin k(\alpha - n_j\delta). \quad (6)$$

In the previous formula, n_j and δ are the number of the operating crank angles which separate the ignition in the 1 - st cylinder from the ignition in the j-th cylinder, respectively the angular difference between two consecutive ignitions. For A_{pk}, B_{pk} and B_{ik} we make the correspondence with A_k, B_k and M_{ik} in the formulae (2.18) and (2.21) of [1]; these are the torque harmonic coefficients due to the gas pressure and to the reciprocating inertia masses and they are supposed to be known from the excitation harmonic analysis. The firing sequence in determining of (6) -th formula have also to be known.

Due to the introduction of the first derivative in equation (1), the dynamic behaviour computation leads automatically to the extension in complex field. This computation may be presented by mean of MTM. For that, we may put the torque components in complex notation:

$$\overline{M_{k_j}} = M_{k_j}^{\,Re} + i^* M_{k_j}^{\,Im}, i^* = \sqrt{-1}, \quad (7)$$

where the real and imaginary parts are indicated by the superscripts *Re* and *Im*. If an identity of the equation (6) with (7) is written, these parts will be:

$$M_{k_j}^{\,Re} = A_{p_{k_j}} \cos kn_j\delta - (B_{p_{k_j}} + B_{ik})\sin kn_j\delta, \quad (8)$$

and

$$M_{k_j}^{\,Im} = -A_{p_{k_j}} \sin kn_j\delta - (B_{p_{k_j}} + B_{ik})\cos kn_j\delta. \quad (9)$$

In order to compute the torsional forced damped vibration of the shafting system, we have to stand out in relief the *point-matrix* and the *field-matrix* for each element in the figure 2:

$$[P_k]_j = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ -J(k\omega)^2 & 1 & -r_k(K\omega) & 0 & -M_k^{Re} \\ 0 & 0 & 1 & 0 & 0 \\ r_k(k\omega) & 0 & -J(k\omega)^2 & 1 & -M_k^{Im} \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}_j, \quad (10)$$

and

$$[F_k]_j = \begin{pmatrix} 1 & \frac{C}{C^2+(\xi_k k\omega)^2} & 0 & \frac{\xi_k(k\omega)}{C^2+(\xi_k k\omega)^2} & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{-\xi_k(k\omega)}{C^2+(\xi_k k\omega)^2} & 1 & \frac{c}{C^2+(\xi_k k\omega)^2} & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}_j. \quad (11)$$

The following form will be obtained for the status vector on the right-side of the *j*-th disc, depending on previous *j-1*-th one:

$$[Z_k]_j^R = [F_k]_j \bullet [P_k]_j \bullet [Z_k]_{j-1}^R, \quad (12)$$

The complex notation of this vector is of the following form:

$$[Z_k]_j = \{\overline{\Phi}_k \; \overline{M}_k \; 1\}^T{}_j, \quad (13)$$

and the real one:

$$[Z_k] = \{\phi_k^{Re} \; M_k^{Re} \; \phi_k^{Im} \; M_k^{Im} \; 1\}_j^T. \quad (14)$$

In the last two expressions, the matrix transposition operation was noted with *T*. The equation (12) for the whole system presented in figure 1 leads to:

$$[Z_k]_n^R = [P_k]_n \bullet \left(\prod_{j=1}^{n-1}[F_k]_j[P_k]_j\right) \bullet [Z_k]_1^L = [B_k] \bullet [Z_k]_1^L. \quad (15)$$

The operations in (15) may be considerably be reduced by the left - side boundary conditions:

$$\overline{M_{1_k}}^{L} = 0 \text{ or } (M_{1_k}{}^{Re})^{L} = (M_{1_k}{}^{Im})^{L} = 0, \qquad (16)$$

which leads to the elimination of the second and fourth columns in the *point matrix* $[P_k]_1$. The *point matrix* of the *n*-th order is:

$$[P_k]_n = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ -J(k\omega)^2 & 1 & -r_k(k\omega k & 0 & -M_{e_k}{}^{Re} \\ 0 & 0 & 1 & 0 & 0 \\ r_k(k\omega k & 0 & -J(k\omega)^2 & 1 & -M_{e_k}{}^{Im} \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}_n . \qquad (17)$$

Therefore the torsional excitation on the propeller disc is taken as null, and the matrix $[B_k]$ in its real notation is:

$$B = \begin{pmatrix} b_{1_k} & -b_{3_k} & b_{5_k} \\ b_{2_k} & -b_{4_k} & b_{6_k} \\ b_{3_k} & b_{1_k} & b_{7_k} \\ b_{4_k} & b_{2_k} & b_{8_k} \\ 0 & 0 & 1 \end{pmatrix}. \qquad (18)$$

The right - side boundary conditions identically to those of (2.16) are:

$$\overline{M_{n_k}}^{R} = 0 \text{ or } (M_{n_k}{}^{Re})^{R} = (M_{n_k}{}^{Im})^{R} = 0. \qquad (19)$$

From here, the real and the imaginary components of the first status vector, $[Z_1]^L$ have the following form:

$$\begin{cases} \Phi_{1_k}{}^{Re} = -\dfrac{b_{2_k} b_{6_k} + b_{4_k} b_{8_k}}{b_{2_k}{}^2 + b_{4_k}{}^2} \\ \Phi_{1_k}{}^{Im} = \dfrac{-b_{2_k} b_{8_k} + b_{4_k} b_{6_k}}{b_{2_k}{}^2 + b_{4_k}{}^2} \end{cases}. \qquad (20)$$

5. CONCLUSIONS

Using now the relation (12) between two succesive status vectors, one can determinate the real and the imaginary components of the status vector alongside the shafting system, therefore the deformed tridimensional shape of this system can be represented as shown in figure 3. In this last figure, the phase between the real and imaginary parts of the j-th disc amplitude have been noted with ψ_j.

The time variation of the j-th disc of the shafting system will be obtained by totaling the N first representative harmonic orders:

$$\Phi_j = \sum_{k=1}^{12} \left(\Phi^{Re}_{j_k} \cos k\omega t - \Phi^{Im}_{j_k} \cos k\omega t \right) \qquad (21)$$

In this manner, the dynamic behaviour of the marine engine shafting system may be determined, for any speed and more exactly as the classic Holzer - Tolle method.

Figure 4 represents the deflected shape of a marine high power engine system for the major harmonic orders and the variation with respect to the time of the last disc (the propeller) based on the computer code developed in this purpose.

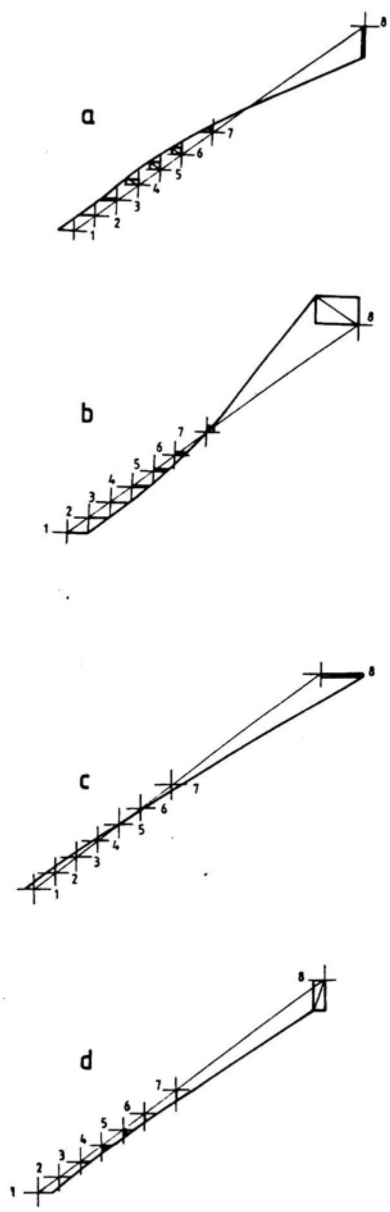


Figure 3. Deflected shape of a marine high power engine system for the major harmonic orders corresponding to a Sulzer 6RND90 marine engine: a-*k*=3; b-*k*=6; c-*k*=9; d-*k*=12

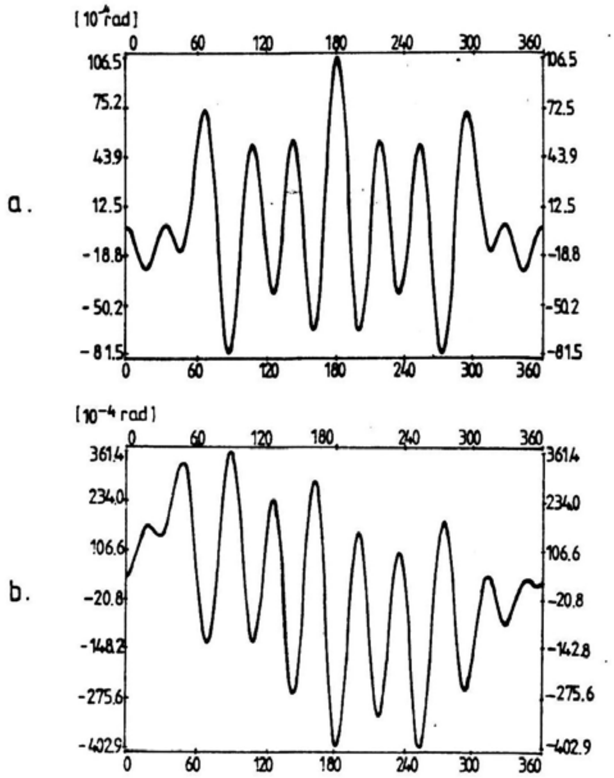


Figure 4. Time dependence of the torsional vibration amplitudes: a-1st disc; 2-last disc

6. REFERENCES

[1] BUZBUCHI, N.C. *Torsional Vibration of Marine Diesel Engines Shafting Systems*, National Technical University of Athens Publishing House, 1995.

[2] FRANGOPOULOS, CH. A. *Torsional Vibration*, National Technical University of Athens Publishing House, 1989.

[3] TARAZA, D. *Dynamics of Internal Combustion Engine*, The Didactic and Pedagogic Publishing House, Bucharest, 1985.

[4] PESTEL, E.C., LECKIE, F.A. *Matrix Methods in Elastomechanics*, McGraw-Hill Company, Inc., New York, 1963.

[5] WAKABAYASHI, K., SHIMOYAMADA, K., KODAMA, T., HONDA, Y., IWAMOTO, S. *A Numerical Computation for Vibration Displacements and Stresses of Crankshaft with a Shear Rubber Torsional Damper*, International Congress and Exposition, Detroit, Michigan, 1993.

[6] YEO, S.D., HAN, C.S., LEE, K.W., CHO, D.B.,CHEON, J. *Three Dimensional Crankshaft Vibratio Analysis Including Gyroscopic Effect*, International Congress & Exposition, Detroit, Michigan, 1993.

[7] WANG, P.C. *Metode numerice în mecanica construcțiilor*, Editura tehnică, Bucureşti, 1970.

[8] WANG, P.C. *Numerical and Matrix Methods in structural Mechanics*, New-York, London, Sydney, John Wiley & Sons Inc., 1965

A SIMPLIFIED APPROACH OF THE COUPLED VIBRATIONS OF THE TWO-STROKE MARINE ENGINE SHAFTINGS

[1]BUZBUCHI NICOLAE, [2]STAN LIVIU CONSTANTIN

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

Due to the complicated shape of the marine Diesel engine crankshaft, its deformations also have a complex nature causing coupling phenomena among its individual vibration types: torsional, bending and axial. Up to now, the vibrations of shafting systems driven by marine Diesel engines were in general calculated by considering only the torsion and axial coupling, or by much simplifying the real formula of the crank. The present study proposes a more flexible and realistic model (based on the finite element method (FEM) for the calculation of the excitations on coupled vibrations of marine Diesel engines. The model assumes a spatial beam structure with a uniformly distributed mass and concentrated masses in specific nodes. The entire set of exciting forces (including engine and propeller excitations) has been taken into account. This model has been verified through experimental investigations. It has been concluded that the torsion vibrations are dominant relatively to the propeller thrust fluctuations in exciting axial vibrations. The method reveals that the axial vibrations reach annoying levels and occasionally indicates the necessity of axial dampers mounting.

Keywords: *Two-stroke marine Diesel, Diesel engine shafting system, coupled vibrations*

1. INTRODUCTION

In general, the vibration analysis of Diesel engine shafting system has taken into account the coupling phenomenon between only two individual vibration type [1], [2] or by considerably simplifying the real form of the cranks [3]. More, recent studies [4] [5] perform a finer discretization of crank shaft ("solid elements"), using the Finite Element Method (FEM), but the amount of calculations is large and the obtained results, when compared to our model, do not justify the expense.

That which sets apart our model is that it is simple but realistic. The structure has been modeled as a spatial set of beams with uniformly distributed masses and as other masses that are equally concentrated on important nodes. All the excitations of the coupled vibrations of the shafting system have also been taken into account. The engine excitation is found through a classical Fourier analysis, while the propeller excitation is found using an original analytical method. The calculations are developed by observing a SULZER 6RND90 in-line six cylinder, two-stroke engine (bore 900 mm and stroke 1550 mm), with 12,800 kW at 122 RPM used for the propulsion of 55.000 DWT bulk carrier. The 4-bladed propeller is a B-Wageningen series with a diameter of 6.4 m and a pitch ratio of 0.7 at 0.6 times the maximum radius.

Because of objective difficulties in realizing a complete experimental investigation on board the same ship, we were obliged to perform tests on another two-stroke, six cylinder engine: MAN K6Sz 52/105 CLe, installed on board a 12,5000 DWT container ship. This second engine can develop 4,700 kW at 140 RPM, has the same crankshaft configuration and firing sequence as the initial one, and is driving a 4-bladed propeller similar to the one but with a diameter of 4.2 m.

We have examined both configurations using the computer codes developed increasing thus our confidence in the model.

2. THE INDIVIDUAL FREE VIBRATION OF MARINE DIESEL ENGINE SHAFTING SYSTEMS

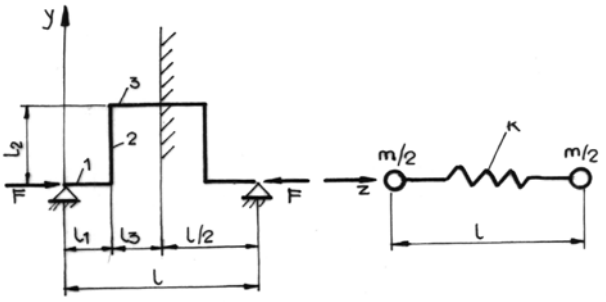
In order to compute individual free vibration, the marine Diesel engine shafting system was replaced by a dynamically equivalent oscillating system, consisting of a number of discrete rigid masses of inertias, separated by massless shafts.

The torsion free vibration was computed by means of the iterative Holzer-Tolle method and thebending vibration was calculated using the coefficients of influence method.

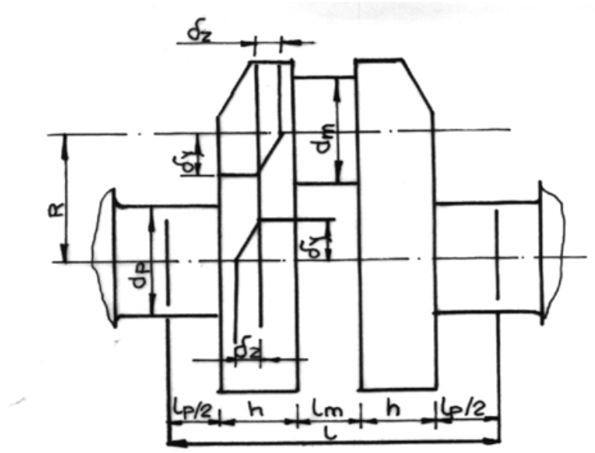
We have to mention that an original method for the calculation of the equivalent axial crank stiffness, based on Castigliano's theorem, by discretization of the crank (Fig. 1(a)) and taking into account that the crank stiffness increases in the web crankshaft filets connecting areas by means the δ_y and δ_z values (Fig. 1(b), for the SULZER type engine of Table 1). This axial stiffness is of the following form:

$$K = \frac{E}{2\left[\frac{l_1-\delta_z}{A_1}+\frac{(l_2-2\delta_y)^3}{3I_2}+\frac{l_2^2(l_3-\delta_z)}{I_3}+\frac{l_3-\delta_z}{A_3}\right]} \tag{1}$$

where, E is the longitudinal elasticity modulus of the crank shaft, A_j is the cross sectional area of the j^{th} crank element, and I_j is the corresponding length.



a



b

Figure 1 Crank Dicretization for the Equivalent Axial Stiffness Calculation

Due to the similarity of the axial and torsional vibrations phenomenon, an iterative Holzer type method was used for the calculation of the axial vibrations.

The values of the natural frequencies of the individual free vibrations, as results from the original computer codes for both engines considered, are shown in Table 1 for the first vibration mode shapes.

According to the Fig. 2(d). the torsional excitation is the T_k tangential force with the respective harmonic coefficients: A_{p_k} ('cos' terms) and B_{p_k} ('sin' terms), due to the pressure gas force and B_{I_k} (only the 'sin' terms), due to the inertia of the reciprocating masses (Table 2, for the SULZER type engine). In the same figure the Z_k radial forces represent the bending vibration excitation. The respective harmonic coefficients $A^I_{p_k}$, $B^I_{p_k}$ and $B^I_{i_k}$ are shown in Table 3. It must be noted that all the harmonic coefficients have been computed according to [6] and using an indicated diagram of the SULZER type engine.

3. THE VIBRATIONS SOURCES ANALYSIS OF MARINE DIESEL ENGINE SHAFTING SYSTEMS

For the harmonic analysis of the propeller excitation on the shafting system, an original method and computer code have been developed and experimentally confirmed [7], for steady-state conditions. The harmonic coefficients of the propeller torque, M_{p_k} and the corresponding phases, φ_k, as well as the thrust harmonic coefficients, T_{p_k} and their respective phases, φ^I_k, are presented in Table 4.

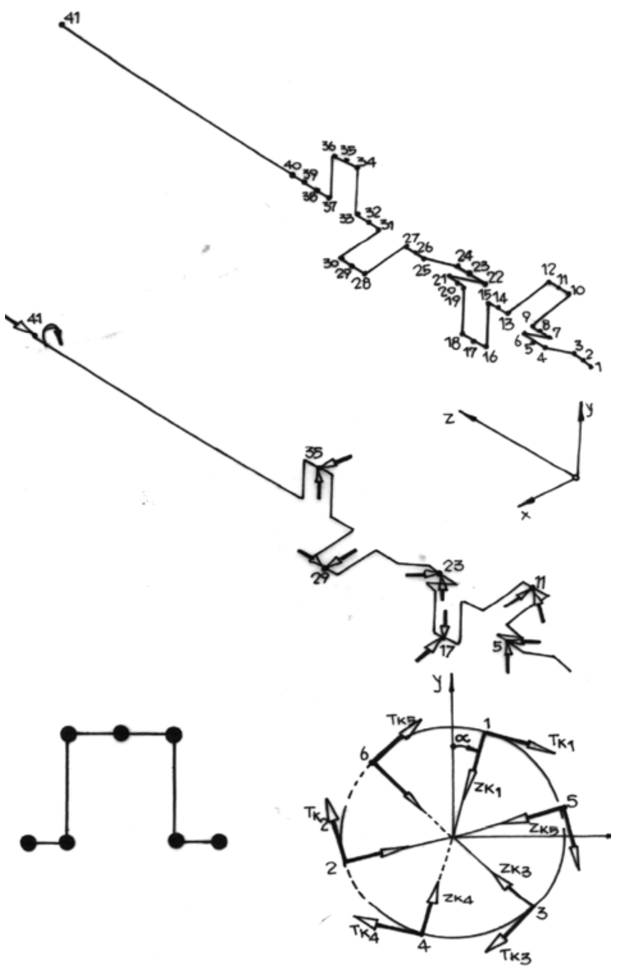


Figure 2 Discretization of the SULZER 6RND Shafting System for the Use of FEM

Table 1. Natural Frequencies

Engine Type	Frequency Order	Torsional Vibrations	Bending Vibrations	Axial Vibrations	Coupled (FEM Vibrations)
		$[s]^{-1}$	$[s]^{-1}$	$[s]^{-1}$	$[s]^{-1}$
6RND90	I	46.351	10.764	18.167	28.274
	II	187.357	49.987	42.103	70.071
K6Sz52/	I	83.287	20.054	31.559	36.014
105 CLe	II	201.405	68.426	77.892	79.238

Table 2. Harmonic Coefficients of the Tangential Force (SULZER Type Engine of Table 1)

k	A_{p_k}	B_{p_k}	B_{i_k}
	$[kN]$	$[kN]$	$[kN]$
1	301.2	753.4	48.9
2	8.2	657.2	-470.1
3	-54.0	374.9	-145.9
4	-69.2	216.5	-9.8
5	-83.6	116.2	0.9
6	-71.7	69.1	0.0
7	-68.3	56.5	0.0
8	-63.5	49.9	0.0
9	-55.1	42.5	0.0
10	-45.3	24.6	0.0
11	-27.4	7.5	0.0
12	-11.0	-11.4	0.0

Table 3. Harmonic Coefficients of the Radial Force (SULZER Type Engine of Table 1)

k	$A^I_{p_k}$	$B^I_{p_k}$	$B^I_{i_k}$
	$[kN]$	$[kN]$	$[kN]$
1	1572.3	203.9	138.1
2	1156.1	428.7	450.3
3	672.3	457.2	143.9
4	404.2	387.4	0.1
5	252.4	342.6	0.1
6	156.1	275.6	0.0
7	55.2	143.5	0.0
8	1.5	116.2	0.0
9	-33.4	85.6	0.0
10	-49.0	62.4	0.0
11	-49.8	42.9	0.0
12	-42.7	25.2	0.0

Table 4. Calculated Harmonic Coefficients of the Propeller Excitation (SULZER Type Engine of Table 1)

k	M_{p_k}	φ_k	T_{p_k}	φ^I_k
	$[kNm]$	$[rad]$	$[kN]$	$[rsd]$
1	21.53	0.351	31.427	0.437
2	4.004	0.722	7.377	-1.117
3	3.754	-1.199	5.444	-0.143
4	1.475	-1.123	2.717	-0.965
5	0.927	1.373	2.349	-1.332
6	0.598	-0.099	1.214	1.290

4. THE VIBRATION COUPLING OF MARINE DIESEL ENGINE SHAFTING SYSTEM

4.1. The model of the shafting system

The crankshaft has been modeled using straight beam elements. The spatial structure thus derived is discretized in 40 finite elements, at 41 nodes. The crank discretization which is more realistic than in [3], is shown in Fig. 2(c). Concentrated masses and moments of inertia have been considered in nodes 1,39,40 and 41 (which correspond respectively to the flange of the free end of the engine, to the collar thrust, to the flywheel and to the propeller) as well as in the middle of the crank pins. Then in the nodes 5, 11, 17, 23, 29 and 35 a radial and a tangential force have been calculated and then projected on the global reference system (fig. 2(d)). Therefore, the crank *j* which corresponds to the cylinder where the ignition is produced after n_j angular intervals δ with reference to the first firing cylinder, the excitation forces have the following components:

$$\begin{cases} T_{k_{j_x}} = T_{k_j} \cdot \cos\left[k\alpha + \left(i - n_j\right)\delta\right] \\ T_{k_{j_y}} = T_{k_j} \cdot \sin\left[k\alpha + \left(i - n_j\right)\delta\right] \\ Z_{k_{j_x}} = Z_{k_j} \cdot \sin\left[k\alpha + \left(i - n_j\right)\delta\right] \\ Z_{k_{j_y}} = Z_{k_j} \cdot \cos\left[k\alpha + \left(i - n_j\right)\delta\right] \end{cases} \tag{2}$$

where:

$$T_{k_j} = \left|T_{k_j}\right| \cdot \sin\left(k\alpha + \theta_{k_j}\right) \tag{3}$$

with:

$$\begin{cases} \left|T_{k_j}\right| = \sqrt{A^2_{p_{k_j}} + \left(B_{p_{k_j}} + B_{i_k}\right)^2} \\ \theta_{k_j} = a\tan\dfrac{A_{p_{k_j}}}{B_{p_{k_j}} + B_{i_k}} - k \cdot n_j \cdot \delta \end{cases} \tag{4}$$

i being the total number of the engine cylinders, k the harmonic order and α the angle of the first crank with respect to the cylinder axis. Similar relations have been deduced for the radial excitation forces of each crank. The last node of the proposed structure is charged with the harmonic expressions [7] (only 'sin' terms) of the propeller moment and thrust, while the respective components of the propeller excitation at the blade frequency will become harmonic components of order z_p at the shafting system frequency.

4.2 Free coupled vibrations of marine Diesel engine shafting system

The calculation of the coupled vibrations of marine Diesel engine shafting systems is made in the global reference system noted as Oxyz, which is orthogonal and has the origin at the node 1.

In order to improve the data input process and increase the program flexibility, we consider also a local coordinate system attached to each beam of the system that must satisfy the following requirements:

- the origin of the system is in node I (I < J, Fig. 3(a));
- the z-axis of the system is the same as the longitudinal axis of the beam;
- the yz-plane is defined with the help of an arbitrary point K placed in the first quarter;
- the x-axis is chosen to br normal to the xy-plane and so that the three axii have the same orientation as the global reference system.

The stiffness and mass matrices as well as the excitation on the beams are calculated with reference to the local system. The displacements of a straight beam I-J are assumed to be positive and constitute a column vector:

$$\overline{\Delta}_{ij} = \left[\overline{\Delta}_i \, \overline{\Delta}_j\right]^T = \begin{bmatrix} u_i \\ v_i \\ w_i \\ \varphi_{ix} \\ \varphi_{iy} \\ \varphi_{iz} \\ u_j \\ v_j \\ w_j \\ \varphi_{jx} \\ \varphi_{jy} \\ \varphi_{jz} \end{bmatrix} \qquad (5)$$

where the dash on top of the symbols indicates the local reference system, and the superscript T notes the transpose matrix. Similarly, the forces and moments on the two ends of the elements are positive (Fig. 3(b)) and constitute the column vector:

$$\overline{\Phi}_{ij} = \left[\overline{\Phi}_i \, \overline{\Phi}_j\right]^T = \begin{bmatrix} F_{ix} \\ F_{iy} \\ F_{iz} \\ M_{ix} \\ M_{iy} \\ M_{iz} \\ F_{jx} \\ F_{jy} \\ F_{jz} \\ M_{jx} \\ M_{jy} \\ M_{jz} \end{bmatrix} \qquad (6)$$

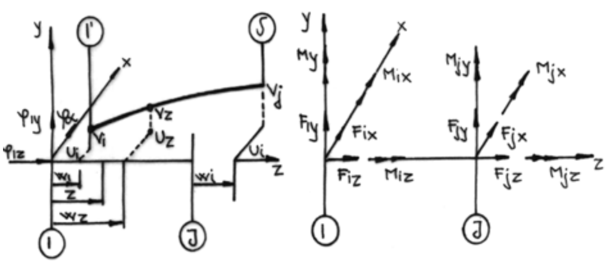


Figure 3 Node Displacements and Load of a Shafting Finite Element

Using the usual expressions [8] for the functions of the node displacements and loads and applying the expressions for the end loads at z=0 and z=l (the length of the element), we obtain the vectors $\overline{\Phi}_i$ and respectively $\overline{\Phi}_j$. The following expression results:

$$\overline{\Phi}^{(e)} = \overline{r}^{(e)} \cdot \overline{\Delta}^{(e)} \qquad (7)$$

where $\overline{r}^{(c)}$ represents the stiffness matrix for the (e) element [8].

Applying the principle of virtual works for the (e) element we will obtain the relation between the forces and node displacements:

$$\overline{\Phi}^{(e)^*} = \overline{m}^{(e)} \cdot \ddot{\overline{\Delta}}^{(e)} + \overline{r}^{(e)} \cdot \overline{\Delta}^{(e)} \qquad (8)$$

where $\overline{m}^{(e)}$ is the mass matrix of the corresponding element. This matrix is of the partitioned form:

$$\overline{m}^{(c)} = \begin{pmatrix} \overline{m}_{ii} & \overline{m}_{ij} \\ \overline{m}_{ji} & \overline{m}_{jj} \end{pmatrix} \qquad (9)$$

where, for an interior element $\overline{m}_{pq}$, the indices p and q take all values i and j successively. The following general expression which takes into account the coupling among all the individual types of vibration (torsional, flexural and axial) has been derived:

$$\overline{m}_{pq} = \frac{\rho A l}{420} \cdot \begin{pmatrix} a_{11_{pq}} & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{22_{pq}} & 0 & 0 & 0 & a_{26_{pq}} \\ 0 & 0 & a_{33_{pq}} & 0 & a_{35_{pq}} & 0 \\ 0 & 0 & 0 & a_{44_{pq}} & 0 & 0 \\ 0 & 0 & a_{53_{pq}} & 0 & a_{55_{pq}} & 0 \\ 0 & a_{62_{pq}} & 0 & 0 & 0 & a_{66_{pq}} \end{pmatrix} \qquad (10)$$

with ρ, A, I and I_p (implicit) being respectively the density, the cross sectional area of the beam, the length, and the polar moment of inertia of A. The value of the above coefficients are presented in Table 5.

The next step is to rotate the local reference system so as to lie parallel to the global one. This is done according to an original method taking also into account the requirements for the local reference system in the beginning of this paragraph. In this way, the rotational matrix L (which contains the directional cosines) was derived. Subsequently, the translation of the local system so as to coincide with the global one will be done automatically when the stiffness and mass matrix for the entire structure is assembled. Therefore expression (8) transforms into:

$$\Phi^{(c)^*} = m^{(c)} \cdot \ddot{\Delta}^{(c)} + r^{(c)} \cdot \Delta^{(c)} \qquad (11)$$

valid for element (e) of the global system, where:

Table 5. Elements of Matrix of (10)

Ind. (p,q)	$a_{11\,pq}$	$a_{22\,pq}$	$a_{26\,pq}$	$a_{33\,pq}$	$a_{35\,pq}$	$a_{44\,pq}$	$a_{53\,pq}$	$a_{55\,pq}$	$a_{62\,pq}$	$a_{66\,pq}$
(i,i)	140	156	22 l	156	22 l	Ip/A	-22 l	4 l^2	22 l	4 l^2
(i,j)	70	54	-13 l	54	13 l	Ip/2A	-13 l	-3 l^2	13 l	-3 l^2
(j,j)	140	156	-22 l	156	22 l	Ip/A	22 l	4 l^2	-22 l	4 l^2
(j,i)	70	54	-13 l	54	13 l	Ip/2A	-13 l	-3 l^2	13 l	-3 l^2

$$r^{(c)} = \left(L^T \bar{r} L\right)^{(e)} \qquad m^{(c)} = \left(L^T \overline{m} L\right)^{(e)} \tag{12}$$

The mass and stiffness matrices are 12x12 for each element and 12n x 12n (where n is the number of nodes) for the entire structure.

For the structure of Fig. 2(a), some of the nodes have concentrated masses and forces. Due to the inertia of the concentrated masses in node g, the corresponding displacement vector will be:

$$\Delta_g = \begin{bmatrix} u \\ v \\ w \\ \varphi_x \\ \varphi_y \\ \varphi_z \end{bmatrix} \tag{13}$$

and the mass matrix will be:

$$m_g = \begin{pmatrix} m & 0 & 0 & 0 & 0 & 0 \\ 0 & m & 0 & 0 & 0 & 0 \\ 0 & 0 & m & 0 & 0 & 0 \\ 0 & 0 & 0 & J_x & 0 & 0 \\ 0 & 0 & 0 & 0 & J_y & 0 \\ 0 & 0 & 0 & 0 & 0 & J_z \end{pmatrix} \tag{14}$$

where J_x, J_y and J_z represent the moments of inertia of a mass m in node g refered to the global reference system.

The generalized forces vector (concentrated moments and forces) in node g is:

$$F_g = \left[F_{g_x} \quad F_{g_y} \quad F_{g_z} \quad M_{g_x} \quad M_{g_y} \quad M_{g_z}\right]^T \tag{15}$$

D'Alembert's principle, as applied for the dynamic equilibrium of node g, gives:

$$F_g - m_g \ddot{\Delta}_g - \sum_{e_h} \Phi_g^{(e)^*} = 0\,. \tag{16}$$

By writing the last equation for all nodes of the discretized structure, we obtain the system of differential equations that describe the dynamic behavior of the entire structure, in the following matrix notation:

$$M\ddot{\Delta} + R\Delta = F \tag{17}$$

where, Δ is the unknown displacements vector:

$$\Delta = \begin{bmatrix} \Delta_1 \\ \Delta_2 \\ . \\ . \\ . \\ \Delta_g \\ . \\ . \\ . \\ \Delta_n \end{bmatrix} \tag{18}$$

M, the mass matrix:

$$\begin{cases} M_{gg} = m_g + \sum_{e_g^I} m_{ii}^{(e_g^I)} + \sum_{e_g^{II}} m_{JJ}^{(e_{JJ}^{II})} \\ M_{gh} = m_{ij}^{(e_g^I)},\ g < h \\ M_{gh} = m_{ji}^{(e_g^{II})},\ h > g \end{cases} \tag{19}$$

R, the stiffness matrix

$$\begin{cases} R_{gg} = \sum_{e_g^I} r_{ii}^{(e_g^I)} + \sum_{e_g^{II}} r_{JJ}^{(e_{JJ}^{II})} \\ R_{gh} = \sum_{e_g^I} r_{ij}^{(e_g^I)},\ g < h \\ R_{gh} = \sum_{e_g^{II}} r_{ji}^{(e_g^{II})},\ h > g \end{cases} \tag{20}$$

and F the generalized external excitation forces vector given by (15).

In equation (19) and (20) we set:

$$e_g = e_g^{'} + e_g^{''} \quad (21)$$

where, e_g^I represents the number of finite elements that start from node g and end in all nodes h, with h > g, while e_g^{II} represents the number of finite elements that start from node g and end in all nodes h, with h < g. Thus, the assembling of the total stiffness and mass matrices are made in a more applicable way.

The mode shapes and natural frequencies are found by solving the homogeneous equation corresponding to (17). Assuming a harmonic displacement function, we obtain a homogenous linear system of equations. In order to acquire a non trivial solution the following condition must be satisfied:

$$D|\Delta| = \omega^2 |\Delta| \quad (22)$$

where, $D = M^{-1} R$ is the dynamic matrix of the structure which is a band matrix of width 12. One way of solving the eigenvalue and eigenvector problem is the matrix iteration method we developed, based on that proposed in [9]. Table 1 contains the values of the natural frequencies obtained using the current method as compared to those calculated for each vibration mode separately.

4.3. Forced coupled vibrations of marine Diesel engine shafting system

In order to determine the amplitude of the forced coupled vibrations, we assumed that the excitation and the response are both harmonic functions with the same frequency. The calculation is made for every harmonic order k. Therefore, the displacement vector has the form:

$$\Delta_k = \left[R - (k \cdot \omega)^2 M\right]^{-1} F_k \quad (23)$$

where ω is the shafting system angular frequency and the components of Δ_k are obtained using the Gauss elimination method. The dimension of the system for this example is 246. The deformed shape can be found using the equation:

$$\Delta = \sum_k \Delta_k \quad (24)$$

valid for the steady-state condition.

4.4. Numerical results

We have developed an original computer code in Turbo Pascal 6.0 based method described in Section 4.3.

The boundary conditions are:

- no axial displacement in node 39 (thrust bearing);
- no radial displacement in nodes 2, 8, 14, 20, 26 and 38 (middle of crank pins);

As can be seen from Table 1, the first order (I) torsional natural frequency is closer to the second order (II) axial one suggesting a coupling between the two modes. The natural frequencies of the coupled vibrations of the second engine in Table 1 are even closer to the values of the natural frequencies of the individual axial vibrations indicating an important influence of the latter in the coupled phenomenon. A much weaker influence of the bending vibrations on the coupled phenomenon can also be seen.

The two first mode shapes of the coupled vibration for the two engines considered are presented in Fig. 4 and 5, for the two engines respectively. The first order torsional vibrations mode shape is very similar to the second order axial one, both of them having a single node. The first order axial vibration mode shape has no sign change; the vibration of the relative axial amplitudes are reduced mainly due to the influence of the thrust bearing.

The deformed shape of the shafting system of the first engine is shown in Fig. 6 for the nominal number of rotations. For this rate, an frequency analysis of the axial displacements of the free end of the shafting (node 1) is shown in Fig. 7. The harmonic orders are that produce pronounced resonance are also presented in Fig. 7. The most dangerous resonance occurs with the order 6, while the influence of the harmonic order 4 (the first order at blade frequency) is much lower. Therefore, the predominant influence on the axial vibration level is exercised by the torsional vibration conforming to the aforementioned coupling phenomenon and not by the propeller thrust fluctuations.

Table 6. Propeller Excitation Variations Relative to the Mean

		Recommended	
Effort Type*	Realized	Bureau Veritas (%)	ITTC 81** (%)
$(\Delta T_p)_{cal} / T_{po}$	5.22	2-12	1-5
$(\Delta M_p)_{cal} / M_{po}$	5.20	2-12	1-5
$(\Delta T_p)_{meas} / T_{po}$	5.80	2-12	1-5
$(\Delta M_p)_{meas} / M_{po}$	7.65	3-12	1-5
* For 1st order harmonic at blade frequency ** The 16th International Towing Tank Conference			

Table 7. Measured Axial Vibration Amplitudes (MAN Type Engine of Table 1)

	Measured Parameters			
Marine Engine		Amplitudes [mm]		
Rating [RPM]	Frequency [Hz]	Axial Without Damper	Axial With Damper	Admissible*
100	10.25	0.865	0.065	0.318
115	11.75	2.740	0.288	0.318
140	14.00	0.726	0.082	0.318
* Recommended by Bureau Veritas				

Table 8. Comparison between Measured and Calculated Axial Vibration Amplitudes (MAN Type Engine of Table 1)

	Parameters			
Marine Engine		Amplitudes [mm]		
Rating	Frequency	Axial, Without Damper		
[RPM]	[Hz]	Measured	Calculated	Admissible *
100	10.25	0.865	-	0.318
115	11.75	2.740	-	0.318
140	14.00	0.726	0.793	0.318
* Recommended by Bureau Veritas		approx 8% error		

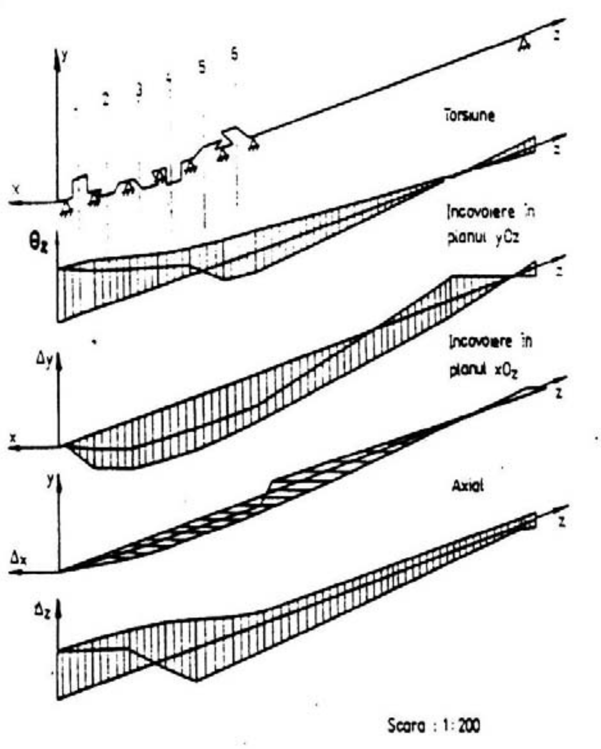


Figure 4 Natural Mode Shape for the SULZER Type Engine of Table 1

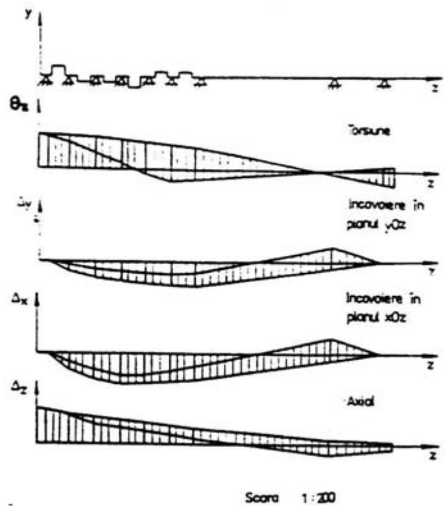


Figure 5 Natural Mode Shape for the MAN Type Engine of Table 1

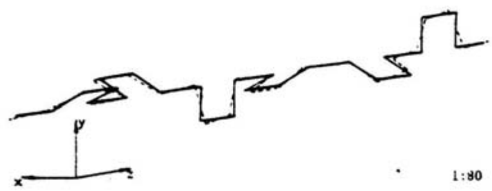


Figure 6 Deformed Shape of the SULZER Shafting System Using the FEM Code

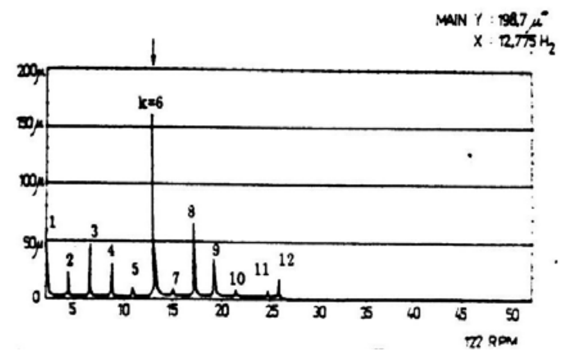


Figure 7 Frequency Analysis of the Axial Displacement of the Free End of the SULZER Type Engine of Table 1

5. CONCLUSIONS

It is very interesting that the main axial excitation of the marine Diesel engine shafting systems, in the frame of the coupling vibrations phenomena is due to the torsional vibrations and not to the propeller thrust fluctuations.

The methods proposed are experimentally validated and may consist a good prediction tool for determining if an axial damper is necessary.

Our computation methods have taken into account only the steady-state operation. Therefore, the damping matrix determination was not necessary. However, we need further experimentation towards this goal and this will be part of our future research.

6. REFERENCES

[1] PARSON, M.G., *Marine Technology*, Vol. 20, No. 3 (1983), p.257.

[2] HOMORI, S., KAMATA, M., AND SASAKI, Y., *J.S.N.A.*, Vol. . 163 (1988) and Vol. 164 (1988).

[3] JENZER, J. AND WELTE, Y., *Coupling Effect between Torsion and Axial Vibration in Installations with Two - Stroke Diesel Engines*, New Slugger Diesel (1991).

[4] LEE, K. - W., YEO, S.- D., CHO D.-B. AND CHEON, J., *Technical Series Paper No 940699*, SAE International Congress & Exhibition (1994).

[5] SHIMOYAMANDA, K., WAKABAYASHI, K., KODANA, T., HONDA, Y. AND IWAMOTO, S., *Technical Series Paper No 930197*, SAE International Congress & Exhibition (1993).

[6] TARAZA, D., *Dynamics of Internal Combustion Engines* (1985), Didactic & Pedagogic Publications (*Bucharest, Romania), p.113.

[7] TARAZA, D., BUZBUCHI, N. AND POPOVICI, J.S., *Technical Series Paper No 941696*, SAE International Off - Highway & Powerplant Congress & Exhibition (1994).

[8] POSEA, N., *Dynamic Calculations of Structures* (1991), Technical Publications (Bucharest, Romania).

[9] WANG, P.C. *Numerical and Matrix Methods in Structural Mechanics*, (1965), John Wiley & Sons.

[10] *Recommendations for Limiting the Vibration Effect on Ships*, (1979), Bureau Veritas.

NEW APPLICATIONS OF FAST LYAPUNOV INDICATOR FOR DISCRETE-TIME DYNAMICAL SYSTEMS

DELEANU DUMITRU

Constanta Maritime University, Romania

ABSTRACT

In this work our intension was to apply the Fast Lyapunov Indicator (FLI) for distinguishing between ordered and chaotic motion in some discrete-time dynamical systems. The behavior of certain discrete maps, like Gaussian map, delayed logistic map and 2-D, respectively 4-D symplectic map studied by Froeschele has been studied and conclusions regarded FLI for ordered/chaotic orbits has been considered. The simplicity of the idea and the correlation between the conclusions obtained by FLI and other tools, like phase-plane or Lyapunov exponents, show that FLI is a very consistent indicator in identifying ordered/chaotic orbits in discrete-time dynamical systems.

Keywords: *Indicator of chaos, Fast Lyapunov Indicator, maps.*

1. INTRODUCTION

Deterministic chaos, often just called "chaos", refers in the world of dynamics to the generation of random, unpredictable behaviour from a simple, but nonlinear rule. Through the rule's repeated application, the long-term behaviour becomes quite complicated.

Chaotic behaviour has been discovered in numerous natural phenomena and analyzed in detail in dozens of papers and experiments. From compound pendula to dripping faucets, from predator-prey ecologies to measle epidemics, from oscillating chemical reactions to irregular beats of a chicken heart, the underlying mechanisms have been detailed.

Appearance of chaos has been identified through various tools in the past. The most known are: Fourier spectra, Poincare maps, Lyapunov exponents, phase-space method, Kolmogorov entropy, correlation dimension and so on. In the recent papers, other analytical or numerical tools have been introduced. They are more efficient and faster then the older ones, especially for multidimensional dynamical system. We just remember the well-known tools like Smaller Alignment Indices (SALI), Fast Lyapunov Indicators (FLI), Dynamic Lyapunov Indicator (DLI) and the 0-1 test.

In the present paper we first recall the definition of the FLI and then show its effectiveness by applying it to some discrete-time dynamical systems (maps).

2. DEFINITION OF FAST-LYAPUNOV INDICATOR

FLI was introduced by Froeschele et al (1997) as a means of detecting chaotic and regular motions[1]. The FLIs are defined as follows:

Starting with an 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:

$$FLI = \sup \|v_j\|,\ j = 1,2,..n \qquad (1)$$

Froeschele has shown that FLI increases exponentially for chaotic orbits and linearly for regular orbits.

3. APPLICATION OF FLI FOR MAPS

We have applied above defined indicator for the models given below:

3.1. Gaussian map

It is a one-dimensional map given by

$$x_{n+1} = \exp\left(-a\, x_n^2\right) + b \qquad (2)$$

where a and b are non-zero parameters.

Now we investigate the behaviour of this map for some fixed value of parameter b, say $b = 7.5$. ([1])

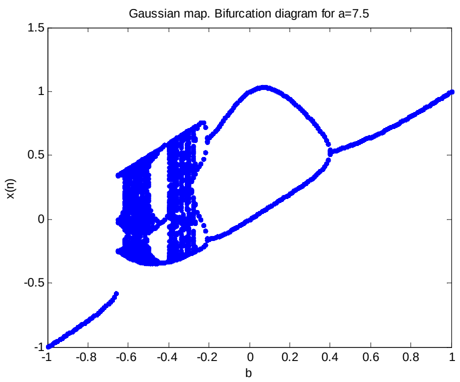


Figure 1 Bifurcation diagram for Gaussian map

In Figure 1, we have plotted the bifurcation diagram. From this diagram we can see, for example, that for $b = -0.469$ the orbit is periodic, with period 6, whereas for $b = -0.51$ it becomes chaotic. This can be clearly observed through the phase plots given in Figures 2 and 3.

The exponential increase of FLI in Figure 5 indicates that the attractor is chaotic. For periodic orbit

FLI tends to zero (see Figure 4). The ordinate in Figures 4 and 5 is taken with base *e*.

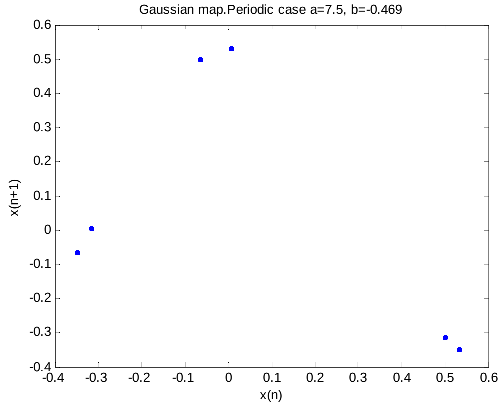


Figure 2 Phase-plane for Gaussian map (a=7.5, b=-0.489)

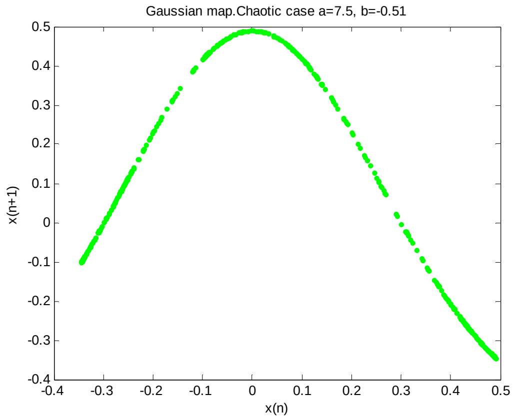


Figure 3: Phase-plane for Gaussian map (a=7.5, b=-0.51)

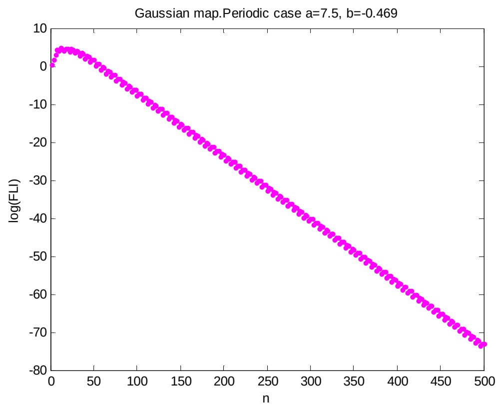


Figure 4: FLI for Gaussian map (a=7.5, b=-0.489)

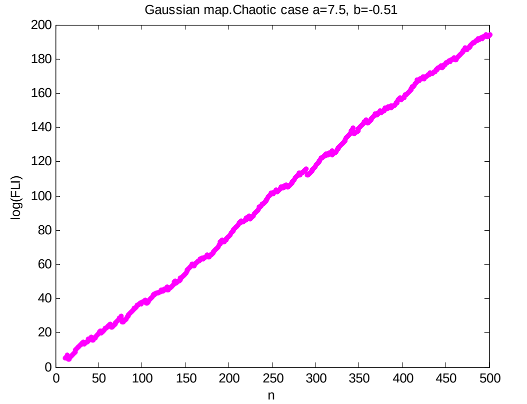


Figure 5 FLI for Gaussian map (a=7.5, b=- 0.51)

3.2. 2-D symplectic map (Froeschele)

As a second example we consider a variant of the 4D map studied by Froeschele [1], more precisely

$$x_{n+1} = x_n + y_n \pmod{2\pi} \qquad (2.a)$$

$$y_{n+1} = y_n - \alpha \sin(x_n + y_n) \pmod{2\pi} \qquad (2.b)$$

with α a real constant. We choose in the following $\alpha = 1$. For initial condition $x_0 = 2,\ y_0 = 0$ the orbit is ordered (see Figure 6) whereas for $x_0 = 3,\ y_0 = 0$ the orbit becomes chaotic (see Figure 7).

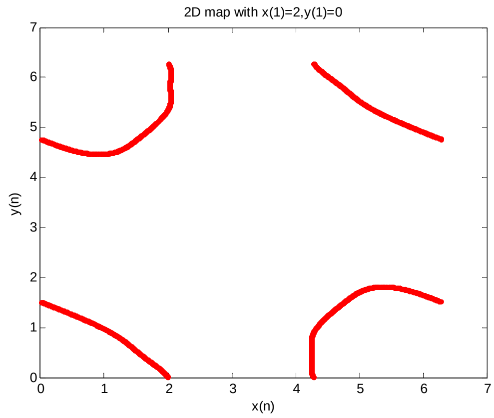


Figure 6 Phase-plane for 2-D symplectic map (ordered orbit)

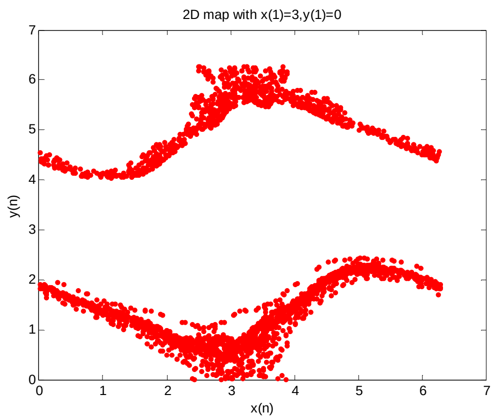


Figure 7 Phase-plane for 2-D symplectic map (chaotic orbit)

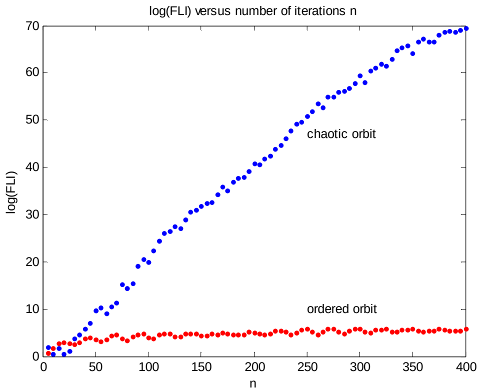


Figure 8 FLIs for 2-D symplectic map

From Figure 8 it is evident that FLI increase exponentially for chaotic orbit and linearly for ordered orbit.

3.3. Delayed logistic map

The 2-D delayed logistic map is described by the

$$x_{n+1} = a\, x_n \left(1 - y_n\right) \qquad (3.a)$$

$$y_{n+1} = x_n \qquad (3.b)$$

For $a = 2.7$ and $\left(x_0, y_0\right) = \left(0.001, 0.001\right)$ the Lyapunov exponents are $\lambda_1 = 0.18312, \lambda_2 = -1.24199$ and indicate chaotic orbit. Indeed, FLI increase exponentially (see Figure 9). For $a = 2.0$ and the same initial conditions, $\lambda_1 = -0.1472, \lambda_2 = -0.7851$ and we have a fixed point (Figure 10). FLI decreases to zero. Phase plots for these cases are shown in Figures 11 and 12.

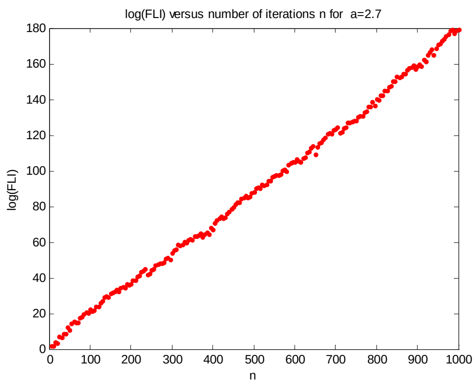


Figure 9 FLI for delayed logistic map (a=2.7)

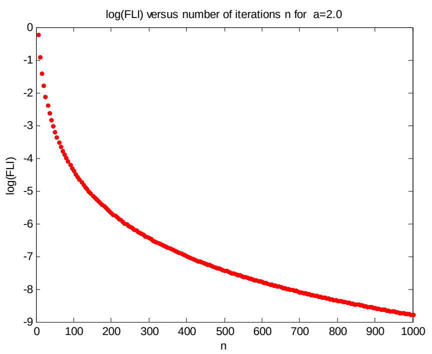


Figure 10 FLI for delayed logistic map (a=2.0)

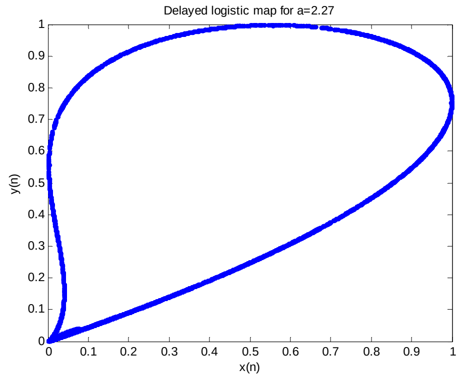


Figure 11 Phase-plane for delayed logistic map (a=2.7)

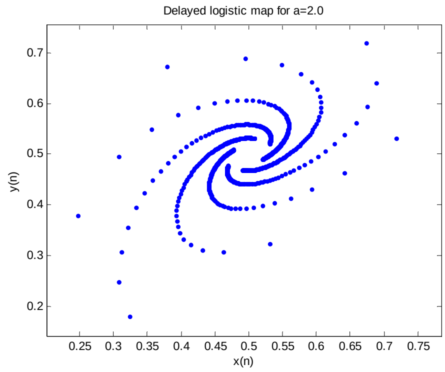


Figure 12 Phase-plane for delayed logistic map (a=2.0)

3.4. 4-D Symplectic map (Froeschele)

As the last example we get the 4-D map

$$x_{n+1} = x_n + y_n \quad (\text{mod } 2\pi) \qquad (4.a)$$

$$y_{n+1} = y_n - u \sin\left(x_n + y_n\right) - \mu\left[1 - \cos\left(x_n + y_n + z_n + t_n\right)\right] \quad (\text{mod } 2\pi) \qquad (4.b)$$

$$z_{n+1} = z_n + t_n \quad (\text{mod } 2\pi) \qquad (4.c)$$

$$t_{n+1} = t_n - v \sin\left(z_n + t_n\right) - \mu\left[1 - \cos\left(x_n + y_n + z_n + t_n\right)\right] \quad (\text{mod } 2\pi) \qquad (4.d)$$

which is composed of two maps of the form (2) , with parameters u and v, coupled with a term of order μ . Skokos et al [5] are considered this map with $u = 0.5, v = 0.1$, $\mu = 0.001$ and founded that for initial condition $\left(x_0, y_0, z_0, t_0\right) = (0.5, 0.0, 0.5, 0.0)$ the orbit is ordered and for $\left(x_0, y_0, z_0, t_0\right) = (3.0, 0.0, 0.5, 0.0)$ it is chaotic. In our study we used the same values and the results show again that FLI is clearer in indicating regularity and chaos (see Figure 13).

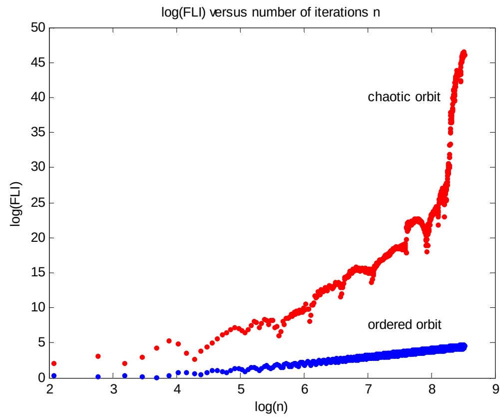


Figure 13 FLIs for 4-D symplectic map

4. CONCLUSIONS

The aim of this paper it was to apply the FLI method for distinguishing between ordered and chaotic motion in the case of some discrete-time dynamical systems. We investigated the 1-D Gaussian map, the 2-D delayed logistic map and 2-D and, respectively, 4-D symplectic maps studied by Froeschele. The main conclusions of our study are:

a) FLI gives very clear indication of ordered and chaotic motion whenever applied. Its computation is fast and easy;
b) FLI increase exponentially for chaotic orbits, linearly for limit cycle and decreases to zero for periodic maps;
c) Only few hundreds of iterations are sufficient to get a conclusion;
d) The FLI method is extremely useful for high-dimensional dynamical systems;
e) FLI may be considered an efficient indicator of regularity and chaos;

For numerical integrations and other calculus, we have used Matlab package.

5. REFERENCES

[1] FROESCHELE, C., GONCZI, R., LEGA, E., *The Fast Lyapunov Indicator: A simple tool to detect weak chaos, Application to the structure of the main a steroidal belt*, Planet. Space Sci., Vol 45, pp. 881-886, 1997.
[2] PADIDAR, V., *Co-existence of regular and chaotic motions in the Gaussian Map*, Electronic Journal of Theoretical Physics, EJTP3, No 13 (2006), pp. 29-40.
[3] SAHA, L.M., TEHRI, R., *Applications of recent indicators of regularity and chaos to discrete maps*, Int.J. of Appl. Math and Mech, vol 6(1), pp 86-93, 2010.
[4] SAHA, L.M., DAS, M.K., BUDHRAIN, M., *Characterization of Attractors in Gumowski-Mira Map Using Fast Lyapunov Indicators*, vol 21, pp. 151-158, 2008.
[5] SKOKOS CH., ANTONOPOULOS CH., BOUNTIS, T.C., VRAHATIS, M.N., *Determining the ordered or chaotic nature of orbits in conservative dynamical systems*, J.Phys., vol 34, pp. 69-74, 2001.

GAS TURBINES FOR MARINE APPLICATIONS. EXERGY ANALYSIS FOR AN IMPROVED GAS TURBINE

[1]MEMET FEIZA, [2]MITU DANIELA

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

In marine applications, the gas turbine is usually driving the propellers of ships or ferry. The major advantage of gas turbines over conventional steam turbines or marine diesel main engines is their excellent power to weight ratio. However, the increasing price of fuel determined a lot of ship companies to return to old marine diesel engines. Fuel cells power systems have attracted attention due to their potential for high efficiencies, low emissions, flexible use of fuels and quiet operation. These benefits recommend fuel cells for the marine use. This paper deals with the exergy analysis applied to gas turbines in order to assess exergy losses in processes developed in the combustion chamber and in a fuel cell replacing it, in order to measure thermodynamic efficiency. It is found that exergy losses in the improved gas turbine are lower compared to the traditional one. This means that the gas turbine having a fuel cell instead of a combustion chamber presents a lower energy demand and works environmentally sensitive.

Keywords: *gas turbines, fuel cells, marine, exergy losses.*

1. INTRODUCTION

The traditional user of gas turbines was initially the military because disadvantages (like costs) have made them unattractive for ship owners. But further developments in gas turbines technology and price policy brought them in the attention of ship owners. Gas turbines are one of the key energy producing devices of our generation. Improved designs of gas turbine components are necessary in order to address the increasing demands of high performance and reduced emissions.

Gas turbines gather air (compressed in a compressor module) and fuel, for burning in a combustion chamber. Combustion gases are then expanded through a turbine. The turbine's shaft continues to rotate and drive the compressor, placed on the same shaft and running thus continues [Stan, 2010].

The pressure to reduce emissions directs attention on pollution produced both at sea and in ports, which should be diminished by modern technologies.

Marine energy systems are not connected to electrical grids and must run with high reliability for long periods. Fuel cells are highly efficient energy sources, able to produce clean, silent and reliable power by converting the chemical energy of a fuel directly into electricity through an electrochemical reaction. These devices can work as long as are supplied with fuel. Considering the increasing demand for fossil fuels and the increasing concern over the impact of burning fossil fuels on the global climate, fuel cells technologies are seen as a better option in maritime sector, by comparison with conventional power generators.

Private owners of boats became more aware of the potential advantages of fuel cells, but also local governments, private companies, military ocean going vessels. The commercial industry is slightly behind regarding fuel cells implementation. Due to their duty, scientific research vessels are environmentally conscious, that is why in their case the interest of this technology is significant.

Considering their advantages related to efficiency and environment, Solid Oxide Fuel Cells (SOFC) are a type of fuel cells seen as adequate for the ship board [Leo et al, 2010].

In the following, will be performed a study dealing with the improvement of a gas turbine, consisting in the substitution of the combustion chamber with a SOFC. An exergy analysis reveals exergy losses, the measure for the process imperfection.

2. MATERIAL AND METHODS

Exergy is considered to be the measure of the usefulness or quality of energy. Usually, exergy is defined as the maximum amount of work that can be produced by a stream of energy or matter, or from a system, as it is brought into equilibrium with a reference environment. Unlike energy, exergy is consumed during real processes due to irreversibilities and conserved during ideal processes.

Exergy analysis is a method based on the first and second laws of thermodynamics for the analysis, design, and improvement of energy and other systems [Bejan et al, 1996]. The exergy method is recommended for improving the efficiency of energy-resource use, since it quantifies the locations, types, and magnitudes of wastes and losses. It is accepted that more viable efficiencies are evaluated with exergy analysis rather than energy analysis because exergy efficiencies are always a measure of the approach to the ideal. Therefore, exergy analysis accurately identifies the margin available to design more efficient energy systems by reducing inefficiencies [Morosuk and Tsatsaronis, 2008].

In the following, an advanced analysis will compare exergy losses in combustion chamber of a gas turbine and in fuel cells, if SOFC replaces the combustion chamber of a traditional gas turbine.

2.1. About SOFC

A fuel cell is an electrochemical device able to convert the chemical energy of a reaction (taking place between fuel and oxidant) directly into electricity. Due to their efficiency and low emissions, fuel cells are considered as an important alternative to power obtained traditionally, from fossil fuels. But a significant challenge in their use is the need for better materials to make fuel cells cost-effective and more durable.

These fuel cells are thought to function between 800–1000°C. Its anode is usually made of yttria – stabilized zirconia (Ni–YSZ), while its cathode is made of LaSrMn. The typical electrolyte is a solid ceramic. In their structure exist also interconnect materials like La–Ca–Cr and La–Sr–Cr oxides.

The anode is feeded with hydrogen produced by hydrocarbon fuel reforming. It is registered a significant catalytic activity at the anode, for hydrogen oxidation. Are get hydrogen ions and electrons. Resulting electrons reach the cathode through an external circuit, being achieved electricity. At the anode is also generated heat. During the cell running is supplied oxygen to the cathode. Oxygen ions are get through the reduction of oxygen, by the upcoming electrons obtained in anode reaction. The ceramic electrolyte leads the oxygen ions from the cathode to the anode. Here is obtained water from ions of oxygen and hydrogen [Panayotova, 2009].

2.2. Exergy analysis

An energy and exergy analysis should pass through the following phases:
- Subdivide the analyzed process into a number of sections, depending on the depth of detail and the understanding resulted from the analysis.
- Write conventional mass and energy balances on the process and determine all basic quantities (like work, heat) and properties (like temperature, pressure).
-Select a reference-environment model according to the nature of the process, the complexity of analysis, and the questions raised.
- Assess energy and exergy values specific to the selected reference-environment model.
- Write exergy balances and evaluate of exergy consumptions.
- Select efficiency definitions according to the needs and determine the efficiencies.
- Interpret the results and formulate conclusions and recommendations dealing with aspects like design improvement, plant modifications, etc.

Exergy is consumed or destroyed because of irreversibilities taking place in all real processes. The loss of exergy (irreversibility) is a quantitative measure of process inefficiency. As mentioned, exergy analysis is based on the second law of thermodynamics and plays a key role in the assessment of processes by considering both the quantity and quality of energy. The exergy stream of matter has the following components [Mrema and Lawrence, 2001]:

$$Ex = Ex_K + Ex_P + Ex_{ph} + Ex_{ch} \tag{1}$$

Kinetic exergy is given by:

$$Ex_K = \frac{1}{2}\left(w^2 - w_0^2\right) \tag{2}$$

Potential exergy is given by:

$$Ex_P = g\left(Z - Z_0\right) \tag{3}$$

Physical exergy is given by:

$$Ex_{ph} = H - H_0 - T_0\left(S - S_0\right) \tag{4}$$

Chemical exergy of the reference gases is given by:

$$Ex_{ch} = RT_0 \ln \frac{P_0}{P_{00}} \tag{5}$$

Where: w – velocity, Z – height, H – enthalpy, T_0 – dead state temperature, S – entropy, R – ideal gas constant, P_{00} – the partial pressure of the component in the reference state.

Exergy losses are assessed according to [Aronis and Leither, 2003].

$$Ex_{loss} = \sum Ex_{in} - \sum Ex_{out,\, useful} \tag{6}$$

The total exergy loss is depicted by the exergy flowing to the surroundings and the exergy destruction appeared inside the process boundaries due to irreversibilities. External exergy losses are the result of the flowing of a quantity of exergy to the environment, while internal exergy losses, known also as exergy destruction or irreversibility, is evaluated as below and it is the result of an overall entropy increment in the system:

$$Ex_d = \sum Ex_{in} - \sum Ex_{out} \tag{7}$$

The exergy efficiency is a rational measure of thermodynamic perfection:

$$\eta_{rat} = \frac{Ex_{desired\ output}}{Ex_{used}} \cdot 100 \tag{8}$$

Where $Ex_{desired\ output}$ is expressed according to the purpose of the process, while Ex_{used} is given by the difference between exergies of input and output resource flows.

The exergy loss in terms of effectiveness [Ploumen and Janssen, 2001]:

$$1 - \varepsilon = 1 - \frac{Ex_{out}}{Ex_{in}} \tag{9}$$

3. EXPERIMENTAL

Gas turbine manufacturers have to face the following challenges:

- increment of the unit output,
- increment of the unit efficiency,
  - to meet the latest regulations regarding exhaust gases,
  - to achieve advanced conversion efficiency.

NOx emissions are taxed all over the world and greenhouse gases, like carbon dioxide and methane are under the international concern, since they contribute to global warming. New trends in gas turbine design refer to low NOx burner development and CO_2 sequestering.

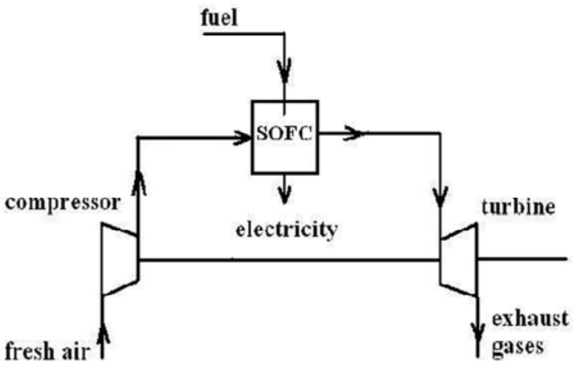


Figure 1 Improved gas turbine

For a gas turbine belonging to F family, the 9 F (50 Hz) gas turbine are calculated exergy losses in the burner, considering the control volume around it. A similar calculation will be done when combustion chamber is replaced by a SOFC, also the control volume being around the fuel cell (see Figure 1).

4. RESULTS AND DISCUSSION

Table 1 shows the result of an exergy analysis developed for the burner of a typical gas turbine. Table 2 presents the same calculation, but for the improved gas turbine. In the following tables were noted: cc-combustion chamber and fc- fuel cell. In the burner the mass flows, the pressures and the temperatures are: 560 kg/s (air), 15 kg/s (fuel), 1470 kPa (air), 1796 kPa (fuel), 390 ^{0}C (air), 27 ^{0}C (fuel). In the fuel cell the mass flows, the pressures and the temperatures are: 5 kg/s (air), 0,1 kg/s (fuel), 861 kPa (air), 1262 kPa (fuel), 578 ^{0}C (air), 578 ^{0}C (fuel).

Table1. Exergy analysis for the burner

Exergy of	Ex_{in}^{cc}	Ex_{out}^{cc}	$1-\varepsilon$
air: 256 MW	1012 MW	788 MW	22%
fuel:756 MW			
exhaust gases: 788 MW			

Table2. Exergy analysis for the fuel cell

Exergy of	Ex_{in}^{fc}	Ex_{out}^{fc}	$1-\varepsilon$
air: 2660 MW	6896 MW	6024 MW	12,64 %
fuel:4236 MW			
exhaust gases: 4217 MW			

The second law of thermodynamics reveals that during natural processes occurs the energy degradation because of their irreversibility. To accomplish a certain exergy output, the processes taking place in the combustion chamber and in SOFC always require a higher exergy input (1012 MW compared to 788 MW – for the combustion chamber; 6896 MW compared to 6024 MW – for the fuel cell).

The difference is the exergy loss caused by the irreversibilities. The exergy loss provides a measure of the thermodynamic efficiency of the processes taking place in the combustion chamber and the fuel cell. The lower the exergy loss, the higher the thermodynamic efficiency of these processes and the lower energy demand.

Exergy losses in the fuel cell are 57% lower.

5. CONCLUSIONS

Fuel cells are gaining acceptance as attractive alternatives to conventional shipboard power sources due to their capability to convert the chemical energy of fuels directly into electricity, with high efficiencies and virtually no pollution, unlike gas turbines.

An exergy analysis was developed for the traditional gas turbine and the improved gas turbine, which requires a fuel cell instead of the combustion chamber. SOFC is considered in this study, as it is a fuel cell type suitable for the maritime sector.

Exergy analysis allows the identification and assessment of inefficiencies of an existing technology and specific process, the localization of exergy losses, the calculation of recoverable energy, the quantification of exergy losses.

Previous analysis, based only on energy, ignored the quality of energy and the degradation of this quality. Exergy analysis exceeds these draw backs, enabling the establishing of the quality of the energy lost pointing out the recoverable and the non recoverable energy.

The estimation of exergy losses in the combustion chamber (22%) and in SOFC (12, 64%) revealed the technology presenting the lowest exergy losses, equivalent to the higher thermodynamic efficiency.

6. REFERENCES

[1]. ARONIS, N., LEITHNER, R. *Thermodynamic analysis and exergetic, economic evaluation of medium scale gas turbine based power plants*. Proc. of ECOS 2003

[2]. BEJAN, A., TSATSARONIS, G., MORAN, M. *Thermal design and optimization*, John Wiley & Sons, Inc. 1996.

[3]. LEO, T., GONZALEZ, O., GOMEZ–BEY, A., CADARSO, L., NAVARRO, E. *Fuel cells technology in marine and naval media*. Journal of Marine Technology and Environment, 2010,
[4]. MOROSUK, T., TSATSARONIS, G. *How to calculate the parts of exergy destruction in an advanced exergetic analysis*. Proc. of ECOS 2008
[5]. MREMA, G.D., LAWRENCE. W. *Exergy analysis of the acetylene gas production: case of the Tanzania oxygen limited in Tanzania*. Proc. of ECOS 2001
[6]. PANAYOTOVA, M. *Fuel cells and their marine application*. Proc. of IMAM 2009
[7]. PLOUMEN, P.J., JANSSEN, F.J.J.G. *Through Exergy approach to more efficient processes. International Journal of Applied Thermodynamics*, 2001
[8]. STAN, L. *Maşini navale*, Ed. Nautica, Constanța, 2010

THE MICROHARDNESS OF CYLINDER LINERS FROM DIESEL ENGINES SUBJECTS CAVITATION PROCESS

SIMIONOV MIHAI

"Dunarea de Jos" University of Galati, Romania

ABSTRACT

Destruction by cavitation of cylinder liners and of cylinder block on the Diesel engine cooling water washed surface, occurs as a result of the simultaneous action of a combination of mechanical, chemical, thermal and electrochemical processes. The main cause of damages of cavitation is the variable pressure caused by vibration cylinder liners. These conclusions were based on the direct dependency between the cavitation phenomena and the processes carried out in the engine cylinder, and also on the identity of the character and appearance sulphides (craters) on the external surface of the cylinder liners ([,1] [3]).

The cavitation damages of the cylinder liners and of the cylinder blocks of the Diesel engines, on the surfaces cooled by water, was determined, in principle, by the cylinder liner vibration. In this way, we can affirm that the cavitation resistance of the cylinder liners is dependent the vibration characteristics of cylinder liners and on the mechanical characteristics of the material alloys. This paper presents the microhardness variation of superficial layer with time testing and for some thickness of the cylinder liner. They are observed, after 100 hours time testing on stand, that the maximum reduction of microhardness value it is produced in the action plan of the excitation force, and specially for the small thickness of the cylinder liner. This problem, associated with the speciality literature data, lead to significant reduction of the cavitation resistance in the mentioned zones (the weight losses by cavitation wear increase by microhardness reduction of the cast iron

Keywords: *cavitation damages, wear, vibration, diesel engine, cylinder liner*.

1. INTRODUCTION

In [6] are presented the studies concerning the interdependence between the mechanical properties (resilience, hardness, traction resistance), for six materials (aluminium, copper, phosphorous bronze, brass, low-alloy steel, non-corrosive steel) . The tested material characteristics are presented in the table 1. Also, it is presented a relation that can be used for the selection of the cavitation resisting materials:

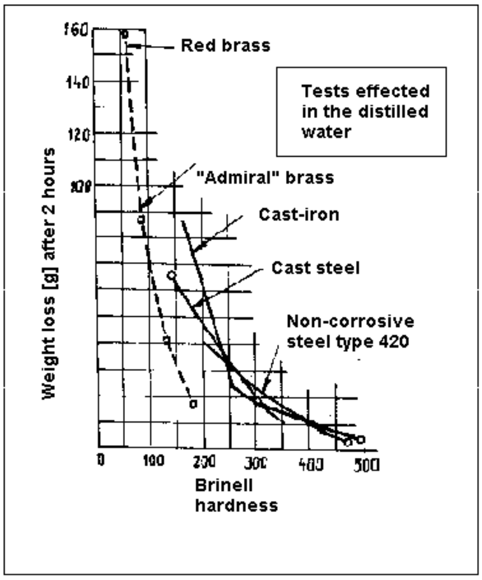


Figure 1 The influence of the fatigue solicitations upon the cavitation corrosion.

$$V_r M_r^m = C, \text{ where } V_r = \left[\frac{V}{t}\right]_x / \left[\frac{V}{t}\right]_0 \qquad (1)$$

In the relation (1), V_r represents the ratio between the volume loss in time of some material and of a reference material, $M_r = M_x/M_o$ – the ratio between the mechanical characteristic of some material and of the standard material, m – an index that takes the values according to by the used material type (table 2).

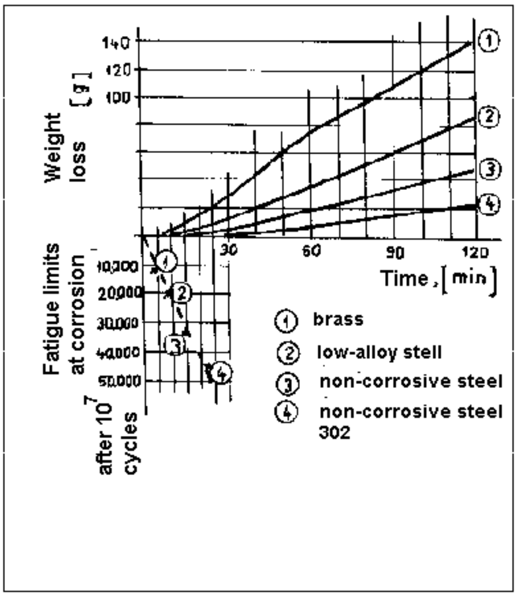


Figure 2 The influence of the metal hardness upon the damage by cavitation

In the presented diagrams there isn't a direct dependence between the indicator of the cavitation damage resistance and the mechanical characteristics of materials.

This defect it was eliminated by Leith and Thompson [4] which had made more experiments to correlate the resistance of metal with some of its mechanical properties (traction resistance, hardness). The figures 1 and 2 put in evidence that a incubation time for laminated metals is proportional with the fatigue resistance limits concerning cavitation damage.
The mechanical characteristics (density, yield limit, traction limit resistance, Brinell hardness, elongation, resistance limit, mechanical deformation energy, Young's modulus) of the tested materials (aluminium, cooper, phosphorous bronze, brass, low-alloy steel, non-corrosive steel) are indicated in [5].

The values of coefficients m, c and a and of the standard percentage of deviation for the mechanical characteristic specified above are indicated in [6].

After [1], the cavitation is due to appearance of phase discontinuities in a fluid motion following the vapor pressure decrease caused by speed increases, by forming of vapor bubbles.

The new Diesel engines are characterized by the increase of the current stress level based on the increase of supercharging pressure and of speed, decrease in mass and size [7].

For this reason, certain organs, such as cylinder liners, due to the extensive destruction on cooling water washed part, lead to the removal of the diesel engine from operation. The outside wear of the cylinder liners determines its replacement before reaching its life-span, set mainly in relation to inner wear [3].

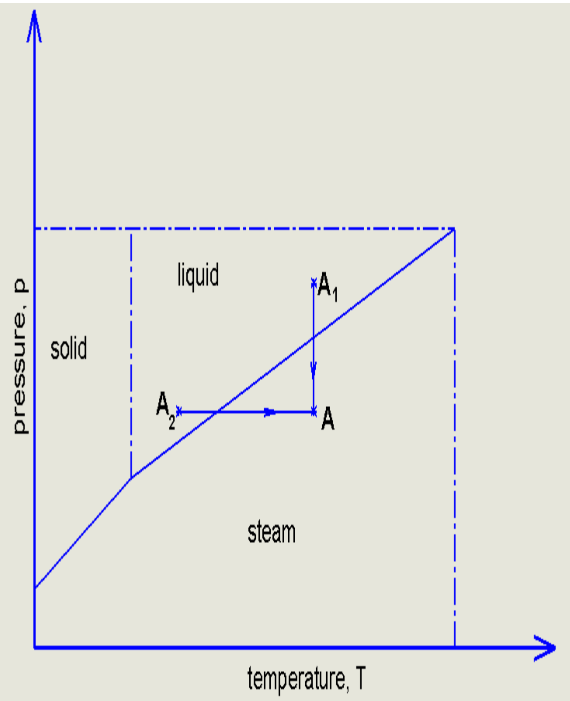


Figure 1 The phase diagram [1].

Most dangerous action of vibratory cavitation occurs on parts of diesel engine cooling systems. Thus, the outer surface cylinder liners wear of the 3 D 6 Diesel engine (wear cavitation) is 3 -5 times greater than the inner surface wear that comes in contact with piston rings [4].

In [3] and [4] are described processes for producing pressure variations in the cooling water system of the Diesel engine. The piston, under the action of normal force, in his cross displacement in the rod plane movement hit the cylinder liner at the time of contact. The impact shock causes local elastic deformations in the form of radial and longitudinal oscillations, leading to excitation of ultrasonic oscillations and noise in the circular layer of cooling water. This way such stresses of tension and compression are generated in cooling water. Thus, at the tension stress, when the pressure is suddenly reduced, tension in the liquid appears and forms cavitation bubbles.

2. EXPERIMRNTAL RESULTS

In the figures 4 – 7 are presented the variation curves of microhardness for the cylinder liners with 6 mm and 4 mm in thickness.

The microhardness values are presented in the table 1 and the table 2 for the initial state and final state (after 100 hours of testing on stand) corresponding with the cylinder liner of the D 103 Diesel engine, with 6 mm and 4 mm in thickness [9], [10]. The points 1, 2, …, 5 where they had made the measurements are presented in the figure 3.

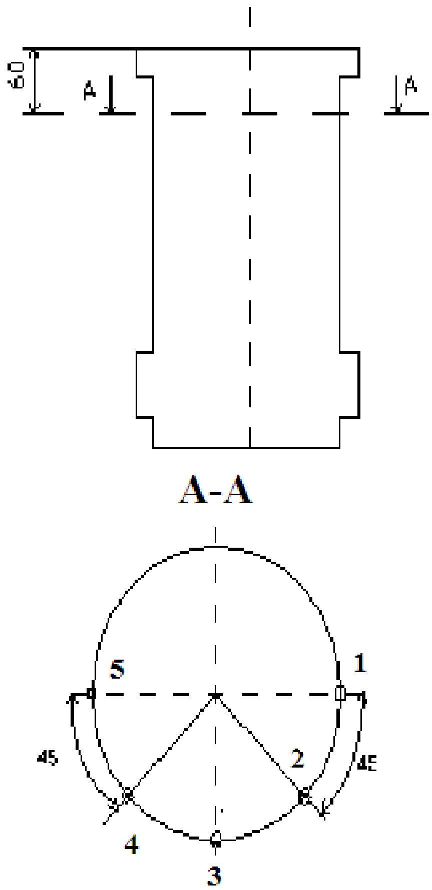


Figure3 The disposal of the measurement points of the tension state on the cylinder liner

Table 1. The microhardness values for the cylinder liner with 6 mm in thickness.

Measurement point	Microhardness, HV_5	
	Initial state (0 h)	Final state (100 h)
1	254	239
2	254	242
3	254	246
4	254	249
5	254	239

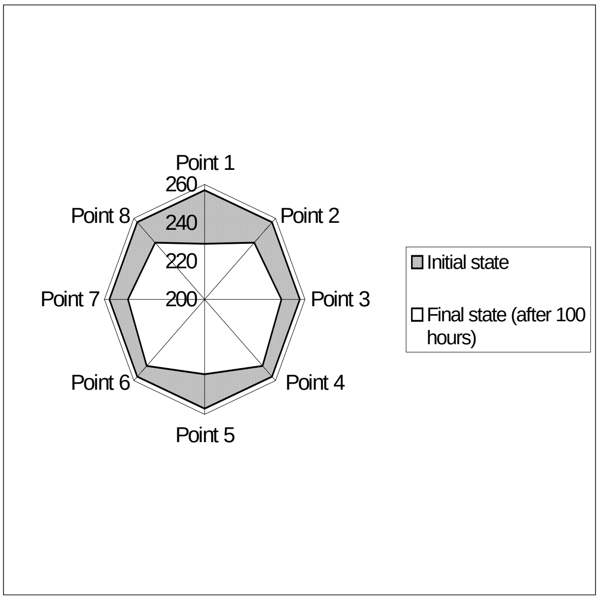


Figure 4 The variation of microhardness in the superficial layer of the cylinder liner with h = 6 mm.

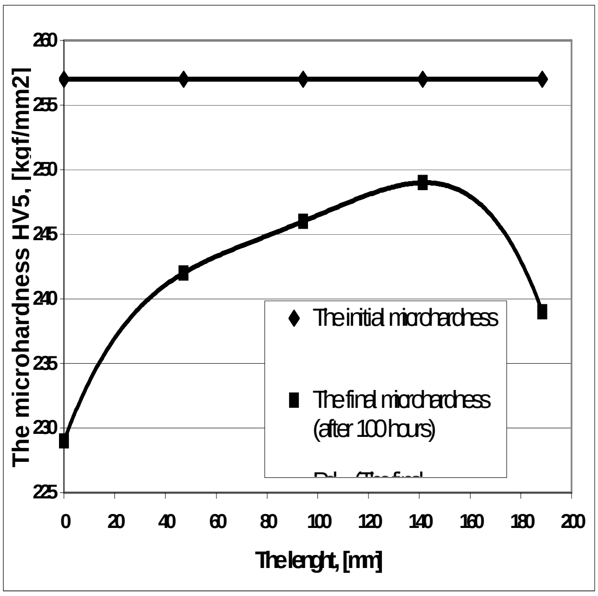


Figure 5 The variation of microhardness in the superficial layer on the extensive semicircle length (cylinder liner thickness h = 6 mm)

Table 2. The microhardness values for the cylinder liner with 4 mm in thickness.

Measurement Point	Microhardness, HV_5	
	Initial state (0 h)	Final state (100 h)
1	248	180
2	248	194
3	248	197
4	248	199
5	248	183

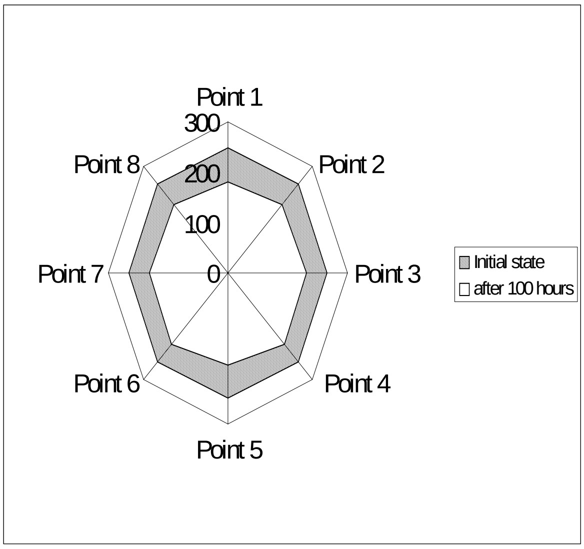


Figure 6 The variation of microhardness in the superficial layer of the cylinder liner with h = 4 mm.

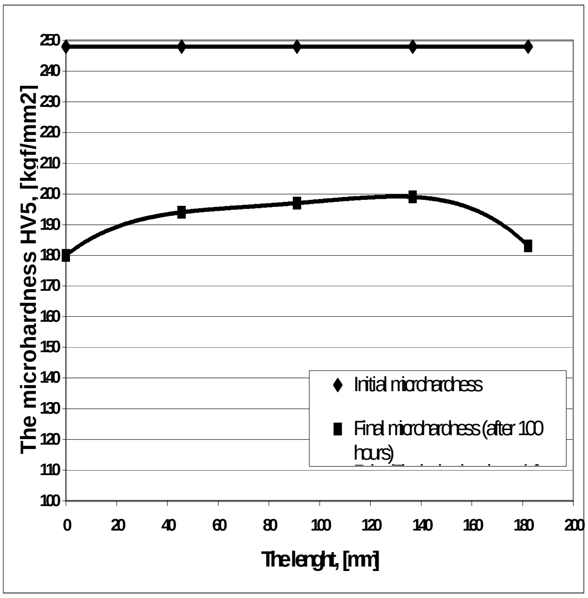


Figure 7 The variation of microhardness in the superficial layer on the extensive semicircle length (cylinder liner thickness h = 4 mm)

3. CONCLUSIONS

According to the experimental data presented in the table 3 and in the figures 4 -7, the following observations results:

- for the two cylinder liners, tested in the same conditions of the medium factors and for the same vibrations parameters, in all 5 measurement points a reduction of the microhardness values resulted;

- the reduction is more obvious in the points 1 and 5, specially at the cylinder liner with small thickness, so: for the thickness h=4 mm, in the point 1 the reduction is 27.42% from initial value of microhardness, and in the point 5, 26.21%; for the thickness h=6 mm, in the point 1 the reduction is 10.89%, and in the point 5, 7%.

These observations confirm the data in the speciality literature [4], which show that the reduction of cast iron microhardness, the loss of weight by cavitation wear increase.

The cavitation processes in Diesel engines cooling system appears as a result of transversal and longitudinal vibration of the cylinder liners.

The principal causes of vibrations represents the piston impact force on cylinder liner.

4. REFERENCES

[1]. ANTON I., *"Cavitatia"*, vol. I, Editura Academiei Române, Bucuresti, 1984

[2]. CRUDU I., SIMIONOV M., GHEORGHIES C., *The Tension State in the Superficial Layer in the Vibration Cavitation Case*, 8th International Conference on Tribology NORDTRIB'98, Ebeltoft, Denmark, 1998

[3]. GHEORGHIES C., SIMIONOV M., "*Study on Tribomodel of the Damage Process in the Diesel Cylinder*", Tribology in Industry Journal, Belgrad, Iugoslavia, 2000

[4]. LEITH W.C., THOMPSON A.L., *Some Corrosion Effects in Accelerated Cavitation Damage*, Journal of Basic Engineering, dec. 1960

[5]. PIMOSENKO A.P., *Zasita sudovîh dizelei ot kavitationîh rezrusenii*, "Sudostroenie", Leningrad, 1983

[6] RAO SYMALVA B.C., RAO LAKSHMANA N.S., SEETHARAMIAH K., *Selecting Metals and Alloys to Resist Cavitation Damage*, Water Power, april 1971

[7]. SIMIONOV M., *The Studies and the Researches Concerning the Cavitation Destruction of theCylinder Liners from the Diesel Engine* (in Romanian), Ph.D. Thesis, University "*DUNAREA DEJOS"* of Galati, Romania, 1997

[8]. SIMIONOV M., GHEORGHIES C., CRUDU I.: *Structural Changes in a Polycrystalline Superficial Layer During Cavitation Process*", Polish Conference on Crystal Growth PCCG-V, Lublin, Poland, 1998

[9]. SIMIONOV M., *The cavitation of the cylinder liners from the Diesel engines*, Mongabit Printing Galati Press, Galati, 2000.

[10]. SIMIONOV M., GHEORGHIES C., CRUDU I., "*The Evolution of the Superficial Layer Microgeometry in the Vibration Cavitation Case*", 9th International Conference on Tribology NORDTRIB 2000, Porvoo, Finland, 2000.

MICROBIOLOGICAL DANUBE WATER QUALITY ASSESSMENT IN CERNAVODA CITY AREA

[1]SUNDRI MIRELA-IULIANA, [2]GOMOIU MARIAN-TRAIAN

[1]*Constanta Maritime University, Romania,*
[2]*National Institute of Marine Geology and Geo-Ecology, Bucharest, Romania*

ABSTRACT

During summer of 2009, water samples were collected from 6 Danube River sites around Cernavoda Nuclear Power Plant and the contents of total coliforms, faecal coliforms, intestinal enterococci, and heterotrophic plate count bacteria were analyzed. Data were used for water quality assessment and estimation of the trends of parameters.

Keywords: *water quality, nuclear power plant, Danube River, heterotrophic plate count bacteria, total coliforms, faecal coliforms, intestinal enterococci.*

1. INTRODUCTION

Bacterial communities are very important for matter and energy flux in the aquatic ecosystems and represent sensitive indicators of environmental fluctuations.

Bacterial parameters such as total heterotrophic plate count, total coliforms, faecal colifoms (thermo-tolerant coliforms) or intestinal enterococci, are widely applied to the assessment of water quality, as indicators of changes in the natural water conditions; they point out an organic matter or faecal water pollution [1]. The density of bacteria is an indicator of water safety for swimming or consumption.

Detailed knowledge of faecal pollution in aquatic environments is important for watershed management activities in order to maintain safe waters for recreational and economic purposes [2]. Although these bacteria are not typically disease causing, they are associated with faecal contamination and the possible presence of waterborne pathogens.

The faecal bacteria, as indicators, should fulfil the following criteria: they should be universally present in large numbers in faeces of humans and warm-blooded animals; they should not grow in natural waters and however, when bacteria are present in water, they should be removed by water treatment in a similar way as waterborne pathogens [3].

Starting from the necessity to assess the impact of Nuclear Power Plant Cernavoda upon the state of the environment and human health, some ecological aspects were monitored in the area under study [4].

The objectives of this microbiological assessment are:

- analysis of the variation of bacteriological indicators in some sampling points of Cernavoda aquatic ecosystems area;
- assessment of water quality by microbiological parameters;
- analysis of the response of bacteriological parameters to anthropogenic impacts (thermal conditions and waste water);
- comparison of the results with previously investigated data collected from the same sites during [5], [6], [7].

2. METHODS

For this study, during summer of 2009, six sampling sites (S1÷S6) were chosen to illustrate the influence of municipal waste water and thermal discharge of Cernavoda Nuclear Power Plant (NPP) cooling system upon Danube water quality (Fig. 1):

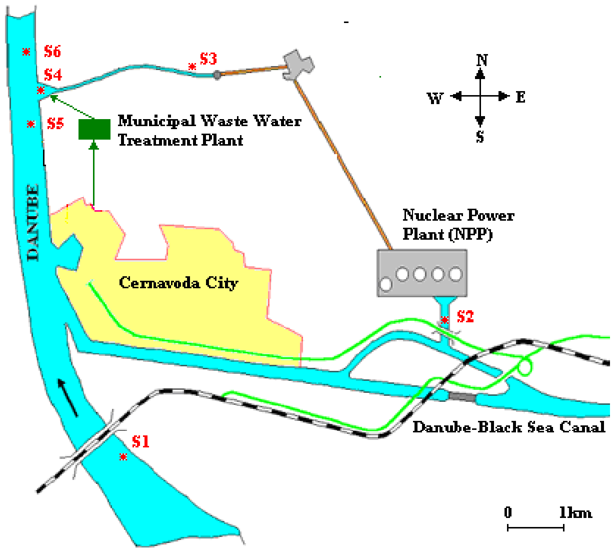


Figure 1 Sampling sites position

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 aquatic ecosystem is expected to be influenced by both pollutants: thermal discharge of the NPP and municipal waste water.

The water samples were collected seasonally in sterilized glass bottles, from depths of 0.2 - 0.3 m, stored and transported in refrigerating conditions. After sampling, within 24 hours the water samples were analysed by standard methods [8].

Microbiological water quality was assessed using the concentrations of microbiological parameters, according to the method presented by The Expert Groups within The International Association for Danube Research (IAD) [9], [10], and considering the EU-Bathing water quality directive 2006/7/EEC [11] (Table 1).

Table 1 Class limit values for microbial pollutions of rivers (after Kavka et al., 2006, modified)

PARAMETER	CLASS LIMIT				
	I	II	III	IV	V
	little	moderate	critical	strong	excessive
Pollution by organic matter					
Heterotrophic Plate Count - CFU/ml	≤500	≤10,000	≤100,000	≤1,000,000	>1,000,000
Faecal pollution					
Total coliforms /100 ml	≤500	≤10,000	≤100,000	≤1,000,000	>1,000,000
Faecal coliforms /100 ml	≤100	≤1,000	≤10,000	≤100,000	>100,000
Intestinal enterococci (FS) /100 ml	≤40	≤400	≤4,000	≤40,000	>40,000

3. RESULTS AND DISCUSSIONS

Water samples collected in the summer 2009 from the mentioned sites S1÷S6 were analyzed concerning heterotrophic plate count bacteria at 22°C, total coliforms, faecal coliforms and intestinal enterococci.

For all investigated parameters, the minimal values were registered in S3. S4 and S5 were the sites with the maximal values of bacteria indicators; these sites are influenced by the wastewater plant effluent discharge and harbour activities.

Heterotrophic plate count density bacteria varied from a minimal value of 2.4 x 10^3 CFU/ml in S3, to 4.1 x 10^3 CFU/ml, registered in S4. A variation from 1.7 x 10^3 MPN/100 ml in S3 to 4.6 x 10^3 MPN/100 ml in S5 was registered for total coliforms. Faecal coliforms has a minimum density in S3 too – 0.88 x 10^3 MPN/100 ml and a maximum in S4 – 1.62 x 10^3 MPN/100 ml. Intestinal enterococci number varied from 0.18 x 10^3 MPN/100 ml in S1 and S3 to 0.8 x 10^3 MPN/100 ml in S4 (fig. 2).

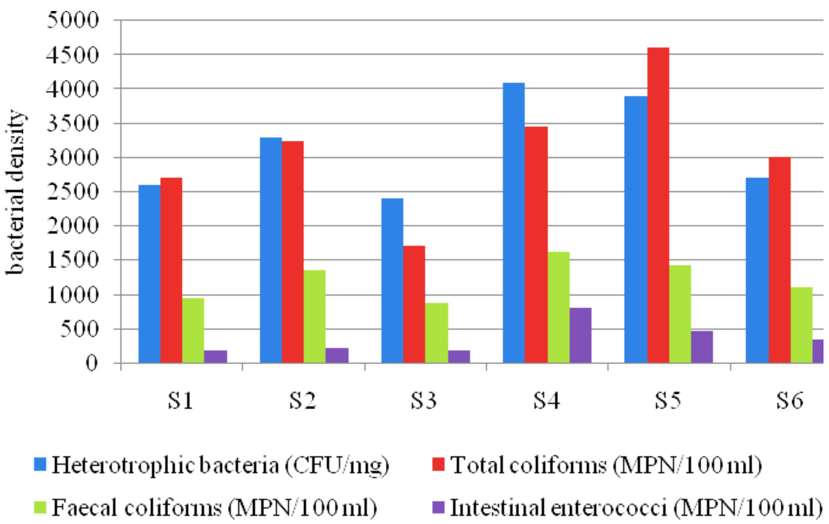


Figure 2 Bacterial density on 2009 sampling sites

There are two pathways of Danube water. First path is on the normal flow of the river S1-S5-S6. Here downstream the harbour in area S5 was registered the highest bacterial density in the summer of 2009. Some runoff pipes for storm waters discharge in the same zone. Bacterial parameters downstream Cernavoda (S6) trends to the values found upstream the city (site S1), proving self purification of the river. On the second path, S1-S2-S3-S4-S6, the minimal bacterial density was registered in S3. In this area the water is affected by physical and chemical stressors from NPP cooling system: high flow rate and turbulence into the pumping system, filters and some kinds of biocides, which should lower the bacteriologic concentration. Hence it results that the factors which could increase the bacteria density in S4 is the higher temperature of the NPP outgoing water and the effluent of wastewater treatment plant.

Using the average values from previous samples, collected during 1998÷2002 and 2006÷2007, the data were compared and the trends of the parameters were estimated.

For the three studied periods (2009 versus 1998÷2002 and 2006÷2007) the investigations were carried out by uniform methods.

The values of investigated microbiological parameters point out a decreasing trend of bacteria water contamination in all sampling site. By comparing with the previous studies, the maximal values registered in 2009 are reduced more than 50%. In the first two periods, the spatial distributions of the microbial density have similar trends regarding the variations from site to site, starting with the minimum values located in site S1 and the maximum in site S5, downstream the waste water discharge. (Fig. 3, 4, 5 and 6).

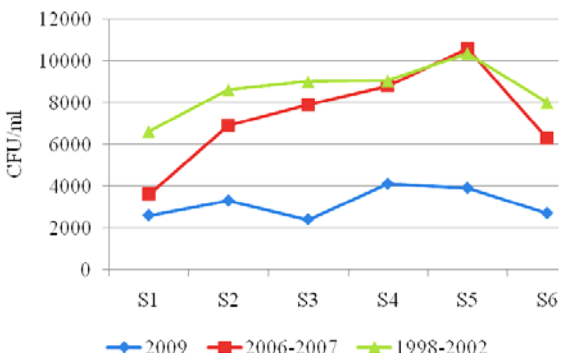


Figure 3 Hetrotrophic bacteria density on the study area

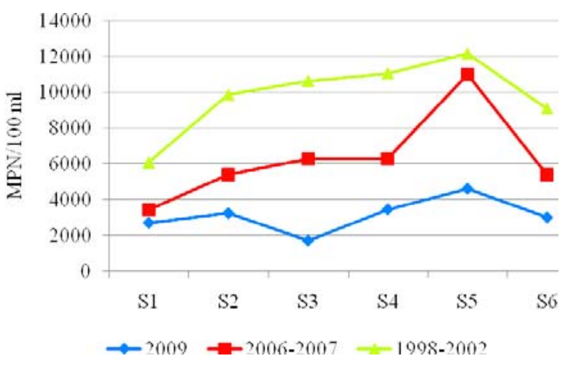


Figure 4 Total coliforms density on the study area

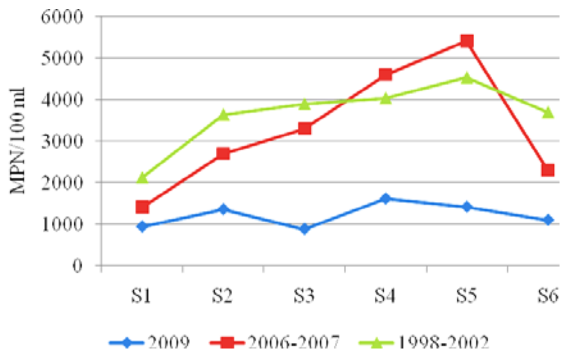


Figure 5 Faecal coliforms density on the study area

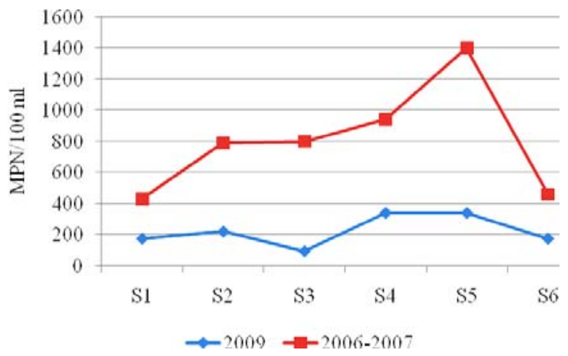


Figure 6 Intestinal ecterococci on density on the study area

The changed trends of bacteria density found in the summer 2009 sampling set were influenced by the municipal wastewater plant effluent.

The average water temperatures in the sites S1÷S6 have a similar spatial distribution for all studies (Tab.2); 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 4.4÷8.2°C.

Table 2 Water temperature on the study area

	S1	S2	S3	S4	S5	S6
2009	25.3	26.1	35.6	34.4	25.6	33.5
2006-2007	25.8	26.2	33.8	33.1	26.0	30.2
1998-2002	25.7	26.6	32.9	32.0	25.9	30.3

A direct assessment of the water quality at the sampling locations according to "EU- bathing water quality directive" cannot be given. The EU-directive requires replications and their respective percentiles. Microbiological water quality in the area of interest, assessed by criteria described above corresponds to class II (moderate) and class III (critical) of pollution (by organic matter or faecal pollution). There is one exception: little polluted water, for 2009 S1 sampling site, assessed by intestinal enteroccocci (Tab. 3). The studies show an improved trend of water quality from the first to the third study.

Table 3 Water sampling sites quality described by average values of bacterial density (the colours' legend is represented in Table 1).

Heterotrophic plate count bacteria (22^{0}C) [10^{3}CFU/ml]						
	S1	S2	S3	S4	S5	S6
2009	2.6	3.3	2.4	4.1	3.9	2.7
2006-2007	3.6	6.9	7.9	8.8	10.6	6.3
1998-2002	6.6	8.6	9.0	9.0	10.4	8.0
Faecal coliforms [10^3 MPN/100 ml]						
	S1	S2	S3	S4	S5	S6
2009	0.9	1.4	0.9	1.6	1.4	1.1
2006-2007	1.4	2.7	3.3	4.6	5.4	2.3
1998-2002	2.1	3.6	3.9	4.0	4.5	3.7

Total coliforms [10^3 MPN/100 ml]						
	S1	S2	S3	S4	S5	S6
2009	2.7	3.2	1.7	3.5	4.6	3.0
2006-2007	3.5	5.4	6.3	6.3	11.0	5.4
1998-2002	6.1	9.9	10.6	11.1	12.2	9.1
Intestinal enterococci [10^2 MPN/100 ml]						
	S1	S2	S3	S4	S5	S6
2009	1.9	2.1	0.2	2.9	3.0	2.8
2006-2007	0.9	5.3	5.1	5.6	13.6	6.8

4. CONCLUSIONS

The two anthropogenic sources of Danube water pollution downstream Cernavoda city, the municipal waste water discharge and the output effluent of the NPP cooling system, have now reduced influences, compare with previous studies: similar values of bacteria concentrations in sites S1 and S6 prove the self-purification effect of the river.

On the direct water flux of the river (path S1-S5-S6) the bacterial density was the maximum in S5.

The second water flux (path S1-S2-S3-S4-S6) is heating by the NPP cooling system. Then the two water fluxes are mixing, hence higher water temperature in S6 than in S1. Also there is thermal pollution on this path proved by the increasing values of bacteria concentrations from S2 to S4.

The two pollution sources do not affect the water quality class of the Danube around Cernavoda city, being the same (II or III) in all sampling sites.

5. REFERENCES

[1] SERVAIS, P., BILLEN, G., GONCALVES, A., GARCIA-ARMISEN, T., *Modelling microbiological water quality in the Seine river drainage network: past, present and future situations,* Hydrol. Earth Syst. Sci., 11, pp. 1581–1592. 2007.

[2] NOBLEA, R.T., MOOREB, D.F., LEECASTERC, M.K., MCGEED, C.D., WEISBERG, S.B., *Comparison of total coliform, fecal coliform, and enterococcus bacterial indicator response for ocean recreational water quality testing,* Water Research **37**, 1637–1643, 2003.

[3] HAVELAAR, A., BLUMMENTHAL, U. J., STRAUSS, M., KAY, D., AND BARTRAM, J., *Guidelines the current position, in: Water quality: guidelines, standards and health,* edited by: Fewtrell, L. and Bartram, J., World Health Organization Water Series, IWA Publishing, London (UK), pp. 17–41, 2001.

[4] GOMOIU, M.T., SECRIERU, D., ZAHARIA, D., *Environmental effects of the thermal effluent discharged from NPP Cernavoda Unit 1 into the Danube River - partial results*, Geo-Eco-Marina 11, pp. 101-106, 2005.

[5] SUNDRI, M. I., *Danube quality water assessment from microbiological point of view in Cernavoda nuclear plant area.* Revue Roumaine de Biologie, Série de Biologie Végétale, Tome 48, N^{0}1-2, Bucarest, pp. 31-39, (2003):

[6] SUNDRI, M.I., IONICĂ, D., *Some bacterial parameters in the stretch near the Cernavodă Nuclear-electrical Power Plant.* 36th International Conference: Danube.River.Life. Interfacing the past and the future of ecology and water management in a large European River, Vienna, pp 348-351, 2006.

[7] SUNDRI, M.I., GOMOIU, M.T., *Some bacteriological characteristics of Danube River waters around Cernavoda Nuclear Power Plant,* 19th International Symposium Ecology & Safety: For a cleaner and safer world, June 7 – 11, 2010, Sunny Beach, Bulgaria. Published in: Journal of International Scientific Publications: Ecology & Safety, Volume 4, Part 2, pp.68-75, 2010.

[8] *** HG 459/2002 privind aprobarea Normelor de calitate pentru apa din zonele naturale amenajate pentru îmbăiere, 2002.

[9] KAVKA, G.G., KASIMIR, D., FARNLEITNER, A. H., *Microbiological water quality of the River Danube (km 2581 - km 15): Longitudinal variation of pollution as determined by standard parameters*, 36th International Conference of IAD, Vienna, pp.415-421. ISBN 13: 978-3-9500723-2-7, 2006.

[10] KAVKA G., POETSCH E., *Microbiology*. In: Joint Danube Survey – Technical Report of the International Commission for the Protection of the Danube River, pp.138-150, (2002):

[11] EU, *Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC*, Official Journal of the European Union L 64, pp 37-51, *2006.*

COMPUTER MODELS IN ACTUAL ENVIRONMENTAL ENGINEERING EDUCATION

SUNDRI MIRELA-IULIANA

Constanta Maritime University, Romania

ABSTRACT

Environmental engineering is a continuous expansive profession due to the globalization of environmental problems and the internationalization of engineering education. A global scale curriculum seems to be necessary for the actual environmental engineers, but there is no common university program to apply this idea. Alternatively, a pragmatic approach is proposed based on the idea to include a basic set of environmental computer modelling tools in the education program of environmental engineer. A group of computer simulating models is presented as scientific and mathematic tool for modern environmental engineers. Some environmental models were introduced in the education programs of students in Environmental Engineering Department of Constanta Maritime University to improve their computational and simulating skills for studying the complex processes in the environment.

Keywords: *Lithosphere, hydrosphere, atmosphere, biosphere, anthroposphere, environmental engineering education, computer models.*

1. INTRODUCTION

Environmental engineering has traditionally been a subspecialty of Civil Engineering and at some colleges and universities it is housed by other department. Environmental engineers act to protect the health of the public by minimizing the release and impact of pollutants into the air, land, and water. Professionals in the environmental field are studying chemistry, biology, mathematics, and engineering sciences and design control and treatment systems that reduce or limit the negative effects that humans have on the many ecosystems of the world.

There will always be a high demand for qualified professional environmental engineers, since there is a continuous need for high-quality drinking water, clean air, and uncontaminated ground and surface water and land. Moreover, changes in population growth, habits, and lifestyles of people around the world create new challenges for environmental engineers. As the world’s population approaches 7 billion, the auxiliary problems associated with providing sanitary living conditions are complex and ever changing. We may list a few urgent demands currently put to the environmental engineers [1]:

- educate the public to increase awareness of environmental issues;
- provide adequate supplies of fresh water;
- deal with the pressures of increasing population;
- anticipate energy shortages, searching for renewable energy sources;
- develop tools to assess the performance and sustainability of existing structures;
- mitigate the threats of global climate change;
- estimate impacts and anticipate risks (earthquakes, floods, storms, contamination);
- restore and reclaim disturbed landscapes;
- develop and strengthen links with other fields of science such as mechanics, biochemical engineering, the geological, biological, computer, social and management sciences.

For this reasons the identity of environmental engineering is more and more pregnant among the others engineering professions.

2. THE PLACE OF ENVIRONMENTAL ENGINEER AMONG ENGINEERING PROFESSION

The required areas of knowledge in environmental engineering have been subjected to periodic expansion because of the increasing intensity and diversity of human activities. Civil and sanitary engineers were the pioneers of environmental engineering once upon a time, when environmental quality concerns were limited to safe water supplies, wastewater disposal and land drainage. At the end of the 1980s, much of the education and employment in environmental engineering was expanded to incorporate soil and groundwater remediation, toxicology, risk assessment, atmospheric modeling and process design. Environmental engineering is said to be different from classical engineering because it is more broadly defined and because its multidisciplinary nature. The scope of environmental engineering has since evolved and expanded over the past decades to cover all facets of the environment, including air, soil, land, water and humans because of the increasing spread of environmental problems, public concern about the environment and environmental legislation.

Figure 1 is a representation of the main components of the environment and their interactions: LITHOSPHERE (land, soil), HYDROSPHERE (liquid and frozen surface waters, groundwater held in soil and rock), ATMOSPHERE (gaseous components of air, solar and cosmic radiations), BIOSPHERE (global sum of ecosystems) and ANTHROPOSPHERE (human actions on the environment) [2].

Environmental engineering actions are graphically marked by the inner aria between the two yellow circles, including zones situated on the both sides of the circular border of ANTHROPOSPHERE. This representation indicates the double role of environmental engineering:

to protect the natural ecosystems against the negative effects of anthropospheric expansions and to limit the human life degradation due to increasing population, decreasing of resources, climate change, and insufficient health care. Environmental engineering mainly control the human ecosystems, but can restore the biodiversity equilibrium by ecological engineering too.

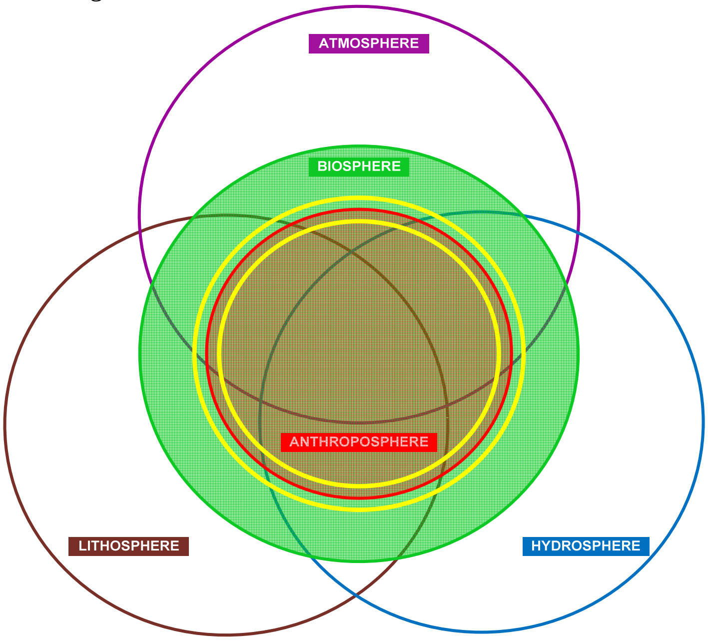


Figure 1 The main components of the environment and their interactions

3. ENGINEERING EDUCATION AND THE INTERNATIONALISATION

It has been observed in recent years that our world is becoming an open place with multiple connections. This has occurred because of the effect of internationalisation of political, cultural, economic, social and environmental processes. Internationalisation affects also the educational aspect. Now, universities around the world are realising the importance of global education, if they are to remain strong competitors of this global market.

There are two major areas of competition between universities. The first is in the quality of education because the opportunities for graduates will become global. Large corporations will be hunting worldwide for the best graduates to incorporate them into their organisations. Secondly, competition will be in research and development (R&D). In order to prepare them for this competitive market, it is vital that university education addresses the reality of globalisation and for these reasons internationalising of curricula becomes necessary [3].

The engineering profession, as most of the other global professions, is going to be submitted to a global evaluation in terms of the universally accepted skills. More and more engineers conduct their work in many countries, sometimes other than where they received their education. Those countries have different laws, cultures, procedures and standards concerning their education and practice of engineering. It is anticipated that the growth of major trading blocs, such as the European Union (EU), the Pacific/Asian area and the Americas, will intensify this process of mobility. Also, instant worldwide communication is a catalyst for the development of global engineering education and practice.

Increased mobility of highly educated workers on a global level will determine educational institutions in many parts of the world to prepare their students for a future in which they will be more and more compared not only to their own country's institutions, but also to institutions in other nations. The internationalisation of degree programmes can ease the transferability of academic credits for courses taken abroad and also may become a way to open doors for students from abroad [4].

These global trends influence environmental engineering education and future too. An outlook on the employment of environmental engineers indicates that this profession is expected to increase at a faster rate than the average for all occupations through 2015. The political aspect, the power of environmental regulations and policies, also plays a major role in the job outlook for environmental engineers, more so when compared to the other types of engineers. It was also reported that environmental engineers are less likely to be affected by economic conditions when compared to other types of engineering.

Sometimes environmental engineers start to solve local problems, but they are finishing concerned with solving widespread environmental problems [5]. Hence, this must be reflected in the globalising environmental engineering education and skills.

4. THE ROLE OF MODELLING IN ENVIRONMENTAL ENGINEERIG

Identity and internationalization are the main problems of actual environmental engineering education.

Due to the impact of internationalisation, some authors considered necessary the establishment of one common, global scale environmental engineering curriculum, which would address an internationally recognised programme and eliminate the need for any accreditation and recognition of courses between countries [5]. But it is difficult to design a unified environmental engineering education program due to the geographical, political, religious and scientific barriers between countries, peoples and universities.

Alternatively, a pragmatic approach is proposed based on the idea to include a basic set of environment oriented computer modelling tools in the education program of environmental engineer. This objective is easier to be fulfilled because scientific models use mathematics, physics, chemistry and biology as non-political, non-religious, universal accepted languages and the differences between environmental scientists can be "modelled" as options of the specific applications.

The role of mathematical models is more and more important in environmental engineering profession, at different levels of complexity and education. For students in environmental engineering at a bachelor's level, the main objective of including mathematical modeling in the curriculum can be to provide a first introduction to models and simulation tools and to use these models to enhance teaching of the core subjects through computer aided teaching. At a master's level, the focus can be on model building procedures based on existing models including calibration and optimal experimental design. This has to be the basic level of the most environmental engineers. At the Ph.D. level, the development of new models (equations) may be the focus [6].

Today, there are advanced software tools available that facilitates the numerical solution of simulations in these complex models. The students do not have to focus on developing their own numerical procedures, being only users of these programs. However, an understanding of numerical methods will help to anticipate the numerical solving algorithm when using a software simulated model.

The composition of a basic set of computer models for environmental engineers has not to be very restrictive, but it is necessary a selection of the models by the area of application and by evaluation. Environmental model evaluation is the process used to generate information to determine whether a model and its analytical results are of a quality sufficient to serve as the basis for a decision [7]. USEPA provides a list of useful framework for documenting the results of model evaluation as the various elements are conducted during model development and application:

- Scientific basis**.** The scientific theories that form the basis for models.
- Computational infrastructure. The mathematical algorithms and approaches used in executing the model computations.
- Assumptions and limitations. The detailing of important assumptions used in developing or applying a computational model, as well as the resulting limitations that will affect the model's applicability.
- Peer review. The documented critical review of a model or its application conducted by qualified individuals who are independent of those who performed the work, but who collectively have at least equivalent technical expertise to those who performed the original work. Peer review attempts to ensure that the model is technically adequate, competently performed, properly documented, and satisfies established quality requirements through the review of assumptions, calculations, extrapolations, alternate interpretations,
- methodology, acceptance criteria, and/or conclusions pertaining from a model or its application (modified from EPA 2006).
- Quality assurance and quality control (QA/QC). A system of management activities involving planning, implementation, documentation, assessment, reporting, and improvement to ensure that a model and its components are of the type needed and expected for its task and that they meet all required performance standards.
- Data availability and quality. The availability and quality of monitoring and laboratory data that can be used for both developing model input parameters and assessing model results.
- Test cases. Basic model runs where an analytical solution is available or an empirical solution is known with a high degree of confidence to ensure that algorithms and computational processes are implemented correctly.
- Corroboration of model results with observations. Comparison of model results with data collected in the field or laboratory to assess the model's accuracy and improve its performance.
- Benchmarking against other models. Comparison of model results with other similar models.
- Sensitivity and uncertainty analysis. Investigation of the parameters or processes that drive model results, as well as the effects of lack of knowledge and other potential sources of error in the model.
- Model resolution capabilities. The level of disaggregation of processes and results in the model compared to the resolution needs from the problem statement or model application. The resolution includes the level of spatial, temporal, demographic, or other types of disaggregation.
- Transparency. The need for individuals and groups outside modeling activities to comprehend either the processes followed in evaluation or the essential workings of the model and its outputs.

5. A BASIC SET OF ENVIRONMENTAL ENGINEERING COMPUTER MODELS

There is a trend away from specialization by media to provide a broader systems-based perspective on the nature of the problems and solutions relevant to environmental engineering. Although traditional media based areas of competence will continue to be used, many schools and consulting firms are describing their areas of competence in much more innovative and diverse ways such as:

- By the nature of the contaminants (toxic/carcinogenic, animal (including human) excreta, household wastes, etc.) — the nature of contaminant sources, releases, fate in the environment, treatment and risk all vary substantially based on the fundamental source of the contaminants. The biochemical oxygen demand, pathogen and nutrient loading problems associated with early sanitary engineering could identify a continuing area of specialization. However, toxic contaminants behave quite differently, are generally detected at much lower concentrations but still pose significant human and ecosystem risks, and require very different treatment or remediation technologies.
- By the broad system of interest — this has been defined as the natural versus engineered systems or the non-built and built environments. However, these distinctions are becoming blurred as green infrastructure and hybrid eco-design processes become more common. Many future environmental engineers will be characterized by the systems (both ecological and technological) being utilized in the design process rather than the traditional applications being designed.
- By the nature of the processes being designed — these could include biological, physical-chemical, fluid flow and transport. Fundamental transformation and transport processes are common across natural and engineered systems. A technical specialization in biological processes, for example, would require depth in microbial processes ranging from the molecular to the reactor scale. This specialization could lead towards the application of these processes to constructed wetlands, municipal wastewater treatment processes, solid waste landfills or in-situ groundwater remediation design. The fundamental science and engineering would be common across all of these application areas.
- By the nature of the intervention — such as minimization (including management practices or engineered solutions), treatment, or assimilation. Engineered solutions can take many forms. Many environmental engineers now consider themselves specialists in the area of minimizing releases or waste generation, while others focus primarily on environmental assimilation of pollutants.

Similarly, models can be categorized according to their fit into a continuum of processes that translate human activities and natural systems interactions into human health and environmental impacts.

A basic set of environmental computer models have to be comprehensive and will include human activity models, natural systems models, emissions models, fate and transport models, exposure models, human health and environmental response models, economic and noneconomic impact models. Examples of models in each of these categories are presented below.

TransCAD is a travel demand forecasting model; develops estimation of motor vehicle miles travelled for use in estimating vehicle emissions. It can be combined with geographic information systems (GIS) for providing spatial and temporal distribution of motor vehicle activity.

BEIS - model for natural emissions of volatile organic compounds; estimates volatile organic compound (VOC) emissions from vegetation and nitric oxide (NO) emissions from soils;

MBL-GEM is a pilot-scale model for nutrient cycling of carbon and nitrogen; simulates, on an annual time step, plot-level photosynthesis and N uptake by plants, allocation of C and N to foliage, stems, and fine roots, respiration in these tissues, turnover of biomass through litter fall, and decomposition of litter and soil organic matter.

PLOAD is for releases to water bodies; PLOAD is a simplified, GIS-based model to calculate pollutant loads for watersheds. It estimates nonpoint sources (NPS) of pollution on an annual average basis, for any user-specified pollutant.

MODFLOW is a modular three-dimensional groundwater flow model; Model can be used to support groundwater management activities such as risk assessment, superfund remediation, to simulate systems for water supply and mine dewatering.

PRZM is hydro-geological type; PRZM simulates a one-dimensional finite-difference model that accounts for pesticide and nitrogen fate in the crop root zone. Newer version includes modelling capabilities for such phenomena as soil temperature simulation, volatilization and vapour phase transport in soils, irrigation simulation, and microbial transformation.

MOBILE is for releases to air; MOBILE calculates emissions of hydrocarbons (HC), oxides of nitrogen (NOx) and carbon monoxide (CO) from passenger cars, motorcycles, light- and heavy-duty trucks. It estimates emissions of both exhaust and evaporative emissions.

HYSPLIT is for releases to air; HYSPLIT model is a complete system for computing simple air parcel trajectories to complex dispersion and deposition simulations. The model can be run interactively on the Web or the code executable and meteorological data can be downloaded to a Windows or Mac PC.

BIOPLUME is for contaminants in groundwater; BIOPLUME is a two-dimensional finite difference model for simulating the natural attenuation of organic contaminants in ground water due to the processes of advection, dispersion, sorption, and biodegradation. Biotransformation processes are potentially important in the restoration of aquifers contaminated with organic pollutants.

HSPF is a mixed type model of watershed hydrology and water quality; HSPF is a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic organic. It allows the integrated simulation of land and soil contaminant runoff processes, from nonpoint pollutant, with in-stream hydraulic and sediment-chemical interactions.

WASP is compartment modelling type for aquatic systems. WASP is a dynamic program including both the water column and the underlying benthos. It allows the user to investigate 1, 2, and 3 dimensional systems, and a variety of pollutant types. It supports management decisions by predicting water quality responses to pollutants in aquatic systems.

QUAL2K is a steady-state and quasi-dynamic water quality model; It is a one dimension, well mixed stream water quality model used as a planning tool for developing total maximum daily load (TMDL). The model can simulate nutrient cycles, algal production, benthic and carbonaceous demand.

CALPUFF is plume type air quality model; CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. It can be applied on scales of tens to hundreds of kilometers and includes algorithms for subgrid scale effects (such as terrain impingement), as well as, longer range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations).

CBM is a receptor type model; CMB is ideal for localized nonattainment problems and has proven to be a useful tool in applications where steady-state Gaussian plume models are inappropriate, as well as for confirming or adjusting emissions inventories. It requires speciated profiles of potentially contributing sources and the corresponding ambient data from analyzed samples collected at a single receptor site. Based on relative contributions of sources, the model is used for air resource management purposes.

APEX is an inhalation exposure model type; it is intended to be applied at the local, urban, or consolidated metropolitan area scale and currently only addresses inhalation exposures. The model simulates the movement of individuals through time and space and their exposure to the given pollutant in various microenvironments (e.g., outdoors, indoors residence, in-vehicle). APEX serves as the human inhalation exposure model within the Total Risk Integrated Methodology (TRIM) model framework.

AQUATOX is an ecosystem type model for fate and effects of pollutants in aquatic environment; AQUATOX predicts the fate of various pollutants, such as nutrients and organic chemicals, and their effects on the ecosystem, including fish, invertebrates, and aquatic plants. This model is a valuable tool for ecologists, biologists, water quality modellers, and anyone involved in performing ecological risk assessments for aquatic ecosystems [8].

BASS- is a mechanistic simulation type model for fish populations exposed to pollutants; it models dynamic chemical bioconcentration of organic pollutants and metals in fish. The model's bioaccumulation algorithms are based on diffusion kinetics and are coupled to a process-based model for the growth of individual fish. Estimates are being used for ecological risks to fish in addition to realistic dietary exposures to humans and wildlife.

The area of environmental engineering includes a lot of technologies for processing all kind of waste, which are evaluated and designed using other specific types of simulating models. For example, the waste water treatment and drinking water technologies are widely modelled by environmental computer added engineering tools such as: STOAT®, GSP-X®, WEST®, OTTER®. Some of these computer modelling tools have to be part of universal environmental engineering curricula.

For every models listed above, there are a few other equivalents models which have almost the same inputs/outputs variables and simulate similar environmental processes. The scientific and mathematic common core of these equivalent computer models represents a modern global scale tool for environmental engineers.

The idea of including a basic set of computer models in the environmental engineering education program have been partial implemented with some groups of students in Environmental Engineering Department of Constanta Maritime University. Introducing mathematical modelling into continuing education courses can be difficult, as participants often have very diverse backgrounds and also very diverse expectations about what they should learn in such a course. Hence the choice of the models was not simple, having to consider some particular aspects:

- Accessibility to the computer software tools. It has been realized using freeware type models, which could be run both during seminars or laboratory and individually at home by each student.
- Correlation between available software models and the education programs of the Environmental Engineering Department.
- Level of the students' knowledge in mathematics, IT and environmental sciences.
- Time resources for designing exercises, classroom demonstration and interpretation of the simulations.
- Evaluation of the educational impact over the students.

For the beginning a set of 5 models were used: HYGHSPLIT, AQUATOX, BASS, STOAT, EPIWEB (a package of models for use in applications such as to quickly screen chemicals). The main didactic result was the active participation of the students who demonstrated their computer-use skills and appreciated a lot the possibility to continue at home the "game" of simulating environmental scenario. They also identified the possibility of using this computer models for projects and became curious to discover new models by exploring the web-world.

For the students, the most difficulties were generated by the multiple mathematical equations of the models having a lot of environmental variables and settable parameters. But this impediment can be minimized by training, starting with simple simulation problems where the role of each variable is tested and explained in the context of the modelled process.

6. CONCLUSIONS

Environmental engineering is a continuous expansible profession from scientific and numeric point of view. The identity and internationalization problems of this profession require a new program of education for environmental engineers. A global scale curriculum seems to be necessary, but there is no common university program to apply this idea. A more realistic approach is based on the idea to include a set of environmental computer modelling tools in the education program of all environmental engineers. The models use mathematics and natural sciences as universal languages and these features cancel the differences between environmental scientists and universities. This set of models could be flexible, but selective evaluations have to be made for choosing only that are universal accepted. Computer models can be gradually introduced in the curricula of environmental engineers, as a necessity for the internationalization demands of actual education.

7. REFERENCES

[1] DRESP-LANGLEY, B., Dimensions of Environmental Engineering. *The Open Environmental Engineering Journal*, 2008, *1*, 1-8.

[2] http://iee.umces.edu.

[3] KUHNKE, R.R., The training of tomorrow's engineers – challenges of change. *Global J. of Engng. Educ.*, 43, 257-261 (2000).

[4] RYAN-BACON, W. and DELISLE, G.Y., Canadian approach to global evaluation of engineering education and services. *Inter. J. of Engng. Educ*., 16, 2, 109-116 (2000).

[5] NGUYEN, D.Q. and PUDLOWSKI, Z.J., Environmental engineering education in an era of globalisation. *Global J. of Engng. Educ.*, 9, 1, 59-68 (2005).

[6] MORGENROTH, E., E. ARVIN and P. VANROLLEGHEM. The use of mathematical models in teaching wastewater treatment engineering, *Water Science and Technology Vol 45 No 6 pp 229–233 © IWA Publishing 2002.*

[7] EPA, Guidance on the Development, Evaluation, and Application of Environmental Models, *EPA/100/K-09/003 | March 2009*, http://www.epa.gov/crem.

[8] SUNDRI, M. I., *Ecotoxicological software tools for environmental engineering*, Constanta Maritime University Annals, vol. XII, pp 255-261, 2009.

SECTION III

ELECTRONICAL ENGINEERING AND COMPUTER SCIENCE

SCADA SECURITY IN THE CONTEXT OF CORPORATE NETWORK INTEGRATION

BOLDEA CIPRIAN

"Politehnica" University Bucharest, Romania

ABSTRACT

The paper presents some considerations regarding security management of Supervisory Control and Data Acquisition (SCADA) networks.

Control systems are potential targets of attack from hackers, cyber terrorists, others who want to disrupt the critical infrastructure, disgruntled or former employees and various collaborators which have worked within the organization. SCADA networks are usually seen as industrial equipment, not affected by cyber threats. Starting from the design of such a network the focus is on functionality, seldom the security not even being taken into consideration.

Since the SCADA networks tends to became more and more integrated with enterprise business networks the risks are more and more similar and this paper empathies the idea to have a unified perspective over the security. There is presented a software solution for security monitoring and management integration.

Keywords: *SCADA, control systems, cyber security, cyber threats, critical infrastructure protection, security management, Alien Vault.*

1. INTRODUCTION

Computerized control systems perform vital functions in enterprises and in distributed infrastructures including: Energy Distribution, Nuclear Reactors, Dams, Commercial Facilities, Critical Manufacturing, Emergency Services, Waste Dams and Chemical Sectors, Transportation and Postal Systems. They are usually composed of a set of networked devices such as controllers, sensors, actuators, and communication devices.

Supervisory Control and Data Acquisition (SCADA) systems are computer-based control systems which are used to monitor and control physical processes distributed over large geographical areas. For example, in natural gas distribution, they can monitor and control the pressure and flow of gas through pipelines; in the electric power industry, they can monitor and control the current and voltage of electricity through relays and circuit breakers; and in water treatment facilities, they can monitor and adjust water levels, pressure, and chemicals used for purification.

Critical infrastructure relies extensively on computerized information technology (IT) systems and electronic data. The security of those systems and information is essential to the security, economy, and public health [1].

Computer-based attacks pose a potentially devastating impact to systems, operations and the critical infrastructures they support.

Reported cyber attacks and unintentional incidents involving critical infrastructure systems demonstrate that a serious cyber attack could be devastating. Corporations and Agencies have experienced a wide range of incidents involving data loss or theft, computer intrusions, and privacy breaches, underscoring the need for improved security practices. As shown in the Figure 1 "Cyber Incidents Reported to US-CERT in 2006 - 2010", the number of incidents reported by federal agencies to United States Computer Incident Response Team (US-CERT) has increased dramatically over the past 3 years, increasing from about five thousand incidents reported in 2006 to almost seventeen thousand incidents in 2008 (about a 200% increase). [2]

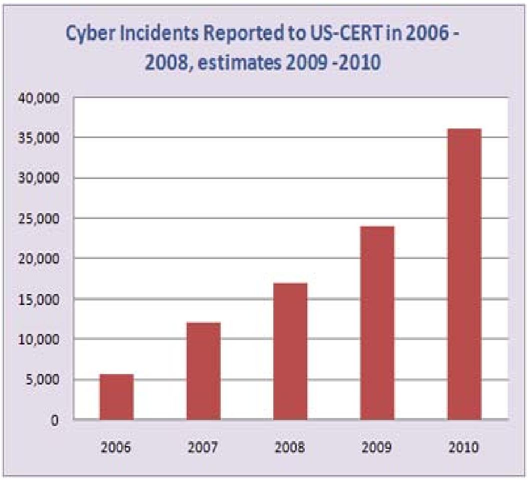


Figure 1 Cyber Incidents 2006-2010 (US-CERT)

2. SCADA ARHITECTURE AND TCP/IP NETWORKS

SCADA network main components are:

- One or more field data interface devices, usually Remote Terminal Units (RTUs), or Programmable Logical Controllers (PLCs), which interface to field sensing devices and local control switchboxes and valve actuators;
- A communications system used to transfer data between field data interface devices and control units and the computers in the SCADA central host. The system can be radio, telephone, cable, satellite, etc., or any combination of these;
- A central host computer server or servers (sometimes called a SCADA Center, master station, or Master Terminal Unit (MTU).

In order for the above mentioned components to work is need a collection of standard and/or custom software - sometimes called Human Machine Interface (HMI) software or Man Machine Interface (MMI) software - used to provide the SCADA central host and the operator with terminal application, support for the communications system, monitor and control of the remotely located field data interface devices

As it can be seen in the Figure 2, SCADA system is usually liked with enterprise network which at is turn is liked to other networks, usually the Internet.

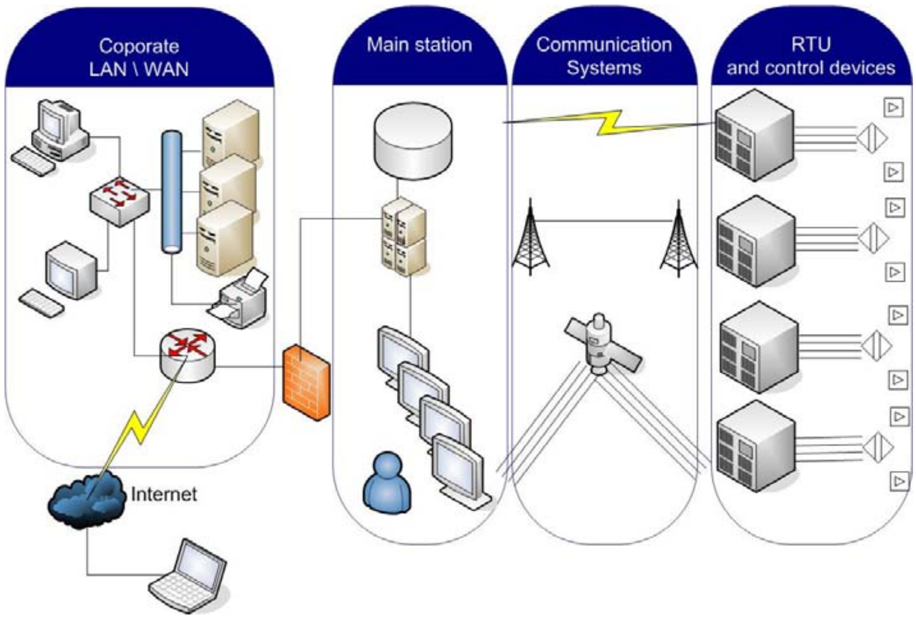


Figure 2 Diagram of a SCADA network

SCADA systems have evolved in parallel with the growth and sophistication of modern IT computing technology, from monolithic to distributed and then to networked systems.

First generation SCADA architecture was "Monolithic" systems. When SCADA systems were first developed, the concept of computing in general was centered on "mainframe" systems. Networks were generally non-existent, and each centralized system stood alone. As a result, SCADA systems were standalone systems with virtually no connectivity to other systems. The networks that were implemented to communicate with remote terminal units (RTUs) were designed with a single purpose - that of communicating with RTUs in the field and nothing else. In addition, network protocols in use today were largely unknown at the time.

The communication protocols in use on SCADA networks were developed by vendors of RTU equipment and were often proprietary. In addition, these protocols were generally very "lean", supporting virtually no functionality beyond that required scanning and controlling points within the remote device. Also, it was generally not feasible to mix other types of data traffic with RTU communications on the network.

Connectivity to the SCADA master station itself was very limited by the system vendor. Connections to the master typically were done at the bus level via a proprietary adapter or controller plugged into the Central Processing Unit (CPU) backplane. Redundancy in these first generation systems was accomplished by the use of two identically equipped mainframe systems, a primary and a backup, connected at the bus level. The standby system's primary function was to monitor the primary and take over in the event of a detected failure. This type of standby operation meant that little or no processing was done on the standby system.

The next generation of SCADA - Distributed systems - took advantage of developments and improvement in system miniaturization and Local Area Networking (LAN) technology. Distribution of system functionality across network-connected systems served not only to increase processing power, but also to improve the redundancy and reliability of the system as a whole. Rather than the simple primary/standby failover scheme that was utilized in many first generation systems, the distributed architecture often kept all stations on the LAN in an online state all of the time. For example, if an HMI station were to fail, another HMI station could be used to operate the system, without waiting for failover from the primary system to the secondary. The WAN used to communicate with devices in the field were largely unchanged by the development of LAN connectivity between local stations at the SCADA master. These external communications networks were still limited to RTU protocols and were not available for other types of network traffic. As it was the case with the first generation of systems, the second generation of SCADA systems was also limited to hardware, software, and peripheral devices that were provided or at least selected by the vendor.

The current generation of SCADA - Networked SCADA systems - is closely related to that of the second generation, with the primary difference being that it is now open system architecture rather than a vendor controlled, proprietary environment. There are still multiple networked systems, sharing master station functions. There are still RTUs utilizing protocols that are vendor-proprietary. The major improvement in the third generation is that of opening the system architecture, utilizing open standards and protocols and making it possible to distribute SCADA functionality across a WAN and not just a LAN.

Open standards eliminate a number of the limitations of previous generations of SCADA systems. The utilization of off-the-shelf systems makes it easier for the user to connect third party peripheral devices (such as monitors, printers, disk drives, tape drives, etc.) to the system and/or the network.

As they have moved to “open” or “off-the-shelf” systems, SCADA vendors have gradually gotten out of the hardware development business. These vendors have looked to system vendors such as Compaq, Hewlett-Packard, and Sun Microsystems for their expertise in developing the basic computer platforms and operating system software. This allows SCADA vendors to concentrate their development in an area where they can add specific value to the system–that of SCADA master station software.

The major improvement in third generation SCADA systems comes from the use of WAN protocols such as the Internet Protocol (IP) for communication between the master station and communications equipment. This allows the portion of the master station that is responsible for communications with the field devices to be separated from the master station “proper” across a WAN. Vendors are now producing RTUs that can communicate with the master station using an Ethernet connection. [3]

Another advantage brought by the distribution of SCADA functionality over a WAN is that of disaster survivability. The distribution of SCADA processing across a LAN in second-generation systems improves reliability, but in the event of a total loss of the facility housing the SCADA master, the entire system could be lost as well. By distributing the processing across physically separate locations, it becomes possible to build a SCADA system that can survive a total loss of any one location. For some organizations where SCADA is a critical function, this is a real benefit. [4]

3. SCADA – CORPORATE NETWORK INTEGRATION BENEFITS AND DRAWBACKS

Historically, SCADA networks have been dedicated networks; however, with the increased deployment of office LANs and WANs as a solution for interoffice computer networking, there exists the possibility to integrate SCADA LANs into everyday office computer networks.

SCADA systems have evolved in recent years and are now based on open standards and COTS products. Most SCADA software and hardware vendors have embraced Transmission Control Protocol/Internet Protocol (TCP/IP) and Ethernet communications, and many have encapsulated their proprietary protocols in TCP/IP packets.

Today’s SCADA systems are able to take advantage of the evolution from mainframe-based to client/server architectures. These systems use common communications protocols like Ethernet and TCP/IP to transmit data from the field to the master control unit.

The foremost advantage of this arrangement is that there is no need to invest in a separate computer network for SCADA operator terminals. In addition, is easier than before to integrate SCADA data with existing office applications, such as spreadsheets, work management systems, data history databases, Geographic Information System (GIS) systems, and modeling systems.

While all of this evolution towards more open-based standards has made it easier for the industry to integrate various diverse systems together, it has also increased the risks of less technical personnel gaining access and control of these industrial networks. On October 1, 2003 Robert F. Dacey, Director, Information Security Issues at the General Accounting Office (GAO) eluded to this and other issues in his testimony before the Subcommittee on Technology, Information Policy, Intergovernmental Relations, and the Census, House Committee on Government Reform. He said: “For several years, security risks have been reported in control systems, upon which many of the nation’s critical infrastructures rely to monitor and control sensitive processes and physical functions. In addition to general cyber threats, which have been steadily increasing, several factors have contributed to the escalation of risks specific to control systems, including the (1) adoption of standardized technologies with known vulnerabilities, (2) connectivity of control systems to other networks, (3) constraints on the use of existing security technologies and practices, (4) insecure remote connections, and (5) widespread availability of technical information about control systems”. [4]

4. ATTACKS AGAINST SCADA SYSTEMS

In today’s corporate environment, internal networks are used for all corporate communications, including SCADA. SCADA systems are therefore vulnerable to many of the same threats as any TCP/IP-based system. SCADA Administrators and Industrial Systems Analysts are often deceived into thinking that since their industrial networks are on separate systems from the corporate network, they are safe form outside attacks. PLCs and RTUs are usually polled by other 3rd party vendor-specific networks and protocols like RS-232, RS-485, MODBUS4, and DNP, and are usually done over phone lines, leased private frame relay circuits, satellite systems, licensed and spread spectrum radios, and other. This often gives the SCADA System Administrators a false sense of security since they assume that these end devices are protected by these non-corporate network connections. Security in an industrial network can be compromised in many places along the system and is most easily compromised at the SCADA host or control room level. SCADA computers logging data out to some back-office database repositories must be on the same physical network as the back-end database systems, or have a path to access these database systems. This means that there is a path back to the SCADA systems and eventually the end devices through their corporate network. Once the corporate network is compromised, then any IP-based device or computer system can be accessed. These connections are open 24x7 to allow full-time logging, which provides an opportunity to attack the SCADA host system with any of the following attacks:

- Denial of Service (DoS) attack - to crash the SCADA server leading to shut down condition (System Downtime and Loss of Operations);
- Delete system files on the SCADA server (System Downtime and Loss of Operations);
- Plant a Trojan and take complete control of system (Gain complete control of system and be able to issue any commands available to Operators);
- Log keystrokes from Operators and obtain usernames and passwords (Preparation for future take down);
- Log any company-sensitive operational data for personal or competition usage (Loss of Corporate Competitive Advantage);
- Change data points or deceive Operators into thinking control process is out of control and must be shut down (Downtime and Loss of Corporate Data);
- Modify any logged data in remote database system (Loss of Corporate Data);
- Use SCADA Servers as a launching point to defame and compromise other system components within corporate network. (create a botnet used for malicious purposes). [4]

5. SECURITY MANAGEMENT

For a company to protect its infrastructure, it should undertake the development of a security strategy that includes specific steps to protect any SCADA system.

Developing an appropriate SCADA security strategy involves analysis of multiple layers of both the corporate network and SCADA architectures including firewalls, proxy servers, operating systems, application system layers, communications, and policy and procedures. Strategies for SCADA Security should complement the security measures implemented to keep the corporate network secure. A good approach must take into consideration the integration of SCADA systems into corporate network.

AlienVault is a provider of Security Information and Event Management (SIEM) solutions. Those solutions include Vulnerability Scanning, Virtual Private Networking, Intrusion Detection and Prevention, Network Access Control, Antivirus and many other critical security tools useful for both corporate and SCADA network.

Open Source SIEM - OSSIM (Figure 3) is a complete Security Management solution available at no cost. AlienVault OSSIM provides all of the functionality required to detect and profiles attacks. It provides a comprehensive, intelligent Security Management platform and toolset. [5]

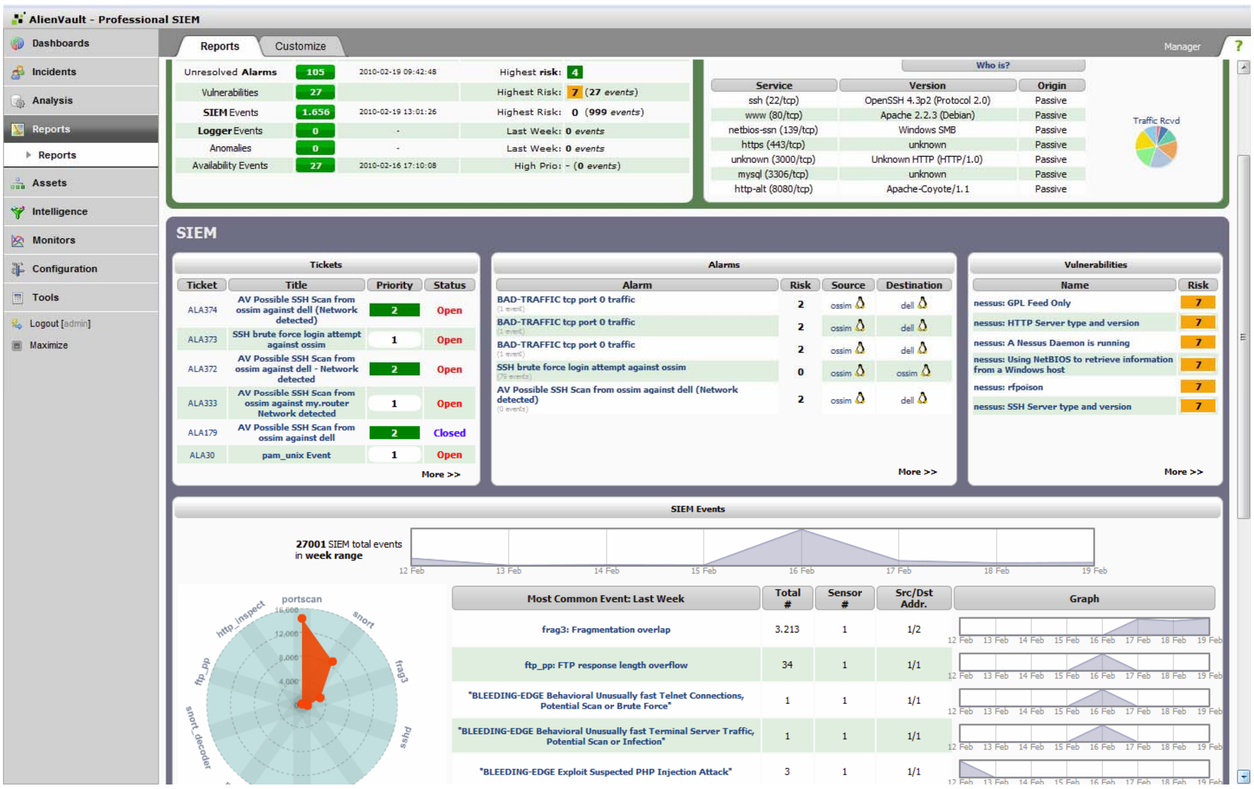


Figure 3. AlienVault Open Source SIEM Graphical User Interface

The entire solution is composed of open source distributions including all integrated tools, and the security management solution.

AlienVault has included all of the features of a complete security solution in a single integrated package offering:

- Reporting and Forensic Logging for Compliance;
- Vulnerability Assessment and Intrusion Detection for Risk Management;
- Advanced Operational and Investigative SIEM Analytics;
- Dashboard for Enterprise and MSSP Security Operations Centers.

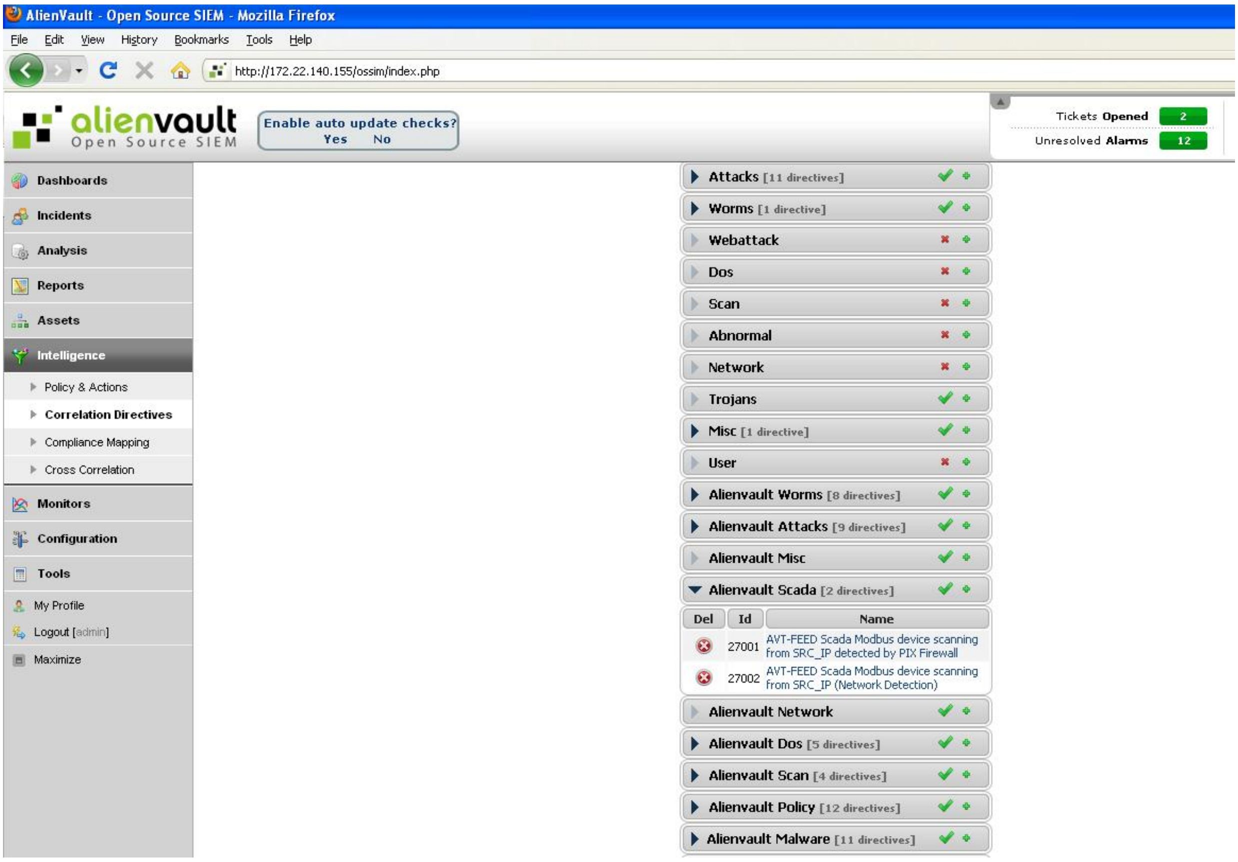


Figure 4. Allien Vault SCADA Intelligence Correlation Directives

AlienVault Unified SIEM has three major components:

- Sensor - performs Vulnerability Scans, Intrusion Detection/Prevention and collects logs and flows;
- SIEM - processes data to provide Reporting, Analytics and Operational Control (Figure 4);
- Logger - digitally signs and forensically stores data.

SIEM, Sensor and Logger can be deployed in Distributed, Hierarchical and Highly Available topologies.

Sensors have been designed for managed security. They compile an arsenal of technology into a single device and introduce this into each remote network like an "eye" detecting and monitoring remote, unauthorized activity. The combined effect of numerous detection and control points is global visibility and compliance management.

AlienVault Sensors are installed on network segments and inspect all traffic, detect attacks through various methods and collect information on attack context without affecting network performance.

These sensors utilize more than 10 expert systems that identify attacks along 5 different axes:

- Intrusion Detection;
- Anomaly Detection;
- Vulnerability Detection;
- Discovery, Learning and Network Profiling systems;
- Inventory systems.

SCADA-specific intrusion detection signatures are embedded in the system as can be seen in Figure 5.

The SIEM component provides the system with Security Intelligence and Data Mining capacities, featuring:

- Risk assessment;
- Correlation;
- Risk metrics;
- Vulnerability scanning;
- Data mining for events;
- Real-time monitoring;

AlienVault SIEM uses a SQL database and stores information normalized allowing strong analysis and data mining capacities.

The Logger component stores events in raw format in the file system. Events are digitally signed and stored en masse ensuring their admissibility as evidence.

The logger component allows storage of an unlimited number of events for forensic purposes. Logger addresses security, legal and compliances needs through:

- Digital Signatures ensures data integrity;
- Encrypted Transport ensures Chain-of-Custody;
- Compression saves valuable space;
- SAN/NAS Interoperability allows for limitless scalability.[5]

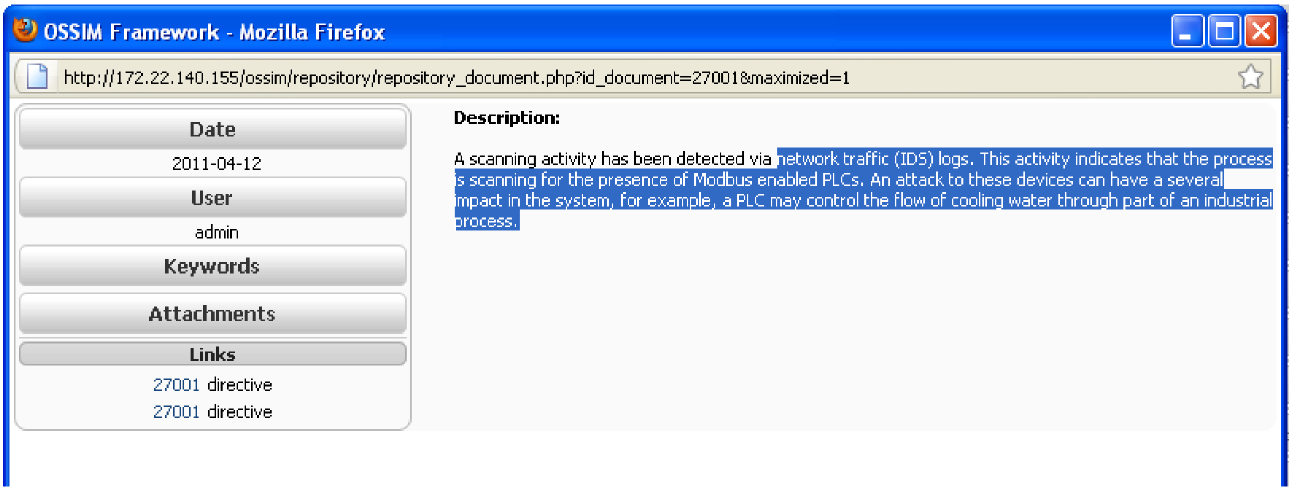


Figure 4. Diagram of a SCADA network

6. CONCLUSIONS

World wide is an increased number of connections between control system and IT networks. This causes concern over the security of control systems which had traditionally been considered closed systems.

Control System Networks today must be assumed to be at risk of electronic compromise.

There are many tools and techniques that could be used to address these threats, and flexibility of security configurations is a key design consideration.

Security best practices dictate that active visibility into the current and historical state of the operational security of a control system network is mandatory. Government and industry regulations will increasingly require auditable, demonstrable, comprehensive control of security on control system networks.

Maintaining situational awareness is the purpose of a SIEM. The AlienVault Unified SIEM is used in transportation control systems and other industrial applications where it's operational and forensic intelligence manage security and demonstrate regulatory compliance.

The AlienVault Unified and Open Source SIEM provide the turn-key technology for integrating security operations on control system networks.

7. REFERENCES

[1] GAO - United States Government Accountability Office, *CRITICAL INFRASTRUCTURE PROTECTION - Current Cyber Sector-Specific Planning Approach Needs Reassessment*, Report to Congressional Requesters, Washington DC, 2009

[2]*** - http://www.cybersecuritymarket.com - , 2011

[3] GAO - United States Government Accountability Office, *Critical Infrastructure Protection Challenges in Securing Control Systems*, Report GAO-04-140T, Washington DC, 2003

[4] OFFICE OF THE MANAGER, NATIONAL COMMUNICATIONS SYSTEM, *Supervisory Control and Data Acquisition (SCADA) Systems*, Technical Information Bulletin 04-1, Arlington VA, 2004

[5]*** - http://alienvault.com/resources - , 2011

NOTES REGARDING THE REDUCTION OF PETRI NETS TRANSITIONSWITH TIMED TRANSITIONS

[1]BORDEA GHEORGHE, [2]DINU SIMONA

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

In this paper, considering T-timed (i.e. with timed transitions) Petri Nets, one establishes rules for determination of nodes timings generated by the net reduction. As an application, a practical example of a T-timed Petri Net reduction by using these rules, is given at the end.

Keywords: *Discret Event System, Modelling, Petri Nets*

1. INTRODUCTION

By reducing the T-timed Petri Net, the timings of the reduced transitions are transmitted to the resulting positions. Thus, in the different stages of reduction, reduced nets are obtained which also have timed positions apart from timed transitions.

In the end, one obtains only timed positions.

2. IMPURE TRANSITIONS REDUCTION

A transition, namely T_i is impure if there is at least a position P_k that is acting for the transition T_i, in both the ways, as an input and as an output position.

The reduction of the impure transition T_i ([1], [2]) is performed by suppressing the input and output arcs that bond the transition T_i and the position P_k. The result is an isolated position P_k. When the reduced transition has not input and output positions anymore, the impure transition is also suppressed.

Rule 2.1: The timing of the isolated position (as a result of an impure timed transition reduction) is equal to the timing of the inpure transition.

Rule 2.2: If the position which is attached to the impure timed transition is timed, the timing of the isolated position resulted following the reduction of an impure timed transition is equal to the sum of the timing of the isolated position and the timing of the impure transition.

Following the reduction of the impure transition, one obtains an isolated timed position. The marking of the resulting isolated position is a marking invariant. For instance, in the figure 1.a, the transition T1 is an impure transition with timing d_1. In order to reduce it, one has to eliminated the arcs which bond it to the timed position P_2 with timing d_2. Thus one obtains the isolated position P_2 (see figure 1.b), whose timing is $d_1+ d_2$.

The marking of the position P_2 is a marking invariant.

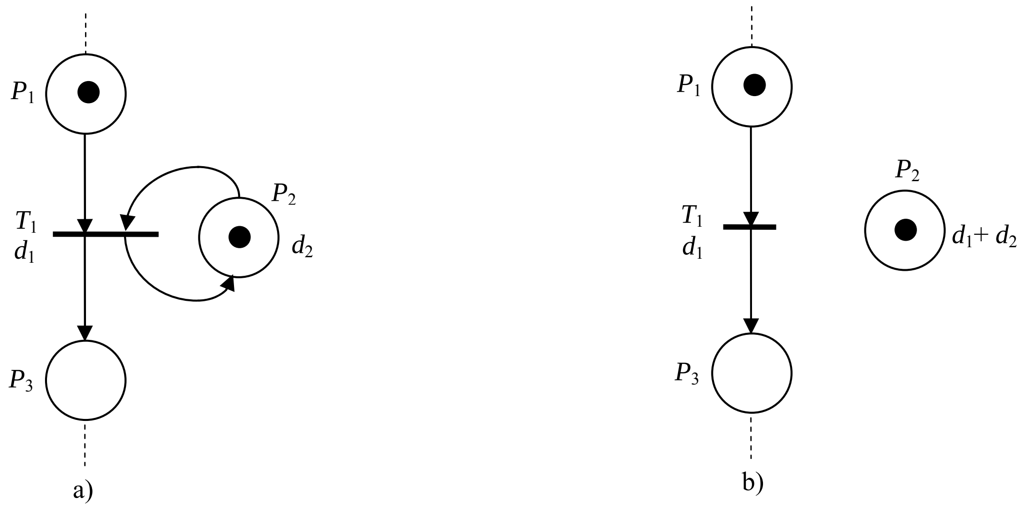


Fig. 1 The reduction of an impure timed transition

3. PURE TRANSITION REDUCTION

For an ordinary Petri Net, a pure transition reduction ([1], [2]) may be performed if this transition has at least a position on input and at least a position on output.

The reduction of such transition shall be performed as following:

1) The transition is suppressed

2) For every positions pair (P_j, P_k), where, for the reduced transition, P_j is input position and P_k is output position, a new position, namely P_j+P_k, is assigned as following:

a) P_j+P_k position marking is the sum of P_j and P_k markings.

b) the P_j -position input transitions become P_j+P_k, -position input transitions.

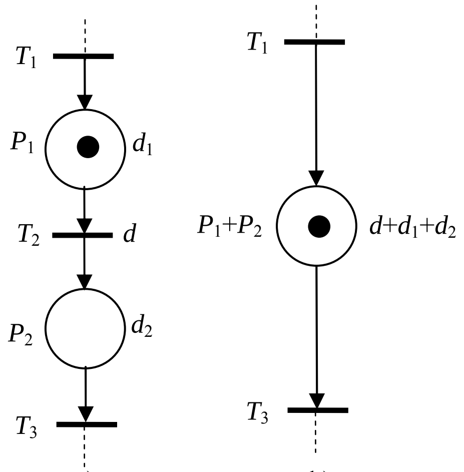
For the timed Petri Nets, the reduction is solved by following the same rules, but the positions and transitions timings of the resulting reduced net depend of the positions and transitions timings involved in the reduction operation.

When the Petri Net selected for reduction is a timed one, to set resulted position timings, the following rules must be adhered to:

Rule 3.1: When the reduced transition has on its input a single position P_i and on its output a single position P_j, for its reduction, the bonding arcs between input and output positions are eliminated, and both the positions are coupled in a new, unique position P_i+P_j,.

If the reduced transition has timing d, P_i position has timing d_i, and position P_j has timing d_j, then position P_i+P_j, which results after the reduction has a timing equal to $d+d_i+d_j$.

For instance, in the figure 2.a, the pure transition T_2 with timing d has on its input a single position P_1 (with d_1 timing) and on its output a single position P_2 (with d_2 timing).



a) b)

Fig. 2 The reduction of a pure transition with one entry position and one exit position

After reduction (figure 2.b) a newly P_1+P_2 position results (its timing is $d + d_1 + d_2$).

Rule 3.2: When the reduced transition has several positions on input and on output, the newly resulted positions are as many as the result of multiplication of the input and output positions numbers. If the reduced transition has timing d, P_j is one of the input positions and its timing is d_j, and P_k is one of the output positions with its timing d_k, the P_j+P_k - position (as a result of the reduction from (P_j, P_k) - pair) timing is

$$d_{jk} = d + d_k + \max(\dots, d_j, \dots),$$

where max(…, d_j, …) is the maximum of the positions timings situated on the reduced transition input ([3]).

For instance, in the figure 3, transition T_3 is a pure transition with timing d. It has on input the positions P_1 and P_2 with d_1 and respectively d_2 timings and on output positions P_3 and P_4 with d_3 and respectively d_4 timings.

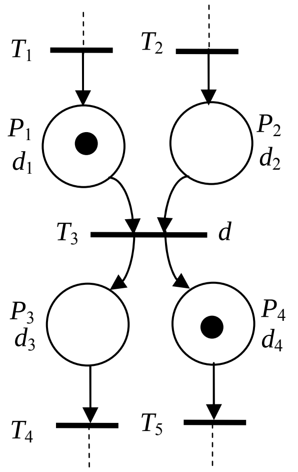


Fig. 3 Pure transition with two entry positions and two exit positions

After reduction (figure 4) the newly P_1+P_3, P_1+P_4, P_2+P_3, P_2+P_4, positions results (their timings are respectively d_{13}, d_{14}, d_{23} and d_{24}, where:

$$d_{13} = d_{23} = d + \max(d_1, d_2) + d_3;$$
$$d_{14} = d_{24} = d + \max(d_1, d_2) + d_4.$$

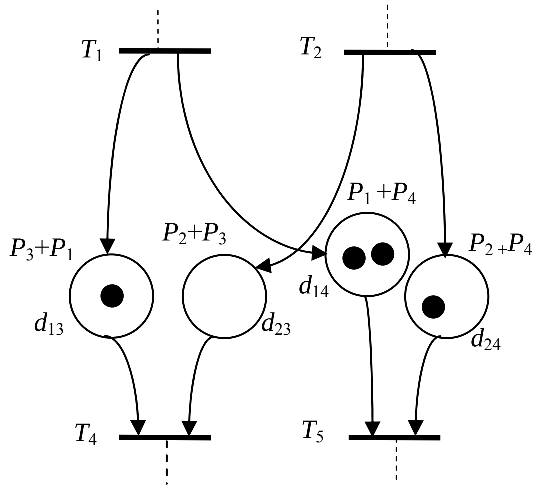


Fig. 4 Reduction of a pure transition with two entry positions and two exit positions

4. AN EXAMPLE OF A T-TIMED PETRI NET REDUCTION

To give an example regarding the reduction rules explained above, we may consider the Petri Net as in the figure 5.

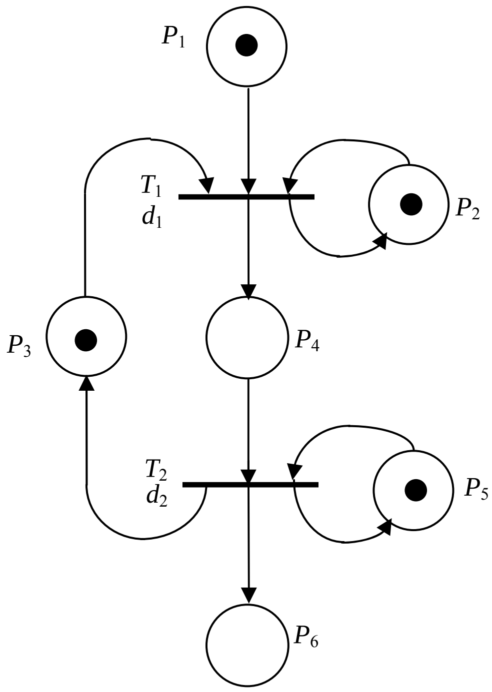


Fig. 5 Example of a T-timed Petri Net

By applying to this net the rule 2.1, one reduces the impure transitions T_1 and T_2 and one obtains the reduced net in figure 6.

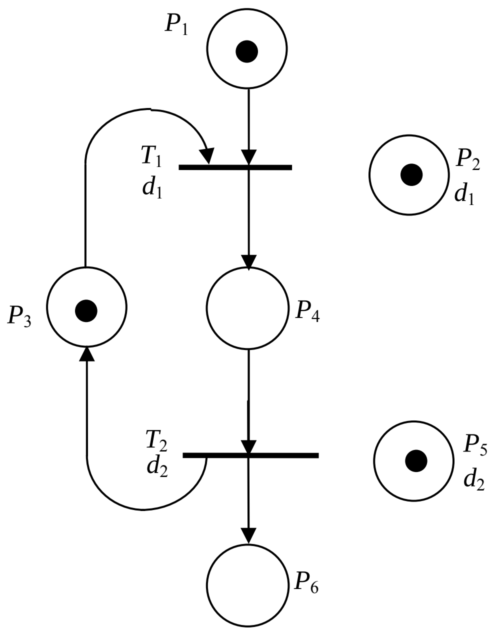


Fig. 6 Reduction of the impure transitions T_1 and T_2.

Following the reduction, one obtains the isolated positions P_2 and P_5 with timings d_1 respectively d_2.

After the reduction, the transitions T_1 and T_2 become pure transitions.

By applying rule 3.2 to the net in fig. 6, one reduces the pure transition T_1 and one obtains the reduced net in fig. 7.

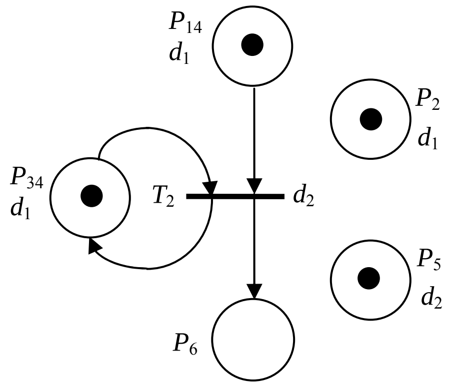


Fig. 7. The reduction of the pure transition T_1.

The timings of the positions P_{14} and P_{34}, which resulted following the reduction are equal to d_1.

After the reduction of the pure transition T_1, the transition T_2 becomes an impure transition once again.

By applying rule 2.2 to the net in fig. 7, one reduces the impure transition T_2 and one obtains the reduced net in fig. 8.

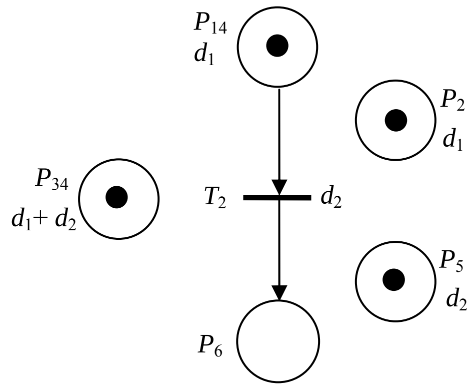


Fig. 8 The reduction of the impure transition T_2.

For the isolated position P_{34} which resulted following the reduction, the timing becomes d_1+d_2.

After the reduction, the transition T_2 becomes an pure transition once again.

By applying rule 3.1 to the net in fig. 8, one reduces the pure transition T_2 and one obtains the reduced net in fig. 9.

For the position P_{146}, which resulted following the reduction, the timing becomes d_1+d_2.

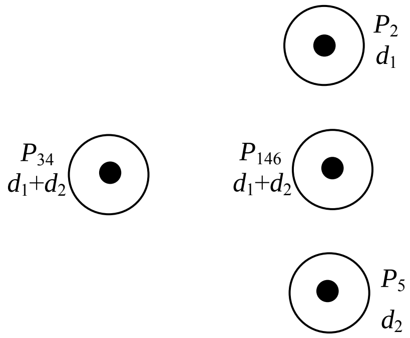


Fig. 9 Isolated positions obtained after the total reduction of the net in fig.5

5. CONCLUSIONS

Reducerea unei rețele Petri permite determinarea unor proprietăți ale rețelei.

For an T-timed net, following the reduction, the timings are transfered to the resulted positions.

The isolated positions as a result of the total net reduction, allow the marking invariants determination and the setting of the minimum duration for performing a sequence of transitions.

6. REFERENCES

[1] David R., Alla H.-*Du Grafcet aux reseaux Petri,* Edition Hermes, Paris, 1989;

[2] David R., Alla H.-*Discrete, Continuous and Hybrid Petri Nets,* Springer Edition, 2005;

[3] Bordea G., Dinu S.- *Notes Regarding The Reduction of The Timed Petri Nets*, Analele UMC, an X, vol 12, ISSN 1582-3601, pag. 275-277, Constanta, 2009.

OPTIMIZATION OF MICROSENSOR STRUCTURES THROUGH HALL – EFFECT MODELLING

[1]CARUNTU GEORGE, [2]PANAIT CORNEL

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

In this paperwork, based on the model of dual Hall devices, it is analysed the operation, and are established the main characteristics for two magnetotransistors structures, realised in the MOS and the bipolar integrated circuits technology.

Using numerical simulation it is emphasized the way in which the choise of its geometry and material features, allow the obtaining of high performance magnetic sensors.

There are also presented and described the original electrical diagrams of the transducers which contain such sensors, proposing possible applications in naval installation.

Keywords: *double-collector magnetotransistors, offset equivalent magnetic induction, noise equivalent magnetic induction, signal-to noise ratio, detection limit.*

1. INTRODUCTION

In the presence of a magnetic field, the Hall effect takes place in the active region of the transistors, however their magnetic sensitivity is insignificant.

Moreover, the Hall effect may interfere with the action of a bipolar transistor in many ways which makes the analysis and optimisation of devices much more difficult.

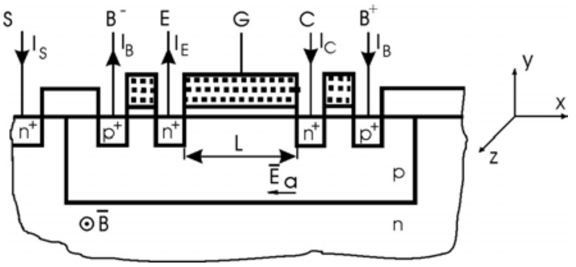


Fig.1 Cross section through a lateral magneto-transistor in CMOS technology

However, there are also magnetotransistors structures in which, under appropriate operating conditions the magnetic sensitivity increases to values useful in practical work.

In this way integrated magnetic sensors can be obtained which are useful for emphasizing and measuring mechanical and geometrical quantities.

2. THE STRUCTURE AND OPERATING PRINCIPLE

Figure 1 illustrates the cross section of a mangnetotransistors operating on the current deflection principle [6].

This device has the structure of a long channel MOS transistor, but operates as a lateral bipolar transistor with a drift-aided field in base region.

The device is situated in a *p*-well, serving as the base region of the transistor. The two base contacts B^+ and B^-, allow the application of an accelerating voltage for the minority carriers injected into the base region. The two n^+ regions laterally separated by the length of base along the distance L, serve as the emitter E and primary collector C. The substrate S works as the secondary collector.

In order to describe the qualitative operation of the device, let us assume that it is adequately biased for the forward active operation.

Owing to the accelerating field $\overline{E}_a$ in the base region, the most part of electrons injected into the base region drift mainly along the base length and are collected by collector C, producing collector current I_C. However, some of the which diffuse downwards, are collected by the secondary collector S, producing the substrate current I_S. The rising of ratio between the useful current I_C and the parasite current I_S is determined by the accelerating field.

A magnetic induction $\overline{B}$ perpendicular to the figure plane, modulates the distribution of the emitter current I_E among I_C and I_S. The modulation in the collector current I_C is used as the sensor signal. If the acceleration field $\overline{E}_a$ in the base region is very small the electrons moving essentially by diffusion, the transverse Hall current will be [2]:

$$I_H = I_Y = \frac{L}{Y} I_C \mu_{Hn} B_\perp = \Delta I_C \qquad (1)$$

where μ_{Hn} is the Hall mobility of electrons in the *p*-well, and Y is a geometrical parameter given approximately by $y_{jn} < Y < y_{jp}$. Here y_{jn} and y_{jp} denote the junction depths of the collector region and the *p*-well respectively.

3. SENSITIVITY AND NOISE EQUIVALENT MAGNETIC INDUCTION

A magnetotransistor may be regarded as a modulation transducer that converts the magnetic induction signal into an electric current signal.

This current signal or output signal is the variation of collector current, caused by induction $B_\perp$. The supply-current-related sensitivity of the device is defined by:

$$S_I = \frac{1}{I_C} \cdot \left| \frac{\Delta I_C}{B_\perp} \right| = \frac{L}{Y} \cdot |\mu_{Hn}| \qquad (2)$$

The noise current at the output of a magnetotransistor can be interpreted as a result of an equivalent magnetic induction.
The mean square value of noise equivalent magnetic induction (NEMI) is defined by:

$$\left\langle B_N^2 \right\rangle = \frac{\int_{f_1}^{f_2} S_{NI}(f) \cdot df}{(S_I \cdot I_C)^2} \qquad (3)$$

Here S_{NI} is the noise current spectral density in the collector current, and (f_1, f_2) is the frequency range.
In case of shot noise, the noise current spectral density at frequencies over 100 Hz is given by [4]:

$$S_{NI} = 2qI \qquad (4)$$

where *I* is the device current.

In a narrow frequency band around the frequency *f*, by substituting (2) and (4) into (3) it results:

$$\left\langle B_N^2 \right\rangle \le 2q \left(\frac{Y}{L} \right)^2 \frac{\Delta f}{\mu_{Hn}^2} \cdot \frac{1}{I_C} \qquad (5)$$

In figure 2 there are shown NEMI values for three magnetotransistor structures made of different materials ($Y/L = 0.5; \Delta f = 1\,Hz$)

MGT_1: Si with $\mu_{Hn} = 0.15 m^2 V^{-1} s^{-1}$

MGT_2: Ga Sb with $\mu_{Hn} = 0.50 m^2 V^{-1} s^{-1}$

MGT_3: Ga As with $\mu_{Hn} = 0.85 m^2 V^{-1} s^{-1}$

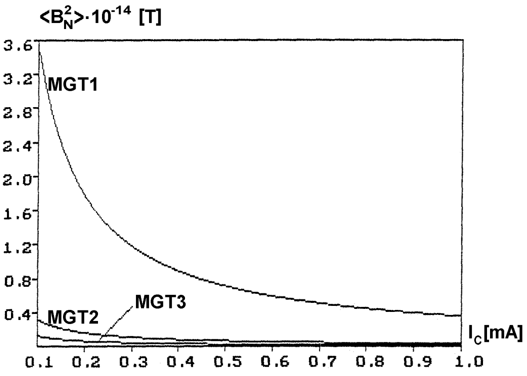


Fig. 2. NEMI depending on the collector current for three devices of different materials

For the same collector current $I_C = 0{,}2 mA$ the NEMI value of the Ga As device decreases by 25.6 times as compared to that of the silicon device.

To emphasise the dependence of NEMI device geometry, there were simulated (figure 3) two magnetotransistor structures realised on silicon and having different ratios Y/L ($L = 50\,\mu m$, $MGT_1 : Y/L = 0.5$; $MGT_2 : Y/L = 0.7$).

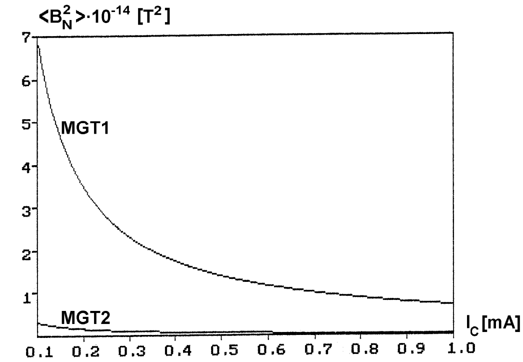


Fig. 3. NEMI depending on the collector current for two devices of different geometry

4. SIGNAL-TO-NOISE RATIO

The noise affecting the collector current of a magnetotransistors is shot noise and $1/f$ noise.
Signal-to-noise is defined by:

$$SNR(f) = \frac{\Delta I_C}{[S_{NI} \cdot (f) \cdot \Delta f]^{1/2}} \qquad (6)$$

where Δf denotes a narrow frequency band around the frequency *f*, and S_{NI} is given by (4). In case of shot noise, by substituting (1) and (4) into (6) it results:

$$SNR(f) = \frac{1}{\sqrt{2}} \mu_{Hn} \frac{L}{Y} \cdot \frac{I_C}{(q \cdot I \cdot \Delta f)^{1/2}} \cdot B_\perp \le$$

$$\le 0{,}707 \mu_{Hn} \frac{L}{Y} \left(\frac{I_C}{q \Delta f} \right)^{1/2} \cdot B_\perp \qquad (7)$$

In figure 4 is shown the $SNR(f)$ dependence on collector current of three magnetotransistor structures of different materials ($L/Y = 5, \Delta f = 1\,Hz, B = 0.2\,T$)

MGT_1: Si with $\mu_{Hn} = 0.15 m^2 V^{-1} s^{-1}$

MGT_2: Ga Sb with $\mu_{Hn} = 0.50 m^2 V^{-1} s^{-1}$

MGT_3: Ga As with $\mu_{Hn} = 0.85 m^2 V^{-1} s^{-1}$

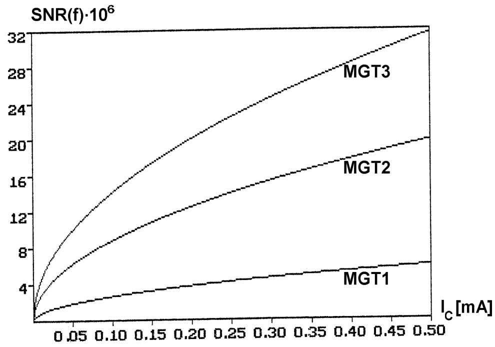


Fig. 4. *SNR(f)* depending on I_C for three devices of different materials

A high value of carrier mobility causes the increasing of $SNR(f)$. So for $I_C = 0.2\,mA$ $SNR(f)$ increases with 60% for Ga As comparative with Ga Sb.

To emphasise the dependence of $SNF(f)$ on device geometry there were simulated (figure 5) three magnetotransistor structures realised on silicon ($\mu_{Hn} = 0.15 m^2 V^{-1} s^{-1}$) and having different ratios L/Y $(L = 50\,\mu m; B = 0.2\,T; \Delta f = 1 Hz)$.

$MGT_1 : L/Y = 5$; $MGT_2 : L/Y = 3$; $MGT_3 : L/Y = 2$.

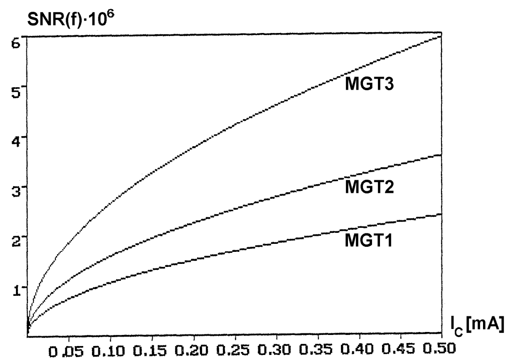


Fig. 5. *SNR(f)* depending on I_C for three devices of different geometry

In case of $1/f$ noise, the noise spectral density at the device output is given by [5]:

$$S_{NI}(f) = I^2 \frac{a}{N} \cdot \frac{1}{f^{\beta}} \tag{9}$$

To illustrate the $SNR(f)$ dependence on device geometry three lateral magnetotransistor structures realised on silicon were simulated (figure 6).

$MGT_1 : L/Y = 0.5$; $MGT_2 : L/Y = 1$; $MGT_3 : L/Y = 4$. It is considered that $f = 1.5 Hz$, $\Delta f = 1 Hz$, $\alpha = 10^{-7}$

$n = 4.5 \cdot 10^{21} m^{-3}, d = 10^{-5} m, q = 1.6 \cdot 10^{-19} C$, the device being biased in the linear region and the magnetic field having a low level.

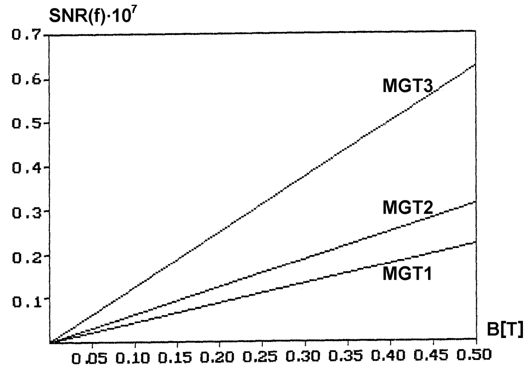


Fig. 6. *SNR(f)* depending on magnetic induction for three devices of different geometry

For the same magnetic induction $B = 0.2T$ $SNR(f)$ is maximum in case $L = 4Y$. The increasing of the geometrical parameter *Y* causes the decreasing of *SNT(f)* with 50% for a square structure $Y = L$ and with 63.3% for $Y = 2L$.

In figure 7 it can be seen the material influence on *SNR(f)* values for three sensors MGT_1, MGT_2, MGT_3 realised on Si ($\mu_{Hn} = 0.15 m^2 V^{-1} s^{-1}$, $f = 1.2 Hz$), GaSb ($\mu_{Hn} = 0.50 m^2 V^{-1} s^{-1}$, $f = 5 Hz$) and GaAs ($\mu_{Hn} = 0.85 m^2 V^{-1} s^{-1}$, $f = 7.8 Hz$); $L = 3Y$, $Y = 20\,\mu m$.

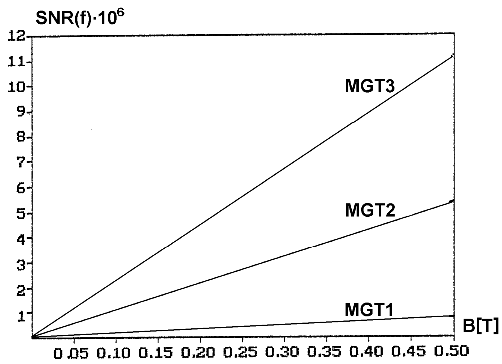


Fig. 7. *SNR(f)* depending on magnetic induction for three devices of different materials

5. THE DETECTION LIMIT OF MAGNETIC SENSORS

A convenient way of describing the noise properties of a sensor is in terms of detection limit, defined as the value of the measured corresponding to a signal-to-noise ration of one. In case of shot noise, it is obtained from expression (7):

$$B_{DL} \geq \frac{(2q\Delta f)^{1/2}}{\mu_{Hm}} \cdot \frac{Y}{L} \cdot I_C^{-1/2} \tag{10}$$

In figure 8 are shown B_{DL} values obtained for three sensors, MGT_1, MGT_2, MGT_3 realised on Si ($\mu_{Hn} = 0.15 m^2 V^{-1} s^{-1}$),GaSb ($\mu_{Hn} = 0.50 m^2 V^{-1} s^{-1}$) and GaAs ($\mu_{Hn} = 0.80 m^2 V^{-1} s^{-1}$).

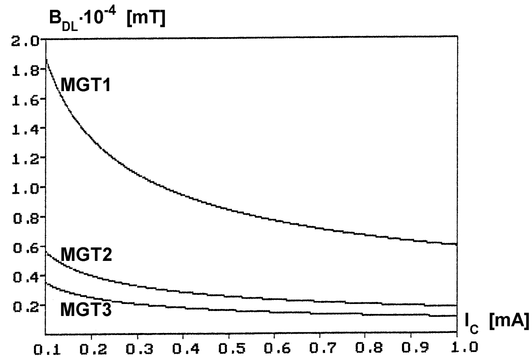


Fig. 8. B_{DL} depending on I_C for three devices of different materials

6. THE CHARACTERISATION OF THE SPLIT COLLECTOR MAGNETOTRANSISTOR.

Figure 9 illustrates the cross section of a split-collector magnetotransistor operating on the current deflection principle. This structure is compatible with bipolar integrated circuit technology [1].

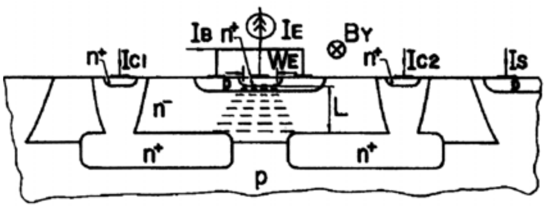


Fig.9. The structure of a split-collector magnetotransistor.

The most part of the low-doped epitaxial layer (n^-) serves as a collector-region and it is emptied by charge carriers because of the reverse biasing of the collector-base junction.

The two split-collector contacts are realised by splitting the buried layer (n^+). L is the emitter-collector distance, and W_E is the emitter width.

In the presence of a magnetic field with induction $B_{\perp}$, the distribution of a emitter electrons current is asymmetrical and causes an imbalance in the two collector currents.

This unbalance grows because of the majority carrier deflection in the collector region (the epitaxial zone): $\Delta I_C = I_{C1} - I_{C2}$. Since the output signal of the double collector mangetotransistor consists of the current variation between its terminals, this device operates in the Hall current mode. Using the features of dual Hall devices, and the Hall current expression it results [3]:

$$\Delta I_C = \frac{I_H}{2} = \frac{1}{2}\mu_{Hn}\frac{L}{W_E}G \cdot I_C B_{\perp} \quad (11)$$

7. NOISE – EQUIVALENT MAGNETIC INDUCTION

Magnetotransistors are usually intended for sensing magnetic field.
The absolute sensitivity of a magnetotransistor is defined by:

$$S_A = \left|\frac{\Delta I_C}{B}\right| \quad (12)$$

Using (11) the supply-current related sensitivity of the device can be put in this form:

$$S_I = \frac{S_A}{I_C} = \frac{1}{I_C}\left|\frac{\Delta I_C}{B_{\perp}}\right| = \frac{1}{2}\mu_{Hn}\frac{L}{W_E}G$$
(13)

The mean square value of noise magnetic induction (NEMI) is given by (3):

$$\left\langle B_N^2 \right\rangle = \frac{\int_{f_1}^{f_2} S_{NI}(f)\cdot df}{(S_I \cdot I_C)^2} \quad (14)$$

From (14) it is obtained the noise-equivalent magnetic induction spectral density:

$$S_{NB}(f) = \frac{\partial\left\langle B_N^2\right\rangle}{\partial f} = \frac{S_{NI}(f)}{B} \quad (15)$$

In case of shot noise by analogy with (5) it results:

$$S_{NB}(f) = 2qI \cdot 4\left(\frac{W_E}{L}\right)^2 \cdot \frac{1}{G^2\mu_{Hn}^2}\cdot\frac{1}{I_C^2} \leq$$

$$\leq 8q\left(\frac{W_E}{L}\right)^2 \cdot \frac{1}{G^2}\cdot\frac{1}{\mu_{Hn}^2}\cdot\frac{1}{I_C} \quad (16)$$

Considering the condition of low value magnetic field fulfilled ($\mu_H^2 B^2 << 1$), it is obtained a maximum value for $\frac{L}{W}G = 0.74$, if $\frac{W}{L} < 0.5$
In this case:

$$< B_N^2 >_{\min} \leq 14.6q\frac{1}{I_C}\cdot\frac{1}{\mu_{Hn}^2} \quad (17)$$

In figure 10 there are shown $S_{NB}(f)$ values obtained by simulation of three magnetotransistors structures from different materials.

MGT₁: Si with $\mu_{Hn} = 0.15 m^2V^{-1}s^{-1}$

MGT₂: InP with $\mu_{Hn} = 0.46 m^2V^{-1}s^{-1}$

MGT₃: GaAs with $\mu_{Hn} = 0.85 m^2V^{-1}s^{-1}$

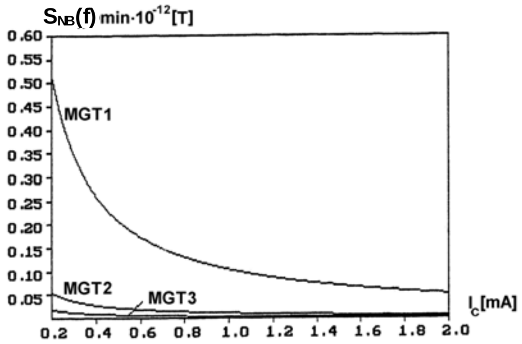


Fig. 10. S_{NB} (f) depending on the I_C for three devices of different materials

To emphasize the dependence of S_{NB}(f) on device geometry there were simulated (figure 11) three double-collector magnetotransistors structures realised on silicon, $\mu_{Hn} = 0.15 m^2 V^{-1} s^{-1}$, and having different ratios W/L $(W = 50 \mu m)$. The devices were biased in the linear region and the magnetic field is low ($\mu_H^2 B^2 << 1$).

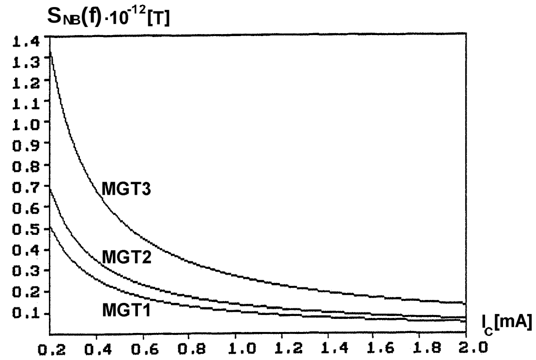


Fig. 11. S_{NB}(f) depending on the I_C for three devices of different geometry

MGT1 with $W_E/L = 0.5$ and $(LG/W_E)^2 = 0.576$

MGT2 with $W_E/L = 1.0$ and $(LG/W_E)^2 = 0.409$

MGT3 with $W_E/L = 0.2$ and $(LG/W_E)^2 = 0.212$

It is noticed that the S_{NB}(f) is minimum for $W/L = 0.5$, and for smaller values of this ratio. The decreasing of the channel length causes the increasing of S_{NB}(f) with 40.8 % for a square structure $W = L$ and with 173 % for $W = 2L$.

8. THE MODELING OF OFFSET EQUIVALENT MAGNETIC INDUCTION

For the split collector magnetotransistor illustrated in figure 9, the offset current is the difference between the two collector currents in the absence of magnetic field:

$$\Delta I_{Coff} = I_{C1}(0) - I_{C2}(0) \quad (18)$$

The causes of offset are essentially the same as those responsible for offset in Hall plates, which are the imperfections of manufacturing process: the material non-uniformity contacts misalignment and piezoeffects.

To charaterize the error caused by the offset, there will be determined the magnetic induction which causes an unbalance I_C equal with I_{Coff}.

The offset equivalent magnetic induction for the split collector magnetotransistor is defined by:

$$B_{off} = \frac{\Delta I_{Coff}}{S_I I_C} = \frac{2}{\mu_{Hn}} \cdot \frac{\Delta I_{C_{off}}}{I_C} \cdot \left(G \frac{L}{W_E} \right)^{-1} \quad (19)$$

For low magnetic fields ($\mu^2 B^2 << 1$) and $\Delta I_{Coff} = 10 \mu A$ there were simulated (figure 12) three magnetotransistors having $\frac{W_E}{L} = 0.5$, the materials being:

MGT1: Si with $\mu = 0.15 m^2 V^{-1} s^{-1}$

MGT2: Ga Sb with $\mu = 0.46 m^2 V^{-1} s^{-1}$

MGT3: Ga As with $\mu = 0.85 m^2 V^{-1} s^{-1}$

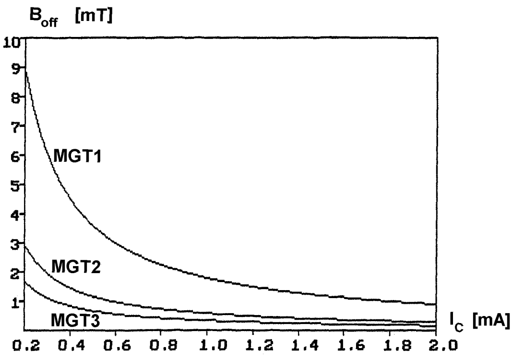


Fig. 12. B_{off} depending on the I_C for three devices of different materials

The offset equivalent induction values could be compared with the noise equivalent magnetic induction values for the same material, geometry and current I_C. It is noticed that B_{off} is smaller than $< B_N^2 >$ with 30%. In figure 13 there is emphasized the geometry influence on B_{of} by simulation of three magnetotransistors structures from *Si* and having the next rations W_E/L ($W_E = 50 \mu m$):

MGT1 with $W_E/L = 0.5$ and $LG/W_E = 0.74$

MGT2: with $W_E/L = 1$ and $LG/W_E = 0.64$

MGT3: with $W_E/L = 2$ and $LG/W_E = 0.46$

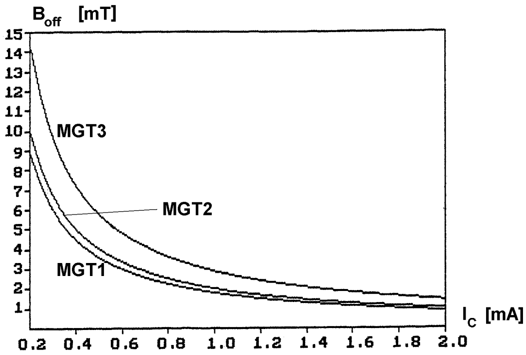


Fig. 13. B_{off} depending on the I_C for three devices of different geometry

9. CONCLUSIONS

The magnetotransistors have a lower magnetic sensitivity than the conventional Hall devices but allow very large signal-to-noise ratios, resulting a high magnetic induction resolution. The detection limit B_{DL} decreases under $10^{-5}T$ in case of GaAs at a total collector current of $1\,mA$.

The analisys of the characteristics of two magnetotreansistor structures shows that the $W/L = 0{,}5$ ratio is theoretically favourable to high performance regarding the signal-to-noise ratio, as well as the offset equivalent magnetic induction

Also substituting the silicon technology by using other materials such as GaAs or InSb with high carriers mobility values assure higher characteristics of the sensors

The uses of magnetotransistors as magnetic sensors allows the archieving of some current-voltage conversion circuits, more efficient that conventional circuits with Hall plates.

The transducers with integrated microsensors have a high effieciency and the possibilities of using them can be extended to some measuring systems of thickness, short distance movement, level, pressure, linear and revolution speeds.

In figure 14 shown the electrical diagram of a speed of rotation transducers based on a double-collector vertical magnetotransistors.

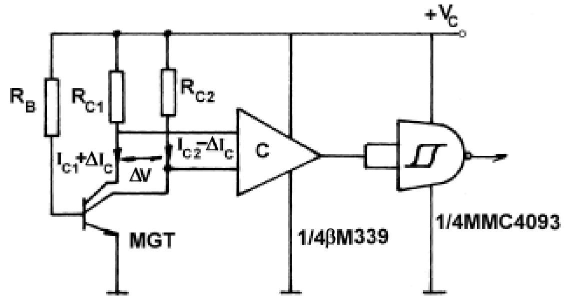


Fig. 14. The electric diagram of transducer

When a magnetic field is present there takes place an imbalance of the collector currents and the effect is potential difference between the two collectors which is proportional to the induction value B.

$$\Delta V_C = \mu_{Hn}\left(\frac{L}{W_E}G\right)R_C I_C B \qquad (19)$$

This voltage is applied to a comparator with hysteresis, which acts as a comutator. The existence of the two travel thresholds ensure the immunity at noise to the circuit. The monostable made with *MMC 4093* ensures the same duration for the transducers generated pulses.

10. REFERENCES

[1]. Bodea M. Traductoare integrate, Microelectronica, Vol. 15, Bucharest, 1987, pp. 73-86

[2] Caruntu G., Dragulinescu M. Consideration about Signal-to-Noise Ratio for Unconventional Hall Devices, Proceedings of The 8'th International Symposium on Systems Theory, Craiova, 1996, pp. 17-22

[3] Caruntu G., Dragulinescu M. The Modelling of Hall Effect in the Structure of a Split Collector Magnetotransistor, Proceedings of The 9'th Symposium on Modeling Simulation and Identification Systems., Galati, 1996, pp. 159-164.

[4] Gray E.P., Searle C.L., Bazele electronicii moderne, Vol I, Editura tehnica, Bucharest, 1973

[5] Hooge F.N. 1/f noise is no surface effect, Phys., 1969 Lett. 29A 139-40

[6] Popović R.S., Widmer R. Magnetotransistor in CMOS technology, IEEE Trans. Electron Devices, 1986, ED-33 1334-40

[7] Vandamme L.K.J. Is the 1/f noise parameter constant? Noise in Physical System and 1/f Noise, ed. M. Savelli, G. Lecoy and J/P Nougier, 1983, pp. 183-192

THE DETERMINATION OF THE SEMICONDUCTOR MATERIALS CHARACTERISTICS

CARUNTU GEORGE

Constanta Maritime University, Romania

ABSTRACT

The HALL devices may be used as magnetic sensors, or as tools for exploring the properties of the applied materials.

In this paperwork are presented specific methods and adequate experimental devices that on the basis of the Hall effect allow the determination of the relevant semiconductors material characteristics, at the same time to avoid errors due to parasitic effects.

It is also emphasised the influence of the constructive imperfection of the measuring devices on the accuracy of the results.

Keywords: *Hall devices, semiconductor materials.*

1. INTRODUCTION

To avoid measurement errors due to parasitic effects, and ease the extraction of relevant material characteristics from the row measurement results, the measurements have to be done following pre-establishing technique conditions, on a wall defined geometry samples with appropriate electrical contacts.
For metals and small-band-gap semiconductors a highly doped semiconductor, simple pressure contacts are usually adequate.

Also for the low-doped large-land-gap semiconductors, a good metal-semiconductors contact imposes a high doping of the semiconductors with a sufficient doping depth of 10 nm.

2. MEASUREMENTS ON A HOMOGENEOUS SEMICONDUCTOR PLATES

2.1. The Carrier Concentration and the Band Gap

The concentration of electrons and holes in an intrinsic semiconductor are equal $n_i = p_i$.
For non-degenerate carriers, the intrinsic carrier concentration is [1]:

$$n \cdot p = n_i^2 = N_c V_v \exp\left(-E_g / kT\right) \quad (1)$$

where: $E_g = E_c - E_v > 8kT$, is the band gap, and N_v and N_c are the effective density of states in the conduction band, and the valence band respectively.

In an extrinsic semiconductor doped with both donors and acceptors the electrical neutrality condition is:

$$n + N_A^- = p + N_D^+ \quad (2)$$

where N_A^- and N_D^+ are the concentration of impurity atoms for acceptors and donors.

If it is considered, in a first approximation that at relatively low temperatures:

$$\left(N_D^+ - N_A^-\right)^2 >> 4n_i^2 \quad (3)$$

on deduce from (1) and (2):

$$n_n \approx N_D - N_A \quad (4)$$

The subscript n stands for an n-type semiconductor.
In case of a non-degenerate n-type semiconductor, if $N_D >> N_A$, then

$$n_n \approx N_D \quad (5)$$

From (1) and (5) it follows that:

$$p_n = \frac{n_i^2}{N_D} \quad (6)$$

In a p-type semiconductor in similar conditions, if $N_A >> N_D$ it is obtained:

$$p_p \approx N_A \quad (7)$$

and

$$n_p = \frac{n_i^2}{p_p} = \frac{n_i^2}{N_A} \quad (8)$$

2.2. The Hall Coeficient

The total current density is a rectangular long sample $\left(l \times w \times \delta\right)$ exposed to the electric $\left(\overline{E}\right)$ and magnetic $\left(\overline{B}\right)$ field, $\left(\overline{E} \perp \overline{B}\right)$ is given by [2]:

$$\overline{J} = \sigma_B \overline{E} + \sigma_B \mu_H \left(\overline{E} \times \overline{B}\right) \quad (9)$$

where σ_B is the material conductivity in the direction of the electric field, when there is a perpendicular magnetic field $B_{\perp}$.

The second term in expression (9) is the current density due to the transversal electric field, $\overline{E}_H = \mu_H \left(\overline{E} \times \overline{H}\right)$, which counterbalances the action of the magnetic force.

The factor μ_H denotes the effective mobility of charge carriers exposed to an electric field equivalent to transversal magnetic forces.
The vector equation (9), can be also written as:

$$\overline{E} = \frac{1}{\sigma_B}\overline{J} - \mu_H\left(\overline{E}\times\overline{B}\right) \quad (10)$$

The scalar and the vector products of this equation by $\overline{B}$ is:

$$\overline{E} = \frac{1}{\sigma_B(1+\mu_H^2 B^2)}\overline{J} - \frac{\mu_H}{\sigma_B(1+\mu_H^2 B^2)}(\overline{J}\times\overline{B}) \quad (11)$$

The above relation can be rewritten in a compact form:

$$\overline{E} = \rho_b\overline{J} - R_H\left(\overline{J}\times\overline{B}\right) \quad (12)$$

The coefficient ρ_b denotes the effective material resistivity, and R_H is the Hall coefficient that characterizes the efficiency of generating the Hall electric field in the semiconductor materials.

An effect associated with the Hall field is the appearance of a transverse voltage, called the Hall voltage [3]:

$$V_H = G\frac{R_H}{\delta}IB_\perp \quad (13)$$

In this relation *G* is the geometrical correction factor and δ is the sample thickness.

In case of an intrinsic semiconductor, the electric conductivity is due both to the electrons and holes.

By analogy with (12) it follows:

$$\overline{E} = \widetilde{\rho}_b\overline{J} - \widetilde{R}_H\left(\overline{J}\times\overline{B}\right) \quad (14)$$

where $\widetilde{R}_H = \widetilde{\mu}_H\left[\widetilde{\sigma}_B\left(1+\widetilde{\mu}_H B^2\right)\right]^{-1}$ represents the average Hall coefficient of the mixed-conductivity material. The following notations have been introduced.

$$\widetilde{\sigma}_B = \sum\sigma_{Bk} = \sigma_{Bn} + \sigma_{Bp} \quad (15)$$

$$\widetilde{\mu}_H = \left(\sum\sigma_{Bk}\mu_{Hk}\right)/\sum\sigma_{Bk} \quad (16)$$

The $\widetilde{\sigma}_B$ is the total conductivity, and $\widetilde{\mu}_H$ is the average Hall mobility.

At low magnetic field, $\widetilde{R}_H$ reduces to the form:

$$\widetilde{R}_H\left(\overline{B}\approx 0\right) = \frac{\sigma_{Bn}\mu_{Hn} + \sigma_{Bp}\mu_{Hp}}{\left(\sigma_{Bn}+\sigma_{Bp}\right)^2} \quad (17)$$

The Hall mobility of carriers with spherical constant energy surfaces, and at low magnetic induction is given by:

$$\mu_H\left(\overline{B}\approx 0\right) = \mu\cdot r_{H0}\cdot sign[e] \quad (18)$$

where r_{H0} denotes the Hall scattering factor. By substituting (18) into (17) it results:

$$R_H\left(\overline{B}\approx 0\right) = \frac{1-s\beta^2\xi}{(1+\beta\xi)^2}\cdot\frac{r_{Hp}}{qp} \quad (19)$$

with: $s = \frac{r_{Hn}}{r_{Hp}}$, $\beta = \frac{\mu_n}{\mu_p}$, $\xi = \frac{n}{p}$.

For the strongly degenerated carriers considering the simplified model of the Hall effect, the scattering factor equals, and expression (19) is reduced to:

$$R_H = \frac{1-s\beta^2\xi}{(1+\beta\xi)^2}\cdot\frac{1}{qp} \quad (20)$$

Considering R_H as a function of electrons density expressed by the intrinsic concentration $n = n_i^2/p$ in figure 1 are shown the values of this function when

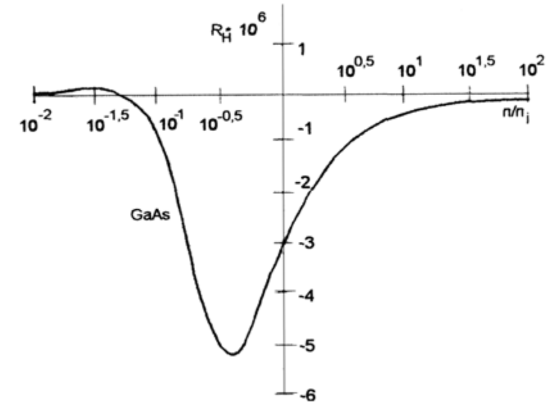


Fig. 1 Tha R_b depending on electrons density for *GaAs*

T=300K, for *GaAs* ($\mu_n = 0{,}850 m^2V^{-1}s^{-1}$, $\mu_p = 0{,}004 m^2V^{-1}s^{-1}$).

Due to the difference of the electrons and holes mobility ($\mu_n > \mu_p$) the condition of cancelling the Hall coefficient:

$$\frac{n}{p}\left(\frac{\mu_n}{\mu_p}\right)^2\cdot\frac{r_{Hn}}{r_{Hp}} = 1 \quad (21)$$

is realised for a higher concentration of impurities of type p.

Then at *GaAs*, $R_H = 0$ for $n = 10\sqrt[3]{10}n_i$.

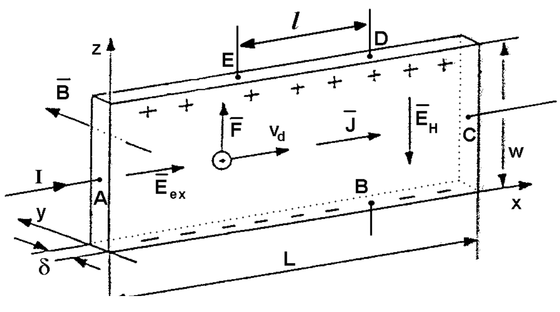


Fig. 2 The long sample for galvanomagnetic measurements

2.3. Measurement of the Band Gap

The temperature dependence on the Hall coefficient R_H, allows experimental determinations of the band gap of a semiconductors.

This method consists in the measurement of the Hall-voltage at various temperatures and highlighting the T_0 value at which Hall coefficient drops to zero. At this temperature, using relation (21) it results:

$$n(T_0)=\left(\frac{\mu_p}{\mu_n}\right)^2\cdot\frac{r_{Hp}}{r_{Hn}}\cdot p(T_0) \quad (22)$$

In case of a Hall device made of p-type material, if almost all dopant atoms are ionised, and $N_A >> N_D$, there is a relation:

$$p(T_0)\approx N_A \quad (23)$$

Relation (8) can be rewritten:

$$n(T_0)\approx n_i^2/N_A \quad (24)$$

By substituting (23) and (24) into (22) it follows:

$$n_i^2(T_0)=\left(\frac{\mu_p}{\mu_n}\right)^2\cdot\frac{r_{Hp}}{r_{Hn}}\cdot N_A^2 \quad (25)$$

According to (1) it results:

$$n_i^2(T_0)=N_cN_v\exp\left(-E_g/kT_0\right) \quad (26)$$

From (1) and (26) it follows that:

$$E_g=kT_0\ln\left[\frac{N_cN_v}{N_A^2}\left(\frac{\mu_n}{\mu_p}\right)^2\cdot\frac{r_{Hn}}{r_{Hp}}\right] \quad (27)$$

3. MEASUREMENT ON A LONG SAMPLE

3.1. Measurement of Resistivity and Sheet Resistance

An adequate form for the galvanomagnetic measurements, which allows an easy extraction of the relevant material characteristics from experimental result, is represented by a long sample ($l >> w$, $l >> \delta$) fitted with five small-area contacts (figure 2). Under these circumstances the geometrical correction factor approximately equals unity.

The supply current I is forced along the sample between the contact A and C.

The longitudinal drop voltage is measured between the contacts E and D, and also Hall voltage, between the contacts B and D.

By the Hall experimental device already described it easy to find the quantities: ρ_b, R_s, $\frac{\Delta R_b}{R_b(0)}$, and V_H.

The resistance of the plate between the contacts E and D, can be expressed as a function of the effective material resistivity on the direction of the total current density ρ_b when the plate is exposed to a magnetic field action, perpendicular to this surface:

$$R_{ED}=\rho_b\, l/w\delta \quad (28)$$

The drop voltage between the contacts E and D is $V_{ED}=R_{ED}\cdot I$, so:

$$\rho_b=\frac{w\delta}{l}R_{ED}=\frac{w\delta}{l}\cdot\frac{V_{ED}}{I} \quad (29)$$

Knowing the sample dimensions it is determined ρ_b by measuring V_{ED} and I. If ρ_b is considered as a function of variables V_{ED} and I, the error sent over the measurement result due to a possible variation ΔV_{ED}, ΔI, can be determined by the differential logarithmic method [4].

The relation which expresses the measurement quantities is logarithmized and then it is transformed into a differential member by member:

$$\ln\rho_b=\ln\left(\frac{w\delta}{l}\cdot\frac{V_{ED}}{I}\right)$$

$$\frac{d\rho_b}{\rho_b}=\frac{l}{\delta w}\left(\frac{dV_{ED}}{V_{ED}}-\frac{dI}{I}\right) \quad (30)$$

To obtain the probable maximum relative error when the errors of V_{ED} and I are the highest add to each other the sign of negative factor on the right member of relation (30) is changed and the differentials by maximum are substituted by absolute errors.

$$\left(\frac{\Delta\rho_b}{\rho_b}\right)_{\max.p}=\frac{l}{\delta w}\left[\frac{(\Delta V_{ED})_{\max}}{V_{ED}}+\frac{(\Delta I)_{\max}}{I}\right] \quad (31)$$

The obtained percentage is:

$$\left(\frac{\Delta\varphi_b}{\varphi_b}\right)_{\max.p}[\%]=\frac{l}{\delta w}\left[\frac{(\Delta V_{ED})_{\max}}{V_{ED}}+\frac{(\Delta I)_{\max}}{I}\right]\cdot 10^2 \quad (32)$$

If V_{ED} and I values are determined directly by analog measurement instruments with the rated measurement ranges U_N and I_N, and also the accuracy closes c_V and c_A, the relation (31) becomes:

$$\left(\frac{\Delta\rho_b}{\rho_b}\right)_{\max.p}[\%]=\frac{l}{\delta w}\left(c_V\frac{U_N}{U}+c_A\frac{I_N}{I}\right) \quad (33)$$

To obtain a superior precision, the value of the electric current I can be measured by a potentiometer by the drop voltage that it produces on measurement standard resistance.

Knowing V_{ED} and I the sheet resistance of the materials can be expressed thus:

$$R_S=\frac{\rho_S}{\delta}=\frac{1}{\delta}\cdot R_{ED}\frac{\delta w}{l}=\frac{w}{l}R_{ED}=\frac{w}{l}\cdot\frac{V_{ED}}{I} \quad (34)$$

Doing the measurements in the absence of the magnetic field and also in the presence of a $\overline{B}_\perp$ value of the normal induction, on the device surface, the physical magnetoresistance can be determined:

$$\frac{\Delta R_b}{R_b(0)} = \frac{R_b(B_\perp) - R_b(0)}{R_b(0)} = \frac{\Delta \rho_b}{\rho_b(0)} \tag{35}$$

where

$$R_b(B_\perp) = \frac{w}{l} \cdot \frac{V_{ED}(B_\perp)}{I} \tag{36}$$

$$R_b(0) = \frac{w}{l} \cdot \frac{V_{ED}(0)}{I} \tag{37}$$

For a precise determination of V_{ED} values the measuring potentiometers can be used.

3.2 Measurement of the Hall Voltage and the Sheet Hall Coefficient

The output voltage of a Hall device can be generally expressed as the sum:

$$v_{out} = V_H + V_{off} + v_N(t) \tag{38}$$

where V_{off} is the offset voltage and v_N is the noise voltage.

To obtain a high signal-to-noise ratio, the sample must be simetrical, the contacts carefully made and also *I* and $B_\perp$ must have high enough values so that the related power device can be passed. The offset voltage can be eliminated by measurement the output voltage V_{DB} (figure 2) for the two ways of the magnetic induction.

Knowing the Hall voltage [2]:

$$V_H = -\int_M^N R_H(\bar{J} \times \bar{B}) d\bar{s} \tag{39}$$

and the offset voltage:

$$V_{off} = \int_N^M \rho_b \bar{J} d\bar{s} \tag{40}$$

it is found:

$V_H(-\bar{B}_\perp) = V_H(-\bar{B}_\perp)$ and $V_{off}(\bar{B}_\perp) = V_{off}(\bar{B}_\perp)$

Consequently

$$V_{DB}(\bar{B}_\perp) - V_{DB}(-\bar{B}_\perp) = 2V_H(B_\perp) \tag{41}$$

so

$$V_H = \frac{1}{2}\left[V_{DB}(\bar{B}_\perp) - V_{DB}(-\bar{B}_\perp)\right] \tag{42}$$

This method is applied when V_{off} is a small value and independent from the magnetic induction way. In case of intrinsic or low-doped semiconductors we find that the magnetoconcentration effect is important therefore the material resistivity and V_{off} dependent on $B_\perp$.

Having determined the Hall voltage, we can calculate the sheet Hall coefficient:

$$R_{HS} = \frac{R_H}{\delta} = \frac{V_H}{IB_L} \tag{43}$$

where it is known that for very long samples, $G \approx 1$.

4. REFERENCES

[1] Kireev, P.: *Fizica semiconductorilor*, Editura Ştiinţifică şi Enciclopedică, Bucureşti, 1977

[2] Căruntu, G.: *Consideraţii privind structura, efectele fizice de bază, condiţiile de funcţionare şi caracteristicile dispozitivelor Hall neconvenţionale realizate pe siliciu.* Master Reference, „Politehnica" University, Bucharest, 1994

[3] Căruntu, G.: *Despre eficienţa senzorilor magnetici Hall*. Sesiunea de Comunicări Ştiinţifice a Universităţii din Piteşti, pp. 52-56, Piteşti, noiembrie, 1997

[4] Căruntu, G.; Dragomirescu, O.: *Errors Computing in the Case of Using, Solid Body Transducers*. Procedings OPTIM'94, pp. 189-192, Braşov, mai 1994.

ACTIVE STEERING BY 4 ELECTRIC THRUSTERS

[1]DORDEA ŞTEFAN, [2]ZBURLEA ELENA

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

The PWM electric drives permit a smooth ajustment of the thrusters operational parameters: voltage amplitude, voltage frequencies, sequences of three generated AC voltages. All these electric parameters can be independly controled for each electro-thruster, in order to increase the ship's maneuvrability.

Keywords: *electro-thruster, E-motor, PWM electric drives*

1. INTRODUCTION

Thrusters have become an essential addition for maneuvering today's maritime vessels.

Big container carriers have modern active steering systems including 4 tunnel electric thrusters, two of them at the fore and two at the stern of the ship (fig.1a).

2. TUNNEL THRUSTERS DISPOSAL

Fore and stern mounted thrusters that have been welded in transverse direction of the hull (fig.1b) are used within inside waters for harbor maneuvers.

Tunnel thrusters electrically driven using a *Pulse Width Modulation* (PWM) technique solve the ship's maneuvering problem within inside waters.

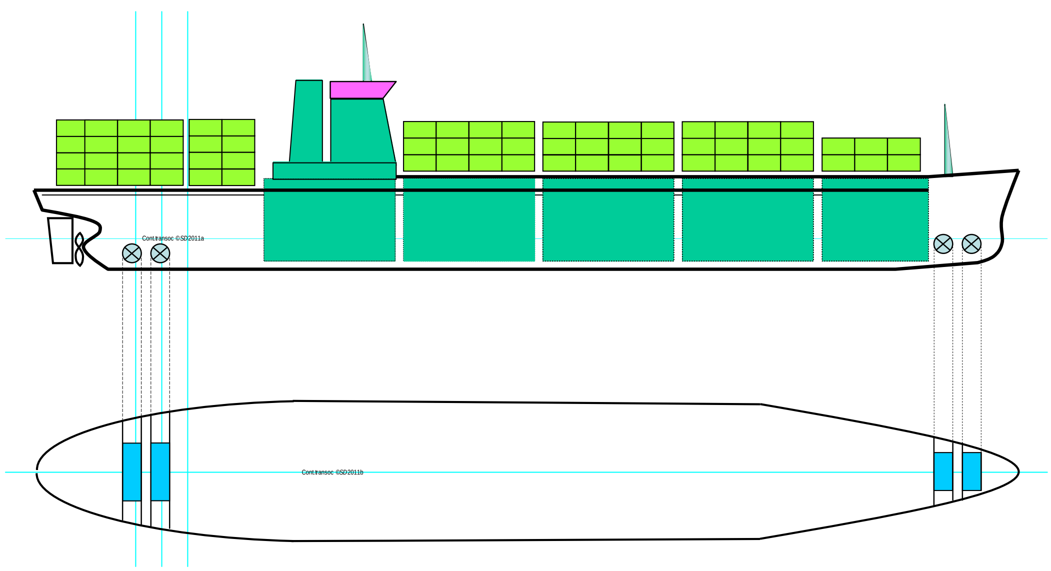


Fig. 1 Disposal of a 4 tunnel thrusters system

3. ELECTRIC THRUSTERS OPERATIONAL

The architecture of an electric bow thrusters operational is given in fig.2. The system is formed by four electric plants, each of them containing two Diesel Generators, the corresponding PWM electric drives and a power switching (distribution) panel. The four panels are connected in-between.

The Operator controls:

- The acting sense of each thruster (fore and stern)
- The speed of each thruster
- The functions of the power electric plants and the PWM electric drives.

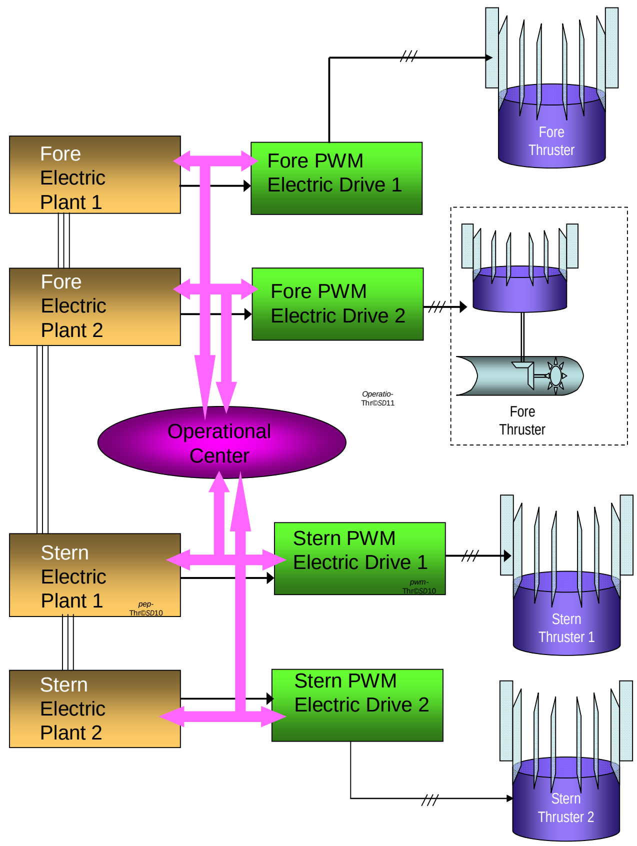


Fig. 2 Controlled system of bow thrusters

4. THE BOW (TUNNEL) THRUSTER

The electric motor (*E-motor*) driving the thruster is mechanically linked by means of a speed reducing gear to the bow propeller (fig.3). The purpose is to obtain a higher torque of the propeller at a lower speed of the E-motor.

Eluding the losses, the mechanical transfer of power is given by the following relations:

$$P_{EM} \cong P_{PROP}$$

$$M_{EM} \cdot \omega_{EM} \cong M_{PROP} \cdot \omega_{PROP}$$

where:

P_{EM} is the electromagnetic power,
P_{PROP} is the propeller power,
M_{EM} is the electromagnetic torque,
M_{PROP} is the propeller torque
ω_{EM} is the angular speed of the *E-motor*,
ω_{PROP} is the angular speed of Propeller

Since the diameter D_1 of input toothed wheel of the reducing gear is smaller than the output one (D_2), is obviously that

$$Z_1 < Z_2 \text{ because } \frac{D_1}{D_2} \cong \frac{Z_1}{Z_2}$$

where:

Z_1 is the teethes number of primary wheel
Z_2 is the teethes number of secondary wheel

and because

$$\frac{\omega_{EM}}{\omega_{PROP}} = \frac{M_{PROP}}{M_{EM}}$$

Results that

$$\omega_{PROP} < \omega_{EM}$$

or, otherwise saying that

$$M_{PROP} > M_{EM}$$

Since the electro-motor is mounted above the ship's hull it is accessible and therefore dismountable and removable in order to be repaired.

The advantage of such architecture consists in facile measurements stator windings and the electric resistance of the E-motor in a dry environment .

The underwater overhauls and eventually repairs on reducing gear and propeller are to be made by specialized sea workers or by putting the ship into a dry shipyard.

5. THE POWER ELECTRIC PLANTS AND THE *PWM* ELECTRIC DRIVES

The mechanical energy of two Diesel engines is converted into electric energy by means of the corresponding three-phased synchronous generators coupled to a distribution switchboard (fig.4).

There are two reasons for equipping the PEP with two Diesel – Generator groups:

- the maneuver safety
- the capability of supplying other minor consumers.

The Operator controls:

- The PWM voltages
- The PWM frequencies

The coupling and parallel operating of the generators is made automatically when a higher electric power is demanded by the system.

The main consumer of the power electric plant is obviously the thruster E-motor controlled by the electric adjustable drive.

The sum of the installedpower of the two Diesel – Generators must be higher than the peak power asked by the thruster; it refers to the maneuver safety.

- The start and stop of each Diesel generator
- The induction fields of both generators

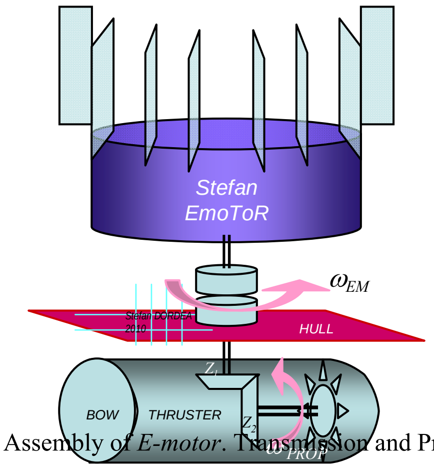


Fig.3 Assembly of *E-motor*. Transmission and Propeller

$$\sum P_{GEN} > \max P_{THRUSTER}$$

A single Diesel generator must cover the power consumption of the thruster.

$$P_{GEN} > P_{THRUSTER}$$

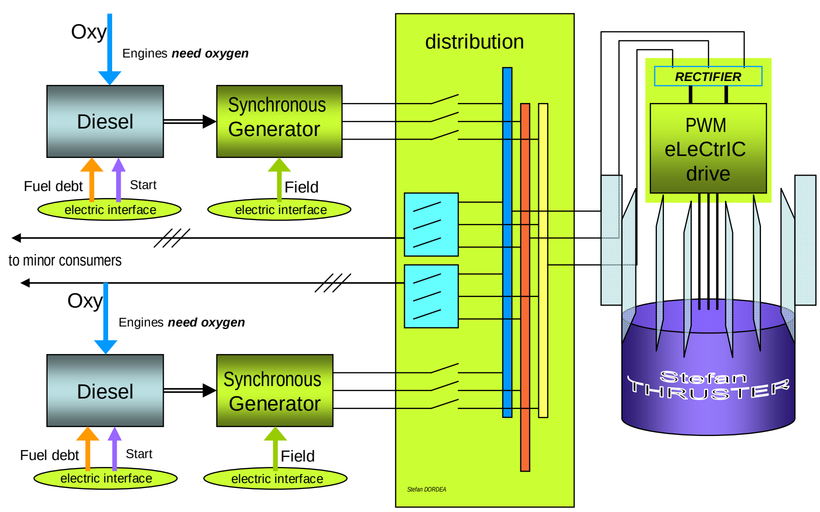


Fig.4 One of the four Power Electric Plants

6. THE FOUR ELECTRIC POWER THE FOUR ELECTRIC POWER

The two electric plants disposed at fore and the two electric plants on the stern of the ship with corresponding thrusters are shown in fig.5.

They are linked in between and they are also supplying some other minor consumers on board (comparing to the thrusters).

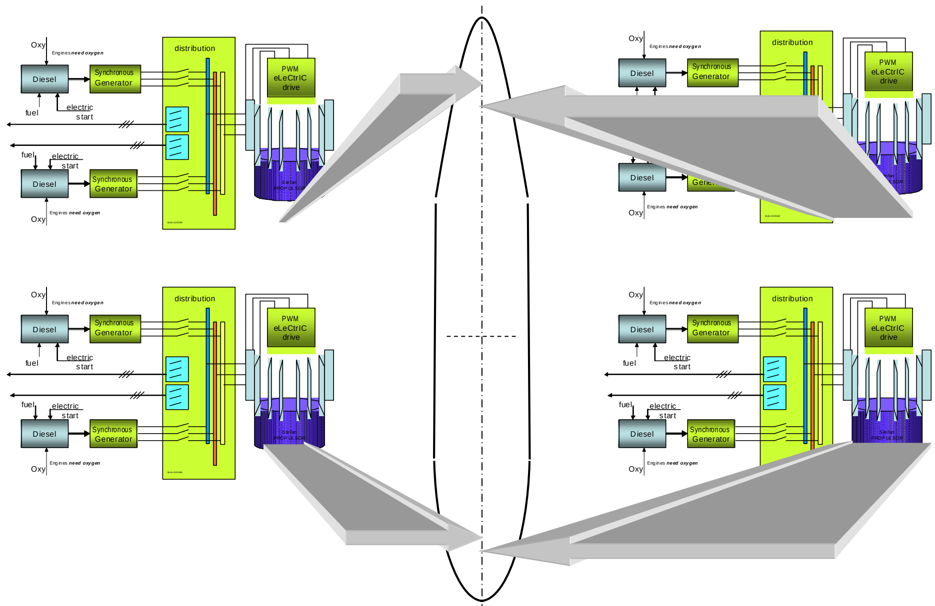


Fig.5 The four Power Electric Plants

7. THE SYNTHETIC VOLTAGES DELIVERED BY THE PWM ELECTRIC DRIVE

The tree-phased set of voltages delivered by the PWM electric drive has the wave shapes shown in fig.6.

The fundamental period of motor voltage is divided into 24 segments (each segment equals 15° of arc). This gives a good sine wave accuracy in many applications. During each “segment” the voltage is a percentage of the DC line voltage, given by duty cycle.

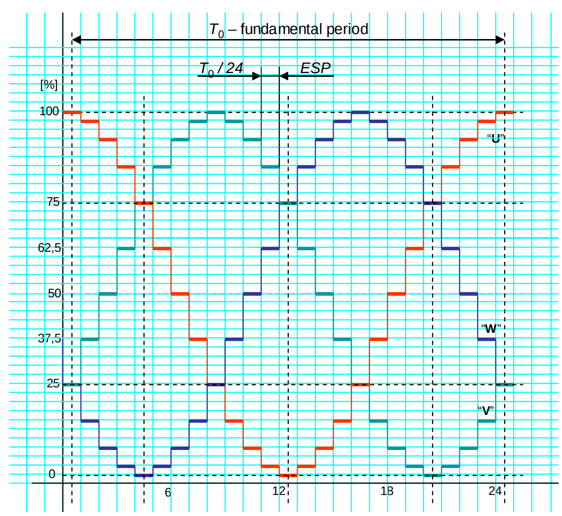


Fig.6 The wave shape of the voltages delivered by the PWM electric drive

The elementary switching period is subdivided into elementary time slots during which all 6 switches of the inverter are in a given state (“on” or “off”). Hence, a switching period can be represented with a pattern, i.e. a sequence of bytes corresponding to the different time slots (42 time slots in our example).

Each segment of the 3-phase sine waves can be represented with a defined average voltage during this segment on each of the 3 phases, and therefore with a given pattern. There must be as many different patterns as period segments (24 segments in our example), as shown in fig.7.

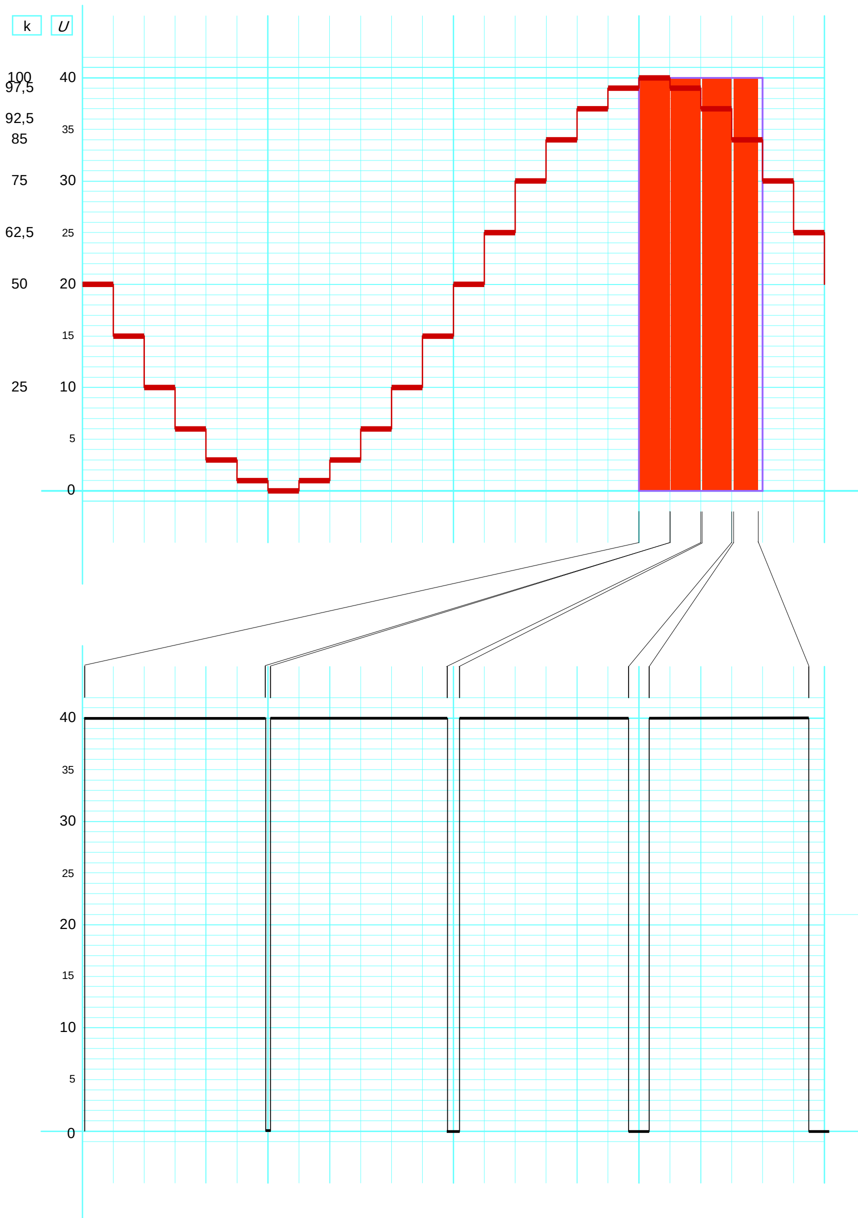


Fig.7 Defined average voltages during these segments

8. CONCLUSIONS

The PWM electric drives permit a smooth ajustment of the thrusters operational parameters:

- Voltage amplitude
- Voltage frequencies
- Sequences of three generated AC voltages

All these electric parameters can be independly controled for each electro-thruster, in order to increase the ship's maneuvrability.

9. REFERENCES

[1] DORDEA, ŞT., ZBURLEA, E., *Active Steering-Electric Thrusters*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 167-176, 10 pg, 2010 (cotat B+ în sistemul CNCSIS)

[2] DORDEA, ŞT., ZBURLEA, E., *Electric drives for azimuth propulsors*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 177-184, 8 pg, 2010 (cotat B+ în sistemul CNCSIS)

[3] DORDEA, ŞT., *Proportional Steering System*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 165-173, 9 pg, 2010 (cotat B+ în sistemul CNCSIS)

[4] DORDEA, ŞT., ZBURLEA, E., *Anti-Hunt Control System*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 173-179, 8 pg, 2010 (cotat B+ în sistemul CNCSIS)

[5] DORDEA, ŞT., CIUCUR, V., *3-Phase Asynchronous Motors Pulse Width Modulation (PWN) Drive*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 301-309, 8 pg, 2009 (cotat B+ în sistemul CNCSIS)

[6] DORDEA, ŞT., ZBURLEA, E., BADEA, M., *Optoelectronic Hydraulic Device*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 309-317, 8 pg, 2009 (cotat B+ în sistemul CNCSIS)

[7] DORDEA, ŞT., ZBURLEA, E., BADEA, M., *Naval Steering Control By Means Of Optic Tracks*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 317-323, 6 pg, 2009 (cotat B+ în sistemul CNCSIS)

[8] DORDEA, ŞT., *Monitoring the steering failures*, Ovidius University Annals of Mechanical, Industrial and Maritime Engineering, Volume X, Tom I, 2008, cod CNCSIS 603, Editura Ovidius University Press, ISSN 1223-7221 (cotat B+ în sistemul CNCSIS)

[9] DORDEA, ŞT., *Double Track Steering Failure Monitoring System*, Annals of the „Dunărea de Jos" University of Galati, Fascicle III – Electrotechnics, Electronics, Automatic Control, Informatics, cod CNCSIS 482 ISSN 1221-454X, 2007 (cotat B+ în sistemul CNCSIS)

[10] DORDEA, ŞT., *A Ship's Rate of Turn Steering Control*, A XXXII-a Sesiune de comunicări ştiinţifice cu participare internaţională „TEHNOLOGII MODERNE ÎN SECOLUL XXI, Academia Tehnică Militară, Bucureşti, 1 – 2 noiembrie 2007

[11] DORDEA, ŞT., *Aparate electrice de navigaţie*, autor unic, Ed. Muntenia, ISBN (10) 973-692-154-9, ISBN (13) 978-973-692-154-4, 105 pag, Constanta, 2006

[12] DORDEA, ŞT., *Acţionări electrice cu undă sintetică*, autor unic, Ed. Muntenia, ISBN (10) 973-692-153-0, ISBN (13) 978-973-692-153-7, 155 pag, Constanta, 2006

[13] DORDEA, ŞT., *Maritime automatic steering system with off-course monitor*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 227-230, 4 pg, 2006

[14] DORDEA, ŞT., *Versatile automatic steering system with off-course monitor*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 231-234, 4 pg, 2006

[15] DORDEA, ŞT., *Digitally activated electro hydraulic distributor*, A XXX-a Sesiune de comunicări ştiinţifice cu participare internaţională „Tehnologii moderne în secolul XXI", Academia Tehnică Militară, Bucureşti, 3-4 noiembrie 2005, pp.13.34-13.37, 4pg, ISBN 973-640-074-3

[16] DORDEA, ŞT., *Repartiţia secvenţială a sarcinii în acţionarea electronică a motoarelor asincrone trifazate*, A IX-a Sesiune de comunicări ştiinţifice cu participare internaţională „Ştiinţa şi învăţământul, fundamente ale secolului al XXI-lea", Ştiinţe tehnice, vol.I, ISBN 973 – 7809 – 04 – 1, ISBN 973 – 7809 – 03 – 3, Academia Forţelor Terestre „Nicolae Bălcescu", pp. 49 – 53, 5 pg, Sibiu, 2004

[17] DORDEA, ŞT., *Ship's rate-of-turn steering control*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 197-202, 6 pg, 2004

[18] DORDEA, ŞT., *Transferul de energie în sistemele electrohidraulice de guvernare navale*, Teză de doctorat, Universitatea „Dunărea de Jos" din Galaţi, 2002.

ELECTRIC PROPULSION WITH TURBO GENERATORS

[1]DORDEA STEFAN, [2]ZBURLEA ELENA

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

The main source of electric energy on board of a light high speed vessel is the turbo generator (gas turbine) ensuring the consomption of the electric propulsors.

A PWM electric drives permit a smooth ajustment of the propulsors operational parameters: voltage amplitude, voltage frequencies, sequences of three generated AC voltages. All these electric parameters can be independly controled for each electro-propulsor, in order to increase the ship's maneuvrability.

Keywords: *electro-propulsor, E-motor, PWM electric drives*

1. INTRODUCTION

The source for power is most often a generator set driven by a combustion engine which is fueled with diesel or heavy fuel oil.

Occasionally one can find gas engines, and also gas turbines, steam turbines or combined cycle turbines, especially for higher power levels, in light high-speed vessels, or where gas is a cheap alternative (e.g. waste product in oil production, boil-off in LNG carriers, etc).

2. GAS TURBINE PRINCIPLE OF OPERATION

Gas turbines are an established technology available in sizes ranging from several hundred kilowatts to over several hundred megawatts.

Gas turbines produce high quality heat that can be used for industrial or district heating steam requirements. Alternatively, this high temperature heat can be recuperated to improve the efficiency of power generation or used to generate steam and drive a steam turbine in a combined-cycle plant.

Gas turbine emissions can be controlled to very low levels using dry combustion techniques, water or steam injection, or exhaust treatment. Maintenance costs per unit of power output are about a third to a half of reciprocating engine generators. Low maintenance and high quality waste heat often make gas turbines a preferred choice for many industrial or large commercial combined heat and power (CHP) applications greater than 3 MW. A schematic of a gas turbine-based CHP system is shown in figure 1.

Gas turbines can be used in a variety of configurations:

(1) simple cycle operation which is a single gas turbine producing power only;

(2) combined heat and power (CHP) operation which is a simple cycle gas turbine with a heat recovery heat exchanger which recovers the heat in the turbine exhaust and converts it to useful thermal energy usually in the form of steam or hot water;

(3) combined cycle operation in which high pressure steam is generated from recovered exhaust heat and used to create additional power using a steam turbine. Some combined cycles extract steam at an intermediate pressure for use in industrial processes and are combined cycle CHP systems.

The most efficient commercial technology for central station power-only generation is the gas turbine-steam turbine combined-cycle plant, with efficiencies approaching 60% lower heating value (LHV).

Simple-cycle gas turbines for power-only generation are available with efficiencies approaching 40% (LHV). Gas turbines have long been used by utilities for peaking capacity. However, with changes in the power industry and advancements in the technology, the gas turbine is now being increasingly used for base-load power.

Gas turbines produce high-quality exhaust heat that can be used in CHP configurations to reach overall system efficiencies (electricity and useful thermal energy) of 70 to 80%.

By the early 1980s, the efficiency and reliability of smaller gas turbines (1 to 40 MW) had progressed sufficiently to be an attractive choice for industrial and large institutional users for CHP applications.

Gas turbine systems operate on the thermodynamic cycle known as the Brayton cycle. In a Brayton cycle, atmospheric air is compressed, heated, and then expanded, with the excess of power produced by the expander (also called the turbine) over that consumed by the compressor used for power generation.

The power produced by an expansion turbine and consumed by a compressor is proportional to the absolute temperature of the gas passing through the device. Consequently, it is advantageous to operate the expansion turbine at the highest practical temperature consistent with economic materials and internal blade cooling technology and to operate the compressor with inlet air flow at as low a temperature as possible. As technology advances permit higher turbine inlet temperature, the optimum pressure ratio also increases.

Higher temperature and pressure ratios result in higher efficiency and specific power. Thus, the general trend in gas turbine advancement has been towards a combination of higher temperatures and pressures.

While such advancements increase the manufacturing cost of the machine, the higher value, in terms of greater power output and higher efficiency, provides net economic benefits.

The industrial gas turbine is a balance between performance and cost that results in the most economic machine for both the user and manufacturer.

Gas turbine exhaust is quite hot, up to 800 to 900 ° F for smaller industrial turbines and up to 1,100 ° F for some new, large central station utility machines and aero derivative turbines.

Such high exhaust temperatures permit direct use of the exhaust. With the addition of a heat recovery steam generator, the exhaust heat can produce steam or hot water.

A portion or all of the steam generated by the HRSG may be used to generate additional electricity through a steam turbine in a combined cycle configuration.

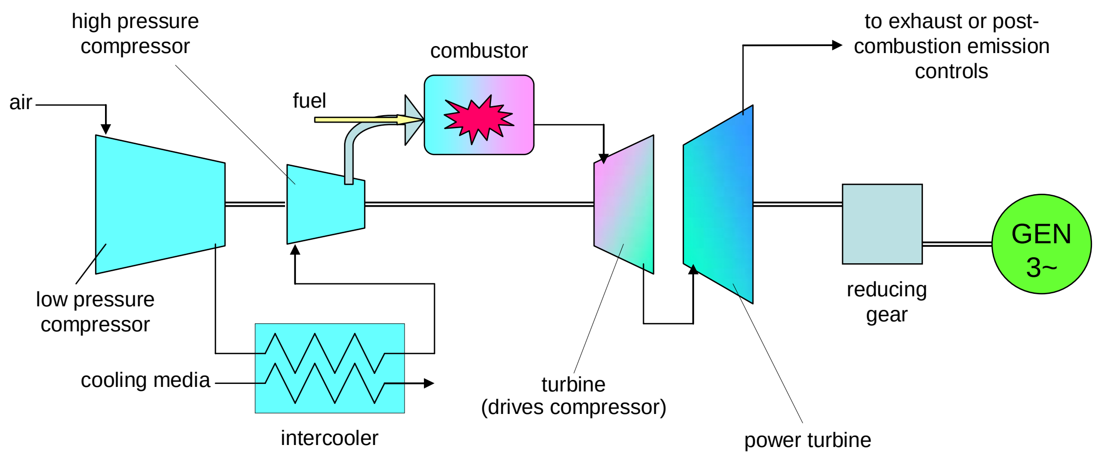


Fig. 1 Gas turbine system

There are two basic types of gas turbines:

Aero derivative gas turbines for stationary power are adapted from their jet and turbo shaft aircraft engine counterparts. While these turbines are lightweight and thermally efficient, they are usually more expensive than products designed and built exclusively for stationary applications.

The largest aero derivative generation turbines available are 40 to 50 MW in capacity. Many aero derivative gas turbines for stationary use operate with compression ratios in the range of 30:1, requiring a high-pressure external fuel gas compressor. With advanced system developments, larger aero derivative turbines (>40 MW) are approaching 45% simple-cycle efficiencies (LHV).

Industrial or frame gas turbines are exclusively for stationary power generation and are available in the 1 to 350 MW capacity range. They are generally less expensive, more rugged, can operate longer between overhauls, and are more suited for continuous base-load operation with longer inspection and maintenance intervals than aero derivative turbines. However, they are less efficient and much heavier. Industrial gas turbines generally have more modest compression ratios (up to 16:1) and often do not require an external fuel gas compressor. Larger industrial gas turbines (>100 MW) are approaching simple-cycle efficiencies of approximately 40% (LHV) and combined-cycle efficiencies of 60% (LHV).

Industry uses gas turbines between 500 kW to 40 MW for on-site power generation and as mechanical drivers. Small gas turbines also drive compressors on long distance natural gas pipelines. Turbines drive gas compressors to maintain well pressures and enable refineries and petrochemical plants to operate at elevated pressures.

In the steel industry turbines drive air compressors used for blast furnaces. In process industries such as chemicals, refining and paper, and in large commercial and institutional applications turbines are used in combined heat and power mode generating both electricity and steam for use on-site.

3. NAVAL ELECTRIC PROPULSION SYSTEM

An example of a high-speed vessel electric propulsion system is given in fig.2.

The system comprise two turbo generators and two Diesel generators. The schematic shows as principals loads the electric propulsors and as secondary ones two transformers needed by the services consumers.

The main voltage of the system is 4.16 kV.
The secondary voltages obtained by transformers are:

- First section 220V, 175V/60 Hz
- Second section 440V, 315V/60 Hz

The propulsion E-motors are directly linked with the fixed pitches propellers. They are supplied by means of two PWM drives (witch in the traditionally way are supplied by means of cycloconverters).

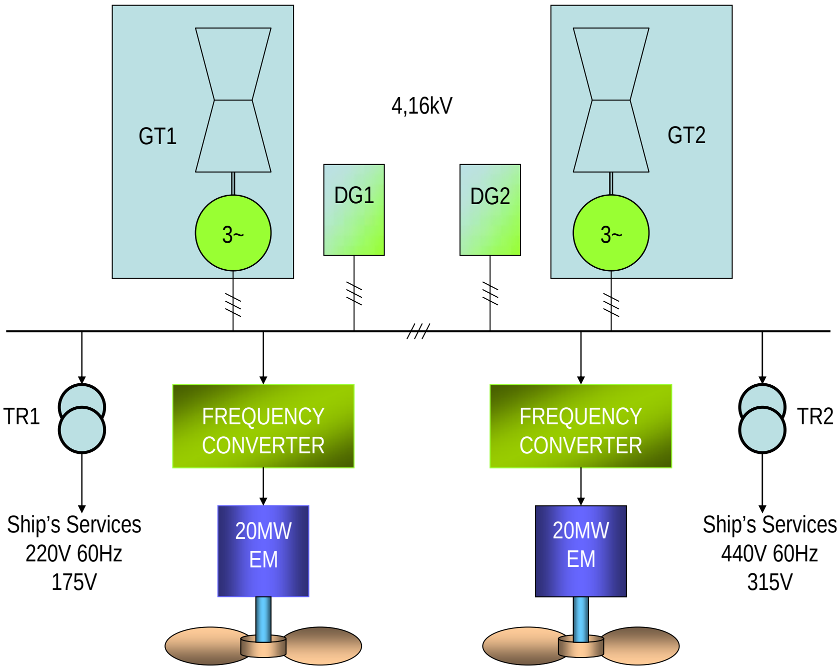


Fig. 2 Single line diagram for a ship with electric propulsion
TG1, TG2: Turbo Generators, DG1, DG2:Diesel Generators,
TR1, TR2: Services Transformers.

4. THE POWER ELECTRIC PLANT AND THE *PWM* ELECTRIC DRIVES

The Operator controls (fig.3):

- The acting sense of each propulsor (fore and stern)
- The speed of each E-motors
- The functions of the power electric plant and the PWM electric drives.

The mechanical energy of two Diesel engines and two turbines is converted into electric energy by means of the corresponding three-phased synchronous generators coupled to a distribution switchboard.

There are two reasons for equipping the PEP with two Diesel – Generator groups:

- the maneuver safety
- the capability of supplying other minor consumers.

The Operator controls:

- The start and stop of each Diesel generator
- The induction fields of both generators
- The PWM voltages
- The PWM frequencies

The main consumers of the power electric plant are obviously the propulsion E-motors controlled by the electronic adjustable PWM drive.

The sum of the installed power of the generators must be higher than the peak power asked by the propulsor; it refers to the maneuver safety.

$$\sum P_{GEN} > \max P_{CONSUMERS}$$

A single turbo generator must cover the power consumption of one propulsion E-motor.

$$P_{TG} > P_{EMOT}$$

The PWM drive contains a power controlled bridge made by six static switches (MOS transistors) controlled by a microcontroller charged with an appropriate program. In order to avoid the components irreversible damage the drive contains also six galvanic separation transformers and two stages of interfaces. This is because the microcontroller and primary interface has a low stabilized voltage and the power stage with the corresponding secondary interfaces have a high supply voltage from the rectifier.

The rectifier is supplied from the distribution board at 4.16 kV.

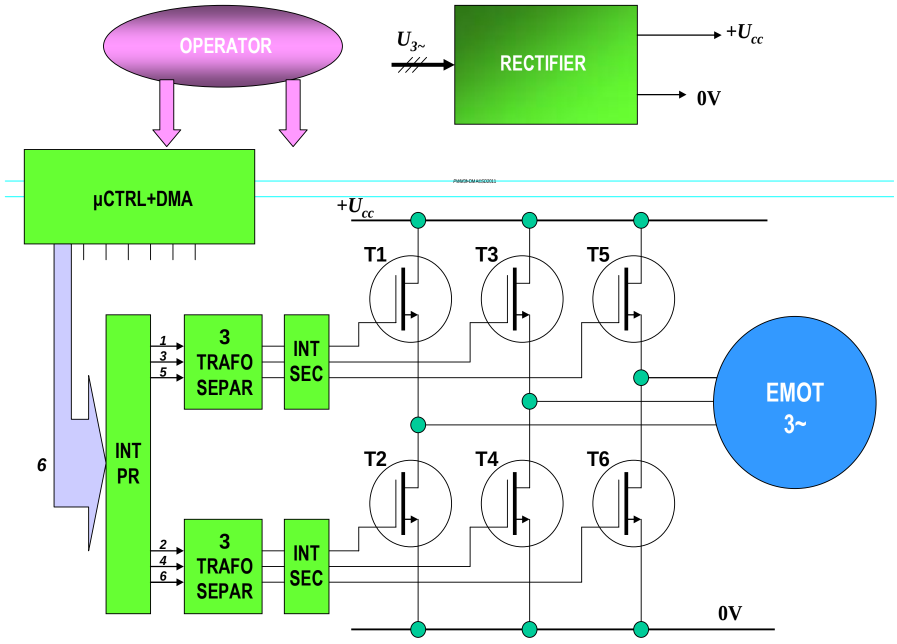


Fig. 3 Controlled system of electric propulsion

5. THE SYNTHETIC VOLTAGES DELIVERED BY THE PWM ELECTRIC DRIVE

Most of propulsors include asynchronous E-motors driven in Pulse Width Modulation (PWM) technique .

The fundamental period of E-motor voltage is divided into 24 segments (each segment equals 15° of arc-fig.4). This gives a good sine wave accuracy in many applications. During each "segment" the voltage is a percentage of the DC line voltage, given by duty cycleThe supply of a propulsor E-motor is made by means of a controlled PWM electric drive (fig.3).

The tree-phased set of voltages delivered by the PWM electric drive has the wave shapes shown in fig.4.

The three-phased voltage set coming from the distribution of the power electric plant is first rectified within the **RECTIFIER** (fig.3) and than the DC voltage U_{CC} is used to supply the power static switches bridge of the drive.

This control unit delivers adequate voltages to the corresponding gate circuits of the PWM power switches block. ***PWM*** control ensures also the galvanic separation between its electronics and the circuitry of power static switches bridge.

The variable speed drive of induction motors requires generating three voltage sine waves and control of their amplitude, phase and frequency.

The first step is to digitize the three phase system in order to create all the necessary data to be stored into the ROM of the ST9 microcontroller.

The elementary switching period is subdivided into elementary time slots during which all 6 switches of the inverter are in a given state ("on" or "off"). Hence, a switching period can be represented with a pattern, i.e. a sequence of bytes corresponding to the different time slots (42 time slots in our example).

Each segment of the 3-phase sine waves can be represented with a defined average voltage during this segment on each of the 3 phases, and therefore with a given pattern.

There must be as many different patterns as period segments (24 segments in our example), as shown in fig.4.

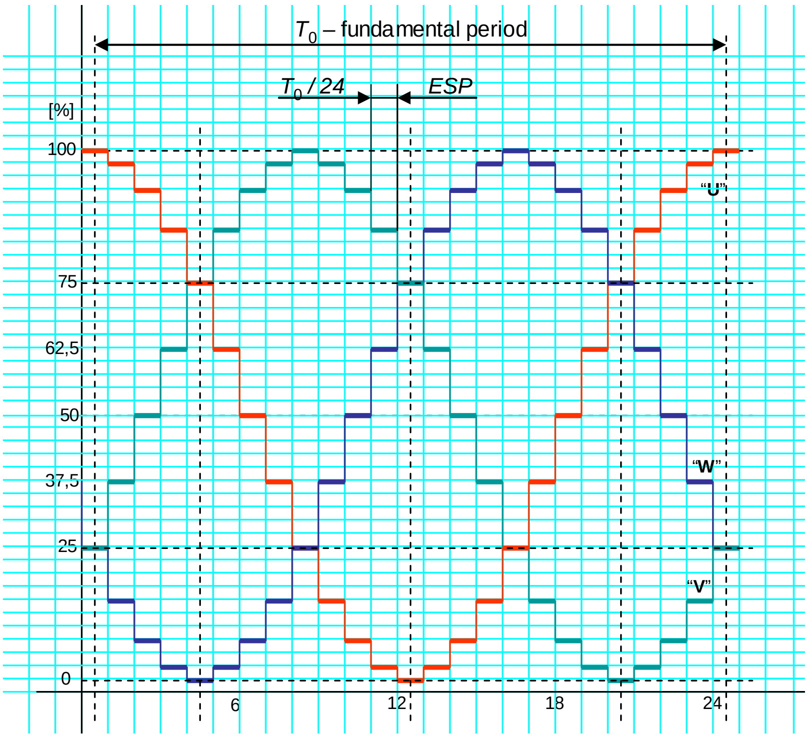


Fig.4 The wave shape of the voltages delivered by the PWM electric drive

6. CONCLUSIONS

The PWM electric drives permit a smooth ajustment of the propulsors operational parameters:

- Voltage amplitude
- Voltage frequencies
- Sequences of three generated AC voltages

All these electric parameters can be independly controled for each electro-propulsor, in order to increase the ship's maneuvrability.

7. REFERENCES

[1] DORDEA, ŞT., ZBURLEA, E., *Active Steering-Electric Thrusters*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 167-176, 10 pg, 2010 (cotat B+ în sistemul CNCSIS)

[2] DORDEA, ŞT., ZBURLEA, E., *Electric drives for azimuth propulsors*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 177-184, 8 pg, 2010 (cotat B+ în sistemul CNCSIS)

[3] DORDEA, ŞT., *Proportional Steering System*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 165-173, 9 pg, 2010 (cotat B+ în sistemul CNCSIS)

[4] DORDEA, ŞT., ZBURLEA, E., *Anti-Hunt Control System*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 173-179, 8 pg, 2010 (cotat B+ în sistemul CNCSIS)

[5] DORDEA, ŞT., CIUCUR, V., *3-Phase Asynchronous Motors Pulse Width Modulation (PWN) Drive*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 301-309, 8 pg, 2009 (cotat B+ în sistemul CNCSIS)

[6] DORDEA, ŞT., ZBURLEA, E., BADEA, M., *Optoelectronic Hydraulic Device*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 309-317, 8 pg, 2009 (cotat B+ în sistemul CNCSIS)

[7] DORDEA, ŞT., ZBURLEA, E., BADEA, M., *Naval Steering Control By Means Of Optic Tracks*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 317-323, 6 pg, 2009 (cotat B+ în sistemul CNCSIS)

[8] DORDEA, ŞT., *Monitoring the steering failures*, Ovidius University Annals of Mechanical, Industrial and Maritime Engineering, Volume X, Tom I, 2008, cod CNCSIS 603, Editura Ovidius University Press, ISSN 1223-7221 (cotat B+ în sistemul CNCSIS)

[9] DORDEA, ŞT., *Double Track Steering Failure Monitoring System*, Annals of the „Dunărea de Jos" University of Galati, Fascicle III – Electrotechnics, Electronics, Automatic Control, Informatics, cod CNCSIS 482 ISSN 1221-454X, 2007 (cotat B+ în sistemul CNCSIS)

[10] DORDEA, ŞT., *A Ship's Rate of Turn Steering Control*, A XXXII-a Sesiune de comunicări ştiinţifice cu participare internaţională „TEHNOLOGII MODERNE ÎN SECOLUL XXI, Academia Tehnică Militară, Bucureşti, 1 – 2 noiembrie 2007

[11] DORDEA, ŞT., *Aparate electrice de navigaţie*, autor unic, Ed. Muntenia, ISBN (10) 973-692-154-9, ISBN (13) 978-973-692-154-4, 105 pag, Constanta, 2006

[12] DORDEA, ŞT., *Acţionări electrice cu undă sintetică*, autor unic, Ed. Muntenia, ISBN (10) 973-692-153-0, ISBN (13) 978-973-692-153-7, 155 pag, Constanta, 2006

[13] DORDEA, ŞT., *Maritime automatic steering system with off-course monitor*, Analele Universităţii Maritime Constanţa, ISSN 1582-3601, pp. 227-230, 4 pg, 2006

[14] DORDEA, ŞT., *Versatile automatic steering system with off-course monitor*, Analele Universității Maritime Constanța, ISSN 1582-3601, pp. 231-234, 4 pg, 2006

[15] DORDEA, ŞT., *Digitally activated electro hydraulic distributor*, A XXX-a Sesiune de comunicări ştiințifice cu participare internațională „Tehnologii moderne în secolul XXI", Academia Tehnică Militară, Bucureşti, 3-4 noiembrie 2005, pp.13.34-13.37, 4pg, ISBN 973-640-074-3

[16] DORDEA, ŞT., *Repartiția secvențială a sarcinii în acționarea electronică a motoarelor asincrone trifazate*, A IX-a Sesiune de comunicări ştiințifice cu participare internațională „Ştiința şi învățământul, fundamente ale secolului al XXI-lea", Ştiințe tehnice, vol.I, ISBN 973 – 7809 – 04 – 1, ISBN 973 – 7809 – 03 – 3, Academia Forțelor Terestre „Nicolae Bălcescu", pp. 49 – 53, 5 pg, Sibiu, 2004

[17] DORDEA, ŞT., *Ship's rate-of-turn steering control*, Analele Universității Maritime Constanța, ISSN 1582-3601, pp. 197-202, 6 pg, 2004

[18] DORDEA, ŞT., *Transferul de energie în sistemele electrohidraulice de guvernare navale*, Teză de doctorat, Universitatea „Dunărea de Jos" din Galați, 2002.

NEW MAGNETIC MICROSENSOR STRUCTURES

[1]PANAIT CORNEL, [2]CARUNTU GEORGE

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

This paperwork presents the structure, the operating conditions and the main features of some microsensors realised in the bipolar and the MOS integrated circuits technology. By using numerical simulation, the values of the sensor response for the two analysed devices are compared and it is also emphasized the way in which choosing the geometry and the material features allows getting high-performance sensors.

Keywords: *the transverse Hall current, supply-current-related sensitivity, noise equivalent magnetic i magnetic sensors, double-drain magnetotransistor, signal-to-noise ratio, Hall effect, double-collector magnetotransistor nduction, carriers Hall mobility*

1. INTRODUCTION

Figure 1 shows an exemple of a Hall device in the form of a rectangular plate.

A bias current I is supplied to the device via two of the contacts, called the current contacts.The other two contacts are placed al two equipotential points at the plate boundary.

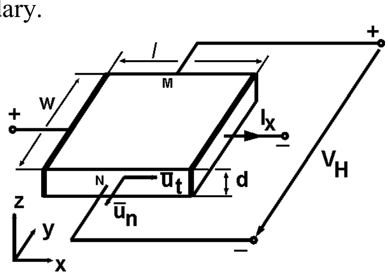


Figure. 1 The Hall semiconductor rectangular plate

These contacts are called the sense contacts. If a perpendicular magnetic field $B_\perp$ is applied to the device the Hall voltage V_H appears between the sense contacts.

$$V_H = \frac{R_H}{\delta} \cdot I \cdot B_\perp \quad (1)$$

where R_H denotes the Hall coefficient, and I the total biasing current.

In the case of a Hall device with finite contacts V_H is [1]:

$$V_H = G\frac{R_H}{\delta} \cdot I \cdot B_\perp \quad (2)$$

G being the geometrical correction factor. For an extrinsic semiconductor:

$$V_H = G\frac{r_H}{qn\delta} \cdot I \cdot B_\perp \quad (3)$$

where r_H is the Hall factor.

At low magnetic inductions, $\overline{B} \cong 0$, for an extrinsic semiconductor, the Hall voltage can be expressed in terms of the bias voltage V, as follows:

$$V_H = \mu_H \frac{w}{l} \cdot GVB_\perp \quad (4)$$

where μ_H is the Hall mobility of the charge carriers.

2. THE MOS HALL PLATES

In a MOSFET structure (figure 1), an extremely thin Hall plate can be realised if the channel constitutes the active region of plate, and the source (S), and drain (D) are the biasing contacts. For the sensing contacts of the Hall voltage SH_1 and SH_2 are manufactured, two strongly doped regions n^+ type. The channel length is L, and the width is W.

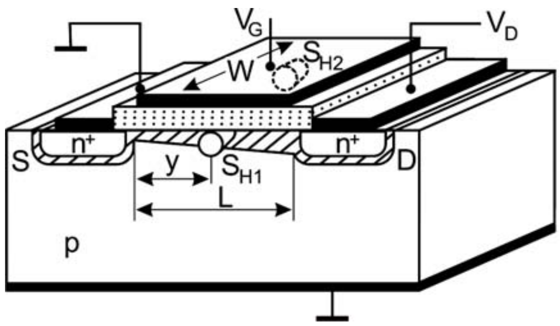


Figure 2. MOS-Hall plate

The bias in the linear region ensures a continuous channel having a thickness almost constant δ, which could be assimilated with a Hall plate.

Thus, we get a magnetic sensitive device converting the magnetic induction variation into variations of Hall-voltage generated.

In the case of a conventional Hall plate, the generated voltage is:

$$V_H = G(r_H / qn\delta)I \cdot B_\perp \quad (5)$$

where G is the geometrical correction factor, r_H the Hall factor and δ the thickness of the plate.

By replacing in (1) the product $qn\delta$ by the surface charge density in the channel Q_{Ch}, and the current I by I_D it results:

$$V_H = G(r_H / Q_{Ch}) I_D \cdot B_\perp \quad (6)$$

Using the drain current expression:

$$I_D = \frac{W}{L} \mu_{Ch} Q_{Ch} V_D \quad (7)$$

from (7) it results:

$$V_H = \mu_{H_{Ch}} \left(\frac{W}{L} G \cdot \right) V_D \cdot B_\perp \quad (8)$$

where $\mu_{H_{Ch}} = \mu_{Ch} \cdot r_H$ represents the Hall mobility of the charge carriers in the channel and V_D is the drain voltage.

3. THE SENSOR RESPONSE

The magnetic sensor response realised on a MOS-Hall plate is expressed by the relation:

$$h(B_\perp) = \frac{V_H}{V_D} = \mu_{H_{Ch}} \cdot \left(\frac{W}{L} G \right) \cdot B_\perp \quad (9)$$

and it is linear for induction values which satisfy the condition: $\mu_{H_{Ch}}^2 \cdot B_\perp^2 << 1$.

The absolute sensitivity of a Hall magnetic sensor is its transduction ratio for large signals:

$$S_A = \left| \frac{V_H}{B_\perp} \right| = G \cdot \frac{r_H}{|Q_{Ch}|} \cdot I_D = = \left| \mu_{H_{Ch}} \right| \cdot \left(\frac{W}{L} G \right) \cdot V_D \quad (10)$$

Supply current related sensitivity is defined by:

$$S_I = S_A / I_D = G(r_H / Q_{Ch}) \quad (11)$$

In figure 3 it can be seen the geometry influence on $h(B)$ values for three magnetotransistor structures, realised on silicon ($\mu_{H_n} = 0.07 m^2 V^{-1} s^{-1}$) and having different ratios L/W $(L = 100 \mu m)$:

PHM1: $L/W = o.5$; $(W/L)G = 0.73$;

PHM2: $L/W = 1$; $;(W/L)G = 0.67$

PHM3: $L/W = 2$; $;(W/L)G = 0.46$

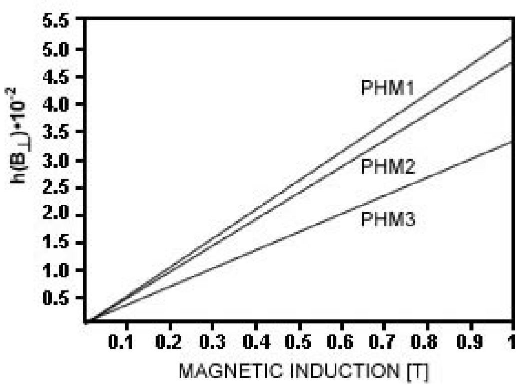


Figure 3. The *h(B)* depending on *B* for three devices of different geometry

It is noticed that the response $h(B)$ is maximum for $L/W = 0.5$ structure.

For the same geometry $L/W = 0.5$, the response is depending on material features.

In figure 4 there are shown $h(B)$ values of three sensors PHM1, PHM2, PHM3 realised on:

Si ($\mu_{H_{Ch}} = 0.07 m^2 V^{-1} s^{-1}$)

GaSb ($\mu_{H_{Ch}} = 0.25 m^2 V^{-1} s^{-1}$)

GaAs ($\mu_{H_{Ch}} = 0.42 m^2 V^{-1} s^{-1}$)

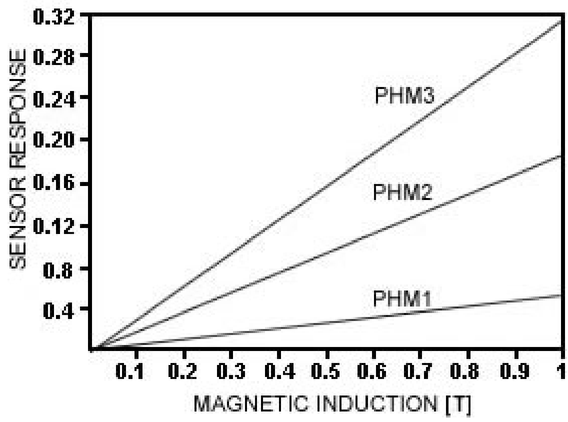


Figure 4. The *h(B)* depending on *B* for three devices on different materials

4. THE CARACTERISATION OF THE DOUBLE-DRAIN MAGNETOTRANSISTOR

The double – drain MOS device (figure 5) is obtained from a MOSFET structure where its conventional drain region is replaced by two adjacent drain regions. Consequently, the total channel current shared between this two drain regions [5].

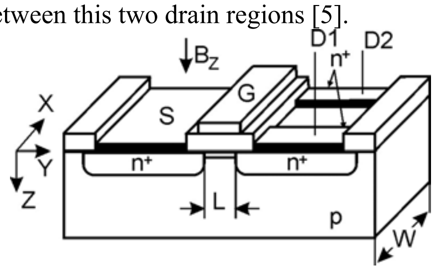


Figure 5. Double-drain MOSFET magnetotransistor.

The result of the bias is the linear region is the obtained of a continuous channel of approximately constant thickness, which can be assimilated with a short Hall plate. The deflection of current lines appears under the action of a magnetic field $B_\perp$, perpendicular to the device surface. The carrier deflection causes a discrepancy between two drain currents:

$$\Delta I_D = \left| I_{D1}(\overline{B}) - I_{D1}(0) \right| = \left| I_{D2}(\overline{B}) - I_{D2}(0) \right| \quad (12)$$

Since the output signal of the double-drain MOS magnetotransistors consists of the current variation between its terminals, this device operates in the Hall current mode. Using the features of dual Hall devices, and the Hall current expression it results [2]:

$$\Delta I_D = \frac{I_H}{2} = \frac{1}{2}\mu_{H_{Ch}} \cdot \frac{L}{W} \cdot G \cdot I_D \cdot B_\perp \quad (13)$$

where G denotes the geometrical correction factor and $\mu_{H_{Ch}}$ is the Hall mobility of the carriers in the channel.

The sensor response is xpressed by:

$$h(B) = \frac{\Delta I_D}{(I_{d1} + I_{D2})_{B=0}} = \frac{1}{2}\mu_{H_{Ch}} \frac{L}{W} \cdot G \cdot B_\perp \quad (14)$$

and it is linear for induction values which satisfy the condition: $\mu_H^2 \cdot B_\perp^2 << 1$.

In figure 6 it can be seen the geometry influence on $h(B)$ values for three magnetotransistor structures, realised on silicon ($\mu_{H_{Ch}} = 0.07 m^2 V^{-1} s^{-1}$) and having different ratios W / L $(W = 50\mu m)$.

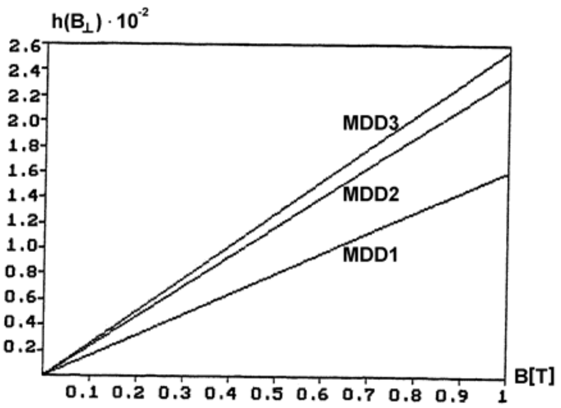


Figure 6. The *h(B)* depending on *B* for three devices of different geometry.

MGT1: $W / L = 0.5$, $(L/W)G = 0.72$;

MGT2: $W / L = 1$, $(L/W)G = 0.68$;

MGT3: $W / L = 2$, $(L/W)G = 0.46$;

It is noticed that the response $h(B)$ is maximum for $W / L = 0.5$ structure.

Decreasing the channel length, $h(B)$ decreases with 37.5% for $W = 2L$, comparative with the maximum value.

The sensor response decreases with 10.7%, comparative with $W/L = 0.5$ structure if the channel length doubles.

5. GENERAL CHARACTERISATION OF THE LATERAL MAGNETOTRANSISTOR IN CMOS TECHNOLOGY

Figure 7 illustrates the cross section of a split-collector magnetotransistor operating on the current deflection principle [3]. The n^+ regions of emitter E and primary collector C, are laterally separated on an L distance from base type *p* region. The two p^+ base contacts, allow the application of the drift-aided field $\overline{E}_a$. On its action the most part of the minority carriers injected into the base drift to primary collector, producing collector current I_C .

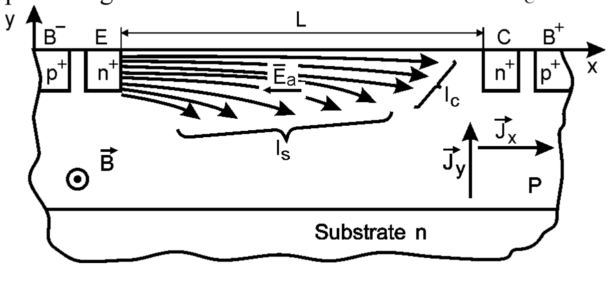


Figure 7 . Cross section of lateral magnetotransistor.

However some of electrons, diffuse downwards to the *n* type substrate (the secondary collector) and thus produce the substrate parasitic current I_S In the presence a magnetic induction $B_\perp$, perpendicular to the plane of the section the ratio between I_C and I_S, change because of the current deflection.

In order to describe the qualitative operation of the device, let us assume that it is adequately biased for the forward active operation.

If the very small magnetic field $\overline{E}_a$,is oriented as shown in figure 7, the electrons are deviated to substrate junction. Only a few electrons will contribute to collector current.

The area from base region, between the emitter contact and collector contact, operates as a short Hall plate, and an induction field $\overline{B}$ causes the deflection of current lines. The transverse will be:

$$I_Y = J_Y(LW) \quad (15)$$

where W is the dimension along the axis Z.

In the absence of a induction $\overline{B}$, the current density along the axis X has the following expression:

$$J_X = \frac{I_C}{WY} \quad (16)$$

The Y parameter takes values in (y_{jn}, y_{jp}).

Here y_{jn} and y_{jp} denote the junction depths of the collector region and the *p*-well respectively.

If it is considered the Hall angle expression [4] $tg\theta_{Hn} = \mu_{Hn} \cdot B$, then it is obtained:

$$J_Y = J_X \cdot tg\theta_{Hn} = \frac{(\mu_{Hn} B) I_C}{WY} \quad (17)$$

By substituting (17) into (15) it results:

$$I_H = I_Y = (L/Y) I_C \mu_{Hn} B_\perp = \Delta I_C$$

(18)

where μ_{Hn} is the Hall mobility of electrons in the *p*-well, and Y is a geometrical parameter given approximately by $y_{jn} < Y < y_{jp}$; y_{jn}, y_{jp} being the junction depths of the collector region , the *p*-well respectively.

6. GENERAL CHARACTERISATION OF THE DOUBLE-COLLECTOR MAGNETOTRANSISTOR

Figure 8 illustrates the cross section of a split-collector magnetotransistor operating on the current deflection principle [5]. This structure is compatible with bipolar integrated circuit technology.

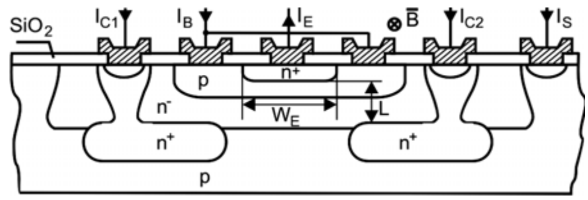


Figure 8. The structure of a double-collector magnetotransistor

In the presence of a magnetic field with induction $B_{\perp}$, the distribution of a emitter electrons current is asymmetrical and causes an imbalance in the two collector currents.

This unbalance grows because of the majority carrier deflection in the collector region (the epitaxial zone): $\Delta I_C = I_{C1} - I_{C2}$.

The analysed magnetotransistor operates in the Hall current mode and ΔI_C depends on the Hall traverse current.

Assimilating the low-doped epitaxial layer of the collector region with a short Hall plate based on the properties of dual Hall devices it results [2]:

$$\Delta I_C = \frac{I_H}{2} = \frac{1}{2}\mu_{Hn}\frac{L}{W_E}G \cdot I_C \cdot B_{\perp} \qquad (19)$$

where μ_{Hn} denotes the carriers Hall mobility, G is the geometrical correction factor, L is the emitter-collector distance, W_E is the emitter width and $I_C = I_{C1}(0) + I_{C2}(0)$.

The sensor response is expressed by:

$$h(B) = \frac{\Delta I_C}{(I_{C1} + I_{C2})_{B=0}} = \frac{1}{2}\mu_{Hn}\frac{L}{W_E} \cdot G \cdot B_{\perp} \qquad (20)$$

and it is linear for induction values which satisfy the condition: $\mu_H^2 \cdot B_{\perp}^2 << 1$.

In figure 9 it can be seen the geometry influence on $h(B)$ values for three magnetotransistor structures, realised on silicon ($\mu_{H_n} = 0.15 m^2 V^{-1} s^{-1}$) and having different ratios W_E / L $(W_E = 50\mu m)$.

MGT1: $W_E / L = 0.5$, $(L/W_E)G = 0.72$;

MGT2: $W_E / L = 1$, $(L/W_E)G = 0.68$;

MGT3: $W_E / L = 2$, $(L/W_E)G = 0.46$;

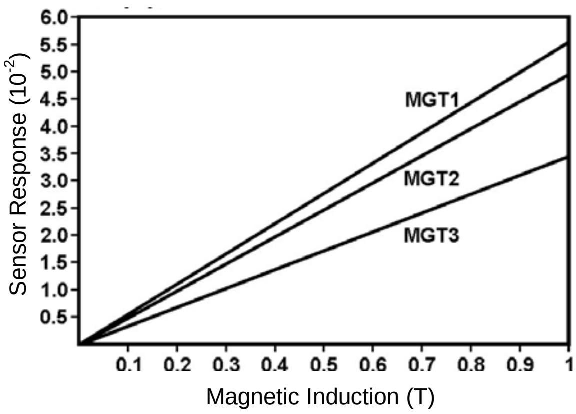


Figure 9. The *h(B)* depending on *B* for three devices of different geometry

It is noticed that the response $h(B)$ is maximum for $W_E / L = 0.5$ structure.

7. CONCLUSIONS

The analisys of the main characteristics of the double-collector magnetotransistor and the double drain magnetotransistor shows that the $W / L = 0.5$ structure is theoretically favourable to high performance regarding the sensor sensitivity. Also substituting the silicon technology by using other materials such as GaAs or InSb with high carriers mobility values assure higher characteristics of the sensors. The uses of magnetotransistors as magnetic sensors allows the achieving of some current-voltage conversion circuits, more efficient that conventional circuits with Hall plates.

6. REFERENCES

[1]. KIREEV P.S., *Fizica semiconductorilor*, Editura Ştiinţifică şi Enciclopedică, Bucureşti 1977

[2] GRAY R.P., MEYER G.R., *Circuite integrate analogice. Analiză şi proiectare*, Editura Tehnică, Bucureşti, 1993.

[3] KLEIMPENNING T.G.M., VANDAME L.K.J., *Comment on Travers 1/f noise in InSb thin films and the SNR of related Hall elements*, J. Appl. Phys. **50** 5547, 1979

[4] MIDDELHOEK S., AUDET S.A., *Physiscs of Silicon Sensors,* pp. 5.20, 5.21, Academic Press, London, 1989.

[5] Bodea, M., *Traductoare integrate*, Microelectronica, vol. 15, Editura Academiei R.S. România, Bucureşti, 1987, pp. 73-86

THE OFFSET-EQUIVALENT MAGNETIC INDUCTION

[1]PANAIT CORNEL, [2]CARUNTU GEORGE

[1,2]*Constanta Maritime University, Romania*

ABSTRACT

An essential parameter in the setting up of the performance of the measurement systems that uses Hall microsensors is the magnetic offset of such devices.

This paperwork presents the structure, the operating conditions, and the main characteristic for some microsensors realised in the MOS integrated circuits technology.

By using numerical simulation, the values of the offset-equivalent magnetic induction for two analysed devices are compared and it is also emphasised the way in which choosing the geometry and the material features allows getting high-performance sensors.

Keywords: *Hall current, lateral bipolar magnetotransisto, r double-drain magnetotransistor, offset collector current, offset equivalent magnetic induction ,noise equivalent magnetic induction*

1. THE LATERAL MAGNETOTRANSISTORS

1.1 General characterisation

Figure 1 illustrates the cross section of a lateral bipolar magnetotransistor structure, operating on the current deflection principle, realized in MOS integrated circuits technology. The device is situated in a *p*-well, serving as the base region of the transistor. The two base contacts B^+ and B^-, allow the application of an accelerating voltage for the minority carriers injected into the base region. The two n^+ regions laterally separated by the length of base along the distance L, serve as the emitter E and primary collector C. The substrate S works as the secondary collector.

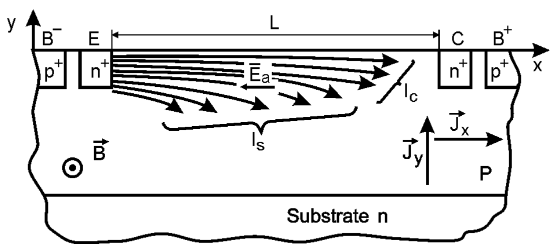


Figure1. Cross section of lateral magnetotransistor

If the very small magnetic field $\overline{E}_a$ is oriented as shown in figure 1, the electrons are deviated to substrate junction (I_S). Only a few electrons will contribute to collector current (I_C). The area from base region, between the emitter contact and collector contact, operates as a short Hall plate, and an induction field $\overline{B}_\perp$ causes the deflection of current lines. The transverse Hall current will be [1]:

$$I_H = I_Y = (L/Y) I_C \mu_{Hn} B_\perp = \Delta I_C \qquad (1)$$

where μ_{Hn} is the Hall mobility of electrons in the *p*-well, and Y is a geometrical parameter given approximately by $y_{jn} < Y < y_{jp}$. Here y_{jn} and y_{jp} denote the junction depths of the collector region and the *p*-well respectively.

1.2 Sensitivity and offset equivalent magnetic inductionon

The absolute sensitivity of the devices is defined by:

$$S_A = \left|\Delta I_C / B\right| = (L/Y)_{Hn} B_\perp) \qquad (2)$$

To describe the error due to the offset it is determined the magnetic induction, which produces the imbalance $\Delta I_C = \Delta I_{Coff}$.

The offset equivalent magnetic induction is expressed by:

$$\mathrm{B}_{off} = \frac{\Delta I_{C_{off}}}{S_I I_C} = \frac{1}{\mu_{Hn}} \cdot \frac{\Delta I_{C_{off}}}{I_C} \qquad (3)$$

where μ_{Hn} is the Hall mobility of electrons in the *p*-well. Considering $\Delta I_{Coff} = 0.10 \mu A$ and assuming that the low magnetic field condition is achieved, in figure 2 is presented the dependence of B_{off} on I_C for three magnetotransistors with the same geometry $L/Y = 0.5$ realized from different materials:

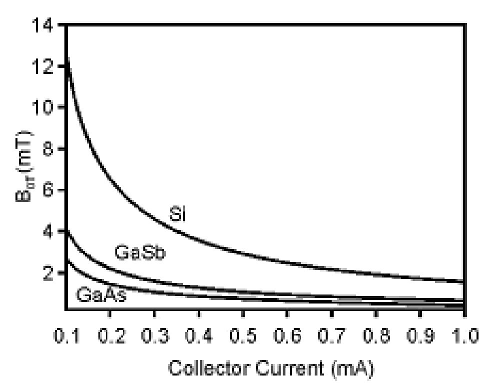


Figure 2. The B_{off} depending on the I_C for three devices of different materials

MGT1: Si with $\mu_{Hn} = 0.15 m^2 V^{-1} s^{-1}$;

MGT2: GaSb with $\mu_{Hn} = 0.50 m^2 V^{-1} s^{-1}$;

MGT3: GaAs with $\mu_{Hn} = 0.85 m^2 V^{-1} s^{-1}$

The offset-equivalent magnetic induction lowers with the increase of carriers' mobility. So for the same collector current $I_C = 0.10 mA$ the B_{off} value of the GaAs device decreases by 70% as compared to that of the silicon device.

2. THE DOUBLE-DRAIN MOSFET STRUCTURE

2.1 General characterisation

The double – drain MOS device is obtained from a MOSFET structure where its conventional drain region is replaced by two adjacent drain regions. Consequently, the total channel current shared between this two drain regions.The result of the bias in the linear region is the obtained of a continuous channel of approximately constant thickness, which can be assimilated with a hall plate.

The deflection of current lines appears under the action of a magnetic field $b_{\perp}$, perpendicular to the device surface. the carrier deflection causes a discrepancy between two drain currents:

$$\Delta I_D = \left| I_{D1}(\overline{B}) - I_{D1}(0) \right| = \left| I_{D2}(\overline{B}) - I_{D2}(0) \right| \quad (4)$$

Since the output signal of the double-drain MOS magnetotransistors consists of the current variation between its terminals, this device operates in the Hall current mode. Using the features of dual Hall devices, and the Hall current expression it results [2]:

$$\Delta I_D = \frac{I_H}{2} = \frac{1}{2} \mu_{H_{Ch}} \cdot \frac{L}{W} \cdot G \cdot I_D \cdot B_{\perp} \quad (5)$$

The supply-current-related sensitivity of the devices is defined by:

$$S_I = \frac{1}{I_D} \cdot \left| \frac{\Delta I_D}{B_{\perp}} \right| = \frac{1}{2} \mu_{H_{Ch}} \cdot \frac{L}{W} G \quad (6)$$

where G denotes the geometrical correction factor and $\mu_{H_{Ch}}$ is the Hall mobility of the carriers in the channel.

2.2 The offset-equivalent magnetic induction

The difference between the two drain currents in the absence of the magnetic field is the offset collector current:

$$\Delta I_{D_{off}} = I_{D1}(0) - I_{D2}(0) \quad (7)$$

The causes consist of imperfections specific to the manufacturing process: the contact non-linearity, the non-uniformity of the thickness and of the epitaxial layer doping, the presence of some mechanical stresses combined with the piezo-effect.

To describe the error due to the offset it is determined the magnetic induction, which produce the imbalance $\Delta I_C = \Delta I_{C off}$.

The offset equivalent magnetic induction is expressed by considering the relation (6):

$$B_{off} = \frac{\Delta I_{D_{off}}}{S_I I_D} = \frac{2}{\mu_{Hn}} \cdot \frac{\Delta I_{D_{off}}}{I_D} \cdot \left(G \frac{L}{W_E} \right)^{-1} \quad (8)$$

Considering $\Delta I_{D_{off}} = 0.10 \mu A$ and assuming that the low magnetic field condition is achieved in figure 3 is presented the dependence of B_{off} on I_D for three magnetotransistors with the same geometry $W / L = 0.5$ realised from different materials:

MDD1: Si with $\mu_{H_{Ch}} = 0.07 m^2 V^{-1} s^{-1}$;

MDD2: InP with $\mu_{H_{Ch}} = 0.23 m^2 V^{-1} s^{-1}$;

MDD3: GaAs with $\mu_{H_{Ch}} = 0.43 m^2 V^{-1} s^{-1}$.

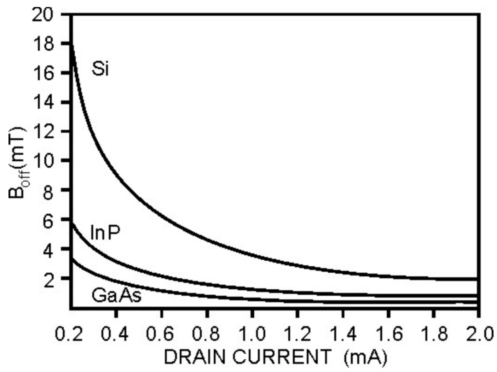


Figure 3. The B_{off} depending on the drain current for three devices of different materials

The geometry influence upon B_{off} is shown in figure 4 by simulating three magnetotransistors structures realised from silicon and having different $\frac{W}{L}$ ratios[3].

MDD1: $W / L = 0{,}5;\ G(L/W) = 0.73$

MDD2: $W / L = 1;\ G(L/W) = 0.67$

MDD3: $W / L = 2;\ G(L/W) = 0.46$

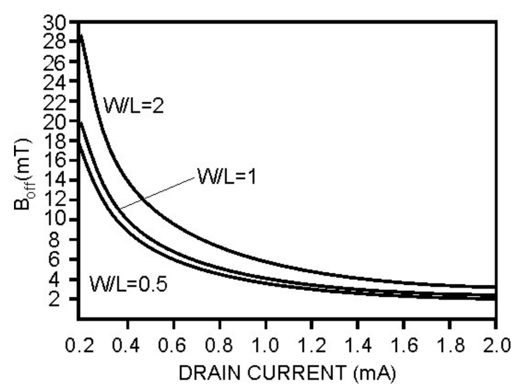


Figure 4. The B_{off} depending on the drain current for three devices of different geometry

If the width of the channel is maintained constant, B_{off} increases as the channel length decreases. So that minimum values for the offset equivalent induction are obtained with the device which has $L = 2W$, and in the MDD3 device these values are 53.5% bigger.

3. THE DOUBLE-COLLECTOR VERTICAL BIPOLAR MAGNETOTRANSISTOR

3.1 Description of the structure and the principle of operation

The structure of a double collector npn vertical magnetotransistor is compatible with the bipolar integrated circuit technology. The two collector contacts are realised by splitting the buried layer $\left(n^+\right)$. L is the collector-emitter distance, and W_E is the width of the emitter.

In the absence of the magnetic field the electron flow injected into the emitter, which crosses the base is symmetrical and the two collector currents are equal: $I_{C_1} = I_{C_2}$. In the presence of a magnetic field having the induction $\overline{B}$ parallel with the device surface, the distribution of the emitter electron current becomes asymmetrical and causes an imbalance of the collector currents. This imbalance is increased by the majority carrier's deflection phenomena, electrons, in the collector region (epitaxial zone): $I_C = I_{C_1} - I_{C_2}$.

The studied magnetotransistors work in the Hall current mode of operation and the deviation ΔI_C is given by the transverse Hall current.

Its expression is determined by equating the epitaxial layer of the collector region with a short Hall plate and applying the proprieties of the dual Hall devices:

$$\Delta I_C = \frac{I_H}{2} = \frac{1}{2}\mu_{Hn} \cdot \frac{L}{W_E} \cdot G \cdot I_C \cdot B \tag{9}$$

where G is the geometrical correction factor, μ_{H_n} represents the Hall mobility of the charge carriers, and $I_C = I_{C_1}(0) + I_{C_2}(0)$.

3.2 The offset equivalent magnetic induction

The magnetic sensitivity related to the devices current is:

$$S_I = \frac{1}{I_C}\left|\frac{\Delta I_C}{B_\perp}\right| = \frac{1}{2}\mu_{Hn}\frac{L}{W_E}G \tag{10}$$

The difference between the two collector currents in the absence of the magnetic field is the offset collector current: $\Delta I_{C_{off}} = I_{C1}(0) - I_{C2}(0)$

The causes consist of imperfections specific to the manufacturing process: the contact non-linearity, the non-uniformity of the thickness and of the epitaxial layer doping, the presence of some mechanical stresses combined with the piezo-effect.

To describe the error due to the offset we determine the magnetic induction, which produce the imbalance $\Delta I_C = \Delta I_{C_{off}}$. The offset equivalent magnetic induction is:

$$B_{off} = \frac{\Delta I_{C_{off}}}{S_I I_C} = \frac{2}{\mu_{Hn}} \cdot \frac{\Delta I_{C_{off}}}{I_C} \cdot \left(G\frac{L}{W_E}\right)^{-1} \tag{11}$$

Considering $\Delta I_{Coff} = 0.10\mu A$ and assuming that the low magnetic field condition is achieved, in figure 5 is presented the dependence of B_{off} on I_C for three magnetotransistors with the same geometry $W_E / L = 0.5$ realised from different materials:

MGT1: Si with $\mu_{Hn} = 0.15 m^2V^{-1}s^{-1}$;

MGT2: InP with $\mu_{Hn} = 0.46 m^2V^{-1}s^{-1}$;

MGT3: GaAs with $\mu_{Hn} = 0.85 m^2V^{-1}s^{-1}$.

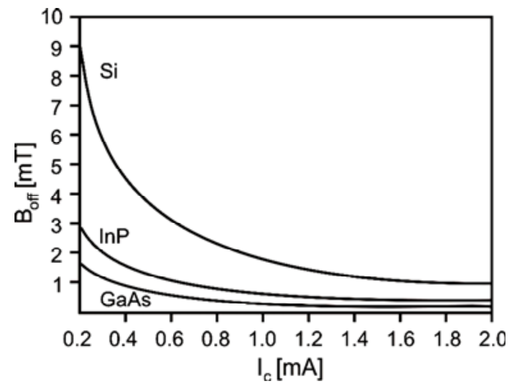


Figure 5. The B_{off} depending on the collector current I_C for three devices of different materials

The geometry influence upon B_{off} is shown in figure 6 by simulating three magnetotransistors structures realised from silicon and having different W_E / L ratios.

If the width of the emitter is maintained constant, B_{off} as the emitter-collector distance decreases. This kind of minimum values for the offset equivalent induction are obtained with the device which has $L = 2W_E$, and in the MGT3 device these values are 53.5% bigger.

MGT1: $W_E / L = 0{,}5$; $GL / W_E = 0.73$;

MGT2: $W_E / L = 1$; $GL / W_E = 0.67$;

MGT3: $W_E / L = 2$; $GL / W_E = 0.46$;

4. MOS-HALL PLATES

4.1.The general characteristic of a MOS-Hall plate

In the MOSFET structure a Hall plate can be realised if the channel is the active region of the plate, and the source (S) and the drain (D) are the biasing contacts. The channel length is *L*, and the width is *W*.

The bias in the linear region ensures a continuous channel having a thickness almost constant δ , which could be assimilated with a Hall plate.

In the case of a MOS-Hall plate, the generated voltage is [4]:

$$V_H = \mu_{H_{Ch}} \left(\frac{W}{L} G \cdot \right) V_D \cdot B_\perp \qquad (12)$$

where V_D is the drain voltage, and $\mu_{H_{Ch}} = \mu_{Ch} \cdot r_H$ represents the Hall mobility of the charge carriers in the channel.

4.2. The offset voltage and the offset equivalent magnetic induction

The absolute magnetic sensitivity for the Hall device used as magnetic sensor is defined by:

$$S_A = \left| \frac{V_H}{B_\perp} \right| = \left| \mu_{H_{Ch}} \right| \cdot \left(\frac{W}{L} G \right) \cdot V_D \qquad (13)$$

In the case of the misalignment of the sensing contacts, for a tolerance ΔL the asymmetrical output voltage or the offset voltage is expressed by [5]:

$$V_{off} = \frac{\Delta L}{W} \cdot \frac{1}{\mu_{Ch} Q_{Ch}} \cdot I_D \qquad (14)$$

The value of the magnetic induction corresponding to a Hall voltage equal with V_{off} represents offset equivalent magnetic induction.

In the case of the geometrical offset of the sensing contacts, the expression of the offset equivalent magnetic induction is got by replacing (14) into (13):

$$B_{off} = \frac{V_{off}}{S_A} = \frac{1}{\mu_{H_{Ch}}} \cdot \left(\frac{W}{L} G \right)^{-1} \frac{\Delta L}{L} \qquad (15)$$

Assuming that the condition of a low magnetic field is fulfilled, minimal values for B_{off} are obtained if $\frac{L}{W} \leq 0.5$ when the product $\left(\frac{W}{L} G \right)$ takes the maximal value 0.74 [3]:

$$(B_{off})_{\min} \cong \frac{1}{0{,}74 \cdot \mu_{H_{Ch}}} \cdot \frac{\Delta L}{L} \qquad (12)$$

In the figure 2 are represented the values B_{off} for three structures with an optimal geometry of the channel $(L = 2W)$ realised from different materials

.

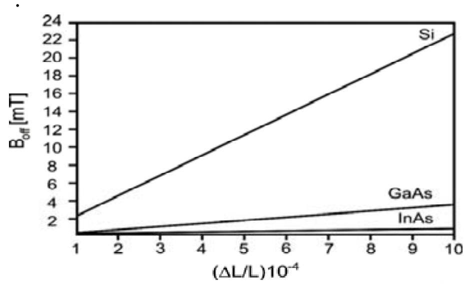


Figure 7. The B_{off} depending on the geometrical offset ΔL/L for three devices of different materials

For values of the geometric offset within the range $[10^{-4}, 10^{-3}]$, in the *Si* device, $(B_{off})_{\min}$ varies between 2.2 *mT* and 22 *mT* and in GaAs device $(B_{off})_{\min}$ covers the range $[0.39; 3.9] mT$, the increase of the offset equivalent induction slope being of 5.67 times smaller in GaAs.

6. CONCLUSIONS

The analysis of the characteristics of the vertical bipolar double – collector magnetotransistor shows that the $W_E / L = 0.5$ ratio is theoretically favourable to high performance regarding the offset equivalent magnetic induction.

Also, substituting the silicon technology by using other materials such as GaAs or InSb with high carrier mobility values, assure higher characteristics of the sensors.

The offset equivalent magnetic induction lowers with the increase of carriers mobility, this increase being significant for collector currents of relatively low values. So for the collector current $I_C = 0.2 mA$, the offset equivalent magnetic induction value of the GaAs device decreases by 81.8% as compared to that of the silicon device.

7. REFERENCES

[1] CĂRUNTU G., DRĂGULINESCU M., *The Noise-Equivalent Magnetic Induction Spectral Density of Magnetotransistors*, *in The Proceedings of CAS 2005*, pp 451-454, October 3-5, 2005, Sinaia, Romania

[2] CĂRUNTU G., *Măsurări galvanomagnetice în dispozitive semiconductoare.* SECOMAR '99, Academia Navală „Mircea cel Bătrân, vol. II, pp. 69-74, Constanța, iunie, 1999.

[3] MIDDELHOEK S., AUDET S.A., *Physiscs of Silicon Sensors,* pp. 5.20, 5.21, Academic Press, London, 1989.

[4] CĂRUNTU G., PANAIT C., *The Noise of MOS Magnetic Microsensors Structures*, *in The Proceedings of CAS 2008*, October, 2008, Sinaia, Romania

[5] CĂRUNTU G., PANAIT C., *On the Stability of MOS Hall Microsensors*, *in The Proceedings of CAS 2006*, October, 2006, Sinaia, Romania

A TIME-DOMAIN MEASURING TECHNIQUE FOR ELECTRICALLY LARGE ULTRA-WIDE BAND ANTENNAS

[1]TAMAS RAZVAN, [2]IOANA CORNEL, [3]CARUNTU GEORGE

[1,3]Constanta Maritime University, Romania,
[2]Grenoble INP/ENSE3 - GIPSA-lab, Departement Images-Signal961 rue de la Houille Blanche BP 46, 38402 Saint Martin d'Hères Cedex, Franta

ABSTRACT

The single-antenna method consists of a virtual transmission between the antenna under test and its image in a conducting reflector. In a previous work we proposed a differential, time-domain single-antenna approach that was found suitable for measuring the impulse response of an ultra-wide band antenna. The approach provides accurate results within the far-field distance range. However, when measuring large ultra-wide band (UWB) antennas operating in the lower UWB frequency band for military applications, i.e., from 0.1 to 1 GHz the distance between the antenna and its image usually falls close to the lower limit of the Fraunhofer region. This paper presents an intermediate-field approach of the time-domain differential single antenna method, based on defining a normalized received signal that can be averaged over a set of distances. The proposed technique is established theoretically and validated experimentally on a cylindrical UWB monopole antenna.

Keywords: *Ultra-wide band antennas, time-domain measuring, single-antenna method.*

1. INTRODUCTION

In a previous work [1] we proposed a differential, time-domain single-antenna technique for measuring the impulse response of an ultra-wide band antenna. As opposed to traditional single-antenna techniques, our method can provide a simpler separation of the three signals at the antenna input (i.e., excitation signal, antenna input reflected signal, and received signal) even though they might be superposed. Measurements are performed in a low-noise environment, such as a Faraday cage; in that case, the antenna under test is placed close to one cage wall.

As shown [1] the time-domain differential single-antenna method provides accurate results as long as far-field conditions are granted. However, such a constraint prevents one from using the method to measure electrically large antennas. That is, the antenna under test cannot be placed too far away from the Faraday cage wall considered as reflector, given that the shorter the distance, the longer the time-span available for extracting the response. It is obviously more difficult to overcome such a constraint for antennas operating in the lower UWB frequency band for military applications, i.e., from 0.1 to 1 GHz. In such cases the distance between the antenna and its image usually falls close to the lower limit of the Fraunhofer region, where the far-field assumption is not accurate. Extrapolation of the intermediate-field measured values [2], [3] can be helpful in such cases.

In this paper, we propose an intermediate-field approach for the time-domain differential single-antenna method. Our technique is based on defining a normalized received signal that can be averaged over a set of distances. The approach is established theoretically and validated experimentally on a cylindrical UWB monopole antenna. In the cases under consideration here, the proposed technique can be seen as a simpler but accurate alternative to extrapolation.

2. AVERAGING TECHNIQUE FOR DIFFERENTIAL TIME-DOMAIN SINGLE-ANTENNA METHOD

Figure 1 shows the equivalent circuit diagram for the time-domain single-antenna setup. The antenna impulse response in transmitting mode was denoted by $h_t(t)$ and the antenna impulse response in receiving mode was denoted by $h_r(t)$.

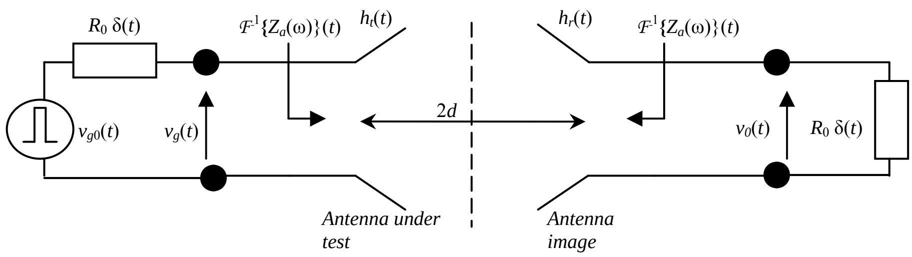


Figure 1 Time-domain single-antenna method: two-antenna equivalent circuit diagram

We assume that the current distribution on the antenna under test lies on the vertical direction i.e., *OZ* axis. For most monopole or dipole antennas an equivalent filamentary current distribution $I(z')$ can be defined (Fig. 2).

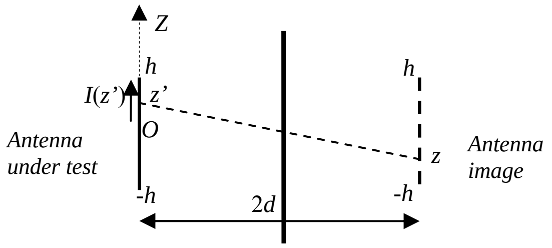


Figure 2 Virtual transmission between a source point on the antenna and a field point on the antenna image

Since practical antenna dimensions might be close to the distance the far-field assumption would not be realistic. Conversely, intermediate-field conditions [4] can be assumed for elementary current filaments on the antenna. Hence the Fourier transform of the received signal can be found as

$$V_0(\omega,d) \sim jk_0 \int_{-h}^{h}\int_{-h}^{h} I(z') \frac{\exp(-jk_0 r)}{4\pi r} dz' dz \quad (1)$$

with

$$r = \sqrt{4d^2 + (z-z')^2} \quad (2)$$

Furthermore, if $d \geq 3h$ then

$$\begin{aligned} V_0(\omega,d) &\sim jk_0 \frac{\exp(-2jk_0 d)}{8\pi d} \\ &\times \int_{-h}^{h} I(z') \int_{-h}^{h} \exp\left[-jk_0 \frac{(z-z')^2}{4d}\right] dz\, dz' \end{aligned} \quad (3)$$

by assuming that $\sqrt{1+x}\Big|_{x<<1} \cong 1+\frac{x}{2}$. A normalized received voltage can be defined as

$$V_{0,norm}(\omega,d) = d\exp(2jk_0 d) V_0(\omega,d) \quad (4)$$

The normalized received voltage becomes independent on the distance in the far-field region, that is, $V_{0,norm}(\omega,\infty) = \lim_{d\to\infty} V_{0,norm}(\omega,d)$. Let

$$F(z',d) = \int_{-h}^{h} \exp\left[-jk_0 \frac{(z-z')^2}{4d}\right] dz \quad (5)$$

Since

$$\lim_{d_2\to\infty} \frac{1}{(d_2-d_1)} \int_{d_1}^{d_2} F(z',x)\, dx = 1 \quad (6)$$

then

$$\begin{aligned} V_{0,norm}(\omega,\infty) &= \lim_{d_2\to\infty} \frac{1}{(d_2-d_1)} \\ &\times \int_{d_1}^{d_2} V_{0,norm}(\omega,x)\, dx \sim jk_0 \int_{-h}^{h} I(z')\, dz' \end{aligned} \quad (7)$$

Relation (7) shows that a close approximation of the far-field antenna response can be found by averaging the normalized received voltage over a set of distances, as long as the minimal distance $d_{min} \geq 3h$. That is,

$$V_{0,norm}(\omega,\infty) \cong \frac{1}{N} \sum_{n=1}^{N} V_{0,norm}(\omega,d_n) \quad (8)$$

Consequently, the far-field transfer function of the antenna [1], i.e., the Fourier transform of the antenna impulse response, can then be calculated.

3. EXPERIMENTAL RESULTS USING THE PROPOSED AVERAGING TECHNIQUE

In order to validate our approach, a large UWB cylindrical monopole ($2h$=45cm) was measured (Fig. 3) by using the differential time-domain single-antenna method [1]. The antenna under test antennas was conceived to operate in the lower UWB band for military applications, i.e., from 0.1 GHz to 1 GHz. Measurements were performed at seven equally spaced distances between 70 cm and 130 cm.

Figure 3 Cylindrical monopole. Antenna dimensions: rod length=22.5 mm, rod diameter=25 mm, gap length =5mm, ground plane side length = 500 mm

As expected for intermediate-field conditions, the spectrum profile of the normalized received voltage is highly different from one distance to another (Fig. 4). The solid thick curve in Fig. 4 shows the average over all seven distances.

As noted from Fig. 5, the magnitude of the average of F(z',d) over all seven distances is close to 1 for frequencies up to 1.2 GHz.

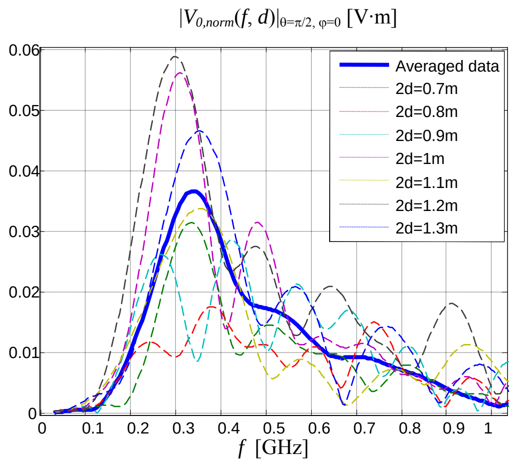


Figure 4 Spectrum profile of the normalized received voltage

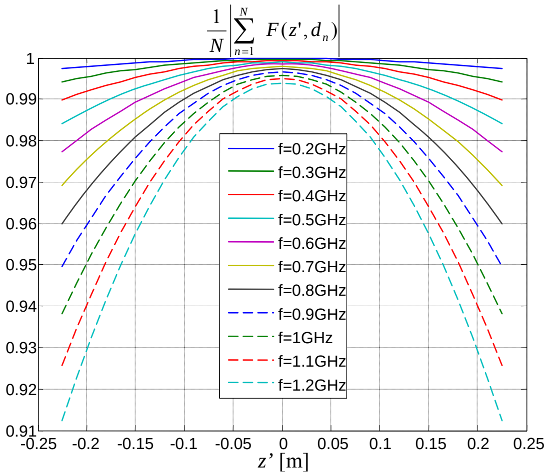


Figure 5 Magnitude of the average of $F(z',d)$ over d

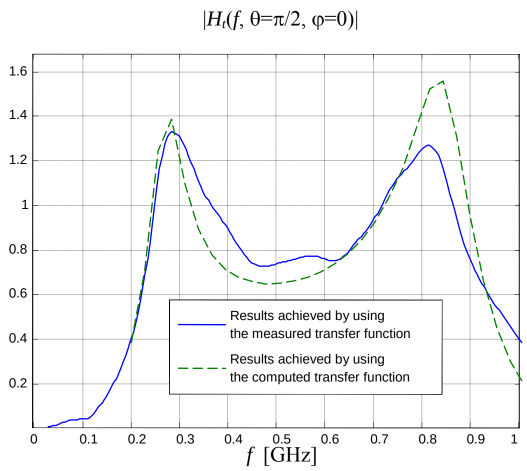


Figure 6 Frequency-domain transfer function of the UWB cylindrical monopole as a transmitting antenna

The transfer function of the antenna [1] was then computed by using the averaged measured data and compared to simulation results obtained by using GNEC. Fig. 6 shows measured and computed transfer function in transmitting mode.

Furthermore, by using the measured and computed transfer function we evaluated the time-domain response of the antenna under test considering an excitation proportional to the first derivative of a Gauss function. The frequency band of the excitation is centered on 500MHz. Time-domain results are given on Fig. 7.

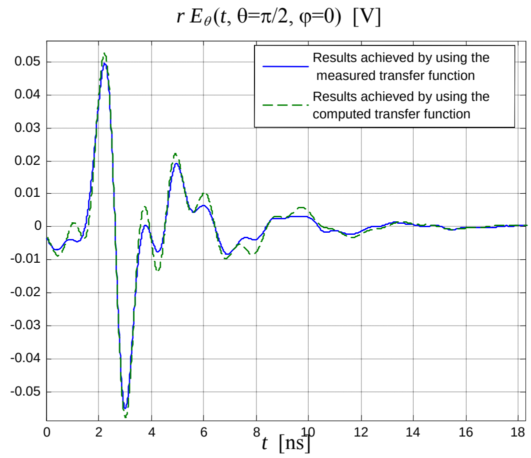


Figure 7 Time-domain response of the UWB cylindrical monopole for an excitation pulse proportional to the first derivative of the Gauss function

4. CONCLUSIONS

As our results show, the differential time-domain single-antenna method can also be used for electrically large UWB antennas although practical distances between the antenna under test and the reflecting plate do not grant far-field conditions. The proposed averaging technique helps to overcome that constraint.

The minimal distance between the antenna under test and the reflecting plate must be chosen such as the magnitude of the field emerging from every current filament is inversely proportional to the distance, that is, $d_{min} \geq 3h$. Furthermore, the choice of the maximal distance only depends on the usual constraints of the single antenna method related to a proper extraction of the reflected signal [1].

The resolution in distance, i.e., the distance increment between two measuring positions sets up the maximal frequency of analysis. This actually explains the increasing difference between the measured transfer function and the computed transfer function of the antenna as the frequency increases.

5. ACKNOWLEDGMENTS

This study was supported in part by the Romanian Ministry of education, research, and innovation – UEFISCDI - under the project SIRADMAR.

6. REFERENCES

[1]. R.D. TAMAS, L. BABOUR, M. ALEXA et al., "Differential Time-Domain Single-Antenna Method for Ultra-Wide Band Antenna Measurements," *IEEE International Workshop on Antenna Technology (IWAT 2009)*, March 2009.

[2]. J.D. KRIEGER, E.H. NEWMAN, and I.J. Gupta, "The Single Antenna Method for the Measurement of Antenna Gain and Phase," *IEEE Transaction on Antenna and Propagation*, vol. 54, no. 11, pp. 3562-3565, November 2006.
[3]. A. C. NEWELL, R.C. BAIRD, P. F. WACKER, "Accurate Measurement of Antenna Gain and Polarization at Reduced Distances by an Extrapolation Technique," *IEEE Transaction on Antenna and Propagation*, vol. 21, no. 4, pp. 418-431, July 1973.
[3]. C. A. BALANIS, *Antenna Theory – Analysis and Design*, 2nd ed., John Wiley and Sons, Inc., pp.140-151, 1997.

A COOPERATIVE METHOD FOR LOCALIZATION OF TELECOMMUNICATION INTERVENTION TEAMS IN CELLULAR NETWORKS

[1]ZEVEDEI DALINA, [2]JURIAN MARIANA

[1,2]*Department of Electronics and Computers University of Pitesti, Romania*

ABSTRACT

In this paper we have studied a method for locate mobile telecommunication teams using hybrid time difference of arrival (TDoA) and received signal strength (RSS) measurements. To improve the positioning accuracy a cellular network cooperates with an ad-hoc network. This paper applies data fusion to combine the information of RSS and TDoA measurements to calculate a superior location estimate.

Keywords: *TDOA, RSS, cooperative positioning, data fusion*.

1. INTRODUCTION

Mobile communication is continuously one of the hottest areas that are developing at a booming speed, with advanced techniques emerging in all fields of mobile and wireless communications. Localization was used till now only to assist emergency calls, but today in the form of location-based services is considered as one of the potential market drives in the telecommunication industry. Location based applications can help companies (e.g. telecommunication companies) to manage their workforce and resources (e.g. repair engineers, sales people) efficiently by dispatching of the nearest team to the intervention place as to provide to the customers a minimal time of response of his requests.

The use of the Global Positioning System (GPS) for mobile localization has been applied in 3G but it does not provide acceptable performance in indoor and urban areas. In 4G connection the research have started in order to define a localization system able to provide accurate location information anytime and anywhere [4]. The performance of positioning can be improved by exchanging positional information between agents. Several existing positioning techniques can be combined in order to improve the localization accuracy according to specific networks and evolving technologies. Conventional positioning techniques rely on the angle of arrival (AOA), received signal strength (RSS), the time to arrival (TOA) and the time difference of arrival (TDoA) measurements. Each technique has its own merits and drawbacks, under given cost and complexity constrains [1].

Angle of arrival (AoA) estimation can be obtained if the network infrastructure provides antenna arrays, but accuracy is dependent on the line-of-sight (LOS) conditions. Time of arrival (TOA) information from a mobile station MS to a base station BS or viceversa can be estimated if both entities are synchronized in time. The TDoA technique can be employed when there is no synchronization between a given node and a reference nodes, but there is synchronization between references nodes. In received signal strength (RSS) technique the distance is estimated using the received power but the power at the MS depen ds on the average path loss and shadowing conditions.

2. TDoA MEASUREMENT MODEL

The TDoA (Time Difference of Arrival) is the difference in TOAs (Times of Arrival) of the MS signal at a pair of BSs. Assume each BSi is capable of performing TOA observation t_i, then TDoA observation is defined assuming [5]

$$T_i = t_i - t_1, \qquad i = 2,.....N.$$

In practice, the range difference measurements obtained are corrupted by noise. We assume a LOS environment and zero-mean noises.

Expressing TDoA observation as a function of station, a hyperbola has the form

$$cT_i = \sqrt{(x-x_i)^2 + (y-y_i)^2} - \sqrt{(x-x_1)^2 + (y-y_1)^2} \tag{1}$$

where c is the speed of light, (x_1, y_1) and (x_i, y_i) are the coordinates of the BS_1 and BS_i respectively, and (x, y) is the unknown MS position. The MS position is determined by solving the intersections of a set of hyperbolas. We observe here that TDoA generated non-linear hyperbolic functions *(x)* and *(y)* which are difficult to solve. The least squares estimation is a common technique to solve TDoA equations linearised by the first two terms of Taylor series [7,8].

If consider (x_0, y_0) the initial position of MS, the linearisation of (1) is given by

$$m_{xi}x + m_{yi}y = cT_i - f_i + m_{xi}x_0 + m_{yi}y_0 \tag{2a}$$

Where

$$m_{xi} = \frac{(x_0 - x_i)}{\sqrt{(x_0 - x_i)^2 + (y_0 - y_i)^2}} - \frac{(x_0 - x_1)}{\sqrt{(x_0 - x_1)^2 + (y_0 - y_1)^2}} \tag{2b}$$

$$m_{yi} = \frac{(y_0 - y_i)}{\sqrt{(x_0 - x_1)^2 + (y_0 - y_1)^2}} - \qquad (2c)$$

$$- \frac{(y_0 - y_1)}{\sqrt{(x_0 - x_1)^2 + (y_0 - y_1)^2}}$$

$$f_i = \sqrt{(x_0 - x_i)^2 + (y_0 - y_i)^2} - \sqrt{(x_0 - x_1)^2 + (y_0 - y_1)^2} \qquad (3)$$

Expressing the set of linearised equations in matrix form

$$A_t X_{MS} = B_t \qquad (4)$$

Where

$$A_t = \begin{bmatrix} m_{x2} & m_{y2} \\ m_{x3} & m_{y3} \\ \vdots & \vdots \\ m_{xN} & m_{yN} \end{bmatrix} \qquad (5)$$

$$B_t = \begin{bmatrix} cT_2 - f_2 + m_{x2}x_0 + m_{y2}y_0 \\ cT_3 - f_3 + m_{x3}x_0 + m_{y3}y_0 \\ \vdots \\ cT_N - f_N + m_{xN}x_0 + m_{yN}y_0 \end{bmatrix} \qquad (6)$$

The least-squares solution is derived from

$$\hat{\boldsymbol{X}}_{\boldsymbol{s}} = (\boldsymbol{A}_t^T \boldsymbol{A}_t)^{-1} \boldsymbol{A}_t^T \boldsymbol{B}_t \qquad (7)$$

To performe the location estimate with higher accuracy, the least squares estimations is performed iteratively by linearising hyperbolas about the point $\hat{X}_{MS}$ feed back from previous estimate into the new estimated until $\hat{X}_{MS} \approx [x_0 y_0]^T$. [5],[12]

3. RSS MEASUREMENT MODEL

In this section, we introduce the RSS based algorithm for mobile positioning assuming [6].

$$RSS = T_x - Zg, \qquad (8)$$

Where RSS is received signal strength, T_x is transmitted signal strength and Z_g are all the parametters that influences signal degradation. All of the parameters are in [dB].Shadowing is not considered.

The unknown position of MS is $[x_s, y_s]^T$ (receiver) and the coordinates of the $i-th$ BS station is $[x_i, y_i]$ (source), $i = 1,2,........N$.

In the presence of disturbance we denote a measured distance r_i

$$r_i = d_i + n_i = \sqrt{(x_s - x_i)^2 + (y_s - y_i)^2} + n_i, \quad i = 1,2...N \qquad (9)$$

Where n_i is the noise of the range error at the BS_i. For the simplification we assume that measurement errors $\{n_i\}$ are zero mean Gaussian variables with known variance σ^2.

The distance r_i determine radius of circle. If we use at least three BS to resolve ambiguities, position of MS is given by the intersection of circles. The circles are given by the equations

$$\begin{aligned} r_i^2 &= (x_s - x_i)^2 + (y_s - y_i)^2 \\ &= R_s - 2x_s x_i - 2y_s y_i + (x_i^2 + y_i^2), \\ i &= 1,2,...,N \end{aligned} \qquad (10)$$

Where $R_S^2 = x_S^2 + y_S^2; r_i$ is the measured distance between the source ***i-th*** the ***i-th*** receiver. By means of new variable definition $K_i = x_i^2 + y_i^2$, we rewrite (10) through a set of linear expressions

$$2x_i x_s + 2y_i y_s - R_s = K_i - r_i^2, \, i = 1,2,.....N \qquad (11)$$

Equation (11) can be expressed in a matrix form

$$\mathbf{GZ=h}, \qquad (12)$$

Where

$$G = \begin{bmatrix} 2x_1 & 2y_1 & -1 \\ 2x_2 & 2y_2 & -1 \\ \vdots & \vdots & \vdots \\ 2x_N & 2y_N & -1 \end{bmatrix}, \qquad (13)$$

$$Z = \begin{bmatrix} x_S \\ y_S \\ R_S^2 \end{bmatrix}, \qquad (14)$$

$$h = \begin{bmatrix} K_1 - r_1^2 \\ K_2 - r_2^2 \\ \vdots \\ K_N - r_N^2 \end{bmatrix}, \qquad (15)$$

The position can be estimate [6] using the standard least squares as $\boldsymbol{Z} = \boldsymbol{G}^{-1}\boldsymbol{h}$. (16)

4. LOCALIZATION MODEL

The positioning method analyzed use three or more BS-MS connections to be established. A cellular network (as shown in Figure 1) working in line with an ad-hoc network where one is a master (MS1) and another is a slave (MS2)[1],[4]. By assuming that the mobiles are static, the MSs measure their relative distance using RSS. Finaly TDoA and RSS measurements are forwarded to a specific server. The estimated value of the MSs location are obtained by server using data fusion (Figure 2).Each MS sends a positioning request to the cellular network which initializes the enhanced localization process. Then, each MS measure the time to arrival difference between two links of neighbouring BS and the received signal strength generated by the other MS.

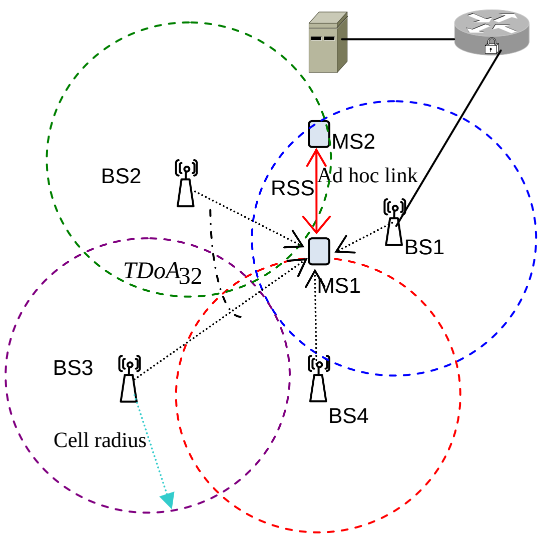


Figure 1 Cooperative positioning method

MS_1, MS_2 transmits a set of TDoA and RSS measurements to the BS_1 and BS_1 sends the data to a location server. The locations of MSs are computed using EKF (Extended Kalman Filter) algorithm. [1],[9],[12].

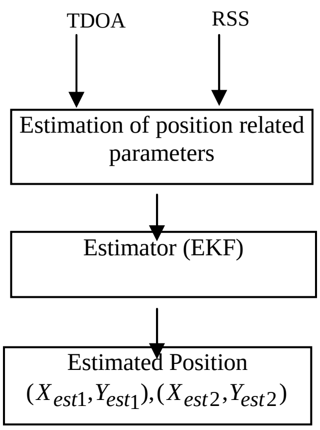


Figure 2 Data fusion

4.1 The Extended Kalman Filter

Extended Kalman Filter is a recursive estimator who has two distinct phases: predict and update. The predict phase uses the state estimate from the previous timestep to produce an estimate of the state at the current timestep. It uses the means of the density functions $p(x_k - x_{k-1})$ and $p(z_k / x_k)$ for state prediction and state update respectively . Assuming [9],[14] our state is the vector x_k and our measurement is the vector z_k, the evolution and perception models are

$$x_k = f(x_{k-1}, \xi) \qquad (17)$$

$$z_k = h(x_k, \xi) \qquad (18)$$

Where z_k is the non linear function of the x_k and the environment ξ. To linearize this function obtain the form

$$z_k = \Lambda x_k \qquad (19)$$

Where Λ is the Jacobian. The Kalman gain is:

$$K(k+1) = P_X(k+1\,|\,k)\Lambda^T\left[\Lambda P_X(k+1)\,|\,k)\Lambda^T + P_Z(k)\right]^{-1} \quad (20)$$

where $P_z(k)$ is the covariance matrix for the measurement z_k. Next we compute the difference between the measurement and the expected measurement:

$$r(k+1) = z(k+1) - h[\hat{x}(k+1\,|\,k), \xi] \qquad (21)$$

The combined state estimate is now given by:

$$\hat{x}(k+1) = \hat{x}(k+1\,|\,k) + K(k+1)r(k+1) \qquad (22)$$

The new state convariance is:

$$P_X(k+1) = [I - K(k+1)\Lambda]P_X(k+1\,|\,k) \qquad (23)$$

4.2 Error Estimation

In time-invariant statistical models, a commonly used bound is the Cramer-Rao Lower Bound (CRLB). CRLB sets the lower limit for the variance (covariance matrix) of any unbiased of an unknown parameter[10].

CRLB is defined as the inverse of the Fisher information matrix where x is the measurement and θ is the unknown parameter.

$$E\{\hat{\theta} - \theta)(\hat{\theta} - \theta)'\} \geq J_\theta^{-1} \qquad (24)$$

$$J_\theta \xrightarrow{def} E\left\{\left[\frac{d}{d\theta}\ln f(\hat{x}\,|\,\theta)\right]\left[\frac{d}{d\theta}\ln f(\hat{x}\,|\,\theta)\right]'\right\} \quad (25)$$

The benefit from the use of RSS measurements in conjunction with TDoA becomes evident at ranges about 30m (Figure 3), for the given channel characteristics.

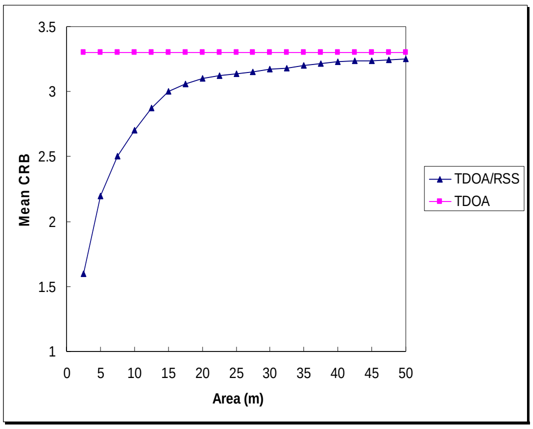


Figure 3 Mean CRB of the TDOA/RSS

5. CONCLUSIONS

In this paper, we analyzed a hybrid TDoA/RSS localization method in order to perform the requested positioning accuracy. Cooperative positioning can improve the positioning performance by exchanging full statistical information between devices. Positional information is important in various applications. Such a cooperative approach improves positioning accuracy, but it increases the computational complexity (as more links have to be taken into account).

5. REFERENCES

[1]. C. Mayorga, F. Della Rosa, S. Wardana, G. Simone, M. Raynale, J. Figueiras, S. Frattasi, *"Cooperative Positioning Techniques for Mobile Localization in 4G Cellular Networks", IEEE International Conference on Pervasive Services, pp.39-44, July 2007.*

[2]. Y. Zhang, Q. Cui, X. Tao, *"Cooperative Group Localization for 4G Wireless Networks"*, IEEE 70th Vehicular Technology Conference, (VTC2009-Fall), pp.1-5, 2009.

[3]. B. Al-Ifan, N. Hamid, M. Othman, S. Subramanian, *"A Hybrid Algorithm for Location Mobile Station in Cellular Network"*, InternationalConference of Future Computer and Communication (ICFCC), 2009.

[4]. Mohamed Samiei, Mehri Mehrjoo, Behzad Pirzade, *"Advanced positioning methods in cellular networks"* 1st International Conference on Communications Engineering 22-24 December 2010

[5] R.-T.Juang,D.-B.Lin and H.-P.Lin *"Hybrid SADOA/TDOA mobile positioning for cellular networks"*

[6] Petre Brida, Peter Cepel, Jan Duha *"Geometric Algorithm for received Signal Strength based Mobile Positioning"*,Radioengineering vol.14, april 2005

[7] Foy,W.H.: *"Position-location solution by Taylor-series estimation"*, IEEE Trans.Aerosp.electron.Syst., 1976,12,(2) pp 187-193

[8] Torrieri,D.J.: *"Statistical theory of passive location systems"* IEEE trans.Aerosp.electron.Syst.,1984,20,pp 183-198

[9] Simone Fratassi, Joao Figueiras *"Enhancement of Localization Accuracy in Cellular Networks via Cooperative Ad-Hoc Links"*

[10] Y. Wang, G. Leus, A.-J. van der Veen, *"Cramer-Rao Bound for Range Estimation," in Proc. IEEE ICASSP, May 2009, pp.3301–3304.*

[11] H. Jamali Rad, A. Amar, and G. Leus, *"Cooperative Mobile Network Localization Via Subspace Tracking" to appear in Proc. of IEEE ICASSP, May. 2011.*

[12] S. Sans, C. Mensing "H*ybrid Data Fusion and Cooperative Schemes for wireless Positioning"*

[13] C. Mensing and S.Plass *"Positioning Algorithms of Cellular Networks using TDOA"*

[14] T.Perala, R.Piche *"Robust Extended Kalman Filter in Positioning Applications"*

SECTION IV

MATHEMATICAL SCIENCES AND PHYSICS

COMMUNITY EDUCATION PROGRAMS

CIUCUR VIOLETA-VALI

Constanta Maritime University, Romania

ABSTRACT

The challenges of a modern society have important consequences on the educational system. During the last decade, the European Union has attempted to harmonize and improve educational policies, in order to give all European citizens the chance to study abroad and to learn and train on a continuous basis. This paper aims at a closer analysis of European educational programmes, such as ERASMUS, Leonardo and other lifelong learning programmes.

Keywords: *education, EU policies, mobility, ERASMUS, Leonardo, lifelong learning.*

1. INTRODUCTION

In 1998 a very important step in education was made when education ministers from France, Germany, Britain and Italy signed the Sorbonne Declaration to harmonize university education.

Sorbonne Declaration goal was expanded a year later at the University of Bologna, the oldest university in Europe, by signing the Bologna Declaration. The 29 European countries that signed the Bologna declaration began implementing the creation of the European Higher Education Area European University Studies (EHEA).

Bologna process was completed in subsequent years through regular meetings of ministers of education and directly by its amendments by the European Commission.

Prague Declaration of May 2001 - added three new elements of the Bologna Process, including the concept of lifelong learning, student involvement and making the European area of university attractive and competitive with other similar areas of education in the world.

2. EDUCATIONAL SUMMITS

Summit in Berlin in September 2000 - the 40 participating countries reiterated that university education is a duty with a strong social dimension, established in 2005 as the deadline for a standard for granting bachelor and master degrees, and international recognition of qualifications and studies, have sought to establish a strong link between the European zone of university and research sector, have established national plans for education scholarships and also created the possibility for mobile scholarships; they have reiterated the need of student involvement in student organizations.

Summit in Bergen on 19-20 May 2005 attempted to set goals for the summit in London in 2007, including implementation of standards and guidelines for ENQA report mentioned in national education programs, rules regarding the granting and recognition diplomas awarded on the basis of inter-institutional cross-country, creating opportunities for flexible methods in higher education, including recognition of previous studies, program of university diplomas granting European on completion of three cycles of education: Bachelor, Masters and PhD.

Given the basic priority of the European Union to become the most competitive and dynamic economy in the world, based on knowledge and able to promote sustainable economic development by creating more jobs and ensuring greater social cohesion (European Council Lisbon, March 2000), European governments have realized that to achieve this objective, the modernization of education and training is essential.

In 2002, Europe set itself the objective to be recognized internationally as a leader in academic education and training provided.

Education Ministers have set three major goals to be achieved for the benefit of EU citizens under the Education and Training:

- improve the quality and effectiveness of European education and training;
- ensuring that they are accessible to all;
- opening of education and training for the world.

To achieve these goals, ministers of education agreed objectives covering thirteen different levels and types of education and training (formal and informal) aimed at realizing a lifelong process. Existing education systems must be improved at all levels:

- teacher training;
- basics;
- integration of information and communication technologies;
- efficiency investments, teaching and learning; continuous support;
- systems flexibility to allow universal access to education;
- mobility and citizenship education, etc.

3. ERASMUS

ERASMUS is part of the SOCRATES Community Programme in Education and includes activities for European cooperation in higher education. ERASMUS is supported by the European dimension of development and graduate program covering all disciplines and fields of study.

Currently, ERASMUS provides mobility grants to thousands of students, focusing on providing academic recognition of studies and teacher mobility, as well as a number of activities designed to improve academic programs and develop new courses, by transnational cooperation.

In the 20 years of the ERASMUS program, over 1.2 million students had the opportunity to travel and study in other countries. As a result, these students have an advantage in the labor market due to the study of other

European languages and cultures, which is a fundamental international educational component of the knowledge that the EU intends to develop in the future.

Introduced in the educational system, the European system of credits transferable study created a standard international system of grading students in the European Union, one semester of study being equivalent to 60 ECTS credits. ECTS credits are given together with other national systems of scoring, with a focus on notary transparency in the European Union.

3.1. ERASMUS Mundus

Operating within the European Union, including those countries that are in the process of EU accession and candidate countries, the European Economic Area and European Free Zone changed. Erasmus Mundus was developed in order to transform the European Union into a world center of education, allowing citizens from non-EU states to study in Europe and vice-versa. It has four levels of participation:

Erasmus Mundus Masters Courses, which integrate academic courses offered by at least three universities, all from different countries in a recognized double, multiple or joint activity of the participating institutions.

Erasmus Mundus scholarships, which provide scholarships for students from non-EU states who are following the Erasmus Mundus masters courses.

The partnerships, which encourage European Union countries and commercial universities from European Free Trade Area to open for students from other countries and to further develop their international focus.

"Increasing attractiveness", which represents a public relations support offered to academic institutions including the promotion of international education and mutual recognition of diplomas and qualifications between the Member States of the European Union and non-members.

3.2 TEMPUS - "People to people" academic cooperation

Trans-European mobility scheme for university studies funds projects between European universities and studies from other 26 partner countries. Its mandate is to facilitate cultural understanding, modernization of the participating universities and mutual understanding between regions and people. Tempus partner regions are the Western Balkans, Eastern Europe, Central Asia, North Africa and the Middle East. TEMPUS grant was meant to develop training programs for teachers, curricula and innovative university management and structural reforms of university educational system. It places particular emphasis on the mobility of academic and administrative staff from higher education institutions within the European Union and partner countries.

4. 2007-2013 CONTINUING EDUCATION PROGRAMMING

Continuing Education Programme comprises four sectoral programs aimed at implementing Comenius school education and higher education - Erasmus, Leonardo da Vinci, vocational education and Adult Education and is supplemented by a cross-cutting program that focuses on political cooperation, the development of language skills on information and communication technology and dissemination and exploitation of results. Finally, the Jean Monnet European integration focuses on process and supporting institutions and associations whose work is in this area.

The purpose of this software package is to contribute through a continuing education program in community development in a European knowledge-based society that seeks to achieve sustainable economic development, the existence of more jobs and social cohesion than the existing one. It also aims to increase interaction, cooperation and mobility between education and professional training in the Community so that these two points become the global benchmark. As regards the four sectoral programs, specific targets have been set to ensure a significant, identifiable and measurable system of four programs. These objectives are as follows:

Comenius - it represents a European Cooperation Program meant for the first level of education, from pre-school stage up to the gymnasium and includes students, educators, parents and local government and nongovernmental organizations. The program supports partnerships between schools, as well as mobility between them, seeking to involve at least three million pupils in joint educational activities during this program.

Erasmus for higher education aims to encourage academic mobility for students and teachers within the European Union and candidate countries and EU accession path, as well as those of the European Economic Area. Inspired by the life of Dutch humanist Desiderius Erasmus and theologian Roterdamus, the program incorporates 2199 universities from 31 states. Students attending an educational program for three years are sent to study in a partner country for a period ranging from 3 months to 1 year. The program aims to achieve a turnover of 3 million students in educational exchange by 2012.

Leonardo da Vinci is applicable to vocational education and training and it is directed towards citizens who enter the labor market. The program is designed to develop skills for employment and unemployment reduction, aimed at increasing the employment rate to complete the program.

Grundtvig is applicable to adults. The program aims to support mobility of 7,000 individuals involved in adult education by 2013.

5. CONCLUSIONS

Educational mobility programmes, as well as lifelong training, have a great contribution on ensuring social cohesion and adaptability, economic development, social and economic competition. A well established and harmonized educational system is the very core of European development.

SPREAD OF THE COMMUNICABLE DISEASES, MODELED AS DYNAMICAL SYSTEM

DRAGOESCU (CAZACU) NINA

Industrial School of Railroad Construction, Bucharest, Romania

ABSTRACT

This paper contains a particular point of view about the solution of an optimal control problem. The subject is the evolution of the infectious diseases modeled as a dynamical systems, when a disturbing external factor is present.

Keywords: *disease, optimal, solution.*

1. INTRODUCTION IN THE DYNAMICS OF THE INFECTIOUS DISEASES

In literature, age individuals in many diseases is an important factor influencing vulnerability and susceptibility to infection. It has also appeared a number of examples of individual age-dependent models; we retain the one proposed by Murray [1] in which the age is evaluated as the time for entry into a class of population, that is one of the following: susceptible to infection, infected, healing and immune, in a string model, which we will present some data in the following.

Suppose that the population can be divided into three classes: S, susceptible to disease, I, infected, R, those who were sick and are immune, or in quarantine (the "removed"). Individual progress is shown by the scheme:

$$S \rightarrow I \rightarrow R \tag{1}$$

The infection contribution to a class is in proportional rate with S and I numbers, namely rSI The susceptible population is supposed to decrease by the same rate. Crossing to the class of healing, the sick class occurs aI rate. Both constants, a and r are positive. The system of equations corresponding to the SIR model is:

$$\begin{aligned} \dot{S} &= rSI \\ \dot{I} &= rSI - aI \end{aligned} \tag{2}$$

Let N the hole population, then, we are led to:

$$\begin{aligned} \dot{S} + \dot{I} + \dot{R} &= 0 \\ S(t) + I(t) + R(t) &= N \end{aligned} \tag{3}$$

The initial restrictions are: $S(0)=S_0>0$, $I(0)=I_0$, $R(0)=0$.

The way in which this mathematical model can be applied is to reduce S_0, by vaccinating young population. Such diseases are epidemic as: polio, measles, tuberculosis, etc. Other diseases, such as venereal, offers no immunity after recovery, and as a result, the factor R is excluded from the equation, obtaining the so-called models IE:

$$\begin{aligned} \dot{S} &= aI - rSI \\ \dot{I} &= rSI - aI \end{aligned} \tag{4}$$

2. THE MATHEMATICAL MODEL OF THE COMMUNICABLE DISEASES SPREAD

Our purpose is not to analysis the mathematical models, they are mentioned only as a reference to proposals, to introduce them. Murray [1] makes the claim that age can be understood as the baseline for the population susceptible to a disease and consider the population divided into $S(t)$, susceptible to disease, $I(a',t)$, infected, where a' is the proper age for exposure to disease, so it is a dependent on age and time model. The number of people likely to be achieved decreases as exposure to disease. Involution is given by the equation:

$$\begin{aligned} \dot{S} &= -\left(\int_0^{\tau} I(a',t)r(a')da'\right)\cdot S(t) \\ S(0) &= S_0 \end{aligned} \tag{5}$$

i.e. the rate of decrease in the susceptible to disease segment, due to those infected, is loaded with the function $r(a')$, that is the rate of infection, dependent on age, which can be variable. Since an infected individual is due to a contagion with a time limit, for example τ, then this is the upper limit of the integral. Since age interpretation is the initially "time", we will show the position function $I(a',t)$, which is a offsetting real function, with temporal variables: a' and t. Let's denote: $E(t)=\int_0^{\tau} I(s,t)r(s)ds$ = the numerical factor for the evolution of the population likely contaminated, so the "growth rate of the likely contaminated". (opposite to the decreasing rate of the susceptible segment) For ease, we have noted age variable a' with: s . $E(t)$ is a self-adjoint operator. Also, it is supposed as being known the next functions: r and λ, different for every case, where: λ is part of $I(s,t)$, and represents the age-dependent removal factor:

$$I(s,t)=I_0 e^{-\int_0^s \lambda(v)dv} \quad \text{if: } t<s \text{ and:}$$

$$I(s,t)=I_0 e^{-\int_{t-s}^t \lambda(v)dv} \quad \text{if: } t>s. \qquad (6)$$

We'll look for a class of diseases, represented by symmetrical functions $I(r,s)$, so that the resulting integrals to be self-adjoint operators. This will allow solving the optimal control problem represented by the above equations (5), applying a semi-inverse method [5]. For example (actual data will allow graphics), we consider a particular case in which the age-dependent removal factor is represented by: $\lambda(v)=k\cdot t$, with $k=$ real constant, so, taking account to equations (6), we are led to the following relation: $I(s,t)=e^{-kst}=e^{-kts}=I(t,s)$

Consequently, the nucleus of the integral is a real, continuous and symmetrical function, so E is a self-adjoint operator; suppose that the rate of infection $r(s)=k_1\cdot s$ is also known or can be determined, with $k_1=$ real constant. We'll consider now two components for the population, compared with the constant age of *ten* years, which, in our example, represents the starting age when the exposure to the epidemy is active: $S_1=$ the susceptible population with age less than 10 years, follows: $S_2=$ the susceptible population with age greater than 10 years. These conventions allow to write the system in the form of the state equations in which the evolution of the infection refers to the transformed variables of the second segment S_2, the age required for contamination.

2.1 The dynamical system of the model

First, we must write the system equations as a dynamical system, in the following form :

$$\begin{aligned}\dot{S}&=A(t)\cdot S(t)+B\cdot u(t)\\ Y(t)&=C\cdot S(t)\end{aligned} \qquad (7)$$

in which: $S(t)$ is the state variable, $R(t)$ is the answer of the system, $u(t)$ is the command (external factor), B,C are square, positive, two-dimensional constant matrices. The system matrix is: $A(t)=\begin{pmatrix}E(t) & 0\\ 0 & E(t)\end{pmatrix}$. E is a self-adjoint operator and A is a symmetrical and positive matrix, so we are in the context of the semi-inverse method [5] . The form of the system (7) is appropriate with the general form of the dynamical system equations. Considering the system matrix in (7), the dynamic form of state variables is the following: (two-dimensional)

$$\begin{pmatrix}\dot{S}_1\\ \dot{S}_2\end{pmatrix}=\begin{pmatrix}\int_0^\tau I(t,s)r(s)ds & 0\\ 0 & \int_0^\tau I(s,t)r(s)ds\end{pmatrix}\cdot\begin{pmatrix}S_1\\ S_2\end{pmatrix}+\begin{pmatrix}1 & 0\\ 0 & 0\end{pmatrix}\cdot\begin{pmatrix}u_1\\ u_2\end{pmatrix}$$

$$\begin{pmatrix}Y_1\\ Y_2\end{pmatrix}=\begin{pmatrix}0 & 0\\ 0 & 1\end{pmatrix}\cdot\begin{pmatrix}S_1\\ S_2\end{pmatrix} \qquad (8)$$

In our case, for example: $\tau=$ 100 years. Also, $u(t)=(u_1(t),u_2(t))$ is the disturbing factor applied to the first component of the state vector $S(t)=(S_1(t),S_2(t))$, the result received to the second, with the initial restriction: $S_0=\begin{pmatrix}S_1(0)\\ S_2(0)\end{pmatrix}=\begin{pmatrix}0\\ 1\end{pmatrix}$ (so it has been supposed the existence of a singular infected individual) In other words, it will influence in a certain way people less exposed to the epidemic, in order to change the most likely exposed. Of course, it can do in reverse, by counteracting the epidemic, there would be an action on the second part, following the outcome of the first age group. System response, denoted by $Y(t)=(Y_1(t),Y_2(t))$ will contain two components of the transformed expressions.

2.2 Optimal solution of the dynamical system

The dynamic system of the mathematical model is in the Kalman's theory conditions, with the coefficients in (8) and the initial conditions:

$$A,B,C\in M_2(R), X=Y, t_0=0, t_1=1, (t_0,t_1)\subset R,$$

$$\rho(t)=0, \sigma^{-1}(t)=1, x_0=1, p(t)=p^*(t), C_0=e^A$$

Consequently, in order to solve the regulation problem of the system and obtain the optimal command, we have to solve a Bernoulli equation**,** formed with the system coefficients: $(A=A^*, B=B^*)$

$$\dot{p}(t)+2A(t)\cdot p(t)-B^2\cdot p^2(t)=0_2 \quad \text{with:}$$

$$p(t_1)=p(\tau), p(0)=C_0 \qquad (9)$$

and the solution: $p(t)=-[v(t)]^{-1}$, where : $v(t)$ is the solution of the equation: $\dot{v}(t)-2A(t)\cdot v(t)-B^2=0_2$, obtained with : $\dot{v}(t)=\dot{p}(t)\cdot p^{-2}(t)$ replaced in the Bernoulli –type equation (9). Finally, the analytical expression for $p(t)$ has the following form: (two-dimensional matrix)

$$p(t)=\left[e^{2\int_0^t A(v)dv}\left(C_0+B^2\cdot\int_0^t e^{-2\int_0^\upsilon A(v)dv}d\upsilon\right)\right]^{-1} \qquad (10)$$

The analytical formula for the optimal command has the particular form: $u^0(t,s)=-B\cdot p(t)\cdot S(t)$, with:

$$S(t)=S_0\cdot e^{\int_0^t [A(t)-p(v)]dv} \qquad (11)$$

The trajectory of the disease evolution, with the particular parameters values: $k = k_1 = 2, \tau = 1$, leads to the following graphical result :

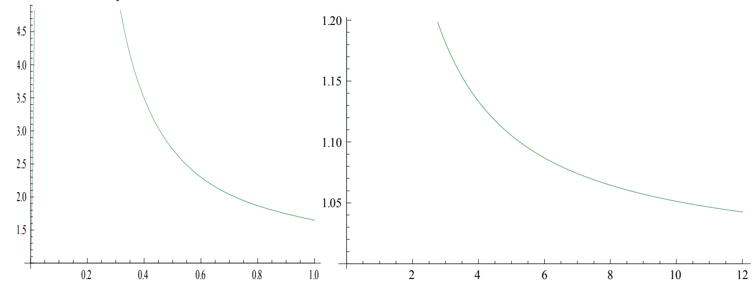


Figure. 1 Spread of the disease in one year(left) and in twelve years(right)

3. A PARTICULAR DYNAMICAL SYSTEM

The dynamic system can be reduced to only one component $S(t)$, without sectioning on the age criteria. The method can still be applied. The first equation of the system can be written:

$$A(t) = \begin{cases} \int_0^\tau e^{-\int_{t-s}^{t} \lambda(v)dv} r(s)ds & t > s \\ \int_0^\tau e^{-\int_0^{s} \lambda(v)dv} r(s)ds & t < s \end{cases}$$

which for the considered $I(r,s)$, leads us to the simple formula: $\dot{S}(t) = \frac{k_1(1 - e^{-kt\tau}(1 + kt\tau))}{kt^2} \cdot S(t)$ (5')

similar with equations (5), and the dynamical associated system:

$$\dot{S}(t) = (\int_0^\tau e^{-kst} k_1 s ds) \cdot S(t) + \alpha \cdot u(t), \quad Y(t) = \beta \cdot S(t) \qquad (8')$$

Consequently, the analytical solution for the optimal command and trajectory, are still obtained using the same method, as an example, for the particular values of the infection rate $r(s) = k_1 s$ and the age-dependent removal factor $\lambda(\cdot) = kt$. The analytical and numerical results for the optimal solutions, are calculated by using "MATHEMATICA 6.0", for the arbitrary values of the parameters $k = 2, k_1 = 2, \tau = 12, \alpha = \beta = 1$ (Annex).

3. CONCLUSIONS

1) From the presented results we conclude that the M. S. A. method can be applied to any similar biological phenomenons produced according to the law of the next form:

$$\dot{S}(t) = (\int_0^\tau f(t,s)g(s)ds) \cdot S(t)$$

and, consequently, we are led to dynamical systems of the following form:

$$\dot{S}(t) = (\int_0^\tau f(t,s)g(s)ds) \cdot S(t) + \alpha \cdot u(t), \quad y(t) = \beta \cdot S(t)$$

Also, $f(t,s)$ is a symmetrical, real, continuous function, $g(s)$ is a real continuous function, so that $\int_0^\tau f(t,s)g(s)ds$ is supposed to be a self-adjoint operator.

2) Mention that the process used in demonstrations, makes possible, in most cases, the introduction of a practically unlimited number of parameters, and allows the analysis of a large number of biosystems. Consequently, for every pair of functions r and λ, particularly for the values of parameters, k, k_1, τ, the method can study the time evolutions for the spread of the communicable diseases, useful in the epidemy preventing strategies.

4. REFERENCES

[1] MURRAY, J. D. , *Mathematical Biology*, Springer, **17**, Interdisciplinary Applied Mathematics Series, New York, 2002, 361

[2] ARNOLD, V. I., *Ordinary Differential Equations*, Scientific and Encyclopedic Publishing House, Bucuresti, 1978

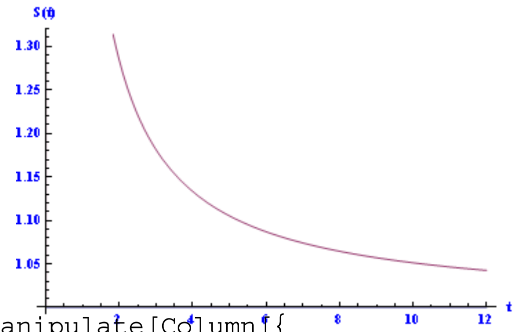
[3] DRAGOESCU (CAZACU),] N., *Solution of the Optimal Control Problem with Quadratic Cost Function*, Ovidius University, Annals Series: Civil Engineering, **11,** Constanța, (2009), 305-309

[4] DRAGOESCU(CAZACU), N., *The human internal ear modelled as a dynamical system*, Proceedings of the twelfth Symposium of mathematics and its Applications, Timisoara, 2009, 320

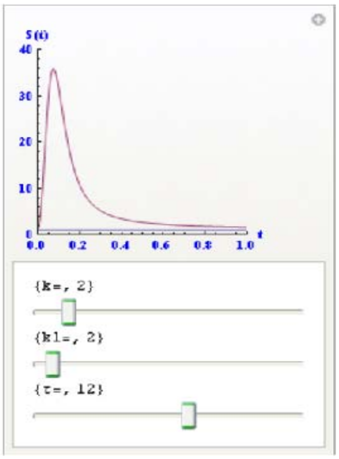
[5] DRAGOESCU(CAZACU), N. , *Discrete growth models for interacting populations*, Constanta Maritime University Annals, XI, **13**, 2010

```
         ⌡ t
          □□
I1=Exp[-k t  t s  ]
      ⌡ □I1 s □s          ⌡ □I1 s □s
A={{k1  0          ,0},{0,k1  0          }}
k=2
k1=2
τ=12
B={{1,0},{0,0}}
r=k1s
B*=B
X=2A
    ⌡ □A □t
C0= 0
         ⌡ □~□ 2C0 □t
V1=C1+Y  0
V=©C0.V1
p=Inverse[-V]
x0=A-Yp
si={0,1}
S=si.Exp[Integrate[x0,{u,0.,t}]]
d=-B*
u0=dpS
Plot[S,{t,0,12},AxesLabel→{"t","S(t)"
},LabelStyle→Directive[Blue,Bold]]
```

ANNEX




```
Manipulate[Column[{
{"k=",k},Slider[Dynamic[k],{1,10,1}],{
"k1=",k1},Slider[Dynamic[k1],{1,20,1}]
,{"τ=",τ},Slider[Dynamic[τ],{1,20,1}]}]
, Delimiter,
Row[{Dynamic[Plot[{S},{t,0,1},AxesLabe
l→{"t","S(t)"},LabelStyle→Directive[
Blue,Bold],AspectRatio→1,PlotRange→{
{0,1},{0,40}}],SynchronousUpdating→Tr
ue]}]]
```



File: Spread of the communicable diseases.nb

MINIMIZATION OF THE LINEAR FUNCTIONAL

RAPEANU ELEONORA

Constanta Maritime University, Romania

ABSTRACT

In this paper we presented some numerical methods for minimization problems as Variational Inequalities of Elliptic (IVE). We treated the numerical analysis, which are obtained based on abstract algorithms and concrete numerical algorithms, described by software (in Pascal).

1. INTRODUCTION

Approximation methods are presented for the elliptic variation inequalities in infinite dimensional spaces that can be used in finite dimensional subspaces obtained by discrediting the finite element method (MEF). This article includes a model problem and numerical methods are applied.

2. OPTIMIZATION METHODS

We start with some necessary Theorem

Theorem 1. Let $x^* \in \operatorname{int} D$. If x^* is a local minimum point and if f is differentiable in the Gâteaux x^*, then x^* is a critical point for *f*.

Theorem 2. If $f : D \subseteq R^n \to R$ is continuous and admits a wide variety of compact, then f has a global minimum point on *D*.

2.1 Method of successive approximations

The problem of elliptic variation inequalities can be

(Piv) { Determine $u \in K$ *such that* $a(u, v-u) \geq (f, v-u)$ *for* $\forall v \in K$ *}*

where a is a bilinear and continuous form; *K* is a lot darker and convex.

or

(Piv 1) { Determine $u \in K$ *such that* $A(u, v-u) \geq (f, v-u)$ *for* $\forall v \in K$ *}*

where *A* is a strong monotone operator,

$\exists \alpha > 0, (Au - Av, u - v) \geq \alpha \|u - v\|^2$ for $u, v \in V$.

According to Theorem 1 for (*Piv*) and Theorem 2 for (*Piv 1*) variation inequality is equivalent to the fixed point equation

$$u = S_\rho(u) \qquad (1)$$

where operator $S_\rho : V \to K$ is defined by

$$S_\rho(v) = P_K(v - \rho(Av - f)) \quad \text{for all } v \in V \qquad (2)$$

From Theorem 1 and Theorem 2 there are values $\rho > 0$ for which the operator S_ρ is contracted. Banach's theorem states that equation (1) has unique solution $u \in K$ which is the unique solution of Elliptic variation inequalities. Also from Banach's theorem we know

$$\lim_{q \to \infty} \|u^{(q)} - u\|_V = 0,$$

where sequence $\{u^{(q)}\}$ is defined by

$$\begin{cases} u^{(0)} \in K \\ u^{(q+1)} = S_\rho(u^{(q)}), \quad q = 0,1,2... \end{cases} \qquad (3)$$

or using equation (2)

$$\begin{cases} u^{(0)} \in K \\ u^{(q+1)} = P_K(u^{(q)} - \rho(Au^{(q)} - f)), q = 0,1,2... \end{cases} \qquad (4)$$

The functional is given by the real Hilbert space *V*, *K* a closed convex subset of *V*, $a : V \times V \to R$ continuous bilinear form, $f \in V^*$ (dual of *V*); functional $J : V \to R$ is defined by $J(v) = \frac{1}{2} a(u, v) - (f, v)$ for $\forall v \in V$.

2.2 Penalty method

Be problem

(Piv) { Determine $u \in K$ *such that* $a(u, v-u) \geq (f, v-u)$ *for* $\forall v \in K$ *}*

Suppose that the assumptions of Theorem 1 are satisfied. Introducing functional convex own $j : V \to R \cup \{\infty\}$. Suppose we have

(H_1) $j(v) \geq 0$ for all $v \in V$.

(H_2) $j(v) = 0$ if and only if $v \in K$ or $Ker(j) = K$, where the j kernel is given by

$$\ker(j) = \{v \in V; j(v) = 0\}.$$

For any $\varepsilon > 0$ we define the functional $j_\varepsilon : V \to R \cup \{\infty\}$

$$j_\varepsilon(v) = \frac{1}{\varepsilon} j(v) \text{ for all } v \in V. \qquad (5)$$

Lemma 1. Suppose that the functional J satisfies the assumptions (H_1) and (H_2). Then for any $\varepsilon > 0$ functional j_ε satisfy her assumptions (H_1) and (H_2).

For any $\varepsilon > 0$ introduce the problem of taxing

(Piv_ε) { Determine $u_\varepsilon \in V$ such that $a(u_\varepsilon, v-u_\varepsilon) + j_\varepsilon(v) - j_\varepsilon(u_\varepsilon) \geq (f, v-u_\varepsilon)$ for $\forall v \in V$ }.

Theorem 3. In the above assumptions the problem (Piv_ε) has a unique solution for any $\varepsilon > 0$ fixed.

Theorem 4. In the above assumptions, let *u* be the solution of the problem (Piv_ε). Then

$$\lim_{\varepsilon\to 0}\|u_\varepsilon - u\| = 0 \qquad (6)$$

$$\lim_{\varepsilon\to 0} j_\varepsilon(u_\varepsilon) = 0 \qquad (7)$$

3. COMPUTER PROGRAMMING PROBLEM OF OPTIMIZATION

3.1 Water flow through a uniform rectangular filter

We consider one-dimensional model of water flow through a rectangular homogeneous sand filter (e.g. J.T. Oden and N. Kikuchi). $\Omega = (0,1)$ corresponds to the length trap field and *u (x)* is the wet region at $x \in [0,1]$ height.

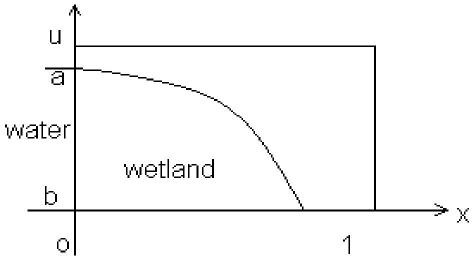


Figure 1

Let $V = H^1(\Omega)$ and

$$K = \{v \in V;\, v(0) = a,\, v(1) = b,\, v \geq 0 \text{ in } \Omega\} \qquad (8)$$

where $a > b \geq 0$ are constant. Then the function u satisfies the variational inequality

$$\int_0^1 u'(v'-u')dx + \int_0^1 (v-u)dx \geq 0 \quad \text{for all } v \in K \qquad (9)$$

solution of inequality (9) Ω satisfies the system

$$\begin{cases} u \geq 0,\ -u''+1 \geq 0, \quad (-u''+1)u = 0 \\ u(0) = a,\, u(1) = b \end{cases} \qquad (10)$$

where $u \in H^2(\Omega)$ (e.g. J.T. Oden and N. Kikuchi).

The system (10) defines a natural partition of domain closure Ω in subsets

$$\Omega^+ = \{x \in [0,1];\, u(x) > 0\},$$
$$\Omega^0 = \{x \in [0,1];\, u(x) = 0\}.$$

Intersection point *P*, $P = cl\Omega^+ \cap cl\Omega^0$, defines a free boundary in the next solution in the sense

$$-u''+1 = 0 \text{ in } [0,P) = \Omega^+$$
$$u = 0 \text{ in } [P,1) = \Omega^0.$$

We take

$$V = H_0^1(\Omega)$$

the change of function $u := u - \varphi$ unde $\varphi(x) = bx + a(1-x)$. In this case we have

$$K = \{v \in H_0^1(\Omega);\, v \geq 0 \text{ in } \Omega\}. \qquad (11)$$

To make the inequality (9) forms an abstract of the IVE introduce the operator $A : V \to V^*$ defined by

$$(Au, v) = \int_0^1 (u'v'+v)dx \quad u,v \in V. \qquad (12)$$

Integrating by parts we obtain

$$Au = -u''+1 \qquad (13)$$

provided that *u* is sufficiently smooth, $u \in H^2(0,1) \cap C[0,1]$. Inequality (9) becomes

$$\text{Determine} \begin{cases} u \in K \quad so \\ (Au, v-u) \geq 0 \quad \text{for all } v \in K \end{cases} \qquad (14)$$

i.e. solution of the problem (*Piv 1*) in the particular case $f = 0$.

Note that the operator *A* and the set *K* given by the relation (11) satisfy the assumptions of Theorem 2 and so the problem (14) has unique solution

FEM discretization (finite element method)

Introducing equidistant grid nodes with $h = 1/N$ on $x_i = ih,\, i = 0,1,...,N$ and finite dimensional subspace $V_h \subset V = H^1(\Omega)$ defined by

$$V_h = \{v_h \in C(\overline{\Omega});\, v_h \in P_1[x_i, x_{i+1}],\, i = \overline{0, N-1}\} \qquad (15)$$

We consider $V = H^1(\Omega)$ and the set K on the relationship

$$K_h = \{v_h \in V_h; v_h(0) = a, v_h(1) = b, v_h \geq 0 in\Omega\} \qquad (16)$$

Let $V_h = span\{\psi_0, \psi_1, ..., \psi_N\}$ base consists of linear functions. Then

$$\psi_0(x)=\begin{cases}(x_1-x)/h & x\in[x_0,x_1]\\ 0 & \text{otherwise}\end{cases} \quad (17)$$

$$\psi_i(x)=\begin{cases}(x-x_{i-1})/h & x\in[x_{i-1},x_i]\\ (x_{i+1}-x)/h & x\in[x_i,x_{i+1}]\\ 0 & \text{otherwise}\end{cases} \quad (18)$$

for $i=1,2,...,N-1$ and

$$\psi_N(x)=\begin{cases}(x-x_{N-1})/h & x\in[x_{N-1},x_N]\\ 0 & \text{otherwise}\end{cases} \quad (19)$$

Any $v_h\in V_h$ can be written $v_h=\sum_{i=0}^{N}v_i\psi_i$. Since $\psi_i(x_j)=0$ for $i\neq j$ and $\psi_i(x_j)=1$, for any i note that

$$v_i=v_h(x_i)\quad i=0,1,2,...,N$$

Any vector $v_h\in V_h$ is represented by its coefficients belonging to R^{N+1}. The set K_h from the relation (16) is reduced to $R_h\subset R^{N+1}$ on

$$R_h=\{(v_i)\in R^{N+1};v_0=a,v_N=b,v_i\geq 0,i=\overline{0,N}\}.$$
(20).

Approximation inequality (9) is

$$\text{Determine}\begin{cases}u_h\in K_h \quad so\\ \int_0^1 u_h^{'}(v_h^{'}-u_h^{'})dx+\int_0^1(v_h-u_h)dx\geq 0\\ for\ all\ v_h\in K_h\end{cases} \quad (21)$$

Take $u_h=\sum_{i=0}^{N}u_i\psi_i$ get

$$\int_0^1[\sum_{i=0}^{N}(v_i-u_i)\psi_i^{'}(x)]\cdot[\sum_{j=0}^{N}u_j\psi_i^{'}(x)]dx+$$
$$+\int_0^1[\sum_{i=0}^{N}(v_i-u_i)\psi_i\ (x)]dx\geq 0$$

for any $(v_i)\in R_h$ hence the

$$\sum_{i=0}^{N}(v_i-u_i)\cdot$$
$$\cdot[\sum_{j=0}^{N}u_j\int_0^1\psi_i^{'}(x)\psi_j^{'}(x)dx+\int_0^1\psi_i\ (x)dx]\geq 0$$

Introducing coefficients

$$a_{ij}=\int_0^1\psi_i^{'}(x)\psi_j^{'}(x)dx \quad (22)$$

$$F_i=\int_0^1\psi_i(x)dx \quad (23)$$

and the above inequality becomes

$$\sum_{i=0}^{N}[(v_i-u_i)(\sum_{j=0}^{N}a_{ij}u_j+F_i)]\geq 0 \quad (24)$$

for any $(v_i)\in R_h$.

Using formulas (17) - (19) is obtained

$$\begin{cases}a_{ii}=2/h & i=\overline{1,N-1},\\ a_{00}=a_{NN}=1/h,\\ a_{ij}=-1/h & for\ |i-j|=1\\ a_{ij}=0 & for\ |i-j|>1\end{cases} \quad (25)$$

And

$$\begin{cases}F_i=h & i=\overline{1,N-1}\\ F_0=F_N=h/2\end{cases} \quad (26)$$

The methods studied in the section above.

3.2 Method of successive approximations

Ritz-Galerkin approximation corresponding problem (14) is

$$\text{Determine}\begin{cases}u_h\in K_h \quad so\\ (A_hu_h,v_h-u_h)\geq 0\\ for\ all\ v_h\in K_h\end{cases} \quad (27)$$

Where the product is R^{N+1}.

Comparing formulas (27) and (24) we see that operator A_h has the formula

$$A_h(\cdot)=[a_{ij}](\cdot)+(F_i) \quad (28)$$

where by (.) noted column vector and [.] matrix.

Apply formula (4) that for *f = 0* becomes

$$\begin{cases}u_h^{(0)}\in K_h\\ u_h^{(q+1)}=P_{K_h}(u_h^{(q)}-\rho(A_hu_h^{(q)})),q=0,1,2...\end{cases} \quad (29)$$

where K_h is given by (16) and taking into account the proper form of crowd R_h (20) and formula (28), the second relationship from (29) can be written component (give up the index *h*).

$$u_0^{(q+1)} = a, \quad u_N^{(q+1)} = b \qquad (30)$$

$$u_i^{(q+1)} = \max\{0, u_i^{(q)} - \rho(\sum_{i=0}^{N} a_{ij} u_j^{(q)} + F_i)\} \qquad (31)$$

$i = \overline{1, N-1}$.

We use SOR method type (Successive Over Relaxation) get

$$u_i^{(q+1)} = \max\{0, u_i^{(q)} - \rho(\sum_{j=0}^{i-1} a_{ij} u_i^{(q+1)} + \\ + \sum_{j=i}^{N} a_{ij} u_i^{(q)} + F_i)\}, \quad i = \overline{1, N-1} \qquad (32)$$

or

$$u_i^{(q+1)} = \max\{0, \omega_i^{(q+1)}\} \quad i = \overline{1, N-1} \qquad (33)$$

$$\omega_i^{(q+1)} = u_i^{(q)} - \rho_i (\sum_{j=0}^{i-1} a_{ij} u_j^{(q+1)} + \sum_{j=i}^{N} a_{ij} u_j^{(q)} + F_i) \quad (34$$

take $\rho_i = \omega / a_{ii}$ where $\omega \in (1,2)$ is the relaxation parameter and formula (34) leads to

$$\omega_i^{(q+1)} = (1-\omega) u_i^{(q)} - \frac{\omega}{a_{ii}} (\sum_{j=0}^{i-1} a_{ij} u_j^{(q+1)} + \\ + \sum_{j=i+1}^{N} a_{ij} u_j^{(q)} + F_i), \quad i = \overline{1, N-1} \quad . \qquad (35)$$

Using (25) and (26) we obtain

$$\omega_i^{(q+1)} = (1-\omega) u_i^{(q)} - \frac{\omega}{a_{ii}} (a_{i,i-1} u_{i-1}^{(q+1)} + \\ + a_{i,i+1} u_{i+1}^{(q)} + F_i) = (1-\omega) u_i^{(q)} - \\ - \frac{\omega h}{2} (-\frac{1}{h} u_{i-1}^{(q+1)} - \frac{1}{h} u_{i+1}^{(q)} + h) = \\ = (1-\omega) u_i^{(q)} - \frac{\omega}{2} (u_{i-1}^{(q+1)} + u_{i+1}^{(q)} - h^2).$$

Each iterate the algorithm is given by the formulas

$$\begin{cases} u_0^{(q+1)} = a, \ u_N^{(q+1)} = b \\ u_i^{(q+1)} = \max\{0, \omega_i^{(q+1)}\} \quad i = \overline{1, N-1}, \\ \omega_i^{(q+1)} = (1-\omega) u_i^{(q)} + \frac{\omega}{2} (u_{i-1}^{(q+1)} + u_{i+1}^{(q)} - h^2) \\ i = \overline{1, N-1}, \quad q = 0,1,2,\ldots . \end{cases} \qquad (36)$$

SUAP Algorithm

- The input variables are:
  a, b, N - with the same meaning as above
  omg - relaxation parameter
  eps - accuracy for the stopping criterion

$$\left\| u^{(q+1)} - u^{(q)} \right\| < \varepsilon \qquad (37)$$

  maxit - maximum number of iterations
- Output variables are:
  x - indexed array [0 .. N] that contains network x_i .
  Uold, Unew - Pictures index [0 .. N] that contain two consecutive iterated. *Uold* corresponds to $u^{(q)}$, and *Unew* corresponds to $u^{(q+1)}$;
  iter - iteration count
  Flag - variable that indicates the state of convergence of the algorithm
  =0 - algorithm is running
  =1 - stopping criterion (37) was satisfied, so algorithm converges;
  =99 (or any value other than 0 or 1) maximum number of iterations was reached without satisfying criterion (37), so the algorithm does not converge.

The core algorithm is built with the formulas (36). Norma used to stop criterion (37) is the discrete l_2 norm. The algorithm is described in Pascal-based language.

```
Begin {SUAP}
Read the input variables: a, b, N, omg, eps,
   maxit;
   h := 1.0 / N
   h2 := h
asth;
      for i := 0 to N do
      x[i] := i * h
   end – for;
   omg 1 : 1.0 – omg;
   Uold [0]:=a; Uold [N]:=b;
   Unew [0]:=a; Unew [N]:=b;
   for i:=1 to N-1 do
         Uold [i]:=0.0
   end – for;
   flag:=0;
   iter:=1

   Start iterative loop
REPEAT
      Iterated new software
      for i:=1 to N-1 do
         ω := omg1 * Uold[i] + 0.5 * omg *
         * (Unew[i – 1] + Uold[i + 1] – hp2);
```

```
            if ω >= 0.0
               then Unew[i] := ω
               else Unew[i] := 0.0
            and if ;
         and – for;
         Stopping Tests
         sum=0.0
         for i:=1 to N-1 do
         sum := sum + (Unew[i] – Uold[i]) ** 2
         end – for;
         dl2 := sqrt(sum);
         if dl2 < eps
            then flag:=1
            else iter:=iter +1;
               if iter <= maxit
                  then Uold:=Unew
                  else flag:=99
               and – if;
         and – if;
   UNTIL flag < > 0;
   if flag = 1
            then Write ('CONVERGE
                       ALGORITHM')
                write (x, Unew 0)
            else Write ('ALGORITHM NOT
                       CONVERGE)
   And – if;
   End SUAP.
```

3.3 Numerical results

Let $K = \{v \in V; v(0) = a, v(1) = b, v \geq 0 \, in \Omega\}$;

$a > b \geq 0$ where u satisfies the variation inequality

$$\int_0^1 u'(v' - u')dx + \int_0^1 (v - u)dx \geq 0$$

for any $v \in K$.

$u \in K$ solution satisfies the problem:

$$\begin{cases} u \geq 0, -u'' + 1 \geq 0, (-u'' + 1)u = 0 \\ u(0) = a, u(1) = b \end{cases} \quad (38)$$

is

$$\begin{cases} 1/2(x - P)^2 & for \ x \leq P, \\ 0 & for \ x > P; \end{cases} \quad (39)$$

$P \in (0,1), u \in C^1[0,1] \cap H_2(0,1).$

We take the numerical tests $a=1/4$ and $b=0$. Obtain from the condition $u(0)=1/4$: $P = \sqrt{2}/2$ and therefore approximate mathematical solution is

$$\begin{cases} 1/2(x - \sqrt{2}/2)^2 & for \ x \leq \sqrt{2}/2, \\ 0 & for \ x > \sqrt{2}/2. \end{cases} \quad (40)$$

For the stopping criterion we take $\varepsilon = 10^{-3}$. SOR relaxation parameter must be in the interval (1,2). If ω values are well chosen convergence is fast and results are appropriate.

Table 1 corresponds to the choice N=40 (h=0.025), Table 2 corresponds to the data N=100(h=0.01). P is the first network node from 0 to 1 where the numerical solution valuation 0. For mathematical solution given by (40) we have $P = \sqrt{2}/2 \approx 0.707$. Valuation *iter* gives the number of iterations performed by the algorithm until convergence is achieved.

Table 1. (N=40)

ω	*iter*	P
1.55	48	0.7
1.6	43	0.7
1.9	41	0.7

Table 2. (N=100)

ω	*iter*	P
1.55	160	0.63
1.6	150	0.64
1.7	125	0.66
1.8	92	0.68
1.9	37	0.71
1.905	35	0.71
1.91	36	0.71
1.92	56	0.71

4. REFERENCES

[1] Antonelli, P. L., Bucataru, I., Rutz, S. F., *Computer algebra and two and three dimensional Finsler geometry*, Publ. Math. Debrecen, 62(2003), no. 3-4, 289-313.

[2] Bao, D., Chern, S.-S., Shen, *Z.*, *An introduction to Riemann-Finsler geometry*, Graduate Texts in Mathematics 2000, Springer\ N.Y., 2000.

[3] Miron, R., Anastasiei, *M.*, *The geometry of Lagrange spaces: theory and applications*, Kluwer Academic Publishers, FTPH no. 59, 1994.
[4] Nishimura, Shin-ichi, Hashiguchi, M., *On the Gaussian curvature of the indicatrix of a Lagrange space*, Rep. Fac. Sci. Kagoshima Univ., 24(1991), 33-41.
[5] Okada, T., *On models of projectively flat Finsler spaces of constant negative curvature*, Tensor, 40(1983), 117-123.

ISSN 1582 – 3601

„Nautica" Publishing House,
Constanta Maritime University

Editura
NAUTICA