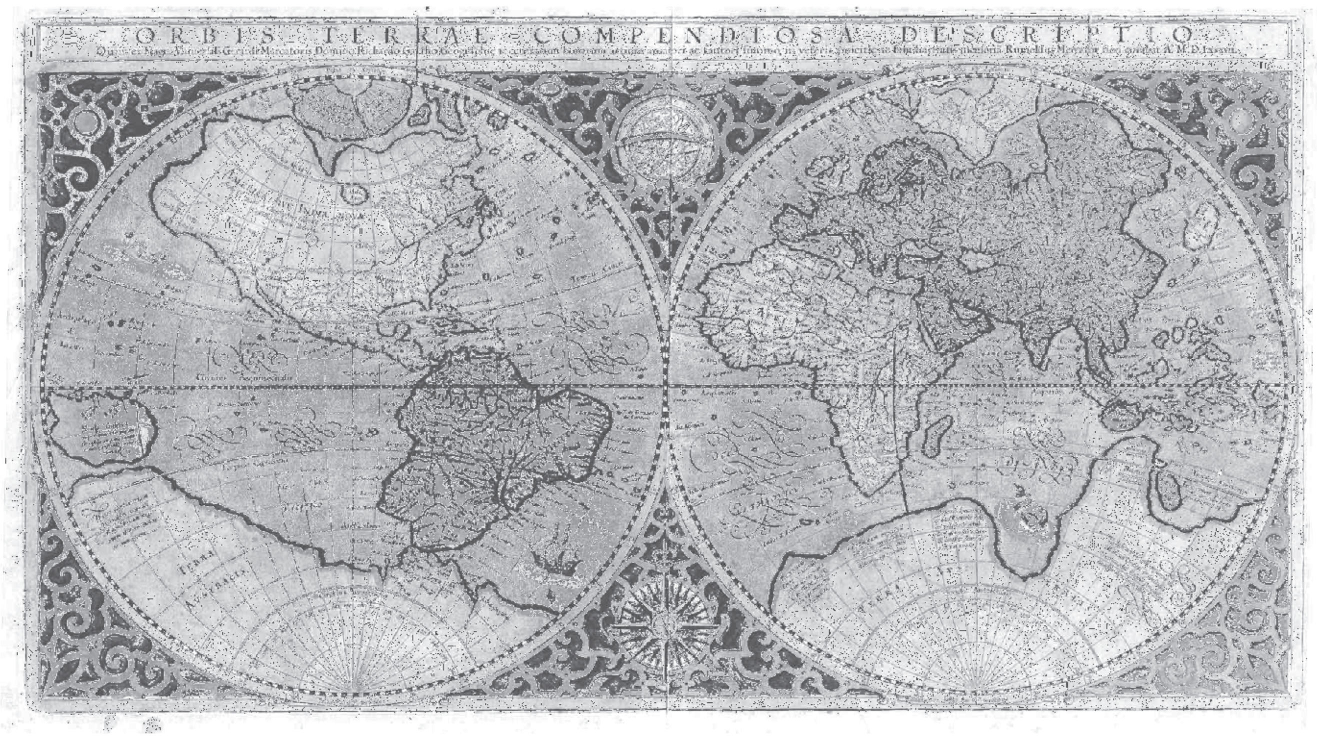
CONSTANTA MARITIME UNIVERSITY

ANNALS



YEAR XIV, 20th issue

Editura NAUTICA

CONSTANŢA 2013

SCIENTIFIC COMMITTEE

CONTENTS

SECTION I – NAVIGATION AND MARITIME TRANSPORT

SECTION II – MECHANICAL ENGINEERING AND ENVIRONMENT

SECTION III – ELECTRONICS, ELECTRONICAL ENGINEERING AND COMPUTER SCIENCE

SECTION IV – MATHEMATICAL SCIENCES AND PHYSICS

SECTION V – ENGLISH FOR SPECIFIC PURPOSES

SECTION VI - TRANSPORT ECONOMICS

SECTION I

NAVIGATION AND MARITIME TRANSPORT

CONSIDERATIONS ON BROACHING PHENOMENON AND ITS INFLUENCE ON LOSS OF SHIP STABILITY IN FOLLOWING SEAS

[1]ANDREI CRISTIAN, [2]BLAGOVEST BELEV, [3]LAMBA MARINEL-DANUT

[1,3]Constanta Maritime University, [2]"N.Y.Vaptsarov" Naval Academy Varna, Bulgaria

ABSTRACT

Ship stability in heavy seas has become one of the areas of the primary concern among ship designers and researchers. The effect of large waves may lead to ship capsize in a different scenarios. Broaching is one of the phenomenons that can lead to ship stability loss or even capsize in following longitudinal waves. The present paper presents the broaching phenomenon as appears on board vessel and point out the factors that influence ship's behaviour due to such situation. A possible solution for assessment such phenomenon is given in a form of recommendation for future development of stability criteria that include the broaching as a possible stability failure mode in heavy seas.

Keywords: *broaching, stability, capsize, criteria.*

1. INTRODUCTION

Ship survivability against capsize in heavy seas has become one of the reasons of the areas of primary concern among ship stability researchers and designers in recent years. Large amplitude vessel motions and capsize have served as hazards of the maritime community for centuries [9]. When a ship is subjected to the effect of large waves it may capsize according to a number of different scenarios, depending on the magnitude and direction of the wave excitation and the ship's own capability to resist such excitations.

Resonant or breaking waves approaching a ship from the side ("beam seas") have a potential to excite large rolling which could result in capsize, especially if the intensive oscillation of the ship causes shift of cargo or, if a considerably quantity of water is shipped on the deck.

In practice, the ships could loose intact stability under the impact of waves and wind in several ways. Typically, it is a chain of events rather than a single event. For example, due to high or abnormal waves, a ship could sustain rudder failure or even more could loose power, which might then cause it to heavily rolling in beam seas, thus in turn leading to shift of cargo and dangerous list of the vessel. Moreover, huge amount of water is shipped on deck and the worst result is capsizing.

More dangerous can be a group of steep and relatively long waves approaching a ship from the bow ("head seas") or from the stern ("following seas"). Waves of this kind are known to incur significant reductions in roll restoring capability (i.e. the tendency to return to the upright position) for many types of vessels and they instigate dangerous coupled motions.

One of the major capsizing scenarios in longitudinal following waves is broaching phenomenon. Broaching can appear as heeling during an uncontrollable, tight turn during which the stability failure caused may be "partial" or "total" [16]. This became dangerous when large angles of heel are developed in following seas.

The high interest developed among researches was also sighted by the International Maritime Organization which included broaching into the prospects for development the new–generation of intact stability criteria, as a major capsizing mode.

2. BROACHING on board ships

The dynamics of broaching is probably the most dynamically complex phenomenon of ship instability [2]. Among many of the theoretical studies on broaching include Davidson [4], Rydill [12], Du Cane & Goodrich [6], Wahab & Swaan [24], Eda [17], Renilson & Driscoll [13], Motora [10], Umeda & Renilson [17], Ananiev & Loseva [1] and Spyrou [14], [15], [16]. As experimental methods, broaching has also been studied by test with scaled radio-controlled physical models that have taken place in large ship square model basins, by Nicholson [11], Fuwa [8], De Kat & Thomas [5] and Umeda [18]**.** More recently were the experiments of Umeda [20] [21] [22]**.**

Broaching is a violent uncontrollable turn of a vessel, occurring despite maximum steering effort in the opposite direction, which lead to violent yaw motions resulting in rapidly change of ship's course, when the waves approaching the ship from astern or from stern quartering directions.

During this high turn, when are produced very high centrifugal forces, a very large heel angle may be developed that may eventually lead to capsizing or represent a partial stability failure. In other words, broaching is a phenomenon in which a ship cannot maintain a constant course despite the maximum steering effort of her helmsman [19] [9]. As a result, the loss of keeping the ship's course is considered, among others, as one of the elements defining the broaching phenomenon.

Umeda [19] used the following definition, for the detection of broaching:

$$\delta = -\delta_{\max}, r > 0, \dot{r} > 0, \qquad (1)$$

where, δ is the angle of rudder and r represents the turning rate. In other words, the broaching is present in case of a positive ship's turning rate even the counteracting rudder force already reached its maximum.

Broaching is an unintentional change in the horizontal-plane kinematics of a ship and it may be described as the "loss of heading" by an actively steered ship that is accompanied by an uncontrollable build-up of large deviation from desired course [16]. The situation of broaching occurs mainly in waves which come from behind and propagate in a direction forming a angle of 180 degrees with the longitudinal axis of the ship [3] (fig. 1).

Steering control can be lost if a wave crest is very slow passing the stern and, consequently, the rudder is in reduced flow conditions for a protracted period. The ship starts veering off course during a prolonged period of poor rudder control and the rate of yaw increase with increasing wave angle to the stern. The hydrodynamic force Fh increases with the rate of yaw so, as the ship comes beam onto the sea, the combined heeling moments of Fh and the wind may be sufficient to capsize the vessel.

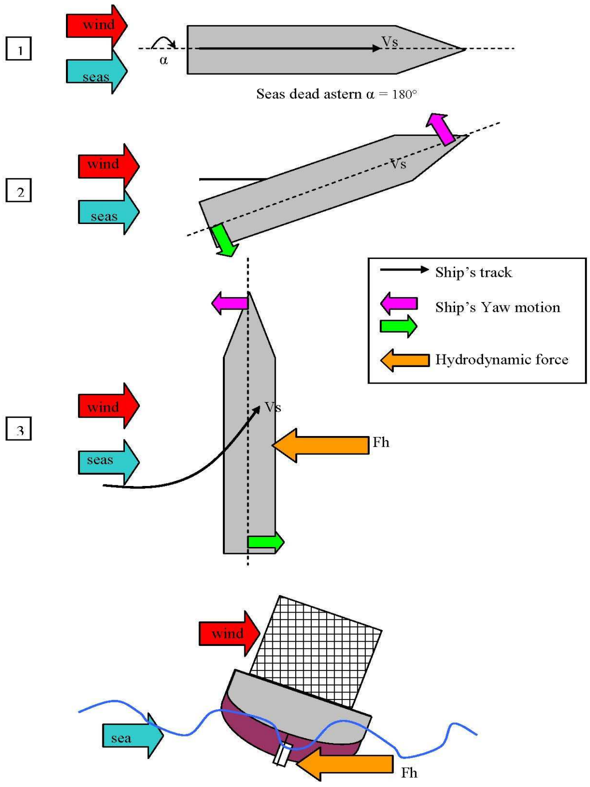


Figure 1 Example of broaching behaviour in following waves

A following wave crest impairs a ship's steering as it passes the rudder because the fore and aft component of the water particle velocity is in the same direction as the ship velocity so water flow over rudder is reduced by water particle velocity (fig. 2).

Rudder effectiveness reduces with increasing of water particle velocity and the control decreases with increasing time taken by the wave crest to pass the rudder, so steerage is lost if the stern sits on a following large crest for long enough [3].

Water particle velocity U and wave phase velocity c_w are given as [3]

$$U = \frac{H_w \cdot g}{2c_w} \tag{2}$$

and

$$c_w^2 = \frac{\lambda \cdot g}{2\pi}, \tag{3}$$

where λ is the wavelength and $g = 9.81 m/s^2$.

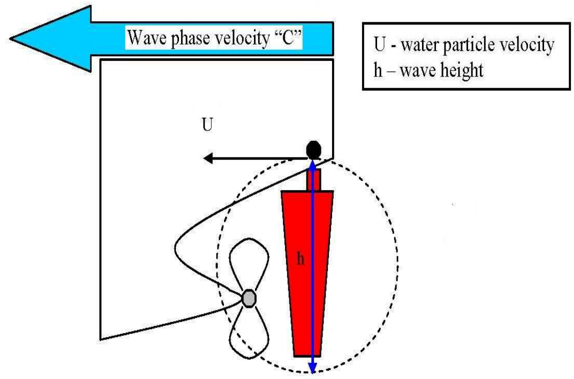


Figure 2 Loss of rudder effectiveness when a following wave is at the stern

Thus, if the equations (2) and (3) are combined, results

$$\frac{U}{c_w^2} = \frac{2\pi Hg}{2c_w \lambda g} \tag{4}$$

hence,

$$\frac{U}{c_w} = \frac{\pi H}{\lambda} \tag{5}$$

As the height of the average deep water wave is about 5% of the wavelength, then U is typically about 16% of the wave's phase velocity c_w.

The peak period in the wave spectrum of a Beaufort force 9 gale is typically about 10 seconds, which gives a wavelength of 150 m with a phase velocity of 15.3 m/s or 29.7 knots. If the average wave height is 5% of the wavelength (i.e. 7.5 m), then the surface water flow over the rudder is reduced by about 5 knots as an average wave crest passes the stern, though this could occasionally increase up to 9 knots for an extra large wave [3]. However, the reduction in the water flow over the entire depth of the rudder will be less than this, as the water particle velocity U also decreases exponentially with depth to become zero at the depth beneath the surface equal to about 40% of the wavelength. Nevertheless, the slow passing of large following waves has a considerable effect on the ship's steering [3].

Although the inception of broaching represents a problem of instability on the horizontal plane, capsize may be incurred at the post-critical stage due to development of large heel as energy is transferred into roll direction.

Broaching could happen to small as well as to larger ships [16]. More frequent the broaching phenomenon is manifested as a sudden divergent yaw, which peaks within a single wave length whilst the control is lost when the middle of the ship lies somewhere on the down-slope and nearer to a trough. In other cases there is a gradual, oscillatory type build-up of yaw as successive waves came on the ship from behind [16]. In moderate sea states a ship is more likely to broach-to if it runs with a high speed and is slowly overtaken by the waves. Broaching may also occur at lower speed if the waves are very steep [16].

IMO, through MSC Circ. 1228, considers a ship to be liable to broach when running ahead of the following or quartering seas at speed equal to or greater than the critical speed V_c which is given as:

$$V_c = \frac{1.8}{\cos\alpha}\sqrt{L}\,, \tag{6}$$

where L is the ship's length (m) and α is the direction of waves relative to the ship's track.

The circular also advices that the ship may broach at less than the critical speed but gives a minimum speed for risk of broaching, as follows:

$$V_{\min} = \frac{1.4}{\cos\alpha}\sqrt{L}\,. \tag{7}$$

For speeds higher than this and for running course ahead of a large following sea, the helm actions should be made with caution.

Broaching occurs mainly in following waves of lengths between 75% and 150% of the ship's length. The oblique velocity of the shorter waves in this range equals $\frac{2.2}{\cos\alpha}\sqrt{L}$ knots. Broaching is highly possible to occur when such waves overtake a ship at less than about 20% of the ship's speed, so MSC Circ. 1228 strongly recommends that a ship's speed is kept below the critical speed of $\frac{1.8}{\cos\alpha}\sqrt{L}$ knots when running before heavy seas coming from within 45° of right astern.

However, having in view his nature, the broaching phenomenon is not a classical problem of intact ship stability. Neither the simple increase of up-righting stability, nor the alteration of certain design parameters, in order to reduce restoring arm variations, will diminish the probability of occurrence of broaching and also does not attenuate the consequences substantially. In the situations of broaching, large rolling angles can be developed and can occur at low values of initial GM. As broaching phenomena are related to course keeping problems in heavy weather, broaching can hardly be avoided by modifying the GM value of the ship. Therefore, broaching has to be considered as a problem of manoeuvring, and, hence, of operating and operator guidance, and must be treated accordingly.

3. RECOMMENDATIONS FOR DEVELOPMENT AN ASSESSMENT CRITERION OF BROACHING

The future criterion for assessment of ships vulnerability to broaching phenomenon can be an accessible and easily computational tool, based on empirical approach, to be used by the officers on board vessel. The most important thing is that the criterion should guarantee a conservative safety level and to be based on a threshold value ascertained for the situation of regular following waves.

In order to determine the broaching threshold in regular following waves, a most suitable solution is an analytical one. Despite the fact that this solution is based on the theoretical background, it is very easy to be evaluated. One of the possible analytical solution is by assuming the proportionality between the ship velocity and the propeller and resistance thrust, where the ship resistance, propeller thrust, hull form offset, manoeuvring and roll damping coefficients and restoring moment are required. In order to develop a sustainable assessment criterion it is also necessary that deterministic thresholds for capsizing due to broaching to be as a function of wave parameters (height and period).

The criterion has to be applied since from the designing stage because if the proposed ship design fails to comply it is expected to apply the direct stability assessment to the subject ship design. In this case, it is very important to evaluate the risk level of the ship's design and the probability of capsizing due to broaching.

4. CONCLUSIONS

The written information for handling of ships in heavy weather is of very little amount. The Admiralty Manual of Seamanship devotes some pages to the handling of ships in severe conditions and explains:

„*How best to handle a ship in heavy weather depends so much upon the type, size and capabilities of the particular ship that it would be unwise to lay down precise instructions as to how to act in various circumstances*."

The seamanship practices indicates that the best way to survive heavy weather is to avoid it. This is borne out also by the development of weather routing systems such as Optimum Track Ship Routing (OTSR), a US Navy system that utilizes route selection and surveillance procedures based on short and extended range forecasting techniques. Seamen also use for long time ago weather forecasting and historical data to create routes of navigation that will both mitigate between the success of the voyage and the risks involved by weather. Once in the vicinity of storm, the general advice is to minimize the risk and damage to the ship. When encountering rough seas were tropical storms are involved, the doctrine is mainly concerned with avoiding the storm centre, depending on the ship's location relative to it. Prudent ship operation dictates that severe sea conditions be avoided when possible; thus, ship operators often have limited experience in severe conditions.

The capability of the ship to withstand the rigors of the seas has influence on decisions regarding speed and heading in heavy weather. The risk of occurring and increasing the broaching phenomenon is running before the sea lessens the extreme forces. Of course, the risk of broaching-to can be minimized by reducing the ship speed in relation to wave speed, but this leads to the increase of the risk of being pooped. As the ship's speed is reduced and the ship slows, relative to wave speed, the overtaking waves can wash along the upper decks from astern. This fact can lead to significant damage, and what is critically is that the officers on watch from the bridge may not notice the damage.

Presently, the ship courses and speeds are chosen based on the guidance provided in the references and on a subjective „seamanship practice feel" for how the ship is reacting to external forces. The information to guide the master when encountering extreme weather is very little in the literature.

In order to allow time for changes to be made, it is necessary to establish methods to aid vessel operators in identifying the onset of threatening ship motion conditions, thus altering the commanded response to environmental conditions and possibly reducing exposure to devastating ship motions or capsize. Therefore, it is of benefit to all sectors of the marine industry to develop methods, which could provide ship's officers with indicators of the onset of inclement ship motions.

Of course, not all the times the heavy weather conditions can be avoided. In this way, the necessity of establishing a set of stability criteria, to show the vulnerability and behaviour of the vessel in such conditions, is of paramount importance. In the present, ships are meet heavy weather conditions but how will react in such conditions remain a big question mark.

5. REFERENCES

[1] Ananiev D.M., Loseva L., *Vessel's Heeling and Stability in The Regime of Maneuvering and Broaching in Following Seas*, STAB'94, Florida, 1994.

[2] Bassler, C.C., Belenky V., Bulian G., Francescutto K., Spyrou K. and Umeda N., A *Review of Available Methods for Application to Second Level Vulnerability Criteria*, Proceedings of the 10th International Conference on Stability of Ships and Ocean Vehicles, St. Petersburg, Russia, 2009.

[3] Clark I.C., *Stability, Trim and Strength for Merchant Ships and Fishing Vessels*, 2nd Edition, The Nautical Institute, 2008.

[4] Davidson K.S.M., *A note on the steering of ships in following seas*, proceeding of the 7th International Congress of Applied Mechanics, London 1948.

[5] DeKat J.O., Thomas W.L., *Broaching and Capsize Model Tests for Validation of Numerical Ship Motion Predictions*, 4th International Ship Stability Workshop, St. Johns, 1998.

[6] DuCane P, Goodrich J.R., *The Following Sea, Broaching and Surging*, Trans. RINA, 1962.

[7] Eda H., *Directional Stability and Control of Ships in Waves*, Journal of Ship Research, No.16, 1972.

[8] Fuwa T., Sugai K., Yoshino T., Yamamoto T., *An Experimental Study on Broaching-to of a Small High Speed Boat*, Tokyo, 1982.

[9] McCue L., Bassler C., Belknap W., *Real-time Identification of Behavior Leading to Capsize*, Proceedings of the 9th International Conference on Stability of Ships and Ocean Vehicles, 2006.

[10] Motora S., Fujino M., Koyonagi S., Ishida S., Shimada K., Maki T., *A Consideration on The Mechanism of Occurrence of Broaching-to Phenomena*, JSNA, 1981.

[11] Nicholson K., *Some Parametric Model Experiments to Investigate Broaching-to*, International Symposium of Maritime, Vehicles and Structures, London, 1974.

[12] Rydill L.J., *A Linear Theory for The Steered Motion of Ships in Waves*, Trans. RINA, 1959.

[13] Renilson M.R., Driscoll A., Broaching, *An Investigation into The Loss of Directional Control Severe Following Seas*, Trans. RINA, 1982.

[14] Spyrou K.J., *Dynamic Instability in Quartering Seas: The Behaviour of a Ship During Broaching*, J.Ship Res., Vol.40, No.1, 1996.

[15] Spyrou K. J., *Dynamics Instabilities in Quartering Seas – Part III: Nonlinear Effects on periodic Motions*, Ship research, Vol.41, No.3, 1997

[16] Spyrou K.J., *The Nonlinear Dynamics of Ships in Broaching*, Marie Curie Fellowships Annals, Vol.1, 2000.

[17] Umeda N., Renilson M.R., *Broaching – A dynamic analysis of yaw behavior of a vessel in a following sea*. In Wilson PA (ed) Maneuvering and Control of Maritime Craft, Computational Mechanics Publication Southampton, 1992

[18] Umeda N., *Nonlinear Dynamics of Ship Capsizing due to Broaching in Following / Quartering Seas*, Journal of Maritime Science, Vo.4, 1999.

[19] Umeda N., Peters A., *Recent Research Progress on Intact Stability in Following / Quartering Seas*, Proceedings of the 6th International Ship stability Workshop, Webb Institute, 2002.

[20] Umeda N., Shuto., Maki A., *Theoretical prediction of Broaching Probability for a Ahip in irregular Astern Seas*, Proceedings to the 9th International Ship Stability Workshop, Hamburg, Germany, 2007.

[21] Umeda N., Maki A., Araki M., *Some Issues on Broaching Phenomenon in Following and Quartering Seas.* Proceedings of the 10th International Ship Stability Workshop, 2008.

[22] Umeda N., Hashimoto H., Maki A., Matsuda A., Momoki T., *Prediction Methods for Broaching and Their Validation – Final Report of Scape Committee (Part 6)*, Proceedings of the 6th Osaka Colloquium on Seakeeping and Stability of Ships, 2008.

[24] Wahab R., Swaan W.A., *Course – keeping and Broaching of Ships in Following Seas*, 1964

KITE INFLUENCE ON THE SHIP'S CAPACITY OF MANEUVERING AND COURSE STABILITY FOR THE UNCONVENTIONAL MIXED PROPULSION

[1]BARSAN EUGEN, [2]GROSAN VOICU-NICOLAE

[1,2]Constanta Maritime University, Romania

ABSTRACT

More than two centuries since the first steam-powered engine was installed on board of a ship ("Clermont", 1807), followed shortly by the invention of the Diesel engine, marine pollution and atmospheric pollution, due to marine propulsion engines, reached alarming levels. Despite all efforts made by the ship-owners, ship builders and all those involved in shipping, the results were not as expected.

In the early twentieth century, given the small number of existing ships on the world market, nobody issued the problem regarding high fuel consumption and air pollution, Without doubt, using unconventional methods of propulsion is a big step towards reducing air pollution.

We can say that the old methods of propulsion systems have returned to date, on the same principles discovered long time ago, but now using the latest technologies and equipment.

The three natural sources: wind, sun and waves showed up at the moment, at least experimentally, (but also practically for wind and solar energy), that future naval propulsion will be provided by mixed methods combined with conventional propulsion engine to some extent, while the future technological development will allow us to use only natural sources.

We say "conventional" propulsion systems, those systems that use fuels to power up the combustion engine and produce movement of rotation of the crankshaft and thus the propeller, thereby moving the ship.

"Unconventional" systems are those systems, methods, ways that do not use fuel powered engine power, or do not work in conjunction with it.

In this paper we watched and analyzed through the simulator, the influence that the kite has over the maneuvering and the ship's course stability of powered combined engine - kite ship.

Keywords: *kite traction, yawing moments, total aerodynamic force, torque moments.*

1. INTRODUCTION

Unconventional propulsion systems were at the basis of navigation since ancient times, their place being taken by marine engines in the nineteenth century, along with the strong industrialization of transport.

Compared to internal combustion engines, these procedures can be considered environmentally friendly for marine waters and air.

Among the most used unconventional systems, some implemented, others remained only at the research stage, are: rotor cylinders Flettner system based on the Magnus effect [1], sails stiff and/or mobile covered with photocells (wind and solar energy), electric motors, kites [2]

The projects reflect the new propulsion methods that use wind or solar energy or combined propulsion methods, methods that do not drop totally up to internal combustion engines but reduce their contribution to the propulsion [3,4].

The work can be framed in the concept "Green Ship", where the alternative methods for naval propulsion are reviewed, along with shipbuilding (hull modified forms, the use of silicone coatings), marine equipment (high performance equipment and less polluting), propulsion engines and fuels (bio-fuels and silent engines),[5].

Because the field of wind energy is very large, in this paper we focused to the effect that a sail raised at a certain height and that tows the ship, a system that is briefly called "kite", has over the ships maneuvering ability, especially the ship's ability to maintain the ordered course.

We treated only kite's influence in the calm sea surface conditions and without using the main propulsion engine.

The calculation of traction forces exerted by kite was achieved by using the program ANSYS Fluent is applied then the navigation simulator (Transas Navi Trainer, 2009). We had the opportunity to study the behavior of the ship for different angles of incidence of the kite's wind. In this first simulation stage we did not take into consideration the sea surface wind and the waves or currents influence.

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.

2. THE FORCES AND TORQUE MOMENTS OF THE KITE

The kite is an airfoil as airplane wing. But, unlike the latter, the kite does not maintain in a fixed position regarding the ship one, of which it is attached. Another factor that creates this distinction is the different angles at which kite operates, these regarding the base plan (water plan) and to the direction of movement of the ship.

The calculation of forces acting upon the kite allows us to calculate the total aerodynamic force. This is the force that pulls the kite on its direction and therefore propels the ship through the traction of the connecting cable.

One of the most important aspects of traction exerted by the kite is the balance that exists between the total aerodynamic force and the connecting cable kite - ship. This balance depends on the position that the kite has against the wind, within an area called "flight range" or "flight hemisphere" [6].

The kite is exposed to three main forces: the force of gravity $\overline{W}$, total aerodynamics force $\overline{T_{af}}$ and the cable tension $\overline{C_t}$.

Total aerodynamic force $\overline{T_{af}}$ is the resultant of two forces: lift force or simply lifting $\overline{L}$, which is perpendicular to the direction of airflow (wind) and the drag force acting on the direction of airflow. The two forces are applied in the "P" center, called “ the kite’s center of pressure”.

The force of gravity $\overline{W}$ acts always in the center of gravity of the kite's, denoted by "G" and directed towards the center of the earth [7].

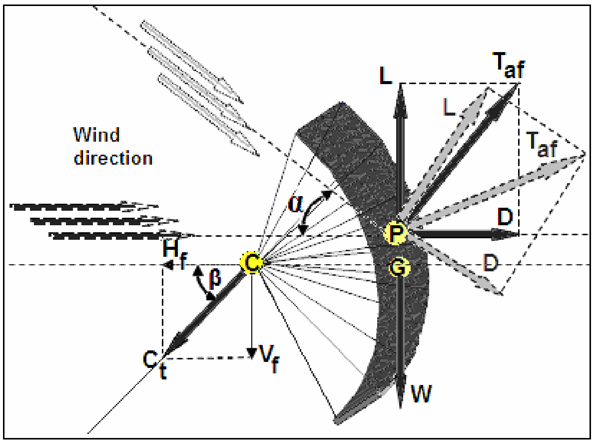


Figure1 The main forces that occur in kite

The third force, the cable tension $\overline{C_t}$, is applied from the point of connection of the cable's connection with kites strings, denoted by "C" point and is called the pivot point. This force has the opposite direction of total aerodynamic force and, as the latter, decomposes into two other forces: the horizontal force $\overline{H_f}$ and the vertical force $\overline{V_f}$.

Under the influence of certain wind speeds, the drag and the lift forces increase in value. Kite will move in the vertical or nearly vertical direction as lifting force is greater than the weight $\overline{W}$ and vertical force $\overline{V_f}$.

Basically, to have left we must have movement, either the kite moves in a steady wind or wind "flows" around a stationary kite. Cable tension increases with drag force.

During its flight, the kite can rotate around the pivot point C, these resulting in a change of the wind angle of incidence α and also can move around this point leading to change position regarding the horizontal angle β.

The magnitude and the direction of forces that are acting upon the kite, especially lift and drag force, depend on the angle of incidence and on the ratio of lift and drag force, which in turn depend on the kite's shape and structure. [8].

For an optimal total aerodynamic force, we shall see to minimize this ratio. If the drag value is greater than the lift, the kite cannot rise to the desired height.

If the forces change values, due to the modification of the wind speed and direction, the center of rotation of the kite's position will change and the kite may fall due to new couple created.

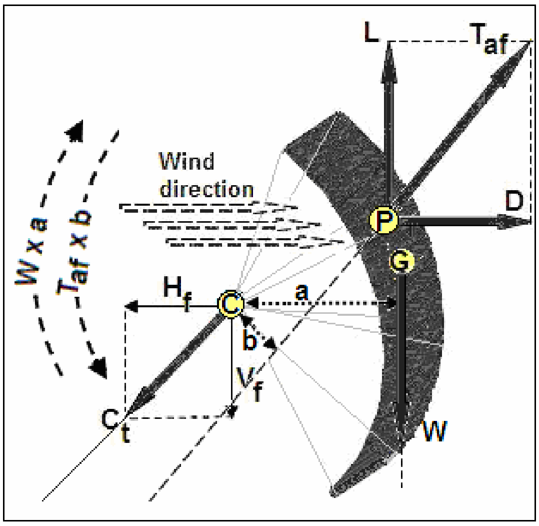


Figure 2 The kite’s torque moments

The torque moment due to gravity is:

$$\left|\overline{M_g}\right| = W \times a \qquad (1)$$

where $\overline{W}$ is the force of gravity and “a” is the arm of the force as distance from the pivot point and the direction of the gravity force.

The torque moment due to total aerodynamic force is:

$$\left|\overline{M_{fta}}\right| = T_{af} \times b \qquad (2)$$

where $\overline{T_{af}}$ is the total aerodynamic force and "b" is arm of the force, as a length from the pivot point to the direction of the aerodynamic force. The torque moment produces a counterclockwise rotation as shown in the figure 2 [9].

Cable tension $\overline{C_t}$ has no effect over kite's twisting moments because the arm of the tension force is zero.

The position the kite's stability, when it is not twisting around its pivot point is given by the next mathematical relation:

$$W \times a = T_{af} \times b \tag{3}$$

If the both torques moments are equal, the kite is in stable equilibrium, without any twists around the pivot point.

If the moments are unequal, the kite will rotate continuously around the pivot point.

It is therefore necessary to reduce torque rotation by calculating the shape, the surface and the structure of the kite as well as the optimal orientation towards wind direction.

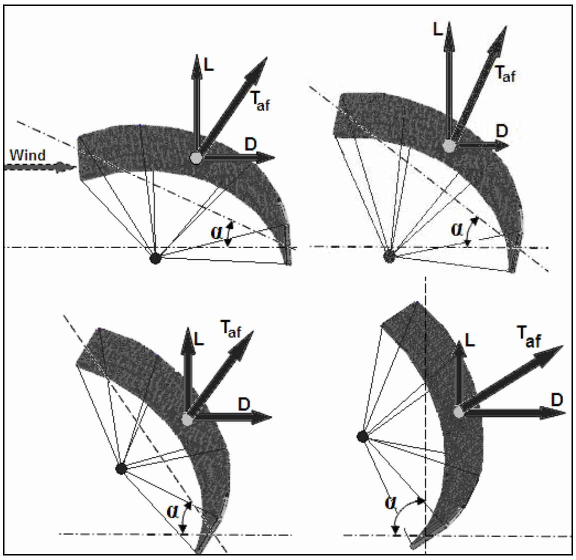


Figure 3 Changes of kite’s forces due to the change of the angle of incidence α

3. THE KITE’S INFLUENCE ON SHIP’S MANOUEVRABILITY AND COURSE STABILITY

Choosing a kite type for auxiliary ship propulsion, or to speak more accurate, choosing kite’s aerodynamic profile is a complex process because:

- using of the kite is a dynamic process; the kite is moving all the time under the influence of the airflow, often on a path that has the shape of the “eight” form,
- in regard to ship's position, the kite is not stationary,
- the kite works at different angles in relation to the water surface and to the direction of the ship.

Angles that the cable traction kite makes about the forward of the vessel varies widely, from zero to 70° or more in a board or another, and the vertical angle about to the sea surface varies between 40° -60°.

The force that is acting upon the kite, calculated using Ansys-Fluent program [10], was projected in the water plan and decomposed by XOY axes system which is joint with the ship (figure 4).

xOyz is the kite system axis (the plane XOY is parallel to the water plane, wind direction is along Ox axis).

Decomposing the force, exerted upon the kite, in a plane parallel to the water plane, will result a lateral force $\overline{F_{lat}}$ (figure 4) [11], whose values are presented in Table 2 (for α = 0 ° and α = 45 °)

This force was calculated for α angles: 0°, 30°, 45°, 60° and 90° and for angles θ: 0°, 5°, 10°, 20° and 30°.

Depending on the ship direction, $\overline{T_{af}}$ decomposes in XOZ plane, which will result a lateral yaw deviation force.

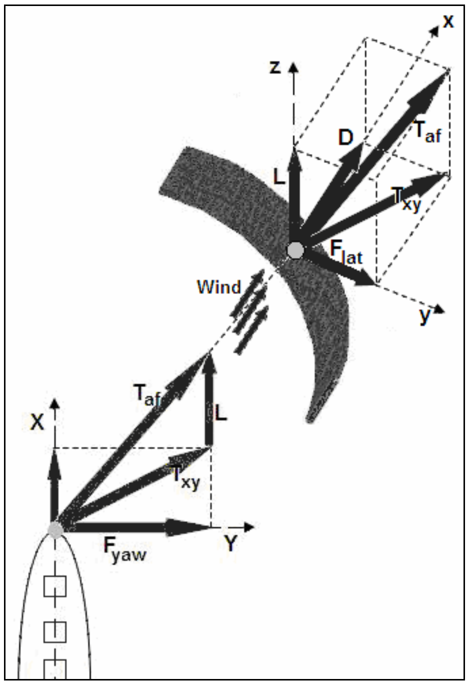


Figure 4 Projection of the forces on the water plan, yaw and lateral forces

Through the program we have developed a simplified representation of the kite's considering a constant thickness value for the profile.

Kite's dimensions are: length 28.57 m, width 7 m, thickness of the profile 0.7 m.

In numerical calculation, besides the angle of incidence α, we took into account also the angle θ, which is the angle that the kite makes it while rotating along the yy' axis.

Wind direction is along the Ox axis.

In figure 5 we have noted the α angle as the angle that the kite makes it while rotating around its vertical axis xx ', axis that is an extension of the chord profile, and with θ, the angle that the kite makes it while rotating about the longitudinal axis yy '.

At this stage we have considered the following values:

- wind speed w = 10 m/s;
- angle of incidence α: 0°, 30°, 45°, 60°, 90°;
- angle of incidence θ: 0°, 5°, 10°, 20°, 30°;
- pressure: 101325 Pa;
- dynamic viscosity of air: 1.7894 x 10^{-5} kg/ms;
- kinematics viscosity of air: 0.0001460735 m^2/s;
- total area of the kite's: 200 m^2.

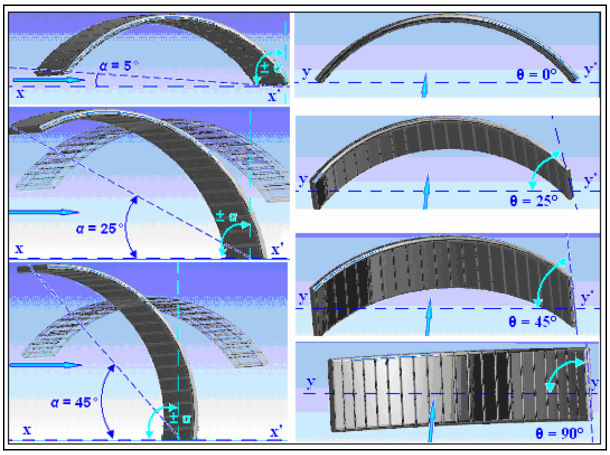


Figure 5 Kite's motion on axis xx 'and yy'

After the calculations, the following results were obtained (illustrated in Table 1): the lift force, the drag force, the total aerodynamic force and lateral force for different angles of incidence α and θ.

Looking into the results of calculations for all situations, we can conclude the following:

- the total aerodynamic force $\overline{T_{af}}$ is maximum for angles α and θ equal to zero [case (a) α = 0°, θ = 0°]. This is because the drag force $\overline{D}$ has the highest value, and the lift force $\overline{L}$ is less contributing,
- lift force $\overline{L}$ is maximum for an angle α equal to zero degrees and an angle θ equal to 30 degrees,
- for the same angle θ, lift force decreases from a maximum to a value close to zero [if θ angle = 0°, $\overline{L}$ decreases from 9754 N α = 0° to 20.98 N for α = 90°], a value for which the kite falls down.

Thus, proven by calculation that the maximum drag force [12] is achieved when the kite is at an angle of incidence of 0 degrees, when, in fact, the only force that appears is the drag force, the lift force is negligible and therefore the kite cannot be arisen.

The greater the exposed surface to wind is, the greater the value of drag force is and hence the total aerodynamic force.

We can notice that at certain angles the lift force has smaller values compared to the drag force.

That is way during kite's handling about the wind direction, it is necessary to position the kite so that the forces should be proportioned in such a way so that there's lift to keep the kite floating in the air stream and enough drag for a good overall aerodynamic force to propel it to the desired direction [13].

Table 1. The values of the L, D, T_{af} and F_{lat} for different α and θ angles for the kite of 200 m^2

θ Angle (°)	Lift Coeff. C_L	Drag Coeff. C_D	Lift Force **L** (N)	Drag Force **D** (N)	Total Aerodynamic force T_{af} (N)	Lateral Force F_{lat}
0°	0.0446	3,1520	570.87	38618.14	38622.219	17.77
5°	0.2595	2.8816	3179.56	35299.90	35442.806	13.14
10°	0.4568	2.6554	5595.80	32535.57	33012.577	11.10
20°	0.5974	2.0700	7319.08	25358.17	26393.103	10.86
30°	0.7962	1.6648	9754.31	20394.54	22606.542	10.34
θ Angle (°)	Lift Coeff. C_L	Drag Coeff. C_D	Lift Force **L** (N)	Drag Force **D** (N)	Total Aerodynamic force T_{af} (N)	Lateral Force F_{lat}
0°	0.0173	2.1794	212.5892	26697.26	26698.106	220.76
5°	0.1089	1.9034	1334.583	23317.65	23355.811	1694.96
10°	0.2842	1.6373	3482.125	20057.00	20357.013	1923.42
20°	0.4661	1.2691	5709.821	15546.99	16562.052	2278.56
30°	0.5741	0.9598	7033.857	11758.18	13701.454	2763.43
θ Angle (°)	Lift Coeff. C_L	Drag Coeff. C_D	Lift Force **L** (N)	Drag Force **D** (N)	Total Aerodynamic force T_{af} (N)	Lateral Force F_{lat}
0°	0.0109	1.5366	133.91	18823.46	18823.932	372.33
5°	0.1013	1.3840	1241.71	16955.08	17000.487	1294.11
10°	0.2235	1.1084	2738.25	13578.65	13851.994	1874.56

20°	0.3841	0.8435	4706.00	10333.28	11354.431	2187.68
30°	0.4833	0.5795	5920.73	7099.74	9244.530	2896.80
θ Angle (°)	Lift Coeff. $\mathbf{C_L}$	Drag Coeff. $\mathbf{C_D}$	Lift Force **L** (N)	Drag Force **D** (N)	Total Aerodynamic force $\mathbf{T_{af}}$ (N)	Lateral Force $\mathbf{F}_{lat}$
0°	0.0058	1.1012	71.84	13490.84	143490.191	467.44
5°	0.1139	0.9136	1395.31	11192.72	11279.350	1662.71
10°	0.2089	0.7766	2559.55	9514.57	9852.833	1778.94
20°	0.3548	0.6069	4346.44	7435.26	8612.245	2055.72
30°	0.4608	0.3937	5644.81	4823.98	7425.271	2110.19
θ Angle (°)	Lift Coeff. $\mathbf{C_L}$	Drag Coeff. $\mathbf{C_D}$	Lift Force **L** (N)	Drag Force **D** (N)	Total Aerodynamic force $\mathbf{T_{af}}$ (N)	Lateral Force $\mathbf{F}_{lat}$
0°	0.0017	0.4367	20.98	5350.74	5350.781	879.13
5°	0.0319	0.3515	391.32	4306.88	4323.744	572.67
10°	0.0578	0.2938	708.68	3599.64	3668.737	214.75
20°	0.0963	0.2245	1180.46	2750.64	2992.951	82.61
30°	0.1231	0.1400	1508.46	1716.65	2285.243	9.30

4. SIMULATION OF THE KITE'S ACTION ON THE SHIP'S CAPACITY MANOEUVERING AND COURSE STABILITY IN THE CALM

Initial conditions:

- the vessel's speed is zero
- orientation of the vessel on the 360° direction;
- the tug engine working at 30% of capacity - corresponding to a tensile force equal to the average horizontal component force of the kite $\overline{T_{xy}}$.
- weather conditions: wind and sea: calm
- towing cable length: 227 meters.
- altitude wind direction: 190° -170° and 210° - 200°.

Results of the simulation [14] session (S1), session presented in detail in figures 6, 7, 8, can be described as follows:

- Initially, the ship is at rest, without applying any force on it (considered at time 0).
- When the kite is aroused, the towing cable starts to stretch on the traction force direction, represented by the arrow and illustrated in figure 6 (1).

This phase corresponds to the situation in which the towing cable is unfold and the kite begins to rise [15]; in this phase the lift force is much higher than the drag force, the main purpose is to raise the kite at the desired height.

Thrust increases in a relatively short time the 360° direction, from zero to a maximum of 1778 tons. The real kite's movement, immediately after his ascension, it manifests the strong thrust force in the first 30 seconds, during which the kite is oriented against the air currents until it "is felt" the resistance of towing cable at the point of application/transmission force.

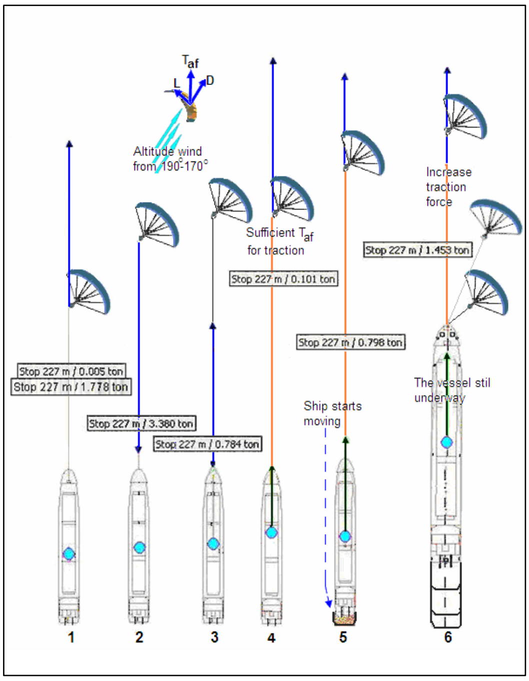
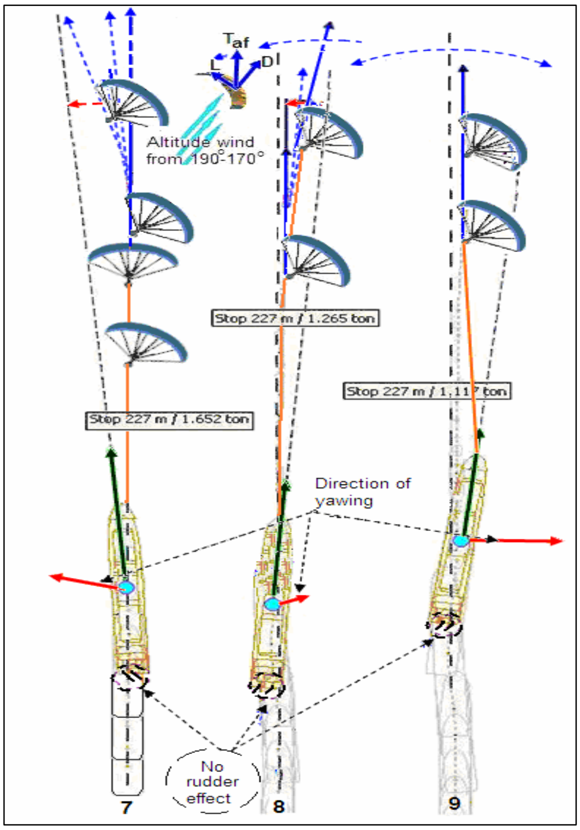


Figure 6 The variation of traction force until kite's stabilization on fly trajectory (1,2,3); kite stabilization and ship's movement due to increasing of traction force (4.5.6)

Once reached the maximum traction force, the kite not being under load, there is a rapid increase in traction force in the opposite direction (180°) to a value of 3.380 tons (figure 6 (2)) for a short time (35 seconds). This is the moment when the kite "feels" the resistance of the ship by the towing cable. Basically it is when the kite is stopped short of lifting free movement and is pulled backwards with a force large enough, and only the constant action and the constant winds combined with the drag force to a relatively high value maintain the kite on its position.

In figure 6(3) and 6(4) we can observe a decline in the value of the drag force on the towing cable on the 180° direction and its return to the direction on which the thrust force is applied.

Figure 7. Ship is going out of established course with



small yawing value in port and starboard.

This is the moment when the kite - oriented on a certain position begins to manifest its propulsion [17], when the thrust force begins to increase in value on the 360° direction [figure 6 (4)]. The ship remains at rest, the thrust force value is not yet big enough to move the ship from its position.

The time in which the activities mentioned above (time 0 - the start of traction) ranges from 0-180 seconds, which corresponds to the period in which the kite is launched to the desired height where it begins the real propulsion.

With the increase of the forward traction force, which corresponds to a traction force between 0.5-1,5 tons, the ship starts moving forward on the direction of the force [figure 6 (5,6)] at a speed between 0, 4 and 1.2 knots, keeping its direction and its speed for a certain period of time (between 2-5 minutes).

The vessel does not deviate from the original course (360°) and the lateral deviation vector, which indicates ship's intention to get out of the way, is zero. This is the moment in which the kite is facing the direction of the air flow. The thrust force does not have a fixed values, the range of variation is between 0.8 tons and 1.6 tons.

This is due to movements that the kite is having (movements in the form of "eight") under the action of air currents, the kite being „in the wind"/windward, when the thrust increases and "under the wind"/leeward, when kite has a period of falling (curve downward motion in the form of "eight") and therefore is less thrust [15, 16].

Therefore, lateral deviation force influences kite's movement all the time the kite is in flight. This is shown in figure 7 [(7, 8, and 9)], the ship starts to leave the 360° direction with small deviations to port and starboard. We can observe that the ship has a continuous intention to leave its direction, indicated by the lateral deviation vector that.

The use of rudder to bring the ship on its direction is not effective because the speed is too low and the steering effect is zero. We can observe the rudder positions to port and starboard but the ship continues to move in directions which are different from then the desired one [18].

In no situation have been found pitching moments due to traction force exerted by the kite, because the ship is too heavy [19]. Also, the lifting force of the bow part is almost zero (in theory this force exists) for the same reason. With the increased ship speed to 1.5 knots there is an increasingly large lateral deviation and any small change of the altitude wind direction makes the ship move away from the original direction.

In figure 8 [(10, 11, 12)] it is shown that a change of the wind altitude direction at 10°-20°, produces a traction force on the 5° -15° direction and a continuous growing lateral deviation, denoted by "y".

5. CONCLUSIONS

While the wind from the sea surface does not manifest at all and the ship is only under the effect of traction force exerted by the kite, its influence on the ship's course stability is at maximum value.

The ship follows the direction of the traction force developed by the kite [20] due to movement in its flying hemisphere, a movement which has the form of eight.

As shown in figures 6, 7, 8, the course stability of the vessel is affected due to lateral deviation, whose values tend to rise continuously.

Simulations were performed while the kite, more accurate the thrust exerted by it applied, manifests onto the right side of the ship. In other words, the traction direction was set between 000° - 030° (right), but during the simulation it did not kept strictly these values.

The situation is similar if the simulations were to be carried out by placing the kite to the left of the ship, with the maximum lateral deviation in this part [21].

Thrust has different values in different directions and at different times: initially high values in the first step in which the kite orientates itself, than its value decreases after a corresponding fall and a changing direction of flight's kite (kite is the downward phase, leeward) and then stabilized at almost constant values for a certain period.

The ship remains still until the thrust is large enough to impose a forward motion [22].

Ideal case is where the altitude wind occurs from south around 170° -190° values, because the thrust manifests towards the desired direction of the vessel (360°) and the lateral deviation that occurs is still low.

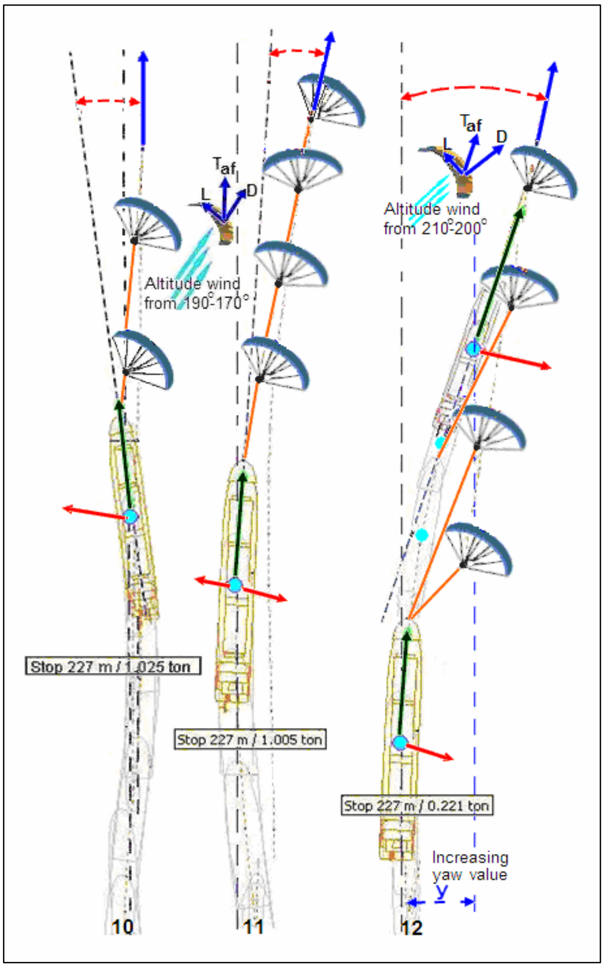


Figure 8 Increasing of yawing because of traction force

As the ship's speed is still low, any attempt to use the rudder in a board or another has no effect. Keeping the ship on the desired way to a speed given by the thrust's kite is not possible because the forces acting on the steering system are not large enough to create the required strength for the ship to change direction.

Kite's influence on ship handling, specifically onto the course stability is more pronounced while the sea surface wind acts upon the ship.

Using of kite sail as additional propulsion method in some favourable winding conditions can reduce the ship's pollution [24] generate by the main engine because the pulling force of the kite will reduce the load on the conventional propulsion system.

6. REFERENCES

[1] Gilmore P. – Spin Sail harness mysterious Magnus Effect for ship propulsion The What's New Magazine- Popular Science-January 1984

[2] Williams P., Lansdorp B., Ockels W.- Optimal cross wind towing and power generation of tethered kites, AIAA Guidance, Navigation and Control Conference and Exhibit, Hilton Head, South Carolina, 2007

[3] Houska B. - *Robustness and Stability Optimization of Open-Loop Controlled Power Generating Kites, Master's thesis, University of Haidelberg,2007*

[4] Fagiano L, M. Milanese, V. Razza, I. Gerlero - *Control of Power Kites for Naval Propulsion* - American Control Conference Marriott Waterfront, Baltimore, MD, USA June 30-July 02, 2010

[5] Green Ship Magazine - *Green Ship of the future*, Denmark, 2009

[6] Naaijen P., V. Koster - *Performance of auxiliary wind propulsion for merchant ships using a kite* , 2nd International Conference on Maritime Research and Transportation, ICMRT, Napoli, Italia, 2007

[7] National Aeronautics and Space Administration, *NASA – Torques on a kite- Principles*, 2008

[8] Barsan E, Grosan V.N - *Kite towed ships and kite generated power- intuitive methods for reducing marine pollution*, 14th International Congress of the International Maritime Association of the Mediterranean - Genova, Italy, published in "Sustainable Maritime Transportation and Exploitation of Sea Resources", ISBN 978-0-415-62081-9 pag. 1113-1117, Pub. Taylor & Francis Group, London, UK, 2011

[9] Paelinck R.- *Kite Power*, Master's thesis, Artesis Hogeschool, Antwerpen, 2010

[10] Ansys Fluent 12- *User's Guide*, 2009

[11] Grosan V.N. - *Researches regarding sail propulsion of the merchant vessels - the influence of the unconventional propulsion systems on the ship's nautical characteristics*, PhD Thesis, Constanta Maritime University, Romania, 2011

[12] Jalkanen J.P., A. Brink, J. Kalli, H. Pettersson, J. Kukkonen, T. Stipa : *A modelling system for the exhaust emissions of marine traffic and its application in the Baltic Sea area*, Atmos. Chem. Phys. Discuss.,2009

[13] Brabeck Stephan - *SkySails – New Energy for Fishing Trawlers*- First International Symposium on Fishing Vessel Energy EfficiencyE-Fishing, Vigo, Spain, May 2010

[14] Transas Navi Trainer 5000 – *Technical Description and User's Guide*, version 5, 2009

[15] Francis de Winter, Ronald B. Swenson, Dave Culp - *KiteShip Project*, Millenium Solar Forum, ISES, Mexico City, 2000

[16] Jalkanen J.P., A. Brink, J. Kalli, H. Pettersson, J. Kukkonen, T. Stipa : *A modelling system for the exhaust emissions of marine traffic and its application in the Baltic Sea area*, Atmos. Chem. Phys. Discuss.,2009

[17] Helldén Ulrika, Lena Bergh, - *Electrical systems in pod propulsion*- Department of Energy and Environment Division of Electric Power Engineering Chalmers University of technology , Göteborg, Sweden, 2007

[18] Dinu D - *Mecanica fluidelor pentru navigatori*, Editura Nautica, Constanța, ISBN 978-806-8105-11-6, 2010

[19] Stan L., Buzbuchi N., *Prevenirea şi combaterea poluării atmosferice produse de nave*, Ed. Nautica, ISBN 978-973-7872-80-7, 2009

[20] Groşan N., Dinu D, Scupi A. – *Mixed propeller ship- Influence of sea surface wind and wave about kite towed ship's manoeuvering capacity*, European Conference on Shipping & Ports 2011, ECONSHIP Chios, Grecia, 22-24.iunie 2011

[21] Groşan N.- *Consideration on the doctoral thesis entiled „Researches regarding kite propulsion of the ship – the influence of the non conventional propulsion methods on the ship's manoeuvering capacity*" Maritime Transport & Navigation Journal, Vol. 3 (2011), No. 3, Constanta 2011

[22] V.N. Grosan, E. Barsan, Manoeuvrability and course stability of thr kite towed ship under influence of external factors , *International Maritime Association of the Mediterranean 2013* – A Coruna, Spain, October 2013, published in Developments in Maritime Transportation and Exploitation of Sea Resources, ISBN 978-1-138-00124-4, pag.103-108, Taylor & Francis Group, London, 2013

[23] The European Environmental Bureau (EEB), The European Federation for Transport and Environment (T&E), Seas At Risk (SAR)- *Air Pollution from Ships* - A briefing document by: Swedish NGO Secretariat on Acid Rain, Updated November 2004.

COMPUTER SIMULATION OF THE MANUFACTURING PROCESS OF WOODEN SHIP MODEL, IN ALBANIAN WOODENWORK ENTERPRISES

[1]BLENARD XHAFERAJ, [2]KRISTOFOR LAPA, [3]ELIDON HASANAJ

[1,2]Department of Naval Engineering, University of Vlora, Vlore, Albania,
[3]Furnishings Production Enterprise FAPIEL, Vlore, Albania

ABSTRACT

Wooden ship models are often required for reasons of production, marketing and for tank testing. The main problems encountered in the production of these models, according the traditional process, mainly are related to problems of accuracy and symmetry defects. When the models are produced for production and marketing purposes these problems, lead their influence in the costs and production times and delivery. When the models are produced for experimental purposes (tank tests), problems related to symmetry affect the accuracy of the experimental results and consequently affect the prediction of ship power and dimensioning of its propulsion system. An efficient way to meet the current challenges and overcome the main problems relating the manufacturing sector of ship wooden model is the implementation of a modern production process, supported by work centres with numerical control machines (CNC). In this article will be present a procedure, that we have implemented in a Albanian woodworking enterprises, for producing wooden ships models, through the use of CAD/CAM technique and numerical control machines.

Keywords: *CAD, CAM, CNC, Ship Model.*

1. INTRODUCTION

In the present conditions on development and industrialization towards the production systems generally are required a very large flexibility.

For satisfying the preferences of the clients the manufacturing sector always has had meant the realization of the required quality of the product at the right moment and with the most advantageous price. That means that challenges before every manufacturing enterprise (small, medium, or large) is to increase the quality, reduce costs, and time of delivery of product.

In the current conditions of a very big competition, besides these three elements, manufacturing enterprises should aim in the increase of flexibility of manufacturing, so it can respond rapidly to; changes in product; changes in production; changes of the processes; changes of equipments and change of labours forces.

Wooden ship models are often required for reasons of production and for tank testing.

The production of ship wooden models, like other sectors of industrial production, is currently facing the challenges of improving quality, reducing production times and costs. In the constant demand for industrialization of processes and improvement of labour productivity all the operators involved in the production of small boats have identified in the realization of models a field where actions are needed: increasing scarcity of qualified operators (carpenters); long production times; low accuracy and symmetry defects due to the natural limits of human operator.

The problems associated with accuracy and symmetry defects of models to be tested in tank obviously affect the accuracy of the final outcome of the experiment and therefore in prediction of power to be installed on board.

Similar problems occur also when the ship models are produced for commercial purposes, by various companies involved in the production and marketing of models in miniature of ships.

Under the constant growth of industrialization and the improvement of efficiency in the manufacturing sector of ship wooden model a very good and efficient way to meet the current challenges and overcome the problems is the implementation of a modern production process, supported by work centres with numerical control machines (CNC).

Although the cost for the initial installation of a numerical control machining center is high the cost / benefit ratio is advantageous because the significant reduction of production times and the accuracy of product amortize totally and briefly the initial machinery costs, required by the implementation of a highly mechanized process.

CNC machines, used in boating industry, may be from the most simplest ones, which can realize cutting of flat sheets, starting from the input of a 2D drawing, up to the more complex five-axis, which are able to work directly over the 3D model and to produce complex shapes from a single block of material.

In boating industry, 5 axes CNC are used to produce models of objects that should be realized. On the basis of this model is produced the female mould for laminating fibreglass. Also, 5 axis CNC machines, have found widespread use for the production of reduced-ship models, for marketing purposes or for tank test.

In Vlora region (south western part of Albania), for a long time, operates a successful enterprise in the realization of different furnishings works, equipped with five axis numeric control machines for the realization of different wooden product.

This enterprise also produces wooden ship models, with length up to 1 m, destined mainly for the internal market in Albania. In the manufacture of the hull of those models the enterprise had difficulties associated with; extended production time; low precision and symmetry defects; difficulty in finding master carpenter and specialized workers; high cost of manufacturing, mainly conditioned by the payment of specialized labour force.

The following paragraphs will be dealt with the procedure that we have implemented, in this enterprise, for the manufacture of small wooden models of ships (as a single body) with length up to 1 m.

After the production of the hull of the model the manufacturing process can proceed in completing the model, easily, with the other accessories necessary to obtain the final product.

2. MATERIAL AND METHODS

FAPIEL Group is a wholly-owned enterprise founded in Albania in 2003. To realize quality products FAPIEL has installed a CNC working centre, through which the various furnishings works are realised. The work centre, CNC Conquest 4200, which is installed near FAPIEL is a 5 axes milling machine (pantograph type). Numerical control of the machine is realized through language OSAI 10 with Windows interface.

In this section of the paper will briefly treat the procedures to be followed for the manufacture of the ship wooden model, as a single piece. The procedure aims the use of computers and technological devices to improve the flexibility and the quality of the production system of small ship wooden models as a single hull.

Since the surface of the ship is complex, with variable curvature in all directions, to ensure the quality of the operation of such surfaces it is necessary that the code for the numerical control machine be developed by the help of computer. [1], [2]

For determining the information flow we have been considered to ensure the flow of information from the database, in CAD software, in CAM software, in CNC and getting into the final product. [1]

The process begins with the design of the hull geometry through a CAD modelling program (Computer Aided Design), which enables the virtual construction of the ship hull.

From the mathematical model (CAD) of the final project and utilizing the possibility of CAM software (Computer Aided Manufacturing) to generate CNC code, are generated the tool paths for the various machining operations required and the technological parameters configured. The three-dimensional graphic simulation allows verifying the actual processing and the behaviour of the tool on the work-piece, ensuring maximum finish quality of its surface.

CAM programming must take into account the maximum dimensions of the CNC machine that will realize the milling. If the model, that should be worked, is with greater dimensions than the maximum permitted dimensions of machinery then we must divide the model in some parts of small dimensions. [2]

Where models will be produced in several parts, since the pieces is still in machine must create alignment points between the individual parts milled, in order to ensure the correct assembling of parts during the production phase, preserving the tolerances on the order of tenths of a millimetre that the CNC machining is capable.

The main works, necessary for the manufacturing of the model, as a single piece, are: the machining in the numerical control machine of the external surface of the model and the machining of deck surface. The surface of the ship deck is a 3D curved surface. To ensure the fixing and non movement of the piece in the desk of the numerical control machine is necessary to produce the deck shape (template) of the model. Above the shape of the model must be placed the piece of work and fulfils the machining of the external surface of the model.

The main processes for the production of the model of the vessel, and their order are:

1. The preparation of work piece.
2. Machining in the numerical control machine of the surface of the deck template.
3. Machining in the numerical control machine of the deck surface.
4. Machining in numerical control machine of the external surface of the model.

During the machining on surfaces care must show that the work piece does not move during the work of the machine. The four above mentioned processes are not necessary in all manufacturing cases of wooden ship model. This depends from the specific requirement for the model. So, for example, if the deck surface of the model is required flat, then processes 2 and 3 are not necessary. Also, where the product is realized in series, only for the first model the four processes are realized. Whereas, for the other models is not necessary the realization of the second process.

The procedure of flow information up to the production of the model is as follows:

1. Projecting the surface of the body of the vessel in CAD software. [3], [4]
2. Convert the data information of the projected surface in a neutral file, which can be a file DXF, IGES or STEP
3. Import the neutral file in CAM software.
4. Planning of manufacture processes in CAM software
5. Simulate and verify the manufacture processes and make necessary corrections, in the CAM software
6. Compile the codes for machine the numerical control (CNC), for each process
7. Execute the codes on the numerical control machine

In Figure 1, is presented, the complete block scheme of the flow of information, CAD/CAM / CNC, for the production of wooden ship hull models.

3. RESULTS AND DISCUSSIONS

The above mentioned block schemes have been applied for the production of a model with maximum length equal to 1 m, maximum breadth 0,353 m, moulded depth 0,161 m.

The geometric modelling of the external surface of the model is realized in the CAD software MAXSURF PRO.

The surface of the hull of the model is designed starting from the known lines plan of the hull of this ship. For this in the body view were carried out 450 measurements, that have served for the creation of the cloud of points, according to which is generated the model surface.

The initial design of the hull surface is made in PREFIT program, part of MAXSURF package, based on 450 markers and 21 sections. For the determination of the number of control points (control point columns and control point rows), used for surface control net, is taken into consideration that: [5]

- The number of stations entered should exceed the number of control point columns.
- The number of markers, for the station with the smallest number of markers, should exceed the number of control point rows.

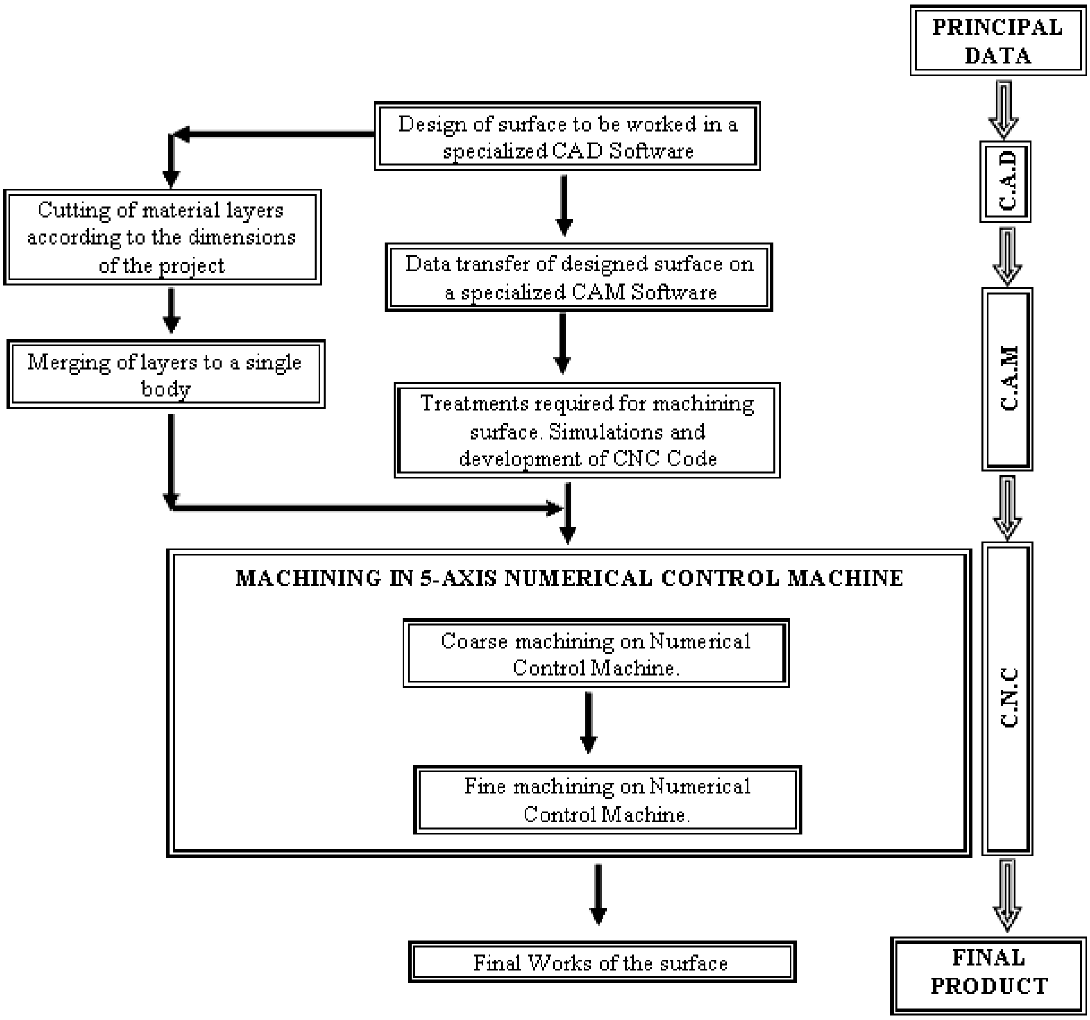


Figure 1 Block scheme

Since splines of order 4 are most suited to the generation of surfaces in Prefit, before generating splines through the markers, we have set the transverse and longitudinal flexibility of the splines at value 4.

The final phase of the design process of surface has been the fairing of the surface projected preliminary in PREFIT. Fairing of the hull shape is carried out in MAXSURF PRO program.

In figure 2, are presented schematically the phases in which has passed the design of surface.

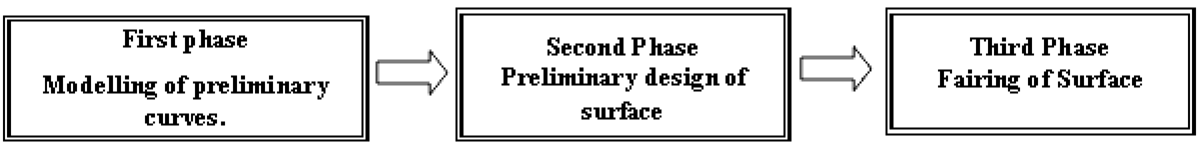


Figure 2 The main stages of the ship hull surface modeling process

A detailed procedure of geometric modelling of hull surface is given in reference [4].

In figure 3, is presented the designed surface, in the software MAXSURF Pro, of the model to be produced.

Surface, designed in Software MAXSURF Pro, is converted to DXF format and then imported in ALPHACAM2007 for further procedures of planning of the manufacture processes in this program.

The planning of the manufacture processes and the developments of the codes for the numerical control machine are realized in the CAM software ALPHACAM 2007.

After the development of the NC codes we have realised the machining of the model surfaces, which are worked on the CNC Conquest 4200.

Before the generation of the CNC code is done a graphic simulation of machining processes in ALPHA CAM software. In figure 4 are presented view of simulation process of gross and finish machining of the hull surface of the model.

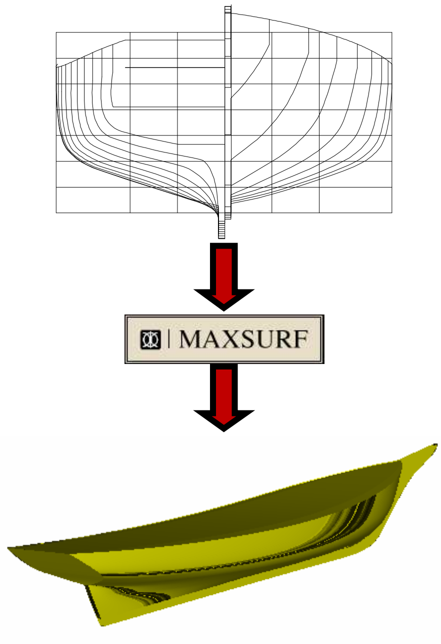


Figure 3 Surface designed in MAXSURF PRO software

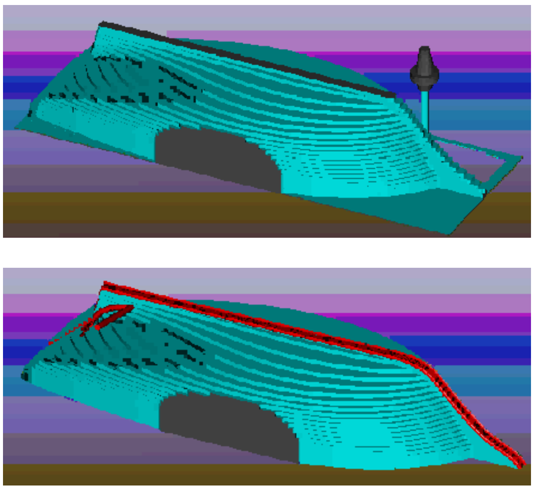


Figure 4 Simulation process of gross and finish machining of the hull surface of the model.

The model is manufactured with medium-density fibreboard (MDF). Medium-density fibreboard are panels with medium size or high and homogeneous and compact structure. Medium-density fibreboard is an engineered wood product formed by breaking down hardwood or softwood residuals into wood fibres, often in a defibrator, combining it with wax and a resin binder, and forming panels by applying high temperature and pressure. MDF is generally denser than plywood. It is made up of separated fibres, but can be used as a building material similar in application to plywood. It is stronger and much denser than particle board. They are easy to work and of excellent dimensional stability. [2]

Unable to have a massive working body we have joined in one body few pieces of MDF. Pieces are cut with dimensions of 1030 * 370 * 25 mm. Piece work is prepared with dimensions 1030 * 370 * 200 mm. All surfaces have been subjected to two works, gross work and finish work.

The feature of the gross machining is that the instrument moves in horizontal planes parallel to each other, having a border profile under which the gross work is realized. [6], [7]

In all cases the gross machining of surfaces (template, deck and hull) was conducted using the key features, as presented in table 1. [5], [6], [7]

Feature of finish work is that instrument passages become parallel to each other according to a pre-determined direction [5], [6]. In this case the instrument passages are performed in the longitudinal direction where the distance from each other passage in all cases was equal to 1mm.

The tolerance of the cutting cord is located 0.1 mm. A so small value has made the code compiled to be longer, but this has guaranteed that the trajectory of instrument follows increasingly the projected surface. [7]

Others key features of the finish machining of all surfaces are presented in table 1. [5], [6], [7]

Before drafting the codes for CNC, are made simulations of processes to verify the planning processes.

Table 1 – Principal characteristics of machining processes

Items	Gross	Finish
Cutter diameter	18 mm	12 mm
The number of rotations of the Spindle	12,000 rpm/min	13000 rpm/min
Progress in work	4000 mm/min	4000 mm/min
Advancing according Z	1000 mm/min	1000 mm/min
The distance between work plans	9 mm	-
Cutter type	Cylindrical	Spherical
Tolerance of cord	0.1 mm	0.1 mm

With the conclusion of all simulations of the processes have been drafted the codes for CNC. One code is developed for each process. Overall have been developed six codes. Developed codes occupy in total

5037 pages of A4, or approximately 1.5 kilometres of paper.

In figures 5, are presented view of machining processes in the numerical control machine and also is presented the wooden model of the ship after completion of all manufacturing processes in the numerical control machine.

To verify the accuracy of the work we have performed several measurements of the main dimensions of the model produced. Their comparisons with the planned dimensions to be manufactured are presented in Table 2.

Figure 5 Machining of hull surface (Gross and Finish machining in CNC) and the completed model

As can be easily ascertained from the data of the table the error in no way exceed 1 mm. After the completion of the production process of the body of the model in the numerical control machine, can easily proceed with setting others accessories. In this case the model is complete with masts for setting the sail and subjected to the process of painting.

In Figure 6, are presented photos of the wooden model at the end of these processes.

Table 2 - Comparison of elements planned and realized in CNC

Items	Planed	Realised
Maximum length	1000 mm	999,3
Maximum breadth at	353 mm	353 mm
Moulded depth at amidships	161 mm	161 mm
Moulded depth at Bow	180 mm	179 mm
Moulded depth at Stern	174 mm	173 mm

Figure 6 The model completed and coated

In Figure 7 are presented the main steps for the production of the model that must be realized.

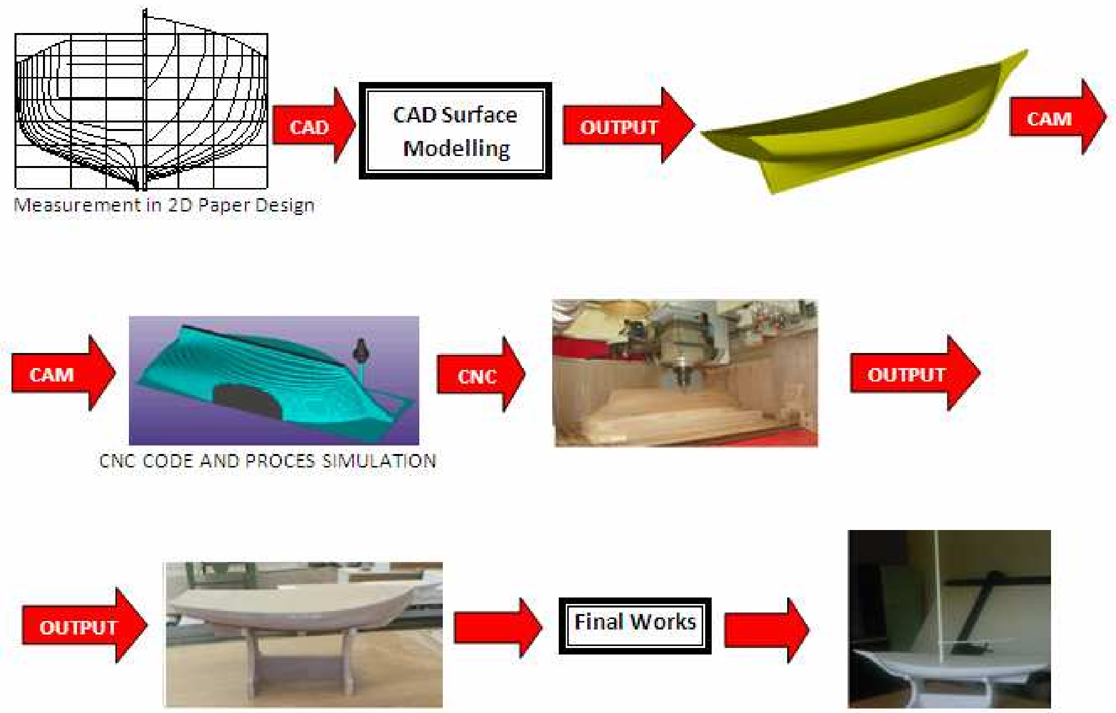


Figure 7 Illustration of main steps for the production of wooden model

3. CONCLUSIONS

In this paper we have treated the implementation of a methodology for producing of the hull of ship model at furnishings enterprise “FAPIEL-Group”. Compared with the traditional production process of wooden models of ships in this enterprise the use of the CNC in the production of such models provides a better quality product, faster production and lower cost.

Some of the conclusions are summarized below:

- Visual verifications conclude that the physical and CAD model matching completely.
- From the measurements we conclude that the dimensional tolerances are reduced to tenths of a

millimetre, this is difficult to reach through the traditional process.

- For its production are needed 16 hours of work, including the time of production of the deck template.
- The production of another model with the same dimensions would require 10-11 hours.
- The methodology provides a production in series.
- At the end of all machining processes the wooden ship model has a very well surface roughness. The level of finish and brilliance of obtained surface of model is adequate to produce a fiberglass mold of good quality.
- The time needed for manual finishing of the model is reduced considerably, due to the minimum machining tolerances of the CNC machine.
- The production of wooden model in CNC can also be done by workers not very much specialized, since CNC codes are prepared in advance and the incidence of skilled labor decreases.

Although we have not done a detailed assessment of costs, according to estimates made by the company can say that it is in satisfactory value versus the traditional process. The entire product cost at the end of manufacturing of the hull is approximately equal to the value of payments that the company was making to specialized employees.

Also, another advantage is that the operations of possible modifications or extensions of models are simplified, precisely due to the transforming capacities of CAD-CAM software.

The procedure can also be used to produce models with large dimensions. Care should be taken in the case when the dimensions of the model to be produced are greater than the maximum allowed dimensions of the machine. In such cases the model should be produced in parts. As we have emphasized in the previous paragraphs, in such cases care should be taken to create alignment point since the pieces are in CNC machine, in order to ensure the correct assembling of parts during the production phase, preserving the tolerances on the order of tenths of a millimetre that the CNC machining is capable.

The procedure can also be used in the realization of pieces of not large size in which are required special accuracy, for example in the case of the centreboard of sailing or racing boat, which must respect a predetermined profile.

With small modifications the procedure can also be used for the manufacture of constructive elements of wooden boats or mould for fibreglass laminations, for example.

- Construction of ribs or templates on which to is applied the plating of hulls constructed with the system of moulded wood or in strip planking.
- In the construction of bulkheads, partitions and various structural elements to be included in the hull. Even in this case the machine may leave with great precision the contours of the pieces so that they fit into the existing structure.
- In the cutting of panels of plating (round bilge boat), or strips of wood that are used in moulded wood.

4. REFERENCES

[1] Radhakrishnan. P. Cad/Cam/Cim. New Delphi: NEW AGE INTERNATIONAL (P) LIMITED, 2008.

[2] Paolo Lodigiani, Costruzione moderna di barche in legno. Manuale per progettisti, costruttori e appassionati: HOELPI, 2012. ISBN 978-88-203-3927-2

[3] Xhaferaj, B.: “Perdorimi i sistemit te programeve Maxsurf per vleresimin e cilesive lundrimore te disa mjeteve te transportit detar Shqiptar” Proceedings: Materialet: Pjese e besueshmerise se mjeteve detare, University of Vlora, Vlore 2008, p 52-61. ISBN-9789995674267. (in Albanian).

[4] Xhaferaj, B., Kasemi, V., Duka, M., ”Design of ship hull surface using modern modelling technique”, Aktet Vol. III (2010) 2, p.261-266.ISSN: 20732244. (in Albanian).

[5] Formation Design Systems – “Maxsurf and Prefit User Manual V.13

[6] ....: ”OSSAI - CNC serie 10 Manuale di Programazione, Rev.16. Torino: OSSAI, 2005. 45004456R.

[7] ....:” OSSAI - CNC serie 10 Manuale di USO, Rev.12. Torino: Ossai, 2002. 45004451F.

[8] ....: “Lavorazione superfici 3D in alphaCAM rel. 1.00 vers. 070619 7.3.

THE MODERN DESIGN OF NAVAL STRUCTURES

[1]ION ALINA, [2]BOCANETE PAUL, [3]TICU RODICA-IONELA

[1,2,3]Constanta Maritime University, Romania

ABSTRACT

Throughout history, the shipping has played an essential role in transportation and trade. Nowadays, approximately 95 % of traded goods are transported by sea. The remarkable expansion of commercial and industrial markets over the last 50 years would have been impossible without a stable and diversified network of naval, maritime and river transportation.

Keywords: *ship types, Registry Rules, structural theories, shipbuilding, structural design*

1. INTRODUCTION

The design of naval structures is a technical process that includes a series of structural analysis and the synthesis itself - when from a range of iron plates and profiles, the resistance project of the ship is achieved. In this process, a number of requirements of reliability and efficiency must be met in order to materialize the project into an optimal construction. Among these requirements, we mention the following: safety with a lower risk coefficient to a minimum weight, maintaining the original quality throughout the whole exploitation period, competitive working volume and manufacturing cost, minimum envelope structures for achieving the maximum indoor, easy accessibility for maintenance, inspection and eventual repairs, wider use of the standardized components and templates, comfort and pleasant overall appearance.

2. THE DESIGN EVOLUTION OF NAVAL STRUCTURES. STAGES OF THE RATIONAL DESIGN

Until very recently (the ‘70^s), ships structures were designed with predilection, sometimes exclusively, by the Rules of Classification Societies and Ships Building (Registries) that were established mainly on the basis of a long experience of design, construction and exploitation.

Although the relative ease of designing structures by the Rules of the Registry is widely recognized because it provides simple sizing information (sampling), easy for endorsement, the expansion of water transportation - as the cheapest means of transportation, the functional/ constructive diversification of ship types, the increase of their size, the modification of reports between the main dimensions required by the new forms of transportation and the freight categories transported, as well as the increased requirements related to the handling of dangerous goods and environmental protection require more frequently, a mixed design based both on the Rules, but also on calculation, the Rules serving to an initial operative assessment. For those types of ships that do not harmonize with the Rules, the design by direct calculation is indispensable. The very development of Rules for such vessels requires research teams to seek new ways of design, by direct calculation.

The Registry Rules are more empirical and are based on the experience and feedback received from the ships in service. They are formulas and sometimes simplified algorithms applicable to all structural elements of any type of ship. These rules have been obtained by watching a variety of vessels in all stages of existence and by transforming the findings noted in enshrined rules that apply not only in the stage of design, but also in the stage of construction and approval. A thorough control is run in the construction stage, in all key stages, and when the ship becomes functional, regular checks are made in order to identify the class of the ship. The structural integrity of the ship is pursued until the ship runs out of service and estimations about life and class are made. If desertions are found or accidents caused by the failure of structural elements occur, the classification company updates the corresponding rules. Therefore, obtaining the maximum efficiency of a design algorithm for a type of ship can take decades. The projection based only on the algorithms of the classification companies has a number of disadvantages and risks.

First of all, the structural failure modes are numerous, complex and interdependent and the simplification brought by the rules can not estimate the exact extent to which the ship is considered safe. In other words, the difference between necessity and over-sizing can not be made.

Therefore, these formulas are not entirely effective. In some cases, it can be seen that the excessive over-sizing of ships can produce waste throughout its service. Moreover, over-sizing does not always mean safety. For example, in the case of vibration and usage, the over-sizing could be a negative factor for the behavior in exploitation of the structure.

In the second place, formulas and algorithms derived from rules are aiming at avoiding structural failure.

Although there are many ways to achieve the same result, the particular method imposed by rules is not always the most suitable for the specific nature and missions of the ship given the economic criteria. The design process should be developed based on the functionality of the ship, trying to optimize structures up to achieving the desired purpose.

In the third place and perhaps most importantly, these rules involve the introduction of a number of simplifying assumptions. Therefore, they can be used only within certain limits (application conditions of the simplifying assumptions). Beyond these limits, formulas lose their accuracy. The history of structural design is rich in examples of flawed design (ships, bridges, and aircraft) that has used methods proven in time by experience, but the accuracy and application limits of which were not sufficiently known from scientific point of view.

So, the mechanical application - without judgment – of the Registry Rules do not allow to highlight the role of each structure in the ensemble of which it is a part, the mistakes made earlier and it does not provide safe opportunities for improving the projects. The sizing relations under the Registry Rules are most often covering, referring to a particular range of situations in which its structure may be found. It is possible that these relations, although they may have a fairly wide range of applicability, do not totally correspond to their intended purpose, criteria of efficiency of the ship designed and other requirements of the beneficiary.

For these reasons, since the 80s, the naval design and structural analysis of the ship's hull was based mostly on rational design, the basic principles of which are:

- the massive use of structural theories (mechanics of solids and fluids, resistance of materials, vibration and elastic stability, usage, breakage mechanics, etc.);

- the use of computers for: implementation of analytical methods, data management, creating mathematical patterns, numerical calculations, etc.

- carrying out optimizations where, as input data, the objective function and a set of strength and stiffness conditions are entered, ultimately obtaining the optimal values specific to the variables of projection, by maximizing the objective and satisfying all requirements.

The computer-aided rational design has as starting point the purpose that the ship must meet, and takes into consideration all aspects of performance and structure, making accurate estimations of the hull behavior. The aim is to build ships that must accomplish their mission in the safest way possible and in economical conditions. This process requires a computational effort far greater than in the case of traditional methods, which without using computers would be impossible to achieve. Therefore, we can say that shipbuilding is nowadays computerized and semi-automatic. The shipbuilding is not fully automated because during a project, a series of specific decisions concerning the objectives, priorities, verification criteria, constraints etc. must be taken.

In the last half century, due to the development of information technology, the methods of numerical analysis have strongly developed. Introducing the finite element method allowed new approaches to the complex issues of structural analysis. By using the finite element method, calculations of resistance and usage of structures can be done with more accuracy. Also, the use of the finite elements method allows the iterative optimization of structural dimensions up to the achievement of all requirements.

Many of the ships entered into service in the last 40-50 yearscould not have been built without advanced calculation procedures based on the analysis with finite elements. We refer to modern ships that carry containers, vessels for liquid petrol, large passenger ships, catamaran and trimaran ferryboats etc. Figure 1.1 represents the model of a medium sized containership analyzed by the finite element method. The evolution from the first containership built in the 60s, which had a maximum capacity of 1000 *TEU* to the giant containerships that can carry more than 13,500 *TEUs* was possible only due to the development of computing techniques.

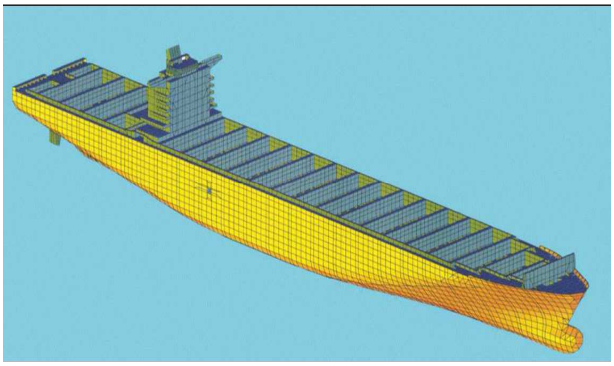


Fig. 1. FEM model of a 9200*TEU* containership

Companies of Ship Classification and Building not only encourage the development of the design concept by direct calculation, but have their own research teams that develop methodologies and programming systems for the calculation of structures. Since 1997, the Companies of Ship Classification and Building have imposed mandatory local and global structural analysis, by the finite element method. The registry rules are, thus, subject to a continuous process of improvement and adaptation to the new requirements.

Regardless of the design adopted (Rules or direct calculation), the structural design of the hull goes through three important stages:

In the *first* stage, the hull geometry is finalized and positions of the major structural items are set - transverse and longitudinal bulkheads, decks and other slabs. Generally, the main dimensions of the ship are determined from structural considerations, but rather based on general requirements, such as the maximum width or maximum draft, the minimum load capacity etc. Therefore, the structural design has as input data, the main dimensions of the ship and must provide a complete set of substructures to ensure the required strength and safety at the lowest cost possible.

Stage *two* – the preliminary structural design – consists of establishing the size of the main elements of the ship structure. Overall, the preliminary structural design includes: *a)* determining the loads and their effects (efforts, challenges, displacements) in all possible loading cases, by taking for sizes, the values obtained after Rules or similar ships; *b)* establishing the limit values of the loading effects, *c)* establishing the reliability factors as reports between the effects of loads and their limit values (the reliability factors are inverse to the safety coefficients); *d)* comparing the reliability factors with those obtained on the basis of standardized requirements for reliability and of possible resizing which consists of reducing or increasing the thickness of some iron plates, changes of shapes and/or distances between them etc. The optimal simultaneous satisfaction of all requirements of reliability resulting from such resizing require advanced knowledge and experience of the engineer of structures and may require a large number of iterations. Usually, special programs for optimization are used. In this case, the limit values of load effects serve to the mathematical formulation of resistance restrictions, to which technological, functional and aesthetic restrictions are added. By taking to extreme the objective function established based on the adopted optimization criterion, the design variables are obtained, and they are generally dimensions of the main elements of the ship structure. Through the use of optimization programs, projects more effective than those that would have been obtained under the standard Registry Rules were obtained. For example, it is mentioned the case of a 96,000 *dwt* ship for which it has been obtained a reduction of 6% from the original cost and of 13 % if the increasing transport capacity during its life is taken into account.

In the preliminary design stage, the methods of rational design are used in the most effective way. When defining the characteristics of the main structural elements, decisions that would significantly reduce the amount of material used and thus, generate a significant economy both in construction and in operation, may be taken. Also at this level, decisions which could greatly improve the safety and nautical qualities of the ship can be taken. The results reached at this stage represent input data for the detailed design; therefore, a good preliminary design is essential.

The *third* stage envisages construction details (joints, reinforcements, cuts etc).

Although the importance of the detailed design is often downplayed, it should be mentioned that the correct performance of construction details contribute to obtaining ships with greater resistance to usage and increased duration of life. Due to the large number of details, it is recommended to design them on the basis of the Registry Rules or of some standard Normative Acts developed based on operating experience and theoretical and experimental research performed on structures of real operating ships and/or laboratories, on models of such ships. The technological factors have a key role in the detailed design. The structural design of a ship presupposes formulating a mathematical pattern that could approximate as accurately as possible how it behaves to load requests. Corresponding to the adopted calculation program, usually with finite elements, the model is discretized and submitted to loading external forces and couplings. The results should be subject to safety criteria in order to certify the strength of the structure. By using the created model, they try to optimize the characteristics of the structure so that its response to the action of loading would optimally correspond to one or more objectives.

In the preliminary design phase of structures, the engineer faces the following main problems: problems of external forces and of internal forces, the problem of limit states and launching, pressure from water, wind etc.)

The external forces problem lies in determining forces acting on the entire ship and on its component structures during construction, launch, operation (in any march conditions and possible load variants) and possible repairs.

External forces can be classified according to several criteria. In the first classification, the forces acting on the ship as a whole can be divided into two categories: 1a) weight (hull and equipment of the ship, cargo and/or passengers carried, crew and supplies); 1b) external forces arising from the environment action (reactions exerted on the ship by the slipways, pressure from water, wind etc.) 1)

Forces in the first category (1a) are deterministic and can be obtained relatively easy.

It is the same with those external forces from the second category that occur due to the action of the environment during the operations of construction, launching, loading and unloading, repair). The external forces arising due to the external environment action (1b) during the march – the longer life period of many ships - are caused by pressures arising from floating in calm water and from additional ones caused by wind and waves (wave pressures, inertial forces, shocks and vibrations - slamming, springing).

Unlike the pressure forces that occur when floating in calm water, the effects produced in the hull, by the additional forces above mentioned can be measured only by using probabilistic methods, considering the sea state as a random phenomenon. But even by using statistical methods, the evaluation of additional forces caused by wind and waves keeps however a strong conventional character.1)

3. CONCLUSIONS

The internal forces problem consists in determining the effort, tensions and displacement appearing in the resistance structures due to external forces acting on them. The answers to these problems are obtained from the structural analysis. Considering the wide variety of forces that require the hull and its structures of resistance, the methods of the structural analysis should provide the possibility to solve structures loaded with any system of forces, possible from the physical point of view.

The problem of limit states appears naturally to normalization, when operation conditions which ensure the reliability of vessel structures, are set. For a proper normalization, obviously it is necessary to know as accurately as possible, the limit states that may occur in various critical situations, in order to be avoided. Although some limit states are highlighted in the Registry Rules, recently engineers have been more frequently put in a position to evaluate unconventional limit states not covered by Rules or to indicate, by calculation, those that are only presupposed. These problems are extremely complex and their resolution can not be conceived without a deep knowledge of the processes of structural analysis. It is noted that, while additional forces caused by wind and waves and their corresponding internal forces are treated as stochastic phenomena, the issue of limit states should also be considered from probabilistic positions.

To solve his problems, the designer of structures resorts to a number of analytical methods, other than the numerical ones. Although they have a limited range of applicability allowing only the solving of relatively simple problems, the analytical methods are underlying the development of very efficient numerical methods. For the proper use of numerical methods, it is necessary the understanding of physical phenomena - which happens mostly in the process of establishing differential equations describing the studied phenomenon. Only for those engineers-designers who deeply understand the physical phenomena and who resort to and use correctly the most appropriate numerical methods of analysis, the multitude of existing software are real and useful tools in solving the complex problems of calculation of structures. Otherwise, there is the risk that many existing software would remain for them, true black boxes.

4. REFERENCES

[1] Gallagher, R. H., and Zienkiewicz, O. C., *Optimum structural design*, John Wiley & Sons, New York, 1973
[2] Gunsteren van F.F., *Springing Wave Induced Ship Vibrations*, International Shipbuilding Progress, Delft, 1970
[3] Hughes O. F., Paik J. K., *Ship Structural Analysis and Design*, The Society of Naval Architects and Marine Engineers, New Jersey, 2010
[4] Pricop M., *Statica şi dinamica structurii corpurilor metalice ale navelor*, Ex Ponto, Constanța, 2000
[5] *Response for Ship Design* ,The Society of Naval Architects and Marine Engineers, New York, 1973
[6] Szebehely V.G.,Tood M.A., *Ship Slamming in Head Seas*, David Taylor Model Basin, Washington,1955
[7] Troesch A.W., *Effects of Nonlinearities on Hull Springing*, Marine Technology, 1984

CHALLENGES FOR MARITIME TRANSPORT IN THE ERA OF GLOBALIZATION

[1]VARSAMI ANASTASIA, [2]GHEORGHE CORINA

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

ABSTRACT

Maritime transport industry develops according to specific tendencies having an impact on port infrastructures and superstructures. First of all there is the economy's tendency to transport more cargo with low costs in a developed liberalization context, during a shorter period of time in a market environment more open towards competitiveness. Secondly, there is the technological development tendency having the same objective, that of a higher productivity by increasing ships' dimensions, higher speed, low transport costs as well as reaching objectives concerning environment protection by reducing risks and consequences following accidents or by reducing the impact that maritime industry has over environment.

Keywords: *globalization, maritime industry, environment protection, shipping, economy.*

1. INTRODUCTION

Globalisation, instability of the worldwide economy market and logistics integration has all redefined the concepts of port and maritime industry. Ports and transport companies are faced with the challenge of renewing their functional role in the chain of values in order to create an improved business environment and also provide development or even survival. Transport companies try to change the present situation by adapting themselves to the newest requests of the market. It may be proved that due to the changing market environment, ports and transport companies are no longer stable. Oil Terminal individual operators and transport companies have the tendency to choose different paths towards satisfying the client's requests.

The main characteristic of the maritime market is the fact that it is being controlled by only few transport and terminal operators. It can be noticed a stronger tendency of market concentration in the hands of the biggest maritime companies who dominate the market and who can afford investing a lot of money in order to ensure a higher percentage of the market. Alliances and fusions represent efficient methods of maintaining a favourable position on the market and of realising economies of scale which can bring considerable profits.

'Globalisation' represents a different concept to different observers of the phenomena. For some it represents the main process guilty for poverty and war, for others it is a necessity of the economic development for the population of the world which is continuously growing. A controversial subject is also the moment 'when globalisation started'. From the maritime economy point of view globalisation is just a concept which describes the tendency of the international trade and that is: a) the trade is registering a faster growth than the world's GDP and b) the trade is not consisted only of defined products and services, but also of components and services which are used inside the globalising production processes. Maritime transport is growing more and more because it is necessary to transfer goods and components, and the trade from the maritime services is deploying at a global scale.

Globalisation refers especially to the evolution of big companies who become global coverage companies in the scope of accomplishing their own operations. Almost a quarter of the international trade takes place inside global companies. The forces which lead to this process of globalisation are the ambitions of the companies for development and gaining profit in larger markets. Such global companies present some characteristics with implications upon the way that the world economy is evolving and in particular, upon the small and middle economies. Therefore, globalisation is facilitated by the generated growth, although not uniform, of the integration rate of the world economy in a single global market for each product.

2. NOWADAYS GLOBALIZATION OF MARITIME TRANSPORT

Transport is one of the four foundations of globalisation. Combined with telecommunications, commercial liberalisation and international standardisation, the rising efficiency of the port and maritime transport services led to reliving the buying/selling process of any kind of products almost anywhere in the world. The international standards and similar products (those with the same characteristics) encourage global competition. Trade liberalisation allows an efficient allocation of the resources. Actually, telecommunication and transport are the main transfer means of information and goods. 'In spite of all declarations coming from World Trade Organisation, NAFTA and other trade pacts, the real force behind globalisation has a poor visibility: low costs of the international transport' (The Journal of Commerce, April 15th 1997).

Meanwhile, maritime activity itself is probably the industry characterised especially by globalisation. Most part of the maritime transport is deploying between two or more countries and the transport services suppliers don't have to be of the same nationality as the countries for which they are carrying the goods. Actually, a simple commercial transaction may imply and properties from different countries.

Globalisation of the world economy led to raising the importance owned by transport. In particular, containerised transport holds a key role inside the process, especially because of the technical and economic advantages held over the traditional means of transport. Placed at the interface between sea transport and land transport, the importance of the container port and its capacities cannot be ignored.

The growth of the world containerised transport is the result of the interaction between macroeconomic, microeconomic and political factors. World transport is facilitated by eliminating the commercial barriers through markets' liberalisation and instability. Actually the public sector redefined its' role inside the port industry and transport industry by using corporate schemes. The intervention of the contemporary governments for an efficient industry focalises on the market liberalisation problem and creating a fair level of competition, on monopole problem and on public goods problem.

Market liberalisation marked the intensification of logistic development all over the world. The international chains of supply became complex, and the logistic models are continuously evolving as a result of the influences and factors like globalisation and extension to new markets, demand as an answer to market production and segmentation, poor practices of manufacturing and the afferent changes of prices. The customers' need for a larger area of global services and integrated services had as a result the appearance of integrated logistic strategies and a change from 3PL transport (Third Party Logistics – the supplier of services invests in warehouses and transport material) to storage and distribution suppliers and in the same time opened the market for innovative forms of logistic services like 4PL (Fourth Party Logistics – the services supplier narrows his goal to the IT chain of supply; the IT consultants and suppliers help the 3PL and 4 PL suppliers to expand to new markets and to become complete suppliers of logistic services).

The essence of a global strategy is the ability of looking at the world (or most of the important regions) as a single market. This implies a high homogenization of the customers' tendencies from all over the world and an ability to manufacture and sell a standardised product as an answer to these tendencies. Also, this suggests the ability to efficiently enter in competition at a world scale.

International companies seeking a global strategy are going to reach towards gaining competitive advantages by locating the activities in the best positions worldwide and are going to try to administrate those activities as independent members of a single system, not as an independent business portfolio. It can be easily observed the relevance which this aspect has upon maritime container traffic, especially in relation with locating and operating terminals. In this sense 'strategy' could mean development of business through organic growth, acquisitions, fusions or alliances, creating new capacities or a combination of these. Obtaining success in these fields should offer benefits (profits) to a global strategy, from which low cost and high efficiency are fundamental.

Low cost can be obtained from scale economies, logistic and/or marketing. There is the proof of important scale economies in maritime transport which derive from increasing the ships' dimensions, exploitation of big ships and orders for port container ships. Also, low cost can be obtained from economies of scope like sharing physical properties (terminals), brands and/or external relations from different business and markets (for example, fusions between companies reducing the cost of local representation). A higher efficiency may depend on the ability of one part of the organisation to transfer, share and develop the knowledge, expertise and experience of other parties at a world scale. This must be realised by centralising the processes of taking a decision inside the organisation in order to ensure an efficient control over the entire system.

3. A CONSTANT NEED FOR GLOBALIZATION AND ITS' ADVANTAGES

One of the main reasons which encourage global integration is technological development which tends to be measured in expansion terms R&D (Research & Development) and in low cost of the technological process. One of the most obvious manifestations of this tendency is the appearance of the international strategic alliances. The main causes of the growth in international alliances and partnerships appearances are the demands of high and risky investments and also the quick development of technology.

Alliances can provide, besides the access to a low cost and sharing the risk, a quick access to new markets, through 'borrowing' the already existing infrastructure from one partner.

In essence, the alliance can provide to a partner the opportunity of benefiting from the facilitations of another partner and this leads to improving its' own position inside the alliance but also outside of it. Based on several studies made in some specific industries, two important factors that lead to industry globalisation were identified:

- The homogenous growth;
- The efficiency of economies of scale.

Most of global industries are characterised by an important level of demand of standardised products. Maritime container transport offers a good example from this point of view, while containers are standard all over the world in order to ensure their efficient handling by different means of transport (ships, trucks, trains, barges) and by loops (terminals). The demand for standardised products extended in time. An example of this aspect from the maritime transport might be the rising level of technological development from the world maritime ports. The chain of production in the global industries tends to include activities that are very sensitive in front of economies of scale and thus they allow gaining an advantage from the global cost point of view.

While the possibility of important economies of scale still exist and they can be generated by operating big ships in advance of small ones, the total efficiency of a ship ultimately depends on the necessary time for finishing the voyage, including the time spent in the port which is a function of the handling goods rate. The general position towards economies of scale in the maritime sector represents a difference between the positive benefit gained on sea and the negative benefit as a result of spending time in port.

The world is seen as a unique market in which the consumers are going to accept standardised products, and these global products will generate huge economies of scale in production, logistic and marketing. Nevertheless, there are analysts who warn of the simplifications which may appear as a result of these tendencies. They demonstrate that the proof of a growth in the demand diversity exists and it is coming from inside the countries and, also, they prove that these companies must adapt their product lines to the idiosyncratic preferences of the countries and that many of these countries are characterised by substantial regional differences, different life styles and different value segments. Indeed, it has been suggested the fact that some companies from different industries which are focalised at a national level have reported a higher profit than their global competitors.

The maritime companies, which serve the same markets, are doing their best to differentiate their 'product' by offering faster 'express' services than the ones belonging to competitors, or by introducing a new service which is faster than the normal one connecting certain markets. An example in this way could be a company which offers shippers the possibility of choosing between a given route of a direct express service (for example: Singapore – United States of America) and an alternative transit with a longer duration (but cheaper) through a pendulum service or through an 'all around the world' service which includes calls in other few ports that are not in that particular route. The conclusion is that different types of services can be set to motion in front of different segments of clients.

Inevitable there will be specific pressures associated with the contradictory needs for global operational integration of the maritime transport activities, and competitors must try to implement the strategies which facilitate a potential for global integration. This means that participating companies to this industry must focalise on more strategies. In spite that, while each company will be under more similar pressure regarding the needs for integration, in practice, these companies could use slightly different strategies in the attempt to meet these needs.

The economic forces tend to push down the transport rates. Economies of scale lead to the appearance of an extra space on board ships which companies are anxious to fill. The overcapacity of goods existing in some fields made the freight rates to decrease, this way neutralising the accomplished cost reduction. Many carriers are in the situation of having small amounts of money and weak chances of recovering. The carrier will reach reasonable profitability when the transport volume is close to or exceeds the provided capacity. Holding the control over capacity in order to meet the demand seems logic but hard to accomplish. The companies are competing for market percentages and the capacity tends to look like an additional ramification. Capacity management is still a challenge until this branched industry will look like an oligopoly.

Besides the cost and profit considerations, the strong force of demand belonging to the market is the main cause determining the carriers to integrate their services inside the supply chain. The carriers take as guaranteed the global coverage of the line services. The whole attention is now concentrated on the ability of carriers to offer complete services. Carriers must meet shippers' demands regarding frequency, punctuality, trust and global coverage. Clients' complex demands of distribution create important opportunities for shipping companies. Carriers, who traditionally were preoccupied only with transporting the goods from one point to another, are now looking for logistic business, integration in the supply chain and management of a logistic information system. With only few exceptions, the management of pure logistic services is done by branch offices from the same 'mother' company like the shipping companies but they work completely independent from the line transport operations.

As it was proven by many studies carried out inside the shipping industry, shippers are asking from carriers a complete services package. This package must include attractive prices, trust in the navigation program, a high port range, IT and intermodal capacity, as well as a high capacity of transport, even a global one (especially for the important shippers who are looking for reducing the number of suppliers they are using). As a conclusion, if a carrier satisfies a shipper from all these points of view, then, this carrier would have much more chances of succeeding and in case he does not manage to fulfil a single demand, the carrier can expect a low level of business.

The reality of poor profits registered by carriers in an industry that is missing differentiation leads to the appearance of a 'personalised services package' coming from shippers, in which the price represents a part of the package and not a factor not to be taken into consideration. It is clear that the carriers' problem is to design these 'personalised services packages' which meet completely the client's needs and can bring satisfying profits.

Big global shippers are looking to work with a smaller number of suppliers and they prefer the ones who offer global services. This tendency is as relevant for the transport services suppliers as for the product services suppliers.

As a consequence and in the same time as a result of the transport networks development by carriers from all over the world, global shippers are looking for global contracts with the container companies.

A global contract in the container line transport can be defined as a general contract which includes all services, volume obligations and contractual clauses which generate a commercial relationship between a carrier and a shipper.

There are a number of benefits for carriers as well as for shippers that derive from this type of global contracts and the most important ones are:

- There is a smaller number of companies that can be done business with, which leads to reducing the time that a shipper needs for administration and negotiation, this way resulting a reduction of the transaction costs;

- Stability for cargo volumes and freight rates which, for the company, means that bigger cargo volumes exist for a longer period of time and the earnings level is known for the same period of time. The costs for transport are fixed for shippers for a very long period of time;
- Facilitation in communication, mutual agreement, transparency and a high level of trust help creating a new shipper/carrier relationship;
- Stronger mechanism of negotiating for shippers by gathering the volume from all the branches around the world and which offers them the possibility of negotiating a global contract with the carriers. This mechanism has as a result lower prices, especially for the transports in which another shipper can only move minimum volumes;
- The efficiency of a ‘offers from all over the world’ system which allows the shippers to compare the best total services packages offered by the best carriers.

4. CONCLUSIONS

Shipping companies, terminal operators and ports are in front of very changing and uncertain situations. Port and maritime markets are no longer stable because the forces that act over this environment are continuously changing. Technological progress, logistic integration and new associated organisational structures are constantly remodelling the port and maritime industry and companies are trying to cope with this situation.

For a long period of time, shipping companies thought that the only way to compete with their rivals was to exploit bigger ships. This unilateral concentration on operational costs proved its’ limits. The essence of shipping companies’ existence gradually moves from pure navigation operations to complete logistic solutions. Each carrier is trying to give an answer to this change of pattern. By using different forms of integration in the supply chain, shipping companies are trying to generate profit, to accelerate the operations on sea, in the port and the ones on land and to create a favourable environment. For the moment, terminal operators are concentrating on developing the level of operations. It is clear that global terminal operators focused their attention from a local port level to a port network level, meaning that the effects of the terminal network must be exploited to the maximum. There are proves of a rising logistic integration regarding land terminals, transport inside the hinterland and high logistic services. Even so, changing the pattern derives from re-focusing of the operators (re-concentration of the operators on another level of operations).

Individual terminal operators and shipping companies might follow different patterns in the search of getting bigger advantages and higher satisfactions of the client. And not only once, the two segments of the container market change these patterns as the competitive basis from this market are about to erode sooner or later. Port and maritime companies are trying to maintain a competitive edge by building barriers in order to prevent competitors’ enter on their own domain. New comers on the market are trying to overcome these types of entering barriers.

Because of the pronounced fusion and alliance phenomena there can be seen a strong concentration of the maritime market, which leads to a control hold by only a few transport and terminal operators. They dominate the market and impose their own interests. All authors must sign the Transfer of Copyright agreement before the article can be published. This transfer agreement enables Elsevier to protect the copyrighted material for the authors, but does not relinquish the authors' proprietary rights. The copyright transfer covers the exclusive rights to reproduce and distribute the article, including reprints, photographic reproductions, microfilm or any other reproductions of similar nature and translations. Authors are responsible for obtaining from the copyright holder permission to reproduce any figures for which copyright exists.

5. REFERENCES

[1] Baird, A. J. (2006) Global strategy in the maritime sector: perspectives for the shipping and ports industry

[2] Carbone, V. and Stone, M. A. (2005) Growth and relational strategies used by the European logistics service providers: Rationale and outcomes. *Transportation Research Part E*, 41: 495–510

[3] Kumar, S. and Hoffmann, J. (2006) Globalization: the maritime nexus.

[4] Man, A. P. and Duysters, G. (2005) Collaboration and innovation: a review of the effects of mergers, acquisitions and alliances on innovation. *Technovation,* 25; 1377–1387

[5] Midoro, R., Musso, E. and Parola, F. (2005) Maritime liner shipping and the stevedoring industry: market structure and competition strategies. *Maritime Policy & Management*, 32(2): 89-106

[6] Panayides, P. M. and Gong, X. (2002) The *stock market reaction to merger and acquisition announcements in liner shipping*. *International Journal of Maritime Economics*, 4: 55-80

[7] Slack, B. (2001) Globalisation in Maritime Transportation: Competition, Uncertainty and Implications for Port Development Strategy.

[8] Thanopoulou, H. A. (2000) From Internationalism to Globalization Trends in Modern Shipping. *Journal for Maritime Research*, ISSN: 1469-1957

SECTION II
MECHANICAL ENGINEERING AND ENVIRONMENT

STRESS AND STRAIN ANALYSIS OF A TOWER CRANE ARM

[1]ANGHELACHE DIANA, [2]CRISTEA SIMONA-ANDRA, [3]IACOB NICOLAE

Research Center for Mechanics of the Machines and Technological Equipments
Engineering Faculty in Braila, University "Dunarea de Jos" of Galati, Romania

ABSTRACT

This paper presents the analysis of a tower crane arm using the finite elements method. It will be draw a crane arm using sizing tehnology of the tower crane from the tehnical prospects of the producer, and for the stress and deformation analysis it will be use the finite element analysis software ANSYS 14.5.

With the analysis program we will learn about the behavior of the crane under load. It will be made a comparativ study between two section, a square and a triangular section, that form the crane arm.

Keywords: *finite element method, crane arm, truss, tension*

1. INTRODUCTION

Tower cranes are machines made of high truss with different sections types like: square, rectangular, circular.

This machines are widespred in construction work because of the advantages such as speed lifting or placing the burden on the installation site.

They have a shift mechanism (trolley on wheels) have great rage, high lift and high lift capacity , they can be controlled on distance and they have a automatic clamping devices.

Tower cranes have a variable range and they are used on construction sites or civil constructions at furnaces, prefabricated buildings, material handling in warehouses and wharfs, at the hydro constructions. Tower cranes are manipulated by a cabin that is located at the top or middle of the tower and it is electrically operated.

They have four mechanism for raising and lowering the load, the mechanism of variation of rage, rotation and displacement of the crane (top three are mounted on the tower and arm, and the fourth on trolleys shift mechanism).

From constructive point of view, tower cranes are fixed and with rotating head, rotating platform and tower (rotating column); after their destination the tower cranes are classified in civil and industrial construction until fourth floors for a four storey building (up to 14 floors) crane with auto-lift tower for the buildings with more then 14 floors, tower cranes for hydraulic constructions, tower cranes are used for loading warehouses and manufacturing sited with prefabricated elements etc.

Figure 1. tower crane – Potain MD 310

Figure 1 presents the main elements of a tower crane Potain MD 310; 1- arm; 2- counter weight, 3-tower, 4-cabin; 5- platform; 6- task trolley.

2. THE ARM OF THE TOWER CRANE

The tower cranes arm is a spatial metal construction, welded and articulated at the slewing platform. The arm can be extended by fitting intermediate sections. The advantage of this method is that the extension arm can get very long with lightweight (latticed beams). Extension or withdrawal sections is performed mechanically. The general design of metal structures that make the principles of calculation and design of meta buildings STAS 8290-83 and metaware design limitation of pipe STAS 763/3-79. Commonly used in general purpose steel for construction like hot rolled steel and certain alloy steel.

3. ANALYSIS OF THE TENSION AND STRAIN OF THE CRANE ARM. COMPARATIVE STUDY

For the case study we analysed using the finite element method the cranes arm length 45 [m].

In this paper we will consider two types of spatial beam forming the cranes arm namely triangular cross section truss and square truss section, then we will make a comparative study between this two sections.

The two designs are made with the same size and positioning of the bars forming the metal frame. The analysis of the two models will be applied to the same boundary conditions, and in the end we will find the differences that occure in states of stress and deformation. To study the stress and strain of the crane arm we use finite element analysis software ANSYS 14.5. The space beam that form the crane arm for the two cases have the length of 45 [m] and height 2 [m] and knots form beams that are arranged to 3 [m].

For the finite element analysis it was performed a statically analysis that were going through following steps:

- ✓ 3D modeling as specified dimensional geometry;
- ✓ Declaration of steel construction material type OL 60;
- ✓ Declaring property type finite element beam with circular cross section. It was declared two type of sections, that is for thick bars diameter Φ = 100 [mm], while for the thin beam coming in strengthening Φ = 60 [mm];
- ✓ Mesh geometry;
- ✓ Application of boundary conditions, namely: at the middle of the beam is catch a steering thrusts for the supporting arm, and at the end of the beam is apply a recess and is catch of tower cranes embedding, and at the end of the beam were applied 2 terminal node with 5000 forces [N].
- ✓ Access the command for the analysis;
- ✓ Interpretation of the results;

The steps above are valid for both beams analysed.

3.1. Analysis of the triangular truss section of an arm crane

In order to achieve the analysis for the triangular arm section it was applied the load for the tasks like in Figure 2, and it consists in two constrains, namely a recess on the node 2675, located at the end of the support arm tendon and a recess at the end of geometry. At the opposite end of the constraints were applied two forces of 5000 [N] to the nodes 3699 and 3361. The analysis consists of 3982 nodes and 2035 finite elements.

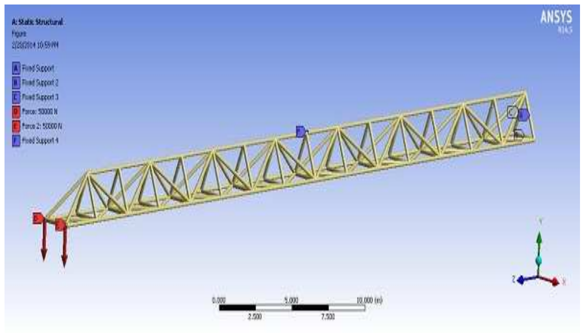


Fig. 2. Loading scheme

For the case of the triangular truss section that is form the tower arm crane seems that the maximum deformation is 0,063[m]. The maximum deformation appears beside forces like in figure no.3.

The figure no.4 presents the distribution of an axial tension in the triangular truss section. It appears that in this case the main axial power is the extent which is greater than compression. The maximum axial tension is 80 [N/mm^2].

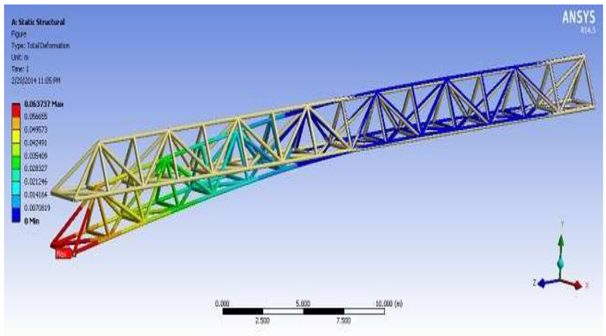


Fig.3 Analysis of maximum deformation in the triangular truss section

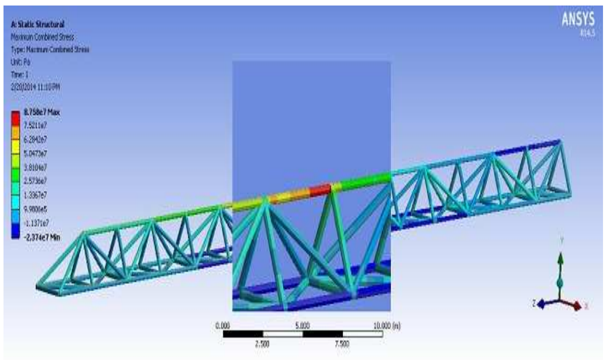


Fig. 4 Axial stress distribution

In the figure no.5 it is shown the bending moment diagram. The maximum bending moment occurs in the constrain area and it has the value of 21592 [N*m].

It appears that it is appropriate amount of bending moments to the two section.

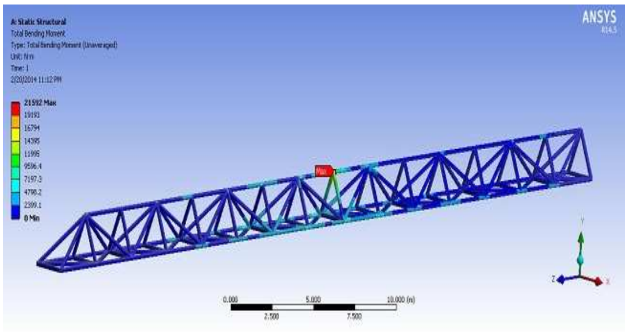


Fig.5 Diagram of bending moments

3.2. Analysis of the square truss section of an arm crane

To analyse the square truss section it shall apply the charging scheme like in the Figure no.6.

Charging scheme is similar to the tasks of the arm with triangular section, the difference appears to the grip of the thoron that support the arm in the nodes 125 and 628 located in the middle of geometry.

At the end of the beam is applied on the curves forming a recess square section. At the opposite end constraints were applied two forces of 50000 [N] on nodes 401 and 352.

The analysis consist of 2563 finite elements and 5012 nodes.

The center of gravity of the crane arm is the middle of the arm.

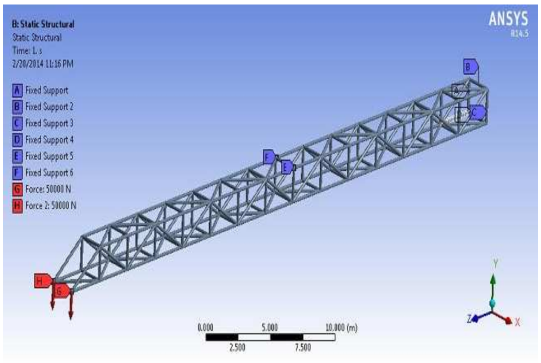


Fig.6 Loading scheme at the square section

Following the analysis of the square section we observed that the maximum bending of the arm is 0,0152 [m] as it is shown in Figure no.7.

This maximum bending occurs due to the right forces and bending moments. In figure 8 is shown a distribution of axial stress.

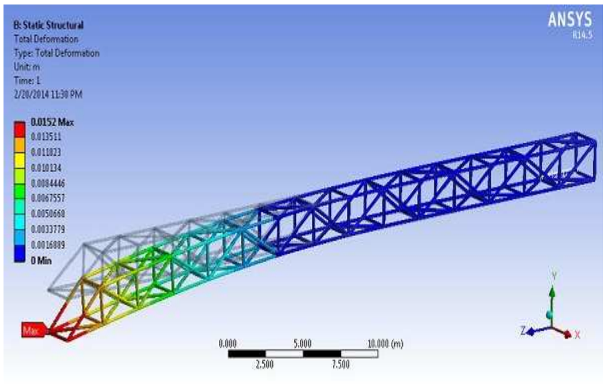


Fig.7 Analysis of maximum deformanion in the square truss section

The axials stretching are greater than the compressive axial. The maximum axial tension is 10,6 [N/mm^2].

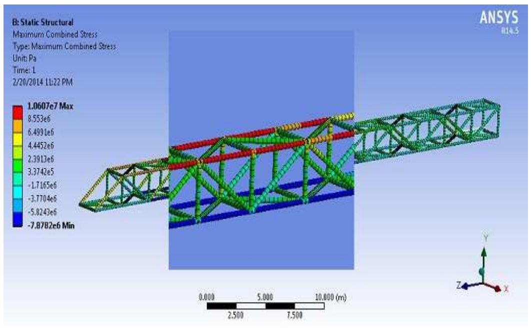


Fig. 8 Axial stress distribution

The bending moment diagram is shown in Figure 9. Maximum bending moment is 4221,8[N*m] and appears in the area where the beam is embedded. As shown the bending moment diagram is in terms of application of forces.

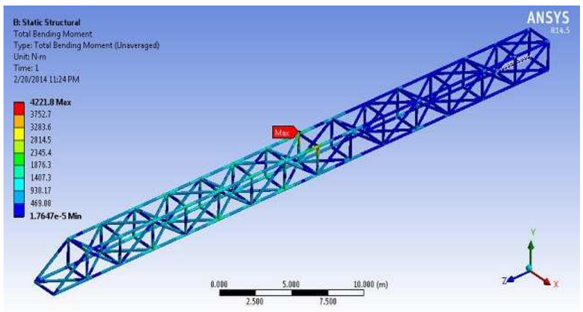


Fig. 9 Diagram of bending moments

4. CONCLUSIONS

The analysis performed on the two sections of the beams had the result that the spatial latticed arm crane in square format performs better in case of the strains and tensions bending moments than the triangular form. The performance of this structure are three time better than triangular section form.

In the both cases the structure of the tower crane arm resist on the load 100000 [N], and have a small deformation with this load. This load is the ten times bigger than the recomanded load of the producter.

From the point of view of deformations and bending moments we can say that results that the requests imposed to the two sections have close values, but not in the case where the axial stress were the triangular sections is much bigger than the square section.

It is preferred to perform an arm tower crane with a triangular section because this has a lower cost in terms of labor and material consumption.

Using the finite element method to determinate the sustainability is a fast and highly efficient, thus with is producing a significant reduction of effort and design, material and energy consumption, and is reinforced by the research presented here.

5. REFERENCES

[1] Alămoreanu M., ş.a. *Maşini de ridicat*, Vol. I şi II. Editura Tehnică Bucureşti, 1996.

[2] Oproescu Gh., Anghelache Diana *Elemente de dinamica maşinilor de ridicat şi transportat*, Galati University Press, 2010.

[3] Oproescu Gh. *Maşini şi instalații de transport industrial*. Editura EDMUNT Brăila, 2001

[4] Segall H. Maşini de ridicat şi transportat pentru construcții, EDP Bucuresti 1966

[5] Spivakovski A, Dyachkov V. *Conveyors and related equipment.* Peace Publishers, Moscow, 1978

[6] I. Vita, L. Surdeanu, T. Nuteanu, C. Alexandru *Masini de ridicat in constructii* , Editura Tehnica Bucuresti.

[7] ***PLM ADAPTOR, (2011). *Simulation and analysis using virtual prototype*, module II, University "Dunarea de Jos Galati", Engineering Faculty of Braila.

IDEAS REGARDING THE FATIGUE ANALYSIS OF THE BOGIE FRAMES

AXINTE TIBERIU

Constanta Maritime University, Romania

ABSTRACT

Bogies are one of the multifunctional parts of trains which are extremely subjected to random loads. This type of oscillating and random excitation arises from irregularities of the track including rail surface vertical roughness, rail joints, variance in super-elevation, and also wheel imperfections like wheel flats and unbalances. Since most of the previously mentioned sources have random nature, a random based theory should be applied for fatigue life estimation of the bogie frame. Static and dynamic forces applied on the bogie with biaxial frame have been obtained for different speeds and rail roughness. The von Mises stresses are adopted as equivalent stresses in the strength calculation. The results show that maximum stress always has been induced in the bogie bowl also the increase in bogie's speed has remarkable effect on the increment of applied stresses in the bogie frame.

Keywords: *Bogie, frame, fatigue, system, FEM, stress*.

1. INTRODUCTION

Bogies are one of the main parts of trains which not only carry static loads due to the body weight but also dynamic loads due to the rail surface roughness and imperfect wheels. Bogie frames are always subjected to dynamic random loads and consequently fatigue phenomena. Fatigue always deals with two main objectives in bogies: safety and excessive maintenance cost.

Some interesting research studies have been recently done to evaluate or improve fatigue life of the bogie frames. Among the research topics, there should be remarked the evaluation of the fatigue life of bogies used in high speed lines using an experiment based on UIC615-4 standard and the estimation of the fatigue life of some types of bogie frames using FEM. Optimization of the bogie weight based on the genetic algorithm is another interesting research direction.

2. BOGIE FRAME

The bogie, as shown in figure 1, is the moving equipment of any wagon that, because of its interaction with the tracks, makes possible the movement and advancement in the direction of the rail.

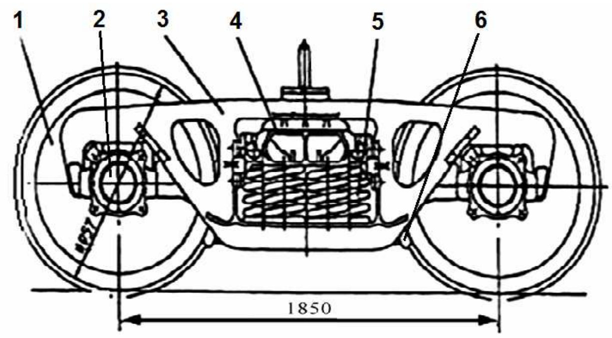


Figure 1 Components of bogie

Bogie is formed of several parts: two wheels and axis (1), journal box (2), two side frames (3), cradle (4), suspension system (5) and brake shoe (6).

3. EQUATIONS OF THE DYNAMIC MODEL

Once an appropriate physical model has been developed, dynamic equations used in the model can be obtained.

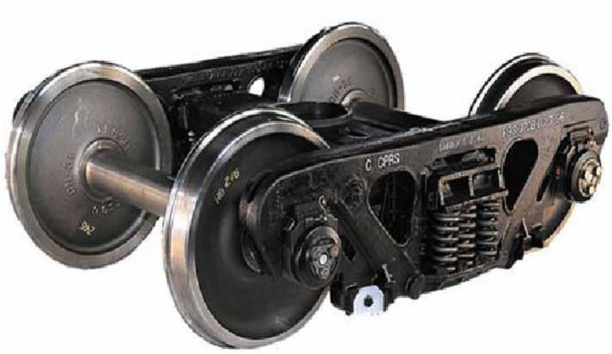


Figure 2 Bogie suspension systems

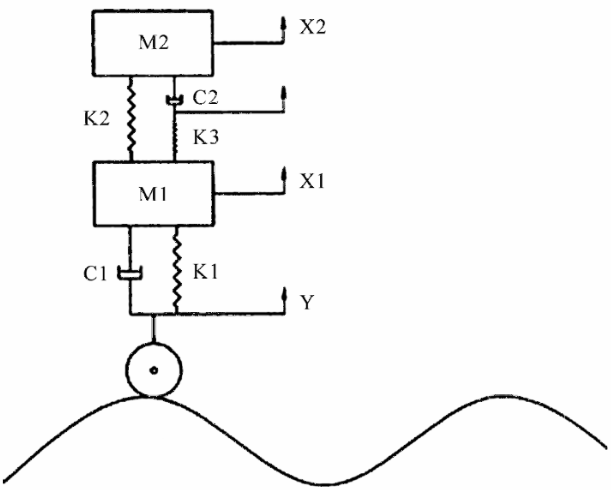


Figure 3 Dynamic model of the bogie wagon

Differential equations of the bogie's model in vertical directions are:

$$m_1\ddot{x}_1+k_1(x_1-y)+c_1(x_1-y)+c_1(\dot{x}_1-\dot{y})+k_2(x_1-x_2)+ k_3(x_1-x_3)=0 \quad (1)$$

After simplification:

$$m_1\ddot{x}+c_1\dot{x}_1+(k_1+k_2+k_3)x_1-k_2x_2-k_3x_3=k_1y+c_1\dot{y} \quad (2)$$

But

$$m_2\ddot{x}_2+k_2(x_2-x_1)+c_2(\dot{x}_2-\dot{x}_3)=0 \quad (3)$$

The parameters that are used in the above equations are:
- m_1: Total mass of side beams.
- m_2: Total mass of the wagon, the load and the cradle.
- x_1: Displacement of m_1.
- x_2: Displacement of m_2.
- x_3: Displacement of the connection point of damper and spring at secondary suspension.
- k_1: The equal elasticity coefficient at first suspension.
- $k2$: The equal elasticity coefficient of springs that are located directly between of linear beam and cradle.
- $k3$: The equal elasticity coefficient of springs which stand between the longitudinal beam and frictional damping.
- $c1$: The equal damping coefficient at first suspension.
- $c2$: The equal damping coefficient of viscous for frictional dampers.

And finally, matrixes of mass, stiffness, damping and forces for the model, may be obtained as it follows:

$$[m]=\begin{bmatrix} m_1 & 0 & 0 \\ 0 & m_2 & 0 \\ 0 & 0 & m_3 \end{bmatrix} \quad (4)$$

$$[k]=\begin{bmatrix} k_1+k_2+k_3 & -k_2 & -k_3 \\ -k_2 & k_2 & 0 \\ -k_3 & 0 & k_3 \end{bmatrix} \quad (5)$$

$$[c]=\begin{bmatrix} c_1 & 0 & 0 \\ 0 & c_2 & -c_2 \\ 0 & -c_2 & 0 \end{bmatrix} \quad (6)$$

$$[f]=\begin{bmatrix} k_1y+c_1\dot{y} \\ 0 \\ 0 \end{bmatrix} \quad (7)$$

The matrixes above define a system of equations:

$$[m]\{x\}+[c]\{\dot{x}\}+[k]\{x\}=\{f\} \quad (8)$$

4. FACTORS FOR FATIGUE STRENGTH ANALYSIS OF BOGIE

The fatigue behavior of welded structures is significantly affected by some factors presented in figure 4, which are specific for these structures or considered of high relevance, as compared to other typically fatigue loaded structures.

The most important among these factors are:
- stress concentrations;
- material mechanical properties variation between different weld joint zones;
- residual stresses;
- fatigue cycle mean stress;
- presence of defects (cracks)

In addition, there may be also considered some other factors, such as:
- multi-axial stress state
- variable amplitude loading assume a specific relevance in connection with railway structures.

All of these factors need to be adequately taken into consideration in an analysis instrument to be employed for the assessment of the railway bogies fatigue strength. Next, the effects of some of these factors will be briefly analyzed.

Stress concentrations in welded structures are mainly due to the following two mechanisms:
- weld joint geometry
- material properties variation within the joint.

Among these, the weld joint geometry is generally the most important, as weld joint cross shape usually includes quite abrupt shape variations, with very small root radius values. The theoretical stress concentration factor ($K_t = \sigma_{max}/\sigma_{nom}$) due to geometric effects typically assumes values in the range from 1.5 up to 5, [2].

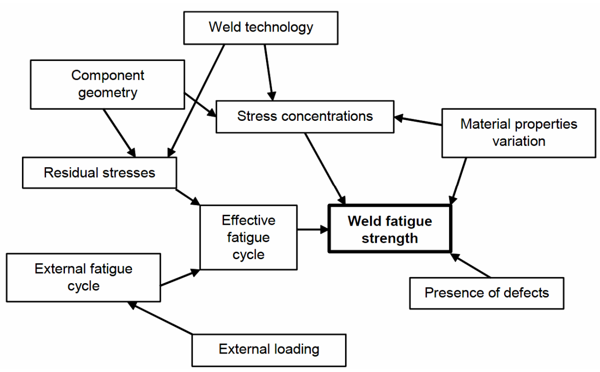


Figure 4 Factors affecting welded structures fatigue strength

A specific problem with welds is that geometric notch root radii are usually very small (typically, less than a few tenth of millimeter). Therefore, elastic maximum stress cannot be employed to predict fatigue life, but it must be replaced by an “effective” value, taking into account the notch sensitivity.

Actual Kt values for welded joints can, in principle, be efficiently evaluated by Finite Element (FEM) models. However, uncertainties in actual joint geometry (which, moreover, usually varies along the weld) can make this evaluation rather difficult and specific analysis procedures were developed.

Material fatigue strength variation within the joint should, in principle jointly act with stress variation to determine the actual fatigue failure initiation site. In practice, however, the former effect is overridden by the latter and fatigue failure is usually observed to occur in one of the highest stress concentration position, i.e. the weld root or the weld toe [3].

Residual stresses in welded structures can reach quite high values, depending on structure geometry and static indeterminacy degree and on the welding technology (type of welding, welding sequence, etc.). The determination of actual residual stress level, either by means of measurement or through the use of computer simulation (i.e. FEM) of the welding process is a quite complex matter, whose results are often affected by very high uncertainty and variability.

The typical effect from figure 5 of residual stresses (σ_{res}) on fatigue behavior of structures is that of superimposing to stresses due to external loading (σ_{ext}), increasing the cycle mean stress (σ_m).

An increase of σ_m is usually accompanied by a reduction of fatigue life and this is also the case for welded structures, at least in the presence of rather small residual stresses.

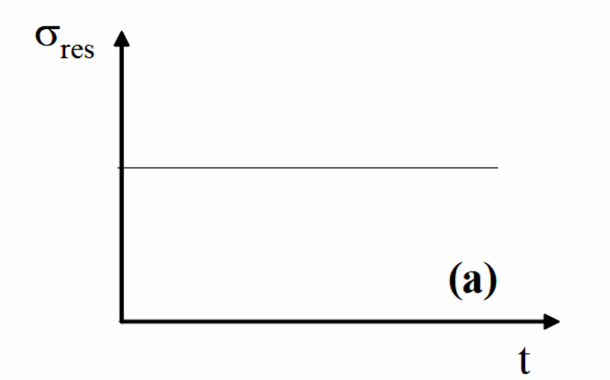


Figure 5 Residual stress

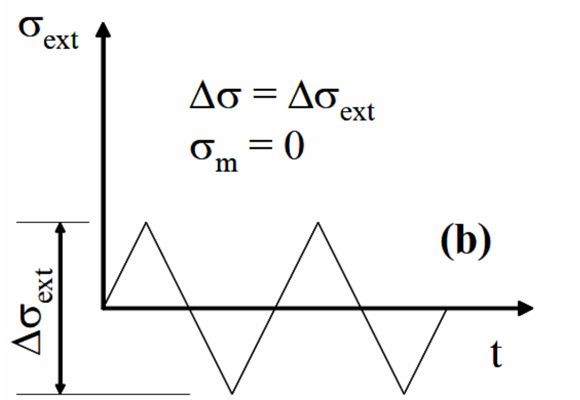


Figure 6 Fatigue cycle due to external loading

However, if the maximum stress in cycle exceeds material yield strength it will be limited to this value and, as a consequence, the cycle mean stress becomes rather independent from external cycle mean stress always attaining the minimum value, typical for very high stress values [1].

The effects of residual stresses are usually not directly considered in fatigue life evaluation. Structures are usually classified into different categories, typically expected to be affected by high or low residual stresses, each with specific allowable stress limits.

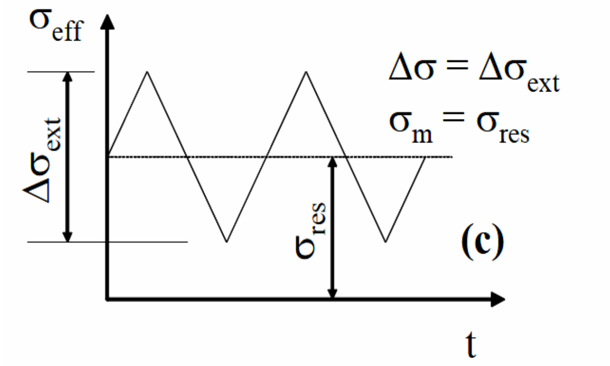


Figure 7 Effective fatigue cycle

The presence of cracks, rather common in welded joints can highly reduce fatigue strength, actually reducing to zero or near zero values the number of cycles required for initiation. Defects are usually considered in regulations by including them in acceptability limits, under which their effect on fatigue life can be considered negligible [1].

5. FEM FATIGUE ANALYSIS OF WELDED JOINTS

The criteria to be employed for the development of a suitable and accurate FEM model to support the structural and fatigue analysis of a bogie welded frame are highly dependent on the fatigue analysis method to be selected. Indeed, the stress estimates required by the previously discussed analysis techniques are quite different one to the other and the FEM model must take proper account of the requirements for their evaluation.

The FEM model can be constructed employing both, solid (“brick”) elements or “shell” elements.

In both cases, it is important to have a correct simulation of effective welded joint stiffness, as compared to base metal sheet stiffness, as this can affect stress distribution within the different regions of the joint.

For fillet welds, this makes it preferable to schematically present the weld transverse geometry (Figure 8) and, in the case of shell models, to insert specific elements having a conventional representative thickness.

Of special concern is the mesh size in the weld zone. Indeed, an excessively coarse mesh could not be able to estimate required stress with acceptable accuracy, while a too refined mesh could evidence undesired or spurious effects, such as stress singularities [4].

The nominal stress can usefully be calculated by considering the forces and moments supported by the weld and calculating, by simple beam theory relationships, the stresses produced on the corresponding cross section.

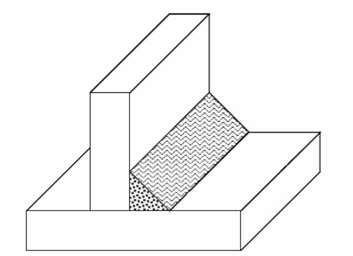


Figure 7 Fatigue cycle due to external loading

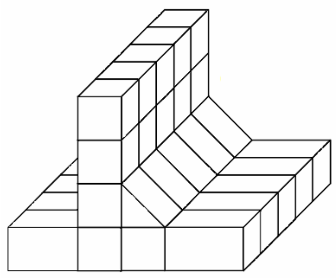


Figure 8 Fatigue cycle due to external loading - model

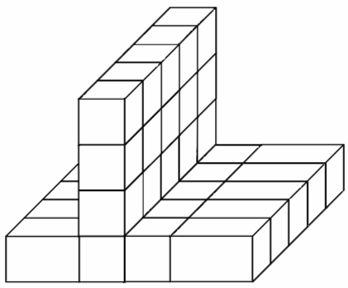


Figure 9 Fatigue cycle due to external loading - variant

The *“Hot- spot” stress method* requires an estimate of the linear component of the stress filed at the weld toe. This stress component is best achievable by “shell” element models figures 7, 8 and 9, which automatically filter the non-linear component. Over the years, several modelling techniques have been developed imposing specific element sizes in front of the weld, to improve HSS evaluation accuracy. This trend to conceive the FEM model set-up is quite laborious.

The FEM model for *“Effective Notch Stress” method,* evaluation is most frequently based on sub structuring techniques in figure 10. A coarse model, similar to those suitable for nominal stress method, is employed to represent general structure displacement field. Then a substructure representing the weld detail and including effective notch root radius is employed to derive *“Effective Notch Stress” method*.

One of the most interesting strong points of the method is the possibility to take into consideration, at least in principle, some effects such as the weld shape defects, including them in the substructure [5].

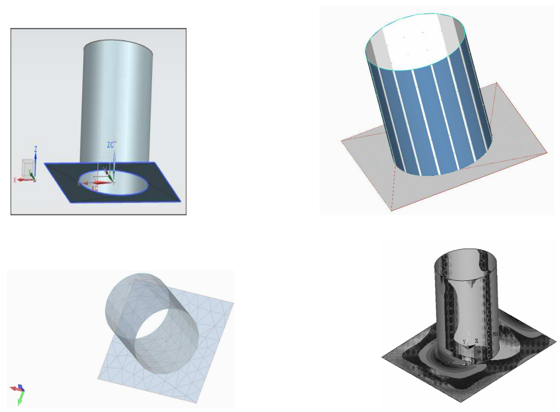


Figure 10 FEM analysis (“shell” elements) of a tubular welded joint, typically employed for HSS evaluation

6. CONCLUSIONS

The methods to predict the fatigue life were applied in the design of various categories of bogie frames used in service.

Based on these applications, the following main observations can be drawn:

- nominal stress, based on EUROFER code and ERRI B12/RP60 CDM produced rather comparable results, which is not surprising, taking account of the analogies between the two techniques.
- as the actual fatigue strength of the bogies was not known, it was not possible to draw precise conclusions about the accuracy of the different prediction methods.

7. REFERENCES

[1] FRICKE, W., MULLER-SCHMERL, A., *Uncertainty Modeling far Fatigue Strength Assessment of Welded Structures*, ASME Journal of Offshore Mechanics and Arctic Engineering, MAY 1998, vol. 120, pp. 97-102.

[2] HECHMER, J., KUHN, E., *Fatigue Strength Reduction Factors for Welds Based on Nondestructive Examination*, *ASME J. of Pressure Vessel Technology*, 1999, vol. 121, pp. 6-10.

[3] JASKE, E., *Fatigue Strength Reduction Factors for Welds in Pressure Vessels and Piping*, *Journal of Pressure Vessel Technology*, ASME, 2000, Vol. 122, pp. 297-304.

[4] KIRKHOPE, K., BELL, L., CARON, R., *Weld detail fatigue life improvement techniques.* Part 1: review, *Marine Structures*, vol. 12 (1999) pp. 447-474.

[5] SAVAIDIS, G., VORMWALD, M., *Hot-spot stress evaluation of fatigue in welded structural connections supported by finite element analysis*, Interactional Journal of Fatigue, vol. 22 (2000) pp. 85-91.

[6] SONSINO, C., RADAJ, D., BRANDT, U., H.P. LEHRKE, *Fatigue assessment of welded joints in AIMg 4.5Mn aluminum alloy (AA 5083) by local approaches*, International Journal of Fatigue, vol. 21 (1999) pp. 985-999.

[7] VERREMAN, Y., NIE, B., *Early development of fatigue cracking at manual fillet welds*, *Fatigue Fract. Engng Mater & Struct.*, Vol. 19, No.6, pp. 669-681, 1996

STUDY OF THE EFFECTS OF VIBRATIONS ONTO THE RAILS

AXINTE TIBERIU

Constanta Maritime University, Romania

ABSTRACT

The paper presents analytical and finite element solutions to the problem of a vibrating beam on an elastic foundation. An application example is a concrete railway sleeper embedded in an elastic medium (the ballast). The sleeper is also elastically connected to the rails. The beam (sleeper) is divided into sections where each section may or may not be supported by the elastic foundation. The elastic connections to the rails are situated at the two joinings of the three sleeper sections. Some conclusions are that Euler-Bernoulli beam theory can be used to calculate two, or maximum three, eigen frequencies of the sleeper. The foundation stiffness influences the lowest bending-mode eigen frequency the most; higher eigen frequencies are practically unaffected by the foundation stiffness. The influence of rail pad (and rail) stiffness on the sleeper eigen frequencies is negligible.

Keywords: *Vibration, system, FEM, rail, beam.*

1. INTRODUCTION

The vertical wheel-rail vibrations may be caused by various factors, such as: irregularities of the wheel/rail rolling surfaces, wheel/rail discontinuities (rail joints, crossings, wheel flats, etc.), the variation of dynamic stiffness caused by the sleeper passing, etc. The vertical vibrations may damage the rolling quality and noise emission. They may also lead to rail corrugation.

Basically, the level of wheel-rail vibrations is related to the mechanical characteristics of both, wheel and rail track. As far as it concerns the rail, the main factors are the rail, sleeper and rail-pad characteristics. In order to study the dynamics of the wheel-rail system, the characteristics above could be reflected by the rail's response to a unitary vertical force. The rail may be described through the finite element method or through analytic models. For example, Nielsen uses finite elements of Rayleigh-Timoshenko beam type. He studies the influence of the irregularities of the wheel/rail rolling surfaces on the vertical loads at different running velocities or calculates the rail corrugation [3].

2. THEORY

Timoshenko's theory of beams constitutes an improvement of the Euler-Bernoulli theory, in that it incorporates shear deformation effects [7]. In this section a sleeper is considered to be a Rayleigh-Timoshenko beam, in that the two effects, *i.e*. shear of a beam lamina due to shear force and influence of rotator inertia, are included in the Rayleigh-Timoshenko theory, but these effects are excluded in the Euler-Bernoulli beam theory.

In Rayleigh-Timoshenko beam theory the total deflection of the beam is separated into two parts: one depends on the bending of the beam and the other part depends on shear deformation of the beam. A beam lamina, with shear force and bending moment plus the corresponding deformations, is presented in Figure 1.

The relevant deformation to the bending moment *M(x,t)* is here indicated by *wM(x,t)* and the other part which is related to the shear force *T(x,t)* is denoted *wS(x,t)*. The following relation presents the connection between these terms:

$$w(x,t) = w_M(x,t) + w_S(x,t) \quad (1)$$

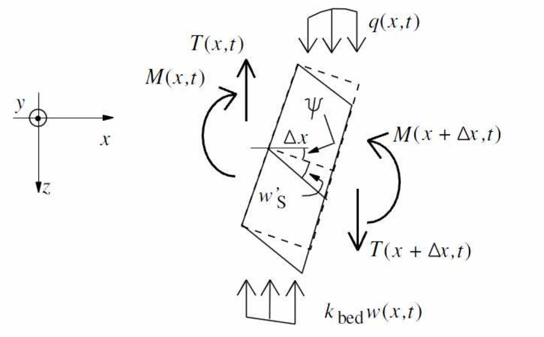


Figure 1 - A beam lamina

The deflection due to the bending moment can be given by use of the rotation angle. In this case the relation between deflection and rotation angle is

$$\psi(x,t) = \frac{\partial w(x,t)}{\partial x} \quad (2)$$

The relationships between the bending moment *M(x,t)* and second derivative of the deflection $w_M(x,t)$ or the first derivative of the angle ψ(x, t), and, furthermore, the relation between the shear force *T(x,t)* and the corresponding deformation can be expressed as follows

$$M(x,t) = -EI\frac{\partial^2 w_M(x,t)}{\partial x^2} = -EI\frac{\partial \psi(x,t)}{\partial x} \quad (3)$$

and

$$T(x,t) = \kappa GA\frac{\partial w_s(x,t)}{\partial x} = \kappa GA\left[\frac{\partial w(x,t)}{\partial x} - \psi(x,t)\right] \quad (4)$$

Here *EI* is bending stiffness of the beam, *E* is Young's modulus, *I* is the second moment of area of the cross sectional area *A*, *G* is shear modulus which can be calculated from the modulus of elasticity *E* and the Poisson ratio ν, the factor κ is a constant, the Timoshenko shear factor, that depends on the form of the cross section and the Poisson ratio ν [6].

3. MATERIAL PROPERTIES

In this study the concrete sleeper has a simplified geometry (as described above) and the material properties are the same throughout the length of the sleeper so it is considered to be a structure with homogenous properties. The material (concrete) in the sleeper has Young's modulus 36.6 GPa. The total mass of the sleeper is 251 kg (thus, with a sleeper volume of 0.1 m^3 the overall density of the concrete and reinforcement is 2510 kg/m^3) [2]. The second moment of inertia of the sleeper cross section is I=1.33×10^{-4} m^4 giving the flexural rigidity EI=4.79 MN/m^2.

The shear modulus of the concrete can be obtained as follows:

$$G = \frac{E}{2(1+\upsilon)} \qquad (5)$$

Some quick calculation in solid mechanics should be performed to find the proper material for replacing a spring with a bar. Hook's low can, in this case, be stated as follows:

$$F = K\,\Delta X \qquad (6)$$

Where K is the stiffness and ΔX is the change of length when applying the force F. Here, for replacing the rail stiffness, a solid cylinder with the length of one meter is considered. The material of this cylinder is steel with Young's modulus E = 205GPa and Poisson's ratio 0.3, respectively. It is worth emphasizing that, because of the requirements in this case, it is only the stiffness property of the material that is important. The density should be set to zero. This will remove the effect of the spring mass [5]. A tensile load of 1000 N applied to the cylinder, and using the formula:

$$\delta = \frac{FL}{AE} \qquad (7)$$

will give, for a cross-sectional area 0.8293×10^{-4} m^2, the elongation - around 0.5882×10^{-4} m.

Next step is to find a suitable material for the bed. Also in this case the same approach is suitable. The only difference is the dimension of the bed which is 3D in this model. Here it extends in the lateral and length directions and the ballast is loaded in vertical direction. Therefore, deformation is allowed only in the load direction. Because of this, the material used is made orthotropic rather than isotropic.

In this case the length and width of the ballast should be the same as the sleeper, and for simplicity, the depth of the ballast bed is assumed to be one meter. Thus, one has to find a proper model by varying the material properties.

4. FEM MODELING

The two rails and rail pad springs are meshed by 2D bar elements and each one consists of only one element. To increase the number of elements in this case would not improve the results.

Each volume has the same thickness and width as the sleeper. Since the ballast is connected to the neutral line of the sleeper, which is parallel to the length, the sleeper is broken into the two volumes in the vertical direction. To keep the fine meshing, each volume in sleeper has two elements in vertical direction and one element in length direction [1].

Thus, overall, the sleeper contains 80 elements (40 volumes and each one contain 2 elements). Each part of the ballast has only one element in each direction, which will give a total of 20 elements of the ballast. Apart from the rail springs, the model contains 100 elements.

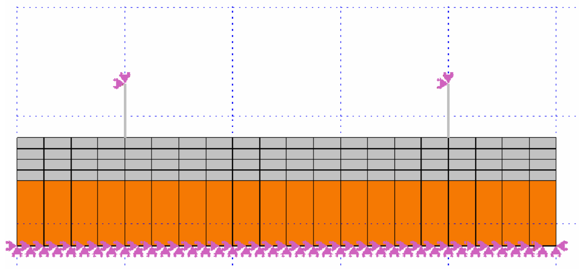


Figure 2 - Mesh of the model

When the calculations are performed the voided parts of the sleeper can easily be created in the model by deleting the appropriate volume elements of the ballast.

Boundary conditions for the model are prescribed so that they reflect the real case as close as possible. Also, the model results depict a small difference with the ones obtained from other studies.

The mentioned description leads to a model with boundary conditions that have fixed points in all direction for the upper point of the rail springs (the bars). Also, the lower surface of the ballast should be fixed in all directions. The other connections between rails and sleeper, and also between sleeper and ballast, are already considered since they have some common points.

The arrangements of the contact between sleeper and ballast bed can take various shapes. In this study it is attempted to evaluate some of the most common situations. From previous assessments, five situations of contact boundary conditions are of practical concern in real railway track problems. In particular, these defects (voids or hanging sleepers) can be detected through vibration tests. The stated patterns are depicted in figure 3. The first part of figure 3 shows the type of imperfection that is called 'central void'. The void starts from the center of the sleeper and after that the void grows out to the sides symmetrically [4].

To evaluate the alteration of the dynamic behavior of the sleeper during the increase of the voided part, the ratio of the central void length to the sleeper length is, in this case, used as a non-dimensional variable. The relation below presents this value:

$$\alpha_c = \frac{L_c}{C} \qquad (8)$$

The next case considers another problem which occurs in the sleeper/ballast contact. This case is referred to as a "single hanging" sleeper. In this type, the void is assumed to form from one of the ends of the sleeper and it expands incrementally to the other end. Also, in this situation the initial case is the fully supported sleeper and the last situation is the totally hanging sleeper. As mentioned in the preceding situation, for assessing the variation of the dynamic behavior of the sleeper during these imperfections a non-dimensional parameter is used which is the ratio of the single-side void length to the length of the model. This relation can be written as follows:

$$\alpha_s = \frac{L_s}{L} \quad (9)$$

Another contact situation that can occur is double-side hanging sleeper. An unsupported part starts to grow from each end of the sleeper, and the contact remains only in the middle segment of the sleeper. This situation is named the 'double hanging' sleeper. Figure 5 displays this situation. Because of the double voiding two parameters are needed in this case to cover all the possible situations. By assuming any value less than 50% for the voided part of one sleeper end, and having the void on the other side grow from zero to highest possible value, it can be guaranteed that no case is missed [10]. Specific parameters in this case are:

$$\alpha_d = \frac{L_{dL}}{L} \quad (10)$$

$$\beta_d = \frac{L_{dR}}{L} \quad (11)$$

The next pattern has more complicated shape. The sleeper is assumed unsupported along three parts; one part in the center of the sleeper plus two more imperfections (voids) at both ends of the sleeper. It is worth emphasizing again that, in this study, only symmetrical voids in the center and also at the ends are considered. Thus, two variables can define this situation. One of the non-dimensional parameters is related to the central void and the other to the unsupported parts at the ends of the sleeper [8]. It results:

$$\alpha_t = \frac{L_t}{L} \quad (12)$$

$$\beta_t = \frac{L_{tc}}{L} \quad (13)$$

The last case contains two imperfections (voids), one of them is a center void and the other is an end void. This situation is mentioned 'side-central voids' and this situation is displayed in figure 6. The asymmetric contact configurations are considered in this case, and two corresponding non-dimensional parameters can be stated as follows:

$$\alpha_{s-c} = \frac{L_s}{L} \quad (14)$$

$$\beta_{s-c} = \frac{L_c}{L} \quad (15)$$

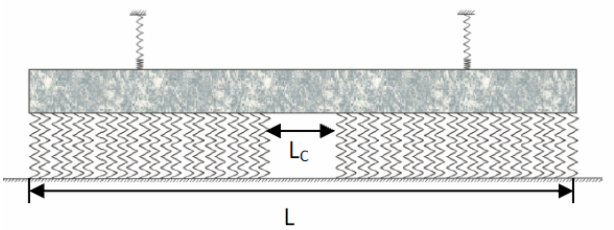


Figure 3 - Central void

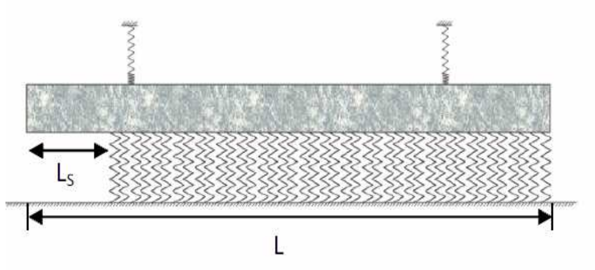


Figure 4 - Single hanging

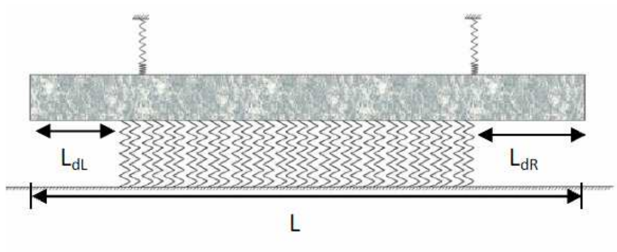


Figure 5 - Double hanging

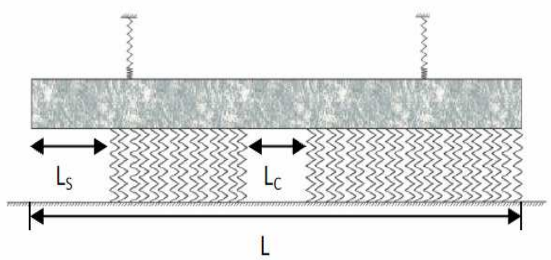


Figure 6 - Triple hanging

5. INFLUENCE OF VELOCITY ON THE WHEEL-RAIL VIBRATION

In order to investigate the influence of velocity on the characteristics of wheel-rail vibration, taking a certain vertical section as an example, we set the slope and the vertical curve radius as 5‰ and 20 km, respectively; and conducted simulations at four different speeds of 200, 250, 300, and 350 km/h.

Figure 7 shows the maximum values of wheel-rail vertical force at different velocities. When the operation speed increases in order from 200 to 350 km/h, the maximum values increase linearly from 49.5 to 51.4 kN. Figure 8 shows the maximum values of vertical centrifugal acceleration of wheel set at different velocities.

When the vehicle velocity is more than 300 km/h, the maximum values are all beyond the permitted value of 0.35 m/s^2. Therefore, according to the European norm, the vertical section parameters above are not suitable for the line with a maximum velocity of 350 km/h [9].

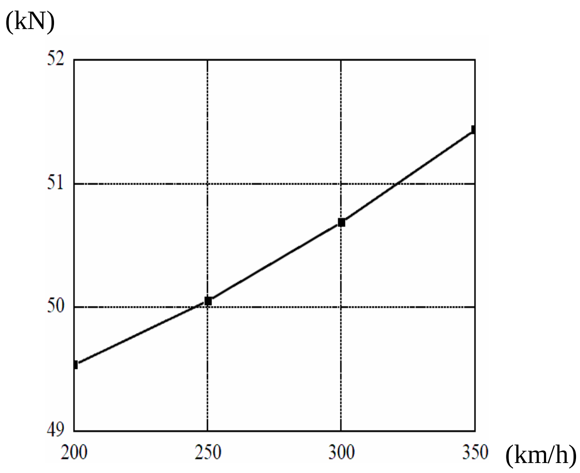


Figure 7 - Maximum wheel-rail vertical force at different velocities

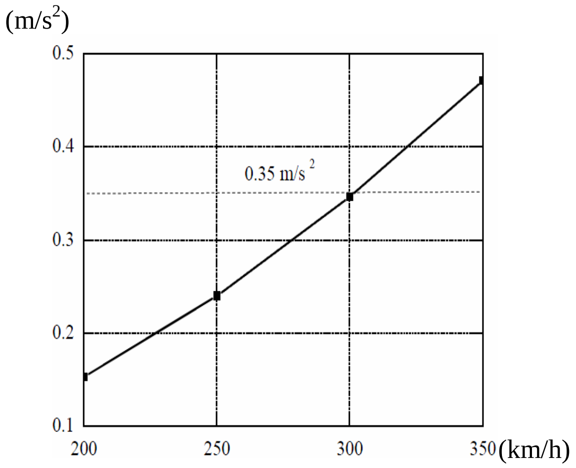


Fig. 8 - Maximum vertical centrifugal acceleration of wheel set at different velocities

On a final note, at the stage of vertical section design for railway lines of different speeds, it is necessary to simulate the matching relationship between the slope and vertical curve radius, so as to determine the most reasonable condition.

6. CONCLUSIONS

The paper presents a study regarding the friction induced vibrations of a railway rail modeled by FEM. The vibrations are induced by lateral friction force caused by the wheel/rail slipping. Stationary process is studied and the internal damping is taken into account. Analyzing the numerical solution of the dynamic model, it could be stated that the friction-induced vibrations occur with the first natural frequency of the system.

When a vehicle rapidly passes through the vertical curve, the wheel-rail vibration becomes severe. The value of vertical dynamics indexes, especially the variation of wheel load and the vertical centrifugal acceleration of the wheel set, are larger when the radius is smaller.

For a line with a maximum speed of 100 km/h, the minimum value of vertical curve radius should be no less than 15 km.

For the principles of designing vertical sections, it is recommended that when the slope is small, the vertical curve radius should be large, but when the slope is large, the radius should be decreased properly.

7. REFERENCES

[1] CHIELLO, O., J.-B. AYASSE, N. Vincent, J. R. Koch, *Curvesqueal of Urban Rolling Stock— Part 3: Theoretical Model*, Journal of Sound and Vibration, Vol. 293, Issues 3–5, 13 June 2006, pp. 710–727.

[2] GLOCKER, Ch., E. Cataldi-Spinola, R.I. Leine, *Curve squealing of trains: Measurement, modelling and simulation*, Journal of Sound and Vibration, Vol. 324 (2009), pp. 365–386.

[3] TONDL A., *To the Problem of Self-excited Vibration Suppression*, Engineering MECHANICS, Vol. 15, 2008, No. 4, pp. 297–307.

[4] TONDL A., *Passive And Active Means For Self-Excited Vibration Suppressing: Two-Mass Model*, Engineering Mechanics, Vol. 15, 2008, No. 2, pp. 133–138.

[5] VAN BOMMEL, P.**,** *Application de la théorie des vibrations nonlineaires sur le problem du mouvement de lacet d'un vehicule de chemin de fer*. Dissertation TH Delft, 1964.

[6] Zheng, D. Y., Fan, S. C., *Instability of vibration of a moving-train-and-rail coupling system.* Journal of Sound and Vibration 255, 243-259, 2002.

[7] TAGHINUCHI, E., THOMPSON, R.G., YAMADA, T., VAN DUIN, R., *City Logistics- Network Modelling and Intelligent Transport System*, Pergamon, New York, 2000.

[8] Instrucţia de norme şi toleranţe pentru construcţia şi întreţinerea căii, nr. 314, MTTc, 1989.

[9] JOLY, R., *D'étude from stable cross ferrovie vehicles circulating a grande Vitesse Rail International*, no. 12, 1971.

[10] SAUVAGE, G., PASCAL, JP, *Nouvelle méthode de calcul des efforts dynamique entre les roueset les rails*, Revue Générale des Chemins de fer, nr. 11, 1976.

[11] SEBEŞAN, I., MAZILU, TR., *Vibraţiile vehiculelor feroviare, Ed. MatrixRom*, 2010.

PROPELLER MODELLING USING CFD TECHNIQUES. SIMULATION AND REPORT

[1]ATTENDEE ZAIDI SARIM, [2]BOCANETE PAUL

[1,2]Constanta Maritime University, Romania

ABSTRACT

Computational fluid dynamics (CFD) represents a branch of fluid mechanics that uses algorithms, numerical methods and computers in order to simulate various processes associated to flow conditions.

In this manner, the flow developed in naval propellers is simulated by using a number of conservation equations together with several additional equations, models for turbulence, pressure, cavitation, heat exchange and chemical species transport or dispersed phases equations. Anyway, there may be several approaches when developing the simulation scenario. One of them is the steady flow simulation, where all the flow quantities depends only on the spatial location. When developing transient simulations, all the flow parameters changes with time. The aim of this article is to study the differences established between the obtained results in the two cases.

Keywords: *CFD, simulation, mesh; Navier - Stokes equations, turbulence modeling, fluid continuity, momentum conservation.*

1. INTRODUCTION

Computational Fluid Dynamics, or CFD, is the computational technology for the analysis of systems involving fluid flow, heat transfer and associated phenomena by means of computer -based simulation. This technology employs numerical methods and algorithms to solve the equations that describe fluid flows and heat transfer. Computers are used to prepare the data, build computational domain and mesh, perform numerical solution of the equations, and to analyze the solution results. The equations that describe the dynamics of fluid represent fundamental laws of physics stating conservation of mass, momentum and energy. Thus, CFD is intended to model realistic media and various bodies interacting with it by virtual (non-physical) means, and to predict their behaviour under different conditions. In other words, CFD enables scientists and engineers to perform “numerical experiments” (i.e. computer-based simulations) in a “virtual laboratory”.

Nowadays CFD methods are routinely used in a wide range of industrial and nonindustrial application areas. These areas include, for example:

• Aerodynamics of aircraft and space vehicles (prediction of lift and drag, and airflow analysis);
• Ship and propeller hydrodynamics (prediction of resistance, propeller characteristics, cavitation, manoeuvring forces);
• Marine engineering (estimation of wind, wave and current loads on offshore structures);
• Power plant technological processes (combustion processes in engine and gas turbines, functions of cooling systems);
• Turbomachinery (analysis of flow in rotating blade-row passages and diffusers, cavitation);
• Chemical process engineering (studies on chemical reactions, mixing, separation, polymer moulding);
• Architecture and building construction (calculation of wind loads on buildings, design of heating, ventilation, water supply and sewage systems); Environmental engineering (analysis of distribution of pollutants and effluents);
• Hydrology and oceanography (studies on flows in rivers, estuaries, oceans);

2. ANALYSIS OF MOTION OF A FLUID ELEMENT

When deriving the equations of fluid motion we need to know rate of change of a fluid property φ per unit mass and per unit volume. Following the method by Euler we will investigate the field of φ (x, y, z, t) assuming that the property of interest is the function of the position of the fluid particle and time. At the given time instant t the particle was located at the point (x, y, z), and after one time step t + Δt it moved to another point with the coordinates (x + Δx, y + Δy, z + Δz). Let us compute the rate of change of the property that corresponds to the aforementioned motion.

The rate of change of property φ per unit volume is given by the product of substantial derivative and density:

$$\frac{\partial \rho}{\partial t}+\nabla\left(\rho\vec{U}\right)=0 \qquad (1)$$

ρ -water density

$\vec{U}$ =(*u, v, w*) - fluid velocity

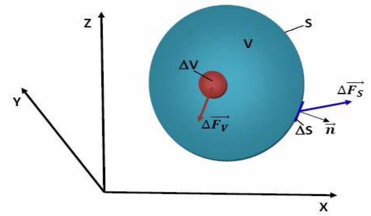


Figure 1. Surface and body forces acting on a fluid volume

The obtained relationship between the substantive derivative of a fluid property, which follows a fluid particle, and the rate of change of this property for a fluid element is fundamental for the derivation and analysis of the governing equations of fluid motion, which represent mathematical expressions of the conservation laws of physics. These laws are:
• The mass of fluid is conserved (continuity equation).
• The rate of change of momentum equals the sum of the forces acting on a fluid particle (Newton's second law).
• The rate of change of energy equals the sum of the rate of heat addition to and rate of work done on a fluid particle (first law of thermodynamics).

3. NAVIER-STOKES EQUATIONS FOR MOMENTUM CONSERVATION

Viscous stresses in the momentum equations can be related to the rates of linear deformations of the fluid element, and the latter are expressed through the velocity components. For the isotropic Newtonian fluids, the relationship between the stresses and rates of deformations is given by the following equation (Ansys Inc., 2011):

$$\begin{vmatrix} p_{xx} & \tau_{xy} & \tau_{xz} \\ \tau_{yx} & p_{yy} & \tau_{yz} \\ \tau_{zx} & \tau_{zy} & p_{zz} \end{vmatrix} = -\begin{vmatrix} p & 0 & 0 \\ 0 & p & 0 \\ 0 & 0 & p \end{vmatrix} + 2\mu \cdot \begin{vmatrix} \varepsilon_x & \vartheta_z & \vartheta_y \\ \vartheta_z & \varepsilon_y & \vartheta_x \\ \vartheta_y & \vartheta_x & \varepsilon_z \end{vmatrix} \qquad (2)$$

This is the form of momentum equations that is the most convenient for the finite volume method formulation. In some sources, the name Navier-Stokes equations is associated with the system of momentum equations and continuity equation.

4. TURBULENCE PHENOMENON

As a physical phenomenon, turbulence may or may not be desirable. Below we will give just a few examples illustrating the opposite effects of turbulence:
• Intensive mixing between the zones with different momentum content can be useful in industrial chemical or thermal mixing processes.
• In the external flows around ships, airplanes and cars, the increased mixing of momentum results in increased frictional forces and, hence, higher skin friction component of drag, compared to laminar flows. At the same time, the boundary layer separation is delayed in turbulent flows as the separation point moves further downstream, and, as a result, the form drag is reduced.
• Atmospheric turbulence caused by mixing of warm and cold air by wind must be accounted for the safe operation of aircraft; it can represent a serious risk factor depending on intensity of turbulence and size of the aircraft.
• Large scale turbulence plays an important role in formation of oceanic currents and atmospheric circulation that can influence weather condition and even climate over large areas.
• Dispersion and mixing of pollutants and contaminants in rivers, seas and atmosphere are dependent on turbulence mechanisms.

In CFD, the random nature of turbulent flows complicates their numerical simulation greatly. Extensive theoretical and experimental research on the mechanisms of turbulence has resulted in a truly impressive bibliography on the subject. These complex topics are beyond the scope of the present course. It is however important to understand the physics and key features of turbulent flow as these underlay the concepts of numerical modelling.

5. CLASSIFICATION AND UNDERSTANDING OF TURBULENCE MODELING CONCEPTS

Numerical modelling of turbulence represents a very challenging task which requires deep understanding of the physics of turbulent flows and extensive knowledge of mathematical methods. In this paper we will approach the practical implications of the modelling approaches. We will begin with a general classification of turbulence modelling concepts, which according to (Bardina et al, 1980) can be divided into the six categories:
1. Concept using correlations: These methods allow for obtaining simple formulas for the hydrodynamic characteristics as functions of the modelling criteria that are valid for simple flows, e.g. Prandtl - Schlichting formula for the skin friction of a flat plate in turbulent flow or ITTC-57 model-ship correlation line.
2. Concept using integral equations: The integral equations are derived from the general equations of motion by integrating them over one or more coordinates. This approach is used, for example, in solution of boundary layer equations discussed .The problem is reduced to one or more ordinary differential equations which are easier to solve than partial differential equations, but the range of validity of this approach is limited.
3. One - point closure concept: These methods use time-averaging and ensemble-averaging of the equations of motion, such as we have considered in the previous section. The averaging leads to a set of partial differential equations called Reynolds-Averaged Navier-Stokes (RANS) equations which represent the main tool in the arsenal of CFD methods used nowadays for the engineering computations of turbulent flows. The averaging makes the equations simpler, but at the same time introduces additional unknowns. In order to form a closed set of equations, the introduction of turbulence models is needed. The purpose of a turbulence model is to relate the additional unknowns that characterize transport of the turbulence properties to the averaged properties of the mean flow.

4. Two - point closure concept: The approach is based on use of the equations for correlation of the velocity components at two points in space or the Fourier transformation of these equations. Two-point closure methods are mainly used for the modelling of homogeneous turbulence and they have not found wide practical application.
5. Large Eddy Simulation (LES) concept: LES methods provide solution for the largest scale motions of turbulent flow. In other words, the largest – and energetically most important – turbulent eddies are computed directly, while the effect of smaller eddies, which are not resolved, is accounted for through additional stresses obtained from the turbulence theory.
6. Direct Numerical Simulation (DNS) concept: DNS methods solve the Navier-Stokes equations directly for all scales of turbulent motions.

6. REYNOLDS AVERAGED NAVIER-STOKES EQUATIONS (RANS)

The equations of the RANS method for incompressible viscous flow are derived by averaging of the Navier-Stokes equations (2). We will only consider the time averaging of the instantaneous continuity and momentum equation. The velocity vector, velocity components and pressure are presented as a superposition of the mean and fluctuations parts.

The density and viscosity of fluid are constant, and the additional momentum sources do not contain fluctuating part. The averaging rules for the mean and fluctuating parts are applied.

It has to be noted that, after averaging, all the same terms are present in the momentum equation, now referring to the mean values. However, one additional term appeared as a result of averaging of the convective term. This new term constitutes convective momentum transfer due to turbulent fluctuations of velocity. It is common to place this term in the right-hand side of the equation to reflect its effect as an additional turbulent stress component on the mean velocity component.

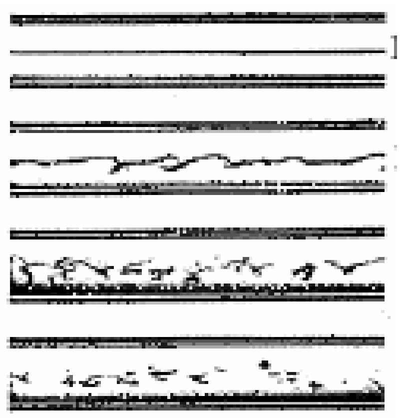
Analogous derivations can be done for the y- and z-momentum equations, and we arrive at the following set of equations for momentum (D. Ponkratov, 2011):

$$
\begin{aligned}
\frac{\partial(\rho u)}{\partial t} + \nabla\left(\rho u \vec{U}\right) &= -\frac{\partial p}{\partial x} + \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + \rho F_x \\
\frac{\partial(\rho v)}{\partial t} + \nabla\left(\rho v \vec{U}\right) &= -\frac{\partial p}{\partial x} + \frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{zy}}{\partial z} + \rho F_y \\
\frac{\partial(\rho w)}{\partial t} + \nabla\left(\rho w \vec{U}\right) &= -\frac{\partial p}{\partial x} + \frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \tau_{zz}}{\partial z} + \rho F_z
\end{aligned}
\tag{3}
$$

The equations (3) are called Reynolds-Averaged Navier-Stokes equations, and they represent the main set of equations to be solved in the RANS method. In order to close the set of RANS equations (Ansys Inc, 2011), one has to relate turbulent stresses to mean velocity components. The complex nature of turbulence does not allow for simple relations between the fluctuating and mean velocity components. The aforementioned relations are established by turbulence models which may vary greatly in complexity of formulation depending on what effects and to what extent these turbulence models are intended to include.

7. TURBULENCE MODELS IN RANS SIMULATION

We have now approached one of the most difficult topics in CFD which is related to modelling of turbulence. From the observations after the simplest turbulent flows we have made in the previous sections one can conclude that it is highly unlikely that one can expect a single turbulence model to be universally suitable for all classes of problems studied, with the exception of DNS modelling which is so far too expensive to be of practical engineering use. Indeed, the choice of turbulence model will depend on such considerations as flow physics, best practice for a specific class of flows, desired levels of accuracy and, of course, available computational resources and time. In view of the limited volume of the present course, the accent will be made on understanding of the key features of the main turbulence models currently used with RANS simulations and implications of their practical use, rather than their numerical implementation in solution algorithms.



$Re<Re_{cr}$

$Re\sim Re_{cr}$

$Re>Re_{cr}$

$Re>>Re_{cr}$

Figure 2. Re_{cr} – critical Reynolds number when instability of the flow causes the growth of vortical structures and their chaotic motion – turbulence (D. Ponkratov, 2011)

8. CFD STUDY OF A NAVAL FIVE BLADED PROPELLER

In order to develop the CFD study for a naval propeller, there was chosen the five bladed propeller, developed for the Workshop on Verification and Validation of Manoeuvring Simulation Methods held in Copenhagen, Denmark, in 14th – 16th of April 2008, by Maritime and Ocean Engineering Research Institute (MOERI), Korea. The KCS was conceived to provide data for both explication of flow physics and CFD validation for a modern container ship with bulb bow and stern. The conditions include bare hull and fixed model. No full-scale ship exists. More information concerning KCS including towing tank results for resistance, generated wave field and pressure field on the hull can be found on the MOERI and NMRI web sites.

The propeller geometry is presented in figure 3.

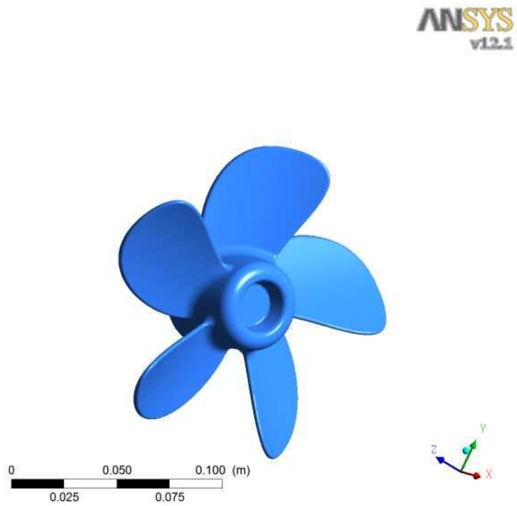


Figure 3 – The geometry for the MOERI KCS propeller

During the stages necessary to develop the simulation it was obtained an unstructured mesh with 400760 nodes and 2164604 elements, presented in figures 4 and 5.

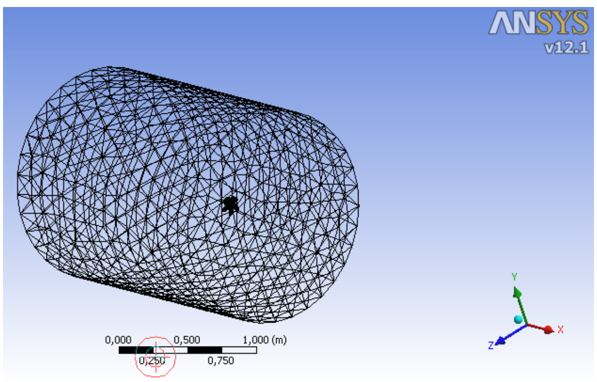


Figure 4 – Domain mesh

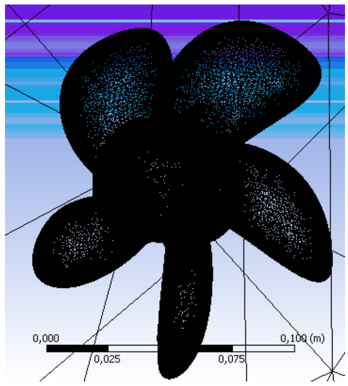


Figure 5 – Mesh refinement on the propeller's surface

After establishing the settings for the boundaries, there were carried 2 different types of simulations. The first one was a static simulation, where the flow is fully developed and t → 0. The second simulation was a transient simulation, developed on a certain time frame, of 500 seconds, with 5 seconds timesteps and 3 iterations per timestep.

In the 1st table are presented the results for the first simulation:

Table 1 - Forces and Torques for static simulation

Location	Type	X	Y	Z
Propeller	Pressure Force	-4.2e+01	-1.0e-01	-2.8e-02
	Viscous Force	-5.8e-02	1.2e-03	4.8e-03
	Total Force	-4.2e+01	-9.8e-02	-2.3e-02
	Pressure Torque	-1.2e+00	2.7e-03	-4.6e-03
	Viscous Torque	9.6e-05	-1.4e-04	5.0e-05
	Total Torque	-1.2e+00	2.6e-03	-4.5e-03

Table 2. Forces and Torques for transient simulation

Location	Type	X	Y	Z
Propeller	Pressure Force	-4.24e+01	-8.97e-02	7.30e-02
	Viscous Force	-5.49e-02	8.32e-03	-3.08e-03
	Total Force	-4.24e+01	-8.14e-02	6.99e-02
	Pressure Torque	-1.28e+00	-9.03e-04	-9.72e-03
	Viscous Torque	-5.26e-05	8.17e-05	1.32e-04
	Total Torque	-1.28e+00	-8.21e-04	-9.58e-03

We can see that the values calculated for the same parameters are different between the two simulations. In the 6th table there are determined the deviation of the determined values, expressed in percents.

Table 3 – Values deviation for the calculated parameters

Location	Type	X	Y	Z
Propeller	Pressure Force	0%	-10%	-354%
	Viscous Force	-6%	555%	-164%
	Total Force	0%	-17%	-392%
	Pressure Torque	0%	-132%	109%
	Viscous Torque	-154%	-158%	164%
	Total Torque	0%	-131%	109%

These differences are established due to the convergence criteria and because in the first simulation, the static one, the flow is related to an indefinite period of time; on the other hand in the transient simulation case, the flow is defined for a specific period of time.

In the following figures are presented the charts for pressure and velocity development during the simulation in several reference planes (xOy and xOz).

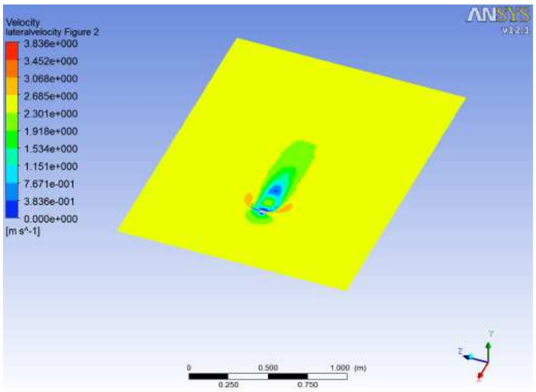


Figure 6 - The velocity in horizontal plane – static simulation

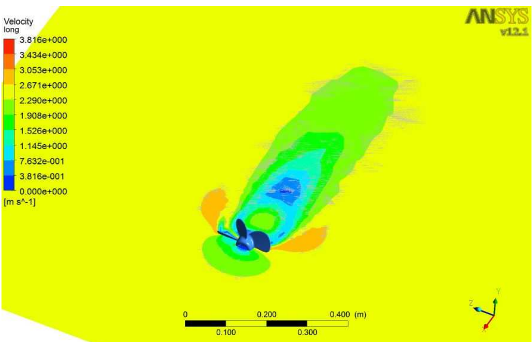


Figure 7 - The velocity in horizontal plane – transient simulation

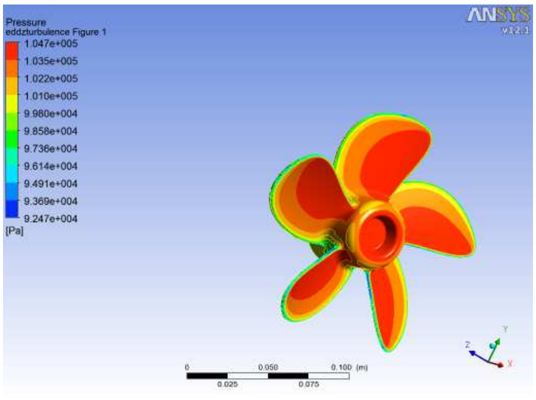


Figure 8 – Pressure profile on the propeller's surface – static simulation

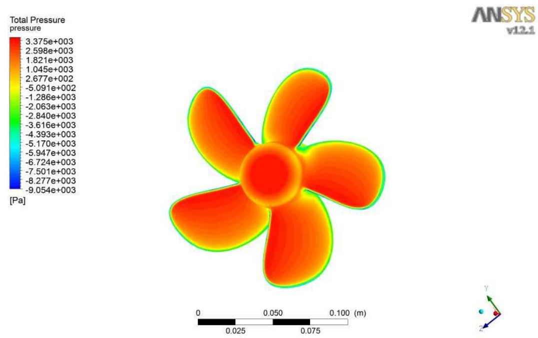


Figure 9 – Pressure profile on the propeller's surface place – transient simulation

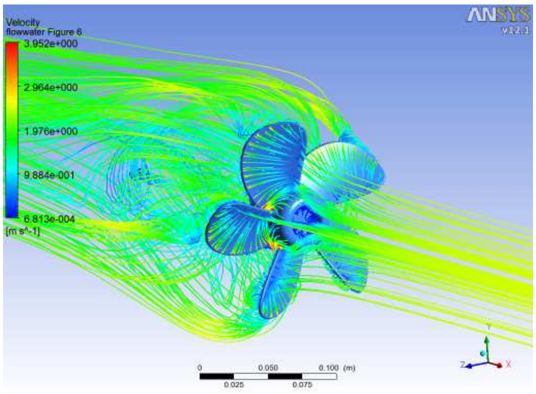


Figure 10 – Flow development – static simulation

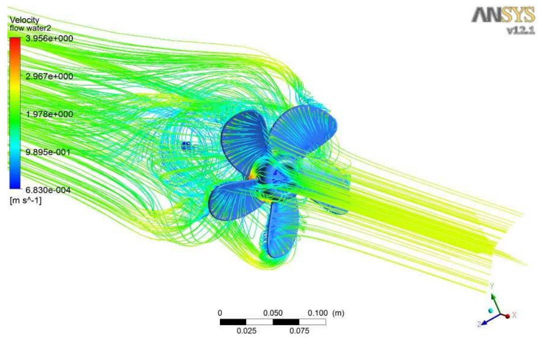


Figure 11 – Flow development – transient simulation

9. CONCLUSIONS

When analysing the obtained results and the differences between them, there can be concluded that the flow profile and the velocity mapping in different planes are following the same patterns for the both simulations

The time dependence of the flow characteristics can be specified as either steady state or transient. Steady state simulations, by definition, are those whose characteristics do not change with time and whose steady conditions are assumed to have been reached after a relatively long time interval. They therefore require no real time information to describe them.

Transient simulations require real time information to determine the time intervals at which the CFX Solver calculates the flow field. Transient behavior can be caused by the initially changing boundary conditions of the flow, as in start-up, or it can be inherently related to the flow characteristics, so that a steady state condition is never reached, even when all other aspects of the flow conditions are unchanging.

Usually, when modelling the flow over a propeller we cannot consider that, eventually, the flow will become steady, due to the fact that there will be always fully developed vortices that will not have a stable position.

During the steady state calculation there can be seen oscillatory behaviour of the residual plots, which indicates a transient problem

10. REFERENCES:

[1] Van, S.H., Kim, W.J., Kim, D.H., Yim, G.T., Lee, C.J., and Eom, J.Y., 1997, "Measurement of flows around a 3600TEU Container Ship Model," Proceedings of the Annual Autumn Meeting, SNAK, Seoul, pp. 300-304 (in Korean).

[2] Lee, J., Lee, S.J., and Van, S.H., 1998, "Wind Tunnel Test on a Double Deck Shaped Ship Model," 3rd International Conference on Hydrodynamics, Seoul, Korea.

[3] Van, S.H., Kim, W.J., Yim, G.T., Kim, D.H., and Lee, C.J., 1998, "Experimental Investigation of the Flow Characteristics Around Practical Hull Forms," Proceedings 3rd Osaka Colloquium on Advanced CFD Applications to Ship Flow and Hull Form Design, Osaka, Japan

[4] Fujisawa, J., Ukon, Y., Kume, K., and Takeshi, H., "Local Velocity Field Measurements around the KCS Model (SRI M.S.No.631) in the SRI 400m Towing Tank," Ship Performance Division Report No. 00-003-02, The Ship Research Institute of Japan, April 27, 2000. SPD Report No. 00-003-02

[5] Tsukada, Y., Hori, T., Ukon, Y., Kume, K., and Takeshi, H., SPD Report No. 00-004-01

[6] Kume, K., Ukon, Y., Fujisawa, J., Hori, T., Tsukada, Y., and Takeshi, H., "Uncertainty Analysis for the KCS Model (SRI M.S.No.631) Test in the SRI 400m Towing Tank," Ship Performance Division Report No. 00-008-01, The Ship Research Institute of Japan, June 1, 2000. SPD Report No. 00-008-01

[7] www.simman2008.dk

[8] ANSYS Inc, ANSYS CFX-Solver Theory Guide, November 2011

[9] Dmitriy Ponkratov, Marine Computational Fluid Dynamics for engineering applications - course handbook, Høgskolen i Ålesund, 2011

[10] J. Bardina, J. Ferziger, W. Reynolds, Improved subgrid-scale models for large-eddy simulation, Chapter DOI: 10.2514/6.1980-1357

GAIN PRACTICE MAINTENANCE EVALUATION FOR A NAVAL BOILER

[1]BUS CAMELIA-GABRIELA , [2]COSTEA MARIUS-AUREL , [3]BOCANETE PAUL, [4]CARLAN MILTIADE

[1]Ministry of Transport, [2] Lumina -The University of South- East Europe, [3]Maritime University of Constanta, [4] S.C. Formenerg S.A., Romania

ABSTRACT

This paper present an evaluation method for the average temperature difference at a heat exchanger (naval boiler), considering the specific contribution of its main parameters: the maximum heat difference and the minimum heat difference. In order to determine the average temperature difference, a nomogram was built; also, in order to quantify the contribution of the weighting coefficients we propose the use of a table (table 4). This paper can be useful to the exploitation staff working with the heat delivering equipments in order to adopt an optimum operational regim and also to the maintenance staff having the responsability to rehabilitate the composing circuits of various equipments and installations. Therefore, by making a differentiation between the contributions of the main parameters, minimum/maximum differences, on the average temperature difference Δt_{med} , both the user and the maintenance activity perceive this method as a useful tool.

Keywords: *Counter-currents apparatus, Mean difference of temperature, The maximum/minimum difference, Growing exponent, The contribution of maintenance give by the I_M indicator.*

1. INTRODUCTION

Heat Exchangers (boiler) have the purpose of transmitting a quantity of thermal energy at level of temperatures given to a cold agent. The primary agent heater, can be: steam, hot water, burning gases, lubrication oil- cooling of the rotary car camps. Apparatuses of heat exchangers can be: cooling, heating, regenerating, recovering, boilers, etc. Concerning the circulation of thermal agents, it can be found the following types: equal-current, counter-current, mixed.

The quantity of thermal energy transmitted by a heat exchanger (boiler) to a cold agent it is given by the relation:

$$Q' = k \cdot S \cdot \Delta t_{med} \tag{1}$$

where: Q is transmitted thermal energy - W; k - global coefficient of heat exchange – W/m^2 , S – heat exchange surface - m^2 and Δt_{med} - mean difference of temperature - ${}^0C$:

$$\Delta t_{med} = \frac{\Delta t_M - \Delta t_m}{\ln \frac{\Delta t_M}{\Delta t_m}} \tag{2}$$

where Δt_M and Δt_m represents the maximum/minimum difference of temperature in the heat exchanger (boiler) apparatus. Figure 1 and figures 2a, 2b and 2c, give the types of heat exchangers frequently used:

A. Equivalent heat exchanger,

For this type of heat exchanger:

$$\Delta t_M = t_1^{'} - t_2^{'} \tag{3}$$

$$\Delta t_m = t_1^{''} - t_2^{''} \tag{4}$$

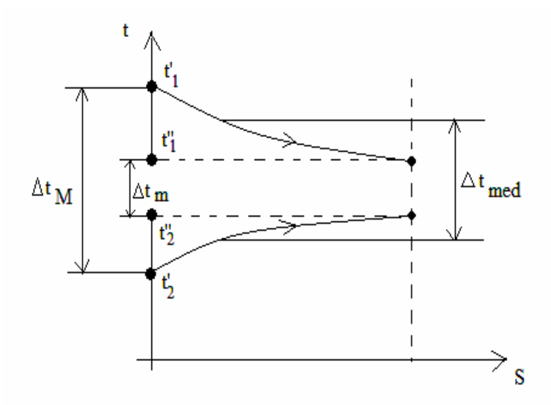


Figure 1 Heat exchanger

B. Counter-current heat exchanger:

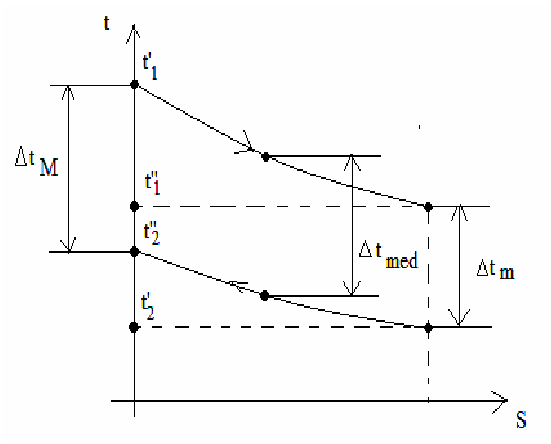


Figure 2a Heat exchanger

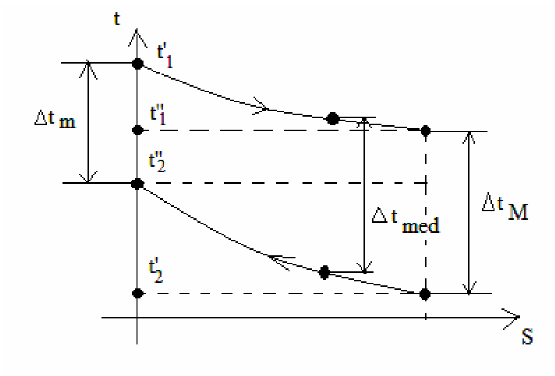


Figure 2b Heat exchanger

Also, are found vaporizer heat exchanger in figure 3 and condenser type in figure 4:

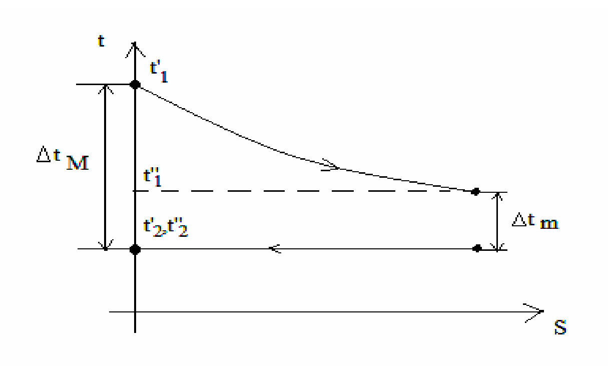


Figure 3 Vaporizer

$$\Delta t_M = t_1^{'} - t_2^{'}, t_2^{''} \qquad (5)$$

$$\Delta t_m = t_1^{''} - t_2^{'}, t_2^{''} \qquad (6)$$

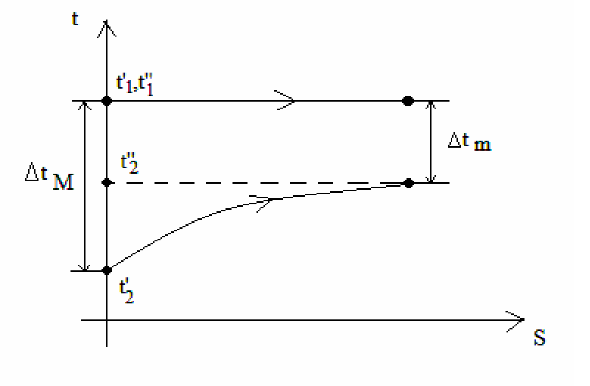


Figure 4 Condenser

$$\Delta t_M = t_1^{'}, t_1^{''} - t_2^{'} \qquad (7)$$

$$\Delta t_m = t_1^{'}, t_1^{''} - t_2^{''} \qquad (8)$$

For constructive-functional structures regarding other types of heat exchangers are recommended the studies [1] and [2]. In the followings, we will refer only to the mentioned heat exchangers: equal-current and counter-current. Regarding the mean difference of temperature the most important characteristic of a thermal transfer apparatus, it can be used the following relations [3]:

- for the rapport

$$q = \frac{\Delta t_M}{\Delta t_m} \in (1;2] \qquad (9)$$

$$\Delta t_{med} = \frac{\Delta t_M + \Delta t_m}{2} \qquad (10)$$

- for the rapport

$$q = \frac{\Delta t_M}{\Delta t_m} \in (2;4,8] \qquad (11)$$

$$\Delta t_{med} = 0,4\Delta t_M + 0,6\Delta t_m \qquad (12)$$

A higher precision degree it can be obtained with the relation:

$$\Delta t_{med} = \frac{1}{3}\left(\frac{\Delta t_M + \Delta t_m}{2} + 2\sqrt{\Delta t_M \cdot \Delta t_m}\right) \qquad (13)$$

Relation valid for the case:

$$q = \frac{\Delta t_M}{\Delta t_m} \leq 10 \qquad (14)$$

For other types of heat exchangers (criss-crossed current, mixed) are recommended various methods in the mentioned studies.

In the followings, we will refer to the first two categories of heat exchangers: counter-current and equal-current.

2. THE CALCULATION OF THE CONTRIBUTION OF MEASURES Δt_M, Δt_m OVER THE MEAN DIFFERENCE OF TEMPERATURE

The importance of resolving this kind of problem finds his answer in the need to mark out, in a distinct way, the influence of measures delta, over the fundamental characteristic of a thermal transfer apparatus. In the study [4] were presented some techniques regarding the resolving of this kind of problem. To those shown, we will get back with some affix, as well as to other techniques of operative calculus.

The proposed regression method

We consider the regression equation as a Cabb-Douglas type function as presented in [5]:

$$\Delta t_{med} = \Delta t_M^{\alpha} \cdot \Delta t_m^{\beta} \qquad (15)$$

α, β being growing exponents:

$$\alpha + \beta = 1 \qquad (16)$$

So:

$$\beta = 1 - \alpha \qquad (17)$$

In the relation (15) becomes:

$$\Delta t_{med} = \left(\frac{\Delta t_M}{\Delta t_m}\right)^{\alpha} \cdot \Delta t_m \qquad (18)$$

Considering the expression used to obtain the average temperature difference (2), the following identity is obtained:

$$\frac{\Delta t_M - \Delta t_m}{\ln \dfrac{\Delta t_M}{\Delta t_m}} = \left(\frac{\Delta t_M}{\Delta t_m}\right)^{\alpha} \cdot \Delta t_m \qquad (19)$$

Calculating according to (19), the expression of the weighting coefficient is obtained α :

$$\alpha = \frac{\ln \dfrac{\dfrac{\Delta t_M}{\Delta t_m} - 1}{\ln \dfrac{\Delta t_M}{\Delta t_m}}}{\ln \dfrac{\Delta t_M}{\Delta t_m}} \qquad (20)$$

The method based on marginal calculus

According to this method results:

$$\alpha = \frac{\delta \Delta t_M}{\delta \Delta t_M + \delta \Delta t_m} \qquad (21)$$

where:

$$\delta \Delta t_M = \Delta t_{med}(\Delta t_M(1+h); \Delta t_m) - \Delta t_{med}(\Delta t_M, \Delta t_m) \qquad (22)$$

$$\delta \Delta t_m = \Delta t_{med}(\Delta t_M; (1+h)\Delta t_m) - \Delta t_{med}(\Delta t_M, \Delta t_m) \qquad (22')$$

h being a no dimension measure sufficiently small in frequent way , $h = 0{,}1$.

The method based on Taylor series development

According to [5] we deduce the expression of the growing exponent α:

$$\alpha = \frac{q \ln q - (q-1)}{(q-1)\ln q} \qquad (23)$$

The Gregory-Newton method based on finite regressive difference [6]

The calculation of the parameter α it is made on a known support, determined on basis of minimization of four values of this parameter, corresponding to four equal distance levels of the measure q:

$$q = \frac{\Delta t_M}{\Delta t_m} \qquad (24)$$

For solving the problem we construct table 1:

Table 1

k	q_k	$\alpha(q_k)$	∇_k^1	∇_k^2	∇_k^3
0	q_0	$\alpha(q_0)$	-	-	-
1	q_1	$\alpha(q_1)$	$\Delta^1(q_1)$	-	-
2	q_2	$\alpha(q_2)$	$\Delta^1(q_2)$	$\Delta^2(q_2)$	-
3	q_3	$\alpha(q_3)$	$\Delta^1(q_3)$	$\Delta^2(q_3)$	$\Delta^3(q_3)$

where:

$$\begin{cases} \Delta^1(q_1) = \alpha(q_1) - \alpha(q_0) \\ \Delta^1(q_2) = \alpha(q_2) - \alpha(q_1) \\ \Delta^1(q_3) = \alpha(q_3) - \alpha(q_2) \\ \Delta^2(q_2) = \Delta^1(q_2) - \Delta^1(q_1) \\ \Delta^2(q_3) = \Delta^1(q_3) - \Delta^1(q_2) \\ \Delta^3(q_3) = \Delta^2(q_3) - \Delta^2(q_2) \end{cases} \qquad (25)$$

The errors decrease as the number of [$q_k ; \alpha(q_k)$] pairs increases.

Case study 1

We consider the next values – table 2.

Table 2

q_k	1,2	3,2	5,2	7,2
$\alpha(q_k)$	0,510	0,548	0,567	0,580

According to those mentioned we can built table 3.

Table 3

k	q_k	$\alpha(q_k)$	∇^1	∇^2	∇^3
0	1,2	0,510	-	-	-
1	3,2	0,548	0,038	-	-
2	5,2	0,567	0,019	-0,019	-
3	7,2	0,580	0,013	-0,006	0,013

The first values –on column- from the table we give the finite regressive differences:

$\nabla^1 = 0{,}038$, $\nabla^2 = -0{,}019$ and $\nabla^3 = 0{,}006$.

An intermediary value $\alpha(q_k)$ it is deduced with the relation:

$$\alpha(q_k) = \alpha(q_0) + U\nabla^1 + \frac{U(U-1)}{2!}\nabla^2 + \frac{U(U-1)(U-2)}{3!}\nabla^3 + ... \qquad (26)$$

where

$$U = \frac{q_k - q_0}{l} \tag{27}$$

step:

$$l = q_{k+1} - q_k \ ; \ l = 2 \tag{28}$$

Being $\alpha\left(q = 4{,}2\right)$

results $U = \frac{4{,}2 - 1{,}2}{2} \Rightarrow U = 1{,}5$

according to (26) we can deduce that:

$$\alpha\left(4{,}2\right) = 0{,}510 + 1{,}5 \cdot 0{,}038 + \frac{1{,}5(1{,}5-1)}{2!}(-0{,}019)$$

$$+\frac{1{,}5(1{,}5-1)(1{,}5-2)}{3!} \cdot 0{,}13$$

and calculating we obtain:

$$\alpha\left(4{,}2\right) = 0{,}559 \ .$$

Checking,
Being:

$$\Delta t_M = 105^0 C \ ,$$

$$\Delta t_m = 25^0 C$$

According to the classical metod – expression (2), the result is:

$$\Delta t_{med} = \frac{105^0 C - 25^0 C}{\ln \frac{105^0 C}{25^0 C}} \Rightarrow \Delta t_{med} = 55{,}746^0 C$$

By using the relations (15) and (16) the following results are obtained:

$$\Delta t_{med} = 105^{0{,}559} \cdot 25^{0{,}441} \Rightarrow$$

$$\Delta t_{med} = 13{,}485 \cdot 4{,}135 \Rightarrow \Delta t_{med} = 55{,}760^0 C$$

So an error comparative with the “classic” method, $\varepsilon < 0{,}03\%$ - practically insignificant. Also, using the relation (20) we can deduce that:

$$\alpha\left(4{,}2\right) = \frac{\ln \frac{4{,}2 - 1}{\ln 4{,}2}}{\ln 4{,}2} = 0{,}558855 \ ,$$ the error being : $\varepsilon < 0{,}026\%$.

The proposed table, table 4, gives the values of α coefficient and figure 6 presents the nomogram proposed for the determination of the average temperature difference. The values of α coefficient influenced by:

$$q = \frac{\Delta t_M}{\Delta t_m} \ .$$

Table 4

i	q_i	α_i	i	q_i	α_i
1	1,2	0,510	20	6,5	0,575
2	1,4	0,513	21	7,0	0,579
3	1,6	0,520	22	7,5	0,581
4	1,8	0,524	23	8,0	0,583
5	2,0	0,529	24	8,5	0,586
6	2,2	0,534	25	9,0	0,587
7	2,4	0,537	26	9,5	0,590
8	2,6	0,540	27	10,0	0,592
9	2,8	0,542	28	11,0	0,595
10	3,0	0,544	29	12,0	0,598
11	3,2	0,548	30	13,0	0,601
12	3,4	0,550	31	14,0	0,604
13	3,6	0,553	32	15,0	0,606
14	3,8	0,556	33	16,0	0,609
15	4,0	0,557	34	17,0	0,611
16	4,5	0,562	35	18,0	0,613
17	5,0	0,565	36	19,0	0,615
18	5,5	0,569	37	20,0	0,617
19	6,0	0,573	38	25,0	0,624

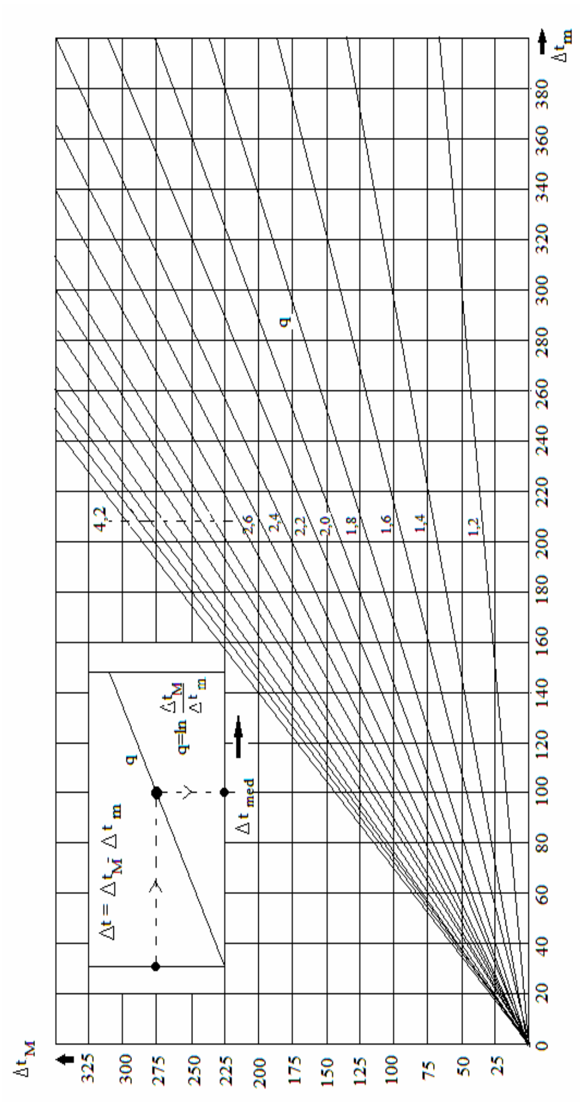


Figure 6 Average temperature difference

3. THE CONTRIBUTION OF MAINTENANCE OVER THE MEAN DIFFERENCE OF TEMPERATURE

Being $$\Delta t_{med}(0) = \frac{\Delta t_M(0) - \Delta t_m(0)}{\ln \dfrac{\Delta t_M(0)}{\Delta t_m(0)}}$$

where $\Delta t_{med}(0), \Delta t_M(0), \Delta t_m(0)$ are the measures entailed before we make maintenance operations at a heat exchanger (boiler). As a consequence to the corrective works made, the measures $\Delta t_M, \Delta t_m$ were increased $r\%$ respective 5%, which means that the mean difference of temperature in an upgrade version becomes:

$$\Delta t_{med}(m) = \frac{\Delta t_M\left(1+\dfrac{r}{100}\right) - \Delta t_m\left(1+\dfrac{5}{100}\right)}{\ln \dfrac{\Delta t_M\left(1+\dfrac{r}{100}\right)}{\Delta t_m\left(1+\dfrac{5}{100}\right)}} \tag{29}$$

The contribution of maintenance over the operational potential of an equipment submitted to a corrective work will be:

$$I_M = \frac{\Delta t_{med}(m)}{\Delta t_{med}(0)} \cdot 100 \tag{30}$$

I_M is a maintenance efficiency assesment index.

Case study 2

Being: $\Delta t_M(0) = 84^0 C$, $\Delta t_m(0) = 24^0 C$, $\Delta t_M(m) = 93^0 C$; $\Delta t_m(m) = 26^0 C$, results:

$$q(0) = \frac{\Delta t_M(0)}{\Delta t_m(0)} = \frac{84}{24} = 3{,}5;$$

$\alpha(0) = 0{,}5515$ - according to table 4.

We obtain (using the expression 15):

$$\Delta t_{med(0)} = 84^{0{,}5515} \cdot 24^{0{,}4485} \Rightarrow \Delta t_{med(0)} = 47{,}9^0 C;$$

$$q(m) = \frac{\Delta t_M(m)}{\Delta t_m(m)} = \frac{93}{26} = 3{,}6;$$

$\alpha(m) = 0{,}553$ - according to table 4.

We can infer that:

$$\Delta t_{med(m)} = 93^{0{,}553} \cdot 26^{0{,}447} \Rightarrow \Delta t_{med(m)} = 52{,}6^0 C;$$

The same values $\Delta t_{med(0)}, \Delta t_{med(m)}$ are obtained usong the classical expression (2). The maintenance efficiency index is $I_M = 1{,}098$, which represents an increase by 9,8%.

4. CONCLUSIONS

The contribution of the maximum temperature difference over the determined parameter, the average temperature difference, for a heat transfer equipment (naval boiler), increases as the minimum temperature difference decreases.

It was shown that the contribution is superior to that corresponding to the minimum temperature difference; this is confirmed by the values of the complementary weighting coefficients, associated to the minimum/maximum temperature differences.

The paper presents proposes some methods to maximum temperature difference and implicitly its complementary, the one associated to the minimum difference as follows:
-a parabolic (regression) method;
-two methods proposed by one of the authors [5]: the method based on marginal calculus and the one based on Taylor series;
-the Gregory-Newton method, adapted to evaluate the contribution of the maximum temperature difference.

The nomogram (fig. 6) and table 4 are designed to ease the process of obtaining the results of the presented problem.

5. REFERENCES

[1] Leca A., " *Ridicarea eficienței aparatelor schimbătoare de căldură"(Lifting equipment efficiency heat exchangers)*. Editura Tehnică, Bucureşti, 1978.
[2] Popa, B., Carabogdan, I., "*Manualul inginerului termotehnician"(Engineer user manual termotehnician)*. Editura Tehnică, București, 1986.
[3] Leca, A., (coordonator), "*Centrale electrice. Probleme"(Electrical stations. Problems)*. Editura Didactică şi Pedagogică,1977.

[4] CÂRLAN M., “*Un indicator al calității lucrărilor de mentenanță*”(*An indicator of the quality of maintenance*). Rev. Producerea, Transportul şi Distribuția energiei electrice şi termice, Bucureşti 1997.
[5] CÂRLAN M., BENDEA C., “*Aportul calității mentenanței asupra diferenței medii de temperatură la un aparat de transfer de căldură*” (*Quality maintenance contribution on average temperature difference in a heat transfer device*). Rev. Tehnologiile Energiei, Bucure□ti, 2009.
[6] Salvadori M.G., Baron M.L., “*Metode numerice în tehnică*” (*Numerical methods in technical*). Traducere din lb. engleză. Editura Tehnică, Bucureşti, 1972.

DETERMINATION OF INERTIA FORCES ACTING ON BREAK BULK CARGO EN ROUTE

CHEPOK OLEKSII

Odessa National Maritime Academy, Ukraine

ABSTRACT

The paper presents the analytical method of defining inertia forces that act on break bulk cargo as a result of the oscillatory motion of the vessel exposed to the effect of ambient forces. Considering that the linear models of roll, pitch and heave applicable in this case, the problem is solved by expressing the angle of heel, the angle of pitch, and the amplitude of heave. The obtained functions are differentiated and the inertia forces are determined by means of applying the Newton's second law.

Keywords: *ship oscillations, forced oscillations, forces of inertia, break bulk cargo, linear models of oscillations, decoupled differential equations.*

1. INTRODUCTION

In the sea transportation of break bulk cargo, particularly that of the non-standard dimensions, both the weight of each load and the acting forces of inertia should be considered when designing the securing arrangement of the cargo. The inertia forces can be evaluated once the linear accelerations affecting the cargo are known, which depend on the laws of linear displacement changes for the cargo and the deck of the vessel relative to the reference coordinate system.

Generally the oscillatory motion of the ship is characterized by six degrees of freedom and is described by six differential equations. The ship oscillations are strongly coupled [1]. It is shown in [2] that one can apply the linear models of roll, pitch and heave to obtain the linear acceleration in the first approximation, i.e. use the corresponding isolated equations for the calculation.

To be able to find the inertia forces acting on a cargo item in an inertial reference frame it is enough to apply the Newton's second law, provided that the mass of the unit and the respective accelerations are known. The accelerations can be found as the second time derivatives of the angle of heel, the angle of pitch, and the amplitude of heave functions.

The expressions for the angles and the amplitude can be obtained by solving the equations for roll, pitch, and heave. This is done on the assertion that for the task of finding the forces of inertia the equations for roll, pitch, and heave can be considered decoupled [3].

2. PARAMETERS OF OSCILLATIONS

2.1. Roll

As roll is the governing factor and generates dominant forces of inertia further considerations proceed with the equation that define roll solving the problem so as to find the expression for the angle of heel θ. For this, as suggested in [4], we use the original second-order linear differential equation that defines the roll angle of a vessel *θ:*

$$(J_x + m_x)\ddot{\theta} + \mu_x\dot{\theta} + Dh_0\theta = \chi_\theta Dh_0 \sin\omega_k t \qquad (1)$$

where J_x = moment of inertia of the vessel about the longitudinal axis X-X; m_x = generalized added masses of water about the longitudinal axis X-X; μ_x = damping coefficient about the longitudinal axis X-X; D = displacement of the vessel (force of gravity); h_0 = transverse initial meta-centric height; χ_θ = reduction coefficient for the roll oscillations; ω_k = the apparent frequency of the waves.

After dividing the equation (1) by the coefficient of the highest derivative we obtain the normalised form of the equation:

$$\ddot{\theta} + 2h\dot{\theta} + \omega_0^2\theta = \chi_\theta\omega_0^2 \sin\omega_k t \qquad (2)$$

where roll damping coefficient *h*:

$$h = \frac{\mu_x}{2(J_x + m_x)}$$

and eigenfrequency of the rolling vessel ω_0:

$$\omega_0^2 = \frac{Dh_0}{(J_x + m_x)}$$

The expression (2) is a linear non-homogeneous differential equation with constant coefficients, and its solution is the sum of a particular solution θr, which describes the forced oscillation of the vessel about the axis X-X influenced by the regular waves, and the solutions of the corresponding homogeneous equation, which describes own damped oscillations of the ship.

Since the amplitude of the vessel's own damped oscillations turns to zero rather quickly, the equation of roll, as a stationary process, according to [4] can be described as forced oscillations only, i.e.:

$$\theta = \frac{\chi_\theta \omega_0^2}{\left[\left(\omega_0^2 - \omega_k^2\right)^2 + 4h^2\omega_k^2\right]^{0,5}} \times \\ \times \sin\left[\omega_k t - arctg\left(\frac{2h\omega_k}{\omega_0^2 - \omega_k^2}\right)\right] \quad (3)$$

2.2. Pitch

Similarly to the case of roll, as it was demonstrated in the works [3, 4] ship performs forced oscillations with the frequency of ω_k while pitching. The isolated equation of longitudinal pitching, as well as its solution, has structure similar to the structure of the transverse rolling equation, i.e. describes not only the vessel's own damped oscillations, but also the forced harmonic oscillations with the pitch frequency. This way the expression that defining the current angle of trim β is similarly characterized by the induced harmonious vibrations with the pitch frequency ω_k:

$$\beta = \frac{\chi_\beta \omega_{0\beta}^2}{\left[\left(\omega_{0\beta}^2 - \omega_k^2\right)^2 + 4h_\beta^2\omega_k^2\right]^{0,5}} \times \\ \times \sin\left[\omega_k t - arctg\left(\frac{2h_\beta\omega_k}{\omega_{0\beta}^2 - \omega_k^2}\right)\right] \quad (4)$$

where χ_θ = reduction coefficient for the roll oscillations; ω_k = eigenfrequency of the pitching vessel; h_β = pitch damping coefficient.

2.3. Heave

Finally, heave is the result of the orbital motion of the vessel on a radius equal to the half of the wave height [3, 5]. Heave motion ζ has harmonic character with the frequency of oscillations ω_k and can be described as follows:

$$\zeta = \zeta_0 \sin(\omega_k t) \quad (5)$$

where ζ_0 = amplitude of the vertical motion induced by the waves with the height of h_w:

$$\zeta_0 = 0,5h_w \quad (6)$$

3. FORMULATING THE INERTIA FORCES

The resulting expressions (3), (4) and (5) allow us to calculate the angular accelerations of the roll and pitch, the linear acceleration and inertia forces acting on the cargo. From this we find the inertia forces induced by roll, pitch and heave that act on a cargo unit with the mass m_c.

The most substantial is the lateral force of inertia of the roll F_θ. It is obvious that:

$$F_\theta = -m_c a_y$$

where a_y = linear acceleration due to roll.

In its turn, the linear acceleration a_y is the product of the angular acceleration $\ddot{\theta}$ by the radius of curvature r_y relative to the longitudinal axis passing through the center of gravity of the vessel G, i.e.:

$$a_y = r_y\ddot{\theta}$$

Thus finding the angular acceleration $\ddot{\theta}$ as the second derivative of the roll angle by differentiating twice the expression (3) yields:

$$\ddot{\theta} = -\theta_0\omega_k^2\sin(\omega_k t - \psi)$$

where

$$\theta_0 = \frac{\chi_\theta \omega_0^2}{\left[\left(\omega_0^2 - \omega_k^2\right)^2 + 4h^2\omega_k^2\right]^{0,5}}$$

$$\psi = arctg\left(\frac{2h\omega_k}{\omega_0^2 - \omega_k^2}\right)$$

Successively the inertia force F_θ is defined as:

$$F_\theta = m_c r_y \theta_0 \omega_k^2 \sin(\omega_k t - \psi) \quad (7)$$

The longitudinal force F_β can be derived in much the same way, i.e.

$$F_\beta = -m_c a_x$$

where a_x = linear acceleration due to pitch.

The linear acceleration in this case is

$$a_x = r_x\ddot{\beta}$$

where r_x = radius of curvature relative to the transverse axis. The angular acceleration $\ddot{\beta}$ can be obtained by differentiating the expression (4) twice:

$$\ddot{\beta} = -\beta_0\omega_k^2\sin(\omega_k t - \psi_\beta)$$

$$\beta_0 = \frac{\chi_\beta \omega_{0\beta}^2}{\left[\left(\omega_{0\beta}^2 - \omega_k^2\right)^2 + 4h_\beta^2\omega_k^2\right]^{0,5}}$$

$$\psi_\beta = arctg\left(\frac{2h_\beta\omega_k}{\omega_{0\beta}^2 - \omega_k^2}\right)$$

Therefore the force of inertia F_β is represented by the equation:

$$F_\beta = m_c r_x \beta_0 \omega_k^2 \sin(\omega_k t - \psi_\beta) \quad (8)$$

As the heaving force of inertia

$$F_\zeta = -m_c \ddot{\zeta}$$

then the linear acceleration $\ddot{\zeta}$ we get as the second derivative of the expression (5):

$$\ddot{\zeta} = -\zeta_0 \omega_k^2 \sin(\omega_k t)$$

Then, taking into account equation (6) we finally put F_ζ as:

$$F_\zeta = 0{,}5 h_w m_c \omega_k^2 \sin(\omega_k t) \quad (9)$$

It is to be noted that the inertia forces F_θ, F_β, and F_ζ were obtained with the reference to the unperturbed system of coordinates (Figure 1).

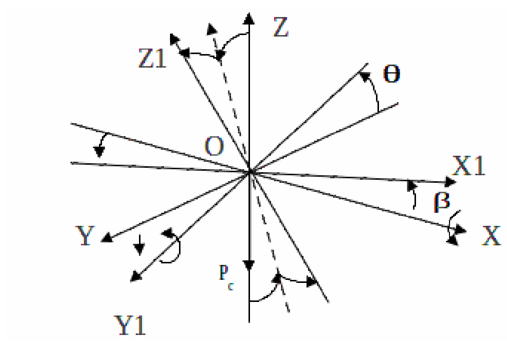


Figure 1 Frame of axes referenced to the unperturbed system of coordinates

Then in order to be able to calculate the reactions in lashings of the cargo these inertial forces and the force of gravity P_c must be projected on to the ship's frame of axes which is inclined by the angles of heel θ and trim β.

4. CONCLUSIONS

The article describes the method of deriving the inertia forces acting on a cargo unit so these forces can be accounted for in further calculations to determine the maximum working load of lashings for the cargo. The method is based on the presumption that the linear models of roll, pitch and heave are sufficient for the case and can be considered independent within the scope of the problem.

The resulting expressions of the angle of heel, the angle of trim and the amplitude of vertical motion induced by waves allow calculating the respective angular and linear accelerations. The inertia forces determined in the unperturbed reference frame can be easily ported to the ship's system of coordinates as the relation between the two systems of coordinates is known.

Functions obtained are consequently used by author in his mathematical model describing the process of safe stowage and lashing of break bulk cargo on board a ship.

5. REFERENCES

[1] KORNEV N., *Ship dynamics in waves*, University of Rostock, 2011
[2] BORODAJ I.K., NECVETAEV Ju.A., *Kachka sudov na morskom volnenii*, L.: Sudostroenie, 1969
[3] SIZOV V.G., *Teorija korablja*, Odessa: Feniks, 2003
[4] VOJTKUNSKIJ I.Ja., *Statika sudov. Kachka sudov. Spravochnik po teorii korablja*, L.: Sudostroenie, 1985
[5] SHIMANSKIJ Ju.A., *Dinamicheskij raschet sudovyh konstrukcij*, L.: Sudpromgiz, 1948

CAVITATION EROSION RESEARCH ON X3CrNi13-4 STAINLESS STEEL SAMPLES WITH CUBIC/CYLINDRICAL SHAPE AND 3D DESIGN FOR NEW BRACKETS USED FOR THE CAVITATION EXPERIMENTAL STAND

[1]CHIRUS DANIEL, [2]NEDELONI MARIAN-DUMITRU, [3]CAMPIAN CONSTANTIN-VIOREL

[1,2,3]*„Eftimie Murgu" University of Resita, Romania*

ABSTRACT

This paper presents results obtained from cavitation erosion research of X3CrNi13-4 martensitic stainless steel. This steel was tested through the stationary specimen method, where was used a bracket (support) for work samples (specimens) with 4 screws. Because this bracket deteriorates the samples, three new models of brackets were designed using a CAD software (SolidWorks). These new models can be used for laboratory future research of the cavitation erosion resistance of materials.

Keywords: *cavitation erosion, X3CrNi13-4 stainless steel, CAD software, 3D brackets, design.*

1. INTRODUCTION

The paper is focused on researches of the cavitation erosion resistance of the of X3CrNi13-4 stainless steel. This steel is used for the manufacturing of rotor blades of the hydraulic turbine from some hydro-power plants of Romania [1, 2, 3, 4].

From a sample of this stainless steel were taken four batches with small different chemical compositions, so the results of investigation are different from each other, with different mass losses of material.

The results of the research are intended to be checked also in analytical form and also are desired to be presented new solutions to improve brackets used in for the clamping of the samples.

2. WORK PROCEDURE AND EXPERIMENTAL RESULTS

The four batches (Fig. 1) belonging to the X3CrNi13-4 martensitic stainless steel, were processed as samples to be tested in the laboratory on the cavitation stand.

Four samples were obtained (Fig. 2) from the batches, as follows: the first sample has a cubic shape of 16 mm, and the remaining three samples have a cylindrical shape of Φ16 x 10 mm.

Each of the four samples was tested in a first phase of the ASTM G-32 cavitation test for a total cumulative time of 180 minutes (Fig. 3) respectively of 1080 minutes (Fig. 4).

The cavitation experimental stand consists of the following components:

- ultrasonic generator;
- piezoelectric converter;
- mechanical transformer (booster);
- sonotrode;
- samples of the X3CrNi13-4 stainless steel;
- cooling coil;
- liquid vessel, in which it is immersed the test sample in distilled water at 25 ± 2°C;
- digital thermometer for measuring and checking the test temperature.

The stand is shown in Figure 5. The stationary specimen method [5, 6] was used. The working parameters was: frequency f=20 ± 0,5 kHz and amplitude (peak to peak) A=50 μm.

The chemical composition of the 4 batches of X3CrNi13-4 stainless steel is shown in Table 1 and in figure 6. The mass loss and the cavitation erosion rate average value of the tested samples are shown in Table 2 (graphically in figures 7 and 8).

Table 3 shows the mass loss values calculated by analytic relationship [7]:

$$M_{anl} = \frac{Ave_{vec}}{No_{per}} \cdot Tot_{time} \text{ [mg]} \tag{1}$$

Where:

M_{anl} is the mass loss in analytical form;

Ave_{vec} is the average of cavitation erosion rate expressed in [mg/min];

No_{per} is the number of the test periods with the value 14 or 37;

Tot_{time} is the total cumulative time with the value 180 or 1080 minutes;

Table 4 shows the absolute and relative error values calculated by the relations [7]:

$$\Delta M = \left| M_{exp} - M_{anl} \right| \text{ [mg]} \tag{2}$$

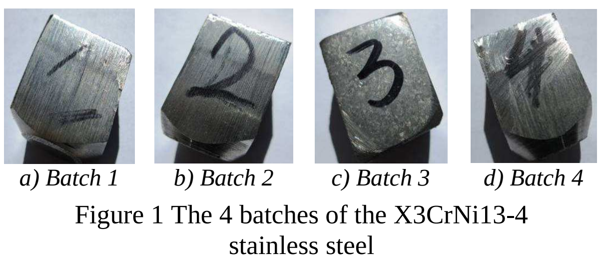
$$\Delta M_{rel} = \frac{\Delta M}{M_{exp}} \cdot 100 \text{ [\%]} \tag{3}$$

Where:

ΔM is the absolute error;

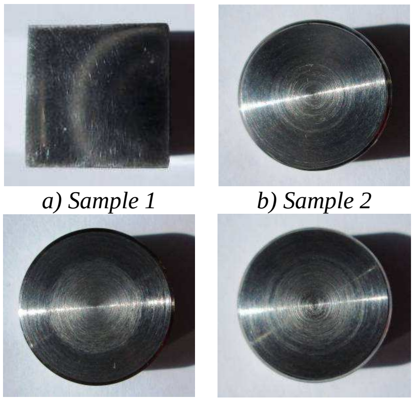
M_{exp} is the experimental mass loss expressed in [mg];

ΔM_{rel} is the relative error expressed in [%];



a) Batch 1 *b) Batch 2* *c) Batch 3* *d) Batch 4*

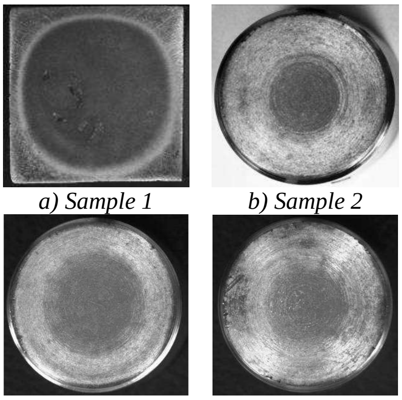
Figure 1 The 4 batches of the X3CrNi13-4 stainless steel



a) Sample 1 b) Sample 2

c) Sample 3 d) Sample 4

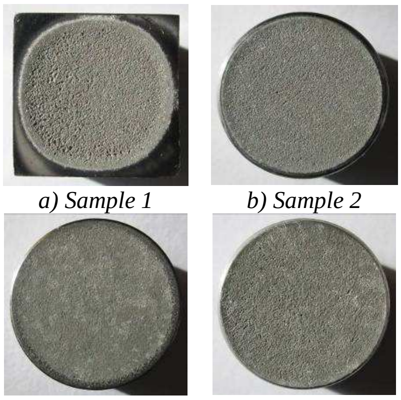
Figure 2 The 4 samples of the X3CrNi13-4 stainless steel



a) Sample 1 b) Sample 2

c) Sample 3 d) Sample 4

Figure 3 The samples surface after 180 minutes



a) Sample 1 b) Sample 2

c) Sample 3 d) Sample 4

Figure 4 The samples surface after 1080 minutes

Figure 5 The cavitation experimental stand

Table 1. The chemical composition of the 4 batches [%]

Batch type	Fe	Cr	Ni	Other chemicals
Batch 1	82,18	12,7	3,8	1,32
Batch 2	82,08	11,15	5,17	1,591
Batch 3	81,46	12,95	3,62	1,968
Batch 4	82,36	12,5	3,81	1,324

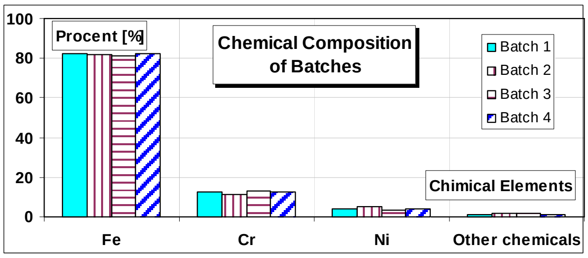


Figure 6 Chemical compositions of batches

Table 2. Mass loss and cavitation erosion rate average value

Total cumulated time [min]	Mass loss and cav. er. rate average	Samples type			
		Sample 1	Sample 2	Sample 3	Sample 4
180	Mass [mg]	5,82	1,77	2,55	2,76
	Rate [mg/min]	0,4287	0,1336	0,1886	0,2027
1080	Mass [mg]	98,31	79,06	50,9	91,67
	Rate [mg/min]	3,3415	2,6822	1,7288	3,1023

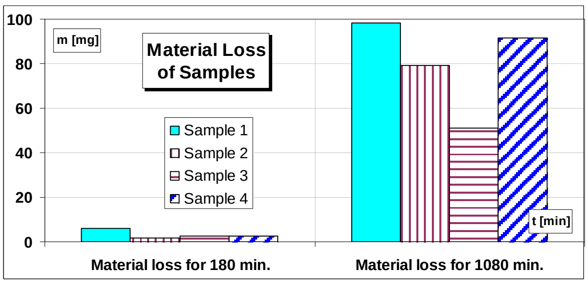


Figure 7 Material loss of samples

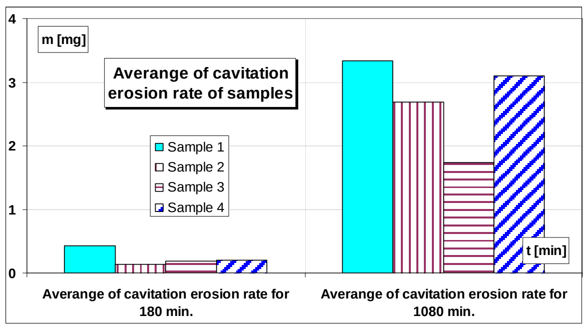


Figure 8 Average of cavitation erosion rate of samples

Table 3. Mass loss value analytic calculated

Time [min]	Samples type and the M_{anl} [mg]			
	Sample 1	Sample 2	Sample 3	Sample 4
180	5,511857	1,717714	2,424857	2,606143
1080	97,53568	78,29124	50,46227	90,55362

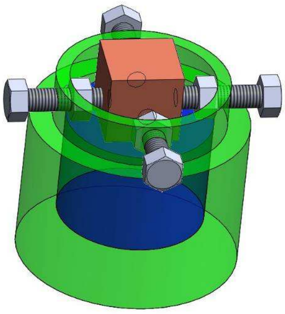
Table 4. The mass loss absolute and relative error calculated value

Time [min]	Error	Samples type			
		Sample 1	Sample 2	Sample 3	Sample 4
180	ΔM [mg]	0,308143	0,052286	0,125143	0,153857
	ΔM_{rel} [%]	5,294551	2,953995	4,907563	5,574534
1080	ΔM [mg]	0,774324	0,768757	0,43773	1,116378
	ΔM_{rel} [%]	0,787635	0,972371	0,85998	1,217823

Although the cavitation stand worked according the G32-10 standard [8, 9] small errors of measurement occur, due to the clamping system and due to the cleaning of the sample after each testing period.

3. THE 3D DESIGN FOR NEW BRACKETS USED FOR THE CAVITATION EXPERIMENTAL STAND

The samples bracket with 4 screws [10, 11] that was used in the experimental tests described above is presented in detail in Figure 9.



a) The 3D design

b) For cubic samples

c) For cylindrical samples

Figure 9 The 3D model and implementation of bracket with 4 screws

The new brackets designed (adapted from [12]) (Figures 10÷12), aimed to be used in further research on the cavitation erosion of the materials were designed using SolidWorks software.

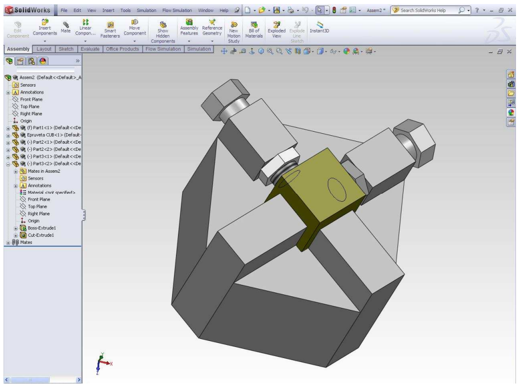


Figure 10 The 3D design of bracket no. 1

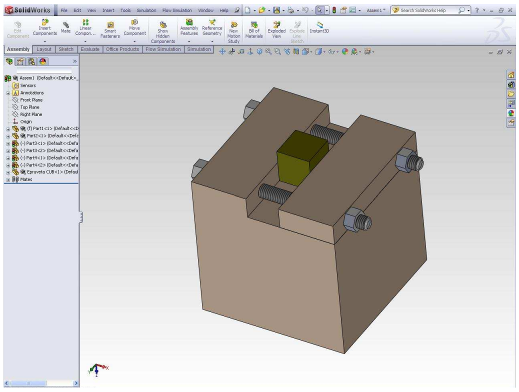
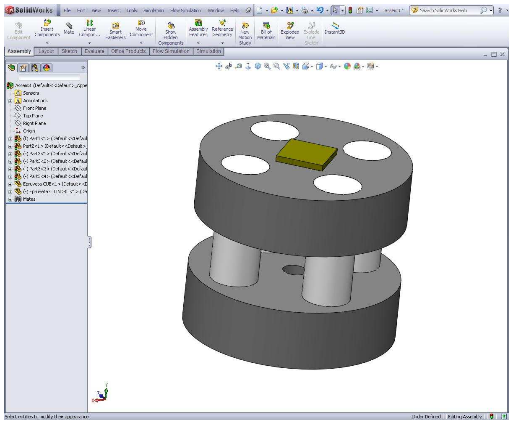
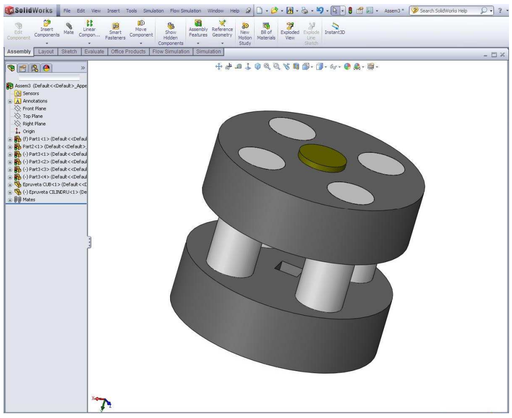


Figure 11 The 3D design of bracket no. 2



a) For cubic samples



b) For cylindrical samples

Figure 12 The 3D design of bracket no. 3

All the three types of brackets can be used for cubic and cylindrical samples.

Also, all 3 types of brackets had to fulfil at least three conditions:

- the brackets geometry must fit within the dimensions of the cooling coil of cavitation stand (the size of 90 mm in diameter);
- the mass of brackets must be at least 250 [mg], because there are vibration during testing;
- those brackets should not oxidize in the liquid, where the actual test is performed, so the brackets material is desired to be made of plastic (Plexiglas or textolit) or stainless steel material.

4. CONCLUSIONS

Following conclusions can be made:

- although the same X3CrNi13-4 material was tested, having for the four batches small different chemical composition, the results differ; the difference being generated by particular percentage of Fe, Cr and Ni;
- for the total cumulative time of 180 minutes, the best cavitation erosion resistance was on batch 2 and the lowest cavitation erosion resistance was on batch 1;
- for the total cumulative time of 1080 minutes, the best cavitation erosion resistance was on batch 3 (which means good resistance for longer time), and the lowest cavitation erosion resistance was also on batch 1;
- the absolute error have value between 0,052286 ÷1,116378 and the relative error have value between 0,787635÷5,574534;
- for the 3 new brackets that need to be made, it can be said, that these will be more practical, such as measurements on cavitation erosion resistance will be more accurate.

5. ACKNOWLEDGMENTS

The authors gratefully acknowledge the support of the Managing Authority for Sectoral Operational Programme for Human Resources Development (MASOPHRD), within the Romanian Ministry of Labour, Family and Equal Opportunities by co-financing the project “Investment in Research-innovation-development for the future (DocInvest)” ID 76813.

6. REFERENCES

[1] NEDELCU, D., NEDELONI, M. D., LUPINCA, C.I., *Cavitation Erosion Research on the X3CrNi13-4 Stainless Steel*, The 15th International Symposium on Metallography (METALLOGRAPHY 2013)

[2] NEDELONI, M.D., NEDELCU, D., CÂMPIAN, C.V., CHIRUŞ, D., AVASILOAIE, R.C., FLOREA, D., *Research regarding the cavitation erosion resistance of the stainless steel with 13% Cr and 4% Ni used to manufacture the components of Kaplan, Francis and Pelton hydraulic turbines*, Constanta Maritime University Annals, ISSN 1582 – 3601, Year XIV, Volumul 19, 2013

[3] BORDEASU, I., POPOVICIU, M.O., MITELEA, I., BALASOIU, V., *Cavitation eroded zones analysis for G-X5 CrNi 13.4 stainless steel*, Special Issue of the Scientific Bulletin of the “Politehnica” University of Timisoara, Transaction on Mechanics, 2008

[4] TRUSCULESCU, M., PADUREAN, I., DEMIAN, G., *Influence of structural state on cavitational erosion of GX4CrNi13-4 stainless steel*, Scientific Bulletin of the “Politehnica” University of Timisoara Transactions on Mechanics, vol. 52 (66), Timisoara, 2007

[5] NEDELONI, M.D., COJOCARU, V., CIUBOTARIU, R., NEDELCU, D., *Cavitation Erosion Tests Performed by Indirect Vibratory Method on Stainless Steel Welded Samples with Hardened Surface*, Annals of „Eftimie Murgu” University, Vol. XIX, No. 1, 2012

[6] FRUNZĂVERDE D., CÂMPIAN C.V., COJOCARU V., MARGINEAN G., BARAN M., CIUBOTARIU R., *Influence of welded layers thickness on the cavitation erosion resistance*, Proceedings of 6th WSEAS International Conference on Energy, Environment, Ecosystems and Sustainable Development (EEESD '10), Timisoara, 21-23 oct. 2010, pp. 316-320, ISSN 1792-5924, 2010;

[7] VLADA, M., *Elemente de teoria erorilor si incertitudinilor. Calcule statistice si modele de aproximare*, Universitatea din București, 2012.

[8] *** ASTM Standard G32-92, *Standard Method of Vibratory Cavitation Erosion Test. Annual Book of ASTM Standards*, Philadelphia, 1992

[9] *** ASTM G32-10, *Standard Test Method for Cavitation Erosion Using Vibratory Apparatus*, Copyright © ASTM International, United States, 2010

[10] NEDELCU, D., *Design and numerical simulation with SOLIDWORKS*, Editions Eurostampa, Timisoara, 2011

[11] POTOCEANU, N., NEDELONI, M. D., CHIRUS, D., FLOREA, D., *Research Regarding on Cavitation Erosion Behavior of the Antifriction Alloy YSn83*, The 15th International Symposium on Metallography (METALLOGRAPHY 2013)

[12] *** EDMUND EO, *World’s Largest Inventory of Optical Components*, Optics and optical instruments annual catalog – Maximize Throughput, Copyright © Edmund Optics, Inc. 2013, information on the website: www.edmundoptics.eu

CASE STUDY ON USE OF VIBRATIONS DIAGNOSIS IN EXPLOITATION OF QUAY CRANES

[1]DRAGOMIR CRISTINA, [2]BOCANETE PAUL

[1,2]Constanta Maritime University, Romania

ABSTRACT

This paper presents a case study of analysis of vibration and shock pulse carried to detect sources of faults in different points of a quay crane with mobile arm 16 t - 32 m. The analysis show that the main cause of the crane's increased engine vibration is the misalignment of the axis with the axis of the input gear reducer (misalignment of the cinematic coupling).

Keywords: *quay, port, harbour, crane, bearing, harmonics, coupling*

1. INTRODUCTION

Today there is a growing need to develop a procedure for fault detection and diagnosis in order to increase reliability and an early detection and diagnosis can help to avoid system breakdown and material damage.

Many investigations have been done to develop fault diagnosis methods [1]. Automatic system diagnosis is an useful tool in machinery condition monitoring and maintenance, safety and product quality. Vibration analysis is employed in many fields: from steel factories to petrochemical ones, from mechanical industries to the aviation and aerospace applications. The measurement of vibrations performed on a generic machine during its working process contains many information on the working condition. Usually, each process set up or inner mechanical changing show a characteristic vibrational pattern; a significative changing of this pattern should be reveal the presence of some anomalies in the system [2].

Vibration signal analysis has been proven to be the one of the most effective techniques for the detection of faults and diagnosis [3] . In the case of quay cranes, the first signs regarding a bad work or the first obvious changes in the evolution of the technical state appear in their "vibrating stamp" [4].

2. VIBRATION DIAGNOSIS OF "BOCSA" QUAY CRANE WITH MOBILE ARM 16 T - 32 M

In April 2012 in port of Constanta was performed a vibrations diagnosis at one of the four quay cranes of a local port operator. The type of the quay crane was Bocsa 16 t - 32 m with mobile arm. The crane was encounting faults of the gear reducer and electric motor bearing damage near the coupling.

To detect sources of faults in different working parts of the quay crane, in the first phase were carried out measurements of vibration and shock pulse needed to assess the operational status of the mechanisms.

In order to analyze the vibration state and the operational status of the bearings, there were used two measurement techniques for measuring the vibration status of the bearings' operating condition: analysis of vibration status, according to ISO 10816 and analysis of bearings operating status through Shock Pulse Method, patented by SPM Instrument Sweden.

According to ISO 10816, vibration velocity fall under the following areas of operation:
-the green area indicate normal operation;
-yellow warning zone indicate operating without restrictions;
-the orange warning zone indicate operating with restrictions;
-the red-zone indicate risks of faults, accidents and is recommended the equipment shutdown and remediation [6].

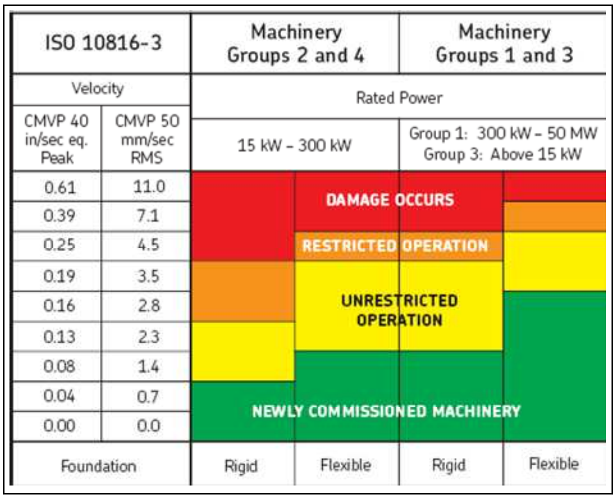


Figure 1 Correspondence between vibration velocity and areas of operation according to the reference standard ISO 10816

In the first method, the analysis of the vibration in accordance with ISO is based on the measurement of vibrations on two radial directions, horizontal and vertical, and an axial direction. As main purpose, this technique takes into account the determination of dynamic imbalance problems - harmonic 1 specific to the base frequency of the electric motor; misalignment - harmonics 2-3 multiple of the basic frequency of the electric motor, structural weakness and mechanical weakening - harmonics of 1 to 10. It was also considered detection of possible gear defects.

The second method is based on determining the operational status of the bearings through shock pulse measurements with SPM sensor calibrated in the resonant frequency of 32 kHz and the analysis of the lubricant film, the lubricant film thickness and quality of the lubricant used.

Given the two techniques, was proceeded the assessment of each measurement point separately.

The first point of measurement was the bearing of the electric motor fan of Bocsa quay crane. The status of the bearing was measured horizontally, vertically and axially. The results showed values much higher than the allowed limit value stated in ISO 10816 in all the three directions of measurement. The analysis of linear spectrum showed that harmonics 1-3 were predominant.

The comparative analysis of spectra from the first measurement point indicates problems of dynamic imbalance caused by axis misalignment (coupling misalignment). In these circumstances the analysis was focused on the second measuring point in the vicinity of the coupling between the engine and the first gear of the reducer.

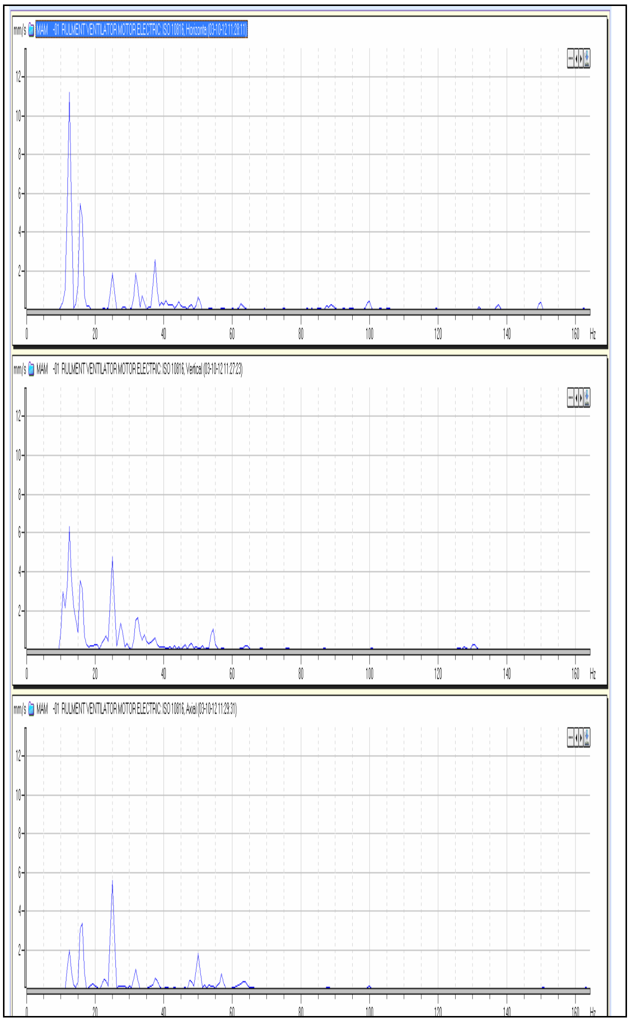


Figure 2 Comparative analysis of harmonic vibration spectra of linear measurement point 1 (horizontal, vertical and axial)

The second measuring point showed that the vibration magnitudes at frequency of 125 Hz and amplitude 2.029 mm/s were also well above the permissible limit according to ISO 10816. Matched symptoms show unbalance and 10X multiples (figure 3).

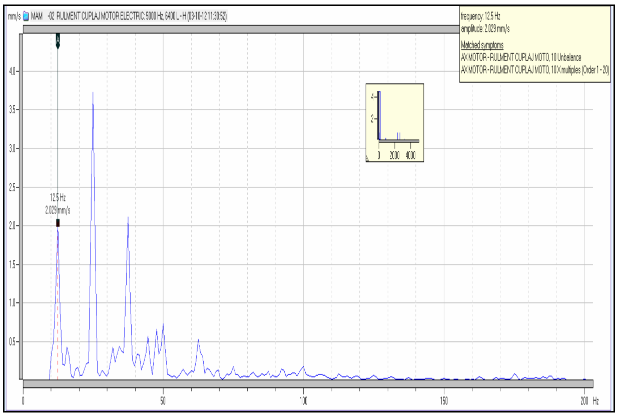


Figure 3 Linear spectrum analysis at the second point of measurement- harmonics 1

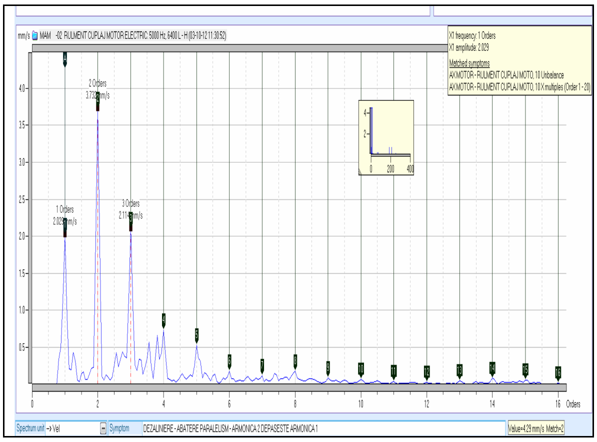


Figure 4 Linear spectrum analysis at the second point of measurement - comparing harmonics 1 and 2 (X1 amplitude: 2.029)

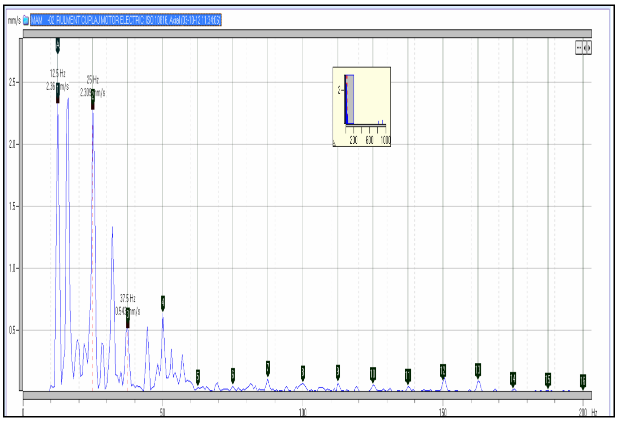


Figure 5 Linear spectrum analysis at the second point of measurement - comparing harmonics 1 (12,5 Hz and 2,36 mm/s) and 2 (25 Hz and 2.309 mm/s) with the rest of harmonics

Measurements from the second point confirm misalignment problems - parallel and angular deviations that automatically lead to a dynamic imbalance. Deviation from parallelism on radial direction results from the fact that harmonic 2 exceeds harmonic 1.

Angular deviation in the axial direction results from the fact that harmonics 1 and 2 are predominant.

These misalignments can cause damage to the coupling elements (bolts, elastic elements), and also may affect the bearings in the vicinity of the coupling. Following, we analyzed the electric motor bearing condition near the coupling, which can be affected by misalignment.

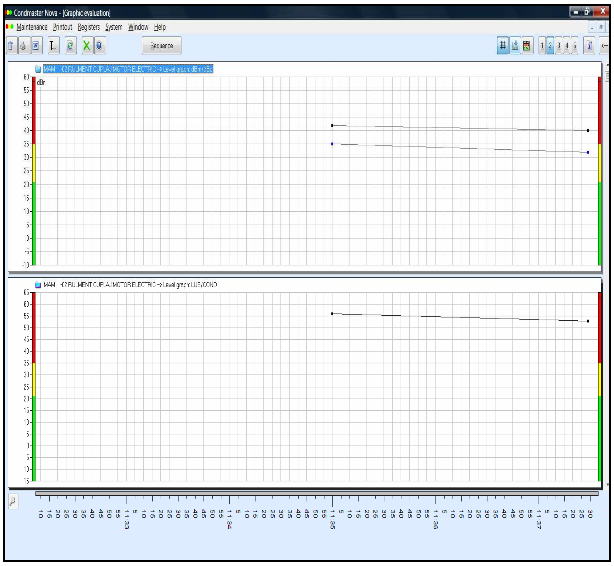


Figure 6 Analysis of the electric motor bearing condition (second point of measurement)

According to the graphic from Figure 6, the nearing is placed in the damage red zone with values if shock impulse dBm = 40/42 which indicates the fact that the bearing is damaged. Following, was analyzied the linear spectrum of shock impulse to clearly see the state of the bearing.

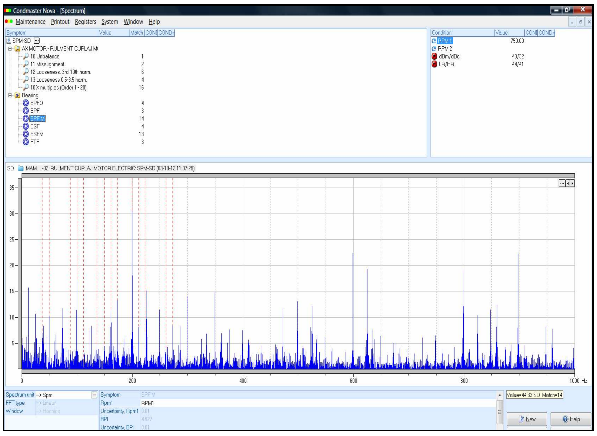


Figure 7 Linear spectral analysis of shock impulses from the electric motor coupling bearing (measuring point 2)

It is clear that the damage occurs in the rolling area of the bearing elements. The damage is overlapping on their basic frequency (BSF) with 14 number of match. Automatically, defects appear on the runways, indoor and outdoor ring.

Following, it was analyzed the bearing’s lubrication state using Lubmaster chart.

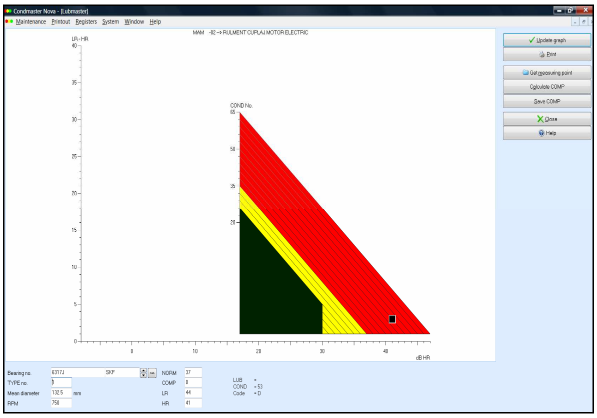


Figure 8 Lubmaster graph of lubrication state analysis of the bearing from the coupling of the electric motor (measuring point 2)

The Lubmaster graph at bearing 6317J SKF shows that film lubrication is discontinuous, allowing the contact of metal on metal (lub number = 0 status code = D). The mean diameter is 132.5 mm, 750 RPM, COND value 53. By analyzing the movement of the spot (almost horizontal) we cab conclude that the lubrification was not appropriate. To avoid lubrication problems it is recommended to use automatic lubricators like in Figure 9 to ensure a steady flow of lubrication. Misalignment problems can negatively influence the lubrication film by the inability to create it due to the fact that the bearing is closely working in some areas due to misalignment.

Figure 9 Lubricant application with automatic lubricator

In a conventional manner, automatic lubricators are activated with a simple twist of the distribution dial on top of the lubricator like in Figure 10 and it can be changed at any time. The lubricant level can be continuously monitored by the control window. Automatic lubricators are indicated for difficult lubricating applications, such as the lubrication points in inaccessible places or hazardous areas. Depending on the design, an automatic lubricator can be programmed to lubricate the critical lubrication points, automatically, 24 hours a day for up to a year.

Figure 10 Adjusting the dispersion period of the automated lubricator (1-12 months)

The analysis continued at other points of the cinematic diagram: electric motor - coupling - gearbox – drum.

In conclusion, the main cause of the increased engine vibration of “Bocsa” quay crane was the misalignment of the axis with the axis of the input gear reducer (misalignment of the cinematic coupling of the two elements).

Also, by analyzing the engine bracket, we can say whether this is inappropriate, constituting itself into a perfectly flat surface, and we can recommend its correction.

3. CONCLUSIONS

Vibration diagnosis is a very useful tool in evaluation of quay cranes or other port equipments' faults, breakdowns or obvious changes of the technical state.

Acording to spectra analysis made at Bocsa quay crane 16 t -32 m, linear misalignment is determined both by the deviation from horizontal and vertical parallelism and the angular deviation both in horizontally and vertically.

Misalignment of the bearing caused damage in the past to crane's gear reducer and also led to the electric motor bearing damage near the coupling.

It is recommended to remove the causes of faults generating power train, engine alignment relative to the laser gear that allows precise alignment compared to conventional methods of alignment (alignment with ruler slit light or alignment with the comparator).

4. REFERENCES

[1] IORGULESCU M., BELOIU R., CAZACU D., Vibration Monitoring for Electrical Equipment Faults Detection Using Fast Fourier Transform, *Proceedings of the 1st International Conference on Manufacturing Engineering*, Quality and Production Systems (Volume I), pp.34-38.

[2] NIOLA V., QUAREMBA G., AVAGLIANO V., Vibration monitoring of gear transmission, *Proceedings of the 9th WSEAS International Conference on Simulation, Modelling And Optimization*, p.74-79.

[3] RENWICK J. T., Vibration analysis - a proven technique as a predictive maintenance tool, *IEEE Transaction on Industry Applications*, vol. 21, pp. 324-332, 1985.

[4] RADU G. N., COMĂNESCU I., The Analysis of the State of Stress and Strain of a loaded Portal Crane, using FEM, with respect to the Strength, Stiffness and Stability, *Mathematical Models in Engineering and Computer Science*, Brasov, 2013, pp. 143-147

[5] ISO 10816-1:2012 - Mechanical vibration -- Evaluation of machine vibration by measurements on non-rotating parts, www.iso.org

NUMERICAL SIMULATION OF THE SHORT FLEXIBLE WHEEL OF THE DOUBLE HARMONIC GEAR TRANSMISSION

[1]IANICI DRAGHITA, [2]NEDELCU DORIAN, [3]IANICI SAVA

[1,2,3]*„Eftimie Murgu” University of Resita, Romania*

ABSTRACT

The paper presents the results of a research regarding the dynamic behaviour of the short flexible wheel of the double harmonic gear transmission, by emphasizing the stress status and the strains of its wall, in case the wheel is deformed using a mechanical wave generator with two rollers. The dynamic analysis involves modeling and the numerical simulation of flexible toothed wheel, by using the finite element method, with the help of SolidWorks Simulation program in elastic range.

Keywords: *flexible wheel, double harmonic gear transmission, simulation, stress, displacement.*

1. INTRODUCTION

The continuous modernization of the current industry led to the improvement of existing actuator systems, as well as the emergence of new systems, which contain in their structure more efficient gear transmissions capable of achieving very high kinematic accuracy, at smaller dimensions and mass.

The category of these modern transmissions also includes the harmonic gear transmissions, which were imposed by the most diverse applications in all of the top technological areas: the of construction ships and cosmic rockets, airplanes, helicopters, nuclear reactors, industrial robots, radar antennas, naval mechanisms, servo-mechanisms, motor reducers, machine tools, precision dividing heads, drives in sealed areas of chemical and petroleum industries etc. [1, 2, 3, 4].

The functioning principle of the harmonic gear transmission is essentially different from the classic gear, because the transmission of the rotary movement is accomplished by means of elastic deformation, which is propagated by the harmonic law, in the periphery of one of its elements called flexible toothed wheel.

The structural scheme of a double harmonic gear transmission (Figure 1) is made of: a wave generator (1) as input element, a short flexible toothed wheel (2) with the respective external and internal toothed crowns, the fixed rigid gear (3) and the mobile rigid gear (4) as output element, [3].

The short flexible toothed wheel has the form of a circular tube with thin wall, open at both ends and having at each end a toothed crown (external z_2 = 200 teeth and internal z'_2 = 192 teeth).

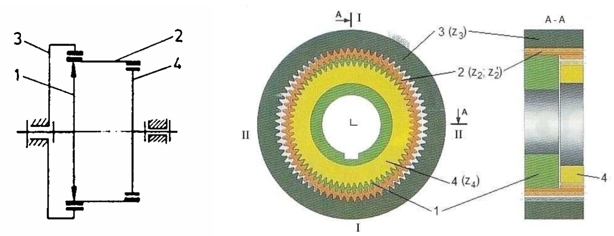


Figure 1 Structural scheme of a double harmonic gear transmission

The wave generator being in sliding contact along the entire periphery of the flexible wheel, it deforms this toothed wheel so that it will have four equidistant driving zones: two with the fixed rigid gear having internal teeth (z_3 / z_2 – first step, I - I) and two with the mobile rigid gear having external teeth (z'_2 / z_4 – second step, II - II). Between the two pairs of opposing driving zones (I - I and II - II respectively) there is a 90^o angle.

By studying the research conducted on the harmonic gear transmission it was found out that the functional performance and durability are greatly influenced by the dynamic behavior and durability of the flexible toothed wheel. This fact lead to the necessity of researching the stress status and the tension of its wall.

2. NUMERICAL SIMULATION OF SHORT FLEXIBLE TOOTHED WHEEL

The flexible toothed wheel of the harmonic gear transmission is in a complex state of tension and elastic deformation, depending on many factors such as: the type of wave generator, the geometric shape of the flexible gear, the torque transmitted and the coupling of the flexible gear with the output shaft.

In order to investigate the state of stress and deformation of the flexible toothed wheel of the double harmonic gear transmission and to achieve numerical simulation using the finite element method, with the help of SolidWorks Simulation module, the following steps were required, [5]:

- 3D geometry modeling of the flexible toothed wheel and wave generator with 2 rollers in SolidWorks CAD software;
- defining case analysis;
- defining material from the library of materials;
- defining restrictions and applying the loading;
- finite element mesh of the model tested;
- calculating the strains and tensions by using SolidWorks Simulation module;
- view and analyze the results.

In numerical calculus, flexible wheel of the double harmonic gear transmission was modeled by a cylinder opened at both ends, defined by the radius, r = 29,3 mm, length l = 30 mm and the constant wall thickness, s = 0.6 mm, which is provided with two teeth (outer respectively inner) of width 12 mm.

The analysis of the dynamic behavior of flexible toothed wheel was made in the case of the geometric model of wave generator with 2 rollers (Figure 2).

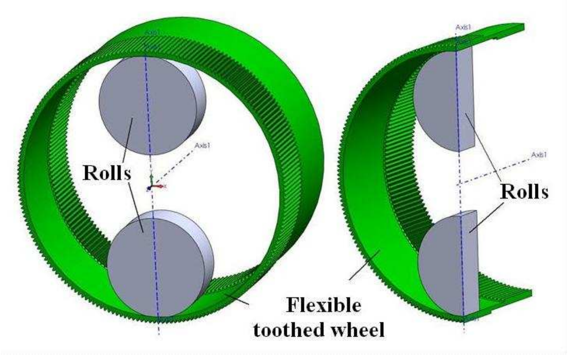


Figure 2 Analysis model

The analysis model is composed of a flexible toothed wheel of double harmonic gear transmission and of a wave generator with 2 rollers. The two rolls were modeled by the two identical circular cylinders, characterized by: cylinder diameter d_r = 22 mm and height of the cylinder b_r = 8 mm.

SolidWorks Simulation operates with the concept of "Study", pointing out specific characteristics of the analysis: analysis type and associated options, materials, set load and boundary conditions and meshing the model analyzed.

The geometry of the flexible toothed wheel of the double harmonic gear transmission was modeled in "solid" and its numerical simulation consisted of a linear static analysis, meshing was performed using spatial finite elements. The selected material for the flexible wheel is steel (Alloy Steel), having the following characteristics: Young's modulus, $E = 2{,}1 \cdot 10^{11}$ N/m^2; Poisson's ratio, $\nu = 0{,}28$; yield strength, $\sigma_c = 620{,}4$ MPa.

The geometry of the flexible toothed wheel has the origin in the point O of its symmetry, the Oz - axis being oriented along the generatrix, the xOy plane being oriented NSVE, the Ox - axis being positively oriented from V to E and the Oy - axis from S to N (Figure 3).

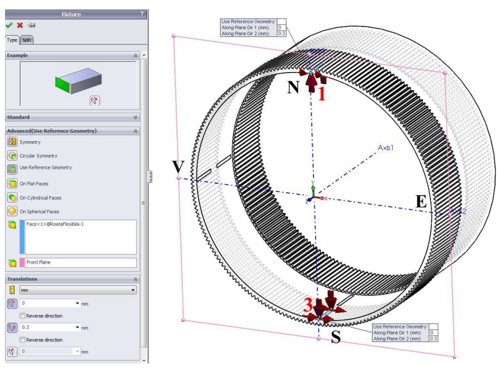


Figure 3 Restrictions applied to the flexible wheel

For the wave generator with 2 rollers, contact between the flexible toothed wheel and the generator, is produced on the inner side of the wheel, in the areas N1 and S3.

In these two areas of contact the following restrictions will be applied to the flexible toothed wheel: two restrictions of value 0, which will cancel the movement of the contact zones N1 respectively S3, in the direction Ox, and two restrictions of value 0.3 mm applied to the exterior of the wheel, which materialize the strain/deformation in the direction Oy of the wheel due to the two rollers of the wave generator.

Also, in simulation will be applied a restriction type Roller/Slider, to the side which is parallel and opposed to the NSVE side. For this type of restriction, the points belonging to this plane side can move freely in their plane, but are not able to move perpendicular to this plane.

The loads applied to the flexible wheel consisted in the only two components of the normal forces (tangential force F_t and radial force F_r), developed in the first stage of harmonic gear (Figure 4). This is because the effect of the interaction between the wave generator and flexible wheel has already been taken into account by imposing elastic deformation produced by the generator inside the flexible wheel.

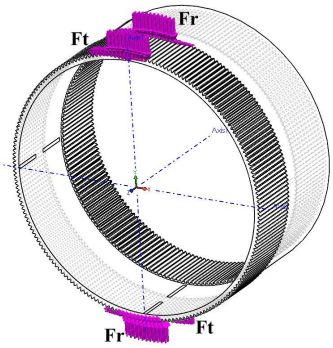


Figure 4 Uploads applied to the flexible toothed wheel

The maximum values of tangential and radial forces from the harmonic gearing were determined for the following steps of the torque of the transmission, M_{t4} (0, 100, 200, 300, 400, 500) N·m, using the relationship:

$$F_{t\,\max} = q_{t\,\max} \cdot b_d = \pi \cdot M_{t4} \cdot p / (2\varphi_2 \cdot d_2^2) \quad (1)$$

$$F_{r\,\max} = F_{t\,\max} \cdot tg\,\alpha \quad (2)$$

where: q_{tmax} – is tangential force reported to the unit of length of the teeth;
b_d – the length of the toothed crowns;
p – circular pitch;
d_2 – diameter pitch circle of flexible gear;
φ_2 – positioning angle of the gearing area;
α – angle of the tooth profile;
M_{t4} – torque to the output shaft.

In order to simulate the flexible toothed wheel, meshing to use solid type (Figure 5) was used, which generated a total number of 63.687 finite elements and a number of 123.511 nodes.

After following the above mentioned stages, the analyses calculus was performed by the simulation of the deformation of the flexible toothed wheel, in order to determine and display graphically the status of stress and strains.

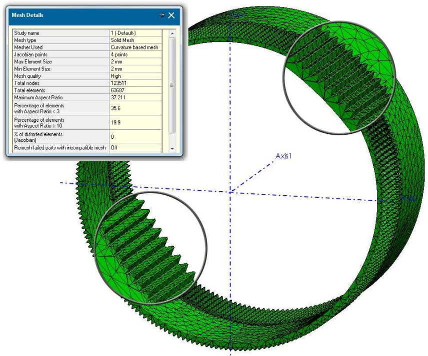


Figure 5 Meshing of the flexible toothed wheel

After the numerical processing of the simulation of the behavior of flexible toothed wheel, can view the results, that can be viewed graphically (charts and color maps) or analytically (numerical values for von Mises stress and displacements).

The tensions presented in diagrams, represent the equivalent stress in the case of composite stresses, which are calculated using the von Mises formula:

$$\sigma_{ech} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - \sigma_1 \cdot \sigma_3 - \sigma_2 \cdot \sigma_3 - \sigma_2 \cdot \sigma_1} \qquad (3)$$

where: σ_1, σ_2 and σ_3 – are the normal stresses after main directions.

3. NUMERICAL SIMULATION RESULTS

In the case of numerical analysis that was performed using SolidWorks Simulation program, there were studied the variations of the displacements and stresses (von Mises), in the body of the flexible toothed wheel, according to the loading moment of the double harmonic gear transmission.

Thus, by successive runs of the numerical analysis program, maximum values of displacements and von Mises stress were recorded for all six steps of charging (M_{t4} = 0, 100, 200, 300, 400, 500 N·m).

The results obtained after applying numerical simulations are summarized in Table 1 - for maximum stress von Mises, respectively Table 2 – for the resultant displacement, and Figures 6 and 7 present their variation diagrams, [3].

Table 1. Maximum stress von Mises

Torque M_{t4} [N·m]	Tangential force F_t [N]	Radial force F_r [N]	Stress $\sigma_{v\ Mises\ max}$ [MPa]
0	0	0	369.1
100	52,33	19,04	371.8
200	104,66	38,09	374.4
300	156,99	57,13	377.2
400	209,33	76,18	389.8
500	261,66	95,23	415.4

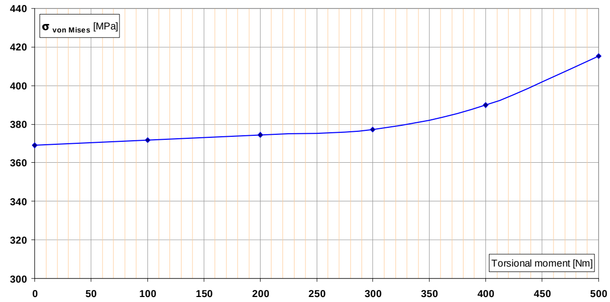


Figure 6 Maximum stress von Mises diagram, $\sigma_{vM} = \sigma_{Vm}(M_{t4})$

Table 2. Resultant displacement of nodes on the generator N

No. node	Positioning share z_{nod} [mm]	Resultant displacement Δ [mm]
1	0	0,3
2	-3,75	0,3
3	-8,25	0,299
4	-12	0,296
5	-16,725	0,294
6	-21,15	0,292
7	-25,575	0,292
8	-29,635	0,291

We can observe that the values of the coordinate z, by which are established the positions of the nodes from a certain flexible wheel generator, give negative results because the Oz-axis has positive orientation, and is in the opposite direction to running through the generatrix.

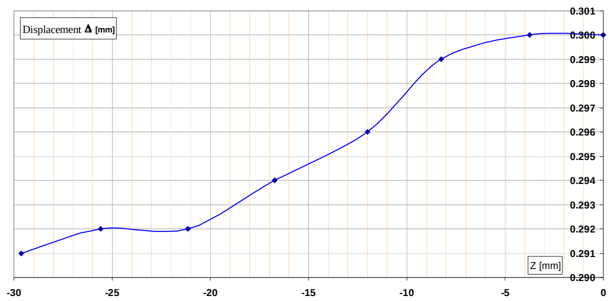
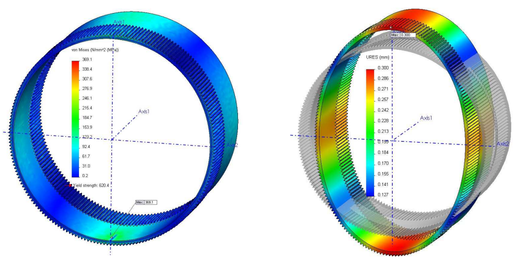


Figure 7 Resultant displacement diagram, Δ = Δ(z)

Figure 8 shows, under the form of color maps, the von Mises stress distribution, respectively the resulting displacement Δ, in the case of deformation of the flexible wheel with the wave generator where the 2 rolls.



$\sigma_{von\ Mises}$ - M_{t4} = 0 Nm   Δ - M_{t4} = 0 Nm

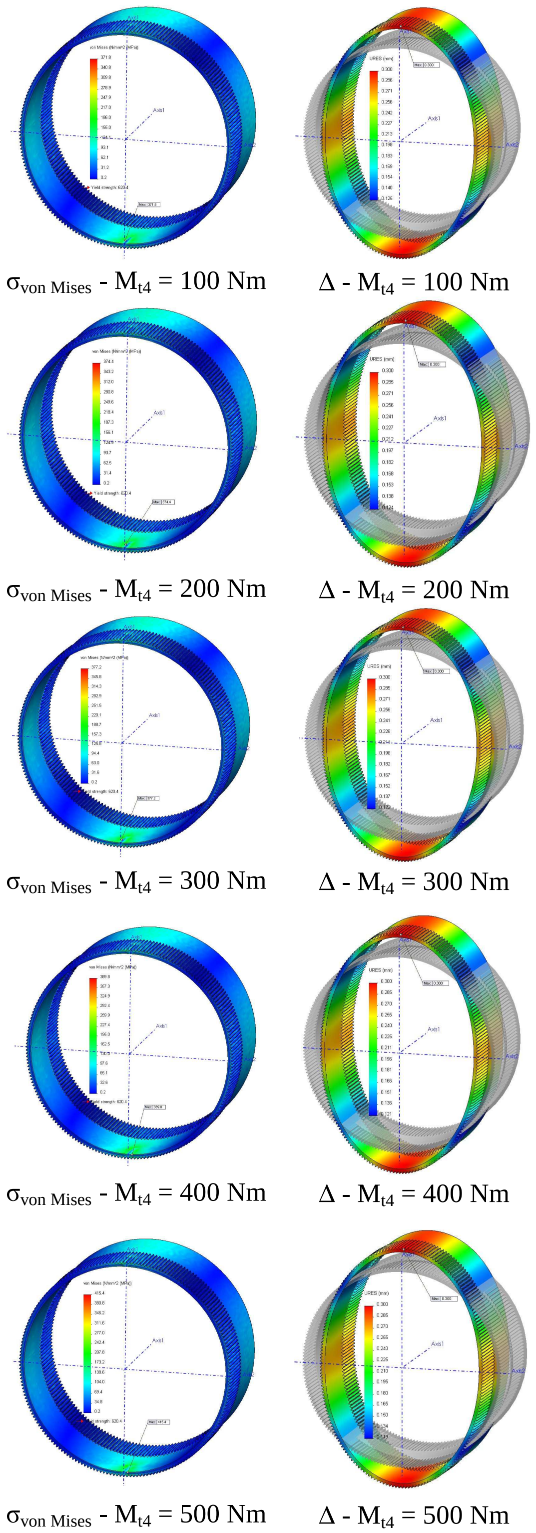


Figure 8 The von Mises stress (σ_{vMmax}) and the resultant displacement (Δ)

In order to research and appreciate more correctly the deformation mode of the flexible toothed wheel there were visualized the resulting displacements Δ of the characteristics nodes, from the finite elements located in the direction of the generatrix N of the wheel, at a load of M_{t4} = 100 N·m (Figure 9).

From the analysis of the variation diagram of the resultant displacements $\Delta = \Delta$ (z), one can see that in the proximity of the point where one applies the deflection force on the flexible toothed wheel (corresponding to cote z = 0 on the N generator), it is found for the value of the resultant displacement the exact value of the maximum radial elastic deformation of the flexible wheel (Δ (0) = w_0 = 0.3 mm).

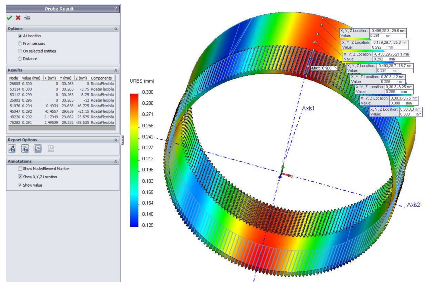


Figure 9 Variation of the resultant displacement Δ

4. CONCLUSIONS

The paper presents the results of numerical simulation of the short flexible toothed wheel, of the double harmonic gear transmission, with the wave generator with 2 rollers, allowing to evaluate the dynamic behavior of the wheel.

The analysis of these results reveals the following conclusions:

- the stress forming in the wall of the flexible toothed wheel are dependent on the load of the transmission, presenting a slightly increasing character (σ_{vMmax} є [369,1; 415,4] MPa) with increasing torque (M_{t4} є [0; 500] N·m);
- the maximum value of the stress occurs in the immediate proximity of the point where we apply the force of elastic deformation on the flexible toothed wheel, in the area of the rolls of wave generator, and this stress is well below the yield strength of the material of the wheel (σ_c);
- maximum stress variation is insignificant at low torque of the transmission ($M_{t4} \leq 100$ N·m);
- the resultant displacement of the nodes located on the generator N has a slightly decreasing character, once we remove the nodes_from the NSVE side of the flexible, a fact that was confirmed by the results of experimental research conducted.

5. REFERENCES

[1] ANGHEL, ŞT., IANICI, S., *Design of mechanical transmissions*, vol. I, Editura I.P.T.V., Timişoara, 1984
[2] IANICI, S., IANICI, D., *Design of mechanical systems*, Editura Eftimie Murgu, Reşiţa, 2010
[3] IANICI, D., *Contributions to the constructive-functional improvement of the double gear harmonic transmission*, Ph.D. thesis, „Eftimie Murgu” University of Resita, 2012
[4] IVANOV, M.N., *Volnovîe zubceatîie peredaci*, Izd. Vîsşaia şkola, Moskva, 1981
[5] NEDELCU, D., *Digital prototyping and numerical simulation with SolidWorks*, Editura Eurostampa, Timişoara, 2011

STUDY REGARDING THE HEAVY FUEL CONSUMPTION FOR THE MAIN ENGINE OF NAVAL POWER PLANTS

LUPCHIAN MARIANA

"Dunarea de Jos" University of Galati, Romania

ABSTRACT

This paper presents an analysis of exploitation parameters for naval propulsion plant at different operating regimes. The paper presents the specific fuel consumption after the feature of propeller (full load) for a few of operating conditions analyzed.

Fuel consumption is mainly what determines the specific cost, which is actually a minimum specific fuel consumption minimum naval propulsion plant. The costs of materials, labour supply, costs of fuel (working fluids) and electricity consumption are analysed. The operation of the vessel must take into consideration the parameters for which it was designed and built, thus satisfying all the technical and economical aspects, competitiveness included.

Keywords: *oil-tanker, energetic plant, operating regime, deadweight, specific costs, ballast*

1. INTRODUCTION

Economic efficiency of the energy of the ship depends on economics all the elements and especially the main engine.

Economy in order to improve the installation of ship propulsion is used for marine main diesel engines of heavy fuel oil heavy fuel especially to slow diesel engines and medium speed diesel engines.

In general for an energy plant with internal combustion engines are subsystems:

- internal combustion engine;
- consumer (consumers);
- mechanisms and installation auxiliary of the energy internal combustion engines [1].

The processing flow of chemical energy of fuels by making a technical stream (power) should be done economically.

The functioning regimes for naval propulsion plants are determined by the mechanic characteristics of the functioning of internal combustion engine, power transmission and the ship.

The ships can be designed with an absolute degree of security due to the diversity and complexity of the navigation.

The functioning regimes for naval propulsion plants are determined by the mechanic characteristics of the internal combustion engine, functioning, power transmission and the ship.

2. THEORETICAL CONSIDERATIONS

For the successful design of a thermal plant is required to estimate the major costs involved and considering the various assumptions predictions about the economic, technological, legislative and using techniques of engineering economic [3].

Marine engine operation is automated and controlled by a computer system that adjusts the parameters to achieve optimal performance in all situations.

The market price of the product is given not only production cost but also the desired profit and other factors such as the requirement of market, supply, competition, laws.

Specific factors which requires the cost of transport there are:

- Specific fuel consumption of engine propulsion system;
- Specific fuel consumption of the auxiliary machinery;
- Specific consumption of lubricants and auxiliary machinery of the main propulsion system;
- Specific cost of fuel used to supply main and auxiliary machinery;
- Specific cost of lubricant used for anointing the main and auxiliary machinery;
- The cost of the propulsion;
- Expenditure for the creation of living conditions of people;
- Number and level of remuneration necessary to crew the service propulsion.

Choosing the type of propulsion system must be the result of a technical-economic analysis that takes into consideration all factors that depend on the safety ship and economically operation.

In the case of the energetic plant with internal combustion engines, which dispose of automating systems, their functionality is assured by two essential elements: their structure and the program of implementing the functioning regimes.

When designing the propulsion is looking to reduce the size of the compartment size of machines to increase the size warehouses for goods transported and increase passenger space, but taking into account the records of the prescriptions governing class sizes crossing from the car in order a convenient and safe exploitation of the energy of the ship.

The technical state of internal combustion engines of the ship careen, can be determined by stochastic methods, some diagnosis parameters monitoring of these state and by means of an artificial neural equivalent network.

3. CASE STUDY

The tanker is equipped with a single propeller, the propulsion of the vessel being provided by a diesel engine, MAN B & W with 6-cylinder.

Engine power: 9480 [kW], 127 [rpm]; deadweight in sea water is 37000 tdw. The ship is equipped with three Diesel generators, each with many 6 cylinder in-line power of 960 kW, speed 900 (rpm).

The manufacturer is running a trial race at full load, ship ballast water is high, the draft of 10.50 [m].

The crew consists of 31 persons [1].

Particulars of ship:

-length overall: 179.96[m],
-the breadth of ship: 32.20 [m],
-height: 16.50 [m],
-speed of service: 15 [Nd].

Figure.1. The propulsion engine Diesel MAN B&W

The ballast system ensures displacement of the centre of gravity of the ship down to bring the desired trim through the boarding or disembarking the ship made of seawater ballast.

The ship left the port of Constanta with seawater ballast.

To evaluate the amount of these expenses must keep in mind that during a voyage, the ship is navigation a variety of situations and the main engine and auxiliary machinery does not work all the time on the same charge.

For merchant ships cost specifically expressed in Euro / tonne mile, or Euro / passenger mile, is the index that can assess and compare economy of a vessel with another vessel of the same type.

The functioning regimes for naval propulsion plants are determined by the mechanic characteristics of the internal combustion engine, functioning, power transmission and the ship [11].

The study was conducted for several operating modes for full load and ballast.

Ballast tanks are built into the hull of a ship in order to help maintain its stability by filling them with seawater [5].

For a naval propulsion plant with internal combustion engines, a independent variables which give its operating regimes are considered.

For naval propulsion plant with internal combustion engines is considered as independent variables which give its operating regimes by the functional characteristics of internal combustion engine, power transmission characteristics, and consumer characteristics.

Fuel efficiency is dependent on several parameters of a vehicle, including engine parameters, aerodynamic, weight and rolling resistance.

Hourly fuel consumption is given in the technical documentation of the ship.

The specific fuel consumption of main engine CS_{MP} [kg / kWh] is calculated using the equation [10]:

$$CS_{MP} = \frac{C_h}{P_{MP}} \text{ [kg/kWh]} \qquad (1)$$

- P_{MP} [kW] - the power of internal combustion engine;
- n - the engine speed [rpm];

$$C_h = C_h(n,h) \qquad (2)$$

- hourly fuel consumption C_h
- h - the injection pump toothed rack position [2].

The functioning regimes for naval propulsion plant are determined by the mechanic characteristics of internal combustion engine, functioning, power transmission and the ship [10]:

- P_e (y_k, n, thermal regime, exterior adjustment parameters of the engine, technical state of internal combustion engines p_0, T_0, φ_0)

p_0, T_0, φ_0 - the external environment parameters (pressure, temperature, relative humidity);

Table 1. The power of internal combustion engine (full load)

n_m [rpm]	v_m [Nd]	$P_{MP,m}$ [kW]	$C_{h,m}$ [kg]	$CS_{MP.load}$ [kg/kWh]
84.80	11.00	3105	589.000	0.1897
94.38	12.00	4019	753.000	0.1873
103.96	13.00	5150	955.000	0.1854
109.42	13.57	6029	1107.388	0.1836
113.54	14.00	6684	1221.000	0.1826
121.87	14.87	8090	1472.000	0.1819
123.12	15.00	8572	1528.800	0.1783
127.00	15.38	9480	1725.600	0.1820
132.70	16.00	11276	2100.000	0.1862

Table 1. shows :

- n_m [rpm] - the engine speed;
- v_m [Nd] - ship's speed;

- $P_{MP,m}$ [kW] - the engine power;
- C_h, fuel consumption;
- CS_{MP} - the specific fuel consumption for the analyzed conditions (ship loaded).

The minimum fuel consumption was obtained for the operating regimes with the engine speed: n_m = 123.12 [rpm] and ship speed: v_m = 15 [Nd].

In table 2. is presented the effective fuel consumption after the feature of propeller (ship ballast).

Table 2. The engine power ($P_{MP,\,b}$) for operating conditions analyzed (ship ballast)

n_b [rpm]	v_b [Nd]	$P_{MP.b}$ [kW]	$C_{h,b}$ [kg/h]	$CS_{MP.ballast}$ [kg/kWh]
80.86	11.00	2559	481.000	0.1879
90.55	12.00	3473	644.500	0.1855
100.50	13.00	4660	856.000	0.1836
105.50	13.57	5428	989.300	0.1822
110.00	14.00	6203	1122.309	0.1809
118.20	14.87	7713	1380.403	0.1789
119.50	15.00	8102	1420.300	0.1752
123.30	15.38	8996	1560.109	0.1734
129.50	16.00	10520	1847.850	0.1756

For the vessel ballasted - the minimum fuel consumption was obtained for the operating regimes with the engine speed: n_b = 123.30 [rpm] and ship speed: v_b = 15.38 [Nd].

Figure 2 shows the dependence of the propulsion engine power (ballast and full load) and specific fuel consumption depending on vessel speed.

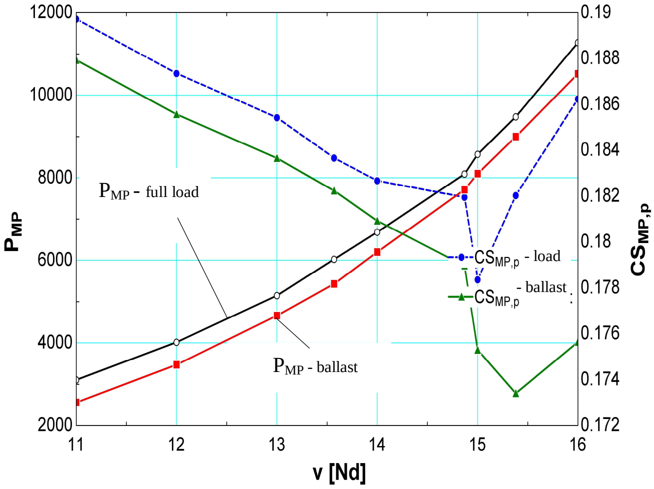


Figure.2. The engine power and fuel consumption depending on vessel speed

The operating regimes of engine propulsion depends on: the type of ship, sailing conditions construction hull, propeller type and mode of power transmission from the engine to the propeller.

Fuel efficiency is dependent on several parameters of a vehicle, including engine parameters, aerodynamic, weight and rolling resistance.

Main engine of a ship is a major energy consumer and producer on board.

4. CONCLUSIONS

Fuel consumption is mainly what determines the specific cost, which is actually a minimum specific fuel consumption minimum naval propulsion plant.

Ship's propulsion system must function safely with minimized expenses, so that the specific cost of transport to be as small.

The ship must meet the mission for which it was designed, in the most economic.

The specific fuel consumption was determined by the ratio between the main engine power and fuel consumption per hour.

Hourly fuel consumption is given in the technical documentation of the ship.

Table 1 and 2 shows the specific fuel consumption after the feature of propeller (full load) for a few of operating conditions analyzed.

The specific cost of transport voyage minimum $CS_{MP,\ load}$= 0.1783 [kg/kWh] was obtained in the speed mode v_m=15 [Nd], n_m= 123.12 [rpm] (full load); and for the race ballasted: $CS_{MP,\ ballast}$= 0.1734 [kg/kWh] with v_b=15.38 [Nd], n_b= 123.30 [rpm].

A ship becomes more cost effective as the more time is the sea navigation or travelling to the port of boarding products or travelling to the port of destination (unloading products) and the downtime (stationary in port for repairs and waiting orders) are smaller.

If the running time of the vessel increases, the annual yield will be higher.

A ship may be said to be is more effective as the ship during the voyage is higher in comparison with the residence time of the vessel.

The ship must carry the parameters for which it was designed and built, thus satisfying all the technical and economic aspects.

The engine is automated and controlled by a computer system that adjusts the parameters to achieve optimal performance in all situations.

Size, tonnage, speed, resistance to progress, propulsive power, manoeuvrability qualities, stability and transverse waves of behaviour are just some of the performance of interest that must be obtained at minimal cost.

The problem may be also transposed in the case of power plant with internal combustion engines, used on vehicles, on railway engines and airship, as there is a perfect analogy of the processes requested by their functioning.

The operation of the vessel must take into consideration the parameters for which it was designed and built, thus satisfying all the technical and economical aspects, competitiveness included.

5. REFERENCES

[1] LUPCHIAN M., *Determination of optimum operating regime for a naval power plant based on minimum fuel consumption*, ModTech Brasov, 2012.
[2] SIMIONOV M., *Instalatii de propulsie navale*, University Press Galati, 2009.
[3] CARAGHIULEA M., *Thermo economic optimization for a naval propulsion plants with internal combustion engines by using nonlinear programming methods,* Buletinul Institutului Politehnic din Iasi, Fasc. 2, Secția Construcții de maşini, 2008.
[4] CEANGĂ, V., MOCANU C. I., TEODORESCU C, *Dinamica sistemelor de propulsie*, Editura Didactică şi Pedagogică, Bucuresti, 2003.
[5] SIMIONOV, M.- Instalații de propulsie navale. Linii de arbori, Editura Evrika, Brăila, 2001
[6] The Motor Ship, *Waste management is a grey area for owners,* 2001
[7] Marine Technology Society, *Journal Scientific & Technical Diving,* 2001
[8] Buzbuchi, N. - Motoare navale, vol I, Editura Didactică şi Pedagogică, Bucureşti, 1996.
[9] Alexandru, C.- Maşini şi instalații navale de propulsie, Editura Tehnica, Bucuresti, 1991.
[10] Bidoaie I., Sarbu N., Chirica I., Ionaş O., *Indrumar de proiectare pentru teoria navei*, Universitatea Dunarea de Jos, Galati, 1986.
[11] Gh. Dumitru, *Maşini şi instalații de propulsie navale*, vol I.1 , vol I.2 , Universitatea din Galati , 1979.
[12] Bejan, A., Moran M. J. - *Thermal Design and Optimization*, John Wiley and Sons, New York, 1996.

ALGORITHM FOR THE ANALYSIS OF TRANSPORTATION SECTOR ON ENERGY AND EXERGY BASIS

MEMET FEIZA

Constanta Maritime University, Romania

ABSTRACT

In the international effort of achieving sustainability in transport, it is stated that transportation sector is one of the most rapidly growing energy consumer. The aim of this article is to present an algorithm for the analysis of a transportation sector which consists of different subsectors, by the use of energy and exergy concepts in order to reveal energy efficiency of this sector.

Energy and exergy efficiencies, calculated according to the algorithm (for different period of time) are strong tools in hands of policy makers when it is aimed the improvement of this sector. Such an analysis can reveal less performant sub-sectors from a transportation sector, presented methodology allowing also the comparison of transportation sectors from different countries.

Keywords: *transportation sector, energy, exergy, efficiency*

1. INTRODUCTION

Transportation is the activity dealing with the movement of people or/and goods from one location to another.

Technological development changed the means and ways of transport: roads and railways were constructed all over the world, ships were modernized, all these allowing people and goods to travel faster, on longer distances.

Transportation became one of the most important human activities all over the world; it is a component of the economy which plays a significant role in spatial relations between places.

A performant transportation system highly contributes to the development of a country or region, from agricultural or industrial point of view, and it permit products to be found on the market at competitive prices.

Also, it will activate foreign trade and intensify tourism related activities finally reflected by the national income.

Because of the growing freight and people transport, we assist to an increase of pollution level and also to congestion risk.

This is why worldwide strategies aim a more sustainable transport, able to ensure access to goods and services in the same time with the minimization of the negative environmental impact.

The transportation system consists of seven key sub-sectors:

- aviation – it includes aircrafts, air traffic control systems, commercial and military airports, heliports, short takeoff and landing ports and seaplane bases;
- highway infrastructure and motor carrier – it include roadways, bridges, tunnels, automobiles, motorcycles, trucks and even school buses;
- maritime transportation – it includes coastline and waterways, ports, exclusive economic zone and intermodal landside connections;
- mass transit and passenger rail – it includes service by buses, rail transit and long distance rail;
- pipeline systems – it includes pipeline networks, spammed all over the country, supplying to the consumers natural gas, hazardous liquids, or different chemicals;
- freight rail – it includes carriers, railroads, freight cars and locomotives;
- postal and shipping – it includes messages, products and daily financial transactions.

In the case of the naval transportation, as in the others sectors, the energy saving and energy efficiency effectively represent a source of energy production. The efforts in this particular case are high, taking into consideration that the ships and by default the naval engines are complex systems for the specificity of their application range which impose big power and big dimensions. (Stan & Buzbuchi, 2010). In order to find out the best way in saving energy, the simulation- in general and combustion simulation- in particular are very important. The complexity of all the associated phenomena and their strong correlation is making out of this a very difficult task. Once with the emerging of modern computer technologies, mainly the computers with high computer power essentially contributed to the development of combustion models but not only. (Buzbuchi & Stan, 2010).

In “International Energy Outlook 2013”, it is shown that U.S. is the world’s largest transportation energy consumer, being seen that energy consumption for marine and rail travel have an ascendant trend, in accordance with the increase of industrial output.

In Canada, as in U.S., the infrastructure is modern and efficient, but this sector is situated on the second place in the hierarchy of nation’s greenhouse gas emission sources.

Due to strong economic growth, in Mexico and Chile it is registered an increase in transportation energy demand, mainly in highway transportation.

In Europe it is seen a decrease in transportation energy use, coming from the increase in fuel efficiency that outweigh increases in highway travel.

Many European countries have introduced energy and emission taxes on motor vehicles aiming fuel conservation.

This measure is found in retail prices, considerably higher than the ones from U.S.

As a result of a quite moderate population growth and economic growth, transportation energy use in Australia and New Zeeland grows by an average 0,6 percent per year.

Even if Middle East has a relatively small population, this is in continuous growth and urbanization and is asking for more intensive transportation.

This is the explanation for the growth in the region’s transportation energy consumption by an average of 1,5 percent per year.

A typical transportation system, based on four transportation sub-sectors: highways, railways, waterways and civil aviation, will be analysed in this study.

In most of the countries, transport sector is dependent on oil products.

EU and its Member States are involved in diminishing total emissions of a basket of six greenhouse gases by 8% under the 1990 level between 2008 and 2012 (Koroneos et al, 2008).

Results that energy efficiency concept should penetrate more intensive in transport sector.

The most valuable analysis method of energy utilization in the transportation sector is based on using energy and exergy methods.

Thus, in the following will be presented topics related to energy consumption in transportation sector and energy and exergy efficiencies.

2. FUNDAMENTATION OF THE ANALYSIS

For the evaluation of the quality levels of different energy carriers, as fuels are, it is needed to find the equivalents of each energy quantity at a specific grade level.

This is possible by the use of the exergy concept. Exergy is 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.

Shortly, exergy is seen as an expression of the quality of energy.

Exergy analysis is a thermodynamic analysis method for systems and processes based on first and second laws of thermodynamics.

The first law of thermodynamics only deals with the magnitude of energy and does not refer to its quality, while the second law of thermodynamics states that energy is featured both by quantity and quality.

The exergy method of analysis is considered to be a strong tool in improving the performance of the systems due to its benefits:

- more viable efficiencies are determined by the use of this method because exergy efficiency (or second law efficiency) is an indicator of the approach to the ideal;
- it is useful when it is aimed a more efficient energy resource use because it permits the identification of locations, types and real magnitudes of wastes and losses;
- it is a sure method able to indicate whether or not and in what measure it is possible to design more efficient energy systems by reducing the inefficiencies from a considered system;
- it is a significant aspect in achieving sustainable development.

Energy and exergy analysis conclude with calculation of efficiencies; results are interpreted, being stated conclusions and recommendations.

Normally, exergy efficiencies present values under the ones of energy efficiency.

In Figure 1 it is presented the Grassman diagram of a given energy conversion process, where “B” is the symbol of the exergy rate (de Oliveira, 2013).

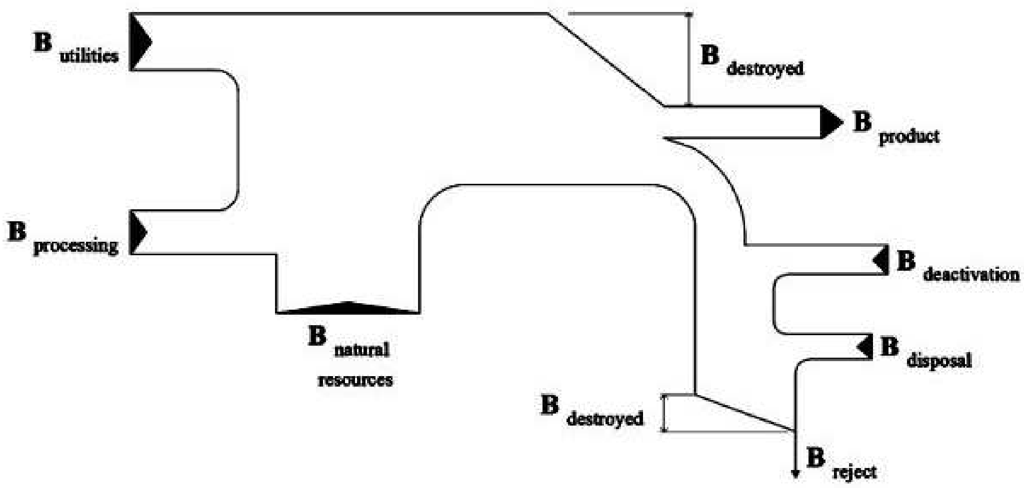


Figure 1 Exergy balance of energy conversion process

3. THEORETICAL BACKGROUND

Energy consumption in a transportation sector is as bellow (Zhang et al, 2011):

$$E^t = \sum_i E_i^t = \sum_{i,j} E_{ij}^t = \sum_{i,j} V_{ij}^t \cdot S_{ij}^t \cdot x_{ij}^t \tag{1}$$

Above, notations are:
- t – time, in years,
- i – number of transportation sub-sectors; in our case i=4 (highways, railways, waterways and airways),
- j – number of transportation modes; in our case j=6, since options are: diesel, electric – for railways, diesel or petrol – for highways, fuel oil – for waterways, fuel oil – for airways,
- E_i^t – energy consumption of the “i” sub-sector in year “t”,
- E_{ij}^t – total energy consumption of “j” mode of the “i” sub-sector in year “t”,
- V_{ij}^t – the converted turnover of “j” mode of the “i” sub-sector in year “t”,
- S_{ij}^t – the ratio of converted turnover of “j” mode of the “i” sub-sector based in year “t” to that of the “i” sector in year “t”,
- x_{ij}^t – the energy consumption per converted turnover of “j” mode of the “i” sub-sector in year “t”.

The turnover is measured by ton-km, while for passenger-trips, person-km is converted to ton-km.

The specific exergy of the fuel at environmental conditions is reduced to the chemical exergy, written as (Sattar et al, 2006):

$$\varepsilon_f = \gamma_f \; H_f \tag{2}$$

where:

γ_f – the exergy grade,

H_f – the higher heating value of the fuel.

Table 1 indicates values of terms involved in equation (1).

Table 1. Data for fuels in discussion

Fuel	H_f (kJ/kg)	ε_f (kJ/kg)	γ_f
Gasoline	47,849	47,394	0,99
Fuel oil	47,405	47,101	0,99
Kerosene	46,117	45,897	0,99
Diesel fuel	39,500	42,265	1,07
Electricity			1

Exergy is assessed with respect to a reference environment.

Referring to reference environment, will be considered, according to weather and climate conditions where analysis is developed, surrounding temperature and pressure and also the chemical composition.

Energy efficiency (first law efficiency), η, and exergy efficiency (second law efficiency), ψ, for the main types of processes involved in such an analysis are as bellow (Al-Ghandoor et al, 2009):

$$\eta = (\text{energy in products/total energy input}) \cdot 100\% \tag{3}$$

$$\psi = (\text{exergy in products/total exergy input}) \cdot 100\% \tag{4}$$

The above efficiencies for shaft work (W) production from electricity are given by (Dincer at al, 2004):

$$\eta_e = W/(m_f H_f) \tag{5}$$

$$\psi_e = E^W/(m_f \varepsilon_f) = W/(m_f \gamma_f H_f) \cong \eta_e/\gamma_f \tag{6}$$

where “W” is the shaft work and “m_f” the fuel mass.

As procedure, are evaluated weighted mean energy efficiencies for each transportation sub-sector, by multiplying weighting factors with specific energy efficiency; weighting factors are given by the ratio of energy input of each sub-sector to the total amount of energy delivered to the sector.

After that, the weighted mean overall energy efficiency of transport sector, for a specific year, is evaluated by summing the weighted mean energy efficiency of all transportation sub-sectors.

The overall weighted mean energy efficiency is determined as:

$$\eta_{ov} = \sum_{i,j} \eta_i \cdot Fr_{i,j} \tag{7}$$

where:
- η_i – the energy efficiency of the “i”-th transportation sub-sector
- $Fr_{i,j}$ – the energy fraction of the “j”-th energy form used by the “i”-th transportation mode.

The overall weighted mean exergy efficiency of transportation sector is found with:

$$\psi_{ov} = \sum_{i,j} (\eta_i/\gamma_i) \cdot Fr_{i,j} \tag{8}$$

where “γ_j” is the exergy factor of the “j”-th energy form.

4. CONCLUSIONS

Exergy based analysis method applied for energy utilization evaluations aiming energy savings, are used by specialists in different industrial sectors and thermal processes.

The exergy method can be successfully applied to the energy utilization assessment of the transport sector of a country.

By the use of presented algorithm, can be determined energy and exergy efficiencies for each sub-sector of transportation, also overall energy and exergy efficiencies.

It will not be a surprise in finding that values of energy efficiencies are lower than the ones of energy efficiencies, since exergy takes into account the losses due to irreversibilities and energy does not.

Results that new energy utilization policies in the transportation sector should rely on exergy instead of energy.

The use of the presented analysis method reveals which sub-sector is the least efficient.

Also, it is possible to compare energy and exergy efficiencies of the transportation sector from different countries, in particular years.

5. REFERENCES

[1] AL-GHANDOOR, A., JABER, J.O., AL-HINTI, I., *Assessment of Exergy and Energy Efficiencies of Power Generation Sub-Sector in Jordan*, Jordan Journal of Mechanical and Industrial Engineering, Vol. 3, No.1, pp.1-8, 2009

[2] BUZBUCHI, N., STAN, L.C. - *Model Simulation of High Power Diesel Engine Exhaust Gas Pollutants*, Proceedings of the 3rd International Conference on Environmental and Geological Science and Engineering (EG'10),http://www.wseas.us/conferences/2010/constantza/eg/, Constanta, Romania, September 3-5, 2010

[3] DINCER, I., HUSSAIN, M.M., AL-ZAHARNAH, I., *Energy and Exergy Utilization in Transportation Sector of Saudi Arabia*, Applied Thermal Engineering, No.24, pp.525-538, 2004

[4] International Energy Outlook 2013, available at www.eia.gov/forecast/ieo/pdf/0484(2013).pdf

[5] KORONEOS, C.J., NANAKI, E.A., *Energy and Exergy Utilization Assessment of the Greek Transport Sector, Resources, Conservation and Recycling*, No. 52, pp.700-706, 2008

[6] de OLIVEIRA Jr, S., *Exergy,Production, cost and Renewability*, Springer, London, ISBN 978-1-4471-4164-8, PP.331, 2013

[7] SATTAR, M.A., JAHIRUL, M.I., MASJUKI, H.H., *An application of Energy and Exergy analysis at the Transportation Sector of Malaysia*, Proc. of the 3-rd BSME-ASME Int. Conference on Thermal Engineering, 20-22 December, Dhaka, Bangladesh, 2006

[8] STAN, L.C., BUZBUCHI, N. - *Operation Factors Influence on the Dynamics Behavior of Marine Propulsion Systems*, Proceedings of the 2nd International Conference on Manufacturing Engineering, Quality and Production Systems (MEQAPS’10), http://www.wseas.us/ conferences/2010/ constantza/ meqaps/, Constanta, Romania, September 3-5, 2010

[9] ZHANG, M., LI, G., MU, H.L., NING, Y.D., *Energy and Exergy Efficiencies in the Chinese Transportation Sector, 1980-2009*, Energy, pp.1-7, 2011.

A STUDY AIMING HEAT TRANSFER COEFFICIENTS ASSESSMENT IN INTERNAL COMBUSTION ENGINES

MITU DANIELA-ELENA

Constanta Maritime University, Romania

ABSTRACT

In the present paper has been analyzed the effect of the heat transfer coefficient on the cylinder combustion pressure. For carry out the analysis has been used a simulation model. This model has been used for the research into the influence of multiple injections on the combustion processes and products in the cylinder of slow-speed marine diesel engines. The combustion nul-dimensional mathematical model was validated by comparing the actual data measured on board a ship and the results obtained from simulations. The paper purpose is to presents the results of the heat transfer influence comparison obtained by applying formulas for the heat transfer used by Woschni, Annand and Eichelberg. The results are statistically analyzed and graphically presented.

Keywords: *heat transfer coefficient, Woschni, Annand, Eichelberg, cylinder combustion pressure.*

1. INTRODUCTION

The different types of heat transfer are usually referred to as modes of heat transfer. There are three of these: conduction, convection and radiation.

- Conduction: This occurs at molecular level when a temperature gradient exists in a medium, which can be solid or fluid. Heat is transferred along that temperature gradient by conduction.
- Convection: Happens in fluids in one of two mechanisms: random molecular motion which is termed diffusion or the bulk motion of a fluid carries energy from place to place. Convection can be either forced through for example pushing the flow along the surface or natural as that which happens due to buoyancy forces.
- Radiation: Occurs where heat energy is transferred by electromagnetic phenomenon, of which the sun is a particularly important source. It happens between surfaces at different temperatures even if there is no medium between them as long as they face each other.

1.1 Conduction

The flow of heat via collisions between atoms and molecules in a substance collisions lead to faster molecules losing speed, and slower molecules gaining speed. This results in the faster molecules transferring some of their kinetic energy to the slower molecules. Thus, heat is always transferred from warmer to colder regions during conduction.

The fundamental law that governs conduction heat transfer is called Fourier's law of heat conduction and is given by:

$$Q_x = -k \cdot A \cdot \frac{dT}{dx} \quad \left[\frac{W}{m^2}\right] \tag{1}$$

where: Q_x is the rate of heat transfer by conduction in x-direction, (W);

(dT/dx) is the temperature gradient in x-direction;

A is the cross-sectional area normal to the x-direction, (m^2);

$k[W/mK]$ is the proportionality constant and is a property of the conduction medium, called thermal conductivity and depends on the materials and their temperature (Table 1).

Table 1 Thermal conductivity values for various materials

Materials	Thermal conductivity, k [W/mK]
Copper	399
Gold	317
Aluminium	237
Iron	80,2
Carbon Steel (1%)	43
Glass	0,81
Plastics	0,2 – 0,3
Wood (shredded/ cemented)	0,087
Water (liquid)	0,6
Hydrogen (gas)	0,18
Air	0,026

1.2 Convection

An energy transfer across a system boundary due to a temperature difference by the combined mechanisms of intermolecular interactions and bulk transport it is called heat convective transfer. Convection needs fluid matter.

Newton's law of heat convection:

$$Q = h \cdot A \cdot \Delta T \tag{2}$$

where: Q - the heat flow from surface, a scalar, (W);

h - the heat transfer coefficient, which is not a thermodynamic property of the material, but may depend on geometry of surface, flow characteristics, thermodynamic properties of the fluid, etc, (W/m^2K);

A - the surface area from which convection is occurring, (m^2);

$\Delta T = T_k - T_f$ - the fluid solid temperature difference; T_k is the temperature of the fluid thin boundary layer at the solid surface from where the heat energy is transferred; T_f is the fluid temperature, (K).

1.3 Radiation

Radiation heat transfer involves the transfer of heat by electromagnetic radiation that arises due to the temperature of the body. Radiation does not need matter.

Emissive power of a surface:

$$E = \sigma \varepsilon T_s^4 \quad \left[\frac{W}{m^2}\right] \tag{3}$$

where: ε - the emissivity, which is a surface property ($\varepsilon = 1$ is black body);

σ - the Stefan Boltzman constant ($\sigma = 5{,}67 \cdot 10^{-8}\, W/m^2K^4$);

T_s - the absolute temperature of the surface, (K).

The above equation is derived from Stefan Boltzman law, which describes a gross heat emission rather than heat transfer.

The expression for the actual radiation heat transfer rate between surfaces having arbitrary orientations can be quite complex.

However, the rate of radiation heat exchange between a small surface and a large surrounding is given by the following expression:

$$Q = \varepsilon \cdot \sigma \cdot A \cdot \left(T_s^4 - T_{sur}^4\right) \quad [W] \tag{4}$$

where: ε - the surface emissivity,

A - the surface area;

T_s - the absolute temperature of surface, (K).

T_{sur} - the absolute temperature of surroundings, (K).

2. HEAT TRANSFER IN INTERNAL COMBUSTION ENGINES

The internal combustion engine is one of the most common and preferred sources of mechanical power in the modern world. This type of engine is used in different fields including but not limited to, transportation and electrical power generation.

Heat transfer to the cylinder walls of internal combustion engines is recognized as one of the most important factors that influences both engine design and operation. In cylinder heat transfer is a significant feature of internal combustion engines (ICEs) which affects engine performance and emissions. However, engine heat transfer analysis and modelling are among the most complicated issues, because of the combustion process, the in-cylinder charge turbulence and the rapid motion of the piston within the combustion chamber. All of these factors contribute to the unsteadiness and local changes of the in-cylinder heat transfer. Moreover, heat transfer also has an effect on the engine exhaust emissions, because of the effect of the temperature changes on the NO_x formation. It was found that a reduction in the peak gas temperature of about (25-50 K) can halve the nitric oxides NO_x emissions [4].

The internal combustion engine (IC) is a heat engine that converts the chemical energy in the fuel into mechanical energy. The process of converting the chemical energy in the fuel is to convert it first to thermal energy by means of combustion with air inside the combustion chamber of the engine. This thermal energy increases the pressure and temperature of the gases within the combustion chamber. The high-pressure gas then expands against the mechanisms of the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, which is the output of the engine. The crankshaft is connected to a transmission and/or power train to transmit the rotating mechanical energy to the desired final use. There are two main types of internal combustion engines, namely two stroke cycles and four stroke cycle, based on the piston movement. In the four stroke engine, the piston experiences four movements over two engine revolutions for each cycle, whereas, in the two stroke engine the piston has only two movements over one revolution for each cycle.

Measurements of heat transfer have been performed and models have been produced by a large number of researchers. The accuracy of predicting the wall heat transfer is required not only to calculate the heat transfer rate from the gas pressure and temperature data, but also necessary for the internal combustion engines to improve the overall engine simulation. The heat transfer process from the gases to the coolant through the combustion chamber wall has in general the three heat transfer elements. From the gases to the combustion chamber wall the heat is transferred mainly by convection with a contribution from radiation. The heat flux is conducted through the combustion chamber walls and then convected from the walls to the coolant, figure 1. In spark ignition engines the radiative component is less important than in compression ignition engine where the radiation heat transfer is significant due to the soot particles during the combustion process [5], [9].

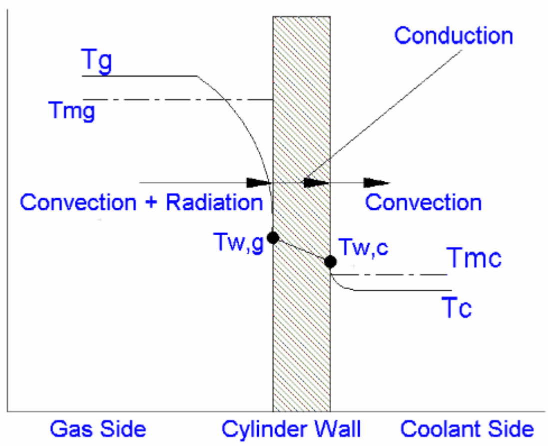


Figure 1 Schematic of temperature distribution and heat transfer modes across combustion chamber wall

The total chemical energy that enters an engine in the fuel is converted into approximately 35% useful crankshaft work and about 30% is carried away from the engine in the exhaust flow. Approximately one third of the total energy is dissipated to the immediate surroundings via heat transfer. Gas temperatures in the combustion chamber during the combustion process may reach 2700 K. Metal components of the combustion chamber cannot tolerate this kind of temperature, which indicates that significant heat transfer must occur in the cylinders of internal combustion engines [8].

The heat transfer from the gases to the combustion chamber walls during the combustion period can reach approximately 10 MW/m^2. Components of the combustion chamber which are in contact with the high-temperature burned gases generally experience the highest heat ux. Thermal stress on these components must be kept under levels that would cause failure or serious engine damage. It is reported that temperature must be less than about 400 ^oC for cast iron and 300 ^oC for aluminium alloys [5]. However, the surface temperature of the piston and cylinder must generally be lower than 200 ^oC in order to avoid decomposition of the lubricating oil [5] [8].

3. T HEAT TRANSFER COEFFICIENTS

Studies [6] and [10] have found that the cylinder liner walls, piston and cylinder head temperature in a stationary mode is a constant one, so that the mean surface temperature can be counted on. The heat transfer coefficients difference over the cylinder liner surface can be ignored, for the purpose of this study, and the mean heat transfer coefficient accepted.

The convection heat transfer speed can be expressed as:

$$\frac{dQ_{st}}{d\varphi} = \sum_{i=1}^{n} \alpha_k \cdot A_{st}\left(T_{st,i} - T_C\right)\frac{dT}{d\varphi}. \tag{5}$$

The wall surface where the heat transfer takes place is equal to the cylinder liner wall exposed surface ($A_{C,i}$), increased for a portion of the piston surface up to the top piston ring:

$$A_{st} = \sum_i A_{C,i} + 2 \cdot d_C \cdot \pi \frac{h_k}{3}, \tag{6}$$

where α_κ is the height from the piston top up to the top piston ring.

In the above expression the greatest unknown is α_κ. Since the gas behaviour (flow) inside the cylinder is a little known, therefore, for calculating α_κ empirical formulas obtained by the experimental measurements of various cases, are commonly in use.

All equations for heat transfer coefficients calculation are based on the Nusselt's heat transfer theory. This dimensionless number is defined by the term: $Nu = \frac{\alpha \cdot b}{K}$ where $\alpha\left[\frac{W}{m^2K}\right]$ is the heat transfer coefficient, b [m] is the wall thickness, and $K\left[\frac{W}{mK}\right]$ is the thermal conductivity coefficient.

Based on the Nusselt's expression and experimental measurements, Woschni [10], [11], has proposed an equation for the mean heat transfer coefficient α_κ, which is used and cited by many authors.

For the purpose of the research presented in this paper, the Woschni's expression is also used into the simulation program specially developed for the doctoral thesis [1], since it gives the best results for the researched topics.

The choice of α_κ depends on the gas velocity at the cylinder liner surface, i.e. the heat exchange between the working fluid and the cylinder liner inner surface is carried out mainly by forced convection. Thus, related to this case, in the literature a large number of expressions for α_κ can be found in literature, and some of the best known are as the following ones:

3.1 Woschni

$$\alpha_K 130{,}5 \cdot D_C^{-0,2} \cdot p_C^{0,8} \cdot T_C^{-0,53} \cdot w^{0,8} \quad \left[\frac{W}{m^2K}\right], \tag{7}$$

where: D_C – the cylinder diameter, [m];
p_C – the cylinder pressure, [bar];
T_C – the cylinder temperature, [K].

$$w = C_1 \cdot c_m + C_2 \cdot \left(p_C - p_{C,K}\right) \cdot \frac{V_S \cdot T_{C,UZ}}{p_{C,UZ} \cdot V_{C,UZ}}, \tag{8}$$

where: c_m – the mean piston speed, [m/s];
V_S – the stroke volume, [m^3];
$P_{C,UZ}$, $T_{C,UZ}$, $V_{C,UZ}$ – pressure, temperature and volume at the inlet valve closing time (in the two-stroke slow-speed marine diesel engine that is the exhaust valve closing time);

$C_1 = 6{,}18 + 0{,}417 \cdot \frac{c_{vr}}{c_m}$ - during the working fluid exchange;

$C_1 = 2{,}28 + 0{,}308 \cdot \frac{c_{vr}}{c_m}$ -during the compression or expansion;

$C_2 = 0{,}00324 \frac{m}{sK}$ - for direct injection diesel engines;

$C_2 = 0{,}00622 \frac{m}{sK}$ - for combustion chamber diesel engines;

$\frac{c_{vr}}{c_m}$ - vortices – secondary piston speed ratio.

3.2 Eichelberg

$$\alpha_K = 2{,}83 \cdot c_m^{0,33} \cdot \left(p_C T_C\right)^{0,5} \quad \left[\frac{W}{m^2K}\right]. \tag{9}$$

3.3 Annand

$$\alpha_K = a \cdot \left(\frac{\lambda}{D_C}\right) \cdot Re^{0,7} + \frac{C}{T_C - T_{st}} \cdot \left[\left(\frac{T_C}{100}\right)^4 - \left(\frac{T_{st}}{100}\right)^4\right], \tag{10}$$

where: a – the coefficient increased by increasing the speed [0,17 up to 0,93];

C – the coefficient that depends on strokes and the engine type:

C = 0 for the compression stroke of gasoline engines,

C = 0,43 for other strokes,

C = 3,27 for diesel engines.

λ – the thermal conductivity, $\left[\frac{W}{m^2K}\right]$;

D_C – the cylinder diameter, [m];

Re – the Reynolds's number, $Re = \frac{\rho \cdot D \cdot c_m}{\mu}$,

where ρ is the density, and μ is the kinematic viscosity.

4. HEAT TRANSFER COEFFICIENTS IMPACT TO COMBUSTION PRESSURE. RESULTS

In the paper purpose, were taken into consideration three heat transfer coefficients: Woschni, Annand and Eichelberg, then the results analysis has been made.

In the figure 2 are presented the indicated pressures values for Wärtsilä 7 RT Flex 50 on 100 % MCR for different crank angles and using different heat transfer formulas.

The figure shows that the best overlap of the measured and simulated values for the tested two-stroke slow-speed marine diesel engine Wärtsilä 7 RT Flex 50 has been obtained by using the Woschni's formula. The formula by Annand and Eichelberg gives little heat transfer so at the end the combustion temperature and pressure are too high as compared to the measured values.

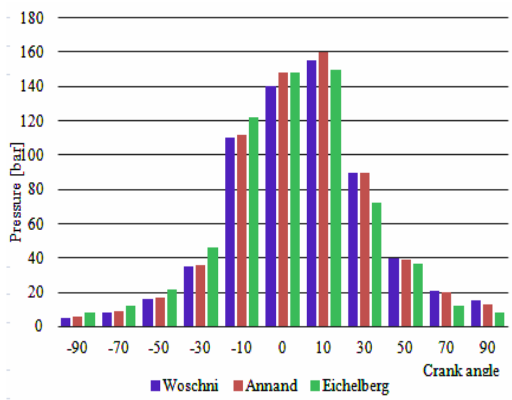


Figure 2 Simulated indicated pressures comparison using different heat transfer formulas

5. CONCLUSIONS

The combustion process simulation results are affected by the heat transfer coefficient and there is a need to choose the best one for a particular research. For different types of engines, the same heat transfer equations do not provide the best results. Therefore, it should be noted that the determination of the most appropriate term for the heat transfer is not easy because it depends on a number of parameters.

The low-power and small diameter IC engines and low piston speed which has a significant impact on the research topics were studied by many researchers. Large slow-speed diesel engines have their own peculiarities that affect, both the combustion and the heat transfer process. Therefore, when modelling the engine processes, a careful attention should be paid in choosing the right heat transfer coefficient(s), as well as the entire heat transfer formula.

In this paper were presented the results of the research carried out on the two most common types of slow-speed marine diesel engines of the MAN B&W ME 60 and Wärtsilä RT Flex 50 new generation. In this simulation the local cylinder temperature are not taken into consideration and the model is simplified by taking mean exhaust gas temperatures, mean cylinder liner wall temperatures and mean cooling water temperature for one combustion process. It should be noted that using the Woschni's formula were obtained the best results.

6. REFERENCES

[1] BERNEČIĆ, D., *Analiza utjecaja višestrukog ubrizgavanja na procese i produkte izgaranja u sporookretnom brodskom dizelskom motoru*, doktorski rad, Pomorski fakultet, Sveučilište u Rijeci, 2011.

[2] MEMET, F., *Entropy generation in steady state heat conduction: a study for the plane wall*, Journal of Marine Technology and Environment, Vol1, pp 109- 114, 2013.

[3] MEMET, F., *Heat transfer and entropy analysis as topics delivered to future marine engineers graduating in CMU*, Proc. of IAMU AGA 14, 26-28 Oct, Constanta, Romania, pp 145-148, 2013.

[4] MEMET, F., MITU, D., E., *Termotehnica. Manualul ofiterului maritime*, Editura Nautica, ISBN 978-606-81105-67-3, Constanta, 2012.

[5] HEYWOOD, J., *Internal Combustion Engine Fundamentals*, 1st ed. New York, NY: McGraw-Hill, 1988.

[6] LÖHNER, K., DÖHRING, E., CHORE, G., *Temperaturschwingungen an der Innenwand von Verbrennungskraftmaschinen*, MTZ, 1956.

[7] NIJEWEME, D., KOK, J., STONE, C. AND WYSZYNSKI, L., *Unsteady in-cylinder heat transfer in a spark ignition engine: experiments and modelling*, Proc Instn Mech Engrs, vol. 215, no. Part D, pp. 747-760, 2001.

[8] PULKRABEK, W., *Engineering fundamentals of the internal combustion engine*, Upper Saddle River, New Jersey: Prentice Hall, 1997

[9] STONE, R., *Introduction to internal combustion engines*, 3rd ed. Chippenham, Wiltshire: Antony Rowe Ltd, 1999

[10] WOSCHNI, G., *Die Berechtung der Wandverluste und thermischen Belastung der Bauteile von Dieselmotoren*, MTZ 31, 12, pp. 491-499, 1970.

[11] WOSCHNI, G., *Einfluß von Rußablagerungen auf den Wärmeübergang zwischen Arbeitsgas und Wand im Dieselmotor*, in Proceedings to Der Arbeitsprozeß des Verbrennungsmotors, Graz 1991.

ALGORITHM FOR THE CALCULUS OF THE GEOMETRICAL CHARACTERISTICS OF THE CROSS SECTIONS BASED ON AN ANALYTICAL GEOMETRY APPROACH

[1]OANTA EMIL, [2]CONSTANTINESCU ELIODOR, [3]LAZAROIU GHEORGHE, [4]AXINTE TIBERIU, [5]DASCALESCU ANCA-ELENA

[1,2,4]Constanta Maritime University, Romania, [3,5]'Politehnica' University of Bucharest, Romania

ABSTRACT

The paper presents original contributions regarding the automatic calculus in structural mechanics domain. The calculus of the stresses and of the displacements requires accurate values of the geometrical characteristics of the sections. A reliable and general method to calculate the geometrical characteristics is to decompose the domain that is the cross section of the bar, in 'simple' shapes, for which there are direct calculus relations. These 'simple' shapes are either solid, or hollow. Each 'simple' shape has assigned some points where the maximum stresses may appear. For the overall cross section, there was conceived and algorithm for the 'filtration' of the points, in order to output the most relevant values of the stresses, meaningful for a structural analyst. Until now, there was developed an algorithm and an original software consisting of more than 9000 computer code lines which considered as 'simple' shapes rectangles and circles. The paper presents the mathematical background and algorithm which, together with rectangles and circles, also considers a triangle as a 'simple' shape. In this way complex shapes may be triangularized and the method may be extensively applied. This general algorithm has several strong points: simple, reliable, always convergent, fast, and potential to increase the accuracy.

Keywords: *Boolean algebra, domain decomposition method, original algorithm, knowledge integration.*

1. INTRODUCTION

Computer based analytic models are important instruments useful in research, CAE and educational fields. Beside their simplicity, analytic models may be easily generalized, from an algorithmic perspective.

Computer based analytic modeling and the automatic calculus in strength of materials are run concerns of the authors, [2], [5], [6], [7], [8], [10], [11], [12], [13].

The paper presents an algorithmic method to generalize the calculus of the geometrical characteristics, based on analytic geometry and computational geometry.

2. PREVIOUS CONTRIBUTIONS

Geometrical characteristics and free body diagrams offer the necessary information to calculate both stresses and displacements of a bar. From this standpoint, the algorithm to calculate the geometrical characteristics must be conceived in a far broader context. In this way there must be considered the calculus of the normal and shear stresses in the most relevant locations of the cross section, in order to apply a failure theory to calculate the equivalent stresses.

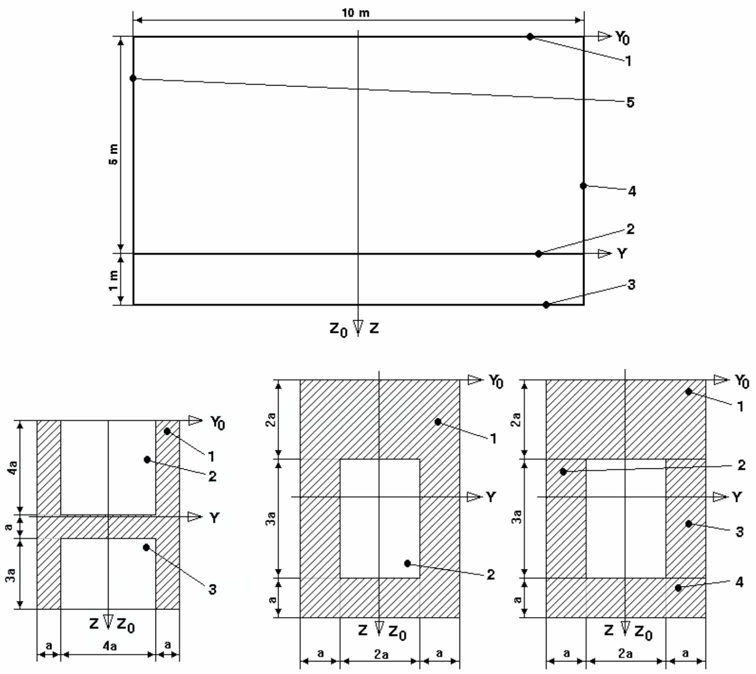


Figure 1 – Various sections divided in solid and hollow 'simple' geometrical shapes.

So far, there was conceived an algorithm which considers the overall shape of the cross-section as a set of simple geometrical bodies. In the class of the 'simple' bodies there are included the shapes for which there are analytical relations for the direct calculus of the geometrical characteristics: rectangles, circles and others. Figure 1 presents some sections divided in 'simple' shapes, solid or hollow.

Beside the theoretical background which is simple, the locations of the points where the stresses should be computed must take into account the areas of the section where both normal and shear stresses have maximum values. The first region is in the most remote area of the section with respect to the centroid axes for the normal stresses and the second one is around the centroid, for the shear stresses. Moreover, in the case of an oblique bending of a bar having a round shape, the extreme values of the shear stresses are in the points of the boundary where the tangents are parallel to the neutral axis. Figure 2 presents the points assigned to the simple shapes where the extreme values may be found.

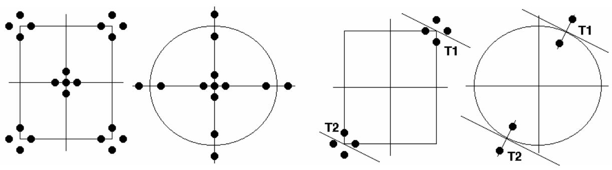


Figure 2 – Locations of the points where the extreme values of the stresses may appear for the 'simple' shapes

For a composite section, many points may be considered several times, so an algorithm to refine the search was developed. As it can be noticed from the figure below, the number of points where the stresses are computed depends on the domain decomposition method.

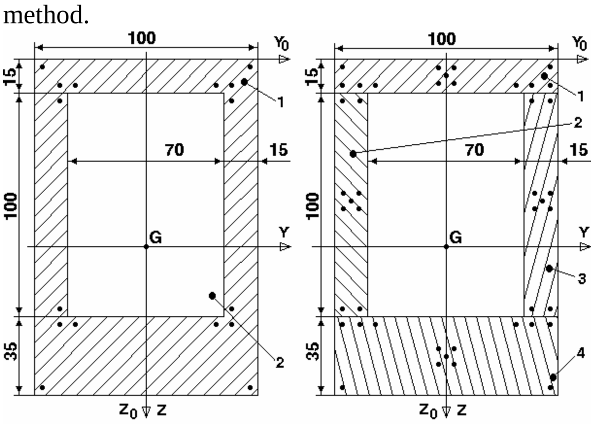


Figure 3 – Locations of the points where the extreme values of the stresses may appear for the composite cross-section, divided in hollow and solid 'simple' shapes

Using this original Boolean algebra which operates with 'simple' shapes having assigned pre-defined points, an algorithm was conceived for both homogeneous and inhomogeneous cross-sections. The algorithm was implemented in a 9000 computer code lines software application. The program generates SCR files for the automatic drawing of the simple shapes in AutoCAD, some examples being given in figures 1 and 3.

Detailed presentation of the algorithm and of the original software is given in references [3], [4], and [9].

3. A GENERAL ALGORITHMIC APPROACH

The contribution presented in the previous section may be applied for many types of section which may be divided in 'simple' shapes, like rectangles and circles.

There must be noticed that complex shapes must consider other 'simple' shapes, beside rectangles and circles. For instance, complex shapes may be approximated with polygons, figure 4.

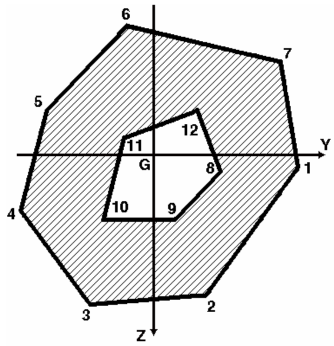


Figure 4 – Complex shaped domain consisting of a solid polygon and a hollow one

As it can be noticed in the figure 4, which presents a complex shape consisting of a solid polygon $1-2-3-4-5-6-7$ and a hollow one, $8-9-10-11-12$, once the problem of a general polygon is solved, there can be solved all the other problems. To have explicit summations of the according geometrical characteristics, for the solid polygon we assign $SGN = +1$ and for the hollow one, $SGN = -1$.

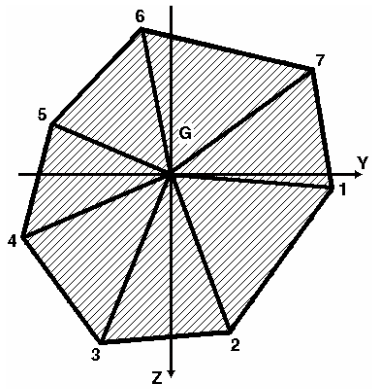


Figure 5 – Domain decomposition using triangles

A general shaped polygon is defined by: the sets of polylines, the coordinates of the vertexes of each polyline, the associated sign, $SGN = \pm 1$ and the physical characteristics of each domain enclosed by a polyline.

Regardless the $SGN = \pm 1$ parameter, let us consider the polygon shaped domain in figure 5. A common procedure in CAE is the discretization of the calculus domain. For instance, for CFD using FDM, discretization means the grid generation, [1], and for FEM it means the generation of the finite elements. In our case, by discretization we consider the triangularization of the domain enclosed by the polyline.

Each generally-located triangle is defined by the coordinated of the corners, figure 6, and it may be included into a 'virtual rectangle'. As it can be noticed, the rectangle $1-2-3$, for which we have SGN_{1-2-3}, may be replaced by the 'relative solid' rectangle $A-B-C-D$, for which $SGN = SGN_{1-2-3}$, plus the 'relative hollow' right triangles $1-A-2$, $2-B-3$ and $3-D-1$, for which $SGN = SGN_{1-2-3} \cdot (-1)$.

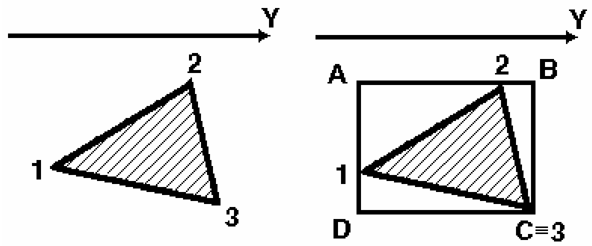


Figure 6 – A generally-located triangle included into a 'virtual' rectangle

The coordinates of the corners belonging to the 'virtual' rectangle are:

$$\begin{cases} A(y_A = y_1; z_A = z_2) \\ B(y_B = y_3; z_B = z_2) \\ C(y_C = y_3; z_C = z_3) \\ D(y_D = y_1; z_D = z_3) \end{cases} \quad (1)$$

The distance between two generally located points M and N may be calculated using the relation:

$$d(M-N) = \sqrt{(y_M - y_N)^2 + (z_M - z_N)^2} \quad (2)$$

This relation may be used to compute the lengths of the sides of the triangles: $d(A-2)$, $d(2-B)$, $d(B-3)$, $d(3-D)$, $d(D-1)$, $d(1-A)$, $d(1-2)$, $d(2-3)$ and $d(3-1)$.

If we denote by a, b and c the lengths of the sides of a triangle and by P the perimeter of the triangle,

$$P = a + b + c \quad (3),$$

the area of this generally located triangle may be calculated using Heron's formula:

$$Area = \sqrt{S \cdot (S-a) \cdot (S-b) \cdot (S-c)} \quad (4),$$

where $S = 0.5 \cdot P$ is the semi-perimeter of the triangle. The area may be directly computed for the right triangles.

According to the Strength of Materials theory, the eccentricities are the distances from the centroid of the geometrical shape to the axis of reference. Accordingly, we have the following values of the e_y eccentricities:

$$\begin{cases} e_{y\,A-B-C-D} = \dfrac{(z_A + z_D)}{2} \\ e_{y\,1-A-2} = z_A + \dfrac{d(A-1)}{3} \\ e_{y\,2-B-3} = z_B + \dfrac{d(B-3)}{3} \\ e_{y\,3-D-1} = z_D - \dfrac{d(1-D)}{3} \end{cases} \quad (5)$$

3.1 General relations for a polygon

In the technical literature, there is considered a general non-self-intersecting closed polygon defined by 'n' vertices: $(y_0; z_0)$, $(y_1; z_1)$, …, $(y_{n-1}; z_{n-1})$, $(y_n; z_n)$, where $y_n = y_0$ and $z_n = z_0$.

According to the technical literature, the area of the polygon is

$$A = |S| \quad (6)$$

where

$$S = \frac{1}{2} \cdot \sum_{i=0}^{n-1} (y_i \cdot z_{i+1} - y_{i+1} \cdot z_i),$$

and the coordinates of the centroid are:

$$\begin{cases} y_G = \dfrac{1}{6 \cdot S} \cdot \sum_{i=0}^{n-1} (y_i + y_{i+1}) \cdot (y_i \cdot z_{i+1} - y_{i+1} \cdot z_i) \\ z_G = \dfrac{1}{6 \cdot S} \cdot \sum_{i=0}^{n-1} (z_i + z_{i+1}) \cdot (y_i \cdot z_{i+1} - y_{i+1} \cdot z_i) \end{cases} \quad (7)$$

3.2 Calculus of the first moments of area of a generally located triangle

The first moments of area may be calculated using the relations:

$$\begin{cases} S_{y\,A-B-C-D} = e_{y\,A-B-C-D} \cdot A_{A-B-C-D} \\ S_{y\,1-A-2} = e_{y\,1-A-2} \cdot A_{1-A-2} \\ S_{y\,2-B-3} = e_{y\,2-B-3} \cdot A_{2-B-3} \\ S_{y\,3-D-1} = e_{y\,3-D-1} \cdot A_{3-D-1} \end{cases} \quad (8)$$

Taking into account SGN for each 'simple' shape, the first moment of area of the $1-2-3$ triangle is:

$$\begin{aligned} S_{y\,1-2-3} = {} & SGN_{A-B-C-D} \cdot S_{y\,A-B-C-D} + \\ & + SGN_{1-A-2} \cdot S_{y\,1-A-2} + \\ & + SGN_{2-B-3} \cdot S_{y\,2-B-3} + \\ & + SGN_{3-D-1} \cdot S_{y\,3-D-1} \end{aligned} \quad (9)$$

and the overall first moment of area is:

$$S_y = \sum_{i \neq j \neq k \neq i}^{i=j=k=NN} SGN_{i-j-k} \cdot S_{y\,i-j-k} \quad (10)$$

where NN is the total number of nodes employed to discretize the calculus domain.

In the same way is calculated the other first moment of area, S_z.

3.3 Calculus of the second moments of area of a triangle and of a polygon

According to the technical literature and taking into account the notations in figure 6, the second moments of area may be calculated using the relations:

$$\begin{cases} I_{y\ A-B-C-D} = \dfrac{d(A-B)\cdot d^3(A-D)}{12} + \\ \qquad + e^2_{y\ A-B-C-D}\cdot A_{A-B-C-D} \\ I_{y\ 1-A-2} = \dfrac{d(A-2)\cdot d^3(1-A)}{36} + \\ \qquad + e^2_{y\ 1-A-2}\cdot A_{1-A-2} \\ I_{y\ 2-B-3} = \dfrac{d(2-B)\cdot d^3(B-3)}{36} + \\ \qquad + e^2_{y\ 2-B-3}\cdot A_{2-B-3} \\ I_{y\ 3-D-1} = \dfrac{d(3-D)\cdot d^3(D-1)}{36} + \\ \qquad + e^2_{y\ 3-D-1}\cdot A_{3-D-1} \end{cases} \tag{11}$$

Taking into account SGN for each 'simple' shape, the second moment of area of the $1-2-3$ triangle is:

$$\begin{aligned} I_{y\,1-2-3} &= SGN_{A-B-C-D}\cdot I_{y\ A-B-C-D} + \\ &+ SGN_{1-A-2}\cdot I_{y\,1-A-2} + \\ &+ SGN_{2-B-3}\cdot I_{y\ 2-B-3} + \\ &+ SGN_{3-D-1}\cdot I_{y\ 3-D-1} \end{aligned} \tag{12}$$

and the overall second moment of area is:

$$I_y = \sum_{i\neq j\neq k\neq i}^{i=j=k=NN} SGN_{i-j-k}\cdot I_{y\ i-j-k} \tag{13}$$

where NN is the total number of nodes employed to discretize the calculus domain.

In the same way is calculated the other second moment of area, I_z.

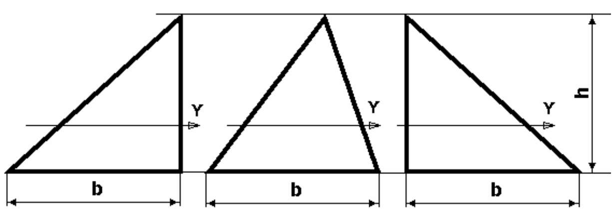


Figure 7 – Triangles having a particular position with respect to axis Y

However, there are certain cases when the triangle has a particular position, figure 7, and its second moment of area may be computed using the relation:

$$I_y = \frac{b\cdot h^3}{36} + e_y^2\cdot A \tag{14}$$

3.4 Calculus of the product moment of area of a triangle and of a polygon

According to the technical literature and taking into account the notations in figure 6, the product moment of area may be calculated using the relations:

$$\begin{cases} I_{yz\ A-B-C-D} = e_{y\ A-B-C-D}\cdot e_{z\ A-B-C-D}\cdot A_{A-B-C-D} \\ I_{yz\,1-A-2} = \dfrac{d^2(A-2)\cdot d^2(1-A)}{24} + \\ \qquad + e_{y\,1-A-2}\cdot e_{z\,1-A-2}\cdot A_{1-A-2} \\ I_{yz\ 2-B-3} = \dfrac{d^2(2-B)\cdot d^2(B-3)}{24} + \\ \qquad + e_{y\ 2-B-3}\cdot e_{z\ 2-B-3}\cdot A_{2-B-3} \\ I_{yz\ 3-D-1} = \dfrac{d^2(3-D)\cdot d^2(D-1)}{24} + \\ \qquad + e_{y\ 3-D-1}\cdot e_{z\ 3-D-1}\cdot A_{3-D-1} \end{cases} \tag{15}$$

Taking into account SGN for each 'simple' shape, the product moment of area of the $1-2-3$ triangle is:

$$\begin{aligned} I_{yz\,1-2-3} &= SGN_{A-B-C-D}\cdot I_{yz\ A-B-C-D} + \\ &+ SGN_{1-A-2}\cdot I_{yz\,1-A-2} + \\ &+ SGN_{2-B-3}\cdot I_{yz\ 2-B-3} + \\ &+ SGN_{3-D-1}\cdot I_{yz\ 3-D-1} \end{aligned} \tag{16}$$

and the overall product moment of area is:

$$I_{yz} = \sum_{i\neq j\neq k\neq i}^{i=j=k=NN} SGN_{i-j-k}\cdot I_{yz\ i-j-k} \tag{17}$$

where NN is the total number of nodes employed to discretize the calculus domain.

For the right triangles in figure 7, there may be used the direct relation:

$$I_{yz} = \frac{b^2\cdot h^2}{24} + e_y\cdot e_z\cdot A. \tag{18}$$

Second moments of area and product moment of area of the overall section are useful for the computation of the normal stresses. The shear stresses are calculated using Juravsky's relation, which requires to evaluate the value of the first moment of area, in various locations of the section.

3.5 Calculus of the first moments of area of a region of a polygon

Let us consider the most general case for the evaluation of the S_y first moment of area, case presented in the figure 8.

For a random position of the z coordinate, we have an area enclosed by the boundary and the horizontal line, figure 8. We must calculate the first moment of area for this hatched area.

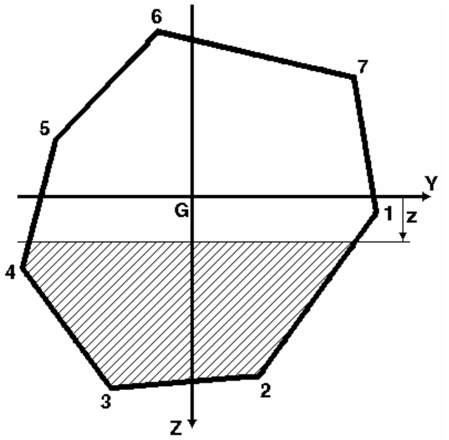


Figure 8 – General case considered for the calculus of the first moment of the hatched area inside a polygon

The boundary of the area is the polygonal line: $I_1-2-3-4-I_2$, figure 9.

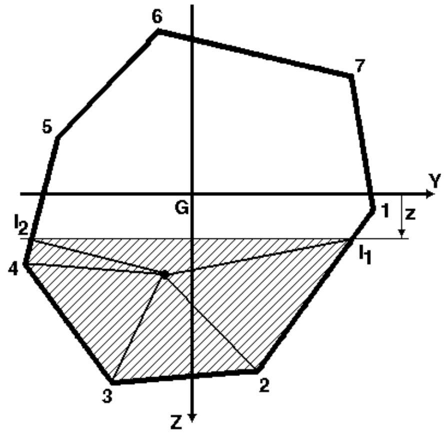


Figure 9 – Domain decomposition method employed to calculate the first moment of area

For a random position of coordinate z, we have several choices to calculate the first moment of area:

- first option is to consider the $I_1-2-3-4-I_2$ polygon as a standalone polygon, to apply relations (6) and (7) and then to directly calculate S_y;
- second option is to triangularize the $I_1-2-3-4-I_2$ polygon and, for these triangles, to apply the method presented in section 3.2;
- third option is to use the triangularization of the initial polygonal domain and to apply the ideas presented in figure 10.

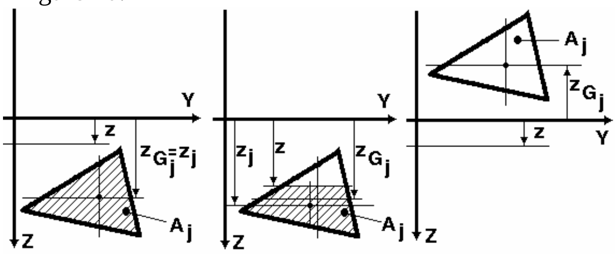


Figure 10 – Position of a triangle with respect to the current z coordinate

As it can be noticed in the previous figure, there are three positions of the triangle with respect to the current coordinate, z. For the leftmost case $S_y=0$. For the rightmost case S_y is calculated using the methodology presented in section 3.2.

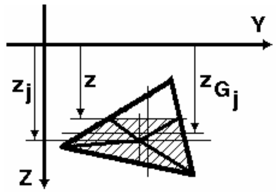


Figure 11 – The hatched quadrilateral is divided in triangles

For the case when the current z coordinate is intersecting the triangle, figure 11, the quadrilateral domain is divided in triangles and for each triangle is applied the computing methodology presented in detail in section 3.2.

The aspects regarding the output data refining process will be presented in a follow-up paper.

4. CONCLUSIONS

The analytical geometry approach previously presented may be the foundation of an original software which can be developed in order to automatically calculate stresses in the cross section of a bar loaded with bending moments and shear forces.

The algorithm previously presented has a series of strong points, such as:

- it is fast, no iterations being required;
- being a non-iterative algorithm, the parallelization of the calculus may be easily done;
- it is reliable, no complex mathematical background being required;
- the convergence of the solution is not a problem;
- it is very close to the technical common sense, so the results may be easily interpreted by a structural analyst;
- a flexible design of the implementation may lead to a library of software applications which can be included in a sustainable development strategy regarding the automatic calculus in structural studies, using analytic models.

As weak points, one could notice that the curved boundaries are approximated with segments, which leads to an inherent lack of accuracy. However, there are two ways to improve the precision:

- a more accurate approximation using a larger number of segments, but it leads a larger running time of the according software;
- a mathematical generalization of the problem, in order to allow the definition of mathematical functions for the boundaries of the calculus domain, this solution being in progress.

The mathematical generalization previously mentioned, together with the algorithm presented in this paper and the previous contributions lead to an upper level of knowledge integration in the structural studies domain.

5. ACKNOWLEDGEMENT

Ideas regarding the mathematical background of the models based on the strength of materials theory are the result of the models developed in the framework of the MIEC2010 bilateral Ro-Md research project, 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, under the supervision of the National Authority for Scientific Research (ANCS), Romania, that is the follow-up of the ID1223 scientific research project: Oanta, E., Panait, C., Nicolescu, B., Dinu, S., Pescaru, A., Nita, A., Gavrila, G., (2007-2010), "Computer Aided Advanced Studies in Applied Elasticity from an Interdisciplinary Perspective", under the supervision of the National University Research Council (CNCSIS), Romania.

Ideas regarding the automatic calculus in structural studies are the result of the models developed in the framework of the scientific research study 'Development of computer assisted marine structures', Emil Oanta, Cornel Panait, Ghiorghe Batrinca, Alexandru Pescaru, Alexandra Nita, Feiza Memet, which is a component of the RoNoMar project, 2010

6. REFERENCES

[1] DINESCU, C.; OANTA, E., *The Influences of the Grid Generation on the Numerical Modeling of the Unsteady Flows in Marine Diesel Engines*, International Symposium on Marine Technologies and Management - TEHNONAV 1998, OVIDIUS University of Constanța, May 21-23, 1998, Vol I, pag. 75-82, ISBN: 973-9367-10-0

[2] OANTA, E., *Tendințe actuale privind utilizarea calculatorului în domeniul Rezistenței Materialelor*, 'Consfătuirea didactico-metodologică REZMAT', Catedra Rezistența Materialelor, Universitatea Tehnică Timişoara, 05 Martie 1994

[3] OANTA, E., *Software for the Calculus of the Geometrical Characteristics of a General Shaped Cross-Section*, International Symposium on Marine Technologies and Management - TEHNONAV 1998, OVIDIUS University of Constanța, May 21-23, 1998, Vol II, pag. 159-166, ISBN 973-9367-10-0

[4] OANTA, E., *Computer Based Method for the Calculus of the Stresses*, International Symposium on Marine Technologies and Management - TEHNONAV 1998, OVIDIUS University of Constanța, May 21-23, 1998, Vol II, pag. 143-150

[5] OANTA, E., *Aspecte ale calculului automat în rezistența materialelor*, Consfătuirea Națională a Catedrelor de Rezistența Materialelor - REZMAT 6 - Academia Navală Constanța, 3 Iunie 1999, pag. 81-86

[6] OANTA, E. *Fundamente teoretice în programarea aplicațiilor de inginerie mecanică asistată de calculator*, 294 pages, Editura Fundatiei "Andrei Saguna", Constanta, 2000, ISBN 973-8146-04-6, Preface by Aramă Constantin, Prof. Dr. H. C., member of the Romanian Science Academy

[7] OANTA, E., PANAIT, C., NICOLESCU, B., DINU S., PESCARU A., NITA A., GAVRILA G., *Computer Aided Advanced Studies in Applied Elasticity from an Interdisciplinary Perspective*, ID1223-Scientific Research Project, National University Research Council (CNCSIS), 2007-2010, Romania

[8] OANTA, E. *Applied Elasticity Computer Models in Automatic Design*, Proceedings of The 2nd International Multi-Conference on Engineering and Technological Innovation: IMETI2009, Section Mech. Eng. including Industrial Eng., Operations research, Aerospace, Marine and Agricultural Eng., Mechatronics, Robotics, July 10th-13th, 2009, Orlando, Florida, USA, Organized by the International Institute of Informatics and Systemics, Volume: ISBN-10 1-934272-68-X, ISBN-13 978-1-934272-68-8, Edited by: Nagib Callaos, Hsing-Wei Chu, Yaroslava Yingling, C. Dale Zinn, pp. 270-275

[9] OANTA, E., NITA, A., *An Original Method to Compute the Stresses in Applied Elasticity*, Journal of Optoelectronics and Advanced Materials - Rapid Communications (OAM-RC), Editor in-chief: Prof. Dr. Mihai A. Popescu, ISSN: Print: 1842-6573, Impact factor 0.224, Vol. 3, No. 11, Nov. 2009, pp. 1226-1230

[10] OANTA, E., *Studii de caz privind modelarea analitica asistata de calculator*, RezMat18 National Conference, Galati, Romania, 2011

[11] OANTA, E.; PANAIT, C.; BATRINCA, G. & PESCARU, A.: *Basic Concepts to Design the Software Application of a Computer Based Mechanical Engineering Model*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISBN 978-3-901509-83-4, ISSN 1726-9679, pp 0505-0506, Editor B Katalinic, Published by DAAAM International, Vienna, Austria 2011

[12] OANTA, E.; PANAIT, C.; MARINA, V.; MARINA, V.; LEPADATU, L.; CONSTANTINESCU, E.; BARHALESCU, M. L.; SABAU, A. & DUMITRACHE, C. L.: *Mathematical Composite Models, a Path to Solve Research Complex Problems*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISBN 978-3-901509-83-4, ISSN 1726-9679, pp 0501-0502, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria 2011

[13] OANTA, E., PANAIT, C., BATRANCA, G., PESCARU, A., NITA, A., MEMET, F., *Development of Computer Assisted Marine Structures*, 130 pag, Editura Nautica, Constanta, 2012, ISBN 978-606-8105-70-3, 629.5

IDEAS REGARDING THE MATHEMATICAL BACKGROUND OF THE ANALYTIC MODELS BASED ON THE STRENGHT OF MATERIALS THEORY

[1]OANTA EMIL, [2]CONSTANTINESCU ELIODOR, [3]LAZAROIU GHEORGHE, [4]AXINTE TIBERIU, [5]DASCALESCU ANCA-ELENA

[1,2,4]Constanta Maritime University, Romania, [3,5]'Politehnica' University of Bucharest, Romania

ABSTRACT

The paper presents some of the basic notions from mathematics which are widely used in the strength of materials theory. Beside the mathematical background, for each mathematical solution the paper presents the technical problems solved in strength of materials and the according original computing methods conceived along the time. The mathematical background is useful in the development of the analytic models and methods, widely used in the computer aided engineering. In this way, the pre-dimensioning of the mechanical parts may be done by the use of some original computing instruments based on analytic models and then studied by the use of the modern computer aided engineering technologies. The mathematical background, together with the numerical methods solutions may be used to solve problems above the classic hypotheses of the strength of materials discipline. To conclude, the paper synthesize information from several academic disciplines: strength of materials, mathematics, numerical methods, theory of elasticity, computer science, this knowledge integration strategy being useful to expand the limits of the classic theory and to create modern calculus instruments for structural problems.

Keywords: *mathematics, hypothesis, strength of materials rules, knowledge integration.*

1. INTRODUCTION

Solving a complex problem requires various types of methods and models, figure 1. Apart from the classification presented in the figure above, complex problems require models which use various types of methods: analytic, numerical and experimental. The analytic component is important, because it is used in all the other approaches, offering both a 'technical common sense' to evaluate qualitatively the problem and the calculus methodology which offers quantitative information.

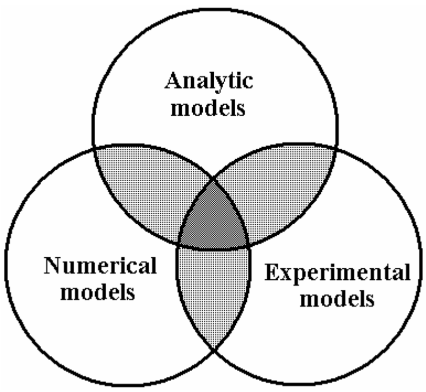


Figure 1 – Types of models in research

From another standpoint, there are several approaches to solve a structural problem in mechanical engineering: analytic methods, engineering methods and 'technical common sense' ones. Analytic methods are useful to design the computer based solutions of a given structural problem. Solving analytically strength of materials problems requires a set of basic information resulted from other engineering topics, such as: mathematics, mechanics, and computer aided geometry/design. Mathematics offers the necessary background and it is important to emphasize on the basic and important mathematical notions which are commonly used in strength of materials models.

2. SYSTEM OF AXES

Strength of materials theories, [1], uses either a right-hand system of axes, or a left-hand system. In the following sections we consider the right-hand system.

The second aspect which must be clarified is about the position of the system of axes with respect to the bar. Let us consider that along the bar we have axis x, downwards is axis z and the direction of the third axis results from the direction of the right-hand system of axes. In this case, axis y is oriented outside the page, in the direction of the reader.

Regarding the sectional problems (geometrical characteristics of the cross-sections, diagrams of normal and shear stresses) there must be used a certain orientation of the axes with respect to the type of the system and position on the bar. In this case, the important aspect is the position of the observer. Let us consider that the observer is looking along the bar in the direction of the x axis. In figure 2, the observer is located at the leftmost end of the bar and the according sectional axes are y on horizontal direction and z on vertical direction. Figure 2 also presents the system of axes used in mathematics in order to draw the graph of a function. All the notions of mathematics may be reused for sectional problems in strength of materials if the law of variation $y = f(x)$ is considered $'Vertical\,axis' = f('Horizontal\,axis')$. In this way the law of variation for the sectional problem, becomes $z = f(y)$.

Using these three basic aspects, a structural analyst may easily adapt to different problems where the system of axes may be different. There must be also defined the sign rule which takes into account the ‘in-tension’ axial force and the mutual orientation of the sectional components with respect to their own axes. Regarding the representation rule for the free body diagrams there must be considered the fiber-in-tension rule for the bending moment diagrams. These general rules may be applied for any approach in solving structural problems, including the ‘technical common sense’ one.

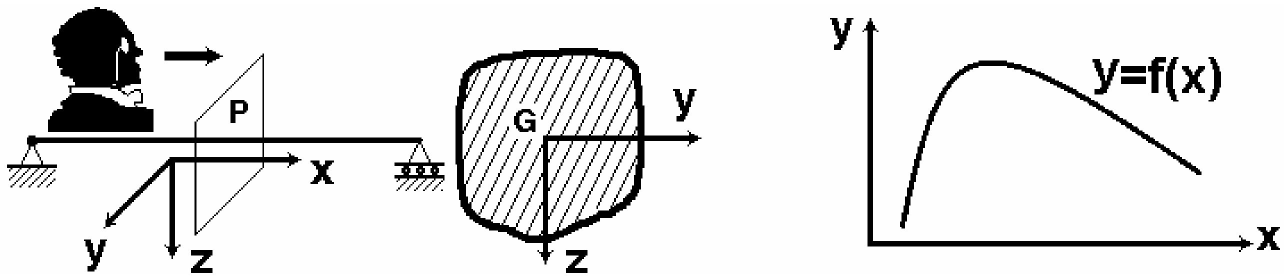


Figure 2 – Systems of axes in mathematics and in strength of materials and the position of the observer.

3. USEFUL TOPICS FROM MATHEMATICS

There are several important mathematical aspects which are useful in the design of a strength of materials model which is based on several sub-models: model of the geometry, model of the loads, model of the supports, and model of the materials’ behaviour. In this section are presented some of the most important mathematical aspects, together with some original solutions.

3.1 Analytical geometry

Analytical geometry is usually employed to define the computing domains where solutions are searched. In this case, computer aided solutions are extensively using the analytical geometry in order to define the geometrical model of the structures. Notions of analytical geometry are used:

- to calculate the neutral axis equation;
- to determine the analytic definition of the boundaries of the core of a cross-section (the part of the column section in which the load can be applied without causing tensile stress anywhere in the section), as presented in figure 3;
- to create the models of the stress-strain curves.

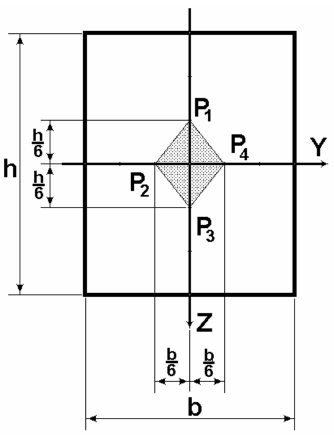


Figure 3 – Core of a rectangle cross-section

In computer aided modelling there are several other cases when analytical geometry is extensively employed to solve various problems, figure 4.

3.2 Equations

Solutions of the equations are used:

- to calculate the position of the section where an extreme value of the bending moment or of the displacement is reached, figure 4;
- to calculate the position of a load along a bar in order to satisfy a given constraint.

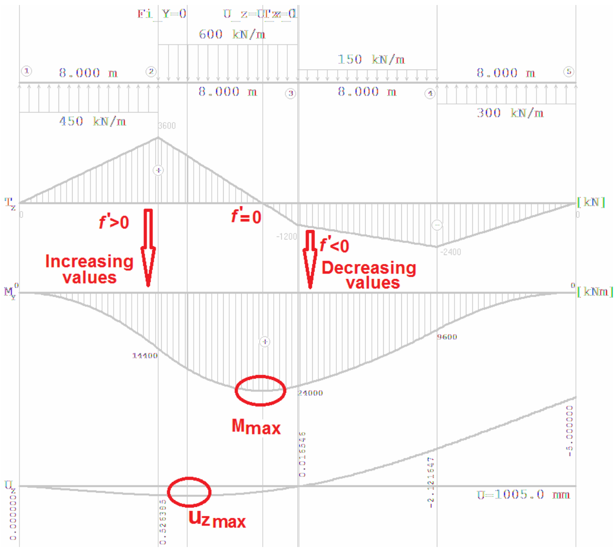


Figure 4 – Sign analysis of functions applied in the strength of materials theory

Equations may be solved using either classic ‘exact’ methods, or if an analytic solution cannot be found, a numerical methods solution.

Reference [9] presents an original method to compute the coefficient of linear expansion and the temperature using experimental data resulted from an experimental study based on the strain gage technology, the algorithm being based on the bisection method.

3.3 Trigonometry

Apart from the trigonometric unit circle (even and odd trigonometric functions, values of the trigonometric functions), notions of trigonometry are widely used to calculate the values employed in free body diagrams for curved beams in 2D or 3D problems, where there must be solved the following type of equation:

$$a \cdot \sin(\alpha) + b \cdot \cos(\alpha) + c = 0 \qquad (1).$$

The variation of the moments of inertia, strains and stresses with respect to a rotated system of axes also uses notions of trigonometry to derive the calculus relations for both general and particular cases.

Calculus of the principal directions and of the principal second moments of area, principal strains and principal stresses also uses notions of trigonometry.

Geometrical interpretation of the geometrical characteristics of the sections, of the strain and stresses use Mohr's circle, where notions of trigonometry are also required.

From a wider perspective, trigonometric series are used to model various problems in the theory of elasticity.

Finally, in several proofs, because of the small displacement hypothesis, there is considered that for small angles, α, there may be used the following approximations: $\sin(\alpha) \approx \alpha$ and $tg(\alpha) \approx \alpha$, for instance

$$\frac{1}{\rho} = \frac{u''}{\left[1 + (u')^2\right]^{\frac{3}{2}}} \approx u'' \qquad (2),$$

where $(u')^2 \approx 0$ for angles $\alpha < 6^\circ$. Same approximation is also used to proof several relations in the theory of the strains.

3.4 Differential equations

There are several cases when the differential equations are governing structural phenomena in strength of materials, for instance the relation between the distributed force, shear force, bending moment, rotation and displacement for a straight beam:

$$\frac{d^4 u_Z(x)}{dx^4} = \frac{d^3 \varphi_{XOZ}(x)}{dx^3} = -\frac{1}{E \cdot I_Y} \cdot \frac{d^2 M_Y(x)}{dx^2} = = -\frac{1}{E \cdot I_Y} \cdot \frac{dT_Z(x)}{dx} = -\frac{1}{E \cdot I_Y} \cdot p_Z(x) \qquad (3)$$

Several methods to solve the differential equations are used in strength of materials, either analytical, or based on geometrical aspects (widely employed in engineering). Some of the methods are customized in order to take into account the particular aspects of the structural problems: specific boundary conditions (supports, cantilever ends, internal pinned / hinged connections, variation of the cross-section geometrical characteristics and others). Moreover, in this way, complex analytic models may be created, over the basic hypotheses currently used in strength of materials, such as the problem of the elastic supports. Thus, the Method of the Initial Parameters is employed to calculate the laws of variation of the displacement and of the rotation for a straight bar. The results, displacements and rotations may be verified using alternate analytic models based on strain energy methods or on Clapeyron's theorem of the three moments.

The mathematical relation between a function and its derivative lead to equations, case presented in section 3.2 or may be applied to the calculus of the principal directions, case presented in section 3.3. This relation is also employed to relate the free body diagrams, such as the sign of the shear force diagram and the variation of the according bending moment diagram, figure 4.

3.5 Calculus of the integrals

Integrals are widely used to define various notions in strength of materials. Calculus of the geometrical characteristics of the cross-sections, strain energy methods, equations of static equivalency, calculus of the coefficients employed in the three moments equation are using integrals which may be calculated either by direct methods or using geometrical interpretation of the integral as the area between the graphic of a given function and the horizontal axis. As an example, the general relation employed to calculate a generic displacement, δ_K, using strain energy methods is:

$$\delta_K = \sum_{i=1}^{n}\left[\frac{1}{(E \cdot A)_i} \cdot \int_{L_i} (N_i \cdot n_i) \cdot dx\right] + \sum_{i=1}^{n}\left[\left(\frac{k_Y}{G \cdot A}\right)_i \cdot \int_{L_i} (T_{Y\,i} \cdot t_{Y\,i}) \cdot dx\right] + + \sum_{i=1}^{n}\left[\left(\frac{k_Z}{G \cdot A}\right)_i \cdot \int_{L_i} (T_{Z\,i} \cdot t_{Z\,i}) \cdot dx\right] + \sum_{i=1}^{n}\left[\frac{1}{(G \cdot I_P)_i} \int_{L_i} (M_{X\,i} \cdot m_{X\,i}) \cdot dx\right] + + \sum_{i=1}^{n}\left[\frac{1}{(E \cdot I_Y)_i} \int_{L_i} (M_{Y\,i} \cdot m_{Y\,i}) \cdot dx\right] + \sum_{i=1}^{n}\left[\frac{1}{(E \cdot I_Z)_i} \int_{L_i} (M_{Z\,i} \cdot m_{Z\,i}) \cdot dx\right] \qquad (4)$$

where $k_{Y\,i} = \frac{A}{I_{Y\,i}} \cdot \int_A \left(\frac{S_Y^2}{b_Y}\right) \cdot dx$, $k_{Z\,i} = \frac{A}{I_{Z\,i}} \cdot \int_A \left(\frac{S_Z^2}{b_Z}\right) \cdot dx$.

Generally, the integrals are computed using either direct methods, or numerical methods approaches.

In strength of materials there may be also used dedicated methods, such as Veresciaghin's rule of integration. Another specific aspect regards the calculus of the integrals in the Clapeyron's three moments method.

Based on specific hypotheses, there are methods to evaluate the importance of the values of the integrals, and to approximate some of the less importance integrals by zero, when the ratio computing time vs. accuracy is focused on the readily calculus and the according precision is satisfactory. For instance, in relation (4), the current calculus methods consider only the influence of the twisting moment and of the bending moments onto the general state of loads.

The differential equation of the neutral fiber was integrated using an 'exact' mathematical method, [13], by disregarding the hypothesis of the small displacements, presented by relation (2). The according integrals were calculated using numerical methods and the results, above the strength of materials theory are applicable for the flexure of the slender bars.

3.6 Interpolation

Interpolation is used to approximate the value of a function defined in a series a points. There are several mathematical interpolation methods.

In strength of materials interpolation is used in many cases to deduce the laws of variation of some given parameters, laws which are used at a later stage for automatic dimensioning of various mechanical parts.

Experimental data reduction, [8], uses interpolation methods either for the analytical description of some graphs resulted from experimental studies, or directly in the experimental data processing stages.

Relations (5) present the shear stresses and the angle of twist of a bar having a rectangular cross section:

$$\begin{cases} \tau_{\max} = \dfrac{M_r}{\alpha \cdot h \cdot b^2} \\ \tau_{\max\ \max} = \dfrac{M_r}{\alpha' \cdot h \cdot b^2} \end{cases}, \ \Delta\varphi = \frac{M_r \cdot \ell}{\beta \cdot h \cdot b^3 \cdot G} \qquad (5)$$

Coefficients α, α' and β are given in tables depending on the height / width ratio between the sides of the rectangle. To solve simple problems with medium precision accuracy of the results, the linear interpolation would be appropriate. Interpolation may be used to have precise values for ratios between the sides which are not included in the tables.

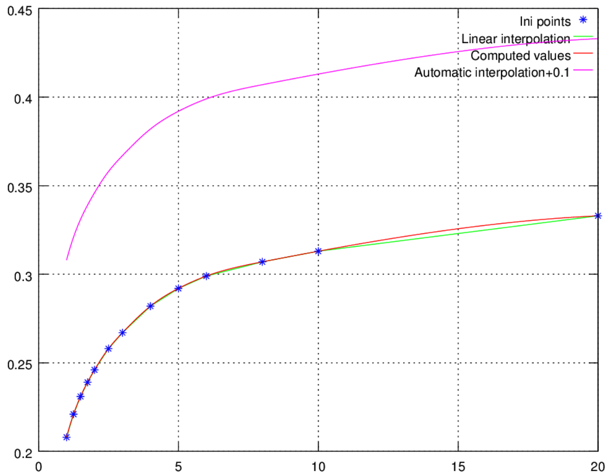


Figure 5 – Tests regarding the interpolation of the values of the α coefficient in Octave using spline functions

Calculus of the laws of variation may be done either in Excel or in Octave / MATHLAB, [2], [7]. If a higher degree of precision is required, there may be used calculus methods from the theory of elasticity (trigonometric series or the finite difference method), methods which have their own inherent lack of accuracy from the numerical computing based perspective.

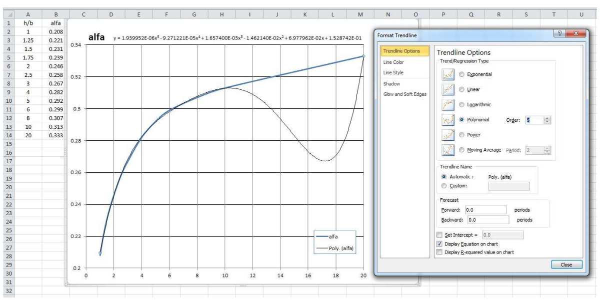


Figure 6 – Tests regarding the accuracy of the interpolation of the values of the α coefficient in Excel using polynomial interpolation, being searched the most appropriate degree which best fits the original values

Other cases when interpolation is necessary are:

- laws of variation of the stress concentration coefficients;
- laws of variation of the coefficients which influence the fatigue phenomena, such as: size factor, surface finish factor, fatigue notch factor, fatigue stress concentration effective factor.

All this types of coefficients require laws of variation in order to create automatic dimensioning computing algorithms.

Interpolation was also employed in the automatic processing of the experimental data resulted from fotoelasticimetry studies, [19].

3.7 *Euclidian vector calculus*

The Euclidian vector calculus is extensively used in strength of materials. Algebraic and differential operations are used to model various phenomena. Vector calculus is usually used for forces and moments and their variation with respect to the current phenomenon which is modelled, such as the force torsor along a beam (2D/3D, straight/curved). Vector calculus is also used to establish relations between tensors expressed as stresses by considering vector operations between infinite small vectors generated by stresses, such as $d\vec{F}$ and $d\vec{M}$.

3.8 *Systems of equations*

Several models based on the strength of materials theory lead to a system of equations which must be solved.

In the class of the systems of indeterminate bars solutions are based on one of the following methods:

- Mohr Maxwell method – unknowns may be forces and moments, [11];
- method of initial parameters – unknowns may be forces, moments, rotations and displacements, [12], [17], [20];
- Clapeyron's theorem of three moments – unknowns may be bending moments or displacements.

All these methods lead to systems of linear equations.

Another problem where a system of equations must be solved is the calculus of the shear stresses in the walls of a multi-connected section loaded by a torque. The equations of the problem are similar with the Kirchhoff's circuit laws, in this case the unknowns being the shear flow.

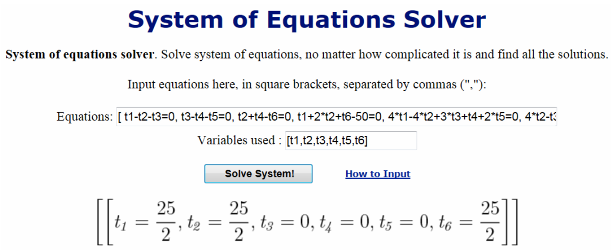


Figure 7 – Online solver employed to calculate the shear stresses in a multi-connected section loaded by a torque

Systems of equations may be solved either ‘by hand’ using a mathematical ‘exact’ method or using a computer based instrument. In the figure above, it is presented an online solver. Several online applications may be found in order to solve some numeric aspects, so it can be noticed that the instruments evolved and more complex analytic models may be conceived.

4. ANALYTIC MODELS

Creation of an analytic model of a structural problem which uses the strength of materials theory requires notions from several academic disciplines, such as: mathematics, computer aided technical drawing, numerical methods, and computer programming. The mathematical background of these analytic models is useful in other academic disciplines, such as: machinery design, theory of elasticity [4], [5], [6], [21], [22], [23], [24] and the finite element method, [10].

Beside the classic mathematical solutions employed to solve the analytic models, there may be noticed some actual trends:

- wide spread of more sophisticated software applications, which offer a support to solve more complex models;
- because of this support, numeric solutions for complex analytic models may be easily conceived;
- a library of original software applications which solve numerical methods problems is necessary to rapidly develop computer aided analytic models.

From this standpoint, an exhaustive survey of the mathematical models in strength of materials is necessary in order to conceive the concepts and the instruments employed to readily develop analytic models, [15], [16], [18].

5. CONCLUSIONS

Analytic models are used to offer the primarily information in the dimensioning of a product to be designed using a CAD application, [14]. Based on the qualitative and quantitative information offered by an analytic model there may be created more sophisticated models: numerical models or experimental mechanics models. Analytic computing methods are used in both numerical and experimental models and studies. It results that the analytic approaches have a great potential, especially when computer aided solutions are designed.

From this standpoint, mathematical background is paramount in the design of the computer aided instruments of modelling. A survey of the mathematical problems and of the original solutions is a basic step to be taken when a sustainable development of the computer based intelligent instruments of investigations must be conceived. Moreover, the results of this survey are important in several directions, such as: education, design and research.

Moreover, mathematical background together with the modern information technologies are the most important vectors of progress in any field of science, and especially in those fields where the basic hypotheses were imposed by a given level of the computing means synchronous with that age of science when that field of science was conceived.

Last but not least, there is no mathematical theory which integrates in a coherent way the computing instruments in strength of materials. Additional means rely on algorithms and information technology instruments, but the mathematical background is far more important in conceiving general solutions, above the so called "classic" hypotheses.

6. ACKNOWLEDGEMENT

Ideas regarding the mathematical background of the models based on the strength of materials theory are the result of the models developed in the framework of the MIEC2010 bilateral Ro-Md research project, 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, under the supervision of the National Authority for Scientific Research (ANCS), Romania, that is the follow-up of the ID1223 scientific research project: Oanta, E., Panait, C., Nicolescu, B., Dinu, S., Pescaru, A., Nita, A., Gavrila, G., (2007-2010), "Computer Aided Advanced Studies in Applied Elasticity from an Interdisciplinary Perspective", under the supervision of the National University Research Council (CNCSIS), Romania.

Ideas regarding the automatic calculus in structural studies are the result of the models developed in the framework of the scientific research study ‘Development of computer assisted marine structures’, Emil Oanta, Cornel Panait, Ghiorghe Batrinca, Alexandru Pescaru, Alexandra Nita, Feiza Memet, which is a component of the RoNoMar project, 2010

7. REFERENCES

[1] BUZDUGAN, G. *Rezistenţa materialelor*, Editura Academiei RSR, Bucureşti, 1986

[2] CONSTANTINESCU, E.; BOGDAN, M. & ION, L., *MATLAB. Caiet de laborator*, Editura Crizon, Constanta, 2008, ISBN 978-973-1909-32-5

[3] CONSTANTINESCU, E.; BOGDAN, M., *Maple and Matlab comparing methods for differential equations solving*, The 33rd Annual Congress of the American Romanian Academy of Arts and Sciences, Alma Mater university of Sibiu, June 02-07, 2009, published in Proceedings, volume II, by Polytechnic International Press Montreal, Quebec, 2009, ISBN 978-2-553-01433-8

[4] FILONENCO-BORODICI, M.M. Teoria elasticităţii, Editura Tehnică, Bucureşti, 1962

[5] GREEN A.E.; ZERNA W. Theoretical elasticity, Oxford at the Clarendon Press, 1968

[6] IEŞAN, D. *Teoria termoelasticităţii*, Editura Academiei RSR, Bucureşti, 1979

[7] LAZAROIU, G., *Sisteme de programare pentru modelare si simulare*, Editura Politehnica, Bucuresti, 2011, ISBN 973-8449-78-2

[8] MOCANU, D.R.; THEOCARIS, P.S.; ATANASIU, C.; BOLEANTU, L.; BUGA, M.; BURADA, C.;

CONSTANTINESCU, I.; ILIESCU, N.; PASTRAV, I.; TEODORU, M *Analiza experimentală a tensiunilor, Volumul 1: Bazele teoretice ale metodelor tensometrice şi indicații practice privind utilizarea acestora*, Editura Tehnică, Bucureşti, 1976

[9] OANTA, E., TARAZA, D., *Experimental Investigation of the Strains and Stresses in the Cylinder Block of a Marine Diesel Engine*, Paper 2000-01-0520, SAE 2000 World Congress, Detroit, Michigan, March 6-9, 2000, ISSN 0148-7191

[10] OANTA, E. *Fundamente teoretice în programarea aplicațiilor de inginerie mecanică asistată de calculator*, 294 pages, Editura Fundatiei "Andrei Saguna", Constanta, 2000, ISBN 973-8146-04-6, Preface by Aramă Constantin, Prof. Dr. H. C., member of the Romanian Science Academy

[11] OANTA, E., *Computer code for the calculus of the displacements using strain energy methods for a system of bars in the applied elasticity*, The 9th International Symposium on Experimental Stress Analysis and Material Testing, Section II: Numerical and Hybrid Methods, Bucharest-Constanta, Romania, May 30-June 01, 2002

[12] OANTA, E., *Comparison Between the 'By-Hand' Calculus and the Automatic Computing for the Method of Initial Parameters Applied for Hulls*, Scientific Bulletin of The Merchant Marine University, ISSN 1582-3601, Constanta, 2002, pag. 167-172

[13] OANTA, E.; NICOLESCU, B. *An original approach in the computer aided calculus of the large deflections*, Analele Universității Maritime Constanța, România, 2003, Year IV, Vol. 5, pag. 53-58, ISSN 1582-3601

[14] OANTA, E. *Applied Elasticity Computer Models in Automatic Design*, Proceedings of The 2nd International Multi-Conference on Engineering and Technological Innovation: IMETI2009, Section Mechanical Engineering including Industrial Engineering, Operations research, Aerospace, Marine and Agricultural Engineering, Mechatronics, Robotics, July 10th-13th, 2009, Orlando, Florida, USA, Organized by the International Institute of Informatics and Systemics, Collection: ISBN-10 1-934272-67-1, ISBN-13 978-1-934272-67-1, Volume: ISBN-10 1-934272-68-X, ISBN-13 978-1-934272-68-8, Edited by: Nagib Callaos, Hsing-Wei Chu, Yaroslava Yingling, C. Dale Zinn, pp. 270-275

[15] OANTA, E., *Studii de caz privind modelarea analitica asistata de calculator*, RezMat18 National Conference, Galati, Romania, 2011

[16] OANTA, E.; PANAIT, C.; BATRINCA, G. & PESCARU, A.: *Basic Concepts to Design the Software Application of a Computer Based Mechanical Engineering Model*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISBN 978-3-901509-83-4, ISSN 1726-9679, pp 0505-0506, Editor B Katalinic, Published by DAAAM International, Vienna, Austria 2011

[17] OANTA, E.; PANAIT, C.; BATRINCA, G. & PESCARU, A.: *Computer Based Educational Model of the Bent Hull in the Context of the Maritime Education*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISBN 978-3-901509-83-4, ISSN 1726-9679, pp 0503-0504, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria 2011

[18] OANTA, E.; PANAIT, C.; MARINA, V.; MARINA, V.; LEPADATU, L.; CONSTANTINESCU, E.; BARHALESCU, M. L.; SABAU, A. & DUMITRACHE, C. L.: *Mathematical Composite Models, a Path to Solve Research Complex Problems*, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISBN 978-3-901509-83-4, ISSN 1726-9679, pp 0501-0502, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria 2011

[19] OANTA, E.; PANAIT, C.; SABAU, A.; BARHALESCU, M. L. & AXINTE, T. *Analytic Method to Compute the Isostatics using the Isoclinic Fringes*, Annals of DAAAM for 2012 & Proceedings of the 23rd International DAAAM Symposium, ISBN 978-3-901509-91-9, ISSN 2304-1382, pp 0493 - 0496, Editor Branko Katalinic, Published by DAAAM International, Vienna, Austria 2012

[20] OANTA, E.; PANAIT, C.; LAZAROIU, G. & DASCALESCU, A. E., *Analytic Model of the Mobile Half-Bridge of a Circular Settling Tank*, EED2013 - 11th WSEAS International Conference on ENVIRONMENT, ECOSYSTEMS and DEVELOPMENT, Brasov, Romania, June 1-3, 2013

[21] POPA, B.; MADARASAN, T.; BATAGA, N; ADAMESTEANU, I. *Solicitari termice in constructia de masini*, Editura Tehnica, Bucuresti, 1978

[22] TEODORESCU, P.P. *Probleme plane în teoria elasticității*, Editura Academiei RPR, Bucureşti, 1961

[23] TEODORESCU, P.P.; Ille, V. *Teoria elasticității şi introducere în mecanica solidelor deformabile*, Vol. I, Vol. II, Editura Dacia, Cluj-Napoca, 1976

[24] VOINEA, R.; VOICULESCU, D.; SIMION, F.P. *Introducere în mecanica solidului cu aplicații în inginerie*, Editura Academiei RSR, București, 1980

A SURVEY OF DEVELOPMENTS IN WAVE ENERGY

SCURTU IONUT-CRISTIAN

Constanta Maritime University, Romania

ABSTRACT

This paper presents few projects that are available today in sea trials and that are already connected to the grid. The energy harvested from waves is clean and should be used on a higher scale around the globe. The huge ocean surface can generate enough power to cover all our needs. Also for a point absorber I plotted with Ansys Fluent the heave motion. All details from the diagram can give us valuable information about speeds and accelerations in point absorbers.

Keywords: *Wave energy, Aquabuoy, Wave Dragon, Wave Star, Pelamis, Ansys, point absorber heave.*

1. INTRODUCTION

New paths in wave energy are developed everyday in order to reach the goal: free energy with no impact on environment. Now we can develop plants with power enough to compete with an coal plant. Below are described few new ways to harvest the wave energy. Also for a single point absorber subjected to waves is plotted the heave.

2. DEVELOPMENTS IN WAVE ENERGY

2.1. AquabuOY

The AquaBuOY project is converting the free surface movements in hydraulic energy, it is a freely floating heaving point absorber that reacts against a submersed tube, filled with water.
Both in the upward and downward movement of the buoy the hose pumps pump or discharge the brine at 30 bar. The average diameter of the buoy is 6m, and the draught of the AquaBuOY is approx. 30m.[1]

AquaBuOYs, presented in fig.1., are designed to maximize power output during more typical, moderate wave conditions on an annual basis vs. extreme wave intensities that occur less frequently during storms. This avoids costly over-design that only captures extreme spikes in storm-based wave intensities.

Fig.1. AquabuOY pumping unit

2.2. Wave Dragon

The WD project, started in 2003, is a pioneering large scale ocean energy solution for bulk electricity generation. WD was designed as a floating offshore wave energy converter.

WD project main improvements are: the Wave Dragon concept combines existing, mature offshore and hydro turbine technology in a novel way, wave Dragon is the only wave energy converter technology under development that can be freely up-scaled, due to its size service, maintenance and even major repair works can be carried out at sea leading to low O&M cost relatively to other concepts.

Wave Dragon is a large-scale technology for the generation of electricity from ocean wave energy. Invented by Erik Friis-Madsen, it has been developed with funding support from the European Union, the Welsh Development Agency, the Danish Energy Authority and the Danish Utilities PSO Programme. [3]

A 1:4.5 scale prototype launched in 2003 was the world’s first offshore grid-connected wave energy conversion device. Deployed off the coast of Denmark at Nissum Bredning, this test unit has accumulated over 20,000 hours of experience supplying electricity to domestic homes. Wave Dragon has achieved a breakthrough in wave energy conversion efficiencies. Excellent sites for wave energy power stations exist around the world, typically located 5-25 km offshore, including the whole of Europe’s Atlantic coastline.

Generating electricity from ocean wave energy avoids the release of carbon dioxide associated with power stations which burn natural gas, oil or coal. Wave Dragon’s technology allows energy generation on the same scale as traditional power plants. Extensive commercial deployment should contribute materially to the reduction of carbon emissions and their known effect on global climate change.

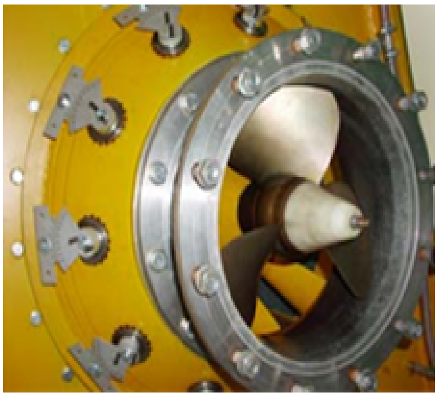


Fig.2. Kaplan turbine

The Wave Dragon is large floating barge that produces energy directly from the power of the water; the only moving parts in the entire structure are the turbines. The Wave Dragon works by facing its outstretched collector arms towards the oncoming waves; these concentrate 300 meters of wave front towards 140 meters of ramp at the front of the structure. This focusing increases the wave height at the ramp, which in turn acts like a beach and causes the waves to break over its top and into the reservoir behind it. By this action the water is elevated and given potential energy, which is turned into electricity by simply running the water down through turbines in the bottom of the structure. The Wave Dragon actually produces energy in almost exactly the same way as a low-head hydro power station. This last fact is one of the major advantages of the Wave Dragon concept. There is no new technology utilised in this structure at all. The low-head turbines we are using are the same as the hydropower industry have been successfully using for over 80 years, the structure its self is based on designs that the maritime world has been using for even longer. This is of course another huge benefit of deploying in Pembrokeshire, in that there is a major resource of maritime construction experience that exists within Milford Haven and Pembroke Dock.[3]

Power generation on the Wave Dragon, fig.3, is based on the potential energy in the water that has overtopped the ramp and is temporarily stored in the reservoir. This reservoir contains approximately 8,000 cu. m. water that has to be let out through the turbines in between two waves.

A special, small sized and low headed turbine has been developed to be used in the Wave Dragon. The photo shows this Kaplan turbine, fig.2., during the testing at the Technical University of Munich. This turbine uses a siphon inlet whereas the next 6 turbines to be installed will be equipped with a cylinder gate to start and stop water inlet to the turbine.

Recent developments in Wave Dragon

The unit off Pembrokeshire will be a 7 MW device and located two to three miles northwest of St Ann's Head and tested for three to five years only, in order to gain operational experience and knowledge on the energy transfer efficiencies. Commissioned in 2010, and deployed 2011/2012 the project would, even in this early demonstration phase, produce enough clean and green electricity each year to meet the annual demand of between 2,500 and 3,000 homes, subject to grid connection.[3]

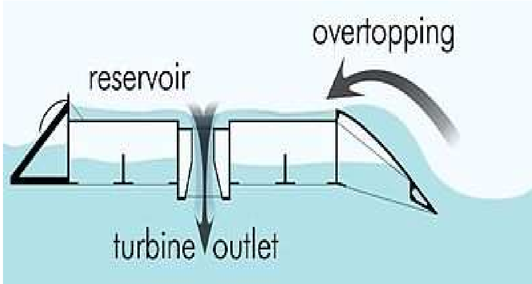


Fig.3 Wave Dragon project details[2]

This clean generation will offset the release of about 1,000 tons of carbon dioxide every year, the main greenhouse gas contributing to global warming and climate change. However, there may be limits placed on us by the local grid capacity, and we are in discussion with Western Power as to exactly how much energy we can bring ashore.

The demonstration site has been selected in order to meet several criteria. It must be exposed to the predominant wind and wave direction but relatively close to land, for economic and operational purposes. The site must be close to a major port, in our case Milford Haven, but yet away from commercial shipping interests and outside of military firing ranges. The landfall of the cable must be close to potential grid connection locations.

2.3. Wave Star

Wave Star (fig.4 and 5 from website: www.wavestarenergy.dk) is a multi point absorber being developed by the company Wave Star Energy.

Fig. 4. Wave Star combined with wind turbine in normal operation mode[8]

The machine is equipped with 2 floats which are moved by the waves to move hydraulic pistons. The pressure will run a hydraulic motor. This motor is rotating a generator and the energy is converted to DC and after that an inverter will generate AC to the grid.[8]

When storms create waves higher than 5 meters, the floats are lifted to a safe position. The two sensor measurements (a sensor on the seabed and one above sea level) will ensure that the storm security system is automatically activated.

Fig.5. Wave Star model in wave test tank[8]

2.4. Pelamis

The Pelamis is a wave energy converter that uses the motion of waves to generate hydraulic power, witch is converted to electricity. It operates in water depths greater than 50m and is typically installed 2-10km from the coast. On average one machine will provide sufficient power to meet the annual electricity demand of approximately 500 homes. The Pelamis is rated at 750kW with a target capacity factor of 25-40 per cent, depending on the conditions at the chosen project site.[7]

The Pelamis, shown in fig 6, machine is made up of five tube sections linked by universal joints which allow flexing in two directions. The machine floats semi-submerged on the surface of the water and inherently faces into the direction of the waves. As waves pass down the length of the machine and the sections bend in the water, the movement is converted into electricity via hydraulic power take-off systems housed inside each joint of the machine tubes, and power is transmitted to shore using standard subsea cables and equipment.

Each of the power take-off units at the joints of the machine are identical, and operate independently from each other with redundancy of all main components.[7]

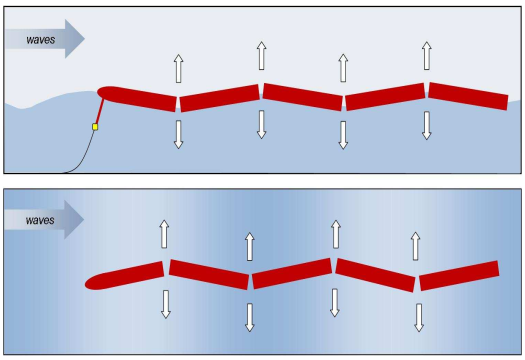


Fig.6. Pelamis wave energy converter

2.5. Seawave Slot-cone Generator

The Seawave Slot-cone Generator is a patent of WaveEnergy AS (www.waveenergy.no), is an overtopping based WEC utilizing a total of three reservoirs placed on top of each other. The SSG, shown in fig 7, is designed as a near shore concrete structure with gates.

Fig.7. Pilot plant installed near Stavanger, Norway.

A prototype plant with a width of 10 m is planned for deployment at the west coast of Kvitsøy, Norway (near Stavanger) during 2007. At this site the average available wave energy resource is approx. 18 kW/m.

The results have been evaluated and used for the formulation of expressions for describing the vertical distribution of overtopping, which then can be used for calculation of overtopping rates into multilevel reservoirs.

3. WAVE ENERGY AS PRESENT RESOURCE

The wave energy has a huge potential to become a great source for future, as shown the actual projects are available at a huge scale in order to develop an electric power similar to a coal powered plant. Below is shown the wave height and the energy developed by waves around Europe. The huge surface is not inhabited so is available for developing future wave plants.

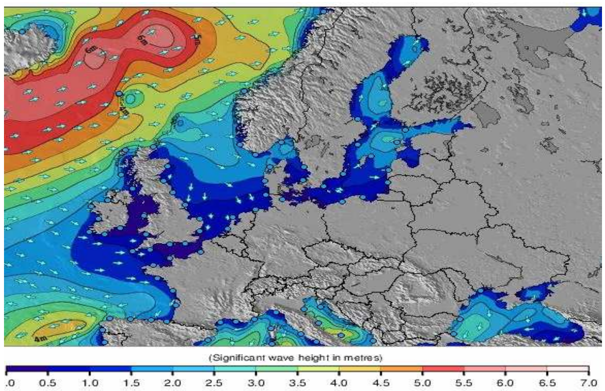


Fig.8. Significant wave height in meters[5]

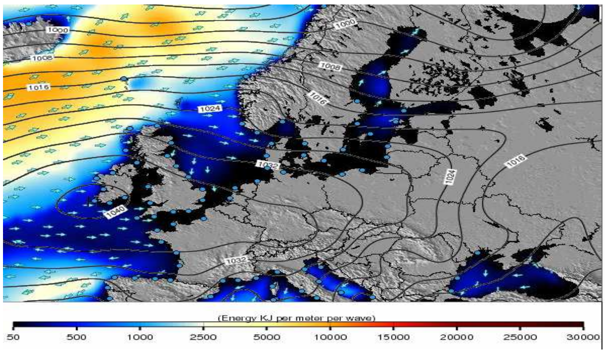


Figure 9. Wave energy in joules, date 27.10.2013 – Aviso[5]

4. ANALISYS OF HEAVE IN WAVES

Ansys fluent simulation can give use the heave motion history of a floating object. For example below the Ansys environment is plotting the heave versus time diagram. The software is able to compute 3000 steps in time and will also compute the vertical movement of the object(Heave diagram).

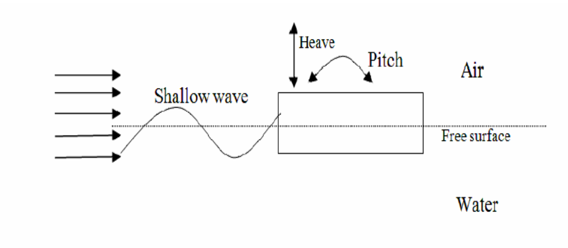


Fig.9. Floating object subjected to waves in Ansys

Wave parameters for the simulated heave motion (Heave diagram- Fig.10.), shown in the diagram below, are: amplitude 0,019 m and wave length 3,8 m. Wave parameters are random and do not reflect any sea state or situation. This simulation is given only for computing the floating object heave.

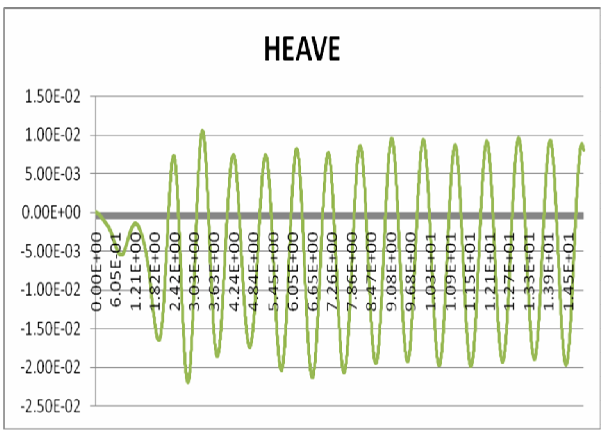


Fig.10. Heave versus time

More and more projects are developed these days, and most of them are based on heave movement of floating objects (like AquabuOY). Further simulation of point absorbers is required in order to get the maximum efficiency from these devices.

5. CONCLUSIONS

Wave energy is now available in many ways and represents a clean energy source. Wave Dragon, Wave Star, Pelamis, or AquabuOY all of these challenges are ready to be used on higher scale to preserve environment and to give us the energy needed for everyday use.

A huge accomplish was done by WaveStar project when the project was put to test with to floats. I am sure that a higher number of floats will make the difference and that this multipoint absorber will be one of future demands.

The heave motion simulation can show us how much energy the waves can give us. The shape and size of each floating device must be determined according to sea state and conditions for a maximum efficiency, simulations will reduce the number of tests and will simplify the heave amplitude determination.

6. REFERENCES

[1] Margheritini, L., Kofoed, J.P., and Frigaard, P., Status and performance of the SSG Wave Energy Converter, Department of Civil Engineering, Aalborg University, Denmark.

[2] H.C.Soeresen, The Wave Dragon-Now ready for test in real Sea (http://vbn.aau.dk/files/48909898/The_Wave_Dragon_now_ready_for_tests_in_real_seas.pdf)

[3] J. P. Kofoed, Recent Developments of Wave Energy Utilization in Denmark. (http://wavestarenergy.com/sites/default/files/Recent_Developments_of_Wave_Energy_Utilization_in_Denmark.pdf)

[4] Kofoed J. P.: Wave Overtopping of Marine Structures – Utilization of Wave Energy. Ph. D. Thesis, defended January 17, 2003 at Aalborg University. Hydraulics & Coastal Engineering Laboratory, Department of Civil Engineering, Aalborg University, ISSN 0909-4296, Series Paper No. 24, December, 2002.

[5] Kofoed, J. P., Frigaard, P., Friis-Madsen, E. and Sørensen, H. C.: Prototype testing of the wave energy converter Wave Dragon. Renewable Energy Journal, 31 (2006), pp. 181 - 189.

[6] http://www.aviso.oceanobs.com/en/

[7] http://www.wavedragon.net/

[8] http://www.pelamiswave.com/

[9] http://wavestarenergy.com/

ATTENUATION OF NOISE PRODUCED BY BANDCONVEYORS IN CAREER OF LIGNITE FROM THE COAL BASIN OF OLTENIA

[1]STANCI ANDREEA-CRISTINA, [2]STANCI AURORA

[1,2]University of Petrosani, Romania

ABSTRACT

Sources of noise may come from urban transport, areas or objects which are large gatherings of people or industrial areas. Rate setting for the urbane noise is to protect the community from excessive noise action. The main source of noise for inhabited areas near the careers of Oltenia are the bandconveyors of the type 1000 – 1400 - 1600 – 1800 – 2000 -2250 mm. One way to combat noise produced by the bandconveyors is the use of curved screens from soundproofing materials. Choice of the dimensions for the curved screens depends on the noise level and the system characteristics that determine noise. In this paper we determined the attenuation produced of the curved screens of polycarbonate which can be used for attenuation of noise from the bandconveyors.

Keywords: *pollution, noise control, noise attenuation.*

1. THEORETICAL CONSIDERATIONS

Sound isolation of a composite material express its ability to prevent the transmission of sound energy. Sound energy transmission factor is defined as fallow: the ratio of the emitted sound energy Wt and transmitted acoustic energy Wi, its value being then more lower than material retention capacity of the sound waves is higher.

Sound isolation is the property that characterizes all separation sound-absorbing panels, and it is necessary to know it in order to indicate the level of noise isolation between the two environments.

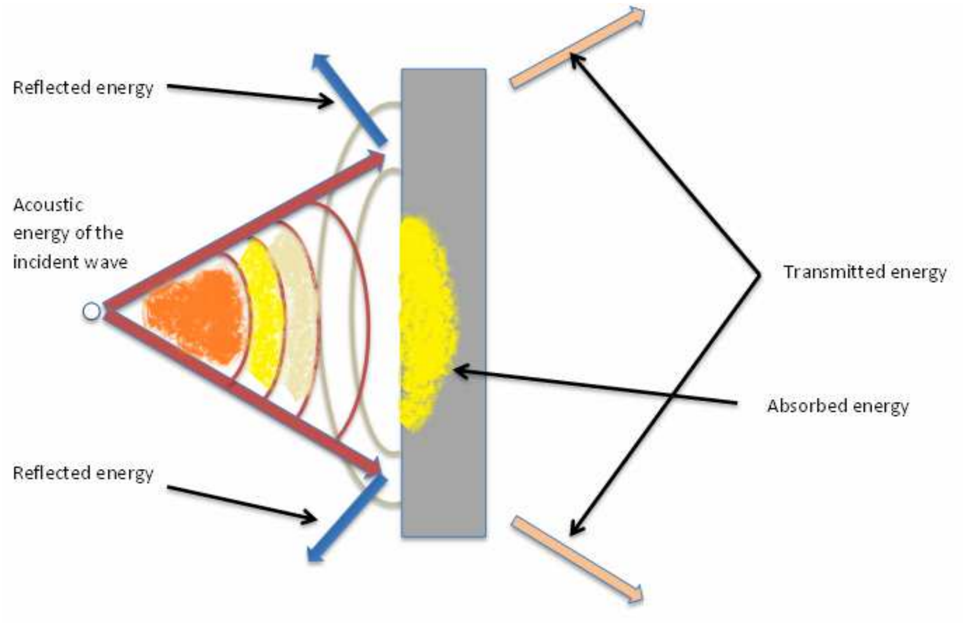


Figure 1 Decomposition of acoustic energy in the presence of obstacles

If the acoustic energy (Wi) encounters an obstacle, consisting of a different environment than that in which it propagates, appear the phenomenon of decomposition (Figure 1): a part of the energy is reflected (Wr), a part is transmitted (Wt), and some part is absorbed by the environment (Wa).

Depending on the type of material used, it changes the proportions of this decomposition respecting the laws of conservation of energy:

$$W_i = W_r + W_a + W_t \quad (1)$$

To obtain a high attenuation of noise level over the entire range of frequencies can be used acoustic curved panels.

Using curved acoustic and soundproofing panels produce good results in terms of sound isolation of that source, if such a system is properly designed and engineered.

Noise attenuation achieved by the use of acoustic soundproof curved panel on one of the sources, considering that inside thereof is a diffuse field, may be determined by the relationship:

$$\Delta l = R - 10\log \frac{S_c}{\sum_i \alpha_i S_i} \quad \text{dB} \qquad (2)$$

where R is sound reduction wall curved panel, Sc - curved screen wall surface ,αi - absorption coefficient inner curved panel elements and Si - corresponding interior surfaces.

Sound absorption coefficient α is defined as the ratio of the absorbed energy and acoustic energy, and express the property of a material to absorb acoustic energy. Sound absorption is basically a transformation of the incident acoustic energy into heat.

$$\alpha = \frac{W_a}{W_i} \qquad (3)$$

From relations (2) results that the attenuation provided by a curved screen depends of sound reduction R of its wall, wall mass and absorption coefficient.

Acoustic waves are spread from the noise source as spherical waves, reach the soundproofing screen under an angle of incidence and are reflected partially under the same angle. On the other hand, display areas are excited under mass theory of bending oscillations and waves are transmitted with a deflection direction. Such, soundproofing surfaces are representing a mass brake and reflected sound excites the panels, losing energy and acoustic pressure under form of bending oscillations.

The ability of a panel to attenuate sound transmitted after being traversed by it is called acoustic isolation.

Sound attenuation obtained with a thin sound barrier may be compromised if it is not designed to ensure that noise level transmitted, is not significantly affecting global noise which that reaches the receiver.

Thereby establishes that a sound barrier attenuates level of noise transmitted at least by 0.5 dB (A),

Sound isolation obtained by the location of the noise barrier is influenced by a number of factors, such as: the mass per unit area, thickness, stiffness, loss of signal, and the angle of incidence of the sound. The most important of these factors is the mass per unit area of the noise barrier.

It is also essential that in sound barrier should not have penetrated holes to prevent leakage of sound, large perforations allow passage without absorb noise and the narrow holes they can amplify noise.

For homogeneous single panels the most important property is the mass per unit area of the panel, by which can be expressed very simple the loss of transport R:

$$R = 20\log(m \cdot f) - 47 \quad \text{[dB]} \qquad (4)$$

where: m - is the mass per unit area, and f - is the critical frequency of material.

The analysis of the relation (4) shows the following:

- a sound isolation R increases with increasing of frequency, for a given mass wall. High frequency sounds are attenuated better than low frequencies sounds;
- noise isolation can be increased for low-frequency sounds if is increased the mass of the wall, meaning that will be made a solid wall;
- increase the sound isolation in relation to the frequency is 6 dB per octave;
- in the case of a constant frequency the noise isolation increases with the mass unit of surface;
- to constant frequency the noise isolation increases by 6 dB for each doubling of mass.

For most of the construction materials, static rigidity must be bigger enough to resist to sound waves with a frequency range between 50-5000 Hz.

A simple soundproofing divider panel, hinted by energy of sound, is subjected to vibration and resonance, phenomena that may influence acoustic behavior. Thus, in areas of high and low frequency may occur losses of soundproofing due to frequencies of resonance or coincidence. The frequency at which the loss begins is defined as the critical frequency (fc), its value can be calculated if is known speed of sound propagation in the material with the next relationship:

$$f_c = \frac{\sqrt{k/m}}{2\pi} \quad \text{[Hz]} \qquad (5)$$

where: k - is the elastic constant of the material, m - mass of the panel.

2. EXPERIMENTAL RESULTS

Noise emission produced by bandconveyors from careers of Oltenia that transport exploited material are producing disturbances in this areas.

The components of a bandconveyor mainly consists of: mechanical equipment, metallic construction, electrical equipment, protective equipment and safety, auxiliary equipment and mechanism for traction.

The width of the bandconveyors used in Oltenia is between 1000-2250 mm and a speed of 4.19 to 6.15 m / s, and the capacity for transport ranges is from 2500 to 12500 m3 / h

The recommended value of 55 dB during the day is exceeded in many places even at larger distances from the source.

A solution to combat noise propagation paths to bandconveyors consists of interposing between it and the noise source a curved acoustic and soundproofing panel. By placing such a screen, we obtain an attenuation of the level noise almost on the entire frequency range. By placing curved screen we should bear in mind that it does not disturb the technological process and to permit monitorization of the running machine.

Noise measurements were made using the digital measuring device 4 in 1 PVE-222.

The digital measuring device 4 in 1 with multiple functions for the environment has been designed to combine the measurement of the sound level, light, humidity and temperature.

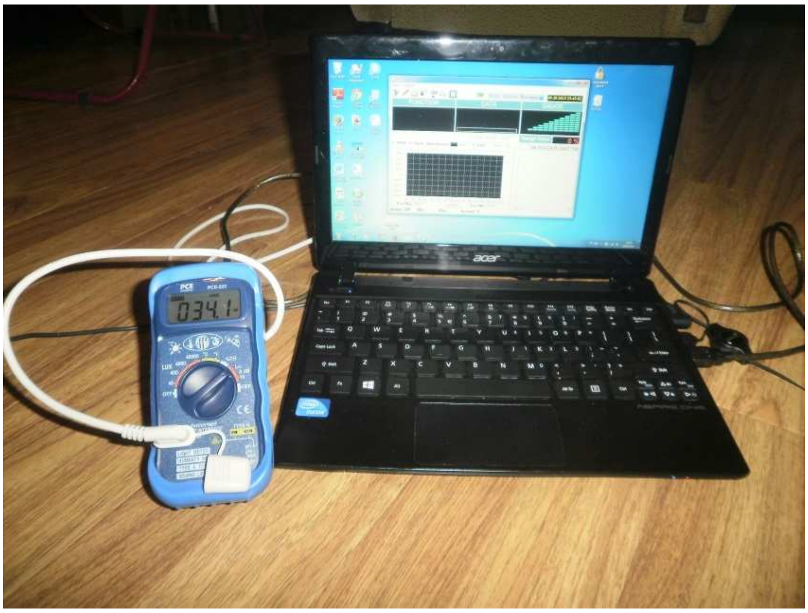


Figure 2 The digital measuring device 4 in 1

To determine the noise levels of the bandconveyors used in the careers of Oltenia, measurements were performed within 4 working hours, at an interval of 30 minutes.

The value measured of noise levels near the bandconveyors –T111 located in close proximity to housing, before starting work is 48.1 dB.

The experimental determinations result that the noise level of 55 dB, the limit permissible under STAS 10009/1988 and Order of the Minister of Health No. 536/1977 and respectively HCL no. 32/1992, is exceeded.

To the construction out the curved panel used for experimental measurements was used polycarbonate plate of 2 mm.

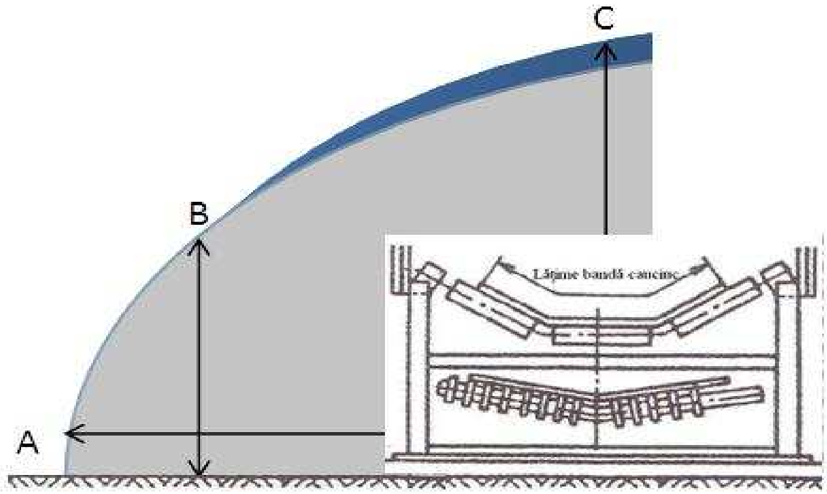


Figure 3 Curved panel for acoustic protection

Table 1. Values of the level of noise obtained by using the curved panel

No. crt.	Measuring point	Value measured of the level of noise before the panel [dB]	Value measured of the level of noise after the panel [dB]	Attenuation [dB]
1	A	79,90	72,50	7,40
2	B	78,35	71,20	7,15
3	C	77,40	70,50	6,90

3. CONCLUSIONS

Improving the soundproofing quality of the screen is bowing the polycarbonate panels or even simply curving the upper extremity. This method leads to getting a larger power of absorption and at the same time reducing the height of screen.

From measurements made using polycarbonate curved panel of 2 mm, showed that the panel can produce a noise attenuation of approximately 7 dB.

Using stratified polycarbonate plates could increase noise isolation of the sources up to 30 dB.

4. REFERENCES

[1] ANDREEA CRISTINA STANCI, AURORA STANCI, IOAN DUMITRESCU, *The Noise Pollution in Career Rosia of Jiu*, Bulletin of the Polytechnic Institute of Iasi, Published by Technical University "Gheorghe Asachi" Iasi Vol. LVII (LXI), Fasc. 4, 2011 Department of Chemistry and Chemical Engineering, p-ISSN 0254-7104, (B+, IC Value - Expected 2011, Evaluation pending), pp. 57-62, (2011).
http://journals.indexcopernicus.com/karta.php?action=masterlist&id=4927,
http://www.tuiasi.ro/facultati/ic/index.php?page=593.

[2] GIANINA ILEANA STAN, IOAN CURTU, *Metode şi procedee de măsurare a proprietăţilor panourilor stradale fonoabsorbante*, Bulletin AGIR no. 1/2011, pp. 55-59. 2011.

[3] IRINELA CHILIBON, *Acustica şi metodele ei de testare*, publishing ELECTRA, ISBN 978-606-507-024-0, 2009.

[2] EASA, S.M., *Analysis of Traffic Operations in Harbor Terminals: Developing a General Overseeing Model for Small Queues*, Ph.D. thesis, Institute of Transportation Studies, University of Berkeley, 1981

THE DRAG REDUCTION BY DIMINISHING THE COEFFICIENT OF FRICTION BETWEEN THE WATER AND THE HULL, BY BLOWING AIR UNDER THE SHIP

[1]TICU RODICA-IONELA, [2]BOCANETE PAUL, [3]ION ALINA

[1,2,3]*Constanta Maritime University, Romania*

ABSTRACT

Through this paper we intend to approach a line of research that can be explored to determine the pressure increase due submission ship or small displacement vessels, the vessel required speed would come in classic mode regime hull wetted hull oiled air MALS method (The Mitsubishi Air Lubrication System).

Keywords: *ship, coefficient of friction, blowing air, propulsion.*

1. INTRODUCTION

Merchant ships have spectacularly evolved regarding the total global displacement and the equipping level for the operation of goods and for ensuring propulsion. In recent years, the development of several classes of specialized ships, including containerships, tankers and ferryboats has been noticed. These ships can be considered as ships of the line, with prescribed routes during the service. Consequently, a significant increase of service speeds has also been remarked; they have wide variations from about 14 knots for a tanker up to 24, 25 knots for a containership or a ferryboat. Under such conditions, the true wind provided by the two components - the environment wind and the air flow coming from the bow of the ship, will have increasingly smaller angles related to the bow, leading obviously to hindering the capture and use of wind energy.

2. ANALYSYS OF MAIN THEORIES RESISTANCE

The air blowing method MALS (The Mitsubishi Air Lubrication System) is the technology that induces the reduction of the friction force by adding air bubbles that would disrupt the contact between the hull and the seawater. Because the frictional resistance proportions, compared to the total resistance are high, especially to large vessels with low speed, the air blowing method has been followed for some time as a significant measure to reduce the resistance to friction. This method of drag reduction is illustrated in Figure no.1.

Figure 1. The method of air blowing under the hull

Air bubbles are introduced under the ship by using valves fitted in the double bottom and the air bubble flow surrounds the vessel bottom. The air discharged from the valves set in the double bottom breaks the additional masses of water that are added to the vessel displacement, and thus significantly reduces the coefficient of friction between the hull and the boundary layer. In order to implement the air blowing method, the total resistance and local resistance have been recently measured, working on a flat plate model with a total length of 50 meters and it has been confirmed that those resistances decrease. During those experiments, the results indicated that 5% of energy was saved, and that brought about the increasing interest in those types of experiments. Consequently, the system was developed by including both the model of the testing data, as well as the results obtained from experiments on a normal ship.

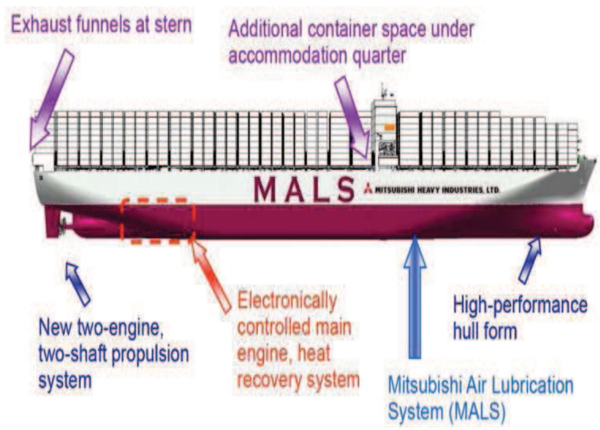


Figure 2. Scheme of the port-container with MALS system

Figure 3 shows the schematic diagram of the system. Thus, the air temporarily stored in a tank is discharged from the valves through 15 pipes of air supply of the ship's bottom, which are related to the portion that provides air for the vessel base.

Each supply pipe is connected to an air room. In the experiment, the air rooms were manufactured, and the air blowing conditions were carefully monitored.

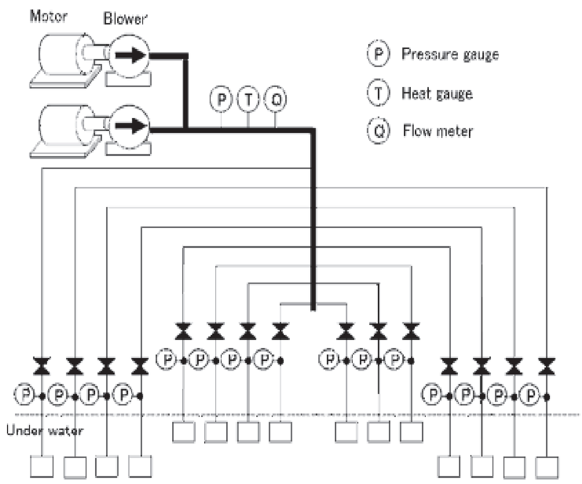


Figure 3. The air blowing system

The air discharged from two sets of valves is collected from a large diameter pipe and then is redistributed in the fifteen pipes in order for the air to be transferred to the air rooms set on the bottom of the ship. Those experiments were encouraging and that was why we continued making experiments on a real port-container type ship.

The main dimensions of the port-container which was used in that experiment are shown in Table 1.

Table 1.

Size	Unit of measurement	Value
Length between perpendiculars	m	162
Maximum width	m	38
Building height	m	9
Draught	m	4,5/6,3
Main machines	kW	3218X2
Speed of service	nodes	13,25

The port-container hull was extremely easy for that research by the fact that the breadth-draught ratio B / d is relatively high and the bottom of the vessel washed with air is represented by a large and flat area.

The main engine is a medium speed diesel engine and the propulsion system consists of 2 engines and 2 shafts, which ends at the exterior as a working machine with two adjustable pitch propellers – Controlable Pitch Propeller (CPP).

To cover the bottom of the vessel with air bubbles, three pieces for blowing the compressed air were installed; the air was provided by two blowers placed in an auxiliary engine room.

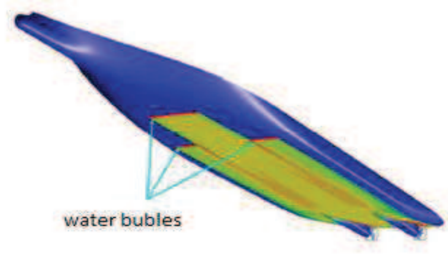


Figure 4. Image of the air under the bottom of the ship

In figure 4, the air evolution during shipping was captured by an underwater camera. We notice how the air blowing from valves from the bottom of the ship turns into air bubbles, which leads to the breaking of the boundary layer of additional water masses surrounding the ship, and through the bursting forces of air bubbles that loosen, the surrounding seawater flow is removed from the hull, directing toward the stern.

After a test at a normal speed without releasing the air, the same speed test was conducted with air release in order to measure the effect of energy saving. The speed was carefully monitored and the power consumed of the one produced by the main engine was calculated by reading one of its load indicators. Simultaneously during the test, a torsiometer was installed to measure simultaneously the power transmitted through the shaft (fig.5.).

The speed test was conducted based on 3 cases of blowing rates. The air supply rate was calculated with the thickness equivalent of the air blown under the ship, which is defined in equation (1), taken as 3 mm, 5 mm and 7 mm, where tb is equivalent to the thickness of the air from the container base, Qa is the rate of air supply, B_a is the depth covered by air bubbles and U is the ship speed.

$$t_b = \frac{Q_a}{B_a \cdot U} \tag{1}$$

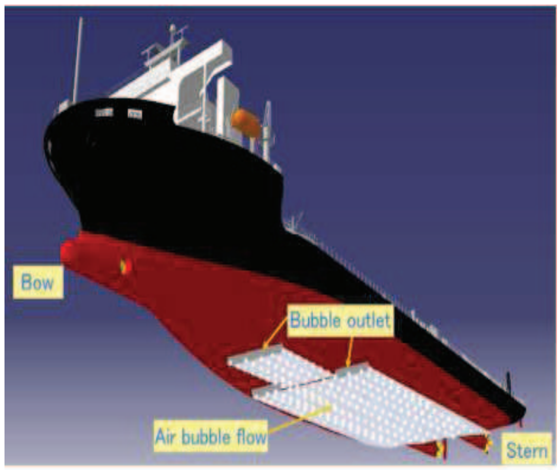


Figure 5. MALS`s System diagram port-container

Figure 6 shows the speed test results. During the speed test of the port-container, the net effect of the energy saving was calculated by decreasing the consumption value of electrical power required to make blowers function, from the power saved at the time when the air was on.

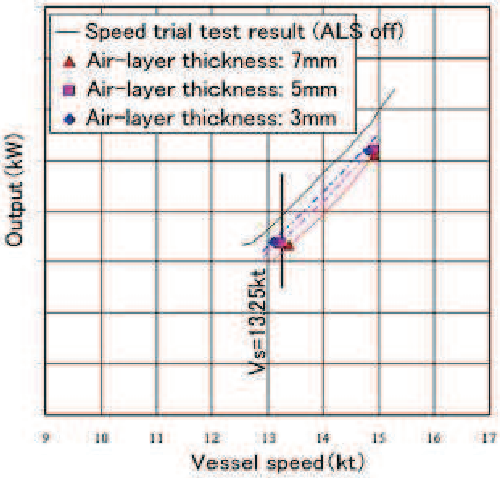


Figure 6. The power consumption depending on the thickness of the blown air-layer

Based on the relation between speed and power consumption during navigation, with the air on, it was found, while increasing the amount of air, the improving of the net effect of energy saving which was confirmed as follows: 12% for a 7 mm air layer, 10% for a 5mm air layer, and 8% for a 3 mm air layer. The experimental results and the efficiency of this method of drag reduction are summarized in Table 2.

Table 2.

The thickness of the air blown under ship	Reducing the power obtained at the same speed	Power consumed by the blower	Net energy saved
[mm]	[kW]	[kW]	[kW], %
7	680	211	469, 12%
5	530	143	387, 10%
3	380	72	308, 8%

The results derived from Table 2 are very convincing and it can be found that the frictional resistance of the port-container hull decreased significantly by using the blowing method (lubrication) with air and aims at decreasing the main engine loading.

We ask the question what happens if we use the power of the wind hostile to the ship drag in order to download blowers, the consumed power of which is the power consumed by the blower. This may be a new way of using the wind even when its direction is not favorable to the shipping. Through this concept, known as the technical notion "Front diffuser", the air is taken from the superstructure and placed under the vessel or can be used as air supply for blowers. Taking advantage of the fact that the wind speed is added to the vessel speed, their flow and pressure will be increased.

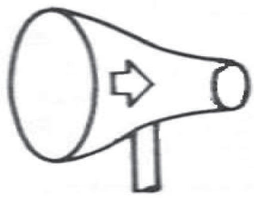


Figure 7. Diffuser that can concentrate the air flow for the MALS system

Basically, aboard, the phenomenon of blowing air under the ship will follow Bernoulli's law, Figure 8

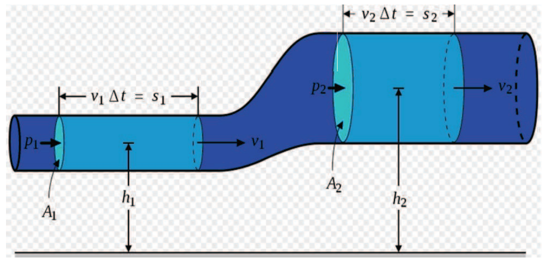


Figure 8. Bernoulli Tube

$$p_1 + \rho \cdot g \cdot h_1 + \frac{\rho \cdot v_1^2}{2} = p_2 + \rho \cdot g \cdot h_2 + \frac{\rho \cdot v_2^2}{2}. \quad (2)$$

3. CONCLUSIONS

The results of this analysis are highlighting that the use of rigid sails is a simple, inexpensive solution with a quick payback in time. In this study based on capturing bow headwinds and placing them under the ship for air lubrication through the already presented MALS method.

This line of research is an extremely important element which would result for small displacement ships, in determining the speed required for the ship to pass from the classic mode of wetted hull to the fully air lubricated hull, through the MALS method. This would allow the sudden reduction of the friction coefficient of the water with the hull and thus, the reduction of the ship resistance and the board propulsion necessary for the ship to march forward.

4. REFERENCES

[1] FINCHAM, A. (1997): *Low cost, high resolution DPIV for measurement of turbulent fluid flow*, Experiments in Fluids, 23, pp. 449–462
[2] **Innovations Bulletin 2011*, volume 106 #6
[3] MUHANDO, E.–Senjyu, T., Urasaki, N., (2007): *Gain Scheduling Control of Variable Speed WTG Under Widely Varying Turbulence Loading*, www.geocites.com/muhandobilli/.RENE.pdf
[4] EIDE, M. ET AL., *Future CO_2 emissions: Outlook and challenges for the shipping industry,* Proceedings of

the 10th International Marine Design Conference (IMDC), Trondheim, Norway, 2009a

[5] EIDE, M. ET AL., *Cost-effectiveness assessment of CO_2 reducing measures in shipping*, Maritime Policy & Management, 36:4,367 — 384, 2009b

[6] EL-SHIMY, M., *Optimal Site Matching of Wind Tur-bine Generator: Case Study of the Gulf of Suez Regionin Egypt*, Renewable Energy, 35(8):1870–1878, 2010

[7] ENDRESEN ET. AL., *A historical reconstruction of ships fuel consumption and emissions*, Journal of Geophysical Research, 112, D12301, doi: 10.1029/2006JD007630, 2007

[8] EYRING, V. ET AL., *Emissions From International Shipping: 2. Impact of Future Technologies on Scenarios Until 2050*, Journal of Geophysical Research, 110, D17306, doi: 10.1029/2004JD005620, 2005.

[9] MUNTEANU, I.–Bratcu, A., I., Ceanga, E. (2008): *Optimal Control in Energy Conversion of Small Wind Power Systems with Permanent-magnet-synchronous Generators,* WSEAS Transactions on Systems and Control. ISSN: 1991-8763, Issue 7, Volume 3, pp. 644-653.

SECTION III

ELECTRONICS, ELECTRONICAL ENGINEERING AND COMPUTER SCIENCE

DESIGN OF THE AMPLIFIER STAGE PHASE SHIFTER USING ELECTRONIK WORKBENCH SOFTWARE

[1]ANGHEL-DRUGARIN CORNELIA-VICTORIA, [2]DRAGHICI SILVIU

Eftimie Murgu University of Reşiţa, Faculty of Engineering and Management, Department Electrical Engineering and Informatics, Romania

ABSTRACT

The article made the design and study of the amplifier stage phase shifter using Electronic Workbench software. This program is a Computer Aided Design, is a more upgraded P-Spice software package. It is very useful in the study of electronic circuits, both analog and digital, with rich libraries and allowing a wide range of circuit simulations. Stage-phase shifter the amplifier or distributed task is able to provide two output signals identical in amplitude and opposite phases, facilitating the replacement transformer with median link, which is very costly to set up, heavy, occupy much space is expensive as manufacturing technology. This aspect is taken into consideration even in naval electrical engineering, where there are many transformers, some of them even with several outlets in the secondary circuit. The proposed scheme will work in small signals (Class A), a few tens of millivolts and low frequencies. As active element will use an NPN bipolar transistor BC 107 type.

Keywords: *amplifier circuitry design, stage phase, distributed task, transformer with center tap, polarization, transformer with median link, Electronic Workbench software.*

1. INTRODUCTION

The type of used amplifier is known as an amplifier with distributed load. Basically, in a certain bias state of the amplifier's double-pole transistor we have the same amount of electric load gathered in the collector and the emitter, hence the name of distributed load amplifier. In our literature it is also known as the phase-shift. This term comes from the fact that at this amplifier, when the bias resistance from the emitter is equal in value with the one from the bipolar transistor collector, then we will have two outputs (from the emitter and from the collector), two voltage signals identical as magnitude, but phase-shifted with 180^0 (in phase opposition).

We will present and explain this phenomenon with examples using the Electronic Workbench software within this paper. For a less difficult presentation and testing we will use a double-pole transistor type NPN. We chose the model BC 107, because it was created in Silicon technology, on a metal housing, and is one of the models mostly used at low frequency and power. This is because we will work with signals of the orders of tens of mV and frequencies of a few kHz, i.e. at low power (low signals, i.e. class A) and low frequencies. It is also a very cheap type of transistor as cost.

We can also, the transistors PNP, j-FET, MOS-FET, type "n", "p" etc, be used. The Electronics Workbench software, developed by the company Interactive Image Technologies Ltd. is a CAD application („Computer Aided Design"). It is the same company that merges in 2005 with National Instruments becoming National Instruments Electronics Workbench Group and subsequently develops the MultiSim program, an application superior to the Electronic Workbench soft, but maintaining most of its characteristics. It is intended for the design and simulation of electrical and electronic circuits. Besides the creation of circuits and the simulation of their functioning with the help of different indicating symbols, of measuring devices, power supplies and signal generators, the software allows the performance of some complex analysis on the operation of the electronic circuits (the direct voltage display in the marked points of the diagram, the lay-out of the amplitude-frequency and phase-frequency characteristics, the analysis of transient operation, the display of the signal harmonic components, the waveform, etc). For digital circuits, it provides TTL logic levels (indicator $+V_{cc}$ used in conducting logic diagrams of the two counters in this paper) as well as CMOS logic levels (indicator $+V_{dd}$).

We should mention is that if an electronic component does not exist in the libraries of the respective software, then it can be created, almost all of its functional characteristics and basic properties can be developed, it can be saved in the Electronic Workbench libraries and used in simulations, and this applies to version 5.12 of the software used here. Recently it reached the version 10.1 of the Electronic Workbench.

2. THE DESIGN OF THE PHASE SHIFT AND THE SIMULATION OF ITS OPERATION USING THE ELECTRONIC WORKBENCH SOFTWARE

With the ground distributed both in the collector and the emitter, the proposed scheme is very simple. We consider the schemes of the amplifier's low signal which supply an outcome signal from the emitter and the collector. Basically, we refer to two very well-known amplifiers which are used in analogical electronic on a large scale: the one with common emitter and the one with a common collector. The phase-shift amplifier merely "encloses" these two!

The electronic scheme is performed within the Electronic Workbench software, simulated and saved in our libraries with the extension .EWB. It is presented together with the captures of the signals supplied by the virtual oscilloscope. We need to mention that the scheme can be developed and tested from any computer that contains the 5.12 version of Electronic Workbench software or other superior versions. Thus, the electric scheme is simple, respecting the characteristics of the NPN double-pole transistor bias, and is presented in the following figure:

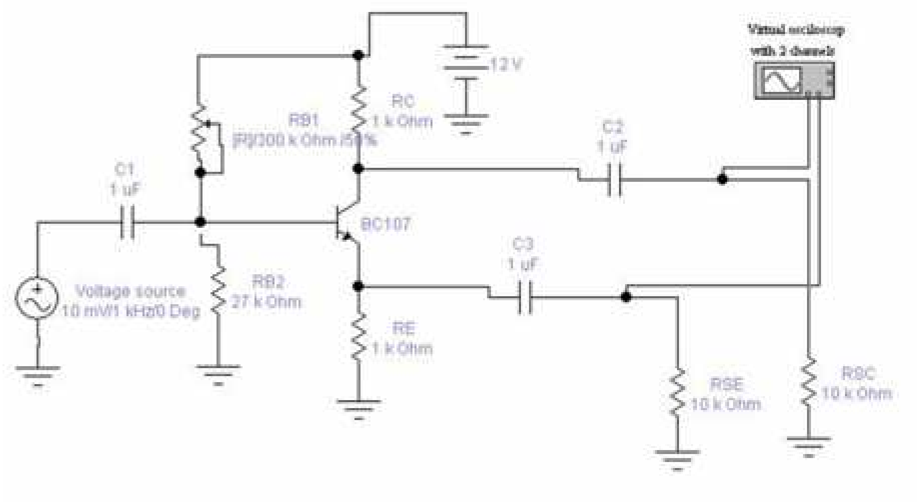


Figure 1 Electronic scheme of the phase-shift amplifier.

The values of the resistance's R_{B1}, R_{B2}, R_C, R_E are chosen from the bias conditions of the BC 107 double-pole transistor, taking into account its characteristics imposed by the catalogue (see Agenda radioelectronistului – Ediția II, pg. 525). R_{B1} is actually a 300 kΩ potentiometer adjustable in steps of 5%; the adjustment/control step can be set soft as much as we want; as noticed in the scheme presented in Figure 2, with key R the value of the potentiometer goes down/sinks, and with the combination of keys Shift+R tasks, it goes up. But other keys can be set as well for this function. R_C and R_E can be variables as long as the transistor doesn't come out of the normal active area. This can be observed very easily on the virtual oscilloscope of the .EWB software. We also considered in the design the real existence, on the market, of the types of resistors and capacitors; hence, the values of the pieces within the scheme are not accidental! The capacitors C_1, C_2 and C_3 are coupling capacitors with the value 1 µF; C_1 protects the signal source from an eventual current shock, eliminating in the same time an eventual DC component introduced by the signal source in the operation of the scheme, and C_2 and C_3 are the coupling capacitors for the collector outputs, the emitter outputs, respectively. We choose R_{SE} and R_{SC} (the load resistences from the emitter, the collector, respectively) as a value of 10 kΩ, standard values. For these above presented values, we obtain at the two outputs two signals identical in magnitude and phase opposition. This can be observed in Figure 2 in which we present the signals viewed on the virtual oscilloscope:

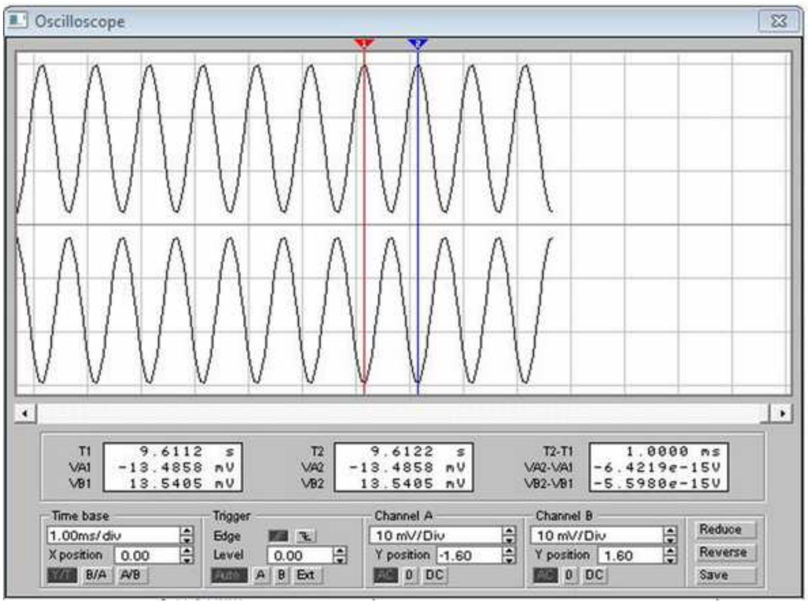


Figure 2 Output signal visualized on the virtual oscilloscope.

As we can see in figure 3, we can successfully replace the differential transformer, but only at equal values of R_E and R_C; at other values, especially when R_C is higher than R_E, we obtain the signal amplified in the collector, more than in the emitter, but still in phase opposition. The signals are in perfect phase opposition as long as the potentiometer R_{B1} has the value presented in Figure 2. The more the value, the more the signals keep their phase opposition, but the collector signal starts to distort, the amplifier functioning in the non-linear saturation area! If the value of R_{B1} starts to go down to 0, we will not have distortions, but the phase opposition will not be kept anymore, thus at the value of 5% of the maximum R_{B1} potentiometer value, the signals from the emitter and the collector will almost be in phase.

A problem which occurs at this type of phase-shift amplifier is that the signals from the two outputs (emitter and collector) come from two different generating sources: the one from the emitter comes from the voltage generator, and the one from the collector comes from a current generator!

In order to overcome this drawback, in the scheme presented in Figure 1 we add in the collector of the current source; thus, we eliminate the issue of the two different signal generators that can create inadequacies and failures, in figure 1, and the output signals come only from the voltage generators (so we have little resistence at the output). We present the modified scheme in the next figure:

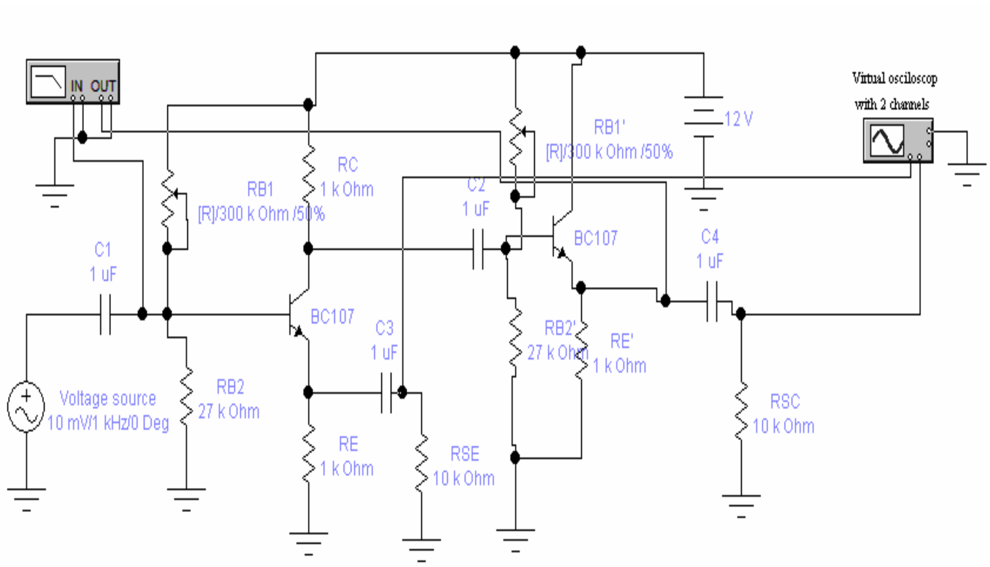


Figure 3 Corrected phase-shift amplifier at the output in connection with the common collector.

In Figure 3 we inserted a Bode-Plotter in order to observe the magnitude-frequency characteristics of the phase shift. We notice that in Figure 4, the magnitude-frequency characteristic improved by the inserated source-follower is better than the charatecteristic obtained at the uncorrected phase-shift amplifier (the one presented in Figure 5). It is better due to its shape, respecting the „hunchback" shape of a classic magnitude-frequency characteristic, as well as due to the fact that at the middle of the waveband (Figure 4 and 5) the signal losses are lower at the improved phase-shift. They are of around -0,09 dB as compared to -0,27 dB at the uncorrected scheme.

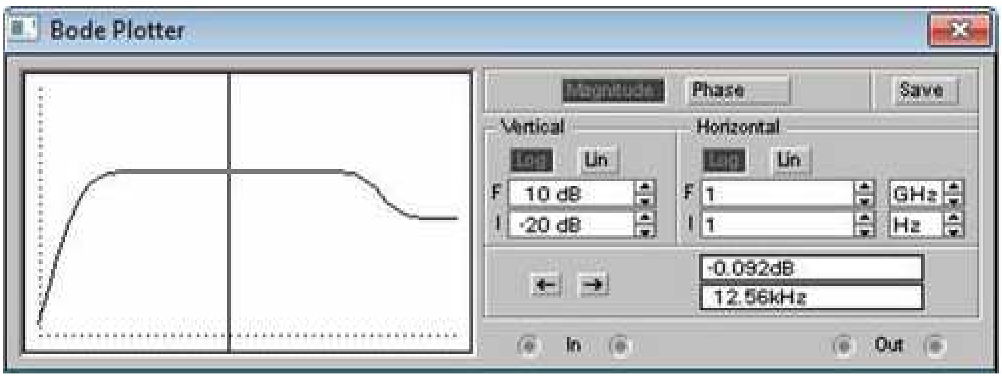


Figure 4 Magnitude-frequency characteristic in Figure 3.

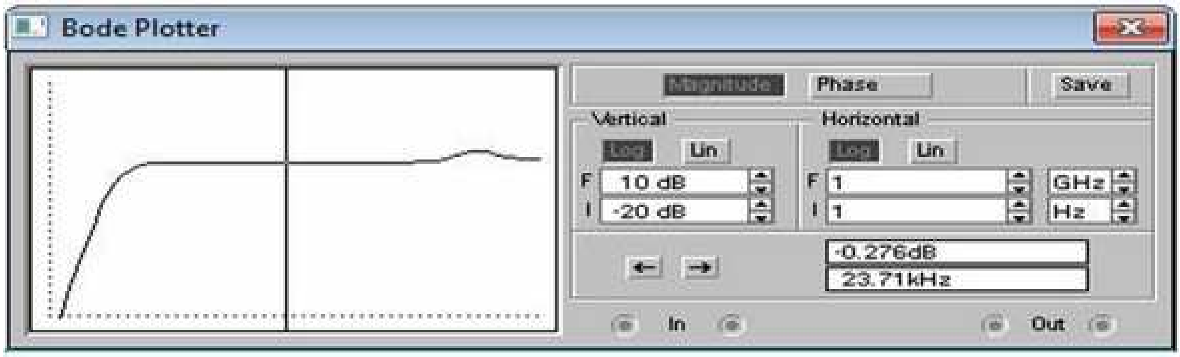


Figure 5 Magnitude-frequency characteristic in figure 1.

3. THE CALCULATION OF THE PHASE-SHIFT PARAMETERS IN THE OPERATION OF THE ALTERNATING CURRENT

Considering that at the two outputs we have a signal that comes from a current generator, as well as one that comes from a voltage generator, (two hybrid, mixed signals), we will use the parameters type H, given by the relation (1):

$$\begin{cases} U_1 = h_{11} \cdot I_1 + h_{12} \cdot U_2 \\ I_2 = h_{21} \cdot I_1 + h_{22} \cdot U_2 \end{cases} \tag{1}$$

In formula (1), we noted with 1 the input value (I_1 and U_1), and with 2the output ones (I_2, U_2); in Figure 6, we noted with U_g and Z_g the voltage, i.e. the resistance from the signal generator; R_B represents the group of bias resistences from the transistor BC 107 connected in parallel in AC; $h_{21}* I_1$ is a current generator, and h_{11} and h_{22} are hybrid parameters from the relation (1); the parameter h_{12} is missing from Figure 6 just because it has a value close to zero; also, h_{22} has a smaller value; R_{acE} and R_{acC} are the AC resistences from the emitter, the double-pole transistor collector, respectively.

In Figure 6 we will present the scheme of the alternating current of the uncorrected phase shift amplifier from Figure 1. We will calculate its parameters because it is more simple than the one in Figure 3, and moreover, from the obtained results we want to highlight that at the outputs we have different output resistences corresponding to the two types of generators (current and voltage).

With $U_{in.}$ we note the alternating voltage seen between B and E in the four-pole scheme [H] from Figure 6, and I_{in} is actually I_1; thus, the input resistance of the phase shift, seen by the transistor, is:

$$Z_{inT} = \frac{U_{in}}{I_{in}} = \frac{h_{11} \cdot I_1 + (1+h_{21}) \cdot I_1 \cdot R_{acE}}{I_1} = h_{11} + (1+h_{21}) \cdot R_{acE} \tag{2}$$

$h_{21} \cdot R_{acE}$ has a great value related to the other terms, thus approximating, the relation (2), becomes:

$$Z_{inT} = h_{21} \cdot R_{acE} \tag{3}$$

Also, considering the relation (1) where we can calculate the parameter h_{21} as a relation between I_2 and I_1 when at the output U_2 =0 (output in fault), as well as the fact that the source follower amplifies in current, thus $I_2 >> I_1$, we demonstrated that the resistence Z_{inT} of the phase shift is very high; basically, the phase shift acts at the input like a source follower!

We will now calculate the two resistences from the phase shift output:

$$Z_{outC} = \frac{U_{outC}}{I_{outC}} \, when \Big| \frac{U_g = 0}{R_{acC} = \infty} \cong \frac{1}{h_{22}} \tag{4}$$

Considering the relation (1) and that $h_{22} = \frac{I_2}{I_1}$ when U_2=0 (output in fault), results that the output resistence from the phase shift collector is higher; it usually has values between hundreds of kΩ and MΩ!

We demonstrated that, as stated at point 2, the phase shift acts in the collector like a current generator!

$$Z_{outE} = \frac{U_{outE}}{I_{outE}} \, when \Big| \frac{U_g = 0}{R_{acE} = \infty} = \frac{1}{g_m} \tag{5}$$

and g_m is the transistor with a value that depends on the collector current and remains almost constant at the connexions common emitter and common basis of the double-pole transistor; chiar panta tranzistorului având o valoare ce depinde numai de curentul de colector şi rămâne aproape constantă la conexiunile emitor comun şi bază comună ale tranzistorului bipolar; g_m has a higher value, so Z_{outE} is very small; hence, the phase shift occurs at the emitter output as a voltage generator!

We demonstrated what we stated in 2th paragraph as well as the need to improve the phase shift amplifier; thus, in practicem Figure 3 is more often used.

Now we calculate also the voltage amplification from Figure 1, seen in the collector:

$$A_{U_C} = \frac{U_{outC}}{U_{in}} = \frac{-h_{21} \cdot I_1 \cdot R_{acC}}{h_{11} \cdot I + (1+h_{21}) \cdot R_{acE} \cdot I_1} = \frac{-h_{21} \cdot R_{acC}}{h_{11} + (1+h_{21}) \cdot R_{acE}} \tag{6}$$

but as stated, the parameter h_{11} has a small value compared to h_{21}, so relation (6) becomes:

$$A_{U_C} \cong \frac{-R_{acC}}{R_{acE}} = -1 \tag{7}$$

we demonstrated what we obtained in the simulation with .EWB soft, i.e. that we have at the output two signals equal in magnitude and phase opposition (when $R_C = R_E$) !

This is due to a negative reaction phenomenon that occurs within the circuit from Figure 1!

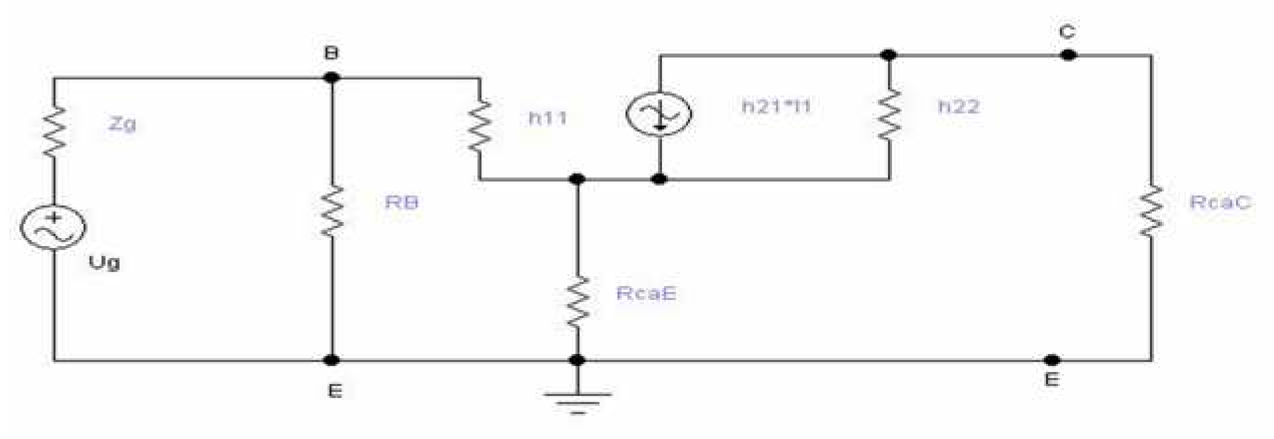


Figure 6 The four-pole scheme [H] for the phase-shift in Figure 1.

4. CONCLUSIONS

The property of the phase-shift amplifier to supply at the outputs two signals equal in magnitude and phase shifted with π is very important in electronics because it leads to the elimination of the static balancer transformer which is very expensive, heavy and which takes too much space, etc. We should consider this aspect even in the navy electronic where there are many transformers, some of them with even more outlets at the secondary circuit.

Another property that should not be neglected is the fact that the phase-shift amplifier can supply amplification if we choose the relation between the collector and the emitter resistances.

The design and study of this amplifier is very useful in electronics using the Electronic Workbench software. We also need to mention that there is a consistency between the EWB software and the superior versions p-Spice (a well known and older electronic circuit simulation software), the schemes simulated in EWB being saved with extensions type .CIR or .SCP which can be further used in the p-Spice software. Although we use an older version of Electronic Workbench (version 5.12), this software is more than enough (as noticed) in the simulation and testing of the electronic schemes. It help to test much more complex schemes; EWB 5.12 has a lot of facilities!

We chose the four-pole scheme [H] and because we worked at low frequencies (1kHz) where this type of representation is more suitable (it is known that the four-pole scheme [Z] is more rarely used in practice because its parameters are not very representative, and [Y] is used at high frequencies).

On the first horizontal hub/terminal of the virtual oscilloscope we have channel A, and on the second one channel B; we shifted the two signals vertically with factor ±1,60 for a better view; the two sliders (see Figure 3) which indicate the difference $T_2 - T_1$ = 1ms on the virtual oscilloscope display; it certifies the fact that we work at a frequency of 1 kHz!

The lateral-vertical terminals are one for the trigger input, and other one for the connection to the ground, but the EWB soft simulates the circuits also without the connection to the ground; it is taken into account only in practice, we didn't want to complicate the scheme. Also, we did not connect ammeters in the scheme, exactly for this reason (the ammeters from the EWB libraries are of very large sizes).

5. REFERENCES

[1] RĂDUCA E. *Electronică Aplicativă*, Ed. Orizonturi Universitare, Timişoara, ISBN 973-638-048-3, 2003.

[2] DRĂGULĂNESCU N. *Agenda radioelectronistului,* Ediția II, pg. 525, Bucureşti, ISBN 973-31-0079-X, 1989

****http://www.softpedia.com/get/Science-CAD/Lucid-Electronics-Workbench.shtml

****http://www.physics.udel.edu/~nowak/phys645/EWB_tutorial.pdf

****http://www.phys.ubbcluj.ro/~anghels/teaching/SIS/Laborator/lucrarea_5.pdf

STEGANOGRAPHY AND CRYPTOGRAPHY ON MOBILE PLATFORMS

[1]BUCERZAN DOMINIC, [2]RATIU CRINA

[1]"Aurel Vlaicu" University of Arad, [2]"Vasile Goldis" Western University of Arad, Romania

ABSTRACT

This paper presents a new solution in order to provide confidentiality of digital data that is transferred through today's available platforms for communication. Our project is to create a set of applications that will use steganography and cryptography to transfer digital information, in a secure manner, on different mobile platforms. Whatever the device used (computer, smart phone, tablet), the user will be able to share secret information through Internet and Mobile Networks.

At this stage of the project, the application called SmartSteg works on Android platform using a sort of LSB steganography and is able to hide and rapidly encrypt large files.

Keywords: *SmartSteg, Steganography, LSB, cryptography, Android.*

1. INTRODUCTION

In today's world, in which "physical" becomes increasingly more "digital", we may say that even the air vibrates of coded messages. Every time we talk on the phone, watch TV, use an electronic card, we use complex forms of digital coding to protect us from so-called cyber criminals.

Digital economy can be regarded as a new dimension of the old economy and has the support of modern technologies of information transmission. We can say that the digital economy represents the beginnings of a new stage of human civilization. As a result of the use of information technology, the society continuously adapts its daily activities, using information in all spheres of its activity and its existence, having a major economical and social impact[1]. In Romania the situation seems to have the sane increasing trend according to the research made by YouBus[12]. The electronic gadgets spread among youth in Romania are smart-phones (51.3%), laptops (52.9%) and digital cameras (53.9%).

The advantages brought by the new economy are due to its strong dynamics due to the digital technologies that make easier and cheaper the access, the processing, the storing and the transmitting information.

In order to get the desired efficiency, one of the issues to be taken into consideration is the environmental security of information transmission. This issue should not be taken lightly - although a lot of progress and new developments have been made in this field - because any part of the digital system can become the target of an attack on electronic information. Figure 1 show briefly today's techniques widely used to secure digital information.

Meanwhile cryptography is used to ensure confidentiality, no-repudiation and integrity. Steganography can be use to ensure protection against detection, protection against removal and ensures the origin of digital information [2].

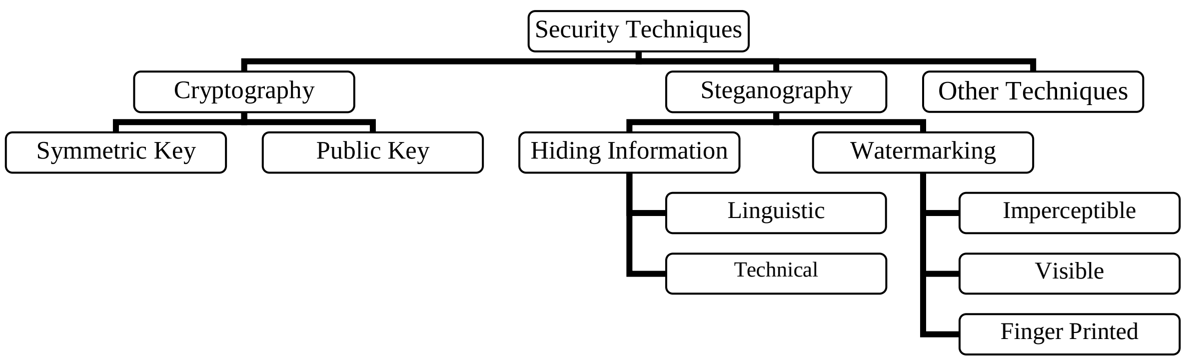


Figure 1 Security techniques [3]

A method to enhance the security of digital information is to combine cryptography with steganography. By hiding the previously encoded message, the information that is intended to be secret may be transmitted without attracting attention in today's insecure environments: Internet and Mobile Networks. Also this method, offers an alternative to the classical storage of data. A user may store he's/she's secret data by encoding and hiding them in digital images to protect them from a possible intruder. We may say that steganography can offer "deniable storage" of information [4].

In this paper we present a solution for the security of digital data that is transferred through Internet and Mobile Networks. We propose a steganography solution that uses digital images as cover, in which we encode and hide any type of file, using a mobile phone that supports Android Operating System. This is the first step in the developing of a package of applications that are designed to run under the most popular operating systems like: Windows, Linux, Android and IOS.

Our idea is to create a set of applications that will decode and unhide digital information, independent of the operating system used to code and hide them. So, whatever the device used, (computer, smart phone, tablet) to encode and hide information, the intended receiver of the secret information may unhide and decode it without the need to use the same type of device as the sender did.

From the beginning, one of the targets that we want to achieve is to design an algorithm that allows to hide a lager quantity of digital data in a digital image, consuming minimal time resources and to minimize the steganalysis detection issues.

2. THE BASES OF OUR CONCEPT

Current trends both in hardware and software technology led industry towards the development of smaller, faster and high-performance mobile devices, which can support a wide range of features and open source operating systems [5].

A rapid growth in this area is registered by mobile hand-held devices which are popularly called *smart gadgets* and they include: smart phones, tablets, e-book readers. The Smartphone's life-cycle has evolved drastically in recent years, having a lifetime of approximately 6 months between generations [5].

There are many factors that influenced the rapid growth of this industry. One of the most important was the availability of operating systems with a revolutionary design and a revolutionary architecture, for mobile handheld devices [5].

Among the major issues that occur in this dynamic, ever changing and evolving environment is the fact that almost all platforms have dedicated application. This fact is in contradiction with one of the principal characteristic of digital information, namely *availability*. In other words, if a sender uses an iPhone to encode and hide some information, the receiver must also use an iPhone to unhide and decode the secret information. And this issue also applies when using a computer.

But, in the case when the sender is restricted to using a computer whereas the receiver has access only to a smart-phone, the secret information is no longer available in this scenario. This is because the application which is designed for computers can't work on smart-phones. A series of factors sustain this issue, among which we may include:

- several physical differences between the devices, which impose some differences in the way the devices are programmed and used;
- every type of device has its own type of operating system;
- every type of device has different performances regarding speed of calculations.

Most of the stenography applications available on the market, designed for smart – phones that work with Android Operating System, are limited to the use of small images through the image view function. This drew a line to the amount of hidden information, limiting it to a few sentences or to a maximum number of characters.

We propose to develop a project that includes a set of applications that use the same algorithm to encode - decode, hide - reveal secret information (almost any kind of digital file) in digital images independent of the type of device used. The idea is shown in figure 2.

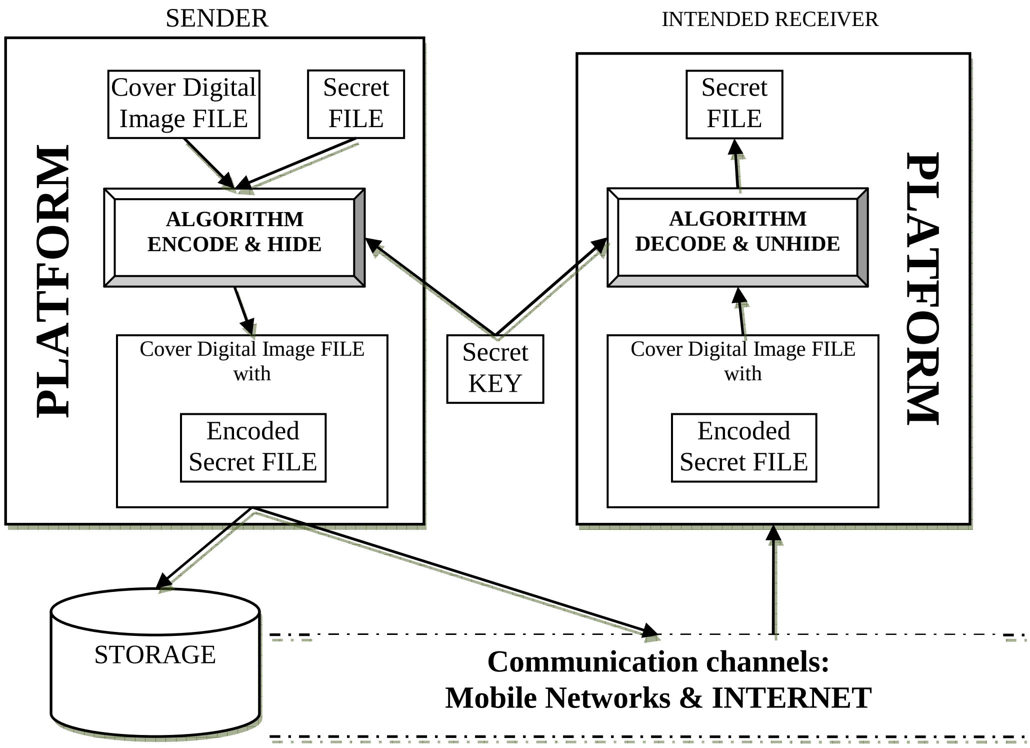


Figure 2 Proposed project

3. THE ACTUAL STAGE OF THE STUDY

Steganography techniques may be classified in four main categories[6]:

- Physical steganography;
- Digital steganography;
- Network steganography;
- Printed steganography.

As mentioned above digital steganography can offer deniable storage of information[4]. This means that secret digital information can be hidden inside of a large variety of cover files: text, images, audio, video and so on. As a consequence there are available tools for steganography that uses as a cover means almost any type of digital source. However the most commonly used method nowadays, is to hide secret information inside digital images, because this technique is relatively easy to implement[4].

Digital imaging has become more than just a popular pastime in contemporary culture. Personal computers, in addition to a plethora of hand-held electronic devices, have become the preferred mode of communication for increasingly large portions of the population. Digital cameras and camera phones have made taking, processing, and sharing photos almost instantaneous, thus making digital images a common component of hi-tech communications [7].

BMP - Windows Bitmap, TIFF - Tagged Image File Format, JPG - Joint Photographic Experts Group, GIF - Graphic Interchange Format and PNG - Portable Network Graphics are file types commonly on Windows, Mac OS and Android operating system, to store digital images [8].

Regarding digital steganography there are three main techniques to embed secret information in a digital image [6]:

- Injection (or insertion) – the secret data is stored in section of a file that is ignored by the majority of applications that may process the cover image: unused header bits or adding harmless bytes to a file leaving it perfectly usable.
- Substitution - the least significant bits of the cover image are replaced with desired data, which will be reproduced on decoding.
- Generation - doesn't require an existing cover image, it generates it just to embed the secret file.

Digital images can store inside them a remarkable amount of secret digital data, without changing noticeable properties of the cover image. Digital images can be altered with many color variation without changing its visible properties, so less attention will be drawn to them. LSB (Last Significant Bit) is the commonly used technique to make these changes, [4] although this method arises several disadvantages. Because it is a relatively easy to implement it is a popular method.

Not all digital images are proper cover means for LSB Steganography. Because this technique may produce change in every bit of each pixel in the cover image, it is needed to use a lossless compression format. Otherwise the changes made can damage irrecoverably the cover image.

BMP files are preferred as a cover images in LSB Steganography mainly because it satisfies this desiderate and offers "lossless" compression, which means that it is a raster graphics image, which equals with „more space to hide”[8].

Using a 24 bit color image, a bit of each of the red (R), green (G) and blue (B) color components can be used, making a total of 3 bits can be stored in each pixel. Thus, a 800 × 600 pixel image can contain a total amount of 1.440.000 bits (180.000 bytes) of secret data[4].

In the literature,[9] steganography methods are divided into three main categories: pure steganography, secret key steganography, and public key steganography.

Based on Kerckhoff’s principle we choose to work with secret key steganography algorithm because in this case no unauthorized person should be able to extract the secret information. Only the sender and the intended receiver should be able to reveal the secret data. The security of the stego-system relies on the „stego-key” which consists of secret information exchanged between the sender and the intended receiver using other secure channels.

There is a similarity between a secret key steganography system and a symmetric cryptographic system[9] the sender chooses an image as a transfer cover and embeds a secret message into it using a secret key. Once arrived at destination, the intended receiver uses the same secret key, to reverse the process and extract the secret message. It is assumed that all communication parties are able to trade secret keys through a secure channel as in cryptography.

If someone intercepts the message, by accident or not, and does not know the secret key, he/she should not be able to obtain evidence of the encoded information, even if the steganographic algorithm is public.

After studing the BMP file specification and structure, the next step in our research was Android Operating System. We choose to work with Android at first because it is a free and open system and widely spread between smart – phones users in Romania.

The Android operating system is able to perform most of the tasks previously accomplished by a personal computer. This includes system files library, middle-ware, and a set of standard applications of telephony, personal information management, and Internet browsing. Also the Android operating system controls the device resources such as camera, GPS, radio, and Wi-Fi[5].

The designed programming language for mobile application that runs on Android Operating Systems is JAVA using Eclipse environment. To optimize the performance of devices applications native code written in the C language through Java Native Interface (JNI) can be mixed. But, native code does not benefit from the Java abstractions (type checking, automated memory management, garbage collection)[5].

In our study due to Android’s support of multiple devices we have encountered some problems regarding how Android manages stored images both on SD card and internal memory of a device.

Most of the applications that exist in this domain are using an image view tool for the cover image.

The image view tool doesn't access directly the original image file. It makes a copy of the original image file and transforms it in an (.png) image type. This technique reduces very much the dimension of the cover image and this is not proper for LSB because it reduces the quantity of secret information which is to be hidden.

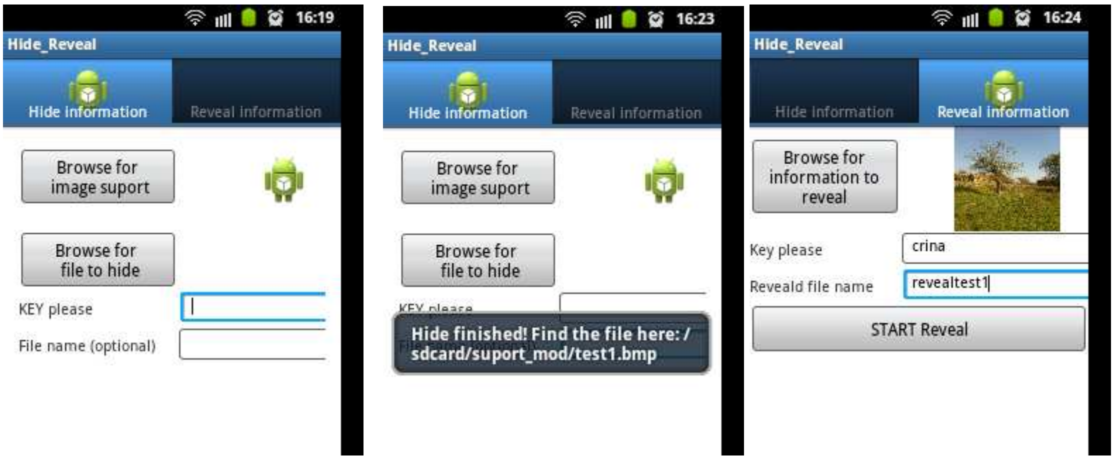


Figure 3 Design for the application that run under Android

The next step in our research was to find a way to access the original digital image file stored on SD card or in phone's memory. This is quite a challenge on Android platform because the way to access the system root folder is different depending on Android's edition and is not widely spread among programmers[3].

The proposed algorithm has reached a very good processing speed between the limits of a reasonable amount of hidden information and the limits of possible steganalysis detection. Calculations and the necessary changes occur instantaneously, which is significant considering that it is working with files of MB dimension on smartphones. So far, the performance of mobile phones have exceeded our expectations concerning the time used in the calculations necessary to encode, to hide, to decode and reveal secret information even using files of MB dimension. However the algorithm remains sensitive to steganalysis detection[3].

4. CONCLUSION AND FUTURE WORK

The usage of steganography is increasing year by year. This fact is sustained by web search [11]:

- 1995 web search produced less than a dozen hits
- 1996 search gave about 500 hits
- 2006 Google search found 1,560,000 references

Google now provides a fine-grained search capability that groups steganography searches by categories such as software, tools, and programs. For example in 2013:

- Steganography had 964.000 hits
- Steganography software had 1.290.000 hits
- Steganography tools had 1.180.000 hits
- Steganography detection had 737.000 hits

Although there are a great number of applications in the field of steganography, few are developed on android platform and their performances are questionable. This is the main reason why we developed this project. We started this project with the implementation of our idea on the Android platform, we will continue to strengthen the encryption algorithm and steganographic algorithm and we will finalize the project by achieving mobility of our proposal on other platforms.

5. ACKNOWLEDGMENTS

This paper would not have been written without the help of several colleagues who offered their availability to test different versions of the application.

6. REFERENCES

[1] IANCU, Ş., *Organizaţia economică modernă şi cultura consacrată creşterii eficienţei cunoaşterii (I)*, ACADEMIA ROMÂNĂ NOEMA, Comitetul Român de Istoria şi Filosofia Ştiinţei şi Tehnicii, ISTORIA ŞTIINŢEI ŞI TEHNICII, Volumul VII 2008, available at http://www.noema.crifst.ro/doc/200801_01.pdf

[2] CUMMINS, J., DISKIN, P., LAU, S., PARLETT, R., *Steganography And Digital Watermarking*, School of Computer Science, The University of Birmingham,2004, available at http://www.cs.bham.ac.uk/~mdr/teaching/modules03/security/students/SS5/Steganography.pdf

[3] BUCERZAN, D., RAŢIU, C., *SmartSteg: A New Android Based Steganography Application*, International Journal of Computers Communications & Control, Vol 8, No5(2013), available at: http://univagora.ro/jour/index.php/ijccc/article/view/642

[4] KRENN, J.R., *Steganography and Steganalysis*, January 2004, available at: http://www.krenn.nl/univ/cry/steg/article.pdf

[5] WANG, Z., MURMURIA, R., STAVROU, A., *Implementing and Optimizing an Encryption Filesystem on Android*, Department of Computer Science George Mason University Fairfax, VA 22030, USA

[6] TUDORIC, G., STÂNEA, P., HUNYADI, D., *"Least Significant Bit" method in steganography*,

Second International Conference Modelling and Development of Intelligent Systems Sibiu - Romania, September 29 - October 02, 2011
[7] COFIELD, M., *Digital Imaging Basics by Information Technology Lab School of Information*, The University of Texas at Austin Summer 2005
[8] SILMAN, J., *Steganography and Steganalysis: An Overview*, SANS Institute InfoSec Reading 2001
[9] KATZENBEISSER, S., PETITCOLAS, F.A.P., *Information hiding techniques for steganography and digital watermarking*, Library of Congress Cataloging-in-Publication, Artech House computing library, 2000
[10] MEIER, R., *Professional Android™ Application Development*, Wiley Publishing, Inc., 2009 - Published simultaneously in Canada
[11] STREETMAN, K. D., *Steganography Art of Covert Communications*, available at: http://www .infragard-etn.org/p/wpcontent/uploads/2011/02/steganography.pdf
[12] ***, *Smartphone-urile, cele mai dorite gadget-uri în randul tinerilor din România*, available at: http://www.agora.ro/stire/smartphone-urile-cele-mai-dorite-gadget-uri-randul-tinerilor-din-romania, Nov.2013

AORTIC ANEURYSMS AND AORTIC DISSECTION IDENTIFICATION USING IMAGE SEGMENTATION WITH MATLAB

[1]COROESCU MIRELA-MARIA, [2]COROESCU TIBERIU

[1]SANA Medical Center Bucharest, Romania, [2]University OVIDIUS of Constanta, Department of Physics and Applied Electronics, Romania

ABSTRACT

This paper analyzes the large application possibilities and opportunities offered in medical imaging by image segmentation to identify aortic aneurysms in general and especially aortic dissection. For effective segmentation of images acquired using the implementation of thresholding techniques was used MATLAB application, with which it was possible the design, implementation and testing of a new graphical user interface through integrated development environment GUIDE. This new GUI is friendly and easy to use, making segmentation in mono, multi and fuzzy modes, for images acquired by any of the current imaging methods for the investigation of aortic aneurysm.

Keywords: *Aortic dissection identification, medical images processing and segmentation, graphical user interface GUI, Matlab applications.*

1. IMAGING METHODS FOR THE INVESTIGATION OF AORTIC ANEURYSM

The aorta is the biggest artery in the organism leading oxygenated blood from the heart through its major branches, throughout the entire body. Anatomically, four major sections of the aorta are described: ascending aorta, from the valvular aortic ring (including Valsalva sinus) to the brachiocephalic trunk, aortic arch from the brachiocephalic trunk to the isthmus (proximately distal to the left subclavian artery), the descending aorta, from the isthmus to the diaphragm, the abdominal aorta, from the diaphragm to the aortic bifurcation (the origin of iliac artery). Aneurysm is a localized pathological dilatation of an aortic segment, which overpasses 50% of initial caliber, given the wall intact with all 3 layers (intima; media; adventitia) [1].

Dissection of aorta consists of the apparition of an intimal rupture allowing blood to pass to the aortic wall, by separating internal of external layers of aorta, formatting a double lumen. Men are twice more affected than women. Most of them are 50-70 aged and hypertensive. Dissection of aorta occurs more frequently at the level of ascending aorta, incidence being estimated about 2.9 - 3.5 to 100,000 persons/year, of which, two thirds are men. In ruptured aorta, only 12% of subjects survive [2].

Imaging examinations are performed preoperatively using the following imaging methods: Chest X – ray, CT examination (MDCT), Magnetic resonance imaging (MRI), Aortography, Echocardiography (TTE, TOE).

On **chest X-ray**, heart along with other mediastinal structures appear with net determined limits, due to best contrast provided by lung full of air, so that any change in cardiac silhouette or outline of the aorta suggests an impairment. In aortic aneurysms, exam has a low specificity; it may show a widening of the mediastinum, best identified in postero-anterior incidence. Sign sensitivity is 67%, many other causes can lead to this enlargement. Radiography can be used for evaluating patients with acute potential, to identify other causes of their symptoms, but it is an inadequate examination for permanent exclusion of acute dissection. An aneurysm of the thoracic aorta can be readily seen on x-ray, modifying the mediastinal contour, or can give deviation for trachea, oesophagus, and compression on left main bronchus; radiography allows the diagnosis of other diseases related to other elements visualized on radiography film (Figure 1). In patients with atherosclerosis and hypertension, aorta appears tortuous and elongated [3].

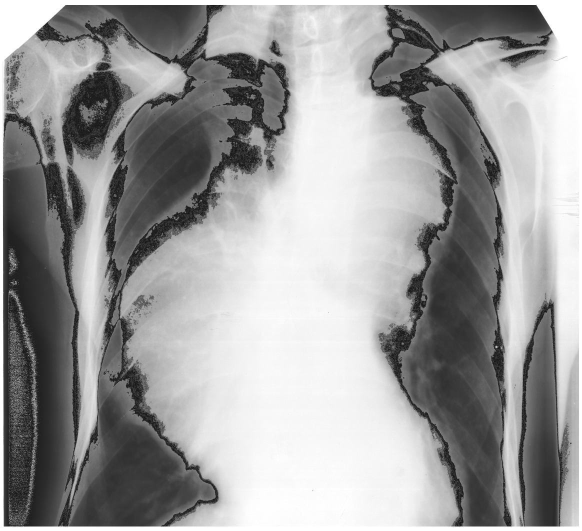


Figure 1 Chest X-ray: Right vascular arch.

Computer Tomography (CT) scan examination of the aorta is the most common today, especially MDCT (Multi-Detector Computed Tomography, especially with 16 slices or more), modifying role of DSA (Digital Subtractive Angiography), which was not long ago the gold standard in the diagnosis and surgical treatment planning. Due to improving of temporal and spatial resolution, examination allows visualization of the entire aorta in a short time (about 5 minutes), entirely ("in one piece"), study of the vessel wall, diagnosis of other diseases of the aorta or thoracic and abdominal organs, to identify anatomical variants or vascular branches involved in the process of dissection, to identify the presence of thrombus and parietal calcifications [4].

Introduction of MDCT has allowed reduction of the acquisition time - arterial phase 10-20 seconds and a greatly increased resolution by slices less than 1 mm thick; reconstruction techniques in examined volume, two-dimensional (MPR – Multi-Planar Reconstruction) or three-dimensional (3D) allow detailed description of the topographic relations between the aorta, its major visceral branches and aneurysm. Axial images, the most common, use reconstruction MPR, MIP (Maximum Intensity Projection) and 3D for offering a panoramic view of the aorta [5].

In patients with suspected aortic dissection, CT is the technique of first choice and starts with a noncontrast scan (to detect IMH) followed by examination of CT angiography (CTA) with contrast agent (CA). Diagnostic criteria include: highlighting of dissection fold, which separates the two lumens, true and false, with the true lumen compression, while aneurysm lumen is normal or increased; moving to the inside of artery intimal calcifications; the input and output place of dissection; aortic enlargement; presence and thrombus extension (extension of more than 10 cm makes a dissection more likely); study of flow in both lumens; dissection's extension to the main branches (Figure 2).

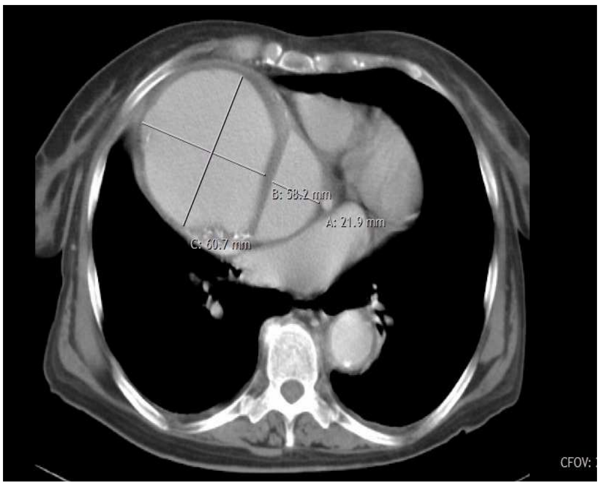


Figure 2 CT with contrast, axial section: aneurysm of the ascending aorta with dissection

To achieve optimal filling of the aorta and visceral vessels with CA, independently on circulation time of the patients, by using the technique "bolus tracking" to activate automatic acquisition; examination is completed with parenchymal phase sequence acquisition at around 80-90 sec. after the initial injection. Acquisitions are obtained with collimation of 1.5 mm, respectively 0.75 mm for arterial phase and examined volume techniques are rebuilt by MPR, MIP, VR, 3D. A full-time examination, including entering and leaving the diagnosis room is between 14-24 minutes. It is not a totally noninvasive technique because CA's administration can cause contrast nephropathy, especially in patients with impaired renal function prior to exam. The great disadvantage of this method is irradiation, especially in young people who require repeated examination, but by using low-voltage-tube techniques (100 kV), that can be applied to the CTA, without being affected the accuracy of diagnosis, it was reduced this negative impact [6], [7].

Magnetic resonance Imaging (MRI) proved to be very effective in the diagnosis of aortic disease, with a specificity and sensitivity that are similar to or exceed those of CT or transoesophageal echocardiography (TOE). Multiplanar method provides an evaluation of the aorta, allowing examination of the entire artery and its branches. MRI offers high quality image in transverse, sagittal and frontal planes, as in oblique incidences and has a sensitivity and specificity of 98-100% in detecting all forms of aortic dissection. The advantages of this test are: identification of anatomical variants of aortic dissection (IMH, PAU), involving branches of the aorta, aortic valve pathology diagnosis, assessment of left ventricular dysfunction, lack of exposure to radiation or contrast agent. Disadvantages include: long duration of examination - meanwhile the patient is inaccessible to treatment; incompatibility with metal implants or claustrophobia; limiting the use of contrast agent - gadolinium in patients with impaired renal function; inaccessibility at many centers; high cost. A relatively new sequence is balanced Steady-State Free Precession (bSSFP), by ackquiring a new set of 3D data in minutes, including fixed images of aorta, when being combined with respiratory navigation and ECG recording, and allows assessment of flow disturbance on the blood vessel, affected by stenosis. It has been suggested that MRI is the best imaging modality for evaluation of aortic dissection and initial examination should be performed in all hemodynamically stable patients. For aneurysms of the abdominal aorta (AAA), has a sensitivity and a specificity of 89% and 98% respectively, and proximal extension of AAA can be shown to nearly 100% of patients, compared to 92% for conventional angiography. MRI is extremely useful in the study of patients after medical or surgical intervention [8].

Magnetic resonance angiography (MRA) has become routine examination of the aorta and great vessels because it is an examination without exposure to ionizing radiation or iodinated contrast agents, which makes it useful in the followup of aortic disease, especially in young people.

When we need to use intravenous contrast material, the volume is reduced compared to iodinated contrast agents, which makes contrast-induced nephropathy to be much lower, compared to CT or aortography. This is very important in morphological evaluations performed in patients at risk for nephrogenic systemic fibrosis (NSF). The method enables the acquisition of functional information (flow and movement of various anatomical elements) which increase the value of a morphological study. Morphological evaluation provides information on vessel diameter, aortic wall characteristics, lumen patency, anatomical relationships with surrounding tissues (relationships obtained for side branches too), and vascular functional assessment. For the study of the aorta can be used quick reliable and reproducible techniques. The technique by administering a contrast agent (gadolinium) extended the clinical applicability of the method in particular by CE-MRA (Contrast Enhanced - MRA). This technique allows high quality images of single apnea patients. Increasing the quality of acquired images is achieved by post-processing methods such as

Figure 3 MRA of the aortic arch. Sagittal MIP

Maximum Intensity Projection MIP (Figure 3).

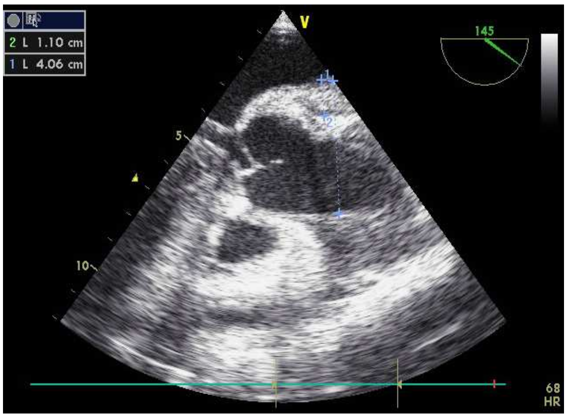
This procedure allows a rapid acquisition of images and a 3D appreciation of the anatomy, clinical elements needed because they are superimposable with those obtained by classical angiography [9], [10].

Aortography had been until recently (2004), the gold standard in the plan of diagnosis and treatment of aneurysms of the aorta. Being an invasive method that utilizes X-rays and iodinated contrast agent for diagnostic, non-invasive methods or minimally invasive (CT, MRI, echocardiography) had replaced this technique; it is used in endovascular treatment or diagnosis, especially in complications (dissection of the aorta). Aortography allows: localization of aneurysms; diameter appreciation; evaluation of relationship with major branches of the aorta and their involvement in the aneurysm; to emphasize the atherosclerotic aortic wall affection; presence of thrombus (relationship with the wall and its extension); diagnosis of aortic dissection and complications that accompany it; to specify the type of treatment to be applied (surgical, endovascular, medical). In diagnosis of aortic dissection, aortography has a sensitivity of 80% and a specificity of 95%. pathognomonic sign is the view of intimal fold commonly associated to delay or slow filling of the second lumen, although about 20% of patients with dissection shows only one visible channel. Aortography, besides documenting dissection, provides information about the presence of aortic insufficiency, vascular involvement and coronary artery branches, particularly when results are equivocal CT or MRI, but there is a strong clinical suspicion of acute aortic dissection. In patients with suspected aortic dissection, the preferred approach path is the femoral one, where pulse wave feels best. Diagnostic catheters are atraumatic, inserted through wire guide and are advanced in floroscophy with repeated injection manual tests (Figure 4).

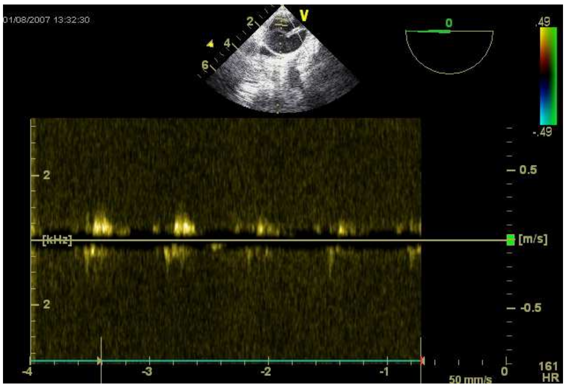
IVUS (Intravascular Ultrasound) is also an angiographic technique that allows examination of the aorta, using special catheters. The pullback techniques can determine: lumen diameter; cross-sectional area; wall thickness; lesion length; shape and position of stenosis (eccentric or concentric); type of lesion (fibrous or calcified); site of flap dissection and extension of this; ulceration; presence of thrombus and its volume [11].

Figure 4 Aortographyc exam; approach with atraumatic guide wire; giant AAA

Echocardiography is the most widely used clinical technique for examining the aorta; it is available in most hospitals, in the form of transthoracic echocardiography (TTE) and transoesophageal echocardiography (TOE). Transthoracic echocardiography TTE is noninvasive and thus can be repeated as needed, is done quickly, especially in suspected acute aortic dissection, directly at the bedside, anywhere in the hospital (intensive care, emergency, operating room). Aortic aneurysm or dilatation, dissection, thrombus, atherosclerotic plaques and calcification, bicuspid aortic valve, Marfan syndrome are well evaluated by this technique, which is used for screening or monitoring series of patients at risk for progression of dilatation. In acute aortic syndrome, diagnosis by TTE is based on highlighting the intimal flap, which separates the two channels, true and false, and has an independent movement to the aortic wall or other heart structures. False lumen is hereby characterized by spontaneous contrast, increased diameter in diastole, absent, delay or reverse flow, presence of thrombus. Aortic dissection variants are also evaluated: IMH appears as a thickening of the aortic wall of 0.5 mm and PAU creates a crater image with irregular edges and is usually associated to extensive aortic atheromatosis. Specificity for dissection of the ascending aorta is 78-90% (type A, 87-96%; type B, 60-83%) and only 31-55% for dissection of the descending aorta. Introduction of harmonic imaging techniques and use of contrast agent have improved sensitivity and specificity of the method (contrast-TTE, similar to trans esophageal ultrasound-TOE). TTE has a low negative predictive value and therefore does not allow the exclusion of dissections, requiring further investigation type CT or MRI. Transoesophageal echocardiography (TOE) overcomes the limitations of TTE by eliminating interposition between chest wall and lung, visualizing the entire thoracic aorta except the "blind point", a short segment of distal ascending aorta, which remains unviewed due to the interposition of trachea and right



a)



b)

Figure 5 Transoesophageal echocardiography TOE. a). longitudinal section - ascending aorta dissection; b). Cross section - fold dissection

bronchus; the method allows oblique measurements at the tortuous and elongated descending aorta (Figure 5).

The first European multicenter study showed a specificity of 90-100% and a sensitivity of 86-100% in acute dissection of the aorta.examination in M mode allows differentiation of intimal folds reverberations caused by neighboring elements (left atrium anterior wall, posterior wall of right pulmonary artery), occurring with a frequency of 44-55%. TOE can identify intimal tear in 78-100% of cases; it appears as a discontinuity of intimal folds with a diameter greater than 5 mm, located in the proximal ascending aorta, in type A dissection, and below the left subclavian artery origin, in type B dissection. Intraoperatively, TOE can emphasis the immediate complication: correct connection between true lumen and tube graft, aortic residual regurgitation, abnormal contraction of the left ventricle, or right reimplantation of the coronary arteries [12].

2. SEGMENTATION IN MONO, MULTI AND FUZZY MODES

In order to recognize objects in a given image, it is often necessary to subdivide the image into meaningful regions. The process of segmentation deals with partitioning an image into a set of non-overlapping regions whose union is the entire image. It is very difficult to find a criterion that yields a meaningful segmentation. However, in general, we can say that regions in the segmented image should be homogenous and should have well-defined boundaries. Many methods of segmentation are available in practice. One possible approach to segmentation is to obtain edge pixels using some local edge detection operator followed by an edge-linking or edge-tracking procedure. Local edge detector operators do not yield continuous edge or boundaries. Often, some edge-linking or edge-tracking method is used after edge detection to obtain continuous boundaries.

Another approach to segmenting an image is *thresholding*, in which we use the histogram of the input image to obtain a threshold value. In this way a simple image that contains a background and an object produces a histogram with two peaks, and the threshold is the one that separates the two peaks in the histogram. Segmentation in this case is one-way segmentation ("uniseg"), which outlines just one element of the picture. This simple thresholding method of segmentation works for simple images with maximum two distinct peaks. [13]

However, in practice, an image may contain several objects, and simple thresholding method may not be applicable. If we have a histogram with more than two peaks, then we need more than one threshold value. For a histogram with three peaks, one peak in the histogram may represent the background, and the other two peaks may represent two different objects in the image. Segmentation in this case is multi-segmentation mode ("multiseg"), in which more elements of the image are outlined. After we segment such an image, the next step is to obtain representation for various regions found. Objects are often of different shapes, and shape descriptors are frequently used as features. Segmentation techniques yield data in the form of pixels contained in a region. In order to recognize or label a region, we extract features that characterize the region. However, sometimes, before we extract features, we use a representation that both characterizes the region and yield a reduced data set. Data representation schemes commonly used are chain codes, signature, and medial axis transformation [14]..

FCM segmentation mode (Fuzzy C-Means) was a method developed by Dunn in 1973, improved by Bezdek in 1988, by Hall in 1992 and by Kulkarny in 2001, beeing very useful in pattern recognition and medical imaging [15]. This kind of segmentation ("fuzzyseg") is based on minimizing an objective function through iterative optimization procedure to obtain the final fuzzy partition, updating cluster centers. Data are grouped by a member function, constructing a matrix of subunit values representing the degree of belonging between data centers and clusters. In the FCM approach, the same date is not exclusive to a well-defined group, but can be placed in a middle position. In this case, the function indicates that every member data can belong to several clusters with different values of the coefficient of membership. The algorithm stops when the deviation is less a subunit error imposed. [16].

3. USER INTERFACE FOR AORTIC ANEURYSMS AND AORTIC DISSECTION IDENTIFICATION

In order to facilitate the interpretation of images acquired by the examining physician, it was developed a graphical user interface GUI using Graphical User Interface Development Environment GUIDE facility in the MATLAB environment [17], [18]. The interface allows uploading images acquired through the push-button "Import JPG Images", and then using thresholding segmentation techniques it is possible to obtain mono image segmentation with the push-button "MONOSEG", outlining one significant segment of the image, or multi segmentation with the push-button "MULTISEG", outlining more significant elements of the image. Fuzzy image segmentation with method FCM ("Fuzzy C-Means") is obtained by pressing the "FUZZYSEG" push-button. Exit the program is realised by pressing the push-button "CLOSE". Newly designed graphical user interface GUI for medical images segmentation is presented in Figure 6

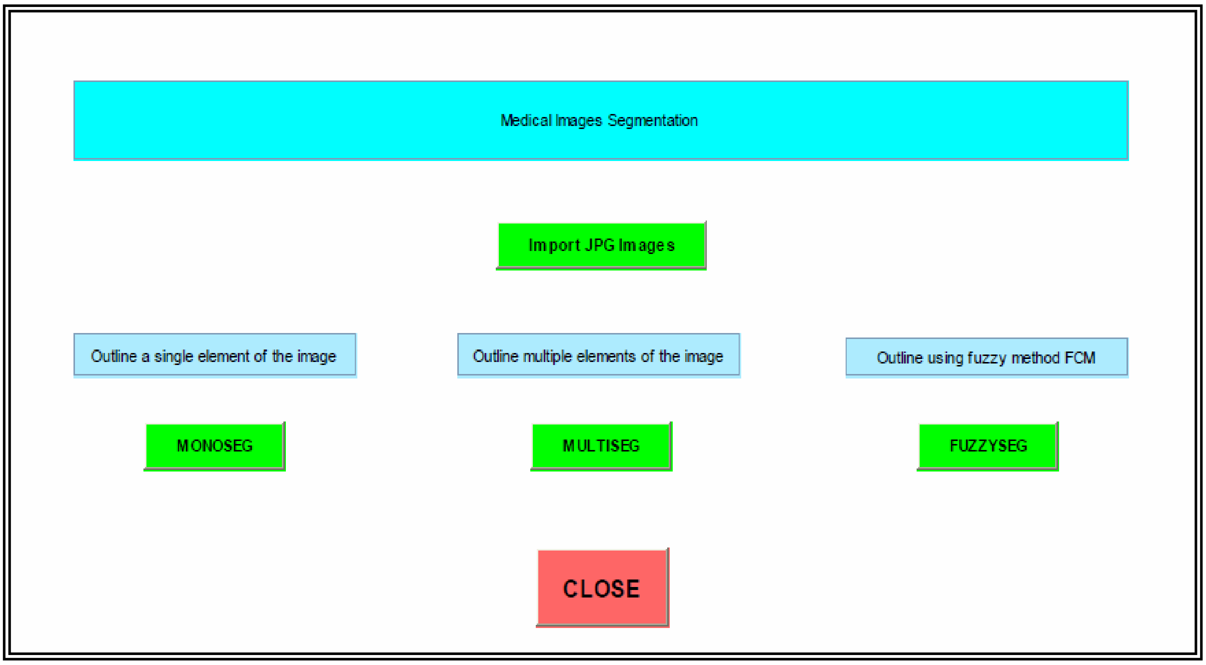


Figure 6 Graphical user interface GUI for medical images

Matlab software function assigned to the first button on the GUI interface, with the role of importing images in JPG format ("Import JPG Images") is the one that follows:

```
[num,cal]=uigetfile('*.jpg','IMPORT JPG IMAGES')
Imagimp=imread(num);
imwrite(Imagimp,'C:\imagimp.jpg');
```

Matlab software function assigned to the second button on the GUI interface, with the role to achieve mono-segmentation ("MONOSEG"), resulting in images shown in Figure 7, is the following:

```
I=imread('C:\imagimp.jpg');
Igr=rgb2gray(I);
figure
imshow(Igr)
title('Imported original image');
se = strel('disk',1);
NHOOD = getnhood(se);
J=rangefilt(Igr,NHOOD);
Iadj=imadjust(J);
Ibw=im2bw(Iadj,0.2);
Iao=bwareaopen(Ibw,1000);
IM=imcomplement(Iao);
IMao=bwareaopen(IM,5000);
IMnobord=imclearborder(IMao,4);
IMao2=bwareaopen(IMnobord,5000);
IMfi=imfill(IMao2,'holes');
IMoutline = bwperim(IMfi);
Segout = Igr;
Segout(IMoutline) = 255;
figure
imshow(Segout)
title('Segmented image MONOSEG');
imwrite(Segout,'c:\monoseg.jpg');
```

Matlab software function that is assigned to the third button on the GUI interface, with the role of achieving multi-segmentation ("MULTISEG"), resulting in images shown in Figure 8, is as follows:

```
I=imread('C:\imagimp.jpg');
Igr=rgb2gray(I);
img=double(Igr);
thres_new=120;
thres=0;
[r c]=size(img);
while (thres~=thres_new)
   m1=0;
   m2=0;
   thres=thres_new;
   for i=1:r
      for j=1:c
         if (img(i,j)>=thres)
            m1=m1+img(i,j);
         else
            m2=m2+img(i,j);
         end
      end
   end
   [x y]=size(find(img>=thres));
   m1_len=x;
   [x y]=size(find(img<thres));
   m2_len=x;
   avg=((m1/m1_len)+(m2/m2_len))/2;
   thres_new=avg;
end
img_thresh=img>thres_new;
figure
imshow(uint8(img))
title('Imported original image');
figure
imshow(img_thresh);
title('Segmented image MULTISEG');
imwrite(img_thresh,'c:\multiseg.jpg');
```

Matlab software function that is assigned to the fourth button on the GUI interface, with the purpose to achieve fuzzy segmentation ("FUZZYSEG"), resulting in images shown in Figure 9, is the following:

```
info = imfinfo('C:\imagimp.jpg');
AA=imread('C:\imagimp.jpg');
I = im2double(AA);
I = imadjust(I,[],[]);
info2 = imfinfo('C:\imagimp.jpg');
I2 = im2double(AA);
I2 = imadjust(I2,[0,1],[1,0]);
figure;imshow(I,[]);impixelinfo;
title('Imported original image');
data = [I(:) I2(:)];
[center,U,obj_fcn] = fcm(data,7);
maxU = max(U);
index1 = U(1,:) == maxU;
index2 = U(2,:) == maxU;
index3 = U(3,:) == maxU;
index4 = U(4,:) == maxU;
index5 = U(5,:) == maxU;
index6 = U(6,:) == maxU;
index7 = U(7,:) == maxU;
fcmImage(1:length(data))=0;
fcmImage(index1)= 1;
fcmImage(index2)= 0.8;
fcmImage(index3)= 0.6;
fcmImage(index4)= 0.4;
fcmImage(index5)= 0.2;
fcmImage(index6)= 0.1;
fcmImage(index7)= 0.0;
imagNew = reshape(fcmImage,256,256);
figure;imshow(imagNew,[]);impixelinfo;
title('Segmented image FUZZYSEG');
imwrite(imagNew,'C:\fuzzyseg.jpg');
```

Matlab software function that is assigned to the fifth button on the GUI interface, with the role of achieving the output from the segmentation program ("CLOSE") is the following:

```
exit_button=questdlg('Exit Now?','Exit
Program','Yes','No','No');
switch exit_button
case 'Yes'
delete(handles.figure1)
case 'No'
return
end
```

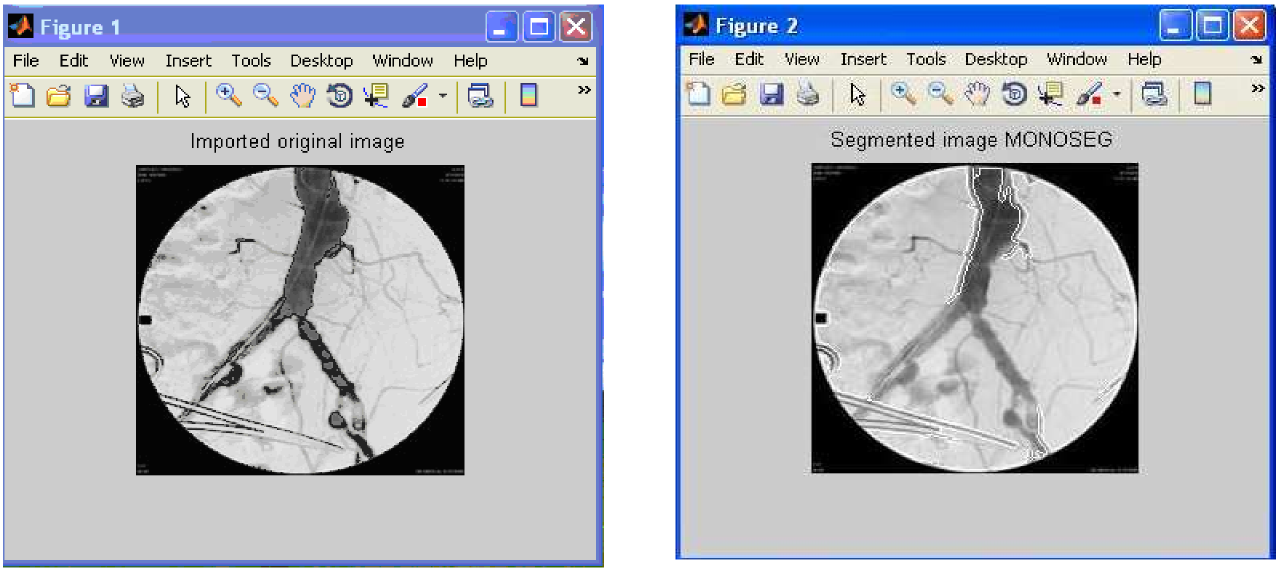


Figure 7. Original and segmented images using MONOSEG

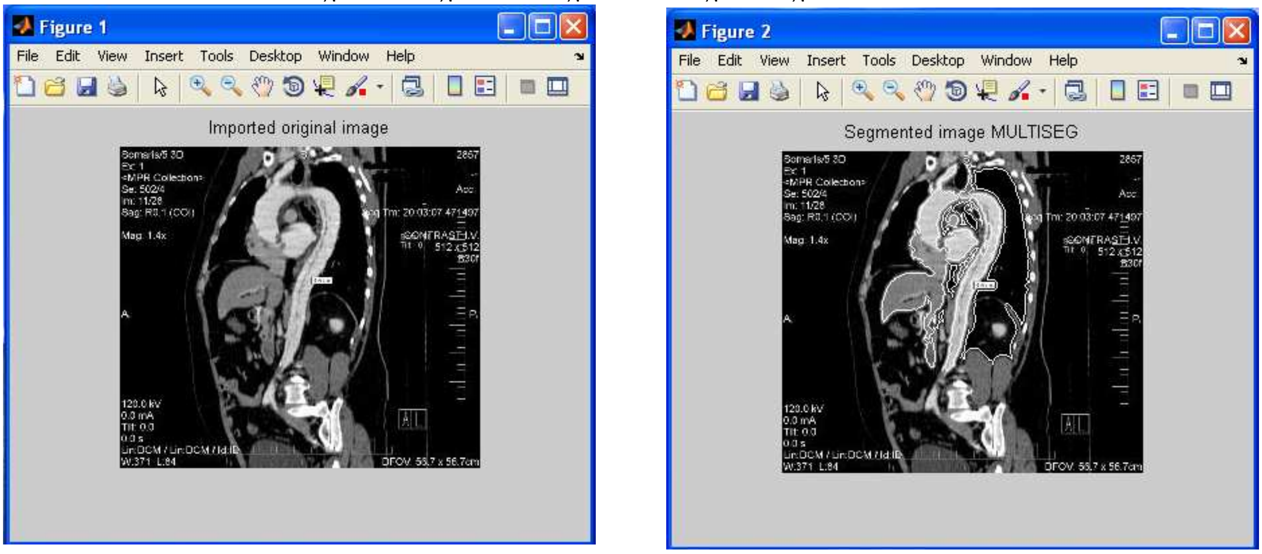


Figure 8. Original and segmented images using MULTISEG

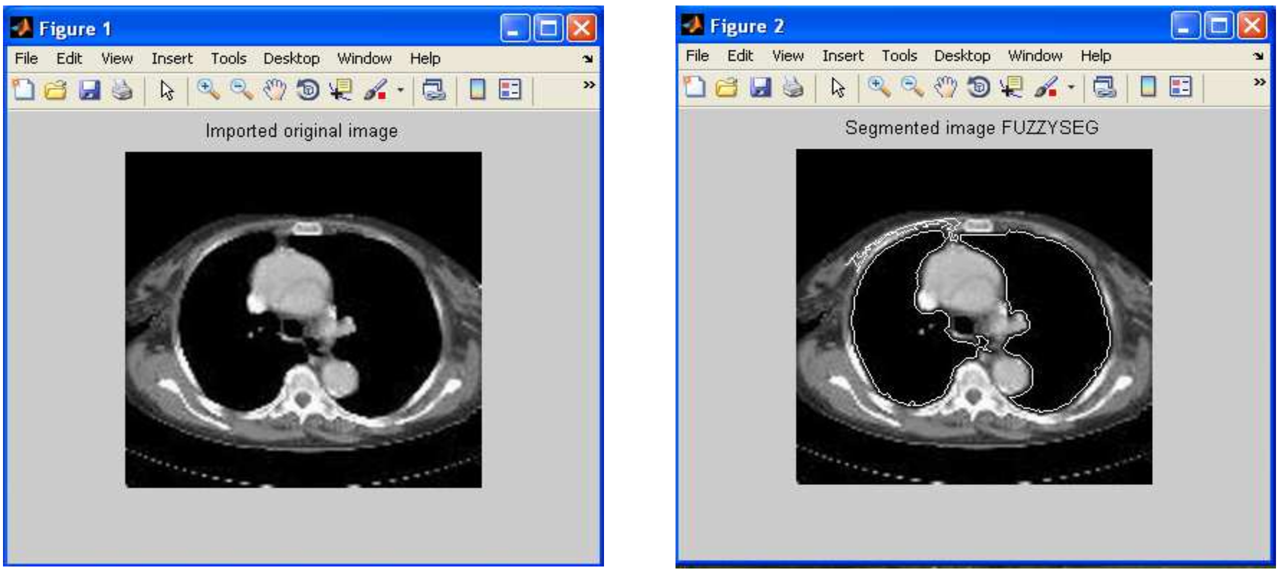


Figure 9. Original and segmented images using FUZZYSEG

4. CONCLUSIONS

The paper emphasizes the perspectives of identifying aortic aneurysms and their complication - aortic dissection by designing, implementing and testing a new graphical user interface GUI for medical imaging, using the integrated development environment for graphical interfaces GUIDE ("Graphical User Interfaces Development Environment") of software MATLAB ("Mattrix Laboratory") for viewing images acquired in an efficient way and in real-time. The practical utility of this new interface should be noted especially in aortography, allowing visualization of aneurysms by reducing the amount of contrast agent, thus reducing aggression on renal function.

5. REFERENCES

[1]. KIRKLIN, J.W., BARRATT-BOYES, B.G., *Cardiac Surgery, Second Edition. Part VII: Thoracic Aortic Disease.* Publisher: Churchill Livingstone Inc. 1993, pp. 1701-1776.

[2]. DI BARTOLOMEO, R., MARTIN-SUAREZ, S., *Chirurgia dell'aorta toracica oggi.* Leadership Medica no 4, 2006.

[3]. ENSOR, R.E., FLEG, I.L., KIM, Y.C. & COL,: *Longitudinal chest x-ray changes in normal man*. J Gerontol 1983; 38: 307-314.

[4]. TAMBORINI, G., GALLI, C.A., MALTAGLIATI, A., et al., *Comparison of feasibility and accuracy of transthoracic echocardiography versus computed tomography in patients with known ascending aortic aneurysm*. Am J Cardiol 2006; 98: 966-969.

[5]. KUMAMARU, K. K., HOPPEL, B. E., MATHER, R. T., RYBICKI, F. J., *CT Angiography: Current Technology and Clinical Use.* Radiol. Clin. North Am. 2010; 48 (2): 213-235.

[6]. HOANG, J.K., MARTINEZ, S., HURWITZ, L.M., *MDCT angiogrphy after open thoracic aortic surgery: pearls and pitfalls.* AJR Am J Roentgenol 2009; 192: 20-27.

[7]. COROESCU, M.M.., CRAIU, E., FURDU, I., BLAJ, C., *CT examination and implications in therapeutic management of aortic aneurysm.* Archives of the Balkan Medical Union, 2013; 48 (2): 154-158.

[8]. HO, V.B., PRINCE, M.R., *Thoracic MR aortography: imaging techniques and strategies*. Radiographics, 1998; 18: 287-309.

[9]. GHOSHHAJRA, B., ENGEL, L.C.H., WALKER, G., MR *Angiography. Chapter 1: Magnetic Resonance Angiography Basics to Future*, pp.1-21, www.intechopen.com.

[10]. COROESCU, M. M., CRAIU, E., NOVELLI, E., *Risk factors and perioperative determinants of prolonged length of stay in the intensive care unit and transfusion requirements in surgical and endovascular treatment of aneurysms of the aorta.* Archives of the Balkan Medical Union, 2013; 48 (1) : 10 – 15.

[11]. KPODONU, J., RAMAIAH, V.G., DIETHRICH, E.B., *Intravascular Ultrasound Imaging as Applied to the Aorta: A New Tool for the Cardiovascular Surgeon.* The Annals of Thoracic Surgery 2008**,** Vol 86, pp.1391-1398.

[12]. LEESON, P., AUGUSTINE, D., MITCHELL, A.J.R., BECHER, H., *Echocardiography, Second Edition* 2012, pp.308-319.

[13]. GONZALES, R., WOODS, R., EDDINS, S., *Digital Image Processing Using MATLAB, Second Edition,* Gatesmark Publishing LLC, Natick, USA, 2009.

[14]. COROESCU, T., CONSTANTIN, S., COROESCU, M.M., *Feed-Forward Associative Neural Networks for 3-D Image Processing, Reconstruction and Modelling in Coronary Arteries.* Proceedings of 2002 IEEE-TTTC International Conference on Automation, Quality and Testing, Robotics, Tome II: Robotics, Image and Sygnal Processing , Applications, 2002, Cluj-Napoca, Romania, pp. 99-104.

[15]. KULKARNI, A., *Computer Vision and Fuzzy-Neural Systems.* Prentice Hall PTR, Upper Saddle River, New Jersey (USA), 2001.

[16]. COROESCU, M.M., COROESCU, T., CONSTANTIN, S., *Medical Image Processing using Segmentation and Feature Extraction Process based on Fuzzy-Neural Networks.* A III-a Conferinta de Inginerie Biomedicala cu participare internationala, INGIMED – 2002, Bucuresti, pp. 1-8.

[17]. MARCHAND, P., HOLLND, O.T., *Graphics and GUIs with MATLAB, Third Edition*, Chapman & Hall CRC, Boca Raton, 2003.

[18]. HAHN, B.D., VALENTINE, D.T., *Essential MATLAB for Engineers and Scientists, Third Edition,* Elsevier Ltd, Oxford, 2007, Chap. 13: Graphical User Interfaces GUIs, pp. 292-305.

CONSIDERATIONS AND CONTRIBUTIONS TO THE IMPROVEMENT OF TRANSMISSION LINES PERFORMANCES

[1]GRIGORESCU LUIZA, [2]DIACONESCU IOANA

[1,2]*Department of Engineering Science and Management, "Dunarea de Jos" University of Galati, Romania*

ABSTRACT

The purpose of our paper is to explain why apparently identical constructions of the antenna and transmission line behave differently, and to offer information on how the transmission line must be dimensioned so that the energy transfer towards the antenna is maximum. We have shown above that the rule of the integer multiple of $\lambda_{linie}/2$ applies only for one frequency from the many frequencies of a band in which radio emission is performed, frequency on which the antenna is actually set. For other frequencies appear two sources of un-adjustment: the antenna is no longer supplied to the frequency on which it is set, and besides the active component of its impedance there are other reactive (capacitive for lower frequencies and inductive for higher frequencies, as compared to the tuning frequency), and the length of the line does not comprise an integer number of semi waves of the operating frequency. To see how important the impact of the alteration is we can use the relations on any available medium, including Microsoft Excel. I preferred Delphi 7, with which I got the following results which will be analyzed.

Keywords: *Transmission lines, impedance matching, line length, power factor.*

1. INTRODUCTION

A radio communication equipment connected to the antenna through a transmission line forms a set of three different mediums, each with its own characteristics, in this case, impedance being the most important. It is known that a maximum transfer of energy from one medium to the other takes place when the impedances of the mediums are equal, which, in practice, is a difficult to achieve goal.

According to picture 1 the equipment (medium 1) has the impedance Z_1 in the connection point to the line, the line (medium 2) has the characteristic impedance Z_0 and the antenna (medium 3) has the impedance Z_3 in the point which connects to the line. A fourth medium (medium 4) appears, in which the electromagnetic field waves are propagated. As far as the nature of these impedances is concerned, it can be certainly said that Z_0 is of a purely active nature, whereas Z_1 or Z_3 may be, generally speaking, complex impedances, with active and reactive components. A tuned, ideal antenna has an impedance of Z_3 without reactive components, respectively *36Ω, 50Ω, 75Ω, 300Ω, 600Ω,* the transmission lines are constructed with the same impedance, for reasons of maximum energy transfer towards the antenna. It is only that this ideal is possible for a single frequency on the working line, and there are other supplementary conditions to add, like: the antenna should be placed at a specific height above a perfectly conductive ground, with no vicinity that would conduct the electrical current (trees, metallic roofs, electrical lines etc).

Therefore, in real cases, the antenna has a Z_3 impedance of a complex nature whose active and reactive components are variable in the frequency band, the Z_3 impedance characterizing both the antenna and the influence of the 4 medium through the so called radiation impedance.

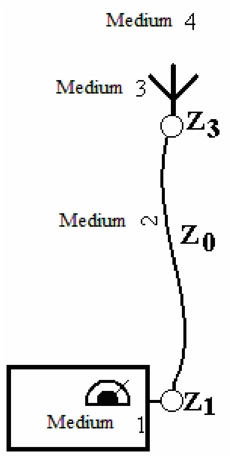


Figure 1 The radio communication equipment

The error from the ideal is much more evident in multiband antennas, which are nevertheless used due to the compromise they allow between the construction cost and the efficiency in traffic. As for industrial equipments, when they are correctly set, they have Z_1 impedance, which is also of a purely active nature, without reactive components, and whose value is equal to the characteristic impedance of used lines. The compensation of the impedance differences between two mediums is usually realized using fixed adaptation devices (transformers) or adjustable (antenna tuner, Z-match, transmatch etc). Unfortunately, they are difficult to set in place or use in the very places where they are most needed, between the line and antenna. The placement between the equipment and the line, namely in the very place where adapting the equipment and line impedance is most easily realized from the construction of the equipment, has the main purpose of protecting the final stage of the transmitter, from the reflected waves which overload it by bringing the energy back, as it is known that a wave transports energy. In this case the adjusting device only performs one adjusting between Z_1 impedance and a complex nature impedance which results as equivalent impedance Z_{ech} of the line, antenna and serial connected medium.

The purpose of our paper is to explain why apparently identical constructions of the antenna and transmission line behave differently, and to offer information on how the transmission line must be dimensioned so that the energy transfer towards the antenna is maximum.

2. THE EQUIVALENT IMPEDANCE OF THE LINE AND THE ANTENNA

We have shown above that the impedance of the antenna Z_3 represents an impedance that characterizes the real antenna together with the reaction of the real medium in which it is placed. This impedance can be measured directly on location, but with devices that are not available to everyone.

The common circuit made up of the Z_0 line of l length and the Z_3 antenna presents at its entrance (which is connected to the exit from the transmitter) an equivalent impedance Z_{ech} in the form of a complex measure with the following expression [2], [3], considering a line without losses or with negligible losses, case which is close to reality in mono or bifilar lines with air as dielectric or coaxial lines no longer (20÷25) m:

$$Z_{ech} = Z_0 \frac{\frac{Z_3}{Z_0}\cdot\cos\left(2\pi\frac{l}{\lambda_{line}}\right) + j\cdot\sin\left(2\pi\frac{l}{\lambda_{line}}\right)}{\cos\left(2\pi\frac{l}{\lambda_{line}}\right) + j\cdot\frac{Z_3}{Z_0}\cdot\sin\left(2\pi\frac{l}{\lambda_{line}}\right)} \qquad (1)$$

As for λ_{line}, this is the wave length from the line corresponds to the frequency we work with at a specific point in time, equal to the wave length in vacuum λ multiplied by the shortening rate of the line *k*, also known as velocity coefficient. In mono or bifilar lines with air dielectric $k = 0{,}95\cdots1$ in coaxial lines with filled dielectric (no gaps, no matter what the diameter, we measured several coaxial cables with diameters from 6 to 12mm and have always found the same value) $k = 0{,}66$. In case of doubt it can be measured very easily, I will show how at the end, for now we have yet to consider several cases:

a) If the line is very short ($l << l_{line}$, meaning $2\pi l/\lambda_{line} \approx 0$), from (1) we get $Z_{ech} \approx Z_3$. This case shows why a very short line offers very good results in low bands, where the wave length is high, but is not as good in higher bands, with wave lengths 8---16 times smaller. In low bands the adjusting device placed between the transmitter and the line practically adjusts the impedance of the Z_1 transmitter directly to the impedance of the Z_3 antenna, as if the line did not exist, transferring the maximum energy directly to the antenna. On the other hand, in superior bands the transmitter transfers the maximum energy to the line-antenna assembly with a $Z_{ech} \neq Z_3$ impedance, which is not always transferred to the antenna as a result of the failure to adapt between Z_0 and Z_3. Part of the energy is reflected from the antenna in the line, is dissipated on the latter (the line radiates) and reduces the energy radiated from the antenna.

b) If the line's length equals an integer multiple of half wave lengths $l = n\frac{\lambda_{line}}{2}$, *n=1,2,3...*, we get $Z_{ech} = Z_3$ no matter how large the value of the line's impedance is. In this case we directly adjust the antenna to the transmitter, as if the line did not exist. Taking into account that the IARU bands' inferior ends are integer multiples of the lowest frequency, a line with the length $l = \frac{\lambda_{line}}{2}$ on the lowest frequency (3,5MHz) will have a length of $l = n\frac{\lambda_{line}}{2}$ on the superior bands, *n=2, 4, 6, 8*, which are, by chance, even numbers.

c) If the line's length is equal to an odd multiple of quarters of wavelength, $l = (2n+1)\frac{\lambda_{line}}{4}$, *n=0,1,2,3...*, we get $Z_{ech} = \frac{Z_0^2}{Z_3}$ which leads to $Z_0 = \sqrt{Z_{ech}Z_3}$. In this case the line acts as an impedance transformer between the antenna's impedance and the output impedance of the transmitter. For *n=0* we get the quarter-wave transformer [1], [4], which is widely used as adjusting transformer because it is simple, safe, and does not present the problem of core losses as it is the case with ferrite ring surfaces transformers. What is more, at high frequencies, especially in the VHF-UHF domain, it results in reasonably small lengths, of maximum tens of centimeters, being available for manual construction, for example to adapt a helicoidally antenna (approximately *125Ω* impedance) to a cable of *50Ω* or *75Ω*. They can be built from pipe and central wire with air insulation, in which case the impedance is given by the following relation:

$$Z_0 = 138\cdot\lg\frac{\rho}{r} \qquad (2)$$

where ρ is the inner radius of the pipe, r is the central thread.

In case the antenna does not have a purely resistive impedance, but it also has reactive components, as in the un-tuned antennas, its impedance is written as a complex number, $Z_3 = a + jb$. Measuring the impedance with specialized devices will provide the values for *a* and *b* where, if $b > 0$, the reactance is inductive, if $b < 0$ the reactance is capacitive. The line input impedance will also be a complex number, Z_{ech}, even for a correctly adjusted and tuned antenna (*b=0*) but if we use a line which is not adapted to the antenna load ($Z_0 \neq Z_3$) with a different length than the one explained in cases **a)** or **b)**, resulting, in the most general case in, $Z_{ech} = p + jq$ with:

$$p = \frac{aZ_0^2}{\left[Z_0 \cos\left(2\cdot\pi \frac{l}{\lambda_{line}} \right) - b \sin\left(2\pi \frac{l}{\lambda_{line}} \right) \right]^2 + a^2 \sin^2\left(2\pi \frac{l}{\lambda e} \right)} \quad (3)$$

$$q = Z_0 \frac{\left(Z_0^2 - b^2 - a^2\right)\cdot \cos\left(2\pi \frac{l}{\lambda_{line}} \right) \sin\left(2\pi \frac{l}{\lambda_{line}} \right) + b\cdot Z_0 \cdot \cos\left(4\pi \frac{l}{\lambda_{line}} \right)}{\left[Z_0 \cos\left(2\cdot\pi \frac{l}{\lambda_{line}} \right) - b \sin\left(2\pi \frac{l}{\lambda_{line}} \right) \right]^2 + a^2 \sin^2\left(2\pi \frac{l}{\lambda_{line}} \right)} \quad (4)$$

For $q>0$ the equivalent impedance has a reactive inductive component which must be compensated with a series circuit capacity between the transmitter and the line, for $q<0$ the equivalent impedance has a reactive capacitive component which has to be compensated with a series circuit inductance between the transmitter and the line. The adjusting device contains variable inductances and capacities allowing the adjustment of the final stage of the transmitter to this complex load, with reactive component, but what gets in the antenna in the form of radiant energy is much diminished because the reactive loads do not dissipate, but save energy, keeping it in circuit or giving it back to the source (the equipment). A consumer, with the complex impedance Z_{ech} on its input, supplied with radiofrequency acts absolutely identically with an electric circuit of alternative power with an uncompensated power factor and whose active power is smaller than the product of the multiplication between current and voltage, which gives the apparent power. Here, too, appears a power factor $\cos(\varphi) = p/\sqrt{p^2+q^2}$ which must be compensated, just as alternative current consumers, using compensation capacities or inductances according to *q*'s sign.

For example we have a vertical antenna adjusted on the frequency *f=14,2MHz,* therefore it has a purely resistive input impedance, respectively *a=35Ω* and *b=0* (let's say we would have wanted *a=50Ω,* but assuming we did not get what we wanted, *35Ω* being a possible impedance for vertical antennas) supplied through a coaxial line with Z_0 =*50Ω* and a length of *5m*. The shortening coefficient is *0,66* so $\lambda_{line} = 13{,}944m$.

Applying the relations from (3) and (4), with the observation that the arguments of the trigonometric functions must be considered in radians, we get $Z_{ech} = 50{,}522 - 18{,}014j$, so *p=50,522, q=-18,014,* for which the phasors diagram is the one in picture 2 and the power factor is, $\cos(\varphi) = 0{,}942$, $\varphi = 19{,}6^o$.

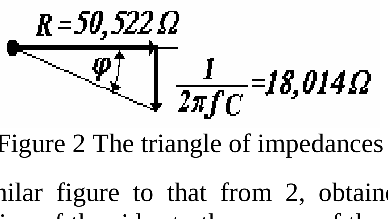
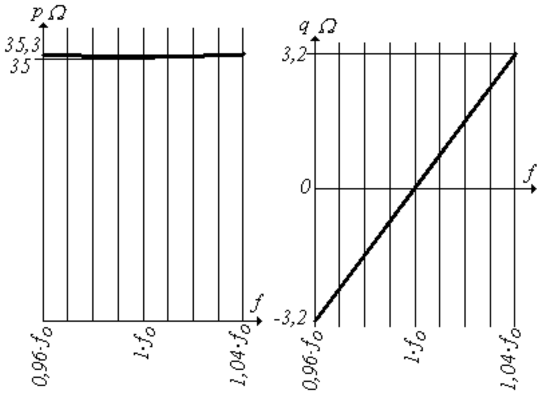


Figure 2 The triangle of impedances

A similar figure to that from 2, obtained by the multiplication of the sides to the square of the current, is that of the powers, from where we can appreciate that the power factor can be a measure of energetic efficacy for the circuit, in this case the line- antenna assembly dissipates a power output of *94,2%* from the apparent power. We notice a reactive component of capacitive nature (the imaginary part is negative), *1/(2πfC)=18,014Ω* of the equivalent impedance which is compensated with an inductance of the same value, connected in series, respectively *2πfL=18,014Ω*, resulting *L=0,2μH.* This kind of compensation is made, using the corresponding settings, by the adjusting device which we use. For a line with Z_0 =75Ω and a length of *5m* the power factor would drop to $\cos(\varphi) = 0{,}773$. If the length of the line were *6,972*m (*n=1*, namely half of the wave length λ_{line}) we get no more capacitive or inductive components at the equivalent impedance, *q=0, p=35Ω* and $\cos(\varphi) = 1$, *φ=0,* (regardless of the line's impedance!), the adjustment of the final stage is made only in relation to a load equal to the antenna's impedance. Therefore the length of the transmission line always matters and the rule which states that the line's length should be equal to an integer multiple of wave length halves λ_{linie} becomes especially important**.** Respecting it can rid us of a lot of trouble in case of uncontrolled altering of the antenna's impedance, either as a result of faulty building or placement which is too close to trees, tin roofs, variable humidity in the soil, electric wires, etc., and the adjustment device adjusts the transmitter directly to the antenna, „jumping" the transmission line. These hold for the specific case $l = n\cdot\lambda_{linie}/2$, *n=1,2,3....* But a radio station does not work on a fixed frequency, but on any frequency in the range of a band, or even on several frequency bands. Does the above information remain true in this case?

3. THE EFFECT OF LINE LENGTH AND FREQUENCY ALTERATION

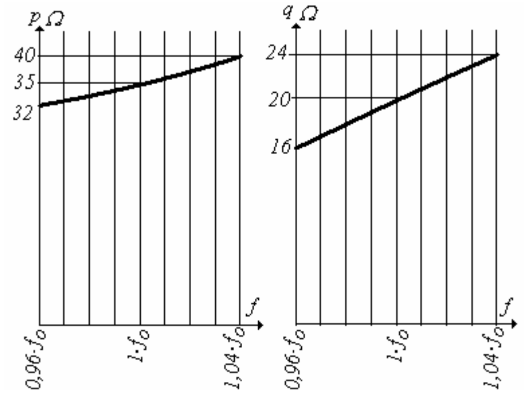
We have shown above that the rule of the integer multiple of $\lambda_{linie}/2$ applies only for one frequency from the many frequencies of a band in which radio emission is performed, frequency on which the antenna is actually set. For other frequencies appear two sources of un-adjustment: the antenna is no longer supplied to the frequency on which it is set, and besides the active component of its impedance there are other reactive (capacitive for lower frequencies and inductive for higher frequencies, as compared to the tuning frequency), and the length of the line does not comprise an integer number of semi waves of the operating frequency. To see how important the impact of the alteration is we can programme the relations (3) and (4) on any available medium, including Microsoft Excel. I preferred Delphi 7, with which I got the following results which will be analyzed.



$Z_0 = 50\Omega$, *a=35Ω*, *b=0, n=1*

Figure 3 The determination of p and q for a resistive antenna and n=1

If each band is checked, we notice that the ratio between the extreme frequencies at its ends is, f_{max} and f_{min}, does not go over the value $f_{max}/f_{min} = 1{,}08$ in the band of *80m* (*3,8/3,5=1,08*), in the rest of the bands being much smaller (*7,2/7=1,028; 14,35/14=1,025; 21,45/21=1,021; 29,7/28=1,06*), even on the domains VHF-UHF (*52/50=1,04; 146/144=1,014; 440/430=1,023; 1300/1240=1,046*). Therefore the diagrams to be presented, based on relations (3) and (4), will result for values of the frequency belonging to the interval $0{,}96 \cdot f_o \cdots 1{,}04 \cdot f_0$, f_0 being the frequency at which I consider the antenna adjusted and for which the wave length from the line is calculated, thus providing the length of the line. I know from practice that the bandwidth of an antenna can cover the deviations considered unimportant the ratio of *1,08* between the maximum and minimum frequency of the band, for those who sized the antenna only on certain sub-bands of a band and this ratio is even closer to 1. For these reasons I consider that the antenna impedance in the bandwidth $Z_3 = a + jb$ does not change, nevertheless, what changes is the ratio between the length of the line and length of the line semi-wave from the line. Simulations we in which we considered that the antenna also changes its impedance did not differ by more than 4% from the consideration of the antenna impedance as constant and, in fact, the idea pursued here is the effect of line length.
Using the antenna given as an example above, the values shown in Figure 3 correspond to a line which is as long as a half of the wave length in the line (*n=1*) for the frequency f_0, at the ends of the band the frequency is of $0{,}96 \cdot f_o$ respectively $1{,}04 \cdot f_o$, so that f_o be as central as possible. The extreme values of the frequency are, in this case, in a ratio of *1,04/0,96=1,08*. At the ends of the interval we obtain a maximum mismatch of negligible value, assessed by the power factor with the value of *cos(φ)=0,996*, therefore an output power transferred to the antenna of *99,6%*.

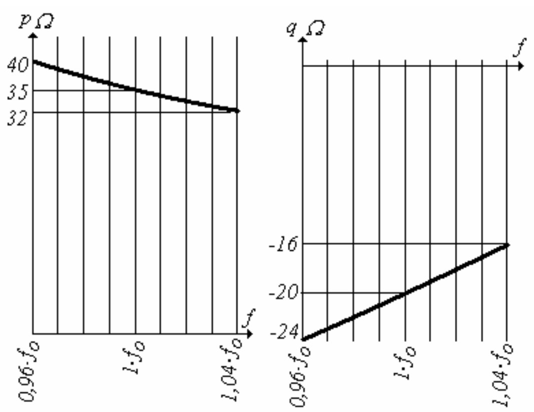


$Z_0 = 50\Omega$, *a=35Ω*, *b=20Ω, n=1*

Figure 4 The determination of p and q for an inductive antenna and n=1

In Figure 4 the data is the same, only the antenna has a reactive component capable of inductive nature with the value of *20Ω*. We notice both a un-symmetry in the graph and a change in the extreme values. In Figure 5 reactance is of a capacitive nature and of the same value, but with a changed sign and the un-symmetry is reversed. The maximum un-adjustment in both cases is not negligible anymore, evaluated through the power factor it is *cos(φ)=0,85*, therefore a reduced efficacy.

Let's see what happens if you take a multiple of n different from 1 for the length of the transmission line. In Figure 6 we are presented with the n=20 case. It is seen that the values of active and reactive components have a periodic but non-harmonic variation with the frequency, regardless of the fairly close edges of the band. It is easy to see that in Figure 3, where n=1, there only is a very narrow area from the central part of Figure 6. The situation is similar for antennas with reactive components in their impedance.



$Z_0 = 50\Omega$, *a=35Ω*, $b = -20\Omega$, *n=1*

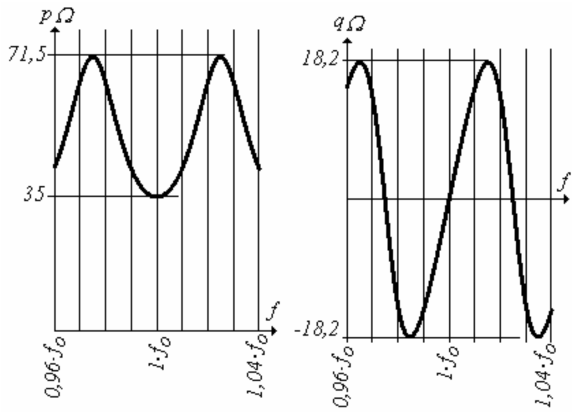
Figure 5 The determination of p and q for a capacitive antenna and n=1

And now we consider another case, which may even be a surprise. I choose a multiple *n=1* for the line length, but correspondingly increase the frequency band, Figure 7. We notice again the same inharmonious periodic variation of active and reactive components, according to frequency. A brief analysis of the above examples shows that the periodic variation has a number of periods n_p, whole or fractional, given by:

$$n_p = \frac{f_{max} - f_{min}}{f_o} \cdot n \qquad (5)$$

where f_{max} and f_{min} are the frequencies from the band's ends which we are interested in, f_o is the frequency on whose wave length the line length is dimensioned.

One thing appears certain in the analyzed diagram: the frequency f_o at which the line has the length strictly equal to an integer multiple of semi-waves, that line does not matter and the antenna appears to be linked directly to the transmitter. For other frequencies ranging between f_{min} and f_{max} the adjustment is better if n_p is smaller and f_o occupies a position which is as central as possible.



$Z_0 = 50\Omega$, *a=35Ω, b=0, n=20*

Figure 6 The determination of p and q for n≠1

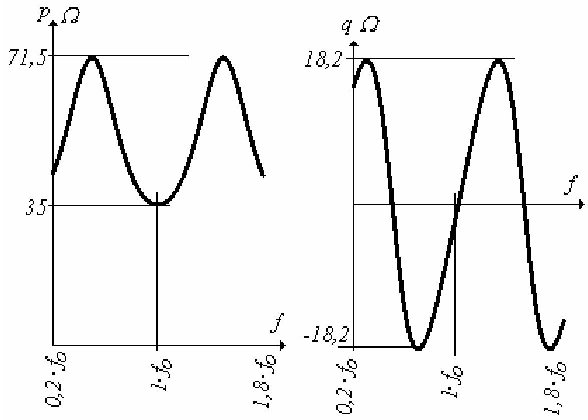
From the above examples it comes off, pragmatically, the maximum value for n_p at which the line acts positively would be $n_p = 0{,}3$ with an output power transfer efficiency of 95%, so that the length of the line does not exceed a maximum n_{max} of semiwaves given by

$$n_{max} = INT\left(\frac{0{,}3 \cdot f_o}{f_{max} - f_{min}}\right) \qquad (6)$$

Where *INT* is the "integer part" function. Whoever wants an efficacy of over *99%* must adopt $n_p = 0{,}1$.

Examples

1. For a band of *144MHz* we choose $f_o = 145\,MHz$, having $f_{min} = 144\,MHz$, $f_{max} = 146\,MHz$, for which, according to (6), $n_{max} = 21$. Considering a coaxial line with *k=0,66* means that the wave length from it is of *1,365m* and the line can only have lengths which are integer multiples of *0,682m*, the maximum length being of $0{,}682 \cdot 21 = 14{,}322m$ in order to conveniently serve the whole band.
2. A US station works on the bands ranging between *3,5* and *28 MHz*. Noticing that *28* is the integer multiple of *3,5* (*n=8*) means that a coaxial line with the length of a semiwave on $f_o = 3{,}65\text{MHz}$ (*n=1* in the center of the band of *3,5MHz*), respectively with a length of *27,12m*, can also be used at *28MHz*. The *8* times multiple of the *3,65MHz* frequency is *29,2MHz*, the line long of *27,12m* and comprises *n=8* semiwave lengths of a frequency of *29,2MHz*. At the edges of the *28MHz* band the frequencies are $f_{min} = 28\text{MHz}$, $f_{max} = 29{,}7\text{MHz}$, for which the number of periods results according to (5), $n_p = 0{,}232$.



$Z_0 = 50\Omega$, *a=35Ω, b=0, n=1*

Figure 7 The determination of p and q for n=1 when frequency band is properly increased

Here is how a line dimensioned for a semiwave in *3,5MHz* with a energy transfer efficiency towards the antenna of over *99%*, insures an efficacy of over *97%* in the band of *28MHz*. This way, with an efficacy of at least 97%, the adjusting device transfers energy directly to the antenna on all IARU bands, "going around" the ***line***. Such a line increases equipment performance, but it should not be understood that it mends any deviations in the antenna construction. But, testing on computer the violation of the above rules, any other length of the line leads to variations in effectiveness ranging 20% and100% on the 5 IARU bands.

Depending on your preference to work more in certain sub-bands, such as the telegraph, telephone or digital modes, the operator can choose the central frequency in the middle of the respective sub-band increasing effectiveness, leaving it to him to accept a slightly reduced efficacy on the sub-bands on which he works more rarely.

4. MEASURING THE VELOCITY COEFFICIENT

In lack of a dynamic wavemeter we improvised a scheme with a radiofrequency signal generator and a measuring device, just like in Figure 8.

We cut a piece of a known length, l_{linie}. At one end we connect the central wire to the braiding forming a small diameter coil (cca 2 cm) through which the line is commanded in radiofrequency, the other end is left free. Modifying the generator's frequency we look at the device's indication to notice the resonating frequency of the line, f_{rez}. At this frequency the length of the wave in void is $\lambda_{vid} = 300/f_{rez}$, λ_{vid} in meters, f_{rez} in *MHz*. A line opened at one end resonates in quarters of wave, therefore the wave length is $\lambda_{linie} = 4 \cdot l_{linie}$.

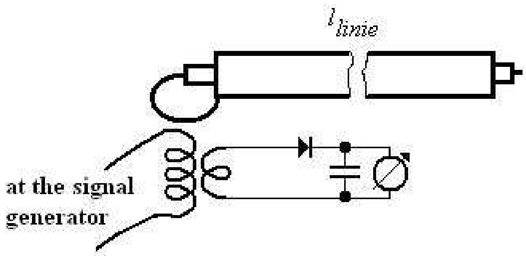


Figure 8 Circuit for velocity coefficient measurement

The velocity coefficient can be found using

$$k = \frac{\lambda_{linie}}{\lambda_{vid}} = \frac{4 \cdot l_{linie} \cdot f_{rez}}{300} = \frac{l_{linie} \cdot f_{rez}}{75} \qquad (7)$$

5. CONCLUSIONS

When the feed line links an emitter and an antenna which working on one single frequency then line's length could be any multiple of wave length's half taking into consideration the speed coefficient if the line impedance is not the antenna's impedance or could has any length if the two impedances are the same.

The issues regarding line's length arise if the emitter and the antenna are working on different frequencies which have values into the frequency band for which the antenna can radiate in good conditions.

In these situations, for an accepted efficiency of the line energy transmission, evaluated as a power factor because of frequency band inadequacy, the line can not have however great length anymore when its length is multiple of wave length's half.

The paper shows that the line must be the shorter when the working frequency band is wider or the desired efficiency is higher.

6. REFERENCES

[1] ROTHAMMEL, KARL., Antennenbuch. *Deutscher Militärverlag*, Berlin 1969.

[2] SMIRENIN, B.A., Radiotechnics coursebook, vol. I. *Editura Energetică de Stat*, 1953.

[3] SMIRENIN, B.A., Radiotechnics coursebook, vol. II. *Editura Energetică de Stat*, 1954.

*** *The ARRL Handbook for Radio Communications*. 86th Edition, editor K1RO, Newington, CT 06111 USA, 2009.

[4] OPROESCU, G., *Dimensionarea liniilor de alimentare*, Radiocomunicatii si Radioamatorism, Nr.6-2012, ISSN 1222.9385.

ANTENNA DESIGN CONCEPTS

[1]GRIGORESCU LUIZA, [2]DIACONESCU IOANA

[1,2]*Department of Engineering Science and Management, "Dunarea de Jos" University of Galati, Romania*

ABSTRACT

The paper presents the results get from determination of antenna's main characteristics such as impedances and radiation diagrams using original applications of MECMET research center from "Dunarea de Jos" University from Galati, based on Delphi soft. The final results allow us to obtain the corect dimensions of antennas so that the radiation resistances of radiant field to be eliminate and so to improve antenna's efficiency.

Keywords: *Antenna, impedance, radiation resistances, radiation fields.*

1. INTRODUCTION

Antennas impedances are very important because regarding their values the matching to the feeding line could be done. These impedances will be analyzed in this paper.

The specific impedance Z_0 is specific impedance for any line with distributed constants. A filer antenna has the specific impedance of any lining conductor with circular section, given by: [4], [5]

$$Z_0 = \sqrt{\frac{L}{C}} = 138\lg\frac{2h}{a} \qquad (1)$$

Own impedance own (local) to be calculated are used other expression which will be developed below.

Impedance of radiation Z_{rad}. Tacking into consideration a space distribution of sinusoidal current, its *I* value into the point placed on x distance from the origin is:

$$I(x) = I_{max}\left|\sin\left(\frac{2\pi x}{\lambda}\right)\right| \qquad (2)$$

It is noticed that a maximum value of this amplitude exits, from (2) results this values on distance x odd multiple of quarter of wave. If the own antenna's impedance Z_{ant} can be calculated in any of its points, *the radiation impedance* Z_{rad} can be determinate as own impedance only point of maximum current. So, the radiation impedance has the lowest value.

The feeding impedance Z_{in}. Is defined the same with the above impedance only that the point is the feeding of antenna line. If this point is the same with the maximum current than the feeding impedance equals radiation resistance R_{rad}. If the feeding point is the same with a current node than the impedance will attend high values, generating difficulty adjusting with impedance of feeding line.

2. THE ANTENNA'S IMPEDANCE

To calculate the antenna's impedance is very complicated because of improper integral equations solved (with gaps at the intervals' ends or along the intervals) using transcendental functions, known as integral sinus or co sinus, ***Si*** *or* ***Ci***. We did programmed such of equations gave by [2], [4], [5], [6] using Delphi7 software, the results are spectacular and surprising, too.

Fundamental in facts, impedance's calculus is a long and complicated algorithm. Some references points of this algorithm, with fundamental equations of each stage, will be shown below. The aim is to argue that this is a hard to solve problem, even today, and is artlessness that errors or odd contradictions to appear.

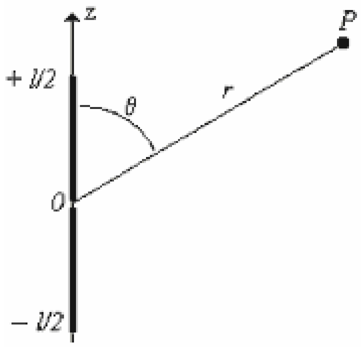


Figure 1.The Referencial system

- It is fixed on a referential system with z axis along the antenna, figure 1.
- It will be find the spatial distribution equation of antenna's current, like in (2), with the origin moved into the antenna's middle.

$$I = I_{max}\sin\left[\beta\left(\frac{l}{2} - |z|\right)\right], \quad |z| \le \frac{l}{2} \qquad (3)$$

where β is the wave factor, $\beta = 2\pi/\lambda_1$, $\lambda_1 =$ wave length into the antenna's medium. For conductors made of uninsulated and unmagnetic materials $\lambda_1 \approx \lambda_{vid}$ with errors under 2%.

- It is calculated the vector of outlying active electric field intensity $\vec{E}$, in any point P, as a dependence on emitting direction θ and distance r using the equation [6].

$$\vec{E}_\theta = \hat{\theta} \cdot j\omega \sin(\theta) \mu \frac{e^{-j\beta r}}{4\pi r} \int_{-l/2}^{l/2} I(z) e^{j\beta z \cos(\theta)} dz \quad (4)$$

where ω is radio-frequency wave pulsation $\omega = 2\pi f$, μ is environment (air or vacuum) magnetic permeability, $j = \sqrt{-1}$, $\vec{\theta}$ unit vector of angle θ, meant vectorial measure**.** The equation (4) diagram represents the radiation characteristic of antenna according to azimuthal angle θ.

- It is calculated radiant power of antenna in outlying active field, P_{rad} [6]

$$P_{rad} = \frac{1}{2\eta} \int_0^{2\pi} d\varphi \int_0^{\pi} \left|\vec{E}_\theta\right|^2 r^2 \sin(\theta) d\theta \quad (5)$$

where $\eta = \omega\mu/\beta$.

- It is found the required impedance from below equations [1], [2], [4], [5], [6]:

$$P_{rad} = \frac{1}{2} Z_{rad} \cdot (I_{max})^2 = \frac{1}{2} Z_{in} \cdot (I_{in})^2 = \frac{1}{2} Z(x) \cdot (I(x))^2 \quad (6)$$

where I_{in} = the current into the feeding antenna's point or $I(x)$ = the current in any point calculated from (2) or (3). Because only waves' electrical component is used than 1/2 coefficient appear, meaning that only half of radiant antenna's power is finding in electrical component, the other half in magnetic component of electromagnetic waves field.

An antenna is situated into a specific environment and this environment represents its effective charge. The environment absorbs the energy supplied by the radio frequency source through the antenna's feeding line.

So, the antenna transfers energy to the environment. Until an emission direction will appear or a wave front will be formed, the waves make towards in all directions (also to the source), so the waves deflect a part of received energy. It is known that if a consumer (environment) gives back a part of given energy it will be not active anymore and it will became a partial reactive consumer. Because of these reasons, the zone close to the antenna is called reactive zone and acts a fundamental role in antenna's appliance. In fact this is what we are looking for through antenna's appliance, that provided energy or power to be integral absorbed be the charge (environment) and not given back to the source. In this purpose, only this reactive zone behavior gives characteristic impedances. Calculated emissivity in this zone will have active and radiation resistances. Calculating emissivity value for far away zones (tens or hundreds of wave lengths) as in (5) results that emissivity has only radiation resistance, with only radiation resistance of impedance as in (6). So, the impedance calculated with far away field power will not give any information regarding antenna's matching through radiation resistance evaluation, but only active value of its impedance. If we calculate the power into close field, with its active and radiation resistances, will result one active and one relative component of this impedance and values will depend only by the antenna's construction. Only on this way could be chosen the antenna's size so that radiation resistance of its impedance to be null or very small and this meant that will not exist reactive field close to antenna which could return a part of the energy to the source.

We will consider a symmetric feed dipole, with conductor of *2l* length and radius *a*. A reference system having origin in the middle of the dipole and *z* axis directed to the antenna's conductor, figure1. *a*, *l* and *z* dimensions have the same measure as the wave's length λ. The dipole is a resonant antenna (has current kinks at the ends, so stationary waves appear into dipole) but to be tuned its length must to be into a tide correlation with wave's length. From bibliography [3] we find out that this conductor must be seriously shorted according to its thickness, without a specific explanation. Let's determine antenna's impedance using emissivity into the close field. The formula of this impedance as input impedance form Z_{in} into the feed point, meaning at the dipole middle, will be determine. For a dipole in semi wave or odd multiple of semi wave this is also the radiation impedance Z_{rad} because in this point the current has the highest value. Tacking into account of all of the above considerations [2], the resulted equation is:

$$\begin{aligned}
&F(z) = \left[\frac{e^{-jkR_1}}{R_1} + \frac{e^{-jkR_2}}{R_2} - 2\cos(kl)\frac{e^{-jkR_0}}{R_0}\right] \sin[k(l-|z|)] \\
&Z_{in} = \frac{j\eta}{4\pi \sin^2(kl)} \int_{-l}^{l} F(z) dz \qquad (7) \\
&\text{unde:} \\
&R_0 = \sqrt{a^2 + z^2}; \quad R_1 = \sqrt{a^2 + (z-l)^2}; \\
&R_2 = \sqrt{a^2 + (z+l)^2}; \quad k = \frac{2\pi}{\lambda}; \quad \eta = \sqrt{\frac{\mu_0}{\varepsilon_0}} \\
&j = \sqrt{-1}
\end{aligned}$$

In some situations [2], MATLAB is used to solve the equation, but we prefer Delphi because its facility to define a mathematical function in any conditions.

Solving the above equation for different values of conductor length and its thickness, it gets, any time, an impedance as:

$$Z_{in} = R_{in} + jX_{in} \quad (8)$$

Even if conductor's thickness is null and length is $l = \frac{\lambda}{2}$ (100% dipole in semi wave), from (8) results:

$$Z_{in} = 73{,}1 + 42{,}5j \quad (9)$$

So, a radiation resistance appears +42,5 Ω (*inductive*), bigger enough in comparison with radiation resistance which value is already known, respectively of 73,1 **Ω**. So, the antenna's conductor is too long and consumes to much reactive energy. If the power would be calculated into the far away field (wave head and propagation direction are clearly defined so that only in this situation Pointing vector could by used) also the impedance using this power, would result a null radiation resistance and the radiation resistance would be of cca. 73 **Ω**.

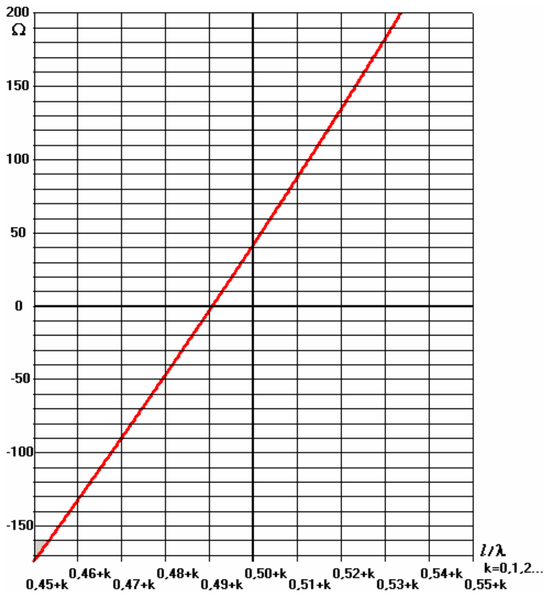


Figure 2**.** Radiation resistance of dipole's impedance

Let's analyze the radiation resistance which really exists and which through its inductive nature shows that the dipole in semi wave is too long and the antenna must be clipped if it would be tuned, means that it must to have null inductance. How much to be clipped? Let's analyze a real case with conductor diameter of 3 mm. The bellow diagram (figure 2), which is using (7), shows us how much must be shorted, respectively its length must be 0,491 of wave length.

For an antenna tuned on 3,65 MHz, a wave length equals with 82,191 meaning the antenna's length of 40,356 instead of 41,095. O difference of "only" 0,739m (1,79%) makes that the charge to become reactive, with a value close up to the active charge value.

In the case of alternative current, for a null thickness of conductor the phase difference with power factor equals with 0.86 appears, situation when the most of usual electrical consumers work with an unacceptable reactive power from energetic point of view. Bigger diameters of antenna's conductor appear at the dipoles for ultra-short waves, where the shorting is important. For a wave length of 2.06 m (145 MHz) a dipole with diameter of 20 mm will have a length equals with *0,469x2,06=0,966m*, which means 6,21%.

The above are the same for any dipole with length odd multiple of semi-waves, diagram from fig.2 is repetitive around the

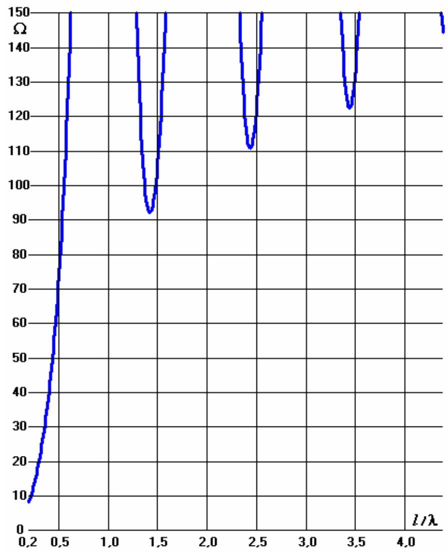


Figure 3. The active component of dipole's *impedance*

values $\frac{l}{\lambda} = 0.5, \quad 1.5, \quad 2.5, \quad 3.5, \quad \cdots$. For dipoles with length even multiple of semi-waves, the radiation resistance is infinite, as $\frac{l}{\lambda} = 1, \quad 2, \quad 3, \quad \cdots$ which are in this situation vertical asymptotes. The straight graph of figure 2 is only a segment of a curve with is an asymptote from left down to up right.

Regarding the radiation resistance of impedance, this is defined for dipoles accorded in odd multiples of semi waves but becomes infinite for even multiples, figure 3 and is not influenced by conductor's diameter. The so-named infinite values are, in fact, finite, but very high values.

Besides the impedance, a dipole is interesting through radiation characteristic. This can be determinate in two planes:

- A plane which contains dipole's conductor, so-named azimuthal characteristic;
- A perpendicular plane on dipole axis.

If the dipole is horizontal, excited only on harmonics which lead to odd number of semi-waves, the azimuthal characteristic will be in horizontal plane as in function's graph (4):

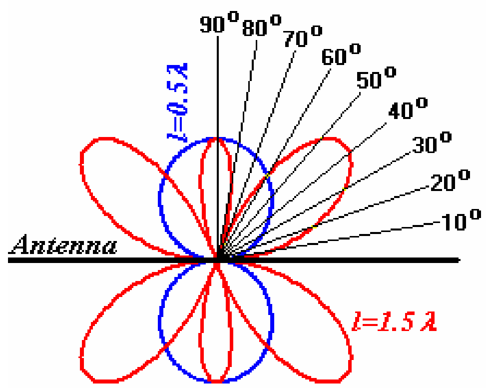


Figure 4. The radiation into antenna's plane

$$f(\theta)=\left|\frac{\cos\left(\pi\frac{l}{\lambda}\cos\theta\right)}{\sin\theta}\right| \tag{10}$$

where $\frac{l}{\lambda}=0.5,\quad 1.5,\quad 2.5,\quad \cdots$ and θ is angle measured in relation with the conductor axis.

If the dipole would be excited in tension, the azimuthal characteristic is given by:

$$f(\theta)=\left|\frac{\sin\left(\pi\frac{l}{\lambda}\cos\theta\right)}{\sin\theta}\right| \tag{11}$$

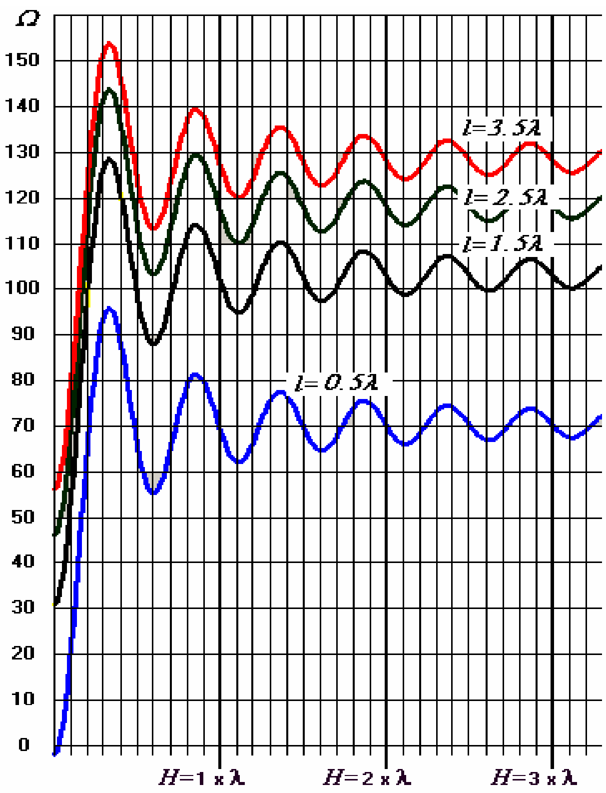


Figure 5. The radiation resistance of input impedance when the ground influence is considered

where $\frac{l}{\lambda}=1,\quad 2,\quad 3,\quad \cdots$

In figure 4 is shown the azimuthal characteristic for two frequencies on which the antenna could be accorded.

The antenna doesn't work alone but as two coupled antennas, the proper antenna and its imagine in conducting medium. The distance between these two antennas is double of the distance from surface which separate antenna environment from conductive environment. The conductive environment has to have sufficiently large which allow to form imagine antenna.

Using only the effect of imagine antenna, the impute impedance equals summing the determinate impedance with mutual impedance between imagine antenna and real antenna.

For horizontal antennas, mutual impedance is calculated as in (7), only that R_0, R_1 si R_2 is calculated like in (12) [2]:

$$R_0=\sqrt{d^2+z^2};\quad R_1=\sqrt{d^2+(z-l)^2};\quad R_2=\sqrt{d^2+(z+l)^2} \tag{12}$$

where *d* is the distance between real antenna and imagine antenna, meaning *d=2H*.

In figure 5 is shown dipole impedance calculated regarding the distance from the ground.

The effect of the ground on the radiation characteristics, in rectangular plan on the antenna, is shown in (13):

$$f(\varphi)=\left|2\sin\left(2\pi\frac{H}{\lambda}\sin\varphi\right)\right| \tag{13}$$

where *H* is the antenna's high and φ is the angle regarding to the ground.

In figure 6 is shown the variation of the starting angle of radio waves regarding the horizontal surface.

So, for great heights in relation to λ the radiation in vertical plane is a circle, without lobes, the ground effect doesn't exist on some directions, which is obviously for the dipoles for ultrasonic waves.

There is one more completion: for the multiband antennas the characteristics in vertical plane will not be the same for all bands because the radiation characteristics will be deferent because of the height expressed in wavelengths is different.

Until now we talked about symmetric dipoles, but there are asymmetric dipoles such as VS1AA and Windom the same antennas but feed in different ways, with monofilar line or coaxial line. For these ones we have to know the radiation impedance of a conductor distant from the ground. Knowing the radiation impedance Z_{rad} and the conductor feeding way someone could find the current distribution through the conductor, also the current into feeding point I_{in} and the input impedance Z_{in} with the relation:

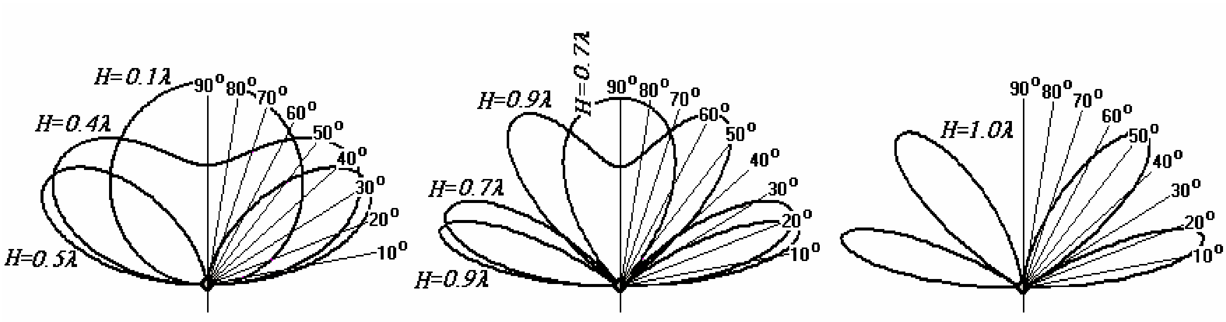


Figure 6. The influence of H upon the starting angle in vertical plane

$$Z_{in} = Z_{rad}\left(\frac{\operatorname{Im}ax}{I_{in}}\right)^2 \qquad (14)$$

For a conductor distant from the ground, the radiation resistance of radiation impedance R_{rad} is calculated with [15]:

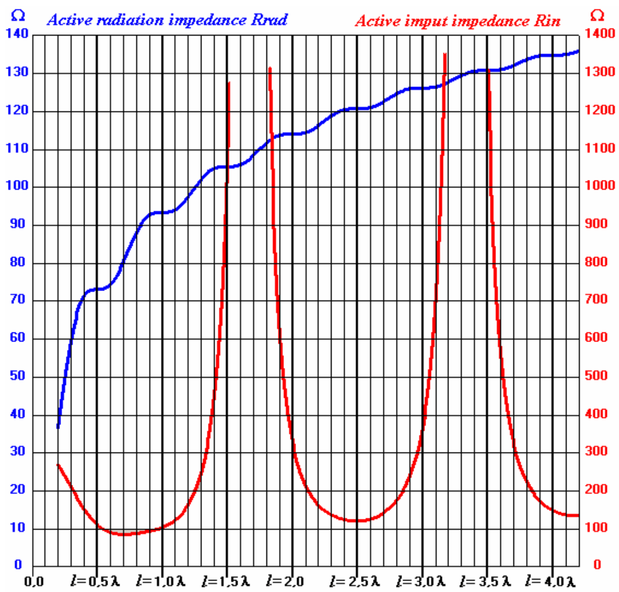


Figure 7. The Windom impedances without ground influence

$$R_{rad} = 30\left[0{,}5772 + \ln\left(4\pi\frac{l}{\lambda}\right) - C_i\left(4\pi\frac{l}{\lambda}\right)\right] \qquad 15)$$

where l is the conductor length and C_i is integral co sinus and is an improper and transcendent integral, with a difficult convergence of calculation:

$$C_i(x) = -\int_x^\infty \frac{\cos x}{x}dx \qquad (16)$$

In figure 7 is shown the graph of this impedance. Regarding radiation resistance, this results as in the dipole case and disappear only in the situation when the conductor is accorded.

If $\frac{l}{\lambda} > 1$, the relation (17) could be used:

$$R_{rad} = 17{,}32 + 30\ln\left(4\pi\frac{l}{\lambda}\right) \qquad (17)$$

Choosing as feeding point a position different from half of antenna (asymmetric antenna), the impedance will be not null for dipole lengths which are even multiples of semi waves. In this way, antennas fed with low impedance power supply lines could be made.

If the feeding point is at 30% distance of one of the antenna's ends, than the harmonics are even, as in figures 7 and 8. In graphs from these figures the relations (15) for resonance impedance, (14) for input impedance and (7) for mutual impedance were used.

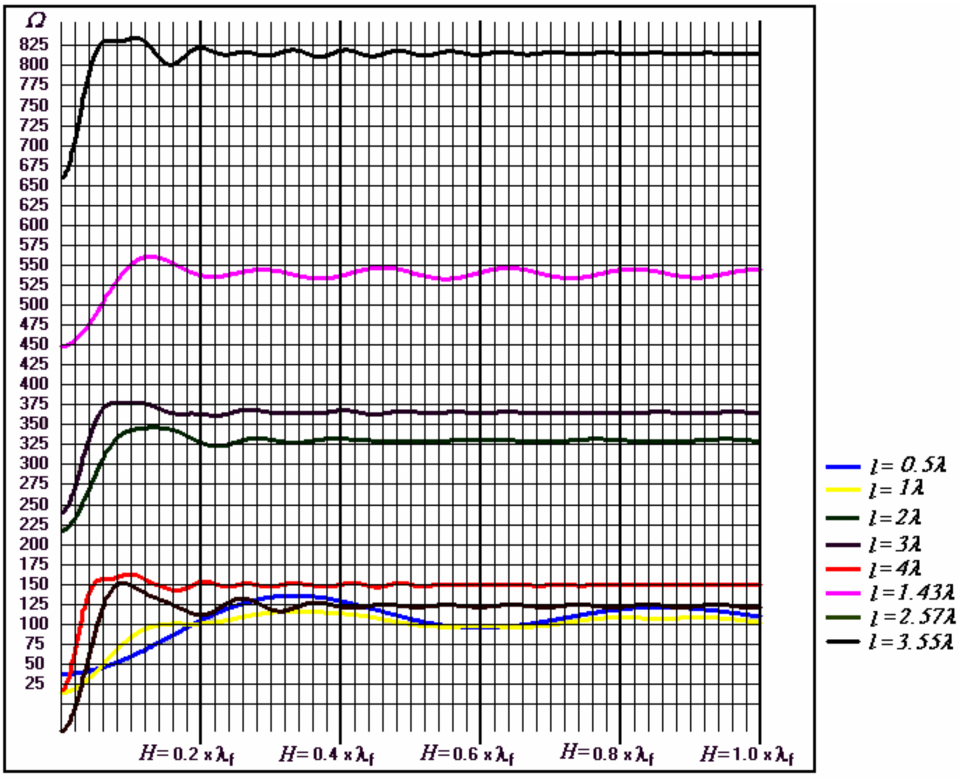
If in calculus would be considered the antenna fed at half of its lengths, the results for symmetric dipole antenna would be obtained.

3. CONCLUSIONS

- The antenna impedance calculus is complicated, improper integral equations (with discontinuities) of transcendent functions are used. Though some researchers [2] prefer specialized soft fro engineering, such as MATLAB, we succeed to solve this equations by using Delphi7 soft, a very flexible program, with many possibilities but also too much choosey and the results are surprising.
- The paper emphasize the difference between the impedance calculates in long-run field and the impedance in close field, using other calculus methods from which result the active and also reactive power, calculate in this way the value of its impedance, with active and radiation resistances of impedance of which value depend only of antenna's construction.

Only in this way it could be selected the antenna's dimensions so that impedance radiation resistance to be null, meaning that it doesn't exist a reactive field close to antenna, field that could to get some of the energy back to the source.

- The calculus from real applications use radiant power in close field. It is emphasized a very reactive field into the close field, with many returning of source energy, without a front of wave with a net contour, even for ideals dipoles with null thickness and a semi wave length. To cancel this radiation resistance, antenna must



λ_f =the wave's lenght of the fundamental frequency, where $l=0.5\lambda$

Figure 8. The active impedances of the Windom antenna according to the height H from the ground

to be shorter than a semi wave. If it will be calculated the power into far away field (when the front of wave and propagation direction are very well defined than it can be used Poynting vector) and also the impedance on this power, would result a null radiation resistance, for the same radiation resistance.

- The application in Delphi 7 soft allow the determination of the measure on which have to reduce the dipole length, according to the conductor diameter and the wave's length of the antenna.

The both dimensions, respectively the conductor diameter and its length have to be expressed of wave's lengths fractions, so their influence on the curtailment are the same for any wave's length of the antenna.

4. REFERENCES

[1] JOHNSON C. R. *Antenna Engineering Handbook*, Third Edition, Georgia Institute of Technology, Atlanta, Georgia, ISBN 0-07-032381-X, 1993.

[2] ORFANIDIS S.J. *Electromagnetic Waves & Antennas*, www.ece.rutgers.edu/~orfanidi/ewa 2008

[3] ROTHAMMEL KARL**.** *Antennenbuch*. Deutscher Militaerverlag, Berlin 1969.

[4] SMIRENIN B.A. *Manual de radiotehnică, vol. II*. Editura Energetică de Stat, 1954.

[5] STUTZMAN W. L., THIELE G. A**.** *Antenna Theory and Design*, Second Edition, John Wiley & Sons Inc. ISBN 0-471-02590-9, 1998

[6] OPROESCU, G., YO4BKM *Antena dipol simetric*. 2 iunie 2013, http://www.radioamator.ro/articole/view.php?id=888

[7] OPROESCU, G., YO4BKM, *Antene multiband.*, 11 august 2013, http://yo4px.blogspot.ro/2013/08/antene-multiband-de-gheorghe-oproescu.html

THE INFLUENCE OF FRICTION FACTOR VARIATIONS ON THE OUPUT PERFORMANCES OF AN INTEGRATED COGENERATION SYSTEM EQUIPED WITH DOUBLE FED INDUCTION GENERATOR

[1]PARASCHIV ION, [2]COSTIN MADALIN, [3]VONCILA ION, [4]FETECAU GRIGORE

[1, 2, 3, 4]"Dunarea de Jos", University of Galati, Romania

ABSTRACT

In the paper has been studied the influence of friction factor of Stirling engine on the response of double fed induction machine in terms of active and reactive power, currents, speed and torque. The complex mathematical model of the analysed integrated system has been implemented in Matlab – Simulink simulation environment. Due to the fact that Stirling engine speed is very sensitive on friction factor variations, the systems equipped with double feed induction generator has a great benefit related by the possibility to operate in both situation as hyper synchronous and hippo synchronous regimes and, thus, the integrated cogeneration system may operate in adequate range of speed.

Keywords: *friction factor, double feed induction generator, optimization, Stirling engine, cogeneration system.*

1. INTRODUCTION

Modern energy conversion systems provide a realistic technical solution for developing green and clean energy with friendly impact on environment. As a consequence of this new approach the developing of unconventional resources take place a major role on actual Europe Union orientation. A lot of unconventional resources are included in the renewable energy class and powerful related as a part of Europe Union directives.

The penetration of the new technologies, according to renewable systems, became a large trend in the field of energy and environment.

In the class of renewable energy there is a large variety of primary resources as: wind energy, photovoltaic energy, marine current energy, fuel cell energy, cogeneration and trigeneration system energy etc. Now, wind energy has the greatest development due to specifically benefits raised by this one: the global distribution of wind potential on the earth surface, distribution of wind in the both day and night, the accumulated experience by centuries on aerodynamics design and, now, the advancement on the technologies etc. Now, photovoltaic is being to have a large interest due to advantages as costs and portability. The rest class of energy remained has different weight on energy systems development and placed in specific place.

A lot of renewable resources are rise up from thermal energy: photovoltaic, wind etc. So, the thermal energy provides a viable source of energy. Important things arise with developing of sources based on thermal energy conversion. In this sense, thermal engine are well-known for a lot of time, but the low efficiency reduce the interest.

A special attraction on unconventional systems development is related by Stirling engine [7]. This engine is known for a long time, but nowadays with the advancement on materials technologies, this kind of engine arise as a promising solution in many modern integrated systems.

Based on the mathematical model of Stirling engine, the speed is sensitive on friction factor variations [7]-[8]. The aim of the paper is to show the influence of the friction factor on the actual speed magnitude and, based on this one the behavior of the double feed induction generator in an integrated system.

2. MATHEMATICAL MODELATION OF THE TRIGENERATION SYSTEM

The conversion system used in this paper has the next topology:

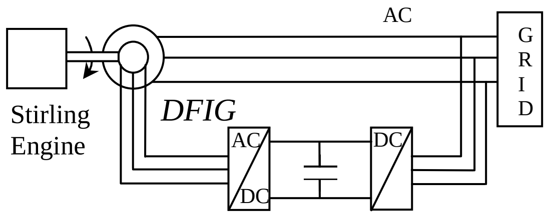


Figure 1 The topology of cogeneration system

The Stirling engine is taking into account as a primer mover. The mechanical power generated by Stirling engine is entered in the double feed induction generator. The generator is placed on grid operation. The grid is considerate to be as ideal one: the voltage and frequency have constant values; the power of grid has an infinite value etc.

The well-know mathematical model of Stirling engine is described by the next system of equation [8]:

$$x = R_e(1+\sin\theta) \tag{1.a}$$

$$A_h = A_{sc}(1+\cos\theta) \tag{1.b}$$

$$A_c = A_{sc}(1-\cos\theta) + P_{ps}x \tag{1.c}$$

$$\dot{S}_h = \frac{A_h\mu(T_h - T_e)}{T_e} \tag{1.d}$$

$$\dot{N}_e = -A_l\sqrt{2\rho_e(P_e - P_a)} \tag{1.e}$$

$$\dot{S}_a = \frac{S_e}{N_e}\dot{N}_a \tag{1.f}$$

$$\dot{S}_e = \dot{S}_h - \dot{S}_c + \dot{S}_a \quad (1.g)$$

$$V_e = V_c + A_p x \quad (1.h)$$

$$\bar{v}_e = \frac{V_e}{mN_e} \quad (1.i)$$

$$T_e = T_0 \left(\frac{\bar{v}_e}{\bar{v}_0} \right)^{-\frac{R}{C_v}} \exp \frac{\bar{s}_e - \bar{s}}{C_v} \quad (1.j)$$

$$P_e = P_0 \left(\frac{\bar{v}_e}{\bar{v}_0} \right)^{-\left(-\frac{R}{C_v}+1\right)} \exp \frac{\bar{s}_e - \bar{s}}{C_v} \quad (1.k)$$

$$F_e = (P_e - P_a) A_p \quad (1.l)$$

$$\tau_e = F_e R_e \cos\theta \quad (1.m)$$

$$\tau_I = \tau_e - \dot{\theta} \quad (1.n)$$

$$\ddot{\theta} = \frac{\tau_e - b\dot{\theta}}{I} \quad (1.o)$$

Where:

- R_e = 1.25 [cm] is the radius of linkage pivot on flywheel;
- A_{sc} = 40 [cm^2] is the heat transfer surface area of cylinder;
- P_{pc} = 4.9 [cm] is the perimeter of power piston;
- A_h (variable) is the hot heat transfer area;
- A_c (variable) is the cold heat transfer area;
- T_e (variable) is the temperature of air in engine;
- μ = 100000 [W/m^2] is the heat transfer constant of cylinder, this was calculated as the thermal conductance of steel with the cylinder wall thickness;
- A_l = 0.06 [mm^2] (nominally) is the area of leak;
- A_p = 1.9 [cm^2] = area of power piston;
- V_c = 40 [cm^3] = volume of air cylinder;
- m = 29 [kg/kmol] = molar mass of air;
- R = 287 [J/kg] = mass gas constant airs;
- $\bar{s}_0$ = 2800 [J/K*kg] is the specific entropy of air at T=300 K;
- T_0 = 300 K is the starting temperature of air in cylinder;
- $P_0 = P_a$ = 1e5 [Pa] is the ambient pressure;
- C_v = 717 [J/kg*K] is the constant volume specific heat;
- b = 0.7e-3 [N/rad/s] is the damping constant;
- I =4 [kg * cm^2] is the inertia of flywheel.

The well-know mathematical model of DFIG described in per unit is composed by next equations [9]:

$$\underline{v}_s = R_s \underline{i}_s + \frac{1}{\omega_0} \cdot \frac{d\underline{\lambda}_s}{dt} + \omega_k M \underline{\lambda}_s \quad (1.2a)$$

$$\underline{v}_r = R_r \underline{i}_r + \frac{1}{\omega_0} \cdot \frac{d\underline{\lambda}_r}{dt} + (\omega_k - \omega_m) M \underline{\lambda}_r \quad (1.2b)$$

where flux linkage are expressed by equations:

$$\underline{\lambda}_s = L_s \underline{i}_s + L_m \underline{i}_r \quad (1.3a)$$

$$\underline{\lambda}_r = L_m \underline{i}_s + L_r \underline{i}_r \,. \quad (1.3b)$$

The mathematical model is completed by motion equation:

$$M_e - M_s = 2H \frac{d\omega_m}{dt} + B_m \omega_m \quad (1.4)$$

The electromagnetic torque is described is described by relationship:

$$M_e = \underline{\lambda}_s \otimes \underline{i}_s = L_m \underline{\lambda}_s \underline{i}_s = \lambda_{ds} i_{qs} - \lambda_{qs} i_{ds} \quad (1.5)$$

The transposed vectors used in above equations are:

$$\underline{v}_s = \begin{bmatrix} v_{sd} \\ v_{sq} \end{bmatrix}; \quad \underline{v}_r = \begin{bmatrix} v_{rd} \\ v_{rq} \end{bmatrix}; \quad \underline{i}_s = \begin{bmatrix} i_{sd} \\ i_{sq} \end{bmatrix}; \quad \underline{i}_r = \begin{bmatrix} i_{rd} \\ i_{rq} \end{bmatrix};$$

$$\underline{\lambda}_s = \begin{bmatrix} \chi_{sd} \\ \lambda_{sq} \end{bmatrix}; \quad \underline{\lambda}_r = \begin{bmatrix} \chi_{rd} \\ \lambda_{rq} \end{bmatrix}; \quad M = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$$

The control loops of active and reactive stator power are provided with PI controllers.

3. NUMERICAL SIMULATIONS

In the order to study the influence of the friction factor variations several simulation tests have been done. In all the cases the stator voltage is considerate at rated constant value, imposed by the ideal grid. All signal obtained are expressed in per unit.

The results obtained for the rated value of friction factor are presented in fig. 2-9.

The steady state speed of Stirling engine depicted in Fig. 2 is above synchronous one, favourable for generator mode.

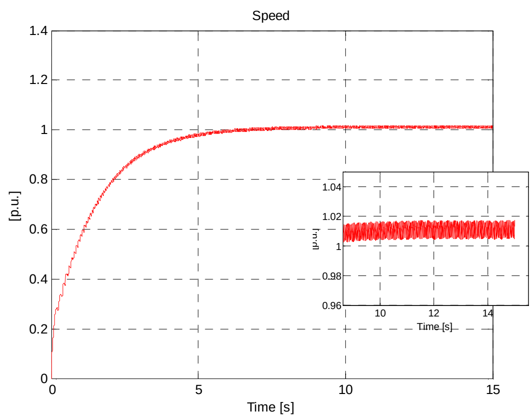


Figure 2 The speed of Stirling engine

The rotor voltages are depicted in fig. 3. At steady regime the frequency of rotor voltages is lower then the one for stator voltages.

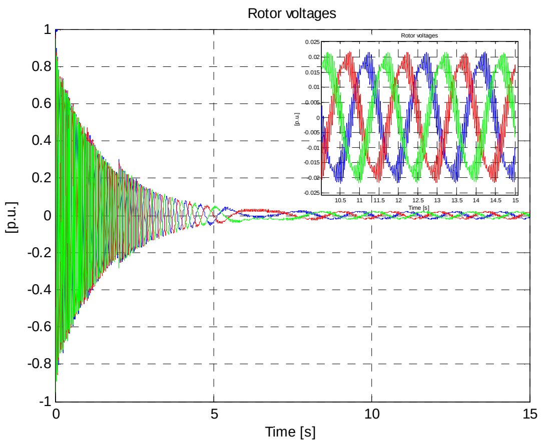


Fig. 4. Rotor voltages

The longitudinal and transversal current components are depicted in fig 5.

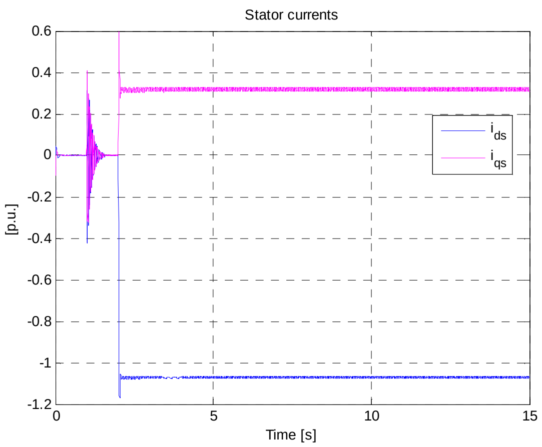


Fig. 5. Stator currents

The actual and reference active stator power are represented in fig. 6. It is observed o good tracing by those signals.

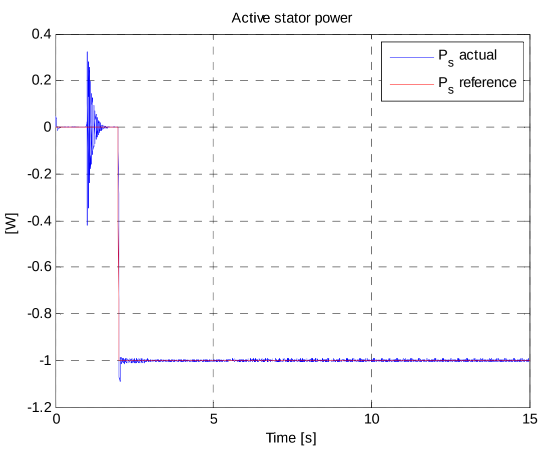


Fig. 6. Active stator power

Also, a good tracing has been obtained for reactive stator power (fig. 7).

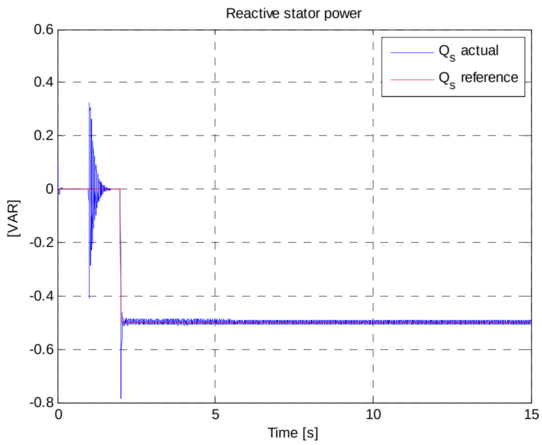


Fig. 7. Reactive stator power

The active and reactive power of rotor is represented in fig. 8.

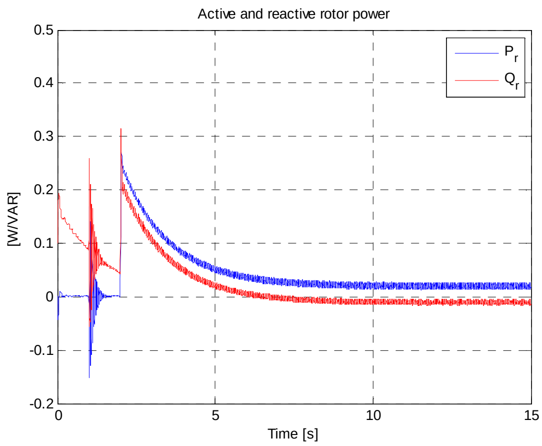


Fig. 8. Active and reactive power of rotor

In fig. 9 is depicted the electromagnetic torque developed by generator.

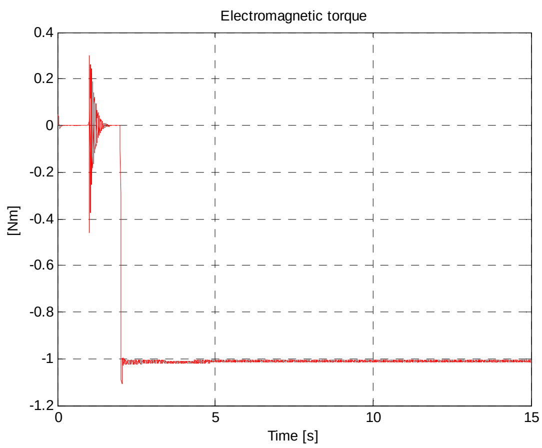


Fig. 9. Electromagnetic torque of double feed induction generator

By increasing the friction factor value with 20 %, are obtained the characteristics depicted in fig 10 – 16. The response of loops is good. In the order to maintain this response the rotor voltage as magnitude and frequency are changed compares with rated situation.

The actual speed of Stirling engine (fig. 2) is under synchronous value.

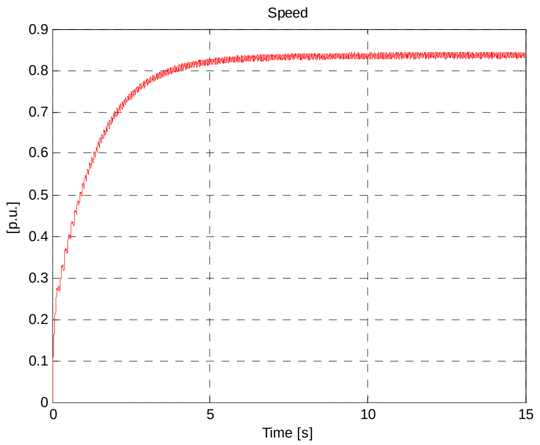


Fig. 10. The speed of Stirling engine

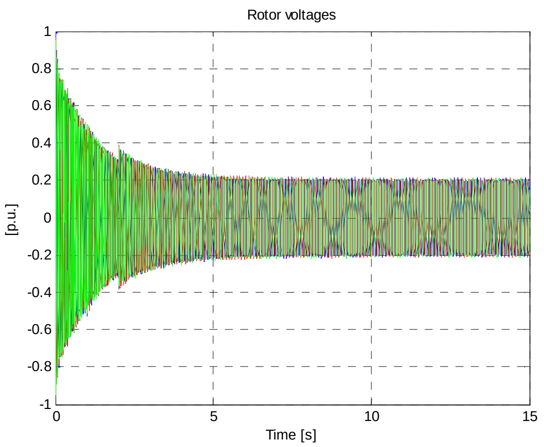


Fig. 11. Rotor voltages

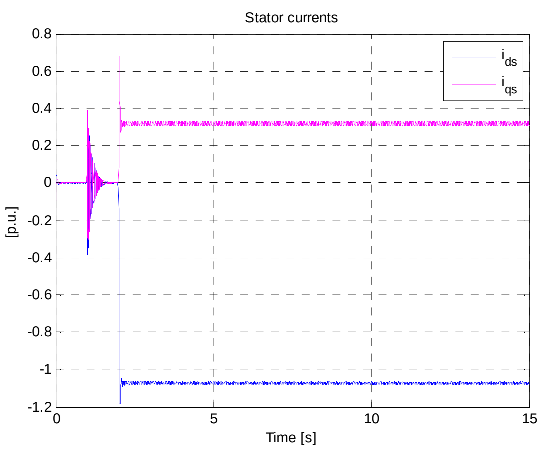


Fig. 12. Stator currents

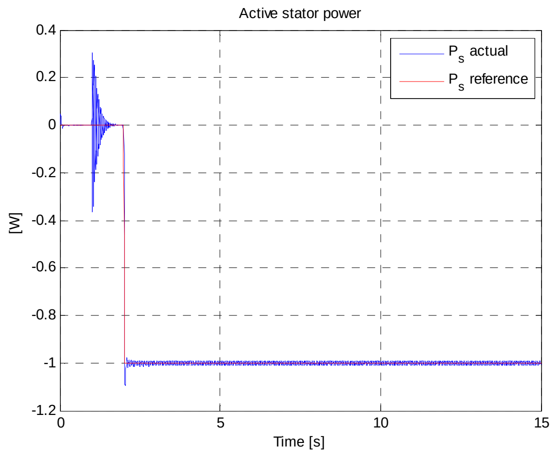


Fig. 13. Active stator power

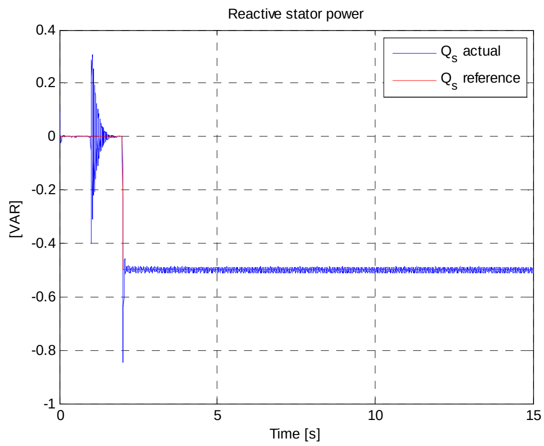


Fig. 14. Reactive stator power

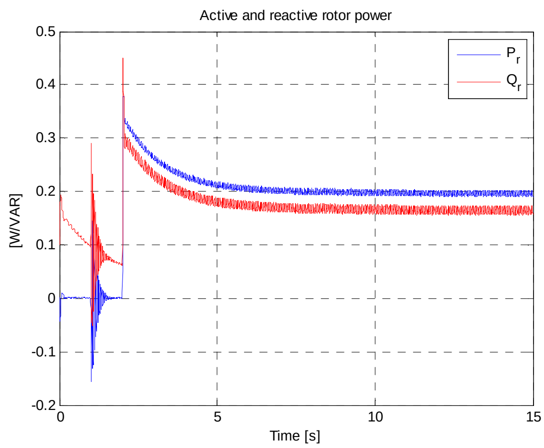


Fig. 15. Active and reactive power of rotor

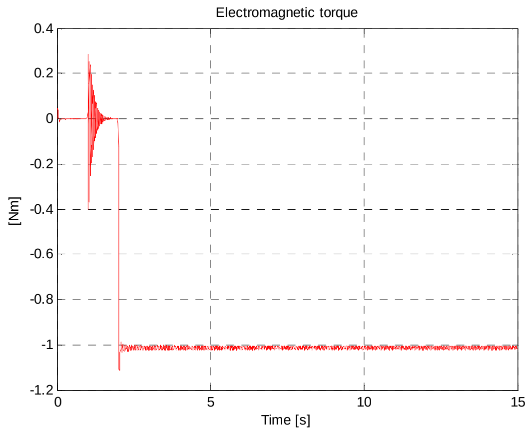


Fig. 16. Electromagnetic torque of double feed induction generator

In the least case of simulations the friction factor is decreased with 20 %. The obtained results are presented in fig. 17-23.
In this case the Stirling engine was increased (fig. 17).

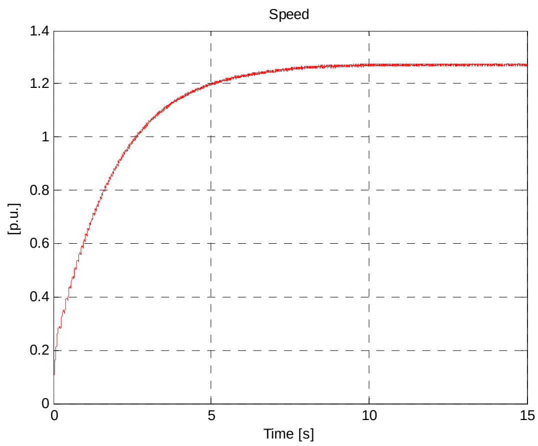


Fig. 17. The speed of Stirling engine

As in the least case, in the order to maintain this response the rotor voltage as magnitude and frequency are changed compares with rated situation (fig. 18).

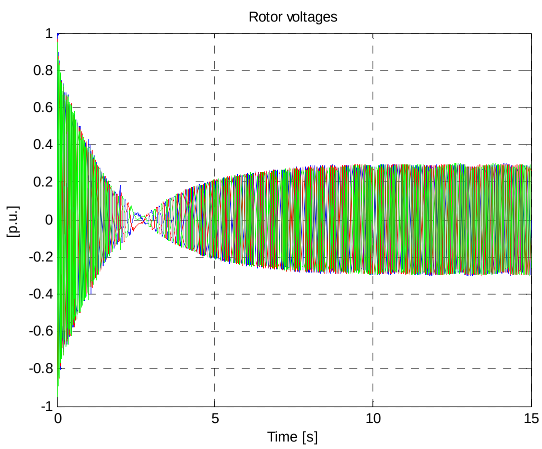


Fig. 18. Rotor voltages

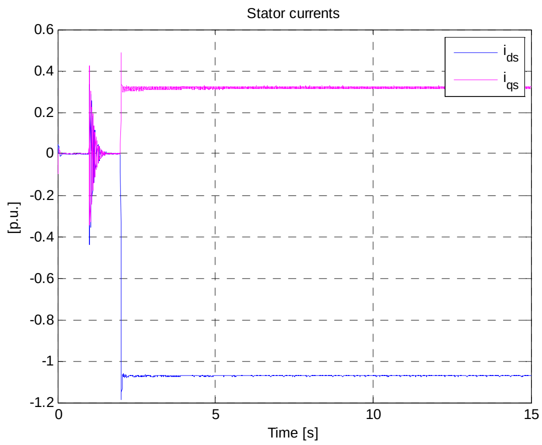


Fig. 19. Stator currents

The response of active (fig. 19) and reactive (fig. 20) stator power is a good one.

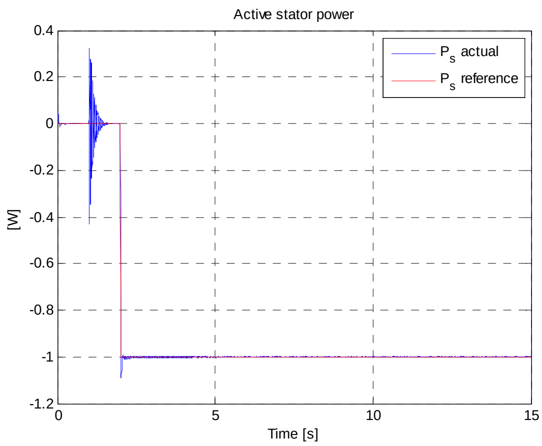


Fig. 20. Active stator power

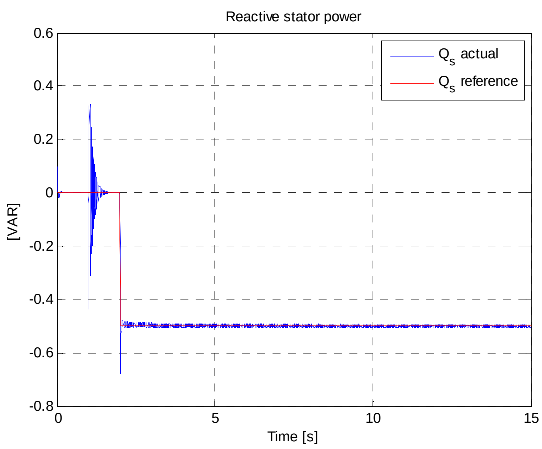


Fig. 21. Reactive stator power

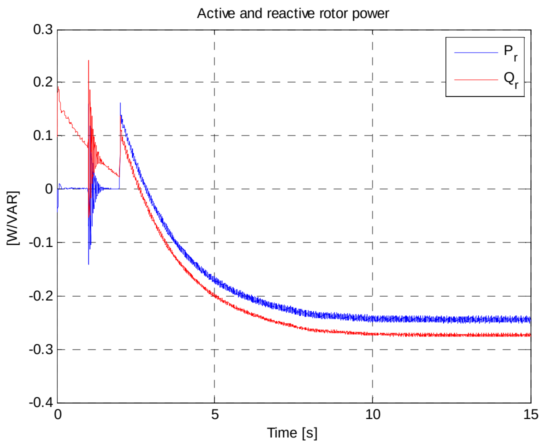


Fig. 22 Active and reactive power of rotor

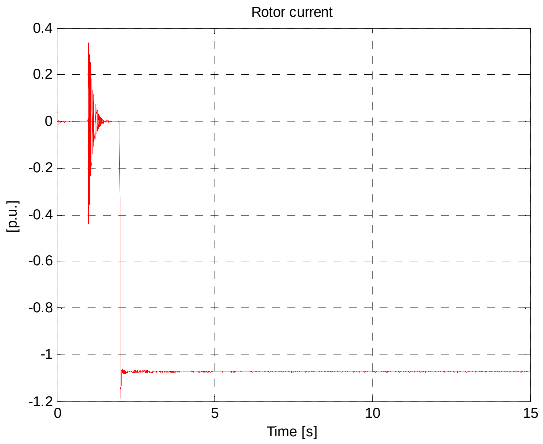


Fig. 23 Electromagnetic torque of double feed induction generator

Due to the fact that the speed of Stirling engine is very sensitive on friction factor variations (those situations are occurring in practice), the cogeneration integrated system must be able to operate this kind of situations. The double feed induction machine has the capability to operate above and under synchronous speed. In the order to maintain a good response of active and reactive power loop, the phenomena are adjustable on rotor (magnitude and frequency of rotor voltages).

4. CONCLUSIONS

The influence of Stirling engine friction factor variations on the cogeneration system output response is related on speed values. A slight variation of Stirling engine friction factor leads to a large variation of the speed of Stirling engine. The double feed induction generator may operate satisfactory in a cogeneration system due to the possibility to operate on under and above synchronous speed. In the order to fall the reference of stator power loops, the flow of rotor is adjustable by power converters according to the necessary desired by loops.

Future work involves the study of parallel operation of cogeneration equipped with different generators.

5. REFERENCES

[1] BOLDEA I., *The Induction Machine Handbook*, CRC Press, 2001.

[2] BOLDEA I., *The induction Machines Design Handbook*, second edition, CRC Press, 2009.

[3] BOLDEA I., *Variabile Speed Generators*, CRC Press, 2005.

[4] CIOC I., NICA C., *Design of Electrical Machines*, Didactic and Pedagogic Publishing House, Bucharest, 1994, (In Romanian)

[5] DORDEA T., *Electrical Machines, Theory, Construction, Design*, Asab Publishing House, Bucharest, 2003. (In Romanian)

[6] HANSEN L. H., HELLE L., BLAABJERG F., RITCHIE E., MUNK-NIELSEN S., BINDNER H., SØRENSEN P. and BAK-JENSEN B., *Conceptual survey of Generators and Power Electronics for Wind Turbines"*, Danemark, 2001.

[7] HOMUTESCU C. A., SAVITESCU G., JUGUREANU E., HOMUTESCU M. V., *Inroduction in Stirling Engines*, CERMI Publishing House, Iasi, Romania, 2003. (In Romanian)

[8] MARTEN B., *Stirling Engine*, Lecture Notes, February, 2012.

[9] RIAZ. M., “Modeling and Simulation of Electrical Drive and Machine”, 2001.

OBJECT DETECTION USING HOUGH TRANSFORM

[1]TODORUT CLAUDIU-ADRIAN, [2]ARDELEAN FLORIN-TRAIAN

[1,2]*Technical University of Cluj-Napoca, Romania*

ABSTRACT

In this paper an implementation is presented for object detection using Hough transform which is superior to other methods. By implementing this algorithm it is detected objects of various forms: lines and circles.

Keywords: *Object recognition, Hough transform, Sobel operator*

1. HOUGH TRANSFORM

1.1 Introduction

Hough transform was invented by Paul Hough in 1962 and patented by IBM. Initial use was to detect the trajectories of charged particles in bubble chamber experiments. Richard Duda and Peter Hart [1] generalized Hough transform created in 1972. If the initial method only detect lines transformed generalized detect any forms [2] (pp. 382-383), in particular line segments, arcs and ellipses.

Hough transform is a technique that can be used to isolate the characteristics of the object in an image. Since this requires that the desired features be specified in a parametric form, Hough transform algorithm is most commonly used for detection of regular curves such as lines, circles, ellipses, etc.

1.2 Hough transform for lines

Hough transform is a method to solve a classic problem of artificial vision: finding straight lines in an image which contains a lot of points of interest, direct method to calculate the right of each pair of points has a high computational complexity, O(n2), and it is applicable to a large number of points. Hough transform was proposed and patented by Peter Hough and initial version was a real-time method to count how many points are placed on every possible right in a picture. This method is based on the straight line representing the slope shape - free period, (y = ax + b), and the construction of a parametric space, called the Hough accumulator. For each point of interest in the image, calculate all possible straight going through it, and increment the elements in the parameter space. Relevant lines are located in local maxima of parameters. The original version was focused on the detection of lines in video images based representation as the slope straight lines and free time. This representation is sub- optimal, as it is bordered: to represent all possible straight from the image, the slope and the constant term should vary the -∞ and +∞. The results of Duda and Hart made popular in the Hough transform artificial vision. The main problem, unbounded parameters, was solved by normal parameterization. Normal parameterization of a fair representation consists of straight line passing through the origin by a vector perpendicular to the right. Normal representation (1) is also called the representation ρ-θ.

$$\rho = x\cos\theta + y\sin\theta \tag{1}$$

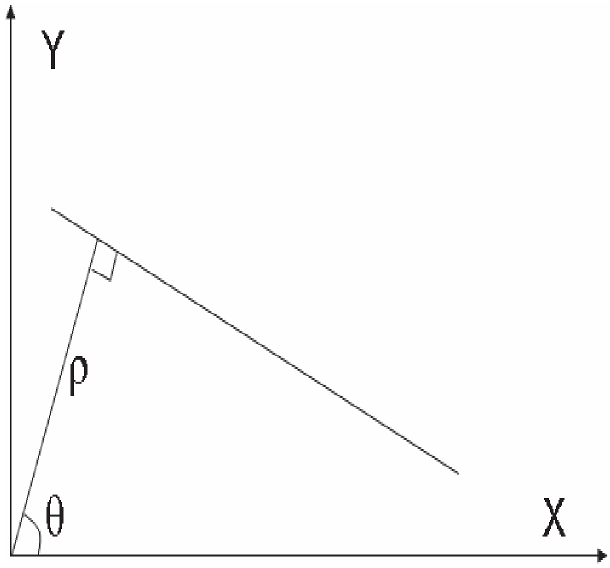


Figure 1: The vector perpendicular to line, passing through the origin, is right by the parameters ρ si θ

Besides the parameters which are limited, parameter's quantization plays an important role in decreasing the computational complexity. Quantization is related to Hough accumulators size. For each of the two parameters of the straight line is determined by the quantization level, which depends on the accuracy required (eg accuracy of ρ can be 10, 1, 0.5 pixels, etc. and the accuracy of θ can be 10 degrees, 1 degree, 0.5 degrees etc.).

The parameters ρ and θ have a limited range of variation because the image has a finite size. The maximum value for ρ is the diagonal image, ρmax. Depending on the chosen interval for θ, there are several equivalent configurations for the parameters:

$\theta \in [-90^\circ, 90^\circ)$ *sau* $\theta \in [0^\circ, 180^\circ), \rho \in [-\rho_{max}, \rho_{max})$

$\theta \in [0^\circ, 360^\circ), \rho \in [0, \rho_{max}]$

Suppose the Hough accumulator parameter space H is quantized right. Quantization steps for ρ and θ are Δρ and Δθ, and their maximum values are ρ and θ_{max}.

1.3 Hough transform for circles

Hough transform can be used to determine the parameter of a circle when there are a number of points which are in that circle area. A circle of radius R with center (a, b) can be described by the following parametric equations:

$$x = a + R\cos(\theta); y = b + R\sin(\theta) \quad (2)$$

When the angle θ takes values between 0 and 360 degrees, points (x, y) follow perimeter of a circle. If an image contains many points, some of which are in the perimeters of circles, the problem is finding triples (a, b, R) to describe each circle. One of the biggest problems is the 3D space, which causes very high computational complexity. For this reason it is better if the radius R is known to reduce search in a 2D space. In our case sought circles radii are not constant, but is within fairly strict boundaries.

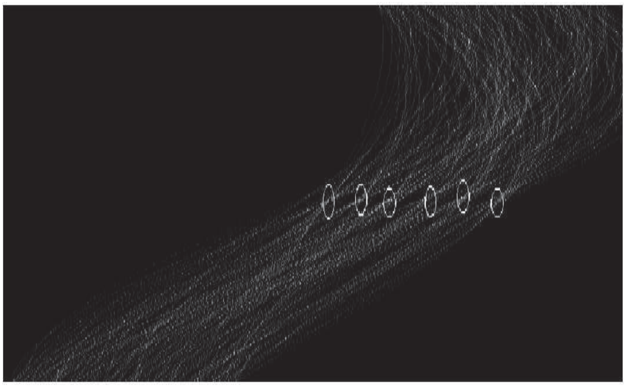


Figure 2 Example of matrix accumulation resulting from applying Hough transform. The circles mark the peaks corresponding to the six lines detected. The graphic display elements using black and gray void with light proportional to the value of the item to null values

2. SOBEL OPERATOR

2.1 Introduction

Image processing is important in modern data storage and data transmission, especially in progressive transmission of images, video coding (teleconference), digital libraries and image databases, remote sensing. It has to do with the manipulation of images algorithm to produce images. Digital Signal Processing (DSP) improves the quality of images taken in extremely unfavorable conditions in several ways: brightness and contrast adjustment, edge detection, noise reduction, focus adjustment [3]. The advantage is that the image processing allows a much wider range of algorithms to be applied to input data to avoid problems such as accumulation of noise and signal distortion during processing [4].

Edge detection is the process of locating an edge in the image. Detecting edges in an image is a very important step towards understanding the characteristics of the image. Edges consist of significant features and contain important information, thus significantly reduces the amount of image size and filter information that can be considered as less relevant and preserve properties of an image [5]. Most images contain a certain amount of redundant information that can sometimes be eliminated when the edges are detected and replaced when they are reconstructed [6]. Eliminating redundancy might be achieved by detecting the edges. When the image edges are detected, any redundancy in the image is removed [7].

The purpose of detecting sharp changes in image brightness is to capture important events. Apply an edge detector to an image may significantly reduce the amount of data to be processed and , therefore, can filter out information that may be regarded as less relevant , and structural properties of the image are preserved . Image quality significantly reflect output edge information and image size is reduced. This, in turn, further explains that edge detection is one of the ways of solving the problem of large volume of images that occupy the computer memory. Problems of storage and transmission bandwidth internet could be resolved when detected edges [8]. Since edges often occur at image locations representing object boundaries, edge detection is widely used in image segmentation when images are divided into working areas corresponding to different objects.

Intuitively, in an image, the edges can be identified where pixel values change suddenly.

Type step edges are between regions characterized by average values of different gray levels. Top edges of type (roof) correspond to local variations of intensity pixel variation shows a maximum or a minimum.

Changes in image intensity can be detected by applying a gradient operator. The gradient of a function at a point is a vector function in normal curve described by that point. On the image as a function of two variables f(x, y) which associates each point (x, y) an amount of intensity (gray level) and making the assumption that the function is continuous and differentiable, the gradient at the point (x, y) will be:

$$\nabla f(x,y) = \left(\frac{\partial f}{\partial x}(x,y), \frac{\partial f}{\partial y}(x,y)\right) \quad (3)$$

The amplitude and orientation of the gradient at the point (x, y) are given by:

$$|\nabla f(x,y)| = \sqrt{\left(\frac{\partial f}{\partial x}(x,y)\right)^2 + \left(\frac{\partial f}{\partial y}(x,y)\right)^2} \quad (4)$$

$$\varphi = \arctan \frac{\partial f}{\partial x}(x,y) / \frac{\partial f}{\partial y}(x,y) \quad (5)$$

Gradient amplitude measures the difference between the intensities of pixels within a neighborhood, and guidance directly relevant most significant changes of intensity, which is probably Edge direction. These formulas are transformed into discrete digital image processing by replacing the partial derivatives by finite differences as follows:

$$\frac{\partial f}{\partial x}(x,y) \approx f(x+1,y) - f(x,y) \quad (6)$$

$$\frac{\partial f}{\partial y}(x,y) \approx f(x,y+1) - f(x,y) \quad (7)$$

In the case of soble operator, convolution kernels will be:

$$G_x = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \quad G_y = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} \quad (8)$$

$$|G| = \sqrt{G_x^2 + G_y^2} \qquad \varphi = \arctan G_y / G_x \quad (9)$$

3. SOURCE CODE

The source code in Java for the detecting lines and circles using Hough transform is the following:

```
public final class SobelFilter {
public int[] processImage() {
      // int max = 0;
      int lineOffset = 0;
      final float[] hx = new float[] { -1, 0, 1, -2, 0, 2, -1,
0, 1 };

      final float[] hy = new float[] { -1, -2, -1, 0, 0, 0, 1,
2, 1 };

      final float[] GX = new float[width * height];
      final float[] GY = new float[width * height];
      final int[] G = new int[width * height];

      for (int x = 1; x < width - 1; x++) {
            for (int y = 1; y < height - 1; y++) {
                  lineOffset = x + y * width;
                  GX[lineOffset] = gradientSum(hx, 3, 3, x,
y);
                  GY[lineOffset] = gradientSum(hy, 3, 3, x,
y);
            }
      }

      for (int x = 0; x < width; x++) {
            for (int y = 0; y < height; y++) {
                  lineOffset = x + y * width;
                  G[lineOffset]        =        (int)
Math.sqrt(GX[lineOffset] * GX[lineOffset] +
GY[lineOffset] * GY[lineOffset]);
            }
      }
      for (int x = 0; x < width; x++) {
            for (int y = 0; y < height; y++) {
                        lineOffset = x + y * width;
                  setPixel(x, y, G[lineOffset]);
            }
      }
      return outputImage;
}
private int gradientSum(final float[] kernel, final int
kernWidth,
                  final int kernHeight, final int x, final int y)
{
      int sum = 0;
      final int halfWidth = kernWidth / 2;
      final int halfHeight = kernHeight / 2;
      int lineOffset = 0;
      for (int x1 = 0; x1 < kernWidth; x1++) {
            for (int y1 = 0; y1 < kernHeight; y1++) {
                  int x2 = x - halfWidth + x1;
                  int y2 = y - halfHeight + y1;
                  lineOffset = x2 + y2 * width;
                  float value = (inputImage[lineOffset]
& 0xff)
                              * (kernel[x1 + y1 *
kernWidth]);
                  sum += value;
            }
}
      return sum;
}
}

public final class HoughCircleFilter {
   int[][] accumulator;
   int circlesToDetect;

   public int[] processImage() {
     accumulator = new int[height][width];
     for (int x = 0; x < width; x++) {
           for (int y = 0; y < height; y++) {
           if ((inputImage[x + y * width] & 0x000000ff)
!= 0) {
                       addPoint(x, y);
                 }
           }
     }
     int pixelValue;
     for (int y = 0; y < height; y++) {
           for (int x = 0; x < width; x++) {
                 pixelValue = (int) (((double)
accumulator[y][x]));
                 accumulator[y][x]    =    0xff000000    |
(pixelValue << 16
                             |  pixelValue  <<  8  |
pixelValue);
           }
     }
     collectCircles();
     return outputImage;
   }
   private int getMaxHough() {
     int max = 0;
     for (int y = 0; y < height; y++) {
           for (int x = 0; x < width; x++) {
                 if (max < accumulator[y][x]) {
                       max = accumulator[y][x];
                 }
           }
     }
     return max;
   }

   private void addPoint(final int x, final int y) {
     int xCenter, yCenter;
```

```
        double thetaRadian;
for (int theta = 0; theta < 360; theta++) {
            thetaRadian = (theta * Math.PI) / 180;
            xCenter = (int) Math.round(x - radius *
Math.cos(thetaRadian));
            yCenter = (int) Math.round(y - radius *
Math.sin(thetaRadian));
            if (xCenter > 0 && xCenter < width &&
yCenter > 0
                    && yCenter < height) {
                    accumulator[yCenter][xCenter]++;
            }
        }
    }
    private void drawHoughCircle(final int xCenter, final
int yCenter, final int pix) {

        // circle-drawing algorithm uses 4-way symmetry
        int y, radius2;
        radius2 = radius * radius;
        setPixel(xCenter, yCenter + radius, pix);
        setPixel(xCenter, yCenter - radius, pix);
        for (int x = 1; x <= radius; x++) {
            y = (int) (Math.sqrt(radius2 - x * x) + 0.5);
            setPixel(xCenter + x, yCenter + y, pix);
            setPixel(xCenter + x, yCenter - y, pix);
            setPixel(xCenter - x, yCenter + y, pix);
            setPixel(xCenter - x, yCenter - y, pix);
        }
    }
    private void collectCircles() {
        final SortedMap<Integer, Pixel> mapPixels = new
TreeMap<Integer, Pixel>(
    java.util.Collections.reverseOrder());
        for (int y = 0; y < height; y++) {
            for (int x = 0; x < width; x++) {
                int pixelValue = accumulator[y][x] &
0xff;
                final Pixel pixel = new Pixel(x, y);
                mapPixels.put(pixelValue, pixel);
            }
        }
        final Iterator<Map.Entry<Integer, Pixel>> it =
mapPixels.entrySet().iterator();
        int contor = 0;
        while (it.hasNext()) {
            if (contor < circlesToDetect) {
                contor++;
                final Map.Entry<Integer, Pixel> pairs =
it.next();
                drawHoughCircle(pairs.getValue().getX(),
pairs.getValue()
                    .getY(), pairs.getKey());
            } else {
                break;
            }
        }
    }

public void setNumberOfObjectsToDetect(final int
circlesToDetect) {
        this.circlesToDetect = circlesToDetect;
    }
}

public final class HoughLineFilter {
    int[][] accumulator;
    int linesToDetect;
    // calculate Hough map's width
    private static final int thetaMax = 180;

    public int[] processImage() {
        final int houghWidth = (int) Math.sqrt(width * width
+ height * height);
        accumulator = new int[thetaMax][houghWidth];
        for (int y = 0; y < height; y++) {
            for (int x = 0; x < width; x++) {
                if ((inputImage[x + y * width] &
0x000000ff) != 0) {
                    addPoint(x, y);
                }
            }
        }
        int maxHough = getMaxHough();
        int pixelValue;
        for (int y = 0; y < thetaMax; y++) {
            for (int x = 0; x < houghWidth; x++) {
                if (maxHough != 0) {
                    pixelValue = (int) (((double)
accumulator[y][x] / (double) maxHough) * 255.0);
                } else {
                    pixelValue = (int) ((double)
accumulator[y][x]);
                }
                accumulator[y][x] = 0xff000000 |
(pixelValue << 16| pixelValue << 8 | pixelValue);
            }
        }
        colectLines();
        return outputImage;
    }
    private void addPoint(final int x, final int y) {
        final int houghWidth = (int) Math.sqrt(width * width
+ height * height);
        int r;

        for (int theta = 0; theta < thetaMax; theta++) {
            double thetaRadian = ((theta) * Math.PI) / 180;
            r = (int) (x * Math.cos(thetaRadian) + y *
Math.sin(thetaRadian));
            if ((r < 0) || (r >= houghWidth)) {
                continue;
            }
            accumulator[theta][r]++;
        }
    }
    private int getMaxHough() {
        final int houghWidth = (int) Math.sqrt(width * width
+ height * height);
        int max = 0;
        for (int y = 0; y < thetaMax; y++) {
            for (int x = 0; x < houghWidth; x++) {
                if (max < accumulator[y][x]) {
                    max = accumulator[y][x];
```

```
                    }
                }
            }
            return max;
        }

        private void colectLines() {
            final int houghWidth = (int) Math.sqrt(width * width
+ height * height);
            SortedMap<Integer, Pixel> mapPixels = new
TreeMap<Integer,
Pixel>(java.util.Collections.reverseOrder());
            for (int y = 0; y < thetaMax; y++) {
                for (int x = 0; x < houghWidth; x++) {
                    int pixelValue = accumulator[y][x] &
0xff;
                    final Pixel pixel = new Pixel(x, y);
                    mapPixels.put(pixelValue, pixel);
                }
            }
            final Iterator<Map.Entry<Integer, Pixel>> it =
mapPixels.entrySet().iterator();
            int contor = 0;
            while (it.hasNext()) {
                if (contor < linesToDetect) {
                    contor++;
                    Map.Entry<Integer, Pixel> pairs =
it.next();
                drawHoughLine(pairs.getValue().getX(),
pairs.getValue().getY(), pairs.getKey());
                } else {
                    break;
                }
            }
        }

        private void drawHoughLine(final int radius, final int
theta,
                final int pixelValue) {
            for (int y = 0; y < height; y++) {
                for (int x = 0; x < width; x++) {
                    final double thetaRadian = (theta *
Math.PI) / 180;
                    final int radiusTemp = (int)
(Math.cos(thetaRadian) * x + Math.sin(thetaRadian) * y);
                    if (radiusTemp == radius) {
                        setPixel(x, y, pixelValue);
                    }
                }
            }
        }
        public void setNumberOfObjectsToDetect(final int
linesToDetect) {
            this.linesToDetect = linesToDetect;
        }
}
```

4. EXPERIMENTAL DETECTION

For the object detection it was used the following configuration: Intel Pentium 1.87 GHz, 2 GB memory, USB Camera Genius FaceCam 300.

In figures 3 and 4 are presented the object detection using Hough transform and Sobel operator. In the first figure are detected lines and in the second only circles. The detected objects are marked with the red line.

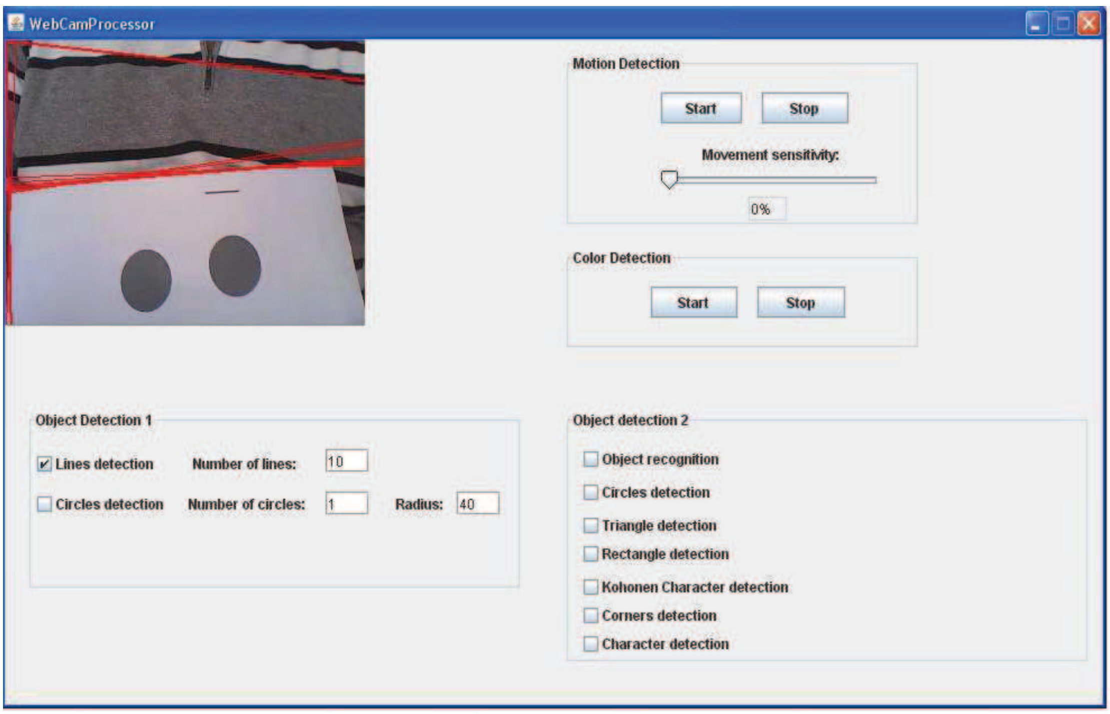


Figure 3 Line detection using Hough transform

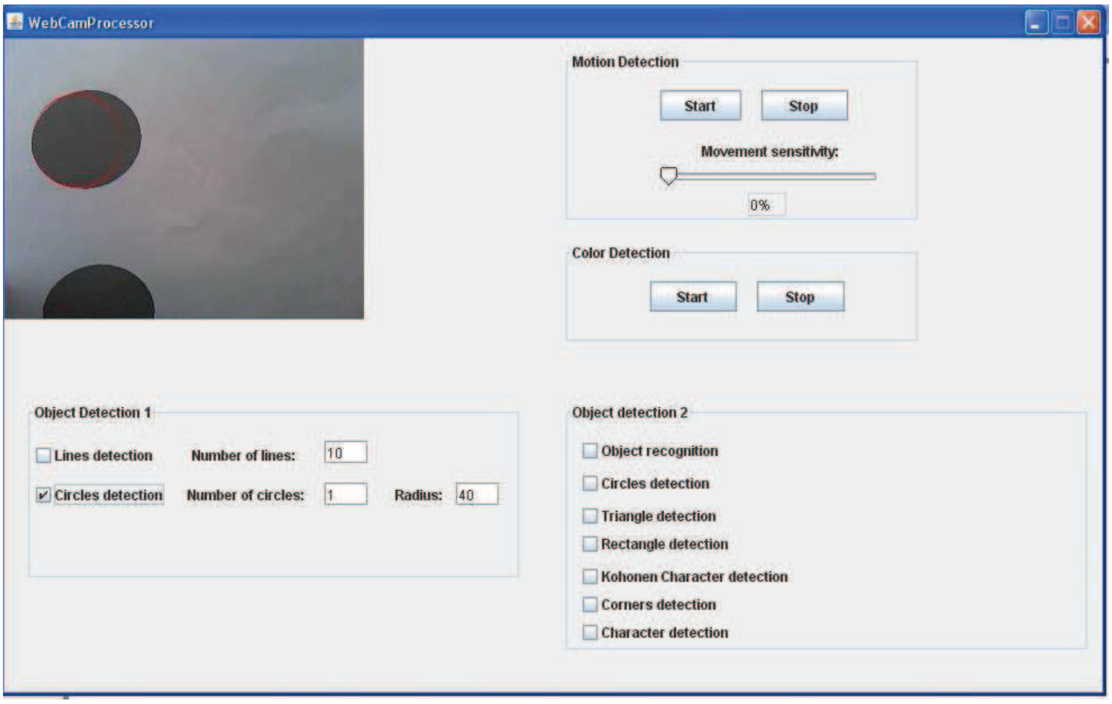


Figure 4 Circle detection using Hough transform

5. CONCLUSION

This paper introduced the concept of Hough Transform and how it is used in object detection. Hough transform has some limitations, can detect only lines and circles.

6. REFERENCES

[1] RICHARD O. DUDA AND PETER E. HART. *Use of the hough transformation to detect lines and curves in pictures*, Communications of the ACM, 15:11–15, January 1972.

[2] STUART C. SHAPIRO, editor. *Encyclopedia of artificial intelligence*, volume 1. John Wiley & Sons, 1990.

[3] GONZALEZ, R., & WOODS, R., *Digital image processing (2nd ed.)*, Prentice-Hall Inc. 567-612, 2002

[4] BAKER, S., & NAYAR, S. K., *Pattern rejection. Proceedings of IEEE Conference Computer Vision and Pattern Recognition*, 544-549, 1996

[5] YUVAL, F., *Fractal image compression (theory and application*), Institute for non-linear Science, University of California, San Diego, USA, 1996

[6] OSUNA, E., FREUND, R., & GIROSI, F., *Training support vector machines: An application to face detection*, Proceedings of IEEE Conference Computer Vision and Pattern Recognition, 1997

[7] SPARR, G., *Image processing and pattern classification for character recognition*, Center for Mathematical Sciences, Lund University, 2, 25-78, 2002

[8] VINCENT, O. R., *Optimization of network bandwidth using image compression,* Proceedings of the National Conference on advanced Data Computing Communications and Security, Kadi, India, 2007

SECTION IV
MATHEMATICAL SCIENCES AND PHYSICS

IMPULSIVE SYNCHRONIZATION OF DISCRETE-TIME CHAOTIC SYSTEMS VIA PECORA - CARROLL TECHNIQUE

DELEANU DUMITRU

Constanta Maritime University, Romania

ABSTRACT

In the paper the impulsive synchronization of discrete-time chaotic systems is analyzed and simulated using Pecora - Carroll method and Matlab programs. Practical schemes and criteria are discussed and applied to typical chaotic systems as Burgers map, Gumowski-Mira map and Rossler discrete hyper-chaotic attractor. Numerical simulations show the effectiveness of the proposed techniques.

Keywords: *Impulsive synchronization, Pecora-Carroll technique, discrete-time chaotic system.*

1. INTRODUCTION

Synchronization of chaos is a process where two or many chaotic systems, identical or not, adjust a given property of their motion to a common behaviour, due to coupling or forcing. Depending on this common feature, there exist several types of chaos synchronization, such as complete (identical) synchronization, partial synchronization, phase synchronization, lag synchronization, generalized synchronization and so on [1-7]. The motivation for the study of chaotic synchronization lies in its numerous potential applications, ranging from living systems applications (in neurobiology and chemistry) to the non-living systems applications (in earth sciences or secure communications).

Many methods and techniques for handling chaos synchronization have been developed, such as Pecora-Carroll method, feed-back approach, adaptive method, back-stepping design technique, active-passive decomposition method, etc.

Most recently, the impulsive synchronization of chaotic systems (called drive and response systems) was introduced as a means to improve the low efficiency of channel usage in secure communications. In this approach, samples of the state variables of the drive system at discrete instances are used to drive the response system. These samples are called the synchronization impulses and are employed to impulsively control the error system between the two systems. Once the error system of the two coupled chaotic systems is asymptotically stable, they are said to be synchronized. This idea drastically reduces the amount of information transmitted from the driving system to the response system which makes this method more efficient and useful in real-life applications [8-11].

In this paper, based on the stability theory of impulse difference equations and Pecora – Carroll discrete method, we study the chaos impulse synchronization of three pairs of coupled discrete chaotic systems, namely Burgers map, Gumowski-Mira map and Rossler discrete hyper-chaotic attractor..

The outline of this paper is listed as follows. In Section 2, a brief description of Pecora-Carrol method is presented. A sufficient criterion for impulsive synchronization of discrete-time chaotic systems is specified in Section 3. Four numerical examples to demonstrate the performances of the proposed approaches are provided in Section 4. We close with a short summary and conclusions in Section 5.

2. PECORA-CARROLL (PC) TECHNIQUE

In ’90, Pecora and Carroll discovered a way to achieve complete synchronization of two identical chaotic systems. To do this, they took a chaotic system (more precisely, a Rossler system), chose a subsystem within it and made a replica of it. The original system is called drive (or master) system and the duplicate is called response (slave). The response is just like the drive except it is missing one or more variables. These missing variables are sent from the drive to the response wherever they are needed there. If a stable response subsystem has been chosen, the slave’s variables will converge to their counterparts in the master and will remain synchronized with them as long as the drive continues to supply the missing variables to the response system.

The method has been successfully applied to obtain chaos synchronization in many important nonlinear systems including Lorenz and Rossler systems, Chua’s circuit, DVP oscillator and so on.

Let us now fix the basic idea from mathematically point of view. Consider the N – dimensional discrete chaotic system

$$X_{n+1} = F(X_n) \tag{1}$$

where $X \in R^N$, and $F : R^N \to R^N$ is a smooth map. Divide the system (1) into two parts in an arbitrary way as

$$X = (x, y), F = (f, g) \tag{2}$$

where $x \in R^m, y \in R^p, f : R^N \to R^m, g : R^N \to R^p$, and $m + p = N$. The drive system has the form

$$\begin{cases} x_{n+1} = f(x_n. y_n) \\ y_{n+1} = g(x_n, y_n) \end{cases}, n = 0, 1, 2,... \tag{3}$$

Now create a new subsystem (driven system) $\hat{y}$ identical to y system and substitute the set of variables x for the corresponding $\hat{x}$ in the function g, i.e.

$$\hat{y}_{n+1} = g(x_n, \hat{y}_n) \quad (4)$$

A compound system was created, namely

$$\begin{cases} x_{n+1} = f(x_n, y_n) \\ y_{n+1} = g(x_n, y_n), \; n = 0, 1, 2, ... \\ \hat{y}_{n+1} = g(x_n, \hat{y}_n) \end{cases} \quad (5)$$

If the chosen subsystem (4) is stable, then both the systems (master and slave) will synchronize as *n* grows, that means the synchronization error $v = y - \hat{y}$ will tends to zero as *n* approaches infinity.

In order to study the dynamics of error *w*, we must to use the variational synchronization error system

$$v_{n+1} = D_y g \cdot v_n \quad (6)$$

where $D_y g = \dfrac{\partial g(x_n, y_n)}{\partial y_n}$ is the matrix of derivatives of *g* with respect to y_n (i.e. the Jacobian matrix). If all the *p* Lyapunov exponents of (6) are negative, then this subsystem is stable, i.e. the identical synchronization of master and slave chaotic systems is achieved.

3. IMPULSIVE SYNCHRONIZATION APPLIED TO PECORA-CARROLL METHOD

To synchronize the two systems (3) and (4) by an impulsive approach one considers the following steps:

Step 1: Choose the period *P* and the width *Q* of the impulse samples. It is obvious that *P* and *S* are positive integers and $Q \le P$.

Step 2: The slave system is written as

$$\begin{cases} \hat{x}_n = x_n \\ \hat{y}_{n+1} = g(x_n, \hat{y}_n) \end{cases} \quad (7)$$

for $n \in [iP, iP + Q), i = 0, 1, 2, ...$, and

$$\begin{cases} \hat{x}_{n+1} = f(\hat{x}_n, \hat{y}_n) \\ \hat{y}_{n+1} = g(\hat{x}_n, \hat{y}_n) \end{cases}, \; n = 0, 1, 2, ... \quad (8)$$

$n \in [iP + Q, (i+1)P), i = 0, 1, 2, ...$

Step 3: Find μ and λ, the largest Lyapunov exponents of the variational synchronization error systems (6) and

$$\begin{pmatrix} u_{n+1} \\ v_{n+1} \end{pmatrix} = \begin{pmatrix} \dfrac{\partial f(x_n, y_n)}{\partial x_n} & \dfrac{\partial f(x_n, y_n)}{\partial y_n} \\ \dfrac{\partial g(x_n, y_n)}{\partial x_n} & \dfrac{\partial g(x_n, y_n)}{\partial y_n} \end{pmatrix} \cdot \begin{pmatrix} u_n \\ v_n \end{pmatrix} \quad (9)$$

with $u_n = x_n - \hat{x}_n$ and $v_n = y_n - \hat{y}_n$.

Step 4: If

$$(\mu - \lambda)Q + \lambda P < 0 \quad (10)$$

then the master and slave systems can be synchronized. Otherwise, choose another pair *(P, Q)* and return to Step 1 [12].

Remark 1: Because the error system is stable, it follows that $\mu < 0$. Noting that $\lambda > 0$, the condition (10) could be rewritten as

$$\frac{Q}{P} > \frac{\lambda}{\lambda - \mu} \stackrel{\Delta}{=} D \quad (11)$$

Remark 2: The relation (10) represents a sufficient condition for chaos synchronization. As a consequence, it is possible that the two systems synchronize for $Q \le DP$.

4. NUMERICAL ILLUSTRATIONS

In this section we study the impulsive synchronization of three discrete-time chaotic systems by applying the theory presented in Sections 2 and 3.

(A) BURGERS MAP

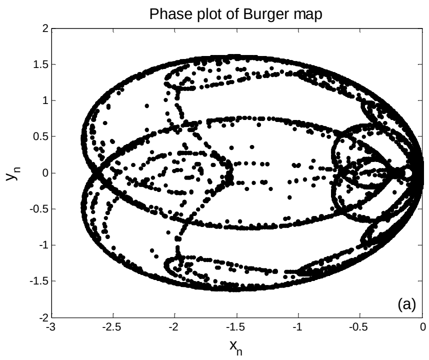
The Burgers mapping is a discretization of a pair of coupled differential equations which were used by to study bifurcations in the case of hydrodynamics flows [13]. The Burgers map is defined in the following way

$$\begin{cases} x_{n+1} = (1 - a)x_n - y_n^2 \\ y_{n+1} = (1 + b + x_n)\, y_n \end{cases} \quad (12)$$

with *a* and *b* real constants. A typical double chaotic attractor is presented in Figure 1 (a), with $a = 0.9$ and $b = 0.856$. Every attractor is located around a fixed unstable point.

The initial conditions for the master and slave systems are taken as $x_1 = -1, y_1 = 0.7$, and $\hat{x}_1 = -2, \hat{y}_1 = 0.5$. Figure 1 (b) shows the time series of $x_n, \hat{x}_n$ and $y_n, \hat{y}_n$ before the synchronization. The two systems evolve independently and have not any tendency to synchronize.

We found that the synchronization is possible if the samples of the state variable y_n are sent to the driven system and value $P = 20$ is selected. Because the largest Lyapunov exponents λ and μ are equal in this case with 0.657 and –2.303, respectively, one get $D = 0.19$.



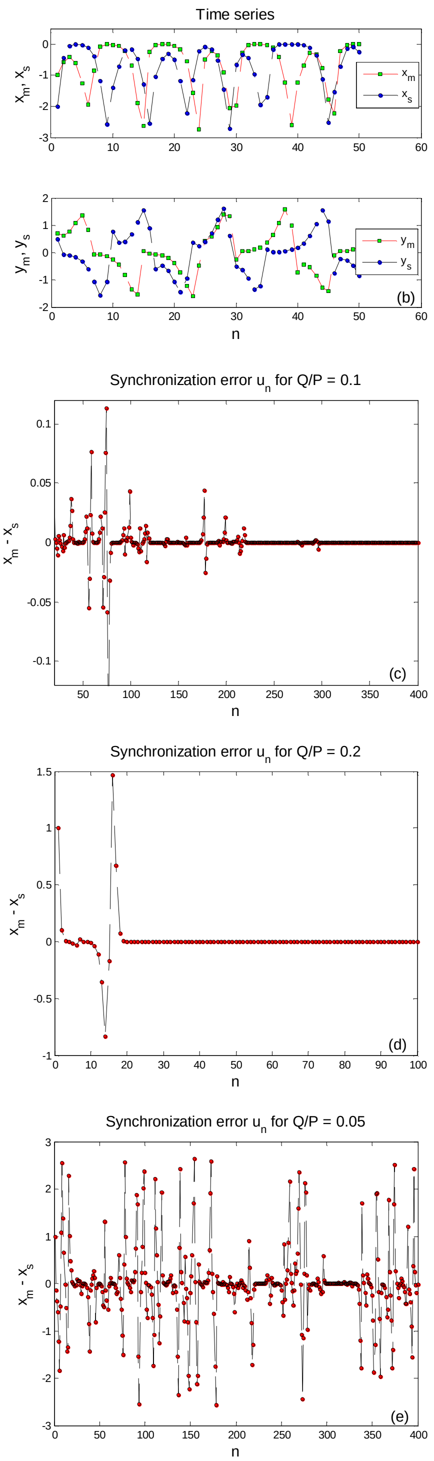


Figure 1: Impulsive synchronization of Burgers map: a) Phase plot (x_n, y_n) of Burgers map; b) Time series for *x* and *y* variables of master and slave systems;
c) Synchronization error $u_n = x_n - \hat{x}_n$ for $P = 20, Q = 2$;
d) Synchronization error $u_n = x_n - \hat{x}_n$ for $P = 20, Q = 4$;
e) Synchronization error $u_n = x_n - \hat{x}_n$ for $P = 20, Q = 1$.

It is expected that for values $Q/P > 0.19$, the master and slave systems can be synchronized. Indeed, Figure 1(d) confirms our expectations ($Q/P = 0.2$). The synchronization process is still possible for $Q/P = 0.1$ (the condition (10) is just sufficient, not necessary), the paid price consisting in increasing the number of iterations until complete synchronization (see Figure 1 (c)). If the ratio Q/P is further decreased, the synchronization cannot be achieved, as is reported in Figure 1 (e).

(B) GUMOWSKI - MIRA MAP

This map has been introduced for modeling and studying accelerated particles trajectories at CERN in 1980. Iterations defined by equations

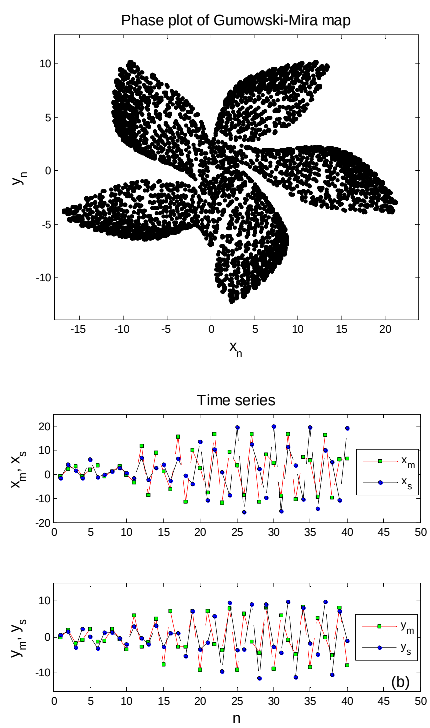
$$\begin{cases} x_{n+1} = y_n + a\left(1 - b y_n^2\right) y_n + h(x_n) \\ y_{n+1} = -x_n + h(x_{n+1}) \end{cases} \tag{13}$$

where

$$h(x) = \rho x + \frac{2(1-\rho)x^2}{1+x^2}, a, b, \rho \text{ constants} \tag{14}$$

produce different kind of cellular patterns such that illustrated in Figure 2 (a). These patterns resemble very much with cross section of living marine creatures [11, 12]. The map evolves chaotically if $a = 0.008, b = 0.05$ and $\rho = -0.8$.

If the initial states of drive and response systems are $x_1 = -0.9, y_1 = 0.0$ and $\hat{x}_1 = -1, \hat{y}_1 = 0.5$, and the synchronization channel is open, the two trajectories are well separated, as depicted in Figure 2 (b). Now, consider that the driving signal y_n is transmitted sequentially to the driven system with period $P = 30$. Here, $\lambda = 0.3223, \mu = -0.5101$ and $D = 0.3872$. Condition (11) assures us that if $Q \in \{12, 13, ..., 30\}$ the master and slave systems will synchronize. Again, the greater Q is, the faster and more accurately the synchronization will be achieved. From Figure 2 (e), we can see that the synchronization process is practically ended after 40 iterations.



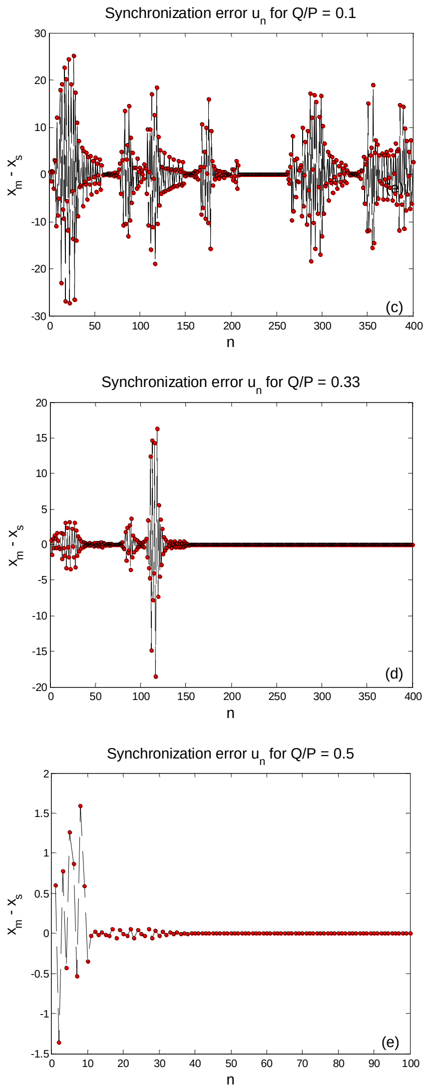


Figure 2: Impulsive synchronization of Gumowski-Mira map: a) Phase plot (x_n, y_n) of Gumowski - Mira map; b) Time series for x and y variables of master and slave systems; c) Synchronization error $u_n = x_n - \hat{x}_n$ for $P = 30, Q = 3$; d) Synchronization error $u_n = x_n - \hat{x}_n$ for $P = 30, Q = 10$; e) Synchronization error $u_n = x_n - \hat{x}_n$ for $P = 30, Q = 15$.

Synchronization was been realized even for $Q = 10$, but values $Q \le 8$ are unacceptable, as shown in Figures 2 (c) and 2 (d).

(C) ROSSLER DISCRETE-TIME HYPER-CHAOTIC SYSTEM

As a last example, we get the 3-D discrete-time Rossler system which dynamics is described by the difference equations

$$\begin{cases} x_{n+1} = a x_n (1 - x_n) - b(z_n + c)(1 - 2y_n) \\ y_{n+1} = d y_n (1 - y_n) + e z_n \\ z_{n+1} = f[(z_n + c)(1 - 2y_n) - 1](1 - g x_n) \end{cases} \qquad (15)$$

with a, b, c, d, e, f and g real parameters. In this section, the parameters are chosen as $a = 3.8, b = 0.05, c = 0.35$, $d = 3.78, e = 0.2, f = 0.1$, and $g = 1.9$. The state space of this hyper-chaotic Rossler system is shown in Figure 3 with initial conditions $(x_1, y_1, z_1)^T = (0.1, 0.1, 0.0)^T$. Maximal Lyapunov exponent is equal to 0.41. Note that this system has another positive Lyapunov exponent.

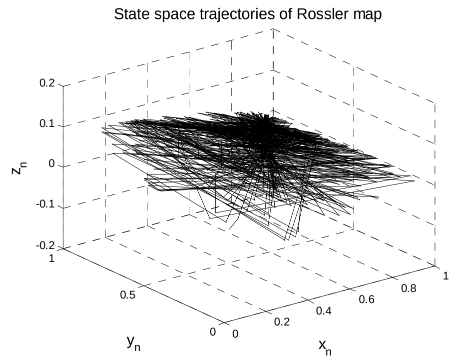


Figure 3: State space trajectories of Rossler discrete hyper-chaotic system

The numerical simulations of the errors between the drive and the response systems before coupling are given in Figure 4 with initial conditions $x_1 = y_1 = 0.1, z_1 = 0.0$, and $\hat{x}_1 = \hat{y}_1 = 0.05, \hat{z}_1 = 0.0$, respectively.

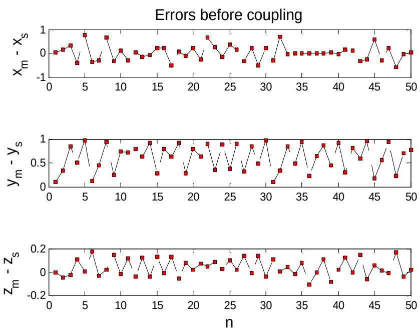


Figure 4: Errors between drive and response Rossler discrete systems before coupling

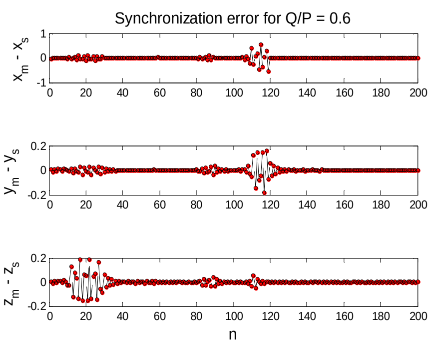


Figure 5: Errors between drive and response Rossler discrete systems after coupling

Driving signal for Rossler system synchronization is given by x_n. The important values P, λ, μ and D for the analyzed case are equal with 20, 1.164, -0.819 and 0.587, respectively. As a consequence, for Q/P = 0.6 it is expected that the slave system will follows the master system, which really happens, as depicted in Figure 5.

(D) EFFECTS OF PARAMETER MISMATCH

By parameter mismatch we understand any parameter difference between the driving system and the response system. In practice, it is hard to build identical systems so such a difference it is expected to appear. The robustness of impulsive synchronization to parameter mismatch is studied in the end of our numerical simulations for Burgers system only.

Figure 6 presents the synchronization errors when the following parameters and initial conditions are used:

Drive system: $a = 0.9, b = 0.856, x_1 = -1, y_1 = 0.7$;

Response system: $\hat{a} = 0.88, \hat{b} = 0.85, \hat{x}_1 = -2, \hat{y}_1 = 0.5$.

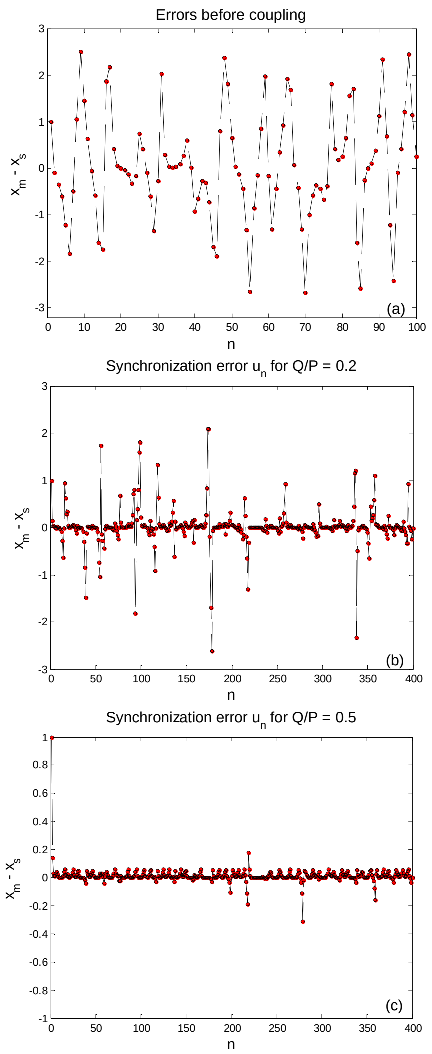


Figure 6: Effects of the parameter mismatch on the Burgers maps impulsive synchronization
a) Errors before coupling; b) Synchronization error $u_n = x_n - \hat{x}_n$ for Q = 20, P = 4; c) Synchronization error $u_n = x_n - \hat{x}_n$ for Q = 20, P = 10.

Figure 6 (a) shows the results when the two systems evolve independently (that means before coupling). The errors $u_n = x_n - \hat{x}_n$ are as greater as x_n and $\hat{x}_n$ are. Figures 6 (b) and (c) show the errors u_n with $P = 20$, $Q = 4$, and $P = 20$, $Q = 10$. Observe that the impulsive synchronization is robust enough to parameter mismatch. The errors decrease as long as *Q/P* increases.

5. CONCLUSIONS

In this paper, we investigated the impulsive synchronization of discrete – time chaotic systems. Discrete Pecora-Carroll approach was combined with impulsive control technology to give a systematic procedure for achieving the complete synchronization of two identical chaotic systems. A sufficient condition on stabilization of impulsive synchronization was presented, which depends on the period and width of impulsive control and on the maximal Lyapunov exponents of the variational synchronization error systems. The procedure was discussed and applied to three identical discrete chaotic systems, namely Burgers map, Gumowski-Mira map and Rossler discrete system. The effects of parameters mismatches were investigated, too.

6. REFERENCES

[1] ALMEDA, D.R., ALVAREZ, J., BORGES, J.G, *Robust synchronization of Sprott circuits using sliding mode control*, Chaos, Solitons and Fractals, 30, p. 11-18, 2006

[2] BOCCALETTI, S., KURTS, J., OSIPOV, G., ZHOU, C.S., *The synchronization of chaotic systems*, Physics Reports, 366, p. 1-101, 2002

[3] CHEN, S., LU, J., *Synchronization of an uncertain unified chaotic system via adaptive control*, Chaos. Solitons and Fractals, 14, p. 643-647, 2002

[4] PECORA, L.M., CARROLL, T.L., JOHNSON, G.A., HEAGY, J.F., *Fundamentals of synchronization in chaotic systems, concepts, and applications*, Chaos, 7(4), p. 520-541, 1997

[5] LO, X., *Generalized Projective Synchronization using nonlinear control method*, International Journal of Nonlinear Sciences, 8(1), p. 79-85, 2009

[6] YANCHUK, S., MAISTRENKO, Y., *Synchronization of time-continuous chaotic oscillators*, Chaos, 13(1), p. 388-400, 2003

[7] YANG, T., *A survey of chaotic secure communications systems*, Int. Journal of Computational Cognition, 2(2), p. 81-130, 2004

[8] PECORA, L.M., CARROLL, T.L., *Synchronization in chaotic systems*, Phys. Rev. Letters, 64, p. 821-824, 1990

[9] SUN, J., ZHANG, Y., QIAO, F., WU, Q., *Some impulsive synchronization criterions for coupled chaotic systems via unidirectional linear error feedback approach*, Chaos, Solitons and Fractals, 19, p. 1049-1055, 2004

[10] ZHANG, R., XU, Z., YANG, S.X., HE, X., *Generalized synchronization via impulsive control*, Chaos, Solitons and Fractals, 30, p. 123-130, 2006

[11] WANG, Q., WANG, Z., *Impulsive synchronization of Lorenz system by the Lyapunov-Razamikhin method*, International Journal of Applied Sciences and Technology, 2(2), p. 13-26, 2012

[12] FENG, G., CAO, J., *Master-slave synchronization of chaotic systems with a modified impulsive controller*, Advances in Difference Equations, 24, p. 1-24, 2013

[13] ITAH, M., YANG, T., CHUA, L.O., *Conditions for impulsive synchronization of chaotic and hyperchaotic systems*, Int. Journal of Bifurcation and Chaos, 11(2), p. 551-560, 2001

[14] BURGERS, J.M., *Mathematical examples illustrating relations occurring in the theory of turbulent fluid motion*, Trans. Royal Netherland Acad. Sci. Amsterdam, 17, p. 1-53, 1939

[15] OTSUBO, K., WASHIDA, M., ITAH, T., KOTSURA, K., HAYASHY, M., *Computer Simulation on the Gumowski-Mira Transformation*, Forma, 15, p. 121-126, 2000

[16] BEN MAALEM, H., RICHARD, P., FERRIER, J.L., LABIB, A., *Using Gumowski-Mira map for artistic creation*,12th Generative Art Conference GA2002, Tunis

[17] HE, W., QIAN, F., CAO, J., HAN, O., *Impulsive synchronization of two non-identical chaotic systems with time varying delay*, Physics Letters A, 375, p. 498-504, 2011

[18] LI, Z., WEN, C., SOH, Y., XIE, W., *The stabilization and synchronization of Chua's oscillators via impulsive control*, IEEE Trans. Circuit Syst., 48, p. 1351-1355, 2001

[19] XIE, W., WEN, C., LI, Z., *Impulsive control for the stabilization and synchronization of Lorenz systems*, Physics Letters A, 275, p. 67-72, 2000

[20] YANG, Y., *Impulsive stabilization for control and synchronization of chaotic systems: theory and applications to secure communications*, IEEE Trans. on Circuits and Systems, 44, p. 976-988, 1997.

'A NEW KIND OF SCIENCE': STEPHEN WOLFRAM'S PARADIGMS FOR A NEW BEGINNING OF MATHEMATICS

HALALAE IOAN

„Eftimie Murgu" University of Resita, Romania

ABSTRACT

"Cellular automata (CA) have been known since John von Neumann investigated them in his search for self-reproducing systems." [1]. After more than 50 years of being treated more as a curiosity, CA became, in the last decade, a major instrument in the universe of mathematics models users. Although the number of field of applications is continually growing, CA are far from being well integrated in metamathematics.

'*A new Kind of Science*' (NKOS) by Stephen Wolfram [2] is the only book aiming the presentation of CA as paradigm. Due to the fertility of the ideas, the book deserves a special attention. The major problem of the book is the rather confuse presentation of the ideas: exclusively visual argumentations and a very dispersed presentation of the themes. In the present paper we realize a synthesis of the topics and problems and also offer a concrete solution for projects using CA.

Keywords: *Cellular Automata, 'A new Kind of Science', Stephen Wolfram, simple programs, the Principle of Computational Equivalence, Perception and Complexity*

1. INTRODUCTION

CA are a software mechanism consisting of interconnected basic units named cells. "At each 'tick' of the clock, every cell switches to a new state determined only by its former state and the states of its neighbours." [1]. The very specific aspect of CA is that mechanism of cell changing value due to a function that includes the former state of the cell and a number of predefined number of neighbor cells.

Probably, the most concise informal definition of CA is: "CA consist of simple elements that combine to generate complexity." [3].

Entered into the 'toolbox' of mathematic models users, CA are claiming now a role also in epistemology. This is exactly what Stephen Wolfram done in his book: introducing CA as paradigm.

2. FROM DILEMMA TO PARADIGM: WOLFRAM'S ROUTE

Prior to NKOS, Wolfram had more than two decades of explorations in the field of CA [4] and, also, of questioning the fundaments of human understanding in general and of mathematics in particular. So, he arrives at several conclusions about the evolution and progress of knowledge and associated mathematics.

The first one is that, progressively, we get a better understanding and wrote more complicated formula.

Then, we face a constant preoccupation for extensions of theories and formalization: Leibniz's objective being to turn every question about the world into a question about mathematics. This conducted to a whole trend in finding better generating systems, but, then, Gödels's theorem showed us first the limits that any axioms based generating system has his limitations. Also, that working out in the classical manner is an essentially mechanical way that all time leads to limitations. all we get are new axiom systems for new possible mathematics, no better than anything we already know. Mainly, not different, just 'alternative mathematics'.

Wolfram's most severe observation is that a large number of phenomenons from nature do not even fit to the existing cultural frame of mathematics! So, he concludes, now we need another approach, to get human knowledge much further.

The continuation of this analysis effort is predictable: Wolfram starts working at this new construct.

Adapted to the era of computing, Wolfram first proposes the replacement of classical computing with computer simulators; at a higher conceptual level, to focus on systematically generating new knowledge instead of obtaining new formulas.

Intending to bring mathematics to a new beginning, Wolfram starts by asking how we obtain order from disorder and complexity from simplicity. As a scientist, Wolfram is preoccupied to explain the order without referring to divine miracles. But, if that order appeared by herself, that means the nature is functioning somehow self organizing. The basic question is what is the mechanism who realized that?

Wolfram's keyword is complexity. He aims not to explain the complexity of a certain phenomenon, but the complexity itself! The 'revelation' is that, contrary to traditional way of thinking, we no longer need to increase the sophistication of formulas. To complete his construction, he formulates a Principle of Computational Equivalence, aiming to factorise behavioural complexity.

Wolfram's start is with simple programs. By sampling the richness of what simple programs can do he obtains unexpected complexity. Also, he discovers that CA behavior, even apparently growing unpredictable, submit to some lows very similar to many other from physics and not only.

Then, the step to generating randomness is natural. And then, with complexity, he closes the circle of paradigms that his new construct necessitates.

To Wolfram, the most unexpected aspect about CA is that they have the necessary characteristics to be models both for parallel physical phenomena and for parallel computers in the current developments. It is like, somehow, CA are analogues both with nature and the mind perceiving it. Both nature and computer are mechanisms processing information: nature starts from a set on initial conditions and arrives to final conditions, and computers are operating from input to output according to instructions. So, Wolfram formulates the big question: what if the nature is a huge computer and the CA are programs?

A larger review of this route can be found in [5] and [6].

3. WOLFRAM'S PRADIGM PROPOSAL

As we already mentioned, Wolfram's ideas are very dispersed in his book. So, we grouped excerpts from the book by major topics.

3.1. The Universe of simple programs and the Principle of Computational Equivalence

Across all the vastly different process that we se in nature, and in systems that we construct one might t first think that there could be very little in common. But the idea that any process whatsoever can be viewed as a computation immediately provides at least a uniform framework in which to discuss different processes.

And it is by using this framework that the Principle of Computational Equivalence is formulated. For what the principle does is o assert that when viewed is computational terms there is a fundamental equivalence between many different kinds of processes.

There are various ways to state the Principle of Computational Equivalence, but probably the most general is just to say that almost all processes that are not obviously simple can be viewed as computations of equivalent sophistication.

And what this suggests is that a fundamental unity exists across a vast range of process in nature and elsewhere: despite all their detailed differences every process can be viewed as corresponding to a computation that is ultimately equivalent in its sophistication.

3.2. Simple structures and complicated prejudices: a new beginning

It is usually assumed that mathematics concerns itself with the study of arbitrarily general abstract systems. But this book shows that there are actually a vast range of abstract systems based on simple programs that traditional mathematics has never considerate. And because these systems are in many ways simpler in construction than the traditional systems in mathematics it is possible with appropriate methods in effect to go further in investigating them.

One can always in principle find out how a particular system will behave just by running an experiment and watching what happens. But the great historical successes of theoretical sciences have typically revolved around finding mathematical formulas that instead directly allow one to predict the outcome. Yet in effect this relays on being able to shortcut the computational work that the system itself performs.

3.3 Mechanisms in programs and in nature: generating randomness

Wolfram outlines three basic mechanisms that can lead to apparent randomness:

- randomness is explicitly introduced into the underlying rules for the system: in correspond essentially to assuming that there is a random external environment which continually affects the system one is looking at, and continually injects randomness into it.
- there is no such interaction with the environment. The initial conditions for the system are chosen randomly, but the subsequent evolution of the system is assumed to follow rules that involve no randomness. The two mechanisms for randomness just discussed have one important feature in common: they both assume that the randomness one sees in any particular system must ultimately come from outside of that system. In any sense, therefore, neither of the mechanisms takes any real responsibility for explaining the origins of randomness: they both in the end just say that randomness come from outside whatever system one happens to be looking at.
- simple programs can produce apparently random behaviour even if they are not given no random input whatsoever. And what this means is hat there is a third possible mechanism for randomness, which this time does not rely in any way on randomness already being present outside the system one is looking at.

There are many systems in nature that show highly complex behaviour. But there are also many systems that show rather simple behaviour – most often either complete uniformity, or repetition, or nesting. And we have fund in this book that programs are very much the same: some show highly complex behaviour, while others show only rather simple behaviour.

Traditional intuition might have made one assume that there must be a direct correspondence between the complexity of observed behaviour and the complexity of underlying rules. But one of the central discoveries of this book is that in fact there is not!

3.4 Randomness and simple programs

At the level of everyday language, when we say that something seems random what we usually mean is there are no significant regularities in it that we can discern – at least with whatever methods of perception and analysis we use. So given this everyday notion of randomness, how can we build on to develop more precise definitions? The first step is o clarify what it means not to be able to recognise regularities in something. We know that when we find regularities, it implies that redundancy is present, and this in turn means that a shorter description can be given. So when we say that we cannot recognize any regularity, this is equivalent to saying that we cannot find a shorter description.

But the fact that no short description can be found by our usual processes of perceptions and analysis does not in any sense mean that no such description exists at all.

From a practical point of view the fact that a short description may exist is presumably not too relevant if we can never find this description by any of the methods of perception and analysis that are available to us. But from a conceptual point of view it may seem unsatisfactory to have a definition of randomness that depends on our methods of perception and analysis.

So one possibily to define randomness so that is considered random only if no short description whatsoever exist of it. And before the descoveries in this book such a definition might have seemed not far from our everyday notion of randomness. But what we have discovered in this book ist hat this it is absolutely not the case, and that in fact even from rules with very short descriptions it easy to generate behaviour in which our standard methods of perception and analysis recognise no significant regularities.

But how can we ever expect to find any kind of precise general characterization of what all our various standard methods of perception and analysis do?

The key point that emerge is that in the end essentially all these methods can be viewed as being based on rather simple programs. So this suggests a definition that can be given of randomness: something should be considered to be random whenever there is essentially no simple program that can succeed in detecting regularities in it.

Usually if one is studying what itself created by a simple program then there will be a few closely related program that always succede in detecting regularities. But if something can reasonably be considered random, then the point ist hat the vast majority of simple programs should not be able to detect any regularities in it.

So does one really need to try essentially all sufficiently simple programs in order to determine this? In my experience, the answer tends to be no. For once a few simple programs corresponding to a few standard methods of perception and analysis have failed to detect regularities, it is extremely rare for any other simple program to succeed in detecting them.

So this means that the everyday definition of randomness that we discussed at the very beginning of this section is in the end already quite ambiguous.

3.5. Perception and Complexity

Much of what I have done in this book has been concerned in one way or another with phenomena associated with complexity. Following our discussion of randomness in the previous section, we are now in the position to consider how the notion of complexity might be formally defined.

Our experience in the natural world is based not directly on behaviour that occurs in nature, but rather on results of our perception and analysis of this behaviour. At the level of everyday language, when we say that something is random what we usually mean is that there are no significant regularities in it that we can discern – at least with whatever methods of perception and analyse we use. But the goal of perception and analysis is precisely to find such descriptions, so when we say something seems complex, what we are effectively saying is hat our powers of perception and analysis have failed on it.

There are two ways in which perception and analysis typically operate. First, they can just throw away details in which we are not interested. And second, they can remove redundancy that is associated with any regularity that they manage to recognize. The definition of the randomness that we discussed in the previous section was base don the failure of the second of these two functions.

But in defining complexity we need to consider both functions of perceptions and analysis. For what we want to know is not whether a simple or short description can be found of every detail of something, but merely whether such a description can be found of those features in which we happen to be interested.

In everyday language, the terms “complexity” and “randomness” are sometimes used almost interchangeably. But if one uses a particular method of perception or analysis, then one can always see how short a description manage to produce. And the shorter description is, the lower one considers the complexity to be.

But to what extent is it possible to define a notion of complexity that is independent of the details of a specific method of perception and analysis? As a practical matter, by far the most common way in which we determine levels of complexity is by using our eyes and power of visual perception. So in practice what we most often mean when we say that something seems complex is hat the particular processes are involved in human visual perception have failed to extract a short description.

Before the discoveries in this book, one might have thought that to create anything whit a significant level of apparent complexity would necessarily require a procedure which itself has significant complexity. And that this means – as the images in this book repeatedly demonstrate – is hat in the end it is rather easy to make pictures for our visual system can find no simple overall description.

4. WOLFRAM’S SELF EVALUATION

As an individual discovery, Wolfram evaluates his theory as being, probably, one of the most important from the whole history of theoretical sciences. The most spectacular aspect is that he offers an answer to the greatest mystery of natural world: which is the secret who allows the nature, with so little effort, to produce so much that we perceive as being so complex.

5. NKOS: FERTILE PARADIGMS AND TECHNICAL CONFUSIONS

Wolfram proposes the universe of simple programs as a new paradigm. In his book, he questions practically all of the classical sciences: mathematics, physics, economy, biology, psychology, from the perspective of the universe of simple programs.

Wolfram research goes towards the secret of nature: how is nature, with so little effort, able to produce all things we perceive as being so complex.

Studying the world of simple programs, Wolfram discovers behaviors that appear recurrently, almost independent from any detail. This leads him to the idea of the existence of certain nearly universal principles inducing the global evolution, which apply not only to simple programs, but also to systems in the natural world and not only.

Wolfram adds also the principle of Computational Equivalence: whenever we see a system whose behavior is not obviously simple, we can conceive it as a computational process with an equivalent computational sophistication level. From his Principle of Computational Equivalence, Wolfram extracts also a new type of Unity: in a large range of systems, the Principle entails the existence of a basic equivalence which makes the same fundamental phenomena appear and allows us to use the same basic scientific ideas and methods. This is, in Wolfram's vision, the special power of the new kind of Science presented in his book.

The attacks against the prejudices regarding complexity are also remarkable:

- we have no reason to avoid experiments with simple structures;
- he eliminates the 'direct' association between the complexity of a studied phenomenon and the complexity of its generating rules;
- the majority of the mechanisms can be viewed as being based on simple generating programs.

Here we have the first problem: Wolfram proposes the Universe of simple programs as a universal paradigm. The problem is really that: a unique mechanism for explaining the whole Universe. It goes to asserting that a *single* theory would do in physics, a *single* theory would do in mathematics, a *single* theory would do in chemistry, etc; and, in general, a *single* theory would do in any science, thus covering the entire scale of specific phenomena that human knowledge explores!

There is yet another major problem: Wolfram approaches the CA as a simple mechanism generating complexity. It is true, the book is meant to address a large class of readers (after all, it is paradigm proposal). In my opinion, the problem is the following: the presentation and the analysis are solely visual. It is true that the most frequent way to determine the complexity level is by using our eyes and a visual analysis; in this idea, a preponderantly visual presentation is the most effective. But, the elimination of any complexity analysis procedure appears to us as a major problem, generating in turn two difficulties:

- Wolfram's definitions are rather visual; a certain confusion of definitions appears, which he himself admits in his Book. To mention only one, the most important unclear definition is that of the evolution of an automaton (implicitly, of randomness, cyclicity etc.);
- so, if one intends to develop a project based on CA, it is clear that we cannot follow the procedures Wolfram used in his Book: we miss exactly the concrete definitions to start with (evolution, cyclicity, randomness, etc); we have to define concrete meanings for the terms.

Wolfram invites us to look at his Book as a new intellectual structure. He discovers and proposes a large number of new interpretations, and the discussions are only at the beginning.

6. CONCLUSIONS

Wolfram's NKOS is a great book. He follows Leibniz's ideas and continues a famous list of predecessors: John Von Neumann, Alan Turing, etc.

His aim is to show that by viewing the process of doing mathematics in fundamentally computational terms makes possible to address important issues about the foundations even of existing mathematics.

His principle of the necessity of concrete simulation combines very well with the new trend of experimental mathematics.

By his exclusively visual approach, he faces a certain 'technical' confusion, but his paradigm of simple mechanisms generating complexity and his Principle of Computational Equivalence are very fertile.

The 'universality' of CA as paradigm is, unfortunately, already negated by the newly appeared swarm dynamics.

For the rest, for concrete problems concrete answers: in a dedicated project using CA, it is up to everyone to define specific concrete definitions [7].

7. REFERENCES

[1] DURHAM, T., *Explorations in the Cellular Microworld*, Computing (January 17, 1985) 24-25.

[2] WOLFRAM, S., *A New Kind of Science*, Wolfram Media, 2002

[3] DEWNEY, A. K., *Computer recreations*, Scientific American 252 (May 1985) 18.

[4] WOLFRAM, S., *Cellular Automata and Complexity: Collected Papers*, Perseus Books, 1994

[5] REGIS, E., *Who's Got Einstein's Office?*, Addison-Wesley, 1987

[6] WOLFRAM, S., *Some Modern Perspectives on the Quest for Ultimate Knowledge*, www.stephenwolfram.com/publications/some-modern-perspectives-quest-ultimate-knowledge/

[7] HĂLĂLAE, I., *A study of cellular automata as noise generators, using genetic algorithms*, Ph.D. Thesis, Universitatea Politehnica Bucureşti, 2010

COMPARATIVE STUDY OF PHOSPHATE REMOVAL FROM WASTEWATER IN WASTEWATER TREATMENT PLANT OF CONSTANTA COUNTY

[1]ZAGAN SABINA, [2]MUSAT FLORENTINA

[1]Constanta Maritime University, [2]Technical University of Civil Engineering Bucharest, Romania

ABSTRACT

The purpose of this paper is to asses the degree of phosphate removal from wastewaters with different organic loads in wastewater treatment plants, using similar technologies. These treatments plants are located in Constanta County. To establish phosphate removal efficiency, a series of physico-chemical parameters were determined and analyzed for wastewaters treated in sewage treatment plants and have established a number of correlations between parameters obtained from analysis.

Keywords: *wastewater treatment, phosphorus, effciency, treatability.*

1. INTRODUCTION

The quality of the treated wastewaters which will be returned to the natural environment, requires the adherence to a set of values for physical and chemical parameters, [1,2], especially those that represents the higher degree of aggression on the environment, in this context being mentioned the negative role of pollutants that contain phosphorus. For this reason, a special attention is required to wastewater treatment technologies, especially the elimination of toxic chemicals-phosphate- and efficiency of wastewater treatment plants. A lot of studies have been published regarding the wastewater treatment [3-8], some of them being focuses on phosphate content. Hyandler et al.[3] studied the retention capacity of different filtering materials in order to improve the phosphate removal from a wastewater plant effluent and L.E. Bashan and Y.Bashan [5] studied biological and chemical treatment of wastewater, the biological one being based on the use of certain bacteria found in domestic wastewater, which is active in nitrogen and phosphorus removal. Biological, chemical, physical and mecanical methods are implemented as working technologies in different wastewater treatment plants.In Dobrudja region there are currently 11 operational wastewater treatment plants, using various treatment technologies:

- ✓ South Constanta – Conventional, mechanical-biological treatment, anaerobic sludge stabilisation, sludge dewatering and storage;
- ✓ North Constanta – Conventional, mechanical-biological treatment, anaerobic sludge stabilisation, sludge dewatering and storage;
- ✓ South Eforie – Conventional mechanical-biological treatment, sludge drying beds;
- ✓ Mangalia – Conventional, mechanical-biological treatment, anaerobic sludge stabilisation, sludge dewatering and storage;
- ✓ Medgidia – Conventional mechanical-biological treatment, sludge drying beds;
- ✓ Poarta Alba – Conventional mechanical-biological treatment, sludge drying beds;
- ✓ Cernavoda – Advanced mechanical-biological treatment (nitrification-denitrification, dephosphorisation), aerobic sludge stabilisation, sludge dewatering and storage;
- ✓ Ovidiu – Conventional mechanical-biological treatment, sludge drying beds;
- ✓ M.Kogalniceanu – Conventional mechanical-biological treatment, sludge drying beds
- ✓ Limanu – Conventional mechanical-biological treatment, sludge drying beds;

Negru Voda - Conventional mechanical-biological treatment, sludge drying beds;

2. EXPERIMENTAL

Samples of water from the WWTP (Mangalia, Medgidia, Poarta Alba and Kogalniceanu) that uses the same technology based on the conventional mechanical-biological treatment were used in this study. The water samples were taken in triplicate every three days, determinations being made at inlet and outlet of wastewater treatment plant.

Measurements were taken over three moths, during summertime.The preparation of samples for analysis was done according to STAS [9-12] and used reagents are of analytical grade (Merck Germany).

In order to experimental determination of quality parameters, the following equipments were used:

- to determine the pH – pH-meter inoLab pH730;
- to determine the CCO – titration with potassium dichromate in acid solution. The determination is made with an Velp Scientifica Thermoreactor ECO6 was used for the quantitative assessment of oxidizing substances in order to determine the CCO;
- an incubator was used for the determination of BOD and the samples were held for 5 days at $20^{\circ}C$;
- for the determination of phosphorus - A Jenway spectrophotometer, series 6715 with wave lenght varying between 190-1100 nm-50 nm. The wavelenght used for phosphorus concentration determination was 880 nm for a 10 mm optical lenght.

3. RESULTS AND DISCUSSIONS

- ❖ The experimental values obtained for pH are within normal limits, according to NTPA001/002 (6.5-8.5 pH units).Note that the pH values varies during the experiment, with a rise due to microbial activity. The lowest value was at Kogalniceanu treatment plant, namely 6.79, as seen in Figure 1.

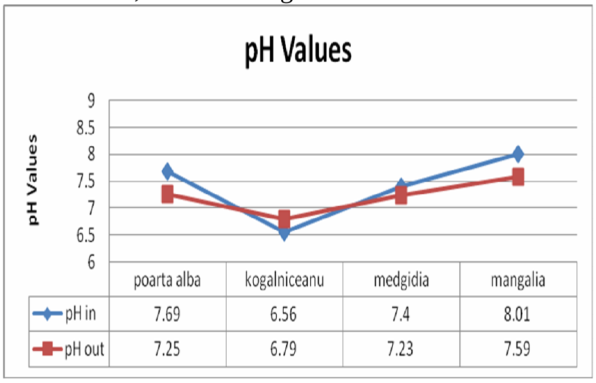


Figure 1. pH variation in 4 wastewater treatment plant

For Poarta Alba and Medgidia treatment plants, the pH values were within the limits established by NTPA 001 and NTPA 002 normatives, for all the studied samples and all the wastewater treatment plants.The values of pH below 6 or above 8 can disturb the wastewater treatment process itself, in the absence of biodegradable organic acids.

- ❖ The experimental values obtained by the COD analysis, shows a proportional relationship between wastewater at inlet and outlet of treatment plant. This feature was obtained in all 4 treatment plants. In Figure 2, is represented COD variation, in the analyzed period.

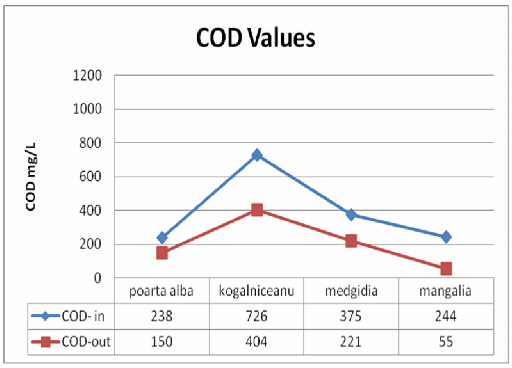


Figure 2.COD variation in 4 wastewater treatment plant

According with the normatives, the COD concentration in treated wastewaters is between 125 and 500 mg/L. It was determined experimentally that Kogalniceanu treatment plant register higher values for this parameter, the best removal of organic matter in the wastewater treatment plant is obtained from Mangalia, in this case the value of 55 mg/l. In according with a good efficiency of biological sewage treatment of wastewater, determination of COD executed on separate suspensions can give information on the overall efficiency of the plant, on the removal of organic matter and the ability of sludge sedimentation.

- ❖ The experimental values obtained for BOD after 5 days of incubation are represented in Figure 3.

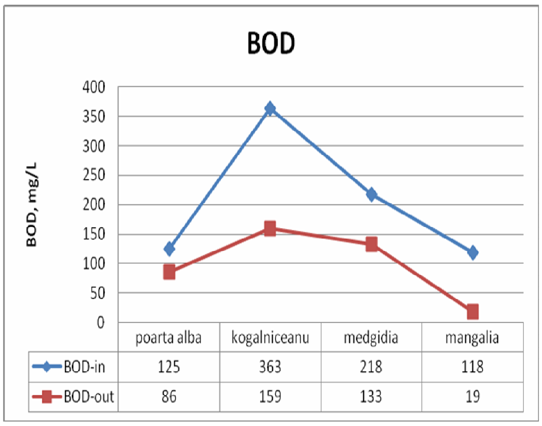


Figure 3. BOD values in 4 waszterwater treatment plants

In the chart it is observed that the lowest BOD value was obtained at Mangalia treatment plant, for outlet, the value from Poarta Alba being closed to it.Regarding, COD and BOD at Poarta Alba, Medgidia and Mangalia watewater treatment plants, the values are between NTPA 002 requests, values were slightly increased at Kogalniceanu treatment plant.

- ❖ Experimental values obtained for the phosphorus concentration in the treated wastewater samples taken from the 4 sewage treatment plants, will be shown in Figure 4.

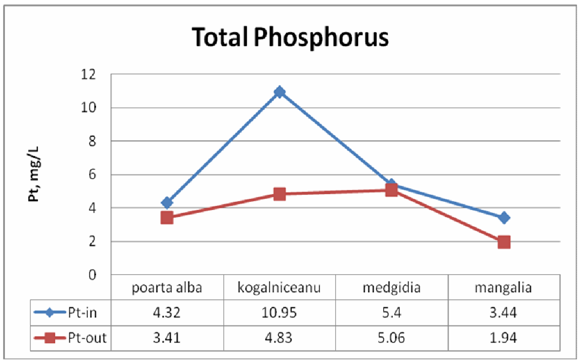


Figure 4. Phosphorus concentration in 4 wastewater treatment plants

The experimental data obtained show a little exceeding in total phosphorus concentration, for Medgidia wastewater treament plant, here registering a concentration of 5.06 mg P/L, after treatment, compared to 5.0 mg P/L, a value specified in present normatives.The lowest value of total phosphorus was at Mangalia treatment plant, of 1.94 mg/L, due to the modernisation process of this plant.

4. CONCLUSIONS

For all water samples collected from wastewater treatment plants, were determined 4 physico-chemical parameters, very important in assesing the efficiency of a wastewater treatment plant: pH, chemical oxygen demand, total phosphorus, at the inlet and outlet of wastewater treatment plant.

Following experimental determinations, it was observed:

- ✓ The pH fell inside the limits provided by the existing normatives, for all the plants;
- ✓ COD and BOD values shows no significant exceeding of the limits, but for the Kogalniceanu plant the values are slightly increased and at the Mangalia treatment plant are smaller;
- ✓ the obtained values for the total phosphorus concentration, at Medgidia WWTP was within limits, but at the Kogalniceanu and Mangalia treatment plants, the outlet value decreased to half of the one form the inlet;
- ✓ The experimental data obtained were subsequently used to evaluate the efficiency of the WWTP and technologies adopted. so, the ratio between chemical oxygen demand and biochemical oxygen demand values, after incubation and standard temperature, for 5 days, characterizes the degree of an treated wastewater. Is important to determine the COD for organic fractions and slightly biodegradable, respectively the quantity of volatile acids with short chain C2-C5 (acetic, propylic, butyric, valeric acids);
- ✓ thus, for the Poarta Alba and Medgidia treatment plants, an ratio values BOD/COD of 0.57 and 0.60, shows a good wastewater treatability, by the eavaluation in removing organic substances or the chemical oxygen demand necessary to metabolic reactions. A ratio value BOD/COD of 0.39 for the Kogalniceanu WWTP, leads to improuving measures of the existing process.

In order of a good efficiency and quality in operating WWTP, the pH determination is important, because
of his influence to microbian activity. So:

- pH between 6.8-7.2 – bacteria are usually inhibited;
- pH <6.8 - have held a series of related changes: kinetics of enzymatic activity, poor floc formation of activated sludge nitrification inhibition and excessive multiplication of fungi and Nocardia bacteria;
- pH> 7.2 - nitrification inhibition occurs, producing high amounts of ammonia inhibition of floc formation, decreased enzyme activity, etc.

The concentration of phosphorus is another chemical parameter used in determination of WWTP efficiency.The experimental data analysed, shows that in generally, the total phosphorus content is reduced to half of his inlet value, at Mangalia WWTP, with an efficiency for about 43.52%, this plant being modernized. For the other stations, higher values are observed, as no modern and efficient technology existing. For the Poarta Alba, low values of total phosphorus for the 2 from the 3 samples, are unique and not a daily average.

In conclusion this study showd that a conventional wastewater treatment, can not give a good performance regarding outlet phosphorus removal, and nutrients, the treatment technology needing continous improvements, introduction of tertiary treatment step, being a major advantage in dephosphorylation process.

5. REFERENCES

[1]. VAICUM L., ‚*Biological bases of wastewater treatment’*,1976

[2]. METCALF&EDDY-„*Wastewater Engineering.Treatment and reuse*, fourth edition, McGrawHill, 2003

[3]. LARS D. HYLANDER, AGNIESZKA KIETLIN, GUNNO RENMAN, GYULA SIMA, *Bioresource Technology 97* p.914–921, 2006

[4]. YUQIU WANG , TIANWEI HAN, ZE XU, GUANGQING BAO, TAN ZHU, Journal of Hazardous Materials B121 (2005), 183–186,

[5]. LUZ E. DE-BASHAN, YOAV BASHAN, ‘*Recent advances in removing phosphorus from wastewater and its future use as fertilizer’*, Water Research 38,p. 4222–4246, 2004

[6]. T. BINDU, V.P. SYLAS, M. MAHESH, P.S. RAKESH, E.V. RAMASAMY , Ecological Engineering 33, p.68–82, 2008

[7]. Z. YOUSEFI, A. MOHSENI BANDPEI, ‘*Nitrogen and phosphorus removal from wastewater by subsurface wetlands planted with Iris pseudacorus’*, Ecological Engineering 36, p. 777–782, 2010

[8]. RYUICHI HIROTA, AKIO KURODA, JUNICHI KATO,and HISAO, J*ournal of Bioscience and Bioengineering,* VOL. 109, No. 5, 423–432, 2010

[9]. SR EN 1189 99- (SREN 6878-2005) – Total phosphorus determination[10]. SR ISO 6060-1996 – Chemical oxygen demand determination.

11]. SR EN 1899-1:2003 – Biochemical oxygen demand determination.

[12].SR ISO10523-1997 –pH determination.

STUDIES ON ION EXCHANGER EFFICIENCY IN WASTEWATER PHOSPHORUS REMOVAL

[1]ZAGAN SABINA, [2]MUSAT FLORENTINA

[1]*Constanta Maritime University,* [2]*Technical University of Civil Engineering Bucharest, Romania*

ABSTRACT

This article aims to study the use of ions exchange resins in wastewater phosphorus removal, following the current trend of replacing traditional chemical methods, using ferric salts. In this respect, the paper presents a series of physico-chemical analyzes [1-4] for wastewater samples, passed through ion exchanger resins mini-columns, for wastewater phosphorus removal. Ion exchanger resins in this experiment, are not curently used especially for phosphorus removal, are strong base anion macroporous type I, designed for use as an organic filter (scavanger) for removal of water-soluble complex organic materials of medium to high molecular weight, respectively for nitrate removal, even in the presence of high sulfates concentrations. The obtained data shows that these polymers have the ability to retain in a high proportion, the phosphorus from the wastewater, obtaining a good efficiency of this process.

Keywords: *wastewater, phosphorus, ions exchange, synthetic polymers.*

1. INTRODUCTION

Ions exchange process, in the literature,[6,7] can be defined in several ways:

- ✓ as an unit process, in which certain ion species are displaced from an insoluble ions exchange material, by the ions of other chemical species;
- ✓ is equivalent ions exchange process, between two or more ionized species, located in different phases, of which at least one is an ion exchanger, without the formation of specific types of chemical bounds;
- ✓ is an substitution of an ion bound to an inert matrix with another ion, by releasing ionic bound, and the formation of a new ionic bound, without any significant structural changes;

The ion exchanger – is the phase that contains an electrical change carries, insoluble and osmotically inactive;"osmotically inactive" term, expressing the wearer's ability to migrate from the located stage in another phase;

Ions exchange resins (ions exchange synthetic polymers) – are organic macromolecular products, consisting of a three – dimensional skeleton, that are fixed polar groups capable for ion exchange process, and are characterized by two main structural components:

- ✓ resins suport, which is an organic polymer type, that functional groups are grafted, participating in ions exchange process;
- ✓ the polymeric structure, that provides ion's exchanger mechanical and chemical stability, to the solvatant solution;

So, synthetic organic ions exchange resins, are used in the wastewater treatment process, based on learning of these macromolecular substances to replace ions from the the wastewater to be treated, with other chemical ions entering in the chemical resin composition.

In the Figure 1, is presented a parallel flow ionic exchange column, otherwise a classical one, in ions exchange processes.

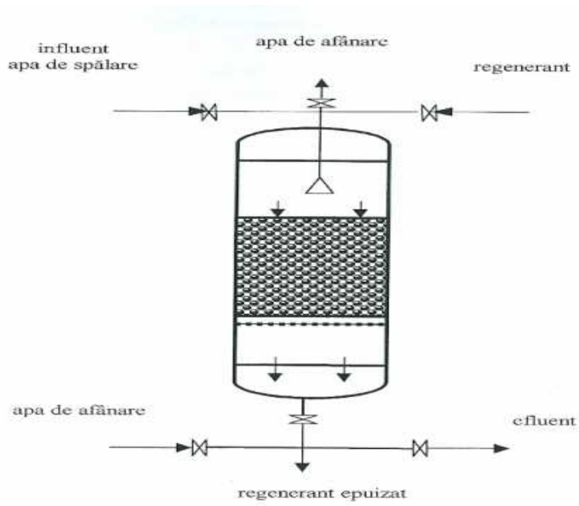


Figure 1 Parallel flow ions exchange column

Disatvantages of fixed bed contacting:

- ✓ low grade of regenerant used, because it is necessary a regeneration solution excess, in order to reduce any possible ions loss, generated by the the ones that are not eluted;
- ✓ operating difficulties;
- ✓ for the fixed bed systems it is recommended high quality resins, with a perfect granulosity, high physical stability, minimum swelling capacity, high resistance in organic substances blocking situation;

Advantages of fixed bed contacting:

- ✓ simple configuration and low cost units;
- ✓ small specific resins volumes and maximum use capacity;

- ✓ the ions exchange capacity of the resins, can be used at closed levels of maximum exchange capacity;
- ✓ more stable conditiones during regeneration process;
- ✓ regeneration yields closed to stoichiometric values;
- ✓ controllable ions losses;

In ions exchange columns, it is necessary the control of liquid flow rate, to ensure adequate contact time, between resin and liquid phase during exhausted cycle, and between resin and regeneration agent, during regeneration process of the resin. The ionic exchange process is made in special in ion exchange columns filled with synthetic resins, and the regeneration process is done when, the resin loses her exchange ion capacity.
The total rate of ion exchange process, is affected by changing flow rate, because of the influence that flow exercises on the following elementary processes:

- ✓ ions diffusion through film liquid on the surface particle area;
- ✓ particle diffusion, with physical-chemical factors;
- ✓ the particle surface area;
- ✓ the ions type presence;
- ✓ pH conditions;

An important physical caracteristic of these synthetic polymers is their porosity and granulosity.

2. EXPERIMENTAL

2.1 Choosing synthetic resins

In order to evaluate the efficiency of using synthetic polymer ion exchangers in wastewater treatment plants, for phosphorus removal, was studied the retention capacity of some synthetic resins, with selectivity by nitrates in drinking water, and respectively by the organic matter in domestic wastewater. The resins used for this purpose, have a common polymer structure polystyrene crosslinked with divinyl-benzene, and as functional group, quaternary ammonium salt, both being strong base anion macroporous resins, studied in literature [8-11].

Most ions exchange resins are obtained by polymer and co-polymer transformations of the styrene with divinyl-benzene (polystyrene crosslinked with divinylbenzene).

The anionic polymerisation resins are obtained by introduction of amino groups in polymer and co-polymer macromolecule structure.

In conventional synthesis, the PS-DVB is chloromethylated and then aminated with various amines. Tertiary amines leads to strong base anion resins: using trimethylamine are obtained type I resins and using dimethylethanolamine, type II resins.

Table 1 The physical-chemical characteristics of the ion exchange resins

Characteristics	Resin 1 A 520 E	Resin 2 A 500 P
Product Description	strong base type I anionic exchange resin, macroporous ;	strong base type I anionic exchange resin, macroporous (using trimethylamine)
Functionality	Nitrate removal from the drinking water, even in the presence of high sulfate concentrations ;	Designed as an „scavenger” filter for removal of organic matter with medium and high molecular weight, from domestic wastewater;
Pore volume	0.404 ml/g	0.805 ml/g
Polymeric mattrix	PS crosslinked with DVB	PS crosslinked with DVB
Functional Groups	$(-N(CH_3)_3{}^+)$	$R-N^+(CH_3)_3$
Ionic form	Opaque Spherical Beads	Opaque spherical beads
Ionic form, as shipped	Cl^-	Cl^-
Bed size range	0.3-1.2 mm	0.3-1.2 mm
Total exchange capacity	0.9 mval/ml	0.8 mval/ml
Maximum operational temperature	100^oC-form Cl^-	60 ^0C (form OH^-)–100^oC(form Cl^-)
Operational pH domain	4.5-8.5	0-14
Regeneration resin	regeneration with a couple of bed volumes of 2BV NaCl 3-10% concentration, with 20-60 min contact time, followed by 4 BV volumes of drinking water for washing operation	regeneration with a couple of bed volumes of 4BV NaCl 10% and NaOH 1-2% concentration, with 40-60 min contact time, followed by 8-16 BV volumes of drinking water for washing operation
Life operational	5-7 years	5-7 years
Annual physical and chemical losts	3-5%	3-5%

2.2 Mini ion exchange columns equipment

The equipment used in circulation and re-circulation of wastewater consists in 3 mini-ion exchange columns, Winzer type (Hirschmann, Germany glass), by 2 cm diameter and height of 10 cm, as seen in Figure 2.

Figure 2 Mini exchange ion columns

For choosing the best ion exchange resin type, for later use, the experiments were made on three mini ion exchange columns of 2 cm diamter and 10 cm height. The 3 columns was placed on a stand, fixed with clamps, and filled with type I and II resin, and high granulosity sand. These columns were filled with 5 cm of filtering material, meaning 30gr of resin/each ion exchange column. The two resin types were placed in a three mini ion echange columns, and in the fourth one, the sand was used as a filtering material.

To highlight the phosphorus retention capacity on the two ion exchange resin types, were initially used in proportion of 1:1:

✓ 2 synthetic solutions of potassium phosphate (K_3PO_4), of concentration 1.7112 mg/L(sample 1), respectively 2.0452 mg/L(sample 2);

✓ 3 wastewater samples from secondary clarifier of Constanta Nord wastewater treatment plant, characterized by different concentrations of total phosphorus, namely: 0.6625 mg/L (sample 3), 0.5863 mg/L (sample 4) and 0.8875 mg/L(sample 5);

✓ note that the 5 times recirculation of the last sample, was made based on new ion exchange resin;(not used the exhausted resin);

The 4th samples were recirculated in the ion exchange resin mini-columns, by 5 times, after each time, the adsorbtion of total phosphorus content being analyzed.

The laboratory analyzes were done in wastewater quality laboratoires Constanta South and Constanta North, of S.C.RAJA S.A.

For the determination of lab chemical analyzis, an Jenway Spectrophotometer was used, 6715 sries (λ = 190-1100 nm), wavelenght of reading total phosphorus concentration being 880nm. For Ph analysis, an WTW Series InoLab 730 was used. For COD analysis (chemical oxygen demand), especially total phosphorus, an ECO6, VelpScientifica thermoreactor was used, where is quantitative assesment of the substances that can be oxidized with oxidants. For MTS (Total solids in suspension, was used an GallenKamp Oven type OHG050 blue band filter paper, type MUNKTELL.All glassware used was from Hirschmann Germany, and chemical reagents, from Mrck Germany, Scharlau and Poch.

2. RESULTS AND DISCUSSIONS

In the first run, 40 mL of synthetic potassium solution was used in each column (sample 1,2) and another 40mL of wastewater from the secondary clarifying tank (sample 3,4,5). The total phosphorus concentrations, obtained after the 5 samples passed through, are presented in Table 2.

Table 2 Total phosphorus content using synthetic solution/wastewater

Sample, mL	[P total] initial mg/L	Number of recirculation	[P total] mg/L , Out from column with resin 1	[P total] mg/L, Out of column with resin 2
Sample 1	1.7112	I	0.0129	0.0165
		II	0.0152	0.0211
		III	0.0215	0.0217
		IV	0.0216	0.0238
		V	0.0218	0.0256
Sample 2	2.0452	I	0.0634	0.0721
		II	0.0712	0.0756
		III	0.0732	0.0763
		IV	0.0832	0.0783
		V	0.0866	0.0832
Sample 3	0.6625	I	0.3500	0.1501
		II	0.3752	0.1522
		III	0.4000	0.1823
		IV	0.4256	0.1864
		V	0.4365	0.1896
Sample 4	0.5863	I	0.3266	0.1433
		II	0.3299	0.1485
		III	0.4002	0.1523
		IV	0.4269	0.1766
		V	0.4278	0.1796
Changed resin				
Sample 5	0.8875	I	0.3001	0.0175
		II	0.3258	0.0250
		III	0.3269	0.0453
		IV	0.3373	0.0750
		V	0.3374	0.0796

Following the results, we can observe [12,13], in the figure 3, some things about nutrients, and the total content of potassium in the soil:

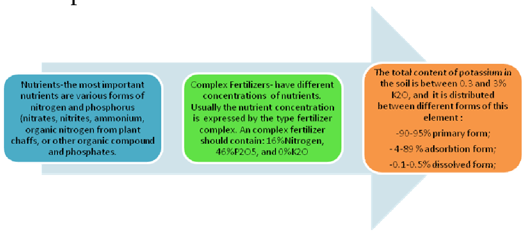


Figure 3 Contain of an complex fertilizer

- ✓ Initially, for the 1 and 2 samples, as noted above, synthetic solution were prepared to be passed later through the 2 resins.Even that the number 1 resin (A520E), has higher selectivity for removal nitrates from drinking water, it is observed mainly the retention on the resin of primary form of total potassium wastewater content, reflecting the sensitivity of the resin in relation to water quality contact;
- ✓ with increasing number of water recirculation in resin, the concentration of total phosphorus is normal to grow, as an input equalization of in and out values, leading to depletion of resin,thus the need for it to be regenerated;
- ✓ regarding the obtained result of the recirculation of synthetic solutions (1 and 2) in the resin type II (A500P), though has the same matrix polymer as the type I resin, it decreases its sensitivity in relation to wastewater contact, having major pore granulation, selectivity and resistance ratio also increased. The preference for various organic substances with high and medium molecular weight, put it in second place in relation with A520E resin, in terms of kinetics of ion exchange and retention of anions of weak/strong acids on the surface area;
- ✓ for 3 and 4 samples, we see a reversal of initial situation, namely: when resin 1 comes in contact with clarifying tank wastewater, due to the complexity of the micro/macro-elements from wastewater, it is observed that phosphorus content is retained to a lesser extent by it; explanation could be besides small granulation, also its selectivity by retaining the nitrates from drinking water;
- ✓ organic substances from wastewater, are retained with 70-80% efficiency for resin type 2, going even up to 92%, for the 5th sample, on the same type of resin;
- ✓ for the sample number 5, was experienced change of the resin, to avoid additional influences of phosphate ion, as a source of initially prepared synthetic solutions ;
- ✓ for all analyzed samples, there was a normal cycle growth of the total phosphorus concentration in effluent, this leading to a depletion of the resin, finally being necessary the regeneration process;
- ✓ when resins are „exhausted”, they are full of nitrates (NO_3^-), while the content of chloride ions (Cl^-), needed instead is poor. This leads to the need of resin regeneration. The regeneration process is restoring load of chloride ions (Cl^-) of anionic mass; they are in sodium chloride (NaCl), named also kitchen salt. During regeneration process, occurs reverse exchange between chloride ions (Cl^-) and nitrat ions (NO_3^-), which are subsequently removed by draining. Due to the fact that the pH of the quaternary ammonium salt is arround 11.5, the filtered water has a basic character, with a pH value of 10.2, respectively 8.36.
- ✓ the obtained values, where for a constant inlet flow rate of the resin with synthetic solution and wastewater, not interferring other factors, that normally occurs in a wastewater treatment plant;
- ✓ the total phosphorus concentration for the two mini-columns filled with the 2 resins, has an inverse trend in favor of resin number 2, for the clarifying tank wastewater, an important observation being that eliminating the additional influence of certain ions existing in synthetic solution (by changing the resin), the phosphorus retention efficiency goes up to 100%, in first phase of the depletion resin cycle;

3. CONCLUSIONS

To asses the overall ion exchange capacity of two resins, Table 3 shows the average values of phosphorus concentration, obtained for each sample each of.

Table 3 Average values of the total phosphorus content for the two synthetic resins

Sample	[TotalP] initially, mg/L	[Total P] mg/L , resin 1 (A520E)	[Total P] mg/L, resin 2 (A500P)
Sample 1	1.7112	0.0186	0.0217
Sample 2	2.0452	0.0755	0.0771
Sample 3	0.6625	0.3344	0.1721
Sample 4	0.5863	0.3822	0.1600
Sample 5	0.8875	0.3255	0.0484

The values from the table 3 are represented in figure 4:

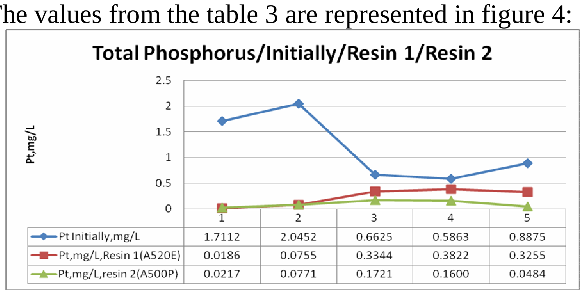


Figure 4 Total phosphorus initially concentration

From the above chart we can see:

- for the 1 and 2 synthetic solution samples, the total phosphorus concentration from the effluent, for both resins are very close, for the 3 and 4 samples, the situation changes;
- the phosphorus concentration value for the sample 4, corresponding to resin number 2, is almost half of value obtained in resin 1 case;
- at sample 5, when interferences where eliminated by changing the resin, the effluent phosphorus concentration form the resin 2, is 6th part of the effluent from resin1, so the best adsorbtion was in resin number 2(A500P);

In the chart below (figure 5), are the retained phosphorus efficiency, for the two types of used resins:

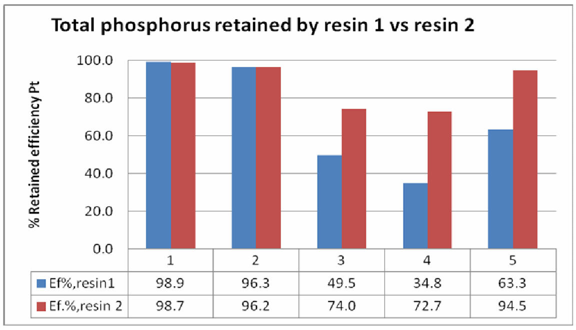


Figure 5 Total phoshorus retained by resin 1 vs resin 2

From the chart above:

- there are no interferences from some unidentified chemical compouds, for samples 1 and 2, so that the retained total phosphorus efficiency for both resin types is approximately equal to 97%, by average;
- for the 3,4,5 samples resin 2 has an upward trend as phosphorus retention efficiency, reaching for clarifying tank wastewater, even up to 94.5%;
- also observed a slight increase of the resin 1 efficiency, in retaining phopshorus, but this will lead to a more rapid depletion of the resin, due to high sensitivity and low selectivity, for certain chemical compounds;

Folowing this experimental study, was observed that the resin 2 (A500P), has the best efficiency in retention of phosphorus from wastewater.This experiment has been study in tle laboratory, and the question is: can the resin give the same yield at macro level, in a real wastewater treatment plant. Of course, you have to take into account also the cost analysis because , the ion exchange process, besides requiring ion exchange resins, also need ion exchange columns.

4. REFERENCES

[1]SR ISO 10523-1997, Determination of pH;
[2] STAS 6953-81, Determination total solids in suspension;
[3] SR ISO 6060-1996, Determination of chemical oxygen demand;
[4] SR EN 6878-2005, Determination of total phosphorus;
[5]SR EN 1899-1:2003, Determination of biochemical oxygen demand;
[6]Macoveanu M., Bilba D., Bilba N.,Ion exchange processes in environmental protection", Series „Environment engineering and chemical", Matrix Rom Bucuresti, 2002;
[7] „Wastewater treatment processess"-Diana Robescu, Niculae Robescu, Ed.Tehnica,2011;
[8]„Anorganic chemistry",Vol.II, Negoiu D., Ed.Tehnica, 1972;
[9] www.revistadechimie.ro
[10] Lin W.,Hsieh Y.L.,J.Polym.Sci:Polymer Chemistry,35,631,(1997);
[11]www.hydrop.pub.ro
[12] www.agricultura-www.usamvcluj.ro
[13] www.biotehnologia.ro

SECTION V
ENGLISH FOR SPECIFIC PURPOSES

ENGLISH AS A PRE-CONDITION FOR INTERNATIONAL STUDENT MOBILITIES? EILC as an alternative.

NEN MADLENA

Military Technical Academy of Bucharest, Bucharest, Romania

ABSTRACT

Every year, host universities participating in Erasmus programme organize Erasmus Intensive Language Courses in order to help incoming students to interact with the other students and to integrate into the academic life. The language courses were designed to help students communicate in everyday life, to understand the language used by the media, to perform academic activities and to develop cultural awareness. On top of presumably universal English language, EILC greatly facilitates students' access on the labor market, in an increasingly globalized world based upon multi-culture.

Keywords: *Erasmus students, human resources, inter-culturality, linguistic barriers.*

1. INTRODUCTION

The Erasmus Programme was addressed to higher education area and targeted specifically at mobility activities of the students and teachers. Among the most notable outcomes of the programme we can cite an improvement of the transparency and of the recognition of qualifications, throughout strongly stimulating the cross European cooperation in the higher education sector.

The number of international mobilities, especially in the framework of the Erasmus programme, has increased constantly during the last years.

This can be looked at as a proof of the growing interest for the European programmes in the field of education. As a result, the number of good practices examples has increased, while new contacts and bilateral agreements were established. One specific aspect emerged from the evaluation feedback of the beneficiaries as presenting particular importance, and that is the improvement of the linguistic competences in the perspective of internationalisation.

Still, English is the most popular language for students. It is known that most of the courses in the host universities are taught in English. However, in some universities there are a lot of faculties or departments where the courses are delivered in other European languages such as Spanish, German, Italian, French languages, especially for incoming students. Some host universities are also organising intensive language courses for the less spoken languages. The courses funding may be sustained through their own budget, or from the organizational mobility budget (OM), that is meant to facilitate the integration of foreign students.

The impact of language competences improvement may be noticed in the area of academic performance, but also throughout various aspects of social life. For the students participating in the mobilities scheme new skills - in both the academic and network sense - were acquired. Promoting equity, social cohesion and active citizenship; enhancing creativity and innovation - entrepreneurship included, at all levels of education and training, were goals that the mobility experience allowed.

1.1 International mobility of students. Romania facts.

It was noticed that Romanian universities have managed to achieve, relatively quickly, effective ways to materialize international cooperation, among which we can cite:

- cross-border exchange of students between the various institutions of higher education, for short study visits or for practical activities, carried out on the basis of bilateral agreements;
- international mobility of students based upon institutional agreements or on affiliation to various networks of universities, recognizing the periods of studies, through the use of systems of compatible and transferable credits;
- departments involvement of some universities in Romania or teachers in the provision of transnational higher education, including joint programs of training, typical programs for virtual universities and other types of institutions that practice e-learning, etc.
- exchange of teaching staff in the field of education and research, covering an existing need in this field at the host university, new supports for learning, new technologies for learning teaching, etc.;
- establishment of programs for granting academic titles in common (joint degrees) on the basis of an agreement between an university in Romania and an university abroad, in accordance with the rules existing in each of the participant countries.

Since 1991, in the framework of Tempus Programme, exchange programs for students and teachers have been established between Romanian universities and their counterparts from EU countries.

Some of Romanian universities offer, since the academic year 1990/1991, complete study programs in international languages, such as English, French and German languages, on top of the regular education carried out in the Romanian language.

Educational staff and support material for learning have been prepared with technical assistance from the partner universities in the UK, France or Germany and with financial support from the Tempus Programme.

In continuation of the Tempus Programme and supplementing it, Socrates and LLP Programme continued the development of international relations between European universities. The new Erasmus+ programme, starting with 2014 will extend the cooperation with some 150 partnerships outside Europe.

The new tool for linguistics competences is expected to be implemented. At the end, the impact of the Erasmus + programme will be evaluated and will be evaluated as a proof of the benefits of the international mobility component.

The evaluation of the universities in Romania, meant to produce a national ranking, was carried out for the first time in recent years in 2011, with the aim to support the HEIs in their continuous effort of developing their strategic management and a solid internal quality assurance culture, including the criteria of the volume of Erasmus mobility. This criterion was maintained over 2012 and, as a result, the Erasmus mobility represents a priority for the Romanian HEIs, as they are considered as instruments for supporting the internationalization process and a contribution to creating the EHEA. The policies in the field of higher education, as foreseen by the new Education law in act since 2013, position the internationalization in the role of the corner stone of the reform process, thus we anticipate that Erasmus and especially the new programme Erasmus+ will be strongly, positively impacted.

On the other hand, some risks occurred and could affect negatively the implementation of the Erasmus programme in the years to come.

The root causes of the above mentioned risks were identified to a great extent: first, over the last 3-4 years a clear decreasing trend has been noticed in the overall number of students to enrol in the Romanian HEIs. The reasons can be traced back to the demographic decline but also the success rate at the graduation of Baccalaureate examination in 2011 and 2012 which was lower as compared to the previous years (around 50%). Consequently, the smaller number of students led to a narrower selection base of the prospective Erasmus students.

However, Erasmus can be considered without a doubt an important instrument in modernizing the HEIs, wherever it was implemented. It is worth noticing its crucial role in introducing modules and/or courses taught in other languages in the universities' curricula, based upon the experience the teaching staff developed during their Erasmus mobility stages in European universities and contributing to an "internationalisation at home" - beneficial for Romanian students who do not apply for a mobility, but also important for attracting incoming students from abroad, whose number is continuously increasing. Therefore, if not at central policy level as such, the programme affects positively the development strategies of all the HEIs, in a convergent approach, i.e. towards their involvement in the creation of the EHEA.

Students who benefit from the Erasmus teaching mobility come back home with a different mentality and with an enriched portfolio of teaching methods. Their new experiences support the improvement of the quality of the curricula and has a lot other beneficial effects, among which we can cite: a change of attitude towards new experiences, an increased flexibility, enhancement of the relations with the students, personal/professional development, improvement of the teaching content and methods, renewed courses or introduction of new ones, improved networking skills for further collaborations and comparing teaching methodology with colleagues from similar compartments, followed by implementing good practices.

Beneficial changes brought by teachers' Erasmus experiences are also reflected in the students' attitude and behaviour. They are more confident, more active and open to other international mobility opportunities. The beneficiaries of the Erasmus mobility grants are real Erasmus "ambassadors"; they are actively involved in many programme promotion activities, that can help the prospective Erasmus students with information, first-hand impressions and advice.

As far as the Erasmus students are concerned, besides the immediate positive perceptions, the real impact of the mobility could be evaluated in the long run by following their educational and professional pathways, and in this respect we expect the HEIs to take more actions in the future in order to ensure a proper follow-up.

Last, but not least, Erasmus programme was the main factor that contributed to the internationalization of the HEIs in Romania, throughout largely opening, since 1997, the gates of the process started by Tempus programme; it also contributed to a fully implementation of the Bologna process.

2. EILC IN ROMANIA

2.1. General information

There were 7 universities that applied for organising EILC courses in the academic year 2011 – 2012, two more than what was planned in the working programme and an increase with two compared to the previous academic year, 2010 – 2011.

Even if the total number of the selected courses was fourteen, actually only 13 courses were financed (one university announced just before signing the contract that it would not be able to organise the total number of courses planned due to the very low number of students applying for autumn classes).

In the academic year 2011 – 2012, the number of courses and the number of participants to these courses was the same as in 2010 – 2011.

Over the last 3 years, the evolution of the number of courses and participants was as it follows:
- 2009-2010: 12 courses and 167 participants;
- 2010-2011: 13 courses and 188 participants;
- 2011-2012: 13 courses and 188 participants.

The lower number of participants (188) compared to the total number of participants proposed in the applications (195) is due to the fact that some students gave up the courses, not to mention that the students from Turkey sent the documents for obtaining the visas very late, which made impossible for them to arrive in Romania in due time to take part in the EILC courses.

2.2. Selection of students

The role of universities in the selection of students was rather an informative one, in the sense that the universities provided them all the necessary details regarding the structure of the courses, extracurricular activities, cultural programmes but did not impose any conditions regarding their knowledge of Romanian language and culture. The only condition was to be interested into learning about Romanian language and culture, and to fill in an application form with personal information and a letter of intent.

The representatives from the ERASMUS Student Network – ESN - presented the cultural and social activities programmed for the participants and distributed brochures and presentation flyers to the participants.

Each Thursday evening, ESN UniBuc organized for the EILC participants thematic parties:

- “ESN Your favorite Romanian phrase”: the students were invited to share what they have learned during the Romanian EILC and come to the party with their favourite phrase in Romanian written on them (on their faces, arms or on their T-shirts) so that everyone can see it,
- Karaoke party: students sang songs in Romanian and in their national language; they took part in a Romanian Song Contest, where the best performance was awarded a special prize (no duets were allowed for the contest and the song had to have only Romanian lyrics).

The ESN UniBuc extra-curricular activities ended with a Graduation Party on the last day of the course.

The students received the volume "Limba Română ca limbă străină – dosare pedagogice" and guides of Bucharest and Romania. During their stay, the students were assisted by EU Programmes Office (ERASMUS) of the university

2.3 Assessment of student’s performance and awarding of ECTS credits (or lack of it)

The universities offer them 5 or 6 ECTS credits, as well as grades,on the base of a continuous assessment and a final exam (oral and written) which consists of: grammar and vocabulary exercises, applying Romanian in daily life situations (at the restaurant, at the airport, visiting cultural sights etc.), speaking about themselves and the others, presenting their cultures and their countries, expressing their opinion on Romania, Romanian-ness and their experience as Erasmus.

The EILC students expressed their initial interest in the cultural programme out of usual curiosity. However, during the course itself, their interest has raised by the teachers’ academic proficiency and the learning experience; in the end, the unanimous appreciation was the new cultural - spiritual information has been received and acquired in an adequate style.

Students’ performance has been constantly assessed, along the entire period of courses – through oral and written examinations, midterm test, home assignments - and at the end of the course students took a written and an oral exam. At the end of the course, after the final test paper, each participant was given an official certificate, that certified their attendance and granted them 5 or 6 ECTS credits for the language course.

2.4 Main difficulties met by the participants in the language courses

The participants were very satisfied with the activities undertaken. The feedback was based upon everyday interaction and feedback throughout the course and at the end of the programme. The host universities adjusted the courses to their interests and suggestions on what they considered it was useful for them to know about the local language and culture.

Some students were not quite satisfied with the short duration of the course, they said they would have needed more time to better learn Romanian, given the difficulties of the language.

Some students drew out attention that some of their colleagues could not participate in the autumn EILC session and they would have wanted to participate in a winter course, as long as their ERASMUS mobility was planned for the second semester.

2.5 The impact of the EILC on the participants

The unanimous opinion, as expressed by the host universities, was the course had a major impact.

The first argument in favour of that appreciation was the fact that all the students were capable, at the end of the courses, to communicate in basic Romanian language in usual, day-to-day situations.

The second argument was that the all the students participated in extracurricular activities the host universities offered, even though the attendance was not compulsory. The interest was high for visiting museums, join cultural trips or attend multi-cultural festivals.

2.6 Relevance

The action had major relevance for the universities as organising institutions, as part of their main strategies is internationalisation. In this respect, the organizing universities became visible among the European university system, by trying to find means to establish connections and offering new courses and learning programmes.

Secondly, the teachers involved in organising the EIL Courses developed new teaching skills, new materials for future courses and, to a personal dimension, established new connections with the participants, which would hopefully become ambassadors of the organizing universities.

Last but not least, the students who were direct beneficiaries of EILC have reached their personal goals as stated in their application forms: to learn Romanian and to find things about the host country. Moreover, they established connections between them and got to know each other’s cultures. The group became extremely united within a month also due to the courses, everyday interaction, cultural events and leisure activities.

2.7 Examples of success stories and best practices.

Some types of best practices have evaluated different aspects of the programme: the educational aspect, the socio-cultural aspect and the one targeting the international universities' branding.

An extremely interesting aspect pointed to the participants to the courses connecting not only to Romanian language and culture, but also to each other's culture. They had the opportunity to present themselves during the extracurricular activities that were organized, among which we can mention the international food evening, traditional events, Romanian evening or the Thursday afternoon movie. Teachers who were involved in the programme also became students in their own turn, by learning about different cultures and by also practicing their abilities in other languages. The entire programme was, in fact, an intercultural one, Romania was not the only Belle of the ball, but all the participating countries were Belles in their own.

Students became ambassadors of their universities by taking part in EILC courses.

For example, West University of Timisoara stipulated that one of the EILC student returned to Timisoara as a volunteer for the next year's course. Moreover, this student has persuaded twelve other students to come not only to Romania for their Erasmus experience, but especially to West University of Timisoara for the EILC. This is, in their opinion, an informal way of branding and advertising, and a non-institutional way - but very efficient - because it is based on student to student relation, and it is even more functional than if it would be based upon an Erasmus coordinator to student relation, which is rather authoritative. They consider that strengthening and extending this kind of relations will ensure not only an intercultural and inter-linguistic awareness, but will also stimulate a better mobility of students.

Another EILC host university is University of Bucharest.

There were EILC participants who remained to study in the University of Bucharest after the end of EILC, to continue learning Romanian at the Romanian course for advanced level, which eventually allowed them to understand written articles from newspapers and magazines, which represent a different aspect of the Romanian language. When they come to the university office, after the EILC, even if the persons from the international office start talking to them in their own language, they say that they want to speak to them in Romanian, and they answered back in Romanian as well.

We can conclude that the organization of EILC courses were very useful not only for students and teachers but also for the host universities.

The overall effects and impact will only be validated in time, but we believe it is obvious at this time that one of the most important achievements so far of the European programmes through EILC courses is the improvement of linguistics competences, doubled by personal and professional development.

3. CONCLUSIONS

Host universities participating in Erasmus programme organize Erasmus Intensive Language Courses in order to help incoming students to interact with the other students and to integrate into the academic life.

It is known that most of the courses in the host universities are taught in English.

An EILC experience as a part of an Erasmus mobility experience is crucial in our point of view, from both the perspective of carrier evolution and from that of personal development.

4. REFERENCES

[1] PERCEC D, ERA EILC grant agreement - organising institution final report form, Bucharest, 2012
[2] CRISTOVICI A, ERA EILC grant agreement - organising institution final report form, Bucharest, 2012
[3] MUNTEANU V, ERA EILC grant agreement - organising institution final report form, Bucharest, 2012
[4] Yearly National Agency Report - 2012 - RO1

SECTION VI
TRANSPORT ECONOMICS

IMPLICATIONS OF THE BILL OF LADING USAGE IN THE PROCESS OF GOODS TRANSPORTATION BY SEA

ADASCALITEI OANA

Constanta Maritime University, Romania

ABSTRACT

The article proposes an analysis of the most important document in the commercial transport of goods by sea i.e. the bill of lading. The multiple functions performed by this document are represented as follows: the bill of lading is a receipt for the goods delivered, it is the clear evidence regarding the terms covered by the contract of carriage and it is a document of title. By means of its functions, one obtains the analysis of the relationships between shipper/charterer-carrier-consignee and in some cases, endorsee, types of bill of lading and their probative value, the relationship between charter contract and the bill of lading and finally, the conditions to be met so that the bill should be considered a document of title.

Keywords: *bill of lading; receipt; evidence; document of title; contract of carriage;*

1. INTRODUCTION

The Bill of Lading is the most important document in the commercial transport of goods by sea [1]. The Bill of Lading plays an essential role in performing the contract of transport. A person wishing to ship a consignment of goods addresses a shipping company directly or more often via a forwarding agent of goods for booking the space on a ship [2]. He gets instructions from the carrier regarding the place and the time of delivery of the goods and in doing so, he is handed a receipt indicating the type and quantity of the goods delivered and the condition in which they were received by the carrier’s agent [2]. Since that moment, the carrier normally has control of goods and is responsible for loading them aboard [2]. Meanwhile, the shipper will obtain a copy of the carrier’s bill of lading form in which he will enter details regarding the type and quantity of the goods shipped together with any relevant marks and will specify the port of destination and the name of the consignee [2].

On this document, the carrier’s agent will check the details concerning the goods by comparison with the copy at the moment of loading and if correct, he will acknowledge them [2]. After calculating the freight and entering it on the bill of lading, the master or his agent will sign the bill and release it to the shipper in return for the delivery of mates receipt (or his equivalent) and for the payment of advance freight when it is due [2]. Then, the shipper is free to dispatch the bill to the consignee or to a bank if the shipment represents the part of an international sales transaction involving documentary credit [2]. In any of the cases, the consignee may decide to sell the goods in transit, case in which he can endorse goods in favour of the purchaser. Eventually, the last consignee or endorsee of the bill will tender it at the port of discharge in return for the goods delivery [2]. The fact that the bills are being issued in multiple original sets increases the possibility of fraud. The carrier is only under the obligation to deliver the goods to the person who presents the bill and not to verify to what extent this person is the legal holder of the document. For this reason, the international banking rules require that goods are to be delivered only in return for the presentation of the whole set of bills of lading [3].

2. THE FUNCTIONS OF THE BILL OF LADING

Currently, there is no established definition of a bill of lading in the common law, nor existing legislation on bill of lading or carriage conditions in which the bill is used [4]. His essence is made up of multiple functions performed by it: the bill of lading is a receipt for the goods delivered; it is the clear evidence regarding the terms covered by the contract of carriage and it is a document of title [4]. To the three basic functions, the specialized literature adds the function of potentially transferable contract of carriage [5].

2.1 The Function of Receipt for the Shipped Goods

The bills of lading contain information on the nature, quantity and condition of the shipped goods. The consignor/shipper may demand the issuance of a bill of lading showing among other things the leading marks, the number, the quantity, the weight, as well as the apparent order and condition of the goods [6]. The carrier is not under an obligation to issue a bill of lading containing these specifications unless it is expressly requested by the consignor and even under these circumstances he can refuse it if he has seriously reasons to believe that the supplied information is not accurate or he does not have the possibility to check it [2]. In this situation, he may issue a special bill of lading by entering the phrase “said to contain” [7].

It is crucial for the shipper to obtain a clean bill of lading, absolute necessary for the documentary sale but the carrier is not under the obligation to issue an incorrect bill [7]. Due to the complications that would arise while checking the goods before shipment, this procedure takes place quite rarely, leaving the consignee and the endorsee unprotected by *Hague-Visby* Rules [7].

Frequently, the shipper and the carrier agree on issuing a clean bill of lading in return of the guarantee of compensation for all losses the carrier may suffer as a consequence of a subsequent action of the consignee or the endorsee [7]. Even though, such agreements are void if the carrier makes a statement he knows as false and the shipper and the carrier act to defraud the bank or the consignee [7].

The bill of lading is *prima facie* evidence of the receipt by the carrier of the goods as described, although proof to the contrary shall not be admissible when the bill of lading has been transferred to a third party acting in good faith [6]. For this reason, carriers try to include in the bill of lading as few details as possible [7]. In the age of containerized cargo, carriers have very few options to make judgments of the external observable condition of the goods. In these situations, the statements only refer to the container and prove to be of limited value for the consignee [7].

In many of the cases, the need to avoid statements about the quantity led to the inclusion of the phrases "quantity and weight unknown" or container "said to contain" [8].When such phrases are used the bill does not contain statements on the goods and has no evidentiary value in this sense [8].

Article 8 of the *Haga-Visby Rules* stresses that "any clause, covenant, or agreement in a contract of carriage relieving the carrier or the ship from liability for loss or damage to, or in connection with, goods arising from negligence, fault, or failure in the duties and obligations provided in this article or lessening such liability otherwise than as provided in these Rules, shall be null and void and of no effect".

In Mata K case it was held that the operation of Article 8 of the *Haga-Visby* Rules is limited to contractual provisions which remove or reduce the liability of the carrier failing to fulfil his obligations under Article 3 (1) and (2) [2]. The inclusion of the provision "weight unknown" has not the effect of relieving the carrier of such liability or lessening it and means only that the provisions of Article 3 (4) are not applicable [2]. It's not the most desirable conclusion because it is inconsistent with the object of the Article 3 (3) [2].

In the opinion of some authors, the bill should contain a clause to the effect that statements as to the quantity and condition of shipped goods must be conclusive evidence of the facts stated as against the shipper and then no other evidence will be admissible to contradict such statements even where a claim has been brought by the consignor and even though the consignor can prove that the goods have not been loaded [2]. Such clauses are rarely used at the moment [2].

2.2 The Function of Evidence of the Contract of Carriage

As it was established in consecrated cases, *Crooks vs. Allan* (1879), *Sewell vs. Burdick* (1884) or *The Ardennes* (1951), the bill of lading is not a contract of carriage but it is an excellent proof of its existence [2].The contract is normally concluded orally long before the bill of lading is issued and its terms are inferred from the announcements of the carrier about navigation and from negotiations with loading brokers before the goods are shipped [2].

Where the terms of the bill of lading do not reflect the terms agreed orally, evidence as to the agreement orally concluded may be submitted by the shipper [4]. External evidences are admissible to contradict not only the terms of the bill of lading but even the terms of the sea waybills and delivery orders [9].

Between the carrier and the third endorsees, the bill of lading may constitute a contract of carriage and not mere evidence of its existence [9]. Indeed, once endorsed for value to a third party acting in good faith, the bill of lading becomes conclusive evidence of the terms of the contract of carriage [2].

Where the consignor of the goods is also the ship charterer, the master will issue the bill of lading [2]. In such cases the bill will operate mere as a receipt for the shipped goods and will not function as evidence of the contract of carriage. The terms of the contract of carriage between the ship owner and the charterer are to be found exclusively in the charter party [2].

In cases where the bill of lading conflicts with the terms of the charter party, the later will prevail [9]. If the charterer will subsequently endorse the bill to a bona fides purchaser, the bill of lading will be conclusive evidence of the contract of carriage so far the endorsee is concerned [2]. The terms of the bill of lading shall prevail over the charter except to the extent that the terms of the charter are actually incorporated by reference into the bill of lading [9].

In German law, the bill of lading is a document that evidences the contract of carriage. In the absence of other indications such as a detailed contract of carriage it is presumed that the bill of lading sets fully and accurately the terms of the contract [7]. In German law it is established the fact that while between the shipper and the carrier contractual provisions of the contract of carriage remain determinative even if a bill of lading is issued, the relationship between the carrier and third party (consignee) is governed by the terms of the bill of lading [7].

2.3 The Function of Document of Title (Negotiable Instrument)

As document of title, the bill of lading was not subject to international conventions until the *Rotterdam Rules* [7]. Furthermore, there is not a universally accepted definition of a document of title not even in national legislations. There, where the statutes refer to a document of title, the expression is used inconsistently depending on the specific purpose of the respective statute [7]. In reality, this function came from the impossibility of the merchants to deliver merchandise – due to long periods of time – which triggered the custom to treat bill as a symbol for the cargo [4].

Since *Lickbarrow vs. Mason* case in 1791 the courts has acknowledged the custom of merchants that the endorsing of the bill of lading transfers not only possessory rights but also the ownership of goods if this was the intention of the parties at the moment of the endorsing the bill [5]. Nevertheless, not every bill of lading will be document of title [2]. A bill will only operate in such quality only if it is drafted as a order bill i.e. a bill under which the carrier agrees to deliver the cargo at their destination to a named consignee or "to his order" or "assigns" [2].

Where the bill of lading contains provisions only for the delivery to a named consignee, it is known as a straight bill or a sea waybill and it lacks the negotiable quality required to qualify it a document of title [2]. The jurisprudence has established that fact completely in the cases of *Lickbarrow v. Mason* (1793), *The Rafaela S.* [2002] and *The Chitral* [2000] [10].

In Rafaela S. the arbitrators decided that "the document of title was the antithesis of a document which could evidence the title of only one person; it was general not specific to one person; it was a document by which goods could be transferred by endorsement and delivery of the document itself; a straight consigned bill was not such a document".[11]

A different opinion was held later on the same case with the following argumentation: "Whatever the history of the phrase in English common or statutory law may be, I see no reason why a document which has to be produced to obtain possession of the goods should not be regarded, in an international convention, as a document of title. It is so regarded by the courts of France, Holland and Singapore.

Is it a 'similar' document of title? If I am right to consider that negotiability is not a necessary requirement of a 'bill of lading' within the meaning of the Rules, then plainly it is. But I also think that the good sense of regarding a straight bill whose production is required for delivery of the goods as a document of title in turn supports the answer to the prior question of whether a straight bill is a 'bill of lading'".[12]

The jurisprudence has in fact established that straight bills of lading are negotiable instruments *only for the purpose of Haga Visby Rules*, not in common law [3;13].

Another question raised in connection with the previous is whether a straight bill of lading must be produced in order to obtain delivery if such a document is a document of title. In jurisprudence was decided: ".... It would seem that *Peer Voss v APL Co Pte Ltd* [2002] 2 Lloyd's Rep 707, Singapore Court of Appeal, concluded that it was (at any rate if it is issued in traditional form in three originals).That was also the view of the Law Commission. It is unnecessary to decide the point, but in my judgment it is. It seems to me to be undesirable to have a different rule for different kinds of bills of lading – which I think was the view of Butt J in The Stettin as well. It is true, as Benjamin states, that in the case of a negotiable bill the carrier needs to have the bill produced in order to be able to police the question of who is entitled to delivery. Yet an analogous problem arises with a straight bill. A shipper needs the carrier to assist him in policing his security in the retention of the bill. He is entitled to redirect the consignment on notice to the carrier, and, although notice is required, a rule of production of the bill is the only safe way, for the carrier as well as the shipper, to police such new instructions. In any event, if proof of identity is necessary, as in practice it is, what is wrong with the bill itself as a leading form of proof? That is of course an inconvenient rule where the carriage is very short, as in cross-Channel shipments, and that is why sea waybills are used in such trades. But it is clear that straight bills are used in intercontinental carriage and therefore the inconvenience argument fades" [12].

The vast majority of the juridical opinion favours the view that the consignee named in a straight bill of lading is entitled to delivery of the goods only on the production or presentation of the bill to the carrier [13].The requirement is based on an express or implied term in the bill to that effect [13].

Such a straight bill of lading is not desirable as security for commercial credit and nor can the holder of the bill transfer a good title whilst goods are in transit [2]. By contrast an order bill is a transferable document while a spent bill is not. [13] Likewise, a bearer bill of lading is a negotiable document that can be transferred from one party to another by mere delivery of the document. Due to the risks associated with such documents, they are seldom used in international commerce [14].

The negotiable/non-negotiable character is one that can be construed. Any transferable document may be deprived of its transferable character by the insertion of the words "not negotiable" [13]. The same effect is obtained by failing to insert into a straight bill of lading the words "Order of" [13].

In *Kum vs. Wah Tat Bank Ltd* [1971] or *The Future Express* [1993] it was held that the term "negotiable" when used in relation to a bill of lading means simply, transferable. The transferee of the bill shall acquire only the title transferred by the transferor [10]. It also implies for the holder of the instrument the right to sue in its own name [14].

The bill of lading as document of title performs a tripartite role in relation to the contract of carriage, with the sale of goods in transit and launching of the financial credit [2].

Endorsement and delivery of the bill will normally transfer the ownership of the goods referred to the endorsee if the following requirements are met: the bill must be transferable on its face (order bill expressly deliverable to the order or assigns of the consignee); the goods must be in transit at the time of endorsement; the bill must come from a person with a valid title; the endorsement must be accompanied by the intention to transfer the ownership of the goods [2].

The transfer of goods between two branches of the same company located in different countries or the endorsement with the intent to pledge as a temporary security for a loan does not amount with the intention to transfer the ownership [2].

The function related to the contract of carriage has the following implications: the holder of the bill controls the goods during the transit; a lawful holder by virtue of s2(1) Carriage of Goods by Sea Act 1992 has the right to sue, under the contract of carriage, as if he had been one of the parties of the contract; the holder is entitled of delivery of goods at the port of destination on presentation of the bill of lading [2].

The national legislations differ in the treatment of the bill of lading as a document of title. While in UK the bills of lading are regulated by the common law, precisely by the law of chattels, in Germany they are under the incidence of the Law of Exchange and in USA they are governed by the Federal Bill of Lading Act 1994 relating to the legislation on financial instruments [7].

3. CONCLUSIONS

The bill of lading is the most important document regarding the transport of goods by sea. Nethertheless, there is no universally accepted definition of it and no legislative consecration in international conventions untill the Rotterdam Rules.

The bill of lading is *prima facie* evidence of the receipt by the carrier of the goods as described. His evidentiary value as receipt is extremly important for the carrier who has very little options to escape liability. The bill of lading is not the contract of carriage but it is an excellent proof of its existence. In some cases such those between carrier and third endorsees it becomes conclusive evidence of the terms of the contract of carriage. Last but not least, it performs the function of a document of title. Many problems arising from the use of bills are resolved by case law although many more, such as the evidentiary value for the goods receipt by the carrier, still need more clarifications.

4. REFERENCES

[1] GIERMANN, Heiko A. *The Evidentiary Value of Bills of Lading and Estoppel*, LIT Verlag Münster, 2004;
[2] WILSON, John F., *Carriage of Goods by Sea*, 7th. ed., London: Longman, 2010;
[3] Burnett Robin, Bath Vivienne, *Law of international business in Australasia*, Federation Press, 2009;
[4] CARR, Indira, *International Trade Law*, 4th ed., Routledge Cavendish, 2010;
[5] BAUGHEN Simon, *Shipping Law*, 4th ed, Routledge Cavendish, 2009;
[6] Haga-Visby Rules, retrievable at http://www.admiraltylaw.com/statutes/hague.html;
[7] Felix Sparka, *Jurisdiction and Arbitration Clauses in Maritime Transport Documents a Comparative Analysis*, Springer, International Max Planck Research School for Maritime Affairs at the University of Hamburg, 2010;
[8] FRANCES Hannah and Professor GRIME, Robert, Sea Carriage Documents in *Australian Maritime Law*, 2 nd.ed., Michael White (Ed.), The Federation Press, 2000;
[9] LARYEA, Emmanuel T. *Paperless trade: opportunities, challenges and solutions*, Kluwer Law International, 2002;
[10] DOCKRAY, Martin & REECE Thomas, Katherine, *Cases and Materials on the Carriage of Goods by Sea*, Cavendish, 2004;
[11] JI MacWilliam Co Inc v Mediterranean Shipping Co SA, The Rafaela S [2002] EWCH 593; [2002] 2 Lloyd's Rep 403;
[12] JI MacWilliam Co Inc v Mediterranean Shipping Co SA, The Rafaela S [2003] EWCA Civ 556; [2003] 2 Lloyd's Rep 113;
[13] TREITEL Guenter, QC; REYNOLDS, Francis M. B., QC, *Carver on Bills of Lading* 2 nd ed, Sweet & Maxwell Ltd, 2005;
[14] MEISELLES Michala, *International Commercial Agreements: An Edinburgh Law Guide*, Edinburgh University Press Ltd., 2013.

EXCLUSIVE ECONOMIC ZONE – THE CONCEPT OF *SUIS GENERIS* AREA AND ITS IMPLICATIONS FOR THE LEGAL ORDER OF THE SEAS

ADASCALITEI OANA

Constanta Maritime University, Romania

ABSTRACT

The Exclusive Economic Zone combines features of the high seas and the territorial sea which gives it a unique character among other maritime territories regulated by the United Nations Convention on the Law of the Sea. Finding a balance between coastal State and third states rights, reflects the very legal nature of this *suis generis* area as it is recognised by the international law. The article aims at analysing the provisions of the Convention in an attempt to understand the actual tendency to disrupt the legal order in this area.

Keywords: *Exclusive Economic Zone; coastal states rights; third states rights; UNCLOS; military activities*

1. INTRODUCTION

The legal regime of the Exclusive Economic Zone is governed by United Nations Convention on the Law of the Sea (UNCLOS), Part V Art. 55-75. The Exclusive Economic Zone combines features of high seas and territorial sea but cannot be assimilated to these [1]. According to the article 55, “The exclusive economic zone is an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part… and by the relevant provisions of this Convention”. Article 86 clearly states that “The provisions of this Part (High Seas- n.n.) apply to all parts of the sea that are not included in the exclusive economic zone…”. However, Article 58 paragraph 2 transposes rules into the Economic Exclusive Zone, which are applicable to the high seas to the extent they are not inconsistent with the UNCLOS and other rules of the international law. As Serdy noted, this fact led to “the frequency of reference in navigational circles to international waters, a term unknown to the law of the sea but useful nonetheless, as it refers to the area seaward of the international waters (i.e. an amalgam of the EEZ and the high seas)”[2].

In reality, the Exclusive Economic Zone is a *suis generis* area with its own arrangements. Unlike the territorial sea, it is not an area in which the coastal states should have the right to sovereignty in plenary and ipso facto, and unlike the high seas, it is not an area in which other states should enjoy unrestricted liberties [1]. It’s an amalgam or a multipurpose area where the coastal states enjoy sovereign rights in relation to economic resources and also the right of jurisdiction not only in respect of those rights but for other issues, including those related to environmental protection [1].

The legal nature of the Exclusive Economic Zone contains three main elements: the rights and obligations which are recognized by law to the coastal states; the rights and obligations the Convention recognizes to other states; and the formula provided by the Convention for activities which do not fall within any of the preceding categories [3].

2. THE RIGHTS OF THE COASTAL STATES WITHIN EXCLUSIVE ECONOMIC ZONE

Regarding this area, UNCLOS recognizes to the coastal States sovereign rights over biological resources [4], correlative requiring conformation to the rights of the third states and compliance with the Convention [4] and the adoption of appropriate conservation and management measures in order to avoid overexploitation [4]. By virtue of exercising the sovereign rights of exploration, exploitation, conservation and management of living resources within the Exclusive Economic Zone, the coastal state may take any legal action to enforce the laws and regulations it has adopted [4]. Furthermore, the Convention extends the coastal state rights granted for the exploitation of biological resources by: the possibility of licensing fishermen or vessels and fishing gear [4]; determining the species whose fishing is permitted and setting rates [4] as well as fixing the age and size of fish and other species that can be caught [4]; regulating seasons, areas of fishing and gear as well as fishing vessels that may be used [4]; requesting information concerning foreign vessels catch and vessel position [4]; regulating the conduct of fisheries research programmes [4]; controlling the catches by imposing an obligation for the foreign vessels to land the catches in the ports of the coastal State [4].

Unlike the position on the non-living resources, the Convention grants the coastal state more extensive rights that may be exercised in an area much larger than they enjoyed under international customary law on exclusive fishing zone [3]. Even in these circumstances it was noted that UNCLOS does not expressly refer to a number of fishing related activities such as bunkering and transhipment operations or other activities on board, such as fish processing [5].

In practice it will be extremely difficult for the coastal state to comply with legal provisions regarding the conservation of fishery resources. The determination of the volume of allowed catches depends on too many variables such as the lack of a precise evaluation mechanism of UNCLOS of highly mobile species such as migratory or straddling species [6]. In addition to this, it is often expensive, especially for developing states, and inadequate for the relevant data collection and analysis [6]. The obligation to determine the volume of allowed catches is irrelevant given the fact that the coastal state can manipulate the information to appear as not having a surplus and it can thus circumvent the requirement to allow other countries access to its biological resources [6].

Moreover, it is considered that the scheme offered by the Convention for the authorized amount of catches is not appropriate for common stocks. The decisive factor for the conservation of these species with such a complex nature is particularly an agreement on a comprehensive management scheme and not the establishment of regional shares for the amount of authorized catches that forms a barrier to the rational directing fishing operations [7]. On the other hand, it will be very difficult for a third country to challenge the authorized volume of catches due to the lack of a dispute settlement mechanism with respect to the conservation of living resources in the exclusive economic zone [6].

The Maximum Sustainable Yield is also a contested concept of the conservation objective because it doesn't take into account a series of factors such as the economic objectives or ecological relationship of species, the habitat quality conditions, the limits of the biomass within the area concerned [6].

Under the terms of Article 56, paragraph 1, the coastal state equally enjoys the sovereign rights on the non-living resources "of the seabed, its subsoil and superjacent waters". The legal regime for the coastal state is identical with the benefiting states on seabed resources in the 1958 Geneva Convention on the Continental Shelf and international customary law [3].

Under the regime established for both the Exclusive Economic Zone and the continental shelf, the coastal state enjoys unfettered rights of exploration and exploitation of non-living resources located under the seabed such as oil or minerals without the obligation of judicious use or conservation [1]. Also, the coastal state has "sovereign rights… with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds" [4]. The article, designed to anticipate future technological developments, has gained increasing relevance under exploitation of renewable energy conditions [1].

In addition to sovereign rights, the Convention offers the coastal state jurisdiction over artificial islands, installations and structures used for economic purposes and installations and structures which may interfere with the exercise of the rights of the coastal state in the zone [4]. The provision does not however preclude other states to deploy listening devices or other devices used for military purposes [8] to which the coastal state shall have no jurisdiction [3].

A number of measures will be taken in the interest of navigation safety. The coastal state shall proper notify the construction of artificial islands, installations and structures [4] and may, where necessary, establish safety zones which shall not exceed a distance of 500 metres around such structures [4]. Artificial islands, installations or structures may not be established; the safety zones around these areas are not allowed because they might interfere while using the recognized sea lanes essential to international navigation [4]. In practice, the states have imposed by national law all sorts of restrictions on navigation and on other activities in the vicinity of artificial islands affecting the interests of other states regarding *jus communicationis* [7].

In the Exclusive Economic Zone, as provided by the relevant provisions of the Convention, the coastal state has jurisdiction over other two activities respectively, marine scientific research and the protection and preservation of the marine environment [4].

Part XIII of the UNCLOS details the conduct of marine scientific research. The marine scientific research is not a term defined by the Convention but it is often used to describe those activities in ocean and coastal waters designed for expanding the scientific knowledge of marine environment [9]. The marine scientific research includes marine biology, fisheries research, oceanography, geological and geophysical scientific research, ocean drilling scientific research [9]. The lack of clarity of the Convention made some activities such as hydro graphic studies, considered by the coastal state as a threat to national security, take place under the umbrella term ambiguity [9].

The marine scientific research in the Exclusive Economic Zone will be conducted by the third states only with the consent of the coastal state [4] exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all mankind [4]. The consent shall be granted in normal circumstances [4] which imply even "the absence of diplomatic relations between the coastal State and the researching state" [4].

Situations of abnormal circumstances can be considered imminent danger of an armed conflict or a legal dispute concerning the delimitation of maritime boundaries in the area where marine scientific research is to be conducted [10].

The consent may be refused in certain strictly defined conditions: if that project is of direct significance for the exploration and exploitation of natural resources [4]; if it involves the construction, operation or use of artificial islands, installations and structures [4]; if the information regarding the nature and objectives of the project is inaccurate or the contract statements from a prior research project have not been paid to the coastal state [4].

The states which intend to undertake marine scientific research in the Exclusive Economic Zone of a coastal state shall provide that state with a series of information regarding the project to conduct [4]. In accordance with Article 56 paragraph 1(iii), within the Exclusive Economic Zone, the coastal state has jurisdiction as provided for in the relevant provisions of this Convention with regard to protection and preservation of the marine environment. The relevant provisions to which reference is made are contained in Part XII. The coastal states shall adopt laws and regulations regarding the marine pollution arising from seabed activities, subject to their jurisdiction, and from artificial islands, installations and structures under their jurisdiction [4]. The states shall adopt laws and regulations on pollution of the marine environment resulted from dumping [4]. The coastal states may, in respect of their Exclusive Economic Zones, adopt laws and regulations regarding the pollution from vessels [4]. The rights of the coastal state under UNCLOS is a novelty from the previous period where the only powers given to state were measures in the event of maritime accidents threatening or causing serious oil pollution and which were adopted under the 1969 International Convention relating to the intervention on the high seas in the event of a maritime accident [3].

Depending on the nature of pollution, the rights of the coastal state differ. Regarding installations and dumping, the coastal state has a large discretion and may adopt laws and regulations which are more stringent than those contained in international standards. As for pollution from ships, the powers afforded to the coastal state are more limited, being forced to comply with the international standards contained within the IMO conventions [1]. Where there is clear objective evidence that a vessel navigating in the Exclusive Economic Zone of a state has committed a violation of the applicable international laws and regulations concerning pollution, that state may institute proceedings, including detention of the vessel, in accordance with its laws [4].

The powers given to the coastal state are balanced by measures which prevent possible abuses on international shipping [5]. The ship shall be released even in the case of violation of the applicable laws and regulations or of the international rules and standards subject to prior bonding or other financial guarantee [4]. Proceedings to impose penalties in respect of any violation of applicable laws and regulations or of international rules and standards shall be suspended upon the taking of proceedings to impose penalties in respect of corresponding charges [4] by the flag State and only monetary penalties may be imposed [4].

3. THIRD STATES RIGHTS WITHIN THE EXCLUSIVE ECONOMIC ZONE

Within the Exclusive Economic Zone other states enjoy the freedom of navigation, over flight and laying of submarine cables and pipelines, as well as the freedom of using the sea for other internationally lawful purposes related to these freedoms and compatible with the other provisions of this Convention [4]. In exercising their rights and performing their duties under this Convention within the Exclusive Economic Zone, the states shall have due regard to the rights and duties of the coastal state and shall comply with the laws and regulations adopted by the coastal state [4].

The rights given to third states are subject to a number of limitations. First, the rights and obligations of third states are governed by the provisions of Articles 88-115 applicable to the high seas as well as by other pertinent rules of international law in so far as they are not incompatible with the UNCLOS [4]. Secondly, third states are obliged to exercise these rights and freedoms with due regard for the interests of other states concerning activities taking place in this area [4]. There is no explicit delimitation based on security criteria afforded to the coastal state beyond those associated with the third state rights. The unique restriction in conducting military activities within the Exclusive Economic Zone of another state will be subject to non-interference with the rights of other users [11]. Definitively, although it is no clear stated that military activities are among freedom of navigation, over flight and other legitimate uses of the sea available under Articles 58 and 97 from UNCLOS, the maritime powers have sought to ensure at negotiations for UNCLOS III that these military operations shall not be excluded from this area [12]. The United States insist upon the freedom of conducting military activities within the Exclusive Economic Zone, being concerned about the fact that its mobility and its naval and aerial access will be severely restricted by the international tendency of “broadening of the jurisdiction” [12]. Causes of concern are in sight. The military activities include manoeuvres of intervention forces, flying missions, military exercises, spatial and telecommunications activities, surveillance activities and intelligence gathering, collecting data on the marine environment, exercises and weapons testing [12; 8].

A number of states among which India, Pakistan, Bangladesh have questioned the right of other states to conduct military activities in the area based on the fact that these may threaten their national security and undermine their sovereignty upon resources [12]. The attempts made to reach a compromise have not yet found the answer. The meeting of Group 21 held between 15-18 September 2005 in Tokyo has reached an agreement concerning the *Guidelines related to navigation and over flight within the Economic Exclusive Zone* [12] but they are soft law and by consequence they lack practical utility.

Many states have chosen to delimitate security zones within the Exclusive Economic Zone with special reference to military activities [11]. Other states banned not only military activities, manoeuvres and weapons testing but they also imposed restriction on navigation and over flight in the interest of national security, in particular to prevent proliferation of weapons of mass power destruction [1]. Australia established a “Maritime Identification Zone” of 1000 nautical miles in which all ships, except agreement ships, are required to provide information before reaching an Australian port [1].

Another problem is represented by the ships carrying dangerous cargo within the Exclusive Economic Zone. Unlike provisions related to territorial sea contained by Article 23, there is no text law within UNCLOS which should regulate the navigation of ships transporting this type of cargo. By consequence, it is difficult to imagine the way in which the coastal states may claim it in order to regulate navigation of such ships [11]. Many states have reserved the right to exclude ships carrying dangerous goods, particularly nuclear material in transit to nuclear power plants, reprocessing plants and waste to disposal [1]. New Zeeland, South Africa, Mauritius, Argentina, Columbia, Dominican Republic are among the states who have done so [1]. In the absence of compliance with the provisions of UNCLOS, justification was found in the provisions of the international environmental law and in particular, in the precautionary principle [1].

4. CONCLUSIONS

The Exclusive Economic Zone remains one of the most controversial areas recognized by the international law. Having already a tradition before the UNCLOS recognition of the current legal formula, the area is a source of disputes between third states and coastal states.

The need for security in the military and economic sense causes navigational and other activities restrictions imposed by the coastal state affecting other states. From the moment of the UNCLOS drafting, the coastal states fight for extensive rights within the Exclusive Economic Zone although they enjoy only theortically of sovereign rights and not soveraignity in the plenary sense. On the other hand, its equally true that maritime powers insist upon their military presence (whatever their form including scientific studies) in the Exclusive Economic Zone of other states based on the freedoms recognised by the Convention and the lack of express interdiction of such activities. The ambiguity of the UNCLOS leaves room for interpretation. Justified or not, the actual tendency of the coastal state to impose its presence increasingly will remove the character of this maritime territory from its initial sense of sui generis area that provided a delicate balance between the rights of the coastal states and the ones of the third states.

5. REFERENCES

[1] ROTHWELL, Donald R., & Stephens, Tim. (2010). *International Law of the Sea*, Hart Publishing;

[2] SERDY, A. Public International Law Aspects of Shiping Regulation. In *Southampton on Shipping Law*, Informa, London 2008;

[3] CHURCHILL, R. R., & LOWE, A. V., *The law of the sea*, (3rd Edition), Manchester University Press, 1999;

[4] United Nations Convention on the Law of the Sea;

[5] ANDERSON, D..*The Modern Law of the Sea, Sellected Essays*, Martinus Nijhoff publishers, 2008;

[6] TANAKA, Y., *A dual approach to ocean governance: the cases of zonal and integrated management in international law of the sea*, Ashgate Publishing, Ltd. 2008;

[7] KWIATKOWSKA, B..*The 200 mile exclusive economic zone in the new law of the sea*, Martinus Nijhoff Publishers, 1989;

[8] ROACH, J. A., SMITH, R. W., *United States responses to excessive maritime claims*, Second Edition, The Hague/Boston/London, Martinus Nijhoff Publishers, 1996;

[9] BATEMAN, S. Hydrographic surveying in the EEZ: differences and overlaps with marine scientific research, *Marine Policy*, 29, 163–174, 2009.

[10] PAVLIHA, M & MARTÍNEZ GUTIÉRREZ, N. A..Marine Scientific Research and the 1982 United Nations Convention on the Law of the Sea, *Ocean And Coastal Law Journal*, 16 (01),115-133, 2011.

[11] KAYE, S., State Practice and Maritime Claims: Assesing the Normative Impact of the Law of the Sea Convention in Chircop, A., McDorman, T., Rolston S.(Eds.), *The future of ocean regime-building: essays in tribute to Douglas M. Johnston*, Martinus Nijhoff Publishers, 2009;

[12] NDIAYE, T. M., WOLFRUM, R., Kojima, C.(assistant pulisher), *Law of the Sea, Environmental Law and Settlement of Disputes: Liber Amicorum Judge Thomas A. Mensah*, Leiden; Boston: Martinus Nijhoff Publishers, 2007.

A NEW APPROACH FOR THE RENTAL RATE EVALUATION IN A PORT

BALUT LUCIAN

Constanta Maritime University, Romania

ABSTRACT

The work presents a new approach of the method of determining the rental rent for the land in a port. According to this approach, the final rental rate must be dependent on how the port operator meets certain efficiency clauses (traffic clauses, performance clauses, consume clauses, environment clauses etc.). In the same time techniques of subsiding or adjusting the rate are introduced depending on the level of implementation of the efficiency clauses.

Keywords: *Rental rates in ports.*

1. INTRODUCTION

MTI Order no. 1286/August 7, 2012 [2] approves the regulation on renting shipping infrastructure in the public domain of the state. It should be noted that this infrastructure is leased to port administrations. At this time between the operators of the Constanta port dock and “Maritime Ports Administration” SA Constanta there are contracts which establish mutual obligations. In accordance with these contracts port operators have been forced to pay a fee to take into account the use of port area. Additionally, two types of clauses introduced. Namely they are: traffic clauses or performance clauses. Traffic clause is strictly related to the amount of goods coming from the operator. Clause performance is strictly linked to the operating speed of the port operator.

In accordance with the legislation in force, the duty to take into account the use of range port must be converted to rent reported to the land use [1]. The value of the rent reported to the land use is determined by tender. Whereas in many circumstances in the invitation to tender shall attend a single tenderer, it is necessary that the starting rental rate in respect of the invitation to tender to be “judicious use” chosen. Supplementary, at least one of the two clauses mentioned above must be introduced in the contract [1].

2. PROBLEM FORMULATION

Procedure used at this time does not seem to be incentive for potential investors. Even more, the important operators want to change contractual relations between them and “Maritime Ports Administration” SA Constanta. Starting from these points of view, two problems must be solved:

- Starting rental rate of the tender;
- Implementation of different clauses in the final rental rate.

3. STARTING RENTAL RATE OF THE TENDER

It is important to mention that the starting rental rate is established by Council of Administration. The Council must keep in mind the rental rates proposed by an independent evaluator. In the same time two other important parameters must be mentioned:

- The area (“s”)
- The cluster (“cl”)

In these circumstances one can write:

$$T_p = T_p(s, cl) \quad (1)$$

where:

T_p The starting rental rate of the tender

Figure 1 presents the characteristic family that may be associated with formula (2):

$$T_p = T_p(s)\Big|_{cl = \text{const.}} \quad (2)$$

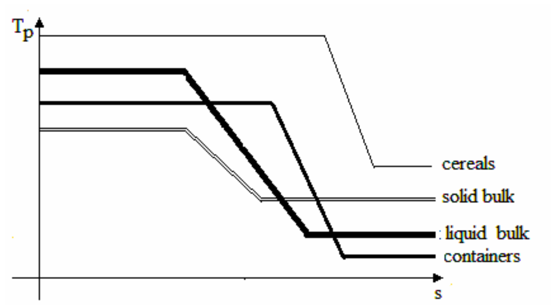


Figure 1 Dependence of the starting rental rate on clusters

4. FINAL VALUE OF THE RENTAL RATE

A possible solution consists in the introduction of flexible fare payment of the rental. This paper proposes the final rental rate will be dependent on how the port operator meets certain efficiency clauses (traffic clauses, performance clauses, consume clauses, environment clauses etc.). Such techniques (subsiding or adjusting) are introduced depending on the level of implementation of clauses of efficiency. So:

$$T_f = T_f(p_1, p_2 \ldots p_n) \qquad (3)$$

where:

$p_{k\ k\in\{1,2,\ldots n\}}$	Estimated parameters of the clauses

On the other hand:

$$T_f(p_1, p_2 \ldots p_n) = T_n + T_v(p_1, p_2 \ldots p_n) \qquad (4)$$

where:

T_n	Nominal fare obtained as a result of the invitation to tender. It has a fixed value.
$T_v(p_1, p_2 \ldots p_n)$	Variable fare.

Accepting that:

$$T_v(p_1, p_2 \ldots p_n) = \sum_{k=1}^{k=n} \alpha_k T_{vk}(p_k) \qquad (5)$$

where:

$\alpha_{k\ k\in\{1,2,\ldots,n\}}$	Weighting coefficient;
$T_{vk}(p_k)_{k\in\{1,2,\ldots,n\}}$	Variable component of rental rate clause introduced by "k" clause.

the formula (4) may be written as:

$$T_f(p_1, p_2 \ldots p_n) = T_n + \sum_{k=1}^{k=n} \alpha_k T_{vk}(p_k) \qquad (6)$$

In these circumstances it becomes necessary to explicit **the** $T_{vk} = T_{vk}(p_k)\Big|_{k=1,2,\ldots,n}$ **functions.**

This study proposes for these functions the next form:

$$T_{vk}(p_k) = \begin{cases} T_{vk}\max & \text{for } p_k \in [0, p_k\min] \\ -\dfrac{T_{vk}\max}{p_k\min - p_k\inf}\, p_k + \dfrac{T_{vk}\max}{p_k\min - p_k\inf}\, p_k\inf + T_{vk}\max & \text{for } p_k \in [p_k\min, p_k\inf] \\ 0 & \text{for } p_k \in [p_k\inf, p_k\sup] \\ \dfrac{T_{kv}\min}{p_k\sup - p_k\max}\, p_k + \dfrac{T_{kv}\min}{p_k\sup - p_k\max}\, p_k\sup & \text{for } p_k \in [p_k\sup, p_k\max] \\ T_{vk}\min & \text{for } p_k \in [p_k\max, \infty) \end{cases} \qquad (7)$$

where:

T_{vk}min	The minimum value of variable rental rate clause introduced by "k" clause
T_{vk}max	The maximum value of variable rental rate clause introduced by "k" clause
$p_k$min	Low level
$p_k$inf	Mid-lower level
$p_k$nom	Nominal level
$p_k$sup	Mid-high level
$p_k$max	High level

Graphical representation of this kind of function is shown in Figure 2.

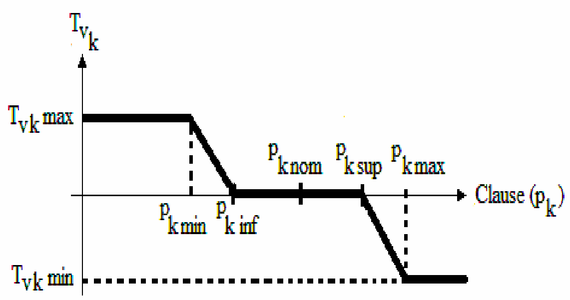


Figure 2
The graph of the function presented by formula (8)

In order to develop a simple procedure for applying the algorithm, formula (6) can be normalized according to formula (9).

$$T_f(p_1, p_2 \ldots p_n) = T_n\left(1 + \frac{\sum_{k=1}^{k=n} \alpha_k T_{vk}(p_k)}{T_n}\right) \qquad (8)$$

Obvious, this relation may be rewritten as follows:

$$T_f(p_1, p_2 \ldots p_n) = T_n\left(1 + \sum_{k=1}^{k=n} \alpha_k \frac{T_{vk}(p_k)}{T_n}\right) \qquad (9)$$

At this point it is interesting to analyze how to make the functions (10) more explicit.

$$\frac{T_{vk}}{T_n} = \frac{T_{vk}(p_k)}{T_n}\Bigg|_{k=1,2,\ldots,n} \qquad (10)$$

Normalizing both abscissa and ordinate relation (10) becomes:

$$\frac{T_{vk}}{T_n} = \frac{T_{vk}}{T_n}\left(\frac{p_k}{p_k\,\mathrm{nom}}\right)\Bigg|_{k=1,2,\ldots,n} \qquad (11)$$

where:

$p_k$nom	The accepted nominal level for clause "k";

In these conditions (8) becomes:

$$\frac{T_{vk}}{T_n}\left(\frac{p_k}{p_k nom}\right)=\begin{cases}\dfrac{T_{vk}\max}{T_n} & \text{for } \dfrac{p_k}{p_k nom}\in\left[0,\dfrac{p_k\min}{p_k nom}\right]\\[2ex] -\dfrac{\dfrac{T_{vk}\max}{T_n}}{\dfrac{p_k\min}{p_k nom}-\dfrac{p_k\inf}{p_k nom}}\dfrac{p_k}{p_k nom}+\dfrac{\dfrac{T_{vk}\max}{T_n}}{\dfrac{p_k\min}{p_k nom}-\dfrac{p_k\inf}{p_k nom}}\dfrac{p_k\inf}{p_k nom}+\dfrac{T_{vk}\max}{T_n} & \text{for } \dfrac{p_k}{p_k nom}\in\left[\dfrac{p_k\min}{p_k nom},\dfrac{p_k\inf}{p_k nom}\right]\\[2ex] 0 & \text{for } \dfrac{p_k}{p_k nom}\in\left[\dfrac{p_k\inf}{p_k nom},\dfrac{p_k\sup}{p_k nom}\right]\\[2ex] \dfrac{\dfrac{T_{kv}\min}{T_n}}{\dfrac{p_k\sup}{p_k nom}-\dfrac{p_k\max}{p_k nom}}\dfrac{p_k}{p_k nom}+\dfrac{\dfrac{T_{kv}\min}{T_n}}{\dfrac{p_k\sup}{p_k nom}-\dfrac{p_k\max}{p_k nom}}\dfrac{p_k\sup}{p_k nom} & \text{for } \dfrac{p_k}{p_k nom}\in\left[\dfrac{p_k\sup}{p_k nom},\dfrac{p_k\max}{p_k nom}\right]\\[2ex] \dfrac{T_{vk}\min}{T_n} & \text{for } \dfrac{p_k}{p_k nom}\in\left[\dfrac{p_k\max}{p_k nom},\infty\right)\end{cases}\quad(12)$$

The graphical representation of this function is shown in Figure 3.

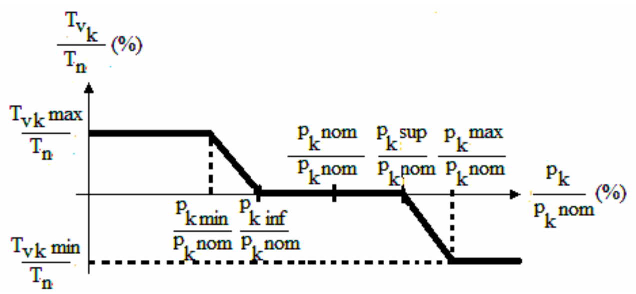


Figure 3 Graphical representation of function (13)

In practical situations such functions are difficult to implement. In these cases it is preferred tabulating them. Starting from the function (12), a relatively convenient tabular solution of it is shown in Figure 4. One can see that besides the five levels for the clause parameter (min. low, nominal, high and max.) an increment for the level is proposed. In the same time, talking about the rental rate, besides the three level (max, nominal and min), an increment is also proposed.

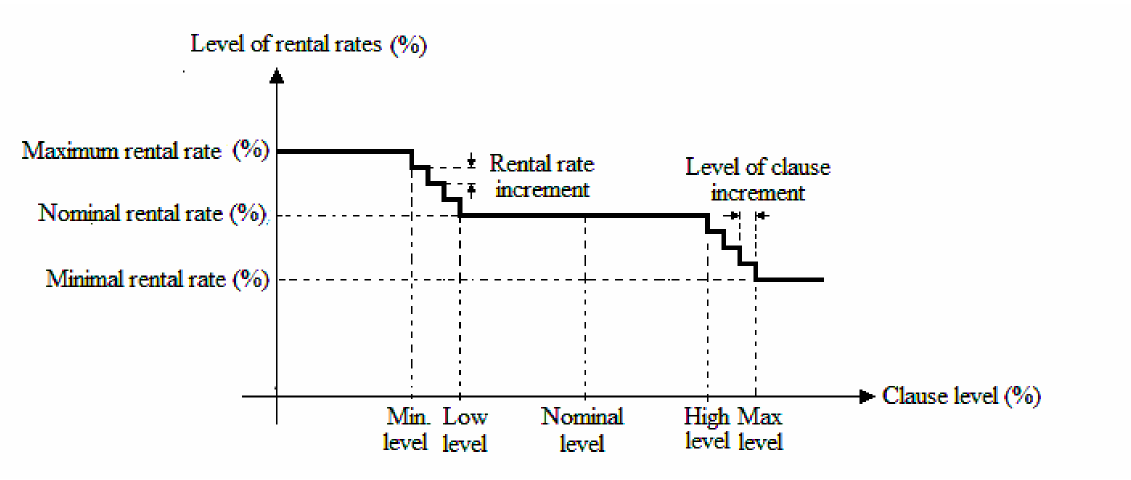


Figure 3 Tabular solution of the function (13)

5. CONCLUSIONS

This approach enables the implementation of a transparent process on rental rate evaluation in a port. It can be seen that in this way one can introduce clauses of efficiency in the rental price. Thus port operator becomes a partner of the administration. Because the rent can be adjusted according to achievements it can receive certain discounts.

In a subsequent paper, the procedure of determining the thresholds between the different levels will be developed.

6. REFERENCES

[1] *** *Law 108 of 03.06.2010 approving GEO no. 86/2007 amending and supplementing Government Ordinance no. 22/1999 on the administration of ports and waterways and shipping activities carried out in ports and waterways, act repealed Ordinance no. 131/2000.*

[2] *** *Order no. 1286/2012 for the approval of the lease naval transport infrastructure in public ownership of the state and it is leased to port administrations and / or inland waterways.*

ANALYSIS OF THE INTERACTION BETWEEN CAPESIZE AND PANAMAX FREIGHT MARKETS

[1]BATRINCA GHIORGHE, [2]COJANU GIANINA, [3]SURUGIU IOANA

[1,2,3]*Constanta Maritime University, Romania*

ABSTRACT

Without the dry bulk shipping market, world trade, industry and our current lifestyles could not be maintained. The dry bulk market is very dynamic due to interactions of its various components. The purpose of this study is to analyze the linkages between the Capesize market segment and the Panamax market segment in order to understand the price mechanism and the behavior of market participants.

Keywords: *Capesize, Panamax, VAR models, dry bulk shipping*

1. INTRODUCTION

In 2012, more than one-third of all international seaborne trade consisted of dry bulk cargo. The importance of the dry bulk shipping market is that without her, world trade, industry and our current lifestyles could not be maintained. Dry bulk shipping market is segmented by ship size and the main types of bulk carriers include Handies, Panamax and Capesize.

Panamax are the mid-sized cargo ships that are capable of passing through the lock chambers of the Panama Canal which are 320.04 m in length, 33.53 m in width, and 12.56 m in depth. These limits have influenced the ship building companies to build Panamax vessels strictly in accordance with the dimensions (width, length and depth) of the lock chambers and the height of the Bridge of the Americas. A Panamax shouldn’t exceed the dimensional limit of 294.13 m in length, 32.31 m in width and 12.04 m draught wise in order to easily and safely fit to the lock chambers and the height of the Bridge of Americas at Balboa. Panamax ships are in operation since the opening of the Panama Canal in 1914. In dry bulk shipping, Panamax vessels are classified as ships with a cargo-carrying capablility between 60 000 and 100 000 dwt. They mainly carry coal, grain and, to a lesser extent, minor bulks, including steel products, forest products and fertilizers. They operate in the Caribbean and Latin American regions.

Capesize are large-sized bulk carriers and tankers typically above 150 000 dwt. Capesize vessels are too large in size (especially their draught) to pass through the Panama Canal. As a result, they must transit via Cape Horn to travel between the Atlantic and Pacific oceans. Earlier, they were not fit to pass through the Suez Canal and required to take a long root via the Cape of Good Hope to travel between the Indian and Atlantic Oceans. But the deepening of the Suez Canal from 18 m to 20 m in 2009 permits most Capesize vessels to pass through it. Due to their large dimensions and deep draughts, Capesize ships are suitable to serve only large ports with deep water terminals in the world. As a result, they can serve a comparatively small number of ports in the world. Capesize ships are commonly used in transportation of coal, iron ore and commodity raw materials. Because of this fact, they are often termed as bulk carriers rather than tankers. In the subcategory of Capesize vessels are included the very large ore carriers (VLOC) and very large bulk carriers (VLBC) of above 200 000 dwt. These vessels are mainly designed to carry iron ore. According to estimates, 93% cargo of Capesize bulkers comprises of iron ore and coal. There is a huge demand for large Capesize vessels in the world today. While a standard Capesize vessel is around 175 000 dwt, bulkers up to 400 000 dwt or even more have been built in recent times to meet the growing demand for bulk ore transportation carriers. But with few of world’s ports having infrastructure to handle ships larger than 200 000 dwt, port access has emerged as a major problem for Capesize vessels. At present, most of large Capesize bulkers are being used for ore transportation between Australia and China, and Brazil and China.

The dry bulk market is very dynamic due to interactions of its various components. When freight rates for Capesize ships are high, charterers prefer to carry goods by two Panamax ships instead. As the number of these options increases, the freight rates for Capesize ships fall. Reversely, when freight rates for Panamax ships are high, there are few goods that can be loaded on Capesize ships, because Panamax ships carry, in addition to ore and coal, grains and fertilizers that can rarely be transported by Capesize ships.

2. LITERATURE REVIEW

The existing researches on the use of vector – autoregressive (VAR) models in shipping industry are scarce.

Bulut et al. (2012) perform an empirical analysis for the prediction of the chartering rates of a group of dry bulk cargo ships. They extend a fuzzy integrated logical forecasting method for multivariate systems by using a vector autoregressive model. The results are compared by the root mean squared error metric. In addition, the C-means clustering method is proposed to optimize the distributions of the cluster sets and the half of the standard deviation is implemented for the initial intervals of the C-means clustering[1].

Chou (2011) investigates the relationships between the global oil index and one year forward freight agreements by applying a vector autoregressive moving-average model in order to provide guidance for entering and exiting bulk shipping markets. The author demonstrates the existence of a stage one lag effect between Capesize forward freight agreements and the global oil index. The final results highlight that an economically meaningful structure exists in a set of bunker world indices and that there are stable long-run relationships between the two variables[2].

The freight rate as a price reflects vital information regarding ship supply and cargo transportation demand. Therefore, it becomes imperious to understand its dynamic properties. Ko (2013) analyzes the term structure in dry bulk freight market by applying a VAR model and two time-varying coefficient models on monthly data set from 1992 to 2012. According to the results of research, the response of long-term rate to short-term structural shock is small and statistically insignificant, while the response of short-term rate to long-term structural shock is large and statistically significant. Furthermore, overall, there is lack of evidence for the stable adjustment speed in both equations for the short and long-term freight rate[3].

The exports of a country are crucial for a country's overall growth. Nadeesha and De Silva (2013) examine the development of Sri Lanka exports, trying to highlight a relationship between exports and shipping services. By applying a Vector auto-regressive analysis, the authors try to produce a proper forecasting model for shipping demand using export in the country. According to the results, there is a strong straight line relationship between the value of exports and the amount of cargo loaded[4].

Xu et al. (2008) investigate the dynamic interrelationships between the sea freight and shipbuilding markets by applying a vector error correction model. Many practitioners argue that the freight rates rely on the shipbuilding activities, while other specialists argue that demand for shipbuilding is activated by the demand of freight market. The findings show that there exists a co-integration relationship between freight rate and shipbuilding price, such that the two rates are related to form an equilibrium relationship in the long run. Concluding, the shipbuilding prices are a function of the past history of freight rate, rather than the expected future values of freight rate[5].

3. DATA AND METHODOLOGY

This research applies a vector autoregressive model in order to analyze the linkages between two important components of the dry bulk shipping market, namely the Capesize market segment and the Panamax market segment. The daily data series of Baltic Capesize Index and Baltic Panamax Index for the time interval 1.03.1999 – 23.10.2013 were used for the empirical study. Data were collected from Baltic Exchange database and the analysis was performed with EViews 7.

A VAR model can be defined as a set of linear dynamic equations where each variable is specified as a function of an equal number of lags of itself and all other variables in the system. The VAR model used in this research paper has the following hypothesis:

$H_1 : BCI = f(BPI)$

$H_2 : BPI = f(BCI)$

The VAR model allows symmetric treatment of the two variables considered. Therefore, it comprises two equations:

$$BCI_t = \alpha_1 + \sum_{j=1}^{k} \beta_j \; x \; BCI_{t-j} + \sum_{j=1}^{k} \chi_j \; x \; BPI_{t-j} + \varepsilon_{1t}$$

$$BPI_t = \alpha_2 + \sum_{j=1}^{k} \delta_j \; x \; BPI_{t-j} + \sum_{j=1}^{k} \phi_j \; x \; BCI_{t-j} + \varepsilon_{2t}$$

where α_1, α_2 are the intercept terms, $\beta, \chi, \delta, \phi$ are the coefficients of the endogen variables and the ε are the stochastic error terms.

4. EMPIRICAL ANALYSIS

Firstly, the ADF test (Augmented Dickey-Fuller) was applied in order to verify the stationarity of time series. A time series is said to be stationary if its mean, variance and its covariances remain constant over time. From an economic point of view, shocks to a stationary time series are temporary and, over time, the effects of the shocks will dissipate. According to Table 1, the existence of a unit root was estimated for the original data and the absence of a unit root for the first-difference data. If the probability is higher than the significance level of 1% the variable is non-stationary. Therefore, the variables are integrated of order 1.

Table 1. The ADF test

BCI		**BPI**	
l(0)	l(1)	l(0)	l(1)
H0: The time series has a unit root (non-stationary)			
0.1063	0.0000	0.2004	0.0000

Source: own estimations

In order to verify if the past values of a variable X_1 contain information that helps predict a variable X_2 above and beyond the information contained in past values of X_2 alone, the Pairwise Granger causality test was applied (Table 2). If the probability is higher than the significance level of 1%, the null hypothesis is accepted. Otherwise, the null hypothesis is rejected.

Table 2. Pairwise Granger causality test

Null hypothesis	**Probabilities**
D_BPI does not Granger Cause D_BCI	7.E-12
D_BCI does not Granger Cause D_BPI	5.E-34

Source: own estimations

Taking in consideration that first difference data became stationary and the Pairwise Granger test reflects causality linkages between variables, a VAR model with 2 variables was created. A VAR model is valid if it has an optimal number of lags, if it's stable and if its residuals have normal distribution, homoskedasticity and lack of autocorrelation.

The number of lags of a VAR model must capture the system dynamics without consuming too many degrees of freedom[6]. In order to determine the optimal number of lags, the criteria provided by LR Sequential tests**,** Akaike Criterion**,** Schwarz and Hanna-Quinn Criterion tests were used. According to Table 3, the VAR model has 4 lags.

Table 3. Estimation of the optimal number of lags

LR	**FPE**	**AIC**	**SC**	**HQ**	**Chosen lag**
4	4	4	4	4	4

Source: own estimations

The stability of the estimated VAR model was tested with "AR Roots Table" test which indicates that all roots are subunitary and the model is stable (Table 4).

Table 4. VAR model stability

Results	**Roots modulus**	
No root lies outside the unit circle. VAR satisfies the stability condition.	0.744890	0.744890
	0.552036	0.552036
	0.537325	0.370897
	0.338825	0.338825

Source: own estimations

Regarding the quality of residuals, their normal distribution, homoskedasticity and lack of autocorrelation were tested (Table 5). If the probability is higher than the significance level of 1%, the null hypothesis is accepted. Otherwise, the null hypothesis is rejected.

Table 5. Residuals tests

Autocorrelation LM test			
H0 No serial correlation at lag order h			
Lag 1: 0.42	Lag 2: 0.24	Lag 3: 0.221	Lag 4: 0.315
Cholesky (Lutkepohl) Normality test			
H0 Residuals are multivariate normal			
Skewness	Kurtosis	Jarque-Bera	
0.2981	0.1555	0.1558	
White Heteroskedasticity test			
H0 no heteroskedasticity			
0.1456			

Source: own estimations

Since all the validity conditions are met, the VAR model can be defined as follows:

$$BCI_t = \alpha_1 + \beta \text{ x } BCI_{t-4} + \chi \text{ x } BPI_{t-4} + \varepsilon_{1t}$$
$$BPI_t = \alpha_2 + \delta \text{ x } BPI_{t-4} + \phi \text{ x } BCI_{t-4} + \varepsilon_{2t}$$

Table 6. VAR model estimation

	D_BCI	D_BPI
D_BCI(-1)	0.882495	0.084718
	(0.01756)	(0.00670)
	[50.2598]	[12.6533]
D_BCI(-2)	-0.250934	-0.078887
	(0.02280)	(0.00870)
	[-11.0043]	[-9.07255]
D_BCI(-3)	-0.073655	0.034458
	(0.02295)	(0.00875)
	[-3.20962]	[3.93795]
D_BCI(-4)	0.059341	-0.010557
	(0.01783)	(0.00680)
	[3.32842]	[-1.55292]
D_BPI(-1)	0.349860	1.105005
	(0.04597)	(0.01753)
	[7.61118]	[63.0438]
D_BPI(-2)	-0.391910	-0.374179
	(0.06715)	(0.02561)
	[-5.83598]	[-14.6126]
D_BPI(-3)	0.097531	0.045211
	(0.06684)	(0.02549)
	[1.45921]	[1.77396]
D_BPI(-4)	0.041647	-0.072603
	(0.04426)	(0.01688)
	[0.94099]	[-4.30209]
C	0.152005	0.065183
	(1.54670)	(0.58977)
	[0.09828]	[0.11052]
R-squared	0.564614	0.757745
Adj. R-squared	0.563660	0.757214
Sum sq. resids	31965868	4647775.
S.E. equation	93.57015	35.67932
F-statistic	591.8324	1427.485
Log likelihood	-21800.49	-18271.74
Akaike AIC	11.91776	9.989476
Schwarz SC	11.93301	10.00473
Mean dependent	0.529508	0.280601
S.D. dependent	141.6527	72.41102
Determinant resid covariance (dof adj.)		9820727.
Determinant resid covariance		9772488.
Log likelihood		-39840.63
Akaike information criterion		21.78067
Schwarz criterion		21.81119

Source: own estimations

The VAR model estimated above describes the autoregressive connections between the Capesize market segment and the Panamax market segment. Based on the estimated model, the impulse-response functions can be determined. The impulse-response functions show the impact of a shock of the Capesize market segment on Panamax market segment and vice-versa (Figure 1).

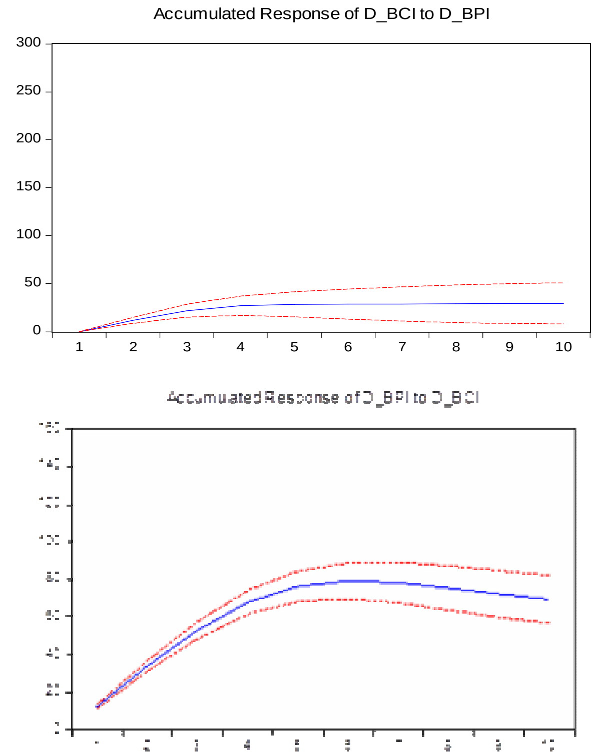


Figure 1. The impulse-response functions
Source: Own estimations

5. CONCLUSIONS

The importance of the dry bulk shipping market is that without her, world trade, industry and our current lifestyles could not be maintained. Dry bulk shipping market is segmented by ship size and the main types of bulk carriers include Handies, Panamax and Capesize. The dry bulk market is very dynamic due to interactions of its various segments.

According to Figure 1, there is a bidirectional relationship between the Capesize market segment and the Panamax market segment, but the influence of Capesize segment on Panamax segment is much stronger than the reverse one. Both market segments follow the same pattern during the analyzed time interval. The explanation of this significant difference lies in the fact that when freight rates for Capesize ships are high, charterers look at splitting their cargo lots in two and to ship them by two Panamax ships instead and in this way the freight rates for Capesize ships fall. Reversely, when freight rates for Panamax ships are high, there are few goods that can be loaded on Capesize ships, because Panamax ships carry, in addition to ore and coal, grains and fertilizers that can rarely be transported by Capesize ships.

6. REFERENCES

[1] Bulut E., Duru O., Yoshida S., “A Fuzzy Time Series Forecasting Model for Multi-Variate Forecasting Analysis with Fuzzy C-Means Clustering”, *World Academy of Science*, Engineering and Technology, 63, 2012.

[2] Chou M.T., “Research on the relationship between forward freight agreements and the fuel oil index”, *African Journal of Business Management*, Vol. 5(20), 2011, pp. 8033-8040.

[3] Ko B.W., “Analysis of Term Structure in Dry Bulk Freight Market”, *The Asian Journal of Shipping and Logistics*, Volume 29, Number 1, April 2013, pp. 001-022.

[4] Nadeesha D.H.D, De Silva A.D., “A Time-Series Analysis of Export-Led shipping demand Hypothesis for Sri Lanka”, *International Journal of Scientific and Research Publications*, Volume 3, Issue 9, September 2013.

[5] Xu J.J., Leung Y.T., Liming L., “Dynamic Interrelationships between Sea Freight and Shipbuilding Markets”, *Proceedings of International Forum on Shipping, Ports and Airports (IFSPA 2008) - Trade-Based Global Supply Chain and Transport Logistics Hubs: Trends and Future Development*, 25-28 May 2008, The Hong Kong Polytechnic University, Hong Kong, China, pp. 480-494.

[6] Burca A.M., Armeanu S.D., Kagitci M. „An empirical analysis of the causality relationship between insurance and economic growth”, *International Finance and Banking Conference*, FI BA 2013, XIth Edition, Supplement ECTAP, pp. 17-29.

AN EMPIRICAL ANALYSIS OF BIDIRECTIONAL RELATIONSHIPS BETWEEN VARIOUS COMPONENTS OF BALTIC SUPRAMAX INDEX

[1]BATRINCA GHIORGHE, [2]COJANU GIANINA, [3]SURUGIU IOANA

[1,2,3]Constanta Maritime University, Romania

ABSTRACT

In shipping, the freight market represents the adjustment mechanism linking supply and demand. Most of the times, the time charter level is a consequence of the equilibrium between demand and supply of ships in the area, but there are also situations when the market raises significantly in an area and, as a consequence, vessels situated at a shorter or a longer distance from that area are ballasting toward the hot area, shattering the equilibrium. The purpose of this study is to assess the bidirectional relationships between various components of Baltic Supramax Index by applying vector autoregressive models.

Keywords: *Baltic Supramax Index, shipping demand, shipping supply, VAR models*

1. INTRODUCTION

In the context of globalization, shipping volumes reached impressive levels. Bulk carriers represent one of the most important means of transportation of our time as they carry billions of tones of goods along major trade routes. Bulk carriers come in all sizes, from the smallest ships of only a few hundred tons deadweight to the largest of over 360 000 tons.

One very important size is the "Supramax", a type which became more and more popular since 2001. These vessels are ranging between 50 000 mt dwt and 61 000 mt dwt, have usually five cargo holds and deck cranes with a lifting capacity between 25 mt and 40 mt with most vessels being fitted with own grabs. A fairly big number are constructed as double hull vessels. Most of the bulk carriers being delivered recently are of double hull constructions and many of the sizes up to Supramax are so called "open hatch" or "semi open hatch" types, which mean they have a wide hatch opening with very narrow deck between hatch coaming and ship's side. Supramax vessels are very popular among dry cargo shippers due to their larger cargo carrying capacities and on-board cargo handling flexibility. Their favorable size allows them to trade in a much wider range of world ports and terminals. Supramax vessels are generally purposed for medium or large ports/berth that may not be able to accommodate a larger vessel due to length or draft restrictions, or those that lack transshipment infrastructure. Supramax vessels increasingly compete with Panamax ships. This is due to their growing size. In addition, they benefit from better fuel efficiency. The Supramax can call up river easier than its bigger brother the Panamax and is generally considered to be more agile, allowing access to tighter spaces. The competitiveness of Supramax vessels when compared to Panamax is also reflected in the freight rate developments.

As far as concerns the freight rate developments, Baltic Exchange produces a wide variety of shipping indices covering different vessel sizes and different cargo types. The Baltic Supramax Index (BSI) was officially launched in January 2006. The Baltic Supramax Index reflects freight rates for a 52 000 mt dwt Supramax-type vessel and consists of six trip-charter routes whose composition is broadly similar to that of the Baltic Capesize Index and Baltic Panamax Index. Routes S1A and S1B are trips from Europe (the northern Continent in the case of route S1A and the northeast Mediterranean in the case of S1B) for delivery anywhere in the region between Singapore and Japan. These routes have a combined weighting of 25% in the index. Route S2 is the trans-Pacific route reflecting movements of cargoes from Australia to Japan, South Korea or China. Route S3 represents the trip back from the Far East to Europe. Each of these routes has a weighting of 25% in the index. At last, routes S4A and S4B highlight cargo movements in the Atlantic basin: route S4A is for a trip from the US Gulf to Europe and route S4B is for a trip from Europe to the US gulf. These routes have a combined weighting of 25% in the index.

According to Alizadeh and Nomikos, the composition of the Baltic routes has to reflect current trends and developments in the freight market and its updates are decided regularly by the Baltic Exchange and its appropriate committees, which consult with the industry, market users and derivative brokers to ensure that market information remains representative of market trends[1].

Table 1. Routes of BSI on 18th October 2013

Route	S1A	S1B	S2	S3	S4A	S4B
Value	20756	17645	11165	6364	21628	6339

Source: www.balticexchange.com

According to Stopford, the freight market represents the adjustment mechanism linking supply and demand. Once the freight rate is established, shippers and shipowners adjust to it and eventually this brings supply and demand into balance. But, in practice, the demand is volatile and supply adjusts to demand with a significant time-lag, generating irregular freight cycles[2].

As can be seen from the time charter levels for each individual route of the BSI there are significant differences between regions (Table 1). Most of the times the time charter level is a consequence of the equilibrium between demand and supply of ships in the area, but there are also situations when the market raises significantly in an area and, as a consequence, vessels situated at a shorter or a longer distance from that area are ballasting toward the hot area and, in this case, they put pressure on the supply and either reduce the increase in the time charter levels from that area or reduce the time charter levels from that area. Ballasting of ships from an area to the other is also changing the equilibrium in the area they are leaving from and, in turn, the market in that area may start moving up or stop moving down.

2. LITERATURE REVIEW

The existing researches on the use of vector – autoregressive (VAR) models in shipping industry are scarce.

Xu et al. (2008) analyze the dynamic interrelationships between the sea freight and shipbuilding markets by applying a vector error correction model. Many practitioners argue that the freight rates rely on the shipbuilding activities, while other specialists argue that demand for shipbuilding is activated by the demand of freight market. The findings show that there exists a co-integration relationship between freight rate and shipbuilding price, such that the two rates are related to form an equilibrium relationship in the long run. Concluding, the shipbuilding prices are a function of the past history of freight rate, rather than the expected future values of freight rate[3].

Chou (2011) examines the relationships between the global oil index and one year forward freight agreements by applying a vector autoregressive moving-average model in order to provide guidance for entering and exiting bulk shipping markets. The author demonstrates the existence of a stage one lag effect between Capesize forward freight agreements and the global oil index. The final results highlight that an economically meaningful structure exists in a set of bunker world indices and that there are stable long-run relationships between the two variables[4].

Bulut et al. (2012) perform an empirical analysis for the prediction of the chartering rates of a group of dry bulk cargo ships. They extend a fuzzy integrated logical forecasting method for multivariate systems by using a vector autoregressive model. The results are compared by the root mean squared error metric. In addition, the C-means clustering method is proposed to optimize the distributions of the cluster sets and the half of the standard deviation is implemented for the initial intervals of the C-means clustering[5].

The freight rate as a price reflects vital information regarding ship supply and cargo transportation demand. Therefore, it becomes imperious to understand its dynamic properties. Ko (2013) investigates the term structure in dry bulk freight market by applying a VAR model and two time-varying coefficient models on monthly data set from 1992 to 2012. According to the results of research, the response of long-term rate to short-term structural shock is small and statistically insignificant, while the response of short-term rate to long-term structural shock is large and statistically significant. Furthermore, overall, there is lack of evidence for the stable adjustment speed in both equations for the short and long-term freight rate[6].

The exports of a country are crucial for a country's overall growth. Nadeesha and De Silva (2013) analyze the development of Sri Lanka exports, trying to highlight a relationship between exports and shipping services. By applying a Vector auto-regressive analysis, the authors try to produce a proper forecasting model for shipping demand using export in the country. According to the results, there is a strong straight line relationship between the value of exports and the amount of cargo loaded[7].

3. DATA AND METHODOLOGY

In this study, a vector autoregressive model was applied in order to analyze bidirectional relationships between various components of the Baltic Supramax Index. The daily data series of S1B, S3 and S4A routes for the period 02.01.2007 – 18.10.2013 were used for the empirical study. Data were collected from Baltic Exchange database and the analysis was performed with EViews 7.

A VAR model can be defined as a set of linear dynamic equations where each variable is specified as a function of an equal number of lags of itself and all other variables in the system. The VAR models used in this paper have the following hypothesis:

a) $H_1 : S1B = f(S3)$

$H_2 : S3 = f(S1B)$

b) $H_1 : S1B = f(S4A)$

$H_2 : S4A = f(S1B)$

The VAR model allows symmetric treatment of the two variables considered. Thus, it comprises two equations:

$$S1B_t = \alpha_1 + \sum_{j=1}^{k} \beta_j \; x \; S1B_{t-j} + \sum_{j=1}^{k} \chi_j \; x \; S3_{t-j} + \varepsilon_{1t}$$

$$S3_t = \alpha_2 + \sum_{j=1}^{k} \delta_j \; x \; S3_{t-j} + \sum_{j=1}^{k} \phi_j \; x \; S1B_{t-j} + \varepsilon_{2t}$$

where α_1, α_2 are the intercept terms, $\beta, \chi, \delta, \phi$ are the coefficients of the endogen variables and the ε are the stochastic error terms.

4. EMPIRICAL ANALYSIS

Firstly, the ADF test (Augmented Dickey-Fuller) was applied in order to verify the stationarity of time series. A time series is said to be stationary if its mean, variance and its covariances remain constant over time. From an economic point of view, shocks to a stationary time series are temporary and, over time, the effects of the shocks will dissipate. According to Table 2, the existence of a unit root was estimated for the original data and the absence of a unit root for the first-difference data. If the probability is higher than the significance level of 5% the variable is non-stationary. Therefore, the variables are integrated of order 1.

Table 2. The ADF test

S1B		S3		S4A	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
H0: The time series has a unit root (non-stationary)					
0.2742	0.0000	0.4138	0.0000	0.1308	0.0000

Source: own estimations

In order to verify if the past values of a variable X_1 contain information that helps predict a variable X_2 above and beyond the information contained in past values of X_2 alone, the Pairwise Granger causality test was applied (Table 3). If the probability is higher than the significance level of 5%, the null hypothesis is accepted. Otherwise, the null hypothesis is rejected.

Table 3. Pairwise Granger causality test

Null hypothesis	Probabilities
D_S3 does not Granger Cause D_S1B	3.E-05
D_S1B does not Granger Cause D_S3	0.0213
D_S4A does not Granger Cause D_S1B	8.E-20
D_S1B does not Granger Cause D_S4A	3.E-06

Source: own estimations

Taking in consideration that first difference data became stationary and the Pairwise Granger test reflects causality linkages, two VAR models with 2 variables were created. A VAR model is valid if it has an optimal number of lags, if it's stable and if its residuals have normal distribution, homoskedasticity and lack of autocorrelation.

In order to determine the optimal number of lags, the criteria provided by LR Sequential tests**,** Akaike Criterion**,** Schwarz and Hanna-Quinn Criterion tests were used. According to Table 4, each VAR model has 2 lags.

Table 4. Estimation of the optimal number of lags

Routes	LR	FPE	AIC	SC	HQ	Chosen lag
S1B – S3	2	2	2	1	2	2
S1B – S4A	2	3	3	2	2	2

Source: own estimations

The stability of the estimated VAR models was tested with "AR Roots Table" test which indicates that all roots are subunitary and the models are stable (Table 5).

Table 5. VAR model stability

Routes	Results	Roots modulus
S1B – S3	No root lies outside the unit circle. VAR satisfies the stability condition.	0.882138 0.774377 0.150545 0.011968
S1B – S4A	No root lies outside the unit circle. VAR satisfies the stability condition.	0.867756 0.744080 0.156842 0.045365

Source: own estimations

Regarding the quality of residuals, their normal distribution, homoskedasticity and lack of autocorrelation were tested (Table 6). If the probability is higher than the significance level of 5%, the null hypothesis is accepted. Otherwise, the null hypothesis is rejected.

Table 6. Residuals tests

S1B – S3 route		
Autocorrelation LM test		
H0 No serial correlation at lag order h		
Lag 1: 0.1818	Lag 2: 0.1629	
Cholesky (Lutkepohl) Normality test		
H0 Residuals are multivariate normal		
Skewness	Kurtosis	Jarque-Bera
0.3732	0.2171	0.2174
White Heteroskedasticity test		
H0 no heteroskedasticity		
0.1141		

S1B – S4A route		
Autocorrelation LM test		
H0 No serial correlation at lag order h		
Lag 1: 0.0534	Lag 2: 0.0403	
Cholesky (Lutkepohl) Normality test		
H0 Residuals are multivariate normal		
Skewness	Kurtosis	Jarque-Bera
0.4625	0.7458	0.7463
White Heteroskedasticity test		
H0 no heteroskedasticity		
0.5681		

Source: own estimations

Since all the validity conditions are met, the VAR models can be defined as follows:

a) $$S1B_t = \alpha_1 + \beta \text{ x } S1B_{t-2} + \chi \text{ x } S3_{t-2} + \varepsilon_{1t}$$

$$S3_t = \alpha_2 + \delta \text{ x } S3_{t-2} + \phi \text{ x } S1B_{t-2} + \varepsilon_{2t}$$

b) $$S1B_t = \alpha_1 + \beta \text{ x } S1B_{t-2} + \chi \text{ x } S4A_{t-2} + \varepsilon_{1t}$$

$$S4A_t = \alpha_2 + \delta \text{ x } S4A_{t-2} + \phi \text{ x } S1B_{t-2} + \varepsilon_{2t}$$

Table 7. VAR model estimation for S1B – S3

	D_S1B	D_S3
D_S1B(-1)	0.909362	0.065265
	(0.02457)	(0.02972)
	[37.0083]	[2.19609]
D_S1B(-2)	-0.030567	-0.033072
	(0.02445)	(0.02957)
	[-1.25023]	[-1.11842]
D_S3(-1)	0.088378	0.909665
	(0.02026)	(0.02450)
	[4.36235]	[37.1250]
D_S3(-2)	-0.057152	-0.102099
	(0.02033)	(0.02459)
	[-2.81076]	[-4.15168]
C	0.160413	-2.862417
	(4.79268)	(5.79654)
	[0.03347]	[-0.49381]
R-squared	0.801455	0.705419
Adj. R-squared	0.800986	0.704723
Sum sq. resids	65937548	96452519
S.E. equation	197.3504	238.6867
F-statistic	1708.507	1013.538
Log likelihood	-11380.75	-11703.66
Akaike AIC	13.41078	13.79112
Schwarz SC	13.42679	13.80713
Mean dependent	-3.921673	-15.64900
S.D. dependent	442.3803	439.2520
Determinant resid covariance (dof adj.)		2.16E+09
Determinant resid covariance		2.15E+09
Log likelihood		-23062.39
Akaike information criterion		27.17597
Schwarz criterion		27.20799

Source: own estimations

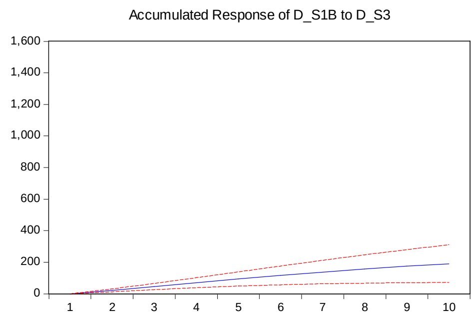
Table 8. VAR model estimation for S1B – S4A

	D_S1B	D_S4A
D_S1B(-1)	0.863390	0.315631
	(0.02475)	(0.06518)
	[34.8804]	[4.84256]
D_S1B(-2)	-0.026163	-0.206513
	(0.02406)	(0.06335)
	[-1.08741]	[-3.25965]
D_S4A(-1)	0.077998	0.859922
	(0.00937)	(0.02468)
	[8.32089]	[34.8390]
D_S4A(-2)	-0.031653	-0.074253
	(0.00959)	(0.02525)
	[-3.30089]	[-2.94067]
C	0.206378	-2.742977
	(4.69548)	(12.3640)
	[0.04395]	[-0.22185]
R-squared	0.809213	0.700147
Adj. R-squared	0.808762	0.699439
Sum sq. resids	63361129	4.39E+08
S.E. equation	193.4563	509.4051
F-statistic	1795.189	988.2754
Log likelihood	-11346.91	-12990.90
Akaike AIC	13.37092	15.30730
Schwarz SC	13.38693	15.32332
Mean dependent	-3.921673	-15.12191
S.D. dependent	442.3803	929.1732
Determinant resid covariance (dof adj.)		9.32E+09
Determinant resid covariance		9.26E+09
Log likelihood		-24302.48
Akaike information criterion		28.63661
Schwarz criterion		28.66863

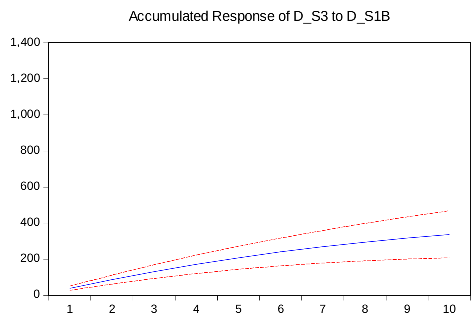
Source: own estimations

The VAR models estimated above describe the autoregressive connections between various components of Baltic Supramax Index. Based on the estimated models, the impulse-response functions can be determined. The impulse-response functions show the impact of a shock of one route on the other route and vice-versa (Figure 1 and Figure 2).

Figure 1 The impulse-response functions for S1B – S3

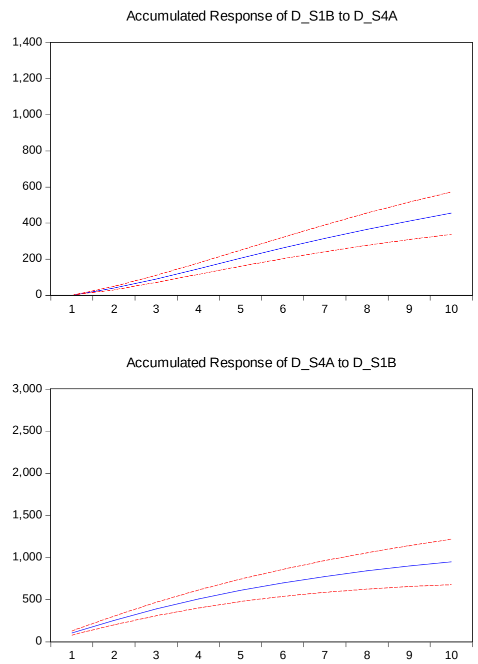


Source: own estimations



Source: own estimations

Figure 2. The impulse-response functions for S1B – S4A



Source: own estimations

5. CONCLUSIONS

Figures show that there are significant differences between regions for each individual route of the Baltic Supramax Index. Most of the times the time charter level is a consequence of the equilibrium between demand and supply of ships in the area, but there are also situations when the market raises significantly in an area and as a consequence vessels situated at a shorter or a longer distance from that area are ballasting toward the hot area and in this case they put pressure on the supply and either reduce the increase in the time charter levels from that area or reduce the time charter levels from that area. Ballasting of ships from an area to the other is also changing the equilibrium in the area they are leaving from and in turn the market in that area may start moving up or stop moving down.

As it can be noticed from Figure 1, there is a bidirectional relationship between S1B route and S3 route, and the influence of S1B route on S3 route is stronger than the reverse one. Both routes follow the same pattern during the analyzed time interval.

Figure 2 shows a symmetrical and bidirectional relationship between S1B route and S4A route, with influences of the same intensity. Also, both routes follow the same pattern during the analyzed time interval.

6. REFERENCES

[1] Alizadeh A.H., Nomikos N.K., *Shipping Derivatives and Risk Management*, Palgrave Macmillan, 2009.

[2] Stopford M., *Maritime Economics* 3rd Edition, Routledge, 2009.

[3] Xu J.J., Leung Y.T., Liming L., “Dynamic Interrelationships between Sea Freight and Shipbuilding Markets”, *Proceedings of International Forum on Shipping, Ports and Airports (IFSPA 2008) - Trade-Based Global Supply Chain and Transport Logistics Hubs: Trends and Future Development*, 25-28 May 2008, The Hong Kong Polytechnic University, Hong Kong, China, pp. 480-494.

[4] Chou M.T., “Research on the relationship between forward freight agreements and the fuel oil index”, *African Journal of Business Management*, Vol. 5(20), 2011, pp. 8033-8040.

[5] Bulut E., Duru O., Yoshida S., “A Fuzzy Time Series Forecasting Model for Multi-Variate Forecasting Analysis with Fuzzy C-Means Clustering”, *World Academy of Science*, Engineering and Technology, 63, 2012.

[6] Ko B.W., “Analysis of Term Structure in Dry Bulk Freight Market”, *The Asian Journal of Shipping and Logistics*, Volume 29, Number 1, April 2013, pp. 001-022.

[7] Nadeesha D.H.D, De Silva A.D., “A Time-Series Analysis of Export-Led shipping demand Hypothesis for Sri Lanka”, *International Journal of Scientific and Research Publications*, Volume 3, Issue 9, September 2013.

APPLICATION OF AUTOREGRESSIVE MODELS FOR FORECASTING THE BALTIC EXCHANGE DRY INDEX

[1]BATRINCA GHIORGHE, [2]COJANU GIANINA, [3]SURUGIU IOANA

[1,2,3]Constanta Maritime University, Romania

ABSTRACT

The shipping industry has been growing rapidly from year to year and until not too long ago, shipping was both the greatest beneficiary and hammering pulse of globalization. But now the global economic and financial crisis has multiplied the problems of shipping industry, generating a high volatility of prices. In this context, it becomes imperious to analyze and estimate the dynamics of various indices that could be useful to capture market volatility in real time. In this respect, the Baltic Dry Index is considered to be a leading indicator of economic activity reflecting global demand for raw materials, representing a reliable and independent source of information.

Keywords: *Baltic Dry Index, shipping, volatility, shipping demand, autoregressive.*

1. INTRODUCTION

In shipping industry, exposure to unanticipated fluctuations may affect the profitability and stability of the company. Therefore, it is always prudent to apply methods and strategies which reduce uncertainty and risk. The activity of risk management in the freight markets requires the availability of reliable price information on the underlying freight market. In this respect, Baltic Exchange is the leading provider of freight-market information by producing various indices. These indices are used by many analysts to assess the states and prospects of the worldwide economic activity.

The first daily freight index was published by the Baltic Exchange in January 1985. The Baltic Freight Index (BFI) initially consisted of 13 voyage routes covering a variety of cargoes ranging from 14 000 metric tons of fertilizer up to 120 000 metric tons of coal, and was developed as a settlement mechanism for the then newly established Baltic International Freight Futures Exchange (BIFFEX) futures contract. It quickly won worldwide acceptance as the most reliable general indicator of movements in the dry-cargo freight market. Over the years, the constituent routes of that original index were refined to meet the ever-increasing and changing needs of the derivative markets [1].

The Baltic Dry Index (BDI) is the successor to the Baltic Freight Index (BFI) and came into operation on 1 November 1999. Since the 1st of July 2009, the Index is a composite of the Capesize, Panamax , Supramax and Handysize Timecharter Averages.

The calculation until the 30th of June 2009 was based on an equally weighted average of the BCI, BPI, BHSI and the BSI index, which superseded the BHMI on 03 January 2006, which superseded the BHI on 2 January 2001. The BDI continues the established time series of the BFI, introduced in 1985.

For the creation of BDI the following formula is used:

((CapesizeTCavg + PanamaxTCavg + SupramaxTCavg + HandysizeTCavg)/ 4)) * 0.113473601

where TCavg = Time charter average.

The multiplier was first applied when the BDI replaced BFI, and has changed over the years as the contributing indices and the methods of calculation have been modified.

The Baltic Dry Index is considered to be a leading indicator of economic activity reflecting global demand for raw materials, representing a reliable and independent source of information. The BDI may be considered a predictor because its variation has a strong association with the commodities market. Since BDI is only operated by actual buyers and/or sellers, there is no speculative part concerning this index. Furthermore, the BDI is now revised and is highly accurate with the daily updates. The BDI can be seen as an equilibrium price of the dry bulk shipping market.

2. LITERATURE REVIEW

Although the academic literature on the BDI has a long history, recent research papers on this subject are scarce.

Theodoulidis and Solís (2009) attempt to identify trends or stages in the BDI associated with economic cycles, as well as other relationships with economic indicators. The authors apply data mining techniques on a dataset consisted of prices for economic indicators from January 1985 to December 2008, including monthly average prices of Copper, Oil, Gold, Silver and the Dow Jones Industrial monthly index values. The models developed in their paper have an average power of classification of 72% in an out-of-sample set and may be used to analyze the current status of the freight market in terms of the economic cycles. Furthermore, the final results highlight that, during recent years, BDI has been more linked with the copper prices and that usually stock market prices have a limited effect on it.

Chung and Ha (2010) investigated the effect of the global financial crisis on the Baltic Dry Index by using the error correction model. Their empirical research highlight that there has been a co-integration relationship between the BDI and certain explanatory variables such as China’s iron import, Eurodollar interest rate and U.S. stock price.

Wong et al. (2010) assess the influence of the Baltic Dry Index on the bulk shipping industry from the demand prospective by applying Grey Relational Analysis with the Entropy method. The research results show that the fluctuation of international steel prices is most closely connected with the BDI, followed by fuel prices, grain prices and coal prices.

Bakshi et al. (2011) try to demonstrate that the Baltic Dry Index has predictive ability for a range of stock markets by applying through in-sample tests and out-of sample statistics. The authors show that the three-month growth rate of BDI is a predictor of global stock market returns, commodity index returns and growth in global real economic activity. Their analysis is carried out with data collected from four MSCI regional stock market indexes, as well as the individual stock markets in the G-7 countries, 12 other developed and 12 emerging market economies, and US dollar-denominated returns.

As an overall economic indicator, BDI is especially relevant for the trade of the less developed countries that export mostly primary goods, relying on bulk carriers for international transportation. Apergis and Payne (2013) examine the information and predictive content of the BDI for both financial assets and industrial production by using panel data methods for the period 1985 2012. Overall, their research highlights the relevance of the BDI as an indicator that captures the variations across financial asset market and the macroeconomy.

Papailias and Thomakos (2013) investigate the cyclical properties of the annual growth of BDI and their implications for short-to-medium term forecasting performance. The authors show that the index has a cyclical pattern which has been relatively stable across time. Furthermore, BDI is negatively synchronized with a weaker dollar and the spread of the US Treasuries and positively synchronized with the GBP/USD exchange rate, the emerging market equities, copper and tin. Also, the authors perform a forecasting performance evaluation by using a variety of models and a 12-month investment exercise which can be useful in building a reliable risk management system.

3. DATA AND METHODOLOGY

In this study, the ARIMA models were applied in order to analyze and forecast the dynamics of the Baltic Exchange Dry Index. The daily data series of Baltic Exchange Dry Index for the period 04.01.1985 – 16.09.2013 were used for the empirical study, comprising 7209 observations. Data were collected from Baltic Exchange database and the ARIMA models were built with EViews 7.

The ARIMA model is a generalization of the autoregressive and the moving average models. The autoregressive (AR) model uses past values of the dependent variable to explain the current value whereas, the moving average (MA) model uses lagged values of the error term to explain the current value of the explanatory variable.

The general ARIMA model is called an ARIMA(p,d,q), with "p" being the number of lags of the dependent variable (the AR terms), "d" being the number of differences required to take in order to make the series stationary, and "q" being the number of lagged terms of the error term (the MA terms). An ARIMA(p,d,q) (AutoRegressive Integrated Moving Average with orders p,d,q) model is a discrete time linear equations with noise, of the form:

$$\left(1-\sum_{k=1}^{p}\alpha_k L^k\right)(1-L)^d X_t = \left(1+\sum_{k=1}^{q}\beta_k L^k\right)\varepsilon_t$$

4. EMPIRICAL ANALYSIS

In the first instance, the ADF test (Augmented Dickey-Fuller) was applied in order to verify the stationarity of time series. A time series is said to be stationary if its mean, variance and its covariances remain constant over time. From an economic point of view, shocks to a stationary time series are temporary and, over time, the effects of the shocks will be absorbed. The existence of a unit root was estimated for the original data and the absence of a unit root for the first-difference data (Table 1). Therefore, the variables are integrated of order 1 and denoted by l(1).

Table 1. The ADF test for first-difference logarithmic data

Null Hypothesis: D_BDI has a unit root
Exogenous: Constant
Lag Length: 10 (Automatic - based on SIC, maxlag=34)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.22347	0.0000
Test critical values:	1% level	-3.431081	
	5% level	-2.861748	
	10% level	-2.566922	

*MacKinnon (1996) one-sided p-values.

Source: own estimations

If the probability is lower than the significance level, the null hypothesis is rejected. It can be observed that the first-difference data is stationary for a 1% significance level.

In order to select the appropriate ARIMA model, the Box-Jenkins approach, which is a three-stage method, comprising identification, estimation and diagnostic checking, will be applied.

In the identification stage, the form of the model has to be identified, because any model may be given more than one different representations. Once the time series stationarity is achieved, the next step is to identify the "p" and "q" orders of the ARIMA model. Therefore, the time plot of the series autocorrelation function (ACF) and partial correlation function (PACF) will be visually analyzed, because they provide useful information regarding outliers, missing values and structural breaks in the data (Table 2).

From the table below, it can be observed that there are three significant spikes on the time plot of the series autocorrelation function (ACF), and then all are zero, while there are two significant spikes in the partial correlation function (PACF). This suggests that the models might have up to MA(3) and AR(2) specifications. Thus, the possible models are the ARIMA(1,1,1), ARIMA(1,1,2), ARIMA(1,1,3), ARIMA(2,1,1) ARIMA(2,1,2), ARIMA(2,1,3) models.

Table 2 Autocorrelation function and partial correlation function

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.801	0.801	4629.1	0.000
		2	0.519	-0.343	6573.1	0.000
		3	0.295	0.035	7200.5	0.000
		4	0.166	0.046	7398.7	0.000
		5	0.106	0.012	7479.4	0.000
		6	0.101	0.071	7552.3	0.000
		7	0.129	0.062	7671.7	0.000
		8	0.153	0.009	7840.7	0.000
		9	0.161	0.025	8027.3	0.000
		10	0.161	0.043	8214.4	0.000

Source: own estimations

According to Box and Jenkins, a valid model should be stationary and invertible. Therefore, the modulus of each AR coefficient has to be lower than 1, the sum of AR coefficients has to be lower than 1 and the modulus of each root has to be lower than 1. These requirements are fulfilled by all the models, excepting ARIMA(2,1,1). Furthermore, the ARIMA(1,1,3) model has the MA(3) term insignificant, the ARIMA(2,1,2) model has the AR(2) term insignificant and the ARIMA(2,1,3) model has the AR(1) term insignificant. Therefore, these models will be dropped.

The remaining models are estimated and analyzed in the estimation stage. The estimated models are compared using the Akaike information criterion (AIC), the Schwartz Bayesian criterion (SBC) and Adjusted R-squared (Table 3). The model that has the smallest AIC and SBC and the highest Adjusted R-squared will be chosen.

Table 3. Summary results of possible ARIMA models

Model	**ARIMA(1,1,1)**	**ARIMA(1,1,2)**
AIC	9.345529	9.328810
SBC	9.348394	9.332630
Adjusted R-squared	0.679482	0.684840

Source: own estimations

According to Table 3, all the criteria suggest that the fit model is ARIMA(1,1,2).) The model is estimated in Table 4 and its validity is tested in Table 5. It can be noticed that the model is stationary and invertible. Also, R-squared and Adjusted R-squared tests are higher than 50%.

Table 4. Estimation of ARIMA(1,1,2) model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.095963	1.214214	0.079033	0.9370
AR(1)	0.578458	0.016022	36.10285	0.0000
MA(1)	0.507971	0.018358	27.67012	0.0000
MA(2)	0.185062	0.016328	11.33417	0.0000

R-squared	0.684972	Mean dependent var	0.090606
Adjusted R-squared	0.684840	S.D. dependent var	45.71960
S.E. of regression	25.66656	Akaike info criterion	9.328810
Sum squared resid	4745137.	Schwarz criterion	9.332630
Log likelihood	-33612.37	Hannan-Quinn criter.	9.330124
F-statistic	5220.534	Durbin-Watson stat	1.998265
Prob(F-statistic)	0.000000		

Inverted AR Roots	.58	
Inverted MA Roots	-.25+.35i	-.25-.35i

Source: own estimations

Table 5. ARIMA(1,1,2) structure

AR Root(s)	Modulus	Cycle
0.578458	0.578458	

No root lies outside the unit circle.
ARMA model is stationary.

MA Root(s)	Modulus	Cycle
-0.253985 ± 0.347208i	0.430188	2.852936

No root lies outside the unit circle.
ARMA model is invertible.

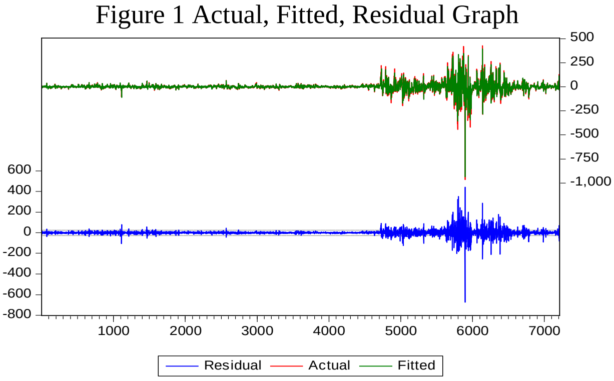
Source: own estimations

In the last stage, the goodness of fit of the model is examined. Therefore, the statistical significance of model's coefficients, the quality and the autocorrelation of residuals will be tested.

As it can be observed from Table 4, all the coefficients are statistically significant for a 1% significance level.

Regarding the quality of residuals, the best view to look at first is Actual, Fitted, Residual Graph (Figure 1). It can be noticed that the fit is very good and the fitted values almost cover up the actual values.

Figure 1 Actual, Fitted, Residual Graph



Source: own estimations

According to the correlogram of residuals (Table 6), since there are no significant spikes of ACFs and PACFs, it means that the residuals of the selected ARIMA model are white noise, so that there are no other significant patterns left in the time series.

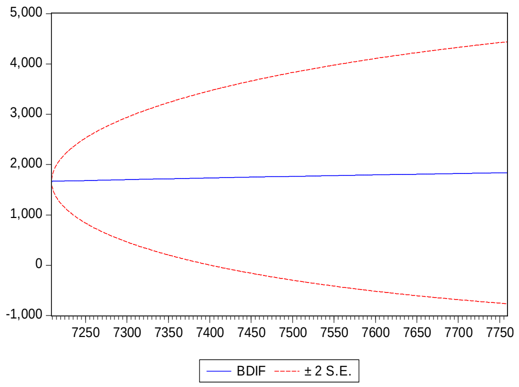
Table 6. Correlogram of residuals

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.001	0.001	0.0054	
		2	0.002	0.002	0.0352	
		3	0.002	0.002	0.0600	
		4	-0.013	-0.013	1.3175	0.251
		5	-0.024	-0.024	5.3917	0.067
		6	-0.018	-0.018	7.6739	0.053
		7	0.043	0.043	20.874	0.000
		8	0.053	0.053	41.249	0.000
		9	0.040	0.039	52.688	0.000
		10	0.010	0.009	53.460	0.000

Source: own estimations

Taking in consideration the results of the tests applied to the estimated model, it can be concluded that the ARIMA(1,1,2) model is appropriate. By using this model, the Baltic Exchange Dry Index will be forecasted for the period October 2013 – December 2015. Figure 2 illustrates the dynamic forecast of BDI and its error margins.

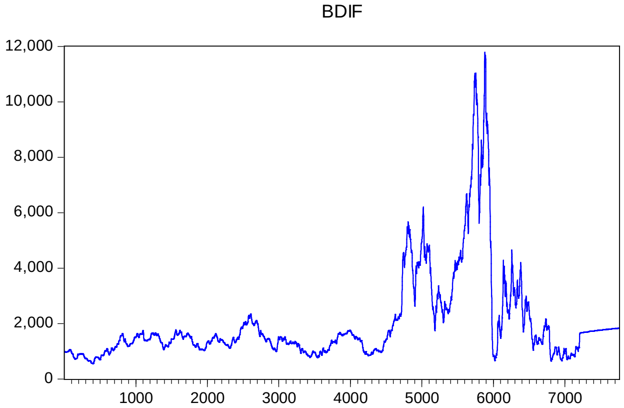
Figure 2. Dynamic forecast of BDI



Source: own estimations

Figure 3 presents the fluctuation of BDI from January 1985 to December 2015

Figure 3.The evolution of BDI



Source: own estimations

5. CONCLUSIONS

As it can be noticed from Figure 3, the dry-freight rates recorded a gradual increase after January 2003 and from that period onwards the market volatility has increased. During 2008, the financial crisis affected the shipping industry due to the fact that many industrial producers reduced or stopped their production. On 20th May 2008 the BDI reached 11 793 points, its all time high. A few months later, the index began to fall and in 7 months lost 95% of its value, dropping to 663 points – the lowest point since 5th December 2008. The index is extremely volatile in the last decade compared to the first 18 years of existence, due to worldwide economic booms and recessions. The trend of the forecasted values of BDI can be easily visualised (starting with observation no. 7000), showing a slight increase during the next two years.

6. REFERENCES

[1] Amir H. Alizadeh and Nikos K. Nomikos – *Shipping Derivatives and Risk Management*, Palgrave Macmillan, 2009

[2] Apergis Nicholas and Payne E. James - *New Evidence on the Information and Predictive Content of the Baltic Dry Index*, Int. J. Financ. Stud. 2013, 1, 62–80; doi:10.3390/ijfs1030062

[3] Bakshi Gurdip, Panayotov George and Skoulakis Georgios - *The Baltic Dry Index as a Predictor of Global Stock Returns*, Commodity Returns, and Global Economic Activity. Available at SSRN: http://ssrn.com/abstract=1747345 or http://dx.doi.org/10.2139/ssrn.1747345, 2010

[4] Chung K. J. and Y. Ha - *The Empirical Analysis for the Effect of Global Finance-Crisis to the Baltic Dry Index*, Journal of Shipping and Logistics Vol. 64, pp. 1-16, 2010

[5] Papailias Fotis and Thomakos Dimitrios - The Baltic Dry Index: Cyclical Analysis and Forecasting, Quantf Research Working Paper Series, 2013

[6] Studenmund A. H. - *Using Econometrics- a practical guide, fifth edition*, Pearson: Occidental College, 2006

[7] Theodoulidis Babis and Solís David Díaz - *Analysis of the Baltic Exchange Dry Index Using Data Mining Techniques*, Manchester Business School University of Manchester, 2009

[8] Wong Hsien-Lun, Tu Yi-Hsien and Fan Shen-Yi - *Integrated GRA with Entropy Method to Evaluate Factors Affecting Baltic Dry Index*, ICGEC '10 Proceedings of the 2010 Fourth International Conference on Genetic and Evolutionary Computing, pp. 493-496, 2010

[9]Baltic Exchange

SUSTAINABLE CONSUMPTION IN THE AREA OF TRANSPORTATION

BRANZA GRATIELA

Constanta Maritime University, Romania

ABSTRACT

In the context in which sustainable development is one of the key objectives of the European Union, the need to develop and evolve towards more sustainable consumption and production patterns is a priority. Due to the fact that in the European Union and in the world the consumption sector related to food, housing and transport represents between 70% to 80% of all environmental impacts, promoting sustainable consumption is extremely important to limit negative environmental and social externalities as well as to provide markets for sustainable products. This paper captures some aspects regarding the definition of sustainable consumption and guidelines in the sphere of education for sustainable consumption. The paper also presents some good practice examples of sustainable consumption in the field of transportation and an efficient tool to measure consumer behaviour in the area of sustainable consumption in transportation – Greendex score.

Keywords: *sustainable, sustainable consumption, education, transportation, consumer, Greendex survey, sustainable behaviour*

1. INTRODUCTION

In 1994 the Oslo Symposium proposed a working definition of Sustainable Consumption as "the use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations". [9]

In the framework of the same symposium, Nick Robins and Sarah Roberts stated that "Sustainable consumption addresses the demand side, looking at how the goods and services required to meet basic needs and improve quality of life - such as food and health, shelter, clothing, leisure and mobility - can be delivered in ways that reduce the burden on the Earth's carrying capacity". [9] Carrying capacity is a concept related to sustainable development issues and represents the maximum number of individuals of a defined species that a given environment can support over the long term.

Dr. Emil Salim in his paper "The challenge of sustainable consumption as seen from the South" give another definition to this concept. According to his opinion, "Sustainable consumption implies that the consumption of current generations as well as future generations improves in quality. Such a concept of consumption requires the optimalization of consumption subject to maintaining services and quality of resources and the environment over time". [9]

Another interesting definition is that of Edwin G. Falkman, presented at Oslo Symposium in his paper entitled "Waste Management International. Sustainable Production and Consumption: A Business Perspective": "Sustainable production and consumption involves business, government, communities and households contributing to environmental quality through the efficient production and use of natural resources, the minimization of wastes, and the optimization of products and services".[9]

To understand this concept, we must focus on some essential aspects, such as: increasing life quality, improving resource efficiency, minimising waste, having in view the equity dimension. The biggest challenge for our society is how to improve life quality for current and future generations, while continuing to reduce environmental damage and to protect human health.

2. EDUCATION IN THE FIELD OF SUSTAINABLE CONSUMPTION

"Education is one of the most powerful tools for providing individuals with the appropriate skills and competencies to become sustainable consumers". [7]

UNESCO has designated 2005-2014 as the "Decade of Education for Sustainable Development". In this framework OECD will contribute by highlighting good practices in school curricula for sustainable development. Italy leads the Marrakech Task Force on Education for Sustainable Consumption, with the aim of producing lessons and exercises for sustainable consumption at all levels of education.

Many OECD countries are promoting sustainable consumption through developing and teaching curricula on subjects related to sustainable development. Other countries created education schemes included in sustainable consumption programmes. For example, Czech Republic is developing an "Action Plan for Education for Sustainable Consumption"; United Kingdom proposed "I Will if You Will" – an action plan for sustainable development in education and skills; Sweden initiated the sustainable consumption programme "Think Twice!". Moreover, UK and Italy are supporting the establishment of "sustainable schools".

Besides, countries promote the development of "eco-schools", which is an international programme founded in 1994 with its main purpose to involve young people in addressing sustainable development issues at local level. In present, there are more than 14.000 participants in eco-schools network, mostly in Europe.

European Union is a good practice example in the field of education in sustainable consumption for its multi-country project entitled "Persuasive Power of Children Towards Energy Consumption". In this project students measured energy savings from different sources, participated in audits of school and household energy consumption.

3. GOOD PRACTICE EXAMPLES OF SUSTAINABLE CONSUMPTION IN TRANSPORT SECTOR

Transportation shows the highest growth of greenhouse gas emissions, affecting biodiversity, leading to substantial health effects and causing many road accidents. Due to these reasons, mobility has been a focus of sustainable consumption. [5]

It is useful to present some examples for sustainable consumption in the field of mobility, in order to reveal the elements that influence consumption and consumer behaviour, as: infrastructure, drivers, opportunities and policies.

One of the good practice examples is Odense, a danish city which developed a network of bike paths. The investments in infrastructure and the bicycle promotion campaign led to the increase of the percentage of bicycle use at 24% and so, to a remarkable level of biking. In this case, it was essential the policy developed in infrastructure and awareness of this.

A similar example is „VELIB" (free bike) – a programme launched in France in 2007, that placed 20.000 bicycles at more than 1000 stations around Paris in the attempt to reduce car traffic and pollution. [7]

Another good practice example is „ZEUS", the acronym for „Zero and Low Emission Vehicles in Urban Society". This project arised from the collaboration between 8 cities: London, Stockholm, Helsinki, Copenhagen, Bremen, Luxembourg, Athens and Palermo. The principal aim of every project partner was to obtain positive ecological effects in the transport sector through „green purchasing" (alternatively fuelled cars) by public agencies and the development of a rudimentary refuelling infrastructure. „ZEUS" case indicates that a strategy that focuses mainly on technological improvements can contribute significantly to the reduction of greenhouse gases.

An interesting project that stressed the role of a change in infrastructure and the rising of awareness for sustainable behaviour is „The Sustainable Transport Modes Strategy in San Sebastian". It started in 1990 and its major purpose was to promote more sustainable methods of transport and to win back public space. The results of this project were significant, as „the number of passengers using public transport has increased by 10%, cycling accounted for over 1% in the modal breakdown of the city and 120,000 square meters space could be won back from the motorized traffic". [5]

From the examples given below, we can conclude that the goals of sustainable consumption measures in the area of mobility can be [5]:

1. Reducing the demand for mobility or limiting its growth by diminishing the distances between home, work place, schools, recreational areas etc.;
2. Influencing the modal split by reducing the areas accesible to cars, by lowering the availability of parking and by promoting environmentally friendly transportation such as biking and public transportation;
3. Increasing the occupancy (load factor) aiming to reduce the number of cars on the road;
4. Influencing the technology choice by encouraging the choice of environmentally friendly or energy efficient cars or providing for renewable fuels.

The majority of the examples indicate that soft policies, like awareness campaigns and active participation of the residents are essential for success.

4. "GREENDEX" – INSTRUMENT OF QUANTITATIVE MEASURING OF CONSUMER BEHAVIOUR IN THE AREA OF SUSTAINABLE CONSUMPTION

Greendex is a survey initiated and realised by National Geographic Society and research consultancy GlobalScan in 2008, 2009, 2010 and 2012. The first Greendex survey studied 14 countries around the world in order to analyse the obstacles and opportunities that people cope with in becoming sustainable consumers. The results showed that consumers in developed countries have a greater impact on the environment than others and they can make more sustainable choices.

"Each respondent earned a score reflecting the environmental impact of his or her consumption patterns within each and four corresponding sub-indices were created. Consumers were then assigned an overall Greendex score out of 100, based on their performance within the four sub-indices."[6]

The results of Greendex Survey 2012 showed that India ranks first and USA last in sustainable behaviour. The sample has comprised 17.000 consumers in 17 countries and the survey's organiser focused on measuring the number of environmentally friendly people in the world in 65 areas relating to housing, transportation, food and consumer goods.

According to the survey, Indians had the most sustainable behaviour with a Greendex score of 58,9; followed by China at 57,8 and Brazil at 55,5. USA ranked last in the Greendex with 44,7% and France ranked last in Europe. [2]

Table 1. Greendex scores by country in the period 2008-2012

Country	2008	2009	2010	2012
India	58.0	59.5	62.6	58.9
China	55.2	56.7	57.3	57.8
Brazil	58.6	57.3	58.0	55.5
Hungary	51.7	53.3	54.1	54.4
South Korea	-	54.6	52.8	54.4
Mexico	52.7	53.8	54.8	53.9
Argentina	-	54.7	54.2	53.6
Russia	51.1	52.0	54.2	53.1
Germany	48.1	51.1	50.0	51.5
Spain	48.0	51.4	50.4	51.2
Sweden	-	51.1	50.7	49.7

Britain	48.2	49.4	49.6	49.4
Australia	47.8	50.5	50.3	49.2
France	46.5	49.5	48.9	49.0
Japan	47.4	49.3	49.7	48.5
Canada	46.3	47.5	47.9	47.9
America	42.4	43.7	45.0	44.7

Source: [6]

Data presented in table 1 point the fact that consumers in countries like India, China, Brazil, Mexico tend to be more concerned about important environmental aspects, such as: air pollution, climate change, water pollution, species loss, shortages of fresh water – all these factors affecting the quality of life in the world. In opposition to this approach, the American, French and British consumers are more concern about the economy and the cost of energy and fuel.

Greendex survey's results show that South Koreans, Germans, Spanish and Chinese registered the biggest increases in 2012 than in 2010 regarding environmentally sustainable consumer behaviour. In contrast, India, Brazil and Russia recorded decreases of their Greendex scores since 2010.

4.1. Greendex – Transportation sub-index

The survey's results showed that the biggest increase of transportation sub-index score was recorded by French and the largest decreases were registered by Indians and Argentineans (see table 2).

Table 2. Transportation sub-index scores by consumers in each country in 2010 and 2012

Consumers	2010	2012
Chinese	68.8	69.0
Hungarians	67.2	68.1
Indians	70.1	67.3
Brazilians	66.4	67.1
Russians	67.6	66.4
Japanese	65.6	65.9
South Koreans	63.6	64.5
Argentineans	66.9	64.1
British	63.4	62.7
Swedes	62.2	62.4
Mexicans	64.3	62.2
Spanish	61.1	62.1
Germans	60.8	61.9
French	57.3	58.9
Australians	56.9	58.2
Canadians	57.4	57.8
Americans	53.7	54.9

Source: [6]

As it is shown in table 2, Chinese and Hungarians occupied the first two places, with the highest transportation sub-index scores in 2012. The last two places were taken by Canadians and Americans with the lowest scores.

The results of Greendex survey 2012 stressed that "the possession of cars or trucks remains much more common among consumers in industrialized economies than those in rapidly developing countries".[6]

In data analysis results that:

- in Argentina and Mexico there is an increasing number of consumers who say they drive alone regularly;

- Australians, French, Germans and Spanish consumers report that they don't drive with no passengers;

- Chinese, Mexican and Indian consumers say that they choose to live close to their usual destinations to minimize the impact of their personal transportation on the environment;

- the frequency of use public transportation is low in most countries. Chinese consumers prefer to walk or ride a bicycle to their usual destination, while Australian, French, Canadian , American consumers use personal cars much more than public transportation.[6]

5. CONCLUSIONS

Promoting sustainable consumption is extremely important to limit negative environmental and social externalities, especially in transportation, which is responsible for most damage to the environment.

In its Communication „Roadmap to a Resource Efficient Europe" European Commission has settled as milestone the following: „by 2020 overall efficiency in the transport sector will deliver greater value with optimal use of resources like raw materials, energy, and land, and reduced impacts on climate change, air pollution, noise, health, accidents, biodiversity and ecosystem degradation. Transport will use less and cleaner energy, better exploit a modern infrastructure and reduce its negative impact on the environment and key natural assets like water, land and ecosystems. There will be on average a 1% yearly reduction, beginning in 2012, in transport GHG emissions".

Education is a vital instrument which can lead to the accomplishments of these goals, as many countries all over the world have developed and promoted „eco-schools" and curricula on subjects related to sustainable development.

Moreover, awareness campaigns and active participation of the residents are essential for success regarding sustainable consumption in the area of transportation. For example, the community can influence the modal split by reducing the areas accesible to cars, by lowering the availability of parking and by promoting environmentally friendly transportation such as biking and public transportation.

Everybody wants to live a more environmentally friendly lifestyle, as Greendex survey show, measuring the impact of the average consumer in each country studied with this main purpose. Besides, each of us can place on the Greendex scale by visiting national geographic. com/greendex and by taking an abbreviated survey.

6. REFERENCES

[1] COMISIA COMUNITATILOR EUROPENE, *COM(2008)397 final, Comunicare cu privire la Planul*

de actiune privind consumul si productia durabile si politica industriala durabila, Bruxelles, 2008
[2] CHADHA, M., *Greendex survey 2012: India ranks first, USA last in sustainable behaviour*, www.cleantechnica.com
[3] EUROPEAN COMMISSION, *Roadmap to a Resource Efficient Europe,* COM(2011)571 final, Brussels, 2011
[4] EUROPEAN COMMISSION, *Making sustainable consumption and production a reality,* Publications Office of the European Union, Luxembourg, 2010
[5] HERTWICH, E., KATZMAYR, M., *Examples of Sustainable Consumption: Review, Classification and Analysis*, International Institute for Applied Systems Analysis, Austria, 2004
[6] NATIONAL GEOGRAPHIC SOCIETY, GLOBESCAN, *Greendex 2012: Consumer Choice and the Environment*, Highlights Report, 2012, www. nationalgeographic.com
[7] OECD, *Promoting Sustainable Consumption. Good practices in OECD countries,* 2008, www.oecd.org
[8] WORLD ECONOMIC FORUM, *Sustainability for Tomorrow's Consumer. The Business Case for Sustainability*, 2009, www.weforum.org
[9] www.iisd.org

ANALYSIS OF TRANSPORT'S EXTERNAL COSTS IN THE EUROPEAN UNION

BRANZA GRATIELA

Constanta Maritime University, Romania

ABSTRACT

Pricing in transport is a complex process that depends mainly on costs. Before the promotion of sustainable development concept in every area of activity, the environmental costs were not being considered and included in transport pricing. But, for many years European Commission have taken these costs into account and sustained the internalisation of external cost in transport as an essential purpose in order to obtain fair and efficient pricing in the field of transportation. The present paper stresses the importance of external costs in transport sector and analysis this component of transport price in the case of every transport modes, especially in maritime shipping.

Keywords: *external costs, European Union, internalisation of external costs, road, rail, inland navigation, aviation, maritime shipping.*

1. INTRODUCTION

Although transport contributes significantly to economic growth, it generates side effects, through its negative influence on the citizens' health and on the environment resources. These effects are known as external effects, such as congestion, accidents, air pollution, noise, impacts on climate change and the cost associated to these are called "external cost".

For many years, the European Commission has raised the problem of estimation and internalisation of external cost of transport in the framework of research and policy development in the field of transportation. In all its strategy papers, the European Commission promoted "the need of fair and efficient pricing considering external costs."[1]

Some examples of this kind of works are:

- COM(95) 691, *Green Paper: Towards fair and efficient pricing in transport*, Brussels, 1995;
- COM (2009) 279 final, *A sustainable future for transport:Towards an integrated, technology-led and user-friendly system,* Publications Office of the European Union, Luxembourg, 2009;
- COM (2011) 144, *White Paper – Roadmap to a single European Transport Area- Towards a competitive and resource efficient transport system,* Publications Office of the European Union, Luxembourg, 2011.

2. INTERNALISATION OF EXTERNAL COSTS BY MODES OF TRANSPORT

An important challenge for European Union transport policy is the internalisation of external costs. "Internalisation, which is often referred to as the "user pays" and "polluter pays" principle means that these costs are made part of the decision making process of the users, usually by introducing market based instruments".[12]

"The polluter pays" principle is mentioned in the European Union Treaty as: "Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay".[12]

In the case of *road transport*, the Eurovignette Directive represents a central element in the European Union policy for internalisation of external costs. Its 2011 revision give the opportunity to member states to charge the full infrastructure costs, including some external costs like air pollution and noise.

In future distance-based systems of charging will replace time-based systems like the Eurovignette, as improvements in vehicle tracking technology can create opportunities for this method of charging.

Taking a brief look to *rail transport*, the instruments considered for the internalisation of external costs in this sector are railway infrastructure access charges and gas oil and electricity excises. The study analysed in this paper shows that all countries charge the wear and tear costs, some countries apply access charges including congestion costs and only few countries consider environmental or accidents costs (Czech Republic, Finland, Latvia, Sweden and United Kingdom).

Regarding energy taxation to railways, environmental costs are internalized through gas oil taxation (e.g. Finland, Ireland, Slovenia) and not through electricity taxation. This fact leads to the cancellation of the Emissions Trading System's impact on rail transport.

Referring to Value Added Tax (VAT) rates on energy for rail transport, almost every member states applies the domestic standard rate. Only Denmark applies a VAT exemption. In the case of intra-community and international transport most of the countries apply VAT exemption with refund of tax paid.

For *inland navigation*, port dues represent the principal charging measure, that all member states apply according to their local government's decisions. One of the main characteristics of internalisation of external costs is that this action is made indirectly through differentiation in vessel size.

An essential effect of the Mannheim Convention and Danube Convention is that all commercial inland vessels are exempted from fuel taxes in almost every member states of the European Union.

In *maritime shipping* the most important charging measures are fuel taxes, sea port dues, waste charges, fairway dues, VAT exemptions, VAT discounts. Some ports offer a discount based on the Environmental Ship Index Scheme, some based on the Green Award Certificate, or a NOx/SOx discount, sulphur fee.

The conclusions of the document analysed in this paper are that in many ports specific dues are raised on the cargo loaded/unloaded in the port, on passengers and their cars embarked/disembarked and for making use of quays. The waste charges are differentiated according to a certain characteristic of the vessel. The VAT rate for international sea passenger transport is zero in all member states and for domestic sea passenger transport usually the reduced standard VAT rate is applied.

Regarding *aviation* area, in all European Union member states' airports landing and take-off charges (LTO), passenger charges and parking charges are applied. Some of the airports have noise and emission charges. The calculation of noise charges takes into account factors, such as: effective perceived noise decibel at take-off, side-line and approach, the time of arrival or departure, the maximum take-off weight of the aircraft.

In aviation sector, emission charges are all based on the amount of emission value in terms of kg NOx in the LTO cycle and are calculated according to a general accepted calculation method. Only the tariffs per kg NOx differ among the airports, recording values from 2.22 euro to 7.78 euro.[12]

For international air passenger transport all the European Union countries don't apply VAT rate. Instead, for domestic air passenger transport most countries apply the standard VAT rate or a reduced one.

3. ANALYSIS OF EXTERNAL COSTS IN MARITIME TRANSPORT

Maritime transport has been a growing sector in the past 20 years worldwide and is one of the economically most important sectors in Europe. Ships transport 90% of the European Union's world trade volume and 40% of its internal commodity exchange. European harbours handle 3,5 billion tons annually. [18] This fact is the result of an increase in the number of ships, the cargo and the size of ships, as we can see in the figure below (year 1=1980, year 2=1985, year 3=1990, year 4=1995, year 5=2000, year 6=2005, year 7=2007).

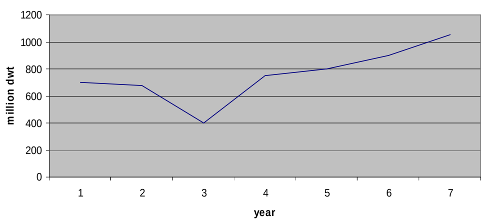


Figure 1. Evolution of world fleet in the period 1980-2007

Source: [18]

Empirical studies consider congestion, accidents, environmental and climate change costs. In the case of maritime costs, congestion and noise costs are considered a negligible component and accident costs are assessed similarly for other transport modes (see table 1).

Table 1. Specification of cost components according to transport modes

Cost component	Road	Rail	Air	Maritime
Costs of scarce infrastructure	Individual transport determines collective congestion.	Scheduled transport is causing scarcities and delays.	Scheduled transport is causing scarcities and delays.	Congestion is individual, if there isn't slot allocation in ports.
Accident costs	Level of externality depends on the treatment of individual self accidents. Insurance covers compensation of victims.	Difference between driver and victims. Insurance is covering parts of compensation of victims.	Difference between driver and victims. Insurance is covering parts of compensation of victims.	No major issue.
Air pollution costs	Roads and living areas are close together.	The use of diesel and electricity should be distinguished.	Air pollutants in higher areas have to be considered.	Air pollutants in harbour areas are complicated to allocate.
Noise	Roads and living areas are close together.	Rail noise is less annoying than other modes, depending on the time of day and the frequency of trains.	Airport noise is more complex than other modes.	No major issue.
Climate change	All GHG relevant.	All GHG relevant, considering use of diesel and electricity production.	All GHG relevant.	All GHG relevant.

Source:[14]

Regarding air impacts, ship emissions on atmosphere include ozone and aerosol precursors (NOx, CO, VOCs, SO_2 etc.) and the emissions of greenhouse gases. Emissions from ships contribute to climate change, as ship emissions let out 150-300 times more sulphur and twice as much NOx per ton-kilometre than a truck.

Being compared with other transport modes, maritime transport has "significant impacts on water, due to the effects of ballast water and the use of antifouling varnish. Last but not least, maritime transport produces important impacts on soil, due to the high land use consumption entailed by location of harbours and due to sediment deposition".[14]

So, the conclusion is that the assessment of environmental costs is extremely important in order to calculate external cost of maritime transport.

Maritime shipping is considered less harmful to the environment than road transport. But recent studies change this statement due to the environmental effects of maritime transport: "It is estimated for the year 2000 that SO_2 and NOx emissions from international maritime shipping in Europe amounted to approximately 30% of the land-based emissions in the European Union. Under business-as usual assumptions, SO_2 emissions from international shipping are computed to increase by more than 40% between 2000 and 2020, NOx emissions by 47% and $PM_{2.5}$ emissions by 56%. The European Commission expects that by 2020 the emissions of SO2 and NOx from maritime transport might exceed emissions from all other sources."[18]

Pollution from oil and other hazardous or noxious substances is one of the biggest negative effect that shipping can have on the marine ecosystem. This effect can have economic and social implications, referring to wildlife, tourism and marine environment.

In order to reduce these risks new improved measures and technical standards have been applied at European Union level. Many "technological advances allowed international regulations to be adopted, reducing the permitted operational discharge of oil effluent from machinery space bilges from 100 parts per million (ppm) to 15 ppm".[17]

Another source of pollution are the emissions from cargo ships over 500 GRT. Maritime transport is an important participant to air pollution, through the emissions of carbon dioxide (CO_2), nitrogen oxide (NOx), sulphur dioxide (SOx) and particulate matter (PM). EMSA estimates that "about 45% of all emissions come from European Union flagged ships and approximately 20% of emissions are emitted within the 12 mile limit of territorial sea".[17] Even if they are emitted at sea, the emissions from ships can cause problems on air quality onshore.

In order to resolve these problems, IMO has developed some policies to reduce greenhouse gas (GHG) emissions from ships. In this context, "market-based instruments are cost-effective policy instruments with high environmental effectiveness."[17]

4. CONCLUSIONS

Considering the negative effects that transport activity determines, it is essential to include the external cost associated to these in prices. So, congestion cost, accidents cost, air pollution cost, noise cost, climate change cost must be considered in the establishment of a fair and efficient pricing in transport sector.

There are different instruments of internalising external costs according to the characteristics of the transport mode. So, in road transport the Eurovignette Directive is used for internalisation of external costs. In rail transport the instruments are railway infrastructure access charges and gas oil and electricity excises. Inland navigation uses port dues as the principal charging measure. Regarding aviation area, in all European Union member states' airports landing and take-off charges (LTO), passenger charges and parking charges are applied.

Maritime transport uses fuel taxes, sea port dues, waste charges, fairway dues as principal charging measures. Being compared with other transport modes, maritime transport can have the highest negative effects on the marine ecosystem, with major economic and social implications. In order to reduce these risks, new improved measures and technical standards have been applied at European Union level.

5. REFERENCES

[1]CE Delft, *Handbook on estimation of external costs in the transport sector*, Delft, CE, 2008, www.ce.nl

[2]CE Delft, Infras, Fraunhofer ISI, *External Costs of Transport in Europe*, 2011, www.cedelft.eu

[3]ECORYS Transport, METTLE, *Charging and pricing in the area of inland waterways*, www.ecorys.com, Rotterdam, 2005

[4]ECORYS Transport, Consultrans, *Analysis of the impact of oil prices on the socio-economic situation in the transport sector*, www.ecorys.com, Rotterdam, 2006

[5]European Commission, *EU Transport in Figures,Statistical Pocketbook*, Publications Office of the European Union, Luxembourg, 2012

[6]European Parliament, *Achieving sustainable, efficient and safe transport in Europe,* Luxembourg, 2009, http:/www.europarl.europa.eu

[7]European Commission DG VII, COM(95) 691, *Green Paper: Towards fair and efficient pricing in transport,* Brussels, 1995

[8]European Commission, *EU Transport in Figures,Statistical Pocketbook,* Publications Office of the European Union, Luxembourg, 2012

[9]European Parliament, *Achieving sustainable, efficient and safe transport in Europe,* Luxembourg, 2009, http:/www.europarl.europa.eu

[10]European Commission DGET, COM (2009) 279 final, *A sustainable future for transport:Towards an integrated, technology-led and user-friendly system*, Publications Office of the European Union, Luxembourg, 2009

[11]European Commission, COM (2011) 144, *White Paper – Roadmap to a single European Transport Area-Towards a competitive and resource efficient transport system*, Publications Office of the European Union, Luxembourg, 2011

[12]European Commission, *Final Report: An inventory of measures for internalising external costs in transport,* Brussels, 2012

[13] MO, *International Shipping Facts and Figures – Information resources on Trade, Safety, Security, Environment,* Maritime Knowledge Centre, 2012, www. imo.org

[14] Miola A., Paccagnan V., Mannino I., Massarutto A., Perujo A., Turvani M., *External costs of transportation. Case study: maritime transport*, 2009, www.jrc.ec.europa.eu

[15] OECD, *External Costs of Transport in Central and Eastern Europe*, www.oecd.org

[16] Organisation for Economic Cooperation and Development, *Globalisation, Transport and the Environment*, www.oecd.org/env/transport/globalisation
[17] OSPAR Commission, *Assessment of the impacts of shipping on the marine environment, Monitoring and assessment series*, 2009, www.ospar.org
[18] Sieber N., *Environmental Costs of Maritime Shipping in Europe*, www.niklas-sieber.de
[19]www.eea.europa.eu
[20]www.emep.int

MARKETING RESEARCH ON STUDENTS' PERCEPTION REGARDING ECONOMIC ENGINEERING IN TRANSPORTS SPECIALIZATION

[1]CRISTEA VIORELA- GEORGIANA, [2]OLTEANU ANA- CORNELIA, [3]SURUGIU IOANA

[1,2,3]Constanta Maritime University, Romania

ABSTRACT

This research aims to analyze the students' perception over their faculty, Faculty of Navigation and Naval Transport, regarding Economic Engineering in Transports specialization from Constanta Maritime University. This research aims to highlight the students' view about the way their faculty is being perceived. Also, this research aims to analyze the differences between those from Economic Engineering in Transports and those from other faculties within Constanta Maritime University. Another objective of this study case is to reduce uncertainty over the management's marketing behavior because it provides information about college students regarding their attitudes, opinions and behavior. The research technique used in this project is based on a questionnaire survey method.

Keywords: *questionnaire, education, Economic Engineering in Transports, students.*

1. INTRODUCTION

The educational process completed with extracurricular activities is the most important mean of training the interests of knowledge for different fields. The school is an educational forming and guidance institution that should form a person able to adapt quickly to labour markets' requirements that are constantly changing.

Rightly stated by Albert Einstein, "Education is what remains after one has forgotten everything he learned in school", university education is important as it improves an individual's quality of life, it also give a chance to greater economic stability and security, a good job as well as better salaries and a good life. Higher education improves an individual's quality of life.

Studies have shown that, compared to high school graduates, college graduates have longer life spans, better access to health care, better dietary and health practices, greater economic stability and security, more prestigious employment and greater job satisfaction, less dependency on government assistance, greater knowledge of government, greater community service and leadership, more volunteer work, more self-confidence, and less criminal activity and incarceration. University education is more than the next level in the learning process; it is a critical component of human development worldwide. An educated populace is vital in today's world, with the convergent impacts of globalization, the increasing importance of knowledge as a main driver of growth, and the information and communication revolution.

The reason a person chooses to attend a college is the need of intellectual developing. There are many reasons that drive one person to choose a college or another, like:

-Curiosity and desire to understand the surrounding facts and phenomena;

-Satisfaction produced by constructive activities, which university provides;

-Pleasant feeling of personal progress;

-Desire to occupy a leading place in a competition;

-Willingness for cooperation through group actions.

There are many cities where the transport on wheels, by railway or air are interconnected with river and maritime transport, which makes it the ideal area for developing this specialization. The Economic Engineering in Transports specialization gives the graduates alternatives for a future career in the field of transports. It is also a good alternative for students who want to have two degrees or graduates of other specializations who choose to work ashore. The students have the chance to sit fewer exams than the usual because they have already passed them while studying a previous specialization within Constanta Maritime University. At the end of studies (4 years) they get a diploma of engineer – economist, which offers graduates more flexibility on the labour market.

The research technique used in this project is based on a questionnaire survey method. The questionnaire which we have proposed is an opinion one, which refers to data that we have not observed directly. On the other hand, it is known that there's not always a convergence between expressed opinions and actual behaviour.

We chose this form of survey because it allows students to respond honestly to questions, not being constrained by the fact that their answers could be used for other purposes.

As you may know, questionnaires are common tools used for many different topics to obtain feedback. The most common functions of a questionnaire is market research, it is a good way to gather information from a group of people and if we refer to organizations or businesses it is used to collect information which is used to make improvements in the organization.

Questionnaires consist of the same set of questions that are asked in the same order and in the same way in order that the same information can be gathered. It is an important element in the research process and its design directly affects the quality of the data collected.

In "Data Collection in Context" (1981), Ackroyd and Hughes identify three types of survey:

1. Factual surveys: used to collect descriptive information, i.e. the government census;
2. Attitude surveys – used to collect and measure people's attitudes and opinions, i.e. 4 out of 5 people believe;
3. Explanatory survey - goes beyond the collection of data and aims to test theories and hypotheses and / or to produce new theory.

Using a questionnaire has many advantages like: respondents have time to think about their answers; they are not usually required to reply immediately, it is very cost effective when compared to face-to-face interviews (as the number of research questions increases it become more cost effective), it is simple to administer, it is easy to analyse the data, it is less intrusive than other surveys and most of all it is familiar to most people and it is practical.

It also has some disadvantages some of which include: respondents may ignore certain questions, questions may be incorrectly completed and respondents may read differently into each question and therefore reply based on their own interpretation of the question or if you forget to ask a question, you cannot usually go back to respondents, especially if they are anonymous.

A questionnaire is intended to gauge one's perception and is designed to be completed swiftly. In our case the questionnaire is designed to investigate the student's perception about their specialization, Economic Engineering in Transports.

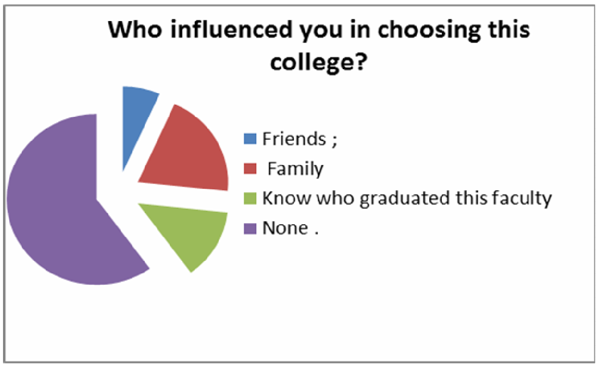
2. SAMPLES' DETERMINATION AND DATA' INTERPRETATION

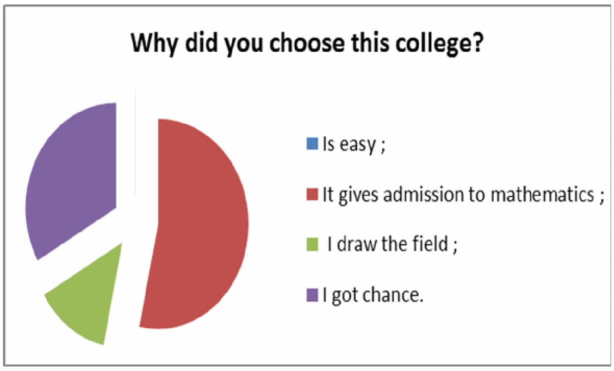
The sample is compounded of 100 subjects, all students at Constanta Maritime University, Economic Engineering in Transports specialization. The reason why we choose only students from this college is the desire to have a more complete view of research on the studied problem.

Data analysis and interpretation is the process of transforming the data collected into credible evidence, assigning meaning to the collected information and determining the conclusions.

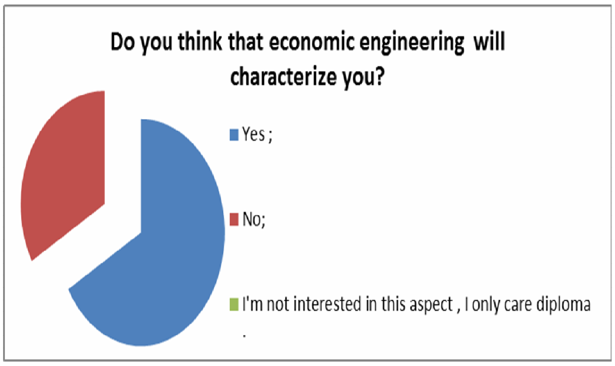
Further the questionnaires' questions will be analyzed.

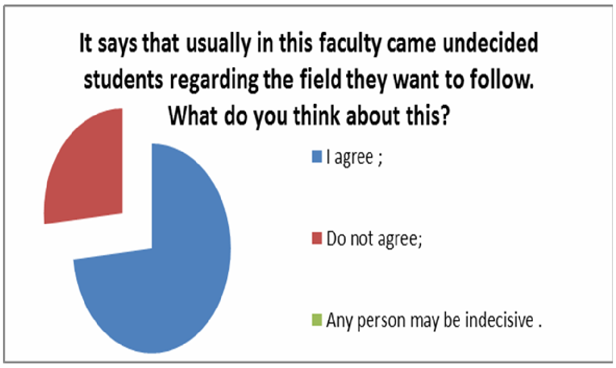
a) Most students said that there was no influence on their decision in choosing this college and the reason for their choice was due to the matter of admission, exact sciences being an advantage for them.



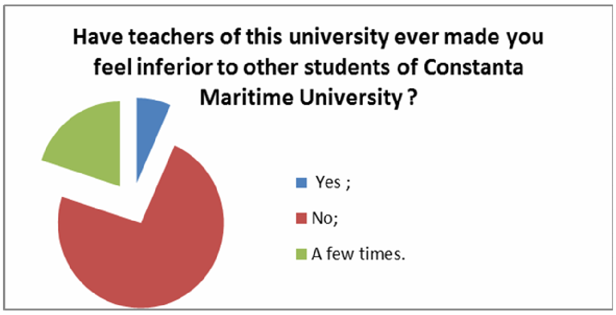


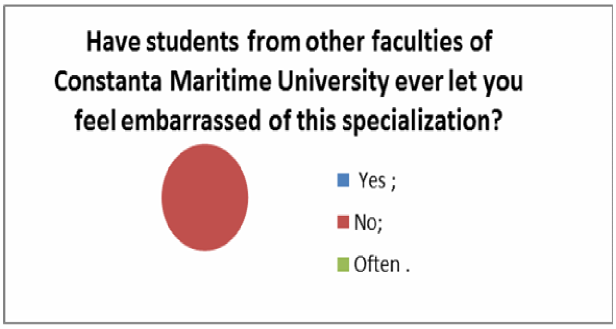
b) Most respondents said that economic engineering is definitely characterizing them, despite the fact that they think that at this university usually come college students undecided on the field they want to follow.

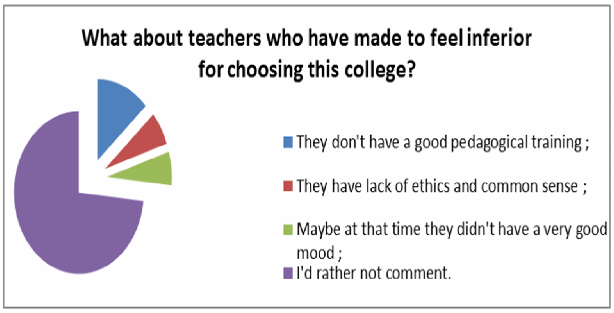




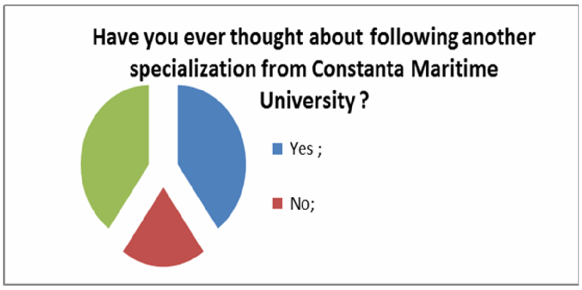
c) Following the survey it was proved once again that teachers of this college and its external collaborators have the necessary training, students attending courses of this specialization feeling supported, this being true also regarding students from this specialization versus students from other faculties from Constanta Maritime University.

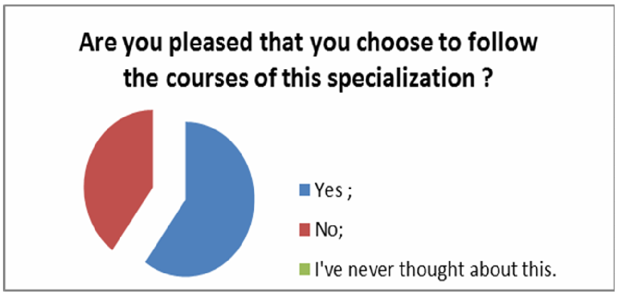


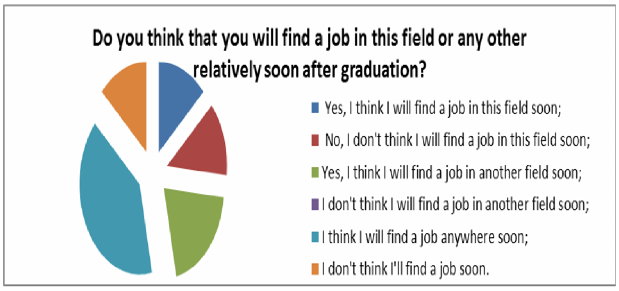




d) Regarding satisfaction of students who attend this specialization we can say that the results are satisfactory although opinions regarding other specialties are divided. The majority of respondents are optimistic about the rapidity of employment in any field they want to go.







3. CONCLUSIONS

The research can specify the following conclusions:
- Most students from Faculty of Navigation and Naval Transport, Economic Engineering in Transports specialization have a good perception about the decision of attending it.
- Due to the double specialization, both economics and engineering, students believe in their chance of getting a job more easily, having the possibility of employment as engineer or as economist. Thus, they perceived it as a college with two majors specializations that are both very useful and that will help them to obtain a good job.
- The university, having modern and well equipped laboratories, allows students a smooth development of classes and due to the fact that there are practice hours within specialized companies, where students can face real problems, help students to understand better the information received in classes.
- As a rough analysis of how professor teach, the respondents are satisfied and they have also this opinion regarding the way how exams are organized.

It may be noted that this faculty is the one that characterizes the students who are pleased of it and they are willing to recommend it to other prospective students. In conclusion, we can say that the perception of Constanta Maritime University students, from Economic Engineering in Transports specialization, is a favorable one.

7. REFERENCES

[1]. BURNS, ALVIN C., & Bush, Ronald F., *Marketing Research* (3rd ed.), New Jersey, USA: Prentice Hall, 2000
[2] CHELCEA, S., *Cunoaşterea vieții sociale: chestionarul şi interviul în ancheta sociologică*, Editura INI, Bucureşti, 1996
[3] De Singly, F., *Ancheta şi metodele ei, Iaşi, Editura Polirom*, Iaşi, 1998

[4]. ILUȚ, P., *Abordarea calitativă a socio umanului*, Editura Polirom, Iaşi, 1997
[5] K. Popper, *The Logic of Scientific Discovery*, 1959, reprinted 2004 by Routledge, Taylor & Francis
[6]. S. ACKROYD and J. A. HUGHES, *Data Collection in Context,* Longman, 1981
[7] SILVERMAN, D., *Interpretarea datelor calitative, Editura Polirom*, Iaşi, 2004
*** http://www.educationalpathwaysinternational.org
*** http://www.cmu-edu.eu
***http://www.statpac.com
***http://www.statcan.gc.ca

INITIAL PUBLIC OFFERS' IMPORTANCE IN FINANCING SHIPPING COMPANIES. CASE STUDY ON SCORPIO TANKERS INC

[1]CRISTEA VIORELA-GEORGIANA, [2]SURUGIU FELICIA, [3]SURUGIU IOANA

[1,2,3]*Constanta Maritime University, Romania*

ABSTRACT

In the shipping industry there is a dynamic business environment which determines shipping companies to get some other financial resources in order to maintain and develop on this market. Through this paper we want to establish the important role of the initial public offers on the stock market, from the different geographically regions; the probability that these offers might determine the success or failure of a company and the way of this financing process could be made by a company which needs resources for development and surviving on such unstable market, as the maritime market is. In order to show how the initial public offers work on the stock market we took an example of a maritime company, Scorpio Tankers Inc., whose shares are listed on New York Stock Exchange, from 2010.

Keywords: *Public offer, shares, transaction, underwriting spread, New York Stock Exchange.*

1. INTRODUCTION

Financing shipping companies has greatly expanded during the last years, moving from financing companies by dividing the value of the ship in 64 equal parts (each investor being able to buy parts of the ship), to finance through charter contracts (used as guarantees, especially time charter contracts), mortgaging ships, using credit (this is one of the most used methods of financing used in the last 30 years, especially because of the possibility of keeping the company's control, credits which can come either from commercial banks or from shipyards), through leasing (in maritime transport we have to do with financial leasing, due to the tax advantages offered so as accelerated depreciation) or attracting important investors, and in this case we refer manly at shipowners resources, different ways of association (the most significant being the Norwegian Association- K/S Companies), naval investment funds or public offers on stock exchange from different parts of the world.

As the business environment changes dynamically in the shipping industry, shipping companies turn to new financial instruments and markets to finance their investment plans. Shipping companies must develop strategies and procedural structures appropriate for companies able to participate on the capital markets (Figure 1).

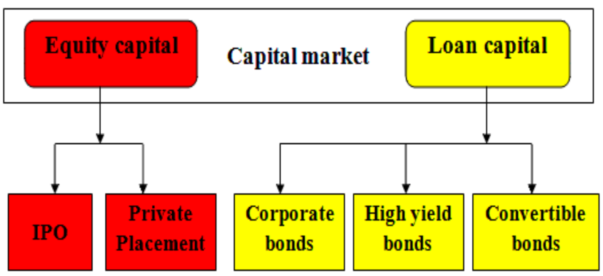


Figure 1 Financing source on the capital market
Sources: www.kpmg.com

2. GENERAL DISCRIPTION

Although financing companies through equity ownership might be the most profitable financing way, due to the capital intensive nature of shipping business, these could determine the low payment or no dividend to investors, who have to accept this reality because most of the times the retained earnings are channelled on fleet replacement and expansion.

An important problem for shipping companies interested in raising equity in the stock market is the pricing of the new issues. In is known that the majority of shipping IPOs refer to bulk shipping offerings, so it is expected that the issuer will set an IPO price at or near market-adjusted net asset value per share. This is reasonable in cases where company earnings and cash flows fully support net asset value (Stokes, 1997). In practice, however, ship prices in the second-hand market do not necessarily reflect operating cash flow and earnings generated by the ships. More frequently, ship prices represent a very high multiple of operating cash flow, whereas in certain bulk shipping segments operating earnings have been negative for a number of years. (Syriopoulos, 2007)

Shipping companies may obtain important financial resources within the public offers on the stock market from different parts of the world. In the maritime transportation's domain, shipping stocks are usually list in: New York, Oslo, Hong-Kong, Singapore or Stockholm (the US stock markets, NYSE and NASDAQ are on the first place in attracting most shipping IPOs, followed by Oslo; London loosed first place, which it has been gained during the last years).

Figure 2 shows the distribution of IPOs over the sectors of the economy.

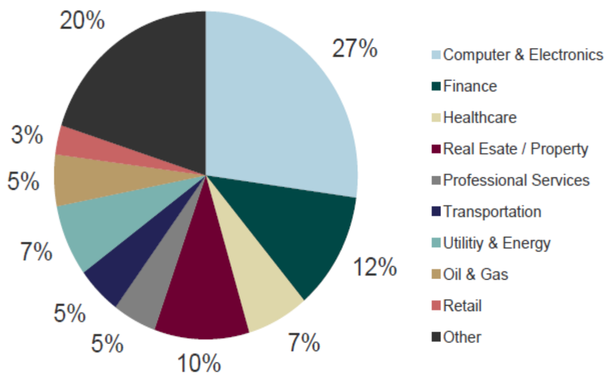


Figure 2 IPOs By Industry
Sources: www.marinemoney.com

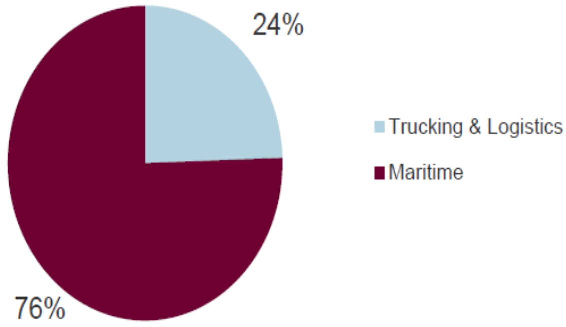


Figure 3 Transportation IPOs
Sources: www.marinemoney.com

A public offer is a type of public offering in which the stock or bonds of a company are sold to the public. Through this process, a private company becomes a public one. Initial public offerings are used by companies to expand their capital and to become tradable companies. A company that sells shares is never required to repay capital to public investors. After the initial public offer, when shares are freely traded on the open market, the money is divided between public investors.

A company can consider an IPO as an alternative only if it is a leading player in the growing and profitable segments of the market, driven by motivation of the personnel and commitment of the key managers to the success of the business (human factor is very important) or it is demonstrating sustainable growth rates and capability to win in a competitive environment.

There are many factors that influence the success of an initial public offering, both in terms of controlling a shipping company within and outside it. Those factors can include:
- overall public capital markets;
- investor perception about the shipping company and about the segment of which it forms part;
- the results of the company;
- experience, quality and commitment of the company's management and Board of Directors.

Shipping IPOs are distinct from those of ordinary industrial or service companies. The market value of a shipping company is often closely associated to the underlying value of the physical assets (vessels). In this respect, shipping IPOs bear similarities with the respective IPOs of closed end funds and property companies. Furthermore, due to extensive information flows in international vessel sales and purchase markets, shipping IPOs tend to exhibit lower information asymmetry. Figure 2 shows transportation IPOs, from which one can easily see that the maritime transport has a large share compared to road transport.

On IPO stock market performance, the following important factors were considered: size of the company, gross proceeds of the IPO issue, proportion of equity offered, gearing level, age of the company and age of the fleet.

3. ADVANTAGES AND DISADVANTAGES

It is true that going public in shipping and not only, is not always an attractive alternative for many companies, this source of financing brings with it many advantages such as:
1. The company will raise a large amount of cash, that can be used for its expansion plans, its growth, its competitiveness or establish an improved financial structure, but also for further research and development or to expand its products and services.
2. After becoming public the company will have access to the public capital markets, which generally enables it to raise money more quickly with less cost and more flexibility than in the private markets
3. The company will receive worldwide media coverage through the financial markets. Listed companies are thought of as financially healthy and having high standards of transparency and information disclosure; it increases the company's credibility and it will reflect positively on is services and products.
4. Becoming public, brings benefits for current employees, who can see the results of their efforts in the share price more immediately. It is sure that allowing employees to benefit alongside the company's financial success will increase productivity and loyalty to the company, which will attract for sure top talent.

Becoming a public company has significant disadvantages as well, some of which include:
1. An IPO is a costly undertaking. Public offerings involve many costs like investment bankers' commissions, lawyers and accountants' fees, ancillary costs, such as public relations, printing, corporate advertising and others, including the costs of maintaining a quote on the stock exchange (stock exchange fees, management time, more extensive audits and reporting, etc.).

2. In order to become public a company needs to disclose information on a regular basis so that investors and potential investors can make buy, sell or hold decisions. This costs money and discloses information to competitors.
3. After becoming public the outsiders often could take control and even fire the entrepreneur which will lead to a big loss of control.
4. The IPO entrepreneurs are allowed to cash out only many months after the initial public offer, due to various restrictions.

4. CASE STUDY

Going over the past we will find an eloquent example which will show the benefits of an IPO. In 1993, Bona Shipholding Ltd, issued on 17 December 1993 on the Oslo Stock Exchange a prospectus offering 11 million shares at 9$ per share. It is known that the price is determined by market supply and demand, so by 1996 the Stock in Bona Shipholding Ltd was trading at 11.79 $, allowing investors willing to sell to get a profit of 2.79 $ per share.

In order to show how this work we took an example of a maritime company, Scorpio Tankers Inc., whose shares are listed on New York Stock Exchange, from 2010 under the symbol "STING".

Scorpio Tankers Inc. is an important company which provide seaborne transportation of refined petroleum products and crude oil worldwide. In October 2009 they began their operations with only three vessels and operating subsidiary companies. Scorpio Tankers Inc. is incorporated in the Republic of The Marshall Islands and has principal executive offices in Monaco and New York. In April 2010, they completed their initial public offering of 12,500,000 shares of common stock at a public offering price of $13.00 per share. Since then they expanded their fleet and in 2013 their fleet consists of 14 wholly owned tankers (one LR2 tanker, four LR1 tankers, one Handymax tanker, seven MR tankers, and one post-Panamax tanker), with a weighted average age of approximately 4.4 years and they have also contracts for the construction of 33 additional new building vessels. It is important to notice that since their initial public offering closed on April 6, 2010, they haven’t paid a dividend.

At December 31, 2010, they had 24,634,913 registered shares authorized and issued with a par value of $0.01 per share. These shares provide the holders with rights to dividends and voting rights. Due to their annual report presented on New York Stock Exchange, we can notice how many shares were sold and at what price:

- In May 2011, they closed on a follow-on public offering of 6,000,000 shares of common stock at $10.50 per share.
- In December 2011, they closed on the sale 7,000,000 shares of common stock in an underwritten public offering at an offering price of $5.50 per share.
- In April 2012, they closed on the sale of 4,000,000 shares common stock in a registered direct placement of common shares at an offering price of $6.75 per share.
- In December 2012, they closed on the sale of 21,639,774 shares of common stock in a registered direct placement of common shares at an offering price of $6.10 per share.
- In February 2013, they closed on the sale 30,672,000 shares of common stock in a registered direct placement of common shares at an offering price of $7.50 per share.
- In March 2013, they closed on the sale 29,012,000 shares of common stock in a registered direct placement of common shares at an offering price of $8.10 per share.

In the table below we can see the highest and lowest market price for their shares of common stock on the New York Stock Exchange.

Table 1. The highest and lowest market price for Scorpio Tankers Inc. shares of common stock

For the year ended	High	Low
December 31, 2010	$13.01	$ 9.50
December 31, 2011	$12.18	$ 4.28
December 31, 2012	$ 7.50	$ 4.93

Sources: www.nasdaq.com

As you can see since their initial public offering in April 2010, when the price per share was of $13.00, they have never had a price bigger that, so we can say that their “paper” profit was not big, but we can also see the big number of shares that were sold, which brought millions of dollars to the company. It is true that they also used other financing sources, but considering the economic crisis and its impacts regarding the maritime and port sector, we can easily say that for Scorpio Tankers Inc. becoming public was a good choice.

The market price has fluctuated widely since Scorpio Tankers Inc. become public as a result of many factors, including the prospects of their competition and of the shipping industry in general and in particular the tankers sector, differences between their actual financial and operating results and those expected by investors and analysts, changes in analysts' recommendations or projections, changes in general valuations for companies in the shipping industry, changes in general economic or market conditions and broad market fluctuations.

5. CONCLUSIONS

The financing process within public offers lead to important capital resources, but it can also be not the best source of capital resources.

The listing also open many financial doors such us:

- Due to the financial controlling process, public companies could obtain better prices when they have debt.
- As there is an important demand on the market, a public company could always obtain much more financial resources which allows mergers and purchases, the resources are translate as a part of the negotiation process.
- Agreements on the open market stocks within liquidities.

6. REFERENCES

[1]. Andreas Merikas, Dimitrios Gounopoulos, Christos Nounis, *Global Shipping IPOs performance*,2009

[2]. BĂTRÎNCA G., *Management financiar în transportul maritim*, ISBN: 973-7966-37-6, Editura Arvin Press, Bucureşti, 2004.

[3]. Brigham, E., & Ehrhardt, M., *Financial management: Theory and practice*. Florida: Southwestern Publications, 2004

[4]. Derrien, F. and A. Kecskes, *The Initial Public Offerings of Listed Firms.* Journal of Finance, 2007.

[5]. Draho, Jason., *IPO Decision, Why and How Companies Go Public*. Edward Elgar Publishing, 2004.

[6]. Kavussanos, M., & Visvikis, H., *Derivatives and risk management in shipping*. London: Witherbys Publishing, 2006

[7]. Marine Money Conference, *IPO for Shipping & Offshore -The Past, Present, & the Future*, 2011-2012

[8]. Sonny Allison, Chris Hall, David McShea, *A Guide for Entrepreneurs, Executives, Directors and Private Investors*, the Initial Public Offering Handbook, 2008.

[9]. Steven E. Bochner, Jon C. Avina, *Guide to the initial public offering*, Seventh Edition, 2010.

[10]. Stokes, P., *Ship finance: Credit expansion and the boom–bust cycle*. London: LLP, 1997.

[11]. Theodore C. Syriopoulos, *Financing greek shipping: modern instruments, methods and markets*, Research in Transportation Economics, 2007.

[12]. UNCTAD. Review of maritime transport. Secretariat Report of the United Nations Conference on Trade and Development. Geneva, 2006.

***http://www.inc.com/

***http://www.investopedia.com/

***http:// www.kpmg.com

*** http://www.marinemoney.com/

***http://www.nasdaq.com/

THE GEO-STRATEGIC AND GEO-POLITICAL SITUATION OF THE CAUCASUS AND THE BLACK SEA REGION AT THE BEGINING OF XXI CENTURY

[1]GEORGESCU STEFAN, [2]ZELHA ALTINKAYA, [3]DRAGAN CRISTIAN

[1,3]Constanta Maritime University, Romania, [2]Istanbul AYDIN University, Turkey

ABSTRACT

Historians' opinion is unanimous in considering that the Cold War was a war between the two dominant political and social systems: capitalism and socialism.

In fact, this war ended with the collapse of communism in the former Soviet Union. With the USSR a crucial geopolitical pole disappeared from the Pontic area and more than ten independent states occurred - Ukraine, Georgia, Lithuania, Latvia, Estonia, Kazakhstan, Armenia, Azerbaijan, etc. - involved in regional and international structures different in interests, orientations and forces, and some still dependent on Moscow, to a lesser or greater extent.

Naturally, the effects of this phenomenon have been passed on the Pontic basin. The Cold War at the beginning of the last decade of the last century, turned the Black Sea into a sum of states, of threats and interests, a phenomenon that profoundly altered the geopolitical reality of this space.

In the Black Sea region, with a vast economic and purchasing potential, live over 325 million inhabitants, which makes it become a huge market, still unsaturated, attractive for investments in various areas of cooperation, such as: transport, communications energy, tourism, etc. This region is endowed with all *energy sources*: oil, natural gas, coal, minerals, wood, etc., representing, in economic terms, a *significant economic force*.

The Black Sea region has considerable potential deriving from geographical location and common history. Reform and structural adjustment processes, geographical proximity and transport facilities along the Black Sea coast bring it in the heart of Europe and give it incomparable advantages over other regions.

The Black Sea basin has a high potential for the expansion of trade from the Urals to the Danube. Due to the favorable location, regional markets can be relatively easily integrated in the large markets in Europe, Central Asia and the Middle East.

Keywords: *Cold War, Black Sea, Wider Black Sea, Danube , Geopolitichal*

1. INTRODUCTION

Most historians, political and military analysts, specialists in international relations consider that, between 1945-1991, Europe and the world lived a period of Cold War[1], that is „a failed peace and an undeclared war which was threatening to spread all over the world"[2]. Throughout the half century of the Cold War there were intense suspicions and rivalries between superpowers. Rivalry could be found in different arenas: military, political, ideological, psychological coalitions, espionage, industrial and technological development (mostly space race) and, also, the costs of the nuclear arms race[3].

The well-known author of one of the most famous history about the Cold War, André Fontaine, shows in his work the fact that this historical process, this phenomenon, modified profoundly the evolution of the world in the XX[th] century, "it modified all of us". "The Cold War", writes the author, "affected our trust and faith, our life style, at San Francisco or Beijing, in Havana or Leopoldville; it devised countries and nations, put arms in the hands of millions of people; killed many and put many in jail; it was a source of enthusiasm, sufferings and let scars, gave birth to both the evil and the good just like all human temptations.[4]".

Of course, there were numerous regrettable aspects regarding the Cold War: the threatening of everybody's future; the resources used for useless arms; the consequences on environment and people's health implied by massive military-industrial complexes; the repressions that darkened the lives of lots of generations; the loss of human life that often came after all these.[5].

Historians' opinion is unanimous in considering that the Cold War was a war predominantly between two social and political systems: capitalism and socialism. Although "the beginning of the end" took place at the end of the 1980's, when the Soviet leader Mihail Gorbaciov negociated with the American president Ronald Reagan, negotiations determined by the Soviets' wish to reduce the costs of arming, because of the country's weakened economy, the end of the Cold War

[1] The plastic expression „Cold War" was formulated in an essay in 1945 entitled *You and the Atomic Bomb.* It has its origin in about the same period with the famous speech in which W. Churchill uttered for the first time the expression „The Iron Curtain", to describe the unwanted barrier the Soviets threw in Europe, from Stettin to Trieste. The idea had been emitted before. In the XIIIth century, Don Juan Manuel would use the Spanish expression „guerra fria" to describe the ideological tension between Christianity and Islamism in the Medieval Spain. (Castelden (2011), p. 427).

[2] Tutula (2001), p.131.

[3] Gaddis (2009), p 342.

[4] Apud Buzatu (2001), p. 41.

[5] No tyrant ever had executed anywhere one fifth of his own population, but the Khmer Rouge leader, Pol Pot, did this after the Vietnam War. The future will surely remember this atrocity, when many other things about the Cold War have been forgotten, still, almost no one outside Cambodia noticed it at that time. There was no trial for crimes against humanity: Pol Pot died in a hut on the border with Thailand in 1998 and was cremated without any ceremony on a pile of trash and old tires (Gaddis (2009), p. 342.

came when the programs of the Soviet Union domestic reform led to demands for self determination from the member states[6]. In December 1989, Gorbachev and the American president George Bush Sr. had a high-level meeting in Malta and officially declared the end of the Cold War. The Soviet alliance system was collapsing, the Communist leaders of the Warsaw Pact countries had their power undermined. The Soviet Union was in a state of collapse[7]. In fact, the Cold War ended with the collapse of communism in the former Soviet Union.

In 1991, on Christmas Day, the Russian flag was hoisted at the Kremlin, replacing the insignia of the Union of Soviet Socialist Republics. Mikhail Gorbachev gave the presidential powers to President Boris Yeltsin of Russia, who was installed in 48 hours in the presidential office. On the night of December 31, 1991, at midnight, the Soviet Union ceased to exist, "extraordinary event without equal in modern history"[8].

With the USSR, a crucial geopolitical pole disappeared from the Pontic area and more than ten independent states occurred - Ukraine, Georgia, Lithuania, Latvia, Estonia, Kazakhstan, Armenia, Azerbaijan, etc. - involved in regional and international structures various as interests, orientations and forces, and some still dependent, to a lesser or greater extent, on Moscow.

The Wider Black Sea Region[9] and the evolutions of its security environment in the post Cold War period became an independent subject of study rather late and in conjunction with other specific areas of interest. The concept, as such, was released in a study by researchers Ronald D. Asmus and Bruce P. Jackson[10] only in 2004, in connection with the development of some similar concepts.

A world of ancient traditions and diverse cultures, located between Europe and Asia, between Christianity and Islamism, between Slavs, Turks and neo-Latins, the Black Sea was , at least until the Ottoman conquest in the fifteenth century, a commercial maritime traffic center "hub"[11] of great traffic and international trade, where Europe, Asia and even Africa found a point of convergence and of elaboration of some economic prospects which were going to break the old medieval scheme, crashing the isolated economic cycle of the Western system, opening the doors to the modern era.

The periodization of the Black Sea region's history was based on the geopolitical argument of the competition and domination over the Pontic area, thus, one can distinguish the stage of the Byzantine "lake", the "Mongol peace" and the Genoa monopoly, on the assertion of the late medieval coastal states, including the Romanian Principalities and Moldavia, of the "Turkish lake" and of the nearly three hundred years old attempts of Russia's claim to hegemony[12].

In the competition for the Black Sea, characterized in particular by the confrontation of the two concepts, that of the "open sea" and that of the limited access for the fleets of war, in particular of the inland states, the Romanian state, due to its very geopolitical determination, was the supporter of free navigation, of the open sea, the guarantee of its freedom[13].

In order to analyse properly the concept of "**the Pontic space as a geohistorical entity and a geopolitical ensemble**", we have to start from the idea that geopolitics studies the space-politics report on the whole, without discriminating or separating the aspects of internal and external politics of a state[14]. Starting from this statement a geopolitical ensemble is a geographic area with conditions specific for the creation of a climate which is characteristic to a region. This climate can be influenced by the presence or the absence of a great power or a regional power, by the position towards the main gravity poles of the system of international relations, by the demographic and ethno confessional map, by the regional economic interdependence, by the isolation or the large opening of the region determined by natural factors as the configuration of the country, and also by internal barriers: mountains, desserts, international rivers, seas. A geopolitical ensemble includes whole states, but it can also include parts of some immense states or states situated on the border of some geopolitical ensembles, such as Russia and Ukraine.[15].

After 1991, six states have direct access to the Black Sea: Turkey, Russia, Ukraine, Romania, Bulgaria, Georgia, for the last four ones, the Pontic route representing the only maritime access. But, thanks to the Danube and to the rivers flowing into the Pontic basin, the Black Sea represents the gate toward the Planetary Ocean for much more European states.

That is why, taking into consideration that the complex theme of this paper over exceeds the issue regarding strictly the Black Sea riparian states, we consider it necessary to start by defining the concept of ***Pontic space***, thus sketching the geographic area where the phenomena that mark post Cold War evolution in the "*extended region of the Black Sea*", a concept more and more used nowadays in the world of the specialists in geopolitics and geostrategy, develop, act and interact.

In **terms of physical geography**, when we refer to the Pontic region we refer implicitly to the basin of the rivers which flow into the Black Sea (Danube, Dnieper, Dniester and so on) and into the Azov Sea (Don etc.), and to the following countries: Romania, Moldova[16],

[6] Werth (2000), p. 129
[7] Castelden (2011), pp. 435-436.
[8] Judt (2008), p. 601.
[9] The concept of the "Black Sea" was used in an extended sense, including countries in the Balkans, the Aegean and even the East of the east of the Mediterranean Sea and the Caucasus and Central Asian countries, and in a limited sense only riparian states. Today it is commonly called Wider Black Sea Region (WBSR), designating, in addition to geographically riparian states, the neighboring ones also, which, by their interests, initiatives and actions, influence the security environment of the whole area such as Moldova, Armenia, Azerbaijan, Uzbekistan and so on, as well as the Balkan Peninsula countries which are not on the Black Sea coast. (Duță (2005), p. 129).
[10] Asmus, Jackson (2004), passim.
[11] Brătianu (1988), p. 76.
[12] Ionescu (2006), p. 8. Introduction to *the volume The Black Sea from the "Byzantine Lake" to the XXIst Century Challenges*.
[13] *Ibidem*, p. 10.
[14] Serebrian (2006), p.15.
[15] *Ibidem.*
[16] Due to the maritime Danube, with which it borders on a 0,8 km length, The Republic of Moldavia is considered a country bordering the Black Sea. (Serebrian (2006), p. 10).

Bulgaria, Slovakia, Austria, Hungary, Ukraine, Turkey,

Georgia, Russia, Czech Republic, Germany, Slovenia, Croatia, Bosnia and Herzegovina, Serbia and Montenegro[17]. The Black Sea region includes physical-geographical areas belonging to other river basins and excludes those that from the socio-geographical point of view, fit into other regional groupings such as Austria and Belarus.

Thus, we have to do, geographically and socially speaking, with the Balkans (Croatia, Bosnia and Herzegovina, Serbia and Montenegro, Albania, Macedonia, Greece and Bulgaria), the Caucasus (Georgia, Armenia, and Azerbaijan), Romania, Moldova, Turkey, Ukraine, Russia, and even Cyprus[18].

Considering this reality, the Black Sea Black Sea appears to be the common element of the geographical area of Balkan-Caucasus-Black Sea basin and of the numerous regional ethnic or religious conflicts.

Important for all the countries from the mentioned area, the Black Sea is to the Caucasus region in particular, the window of communication with the outside world, a single outlet that allows the Caucasians to get out of the Roso-Turkish-Iranian encirclement.

Certainly, the Caspian Sea has became an equally important factor for the regional policy, due to the increasing riparian independents and to the discovery of some important deposits of hydrocarbons in the submarine platform and coastal regions.

It is the hydrocarbon resources of the Caspian basin - Kazakhstan, Turkmenistan, Azerbaijan – that have brought geopolitical and geo-economic additional value to the Caucasus and, by ricochet to the Black Sea region, which serves as pathway via the Caucasus towards the gas and oil fields from the Caspian basin[19].

The Pontic Area, as **a geopolitical ensemble**, is a heterogeneous and diverse region, made up of different people with different religions and cultures, where geopolitical transformations, occur extremely rapidly.

From this perspective, the Black Sea region is "*a relatively small area, traversed in time by forces from the North-East (Russia, via-Ukraine and / or Georgia), from the South (Turkey) and from the West (European powers: France Germany, Austria, UK or states as Romania and Bulgaria)*"[20].

The participating states, mentioned above, are a powerful diversified group. Although Armenia, Azerbaijan, Moldova and Greece are not Black Sea littoral states, history, proximity and close ties make them natural regional actors[21].

This space was characterized by **political** instability. Being a border area and a region of the dispute between Habsburg, Tsarist and Ottoman Empires in the Black Sea Area, there were many wars that have left their mark in the collective mind.

Over time, the countries of the Black Sea have been known "*more for their conflictual potential than for their regional solidarity*"[22]. This "historical heritage" can be found in recent history, known as the disputes and armed conflicts as: Armenia against Azerbaijan (Nagorno-Karabakh), Russia against Ukraine (Crimea and the Black Sea fleet), Georgia with South Ossetia and Adjara because of the secessionist tendencies of the latter;

Moldova clashes between the indigenous and the minority Russians, the old conflicts between Turkey and Greece etc.

As a competition area, the Black Sea was less an area of cooperation, which was tested only in the interwar period and especially now after the Cold War and the Soviet Union unraveling[23].

Herein tumultuous history, the Cold War saw the unchallenged dominance of the USSR on the Black Sea. Controlling more than two-thirds of the coastline through its own territory and its satellites of that time, Romania and Bulgaria, the USSR tried to control the whole area through direct pressure on Turkey, the only one among littoral states which was not under its dominance[24].

From the **economic** point of view, in the Pontic area *there are developed countries and others less developed.* Economic regimes in the region are coordinated and underdeveloped, as follows: customs regime is inadequate, making harmonization difficult; goods standardization and certification are very difficult to achieve; member countries lack the legal and institutional framework; the concrete benefits of the liberalization of agricultural production are unlikely in the short term perspective; there are no incentive structures and there is no efficient allocation of resources, their economies are facing the problem of inflation and unemployment; agriculture is subsidized; military spending is still at a high level[25].

Most states have ***limited financial resources***. The support of international financial organizations is necessary to finance projects.

In the Black Sea region, with a vast economic and purchasing potential, over 325 million inhabitants live, which makes it become a huge market, still unsaturated, attractive for investment in various areas of cooperation, such as: transport communications energy, tourism, etc.

This region is endowed with all *energy sources*: oil, natural gas, coal, minerals, wood, etc., representing, in economic terms, *a significant economic force.*

In short, the Black Sea region has considerable potential deriving from geographical position and common history.

Reform and structural adjustment processes, geographical proximity and transport facilities along the Black Sea coast, bring it in the heart of Europe and give it incomparable advantages over other regions.

[17] Serebrian (2006), p. 12.
[18] The Caucasus and the Balkans, despite the distance that separates them, have more commonalities than the Caucasus and Central Asia on the one hand, and the Balkans and Apennines, on the other hand, this is because of the decisive events in this space that created historical and cultural similarities. (*Ibidem*, p. 13).
[19] *Ibidem*, p. 92.
[20] Bordonaro (2005), p. 102.
[21] Atanasiu (2011), pp. 1-4.
[22] Buzăianu (2005), pp. 41-42.
[23] Ionescu (2006), p.10. *Introducere…*
[24] King (2004), p. 229.
[25] Atanasiu (2011).

The Black Sea basin has a high potential for the expansion of trade from the Urals to the Danube. Due to the favorable location, regional markets can be relatively easily integrated in large markets in Europe, Central Asia and Middle East[26].

Black Sea countries are based on a large variety of complementary industries and agriculture: some of them have **cheap hand work** (Romania and transcaucasian countries**), others have well developed and advanced technologies** (Turkey), in some countries there is a strong **heavy industry** (Ukraine and the Russian Federation) and others have well-developed **agricultural sector** (Ukraine) or **food industry** (Bulgaria).

Countries in the region can make use of comparative advantages, mainly for the development of trade through the ports and shipping routes down to the Black Sea[27].

In **socio-political** terms, the wider Black Sea region - is characterized by a variety of specific problems and phenomena of transition from authoritarian government and economy to pluralist democracy and free market economy.

Unlike other areas of the Euro-Atlantic area, where specific developments of the post-Cold War are visible, in the wider Black Sea region the overcome of the problems associated with the Soviet legacy is long overdue.

At the same time, the geopolitical Balkan-Caucasian-Pontic ensemble, whose binder is the Black Sea, has a **strategic settlement** thanks to the direct presence of European Union and Russia, as well as to the proximity of the hydrocarbon basin in the Persian Gulf and the one around the Caspian Sea, particularly important for the global energy situation.

The geostrategic importance of the Black Sea also stems from this context of international relations. Worldwide, there are two main factors which coordinate the policies of the strategic actors, be them states or international organizations: the need for energy and terrorist organizations' threat[28], often intertwined elements.

Due to its geographical position, the Black Sea has the answers to both problems listed above. First, it is a single strategic corridor, linking Western Europe with Central Asia and the Middle East, connecting the energy need of European and American markets with existing resources of Central Asia and the Caspian Sea markets[29].

On the other hand, regarding the threat of terrorist organizations in recent years, **the Wider Black Sea**, a phrase that pushes the geographical boundaries of the region beyond the borders of the countries with direct access to the Black Sea basin, won an unprecedented

strategic importance, demonstrated both by the international campaign against terrorism and the expansion of NATO and the European Union.

Managing to integrate into NATO, countries such as Romania and Bulgaria, joined Turkey trying to influence the West to declare the Black Sea a "more important strategic priority"[30] and that is because ***the Black Sea is today, for all intents and goals, the eastern border of Europe.***

The proximity of the outbreaks of tension in the Near and Middle East increases the value of this region in the context of global geopolitics.

This also explains the increase of the American interest in the Black Sea region and also the reanimation of some alien presence that had not been felt in the area for a long time, such as France and Germany.

Referring to this, political analyst Federico Bordonaro said that the geopolitical structure of the Black Sea region would be marked at this time by the substitution of ex Russian influence with American influence, which in turn competes with the ambitions of France and Germany[31]. Without contradicting this statement, it can not be denied the fact that a great contemporary power, Russia, and two regional powers, Ukraine and Turkey, are building their strategic political and economic conceptions, taking into consideration the sea and its adjacent area.

The great Romanian historian Gheorghe I. Brătianu said in his well-known work *The Black Sea*, that "*the theatre offered by the Black Sea basin, favors, more than others, considerations beyond regional issues and reports to the forces acting on the field of the world history*." [32]

The obvious interest of the two superpowers of the beginning of the third millennium - the EU and the U.S., increasingly more present in the area, confirms the correctness of the Romanian historian's assertion[33].

2. REFERENCES

[1] ALEXANDRU, Constantin (1996) „Politica de securitate națională a Rusiei 1996-2000", în *Lumea Magazin*, nr. II/96.

[2] ANGHEL, Petre (2003), *Instituții europene şi tehnici de negociere în procesul integrării.* XI. *Structurile şi instituțiile O.S.C.E.*, la http://ebooks.unibuc.ro/StiintePOL/anghel/11.htm

[3] ALEXANDRU, Constantin (1996) „Politica de securitate națională a Rusiei 1996-2000", în *Lumea Magazin*, nr. II/96.

[4] ANGHEL, Petre (2003), *Instituții europene şi tehnici de negociere în procesul integrării.* XI. *Structurile şi instituțiile O.S.C.E.*, la http://ebooks.unibuc.ro/StiintePOL/anghel

[26] *Ibidem.*
[27] *Ibidem*
[28] Bordonaro (2005), p. 110.
[29] The system of pipes: Caspian Pipeline Consortium, Blue Stream, Odessa-Brody (alredy existing), Baku-Tbilisi-Ceyhan (in construction), as well as other plans in progress.

[30] Asmus, Jackson (2004), pp. 18 - 19.
[31] Apud Roncea (2005), p. 82; see also Serebrian (2006), p. 19.
[32] Brătianu (1988), p. 76.
[33] For details see Asmus, Dimitrov, Forbrig (2004), passim.

ECONOMIC ASPECTS OF HEALTH AND SAFETY AT WORK

GHEORGHE LUCIAN

Ovidius University of Constanta, Romania

ABSTRACT

Safety and health at work is a set of activities aimed at providing the best working conditions, protection of life, health, physical and mental integrity of workers. The purpose of health and safety legislation in the Romanian labor is the relative risk reduction in the life, health or physical integrity of the rendering work.

They contribute to the achievement of the various branches of law provisions.

The main regulation is contained in Law no. 319/2006 on health and safety. Health and safety at work of Romanian workers are protected to the same extent as that of European workers in legally, with the entry into force of Law no 319/2006 on health and safety, rules for the application of its transposing directives in the field.

Important to note about the Romanian legislation on safety and health at work is that it is in a permanent process of transformation in order to harmonize with EU directives in this area.

Keywords: *health, safety, organization*

1. INTRODUCTION

Revision of the Treaty of Rome, the “Single European Act” and the insertion of Articles 100A and 118A meant the establishment of the legal basis of the internal market and achieve specific health and safety at work.

The purpose of health and safety legislation in the Romanian labor is the relative risk reduction in the life, health or physical integrity of the rendering work. Important to note about the Romanian legislation on safety and health at work is that it is in a permanent process of transformation in order to harmonize with EU directives in this area.

Occupational health and safety law states that its provisions apply to all sectors, both public and private employers and workers, the law aimed at establishing measures to encourage improvements in the safety and health of workers and establishes general principles occupational risk prevention, health and safety of workers, the elimination of risk and accident factors, the informing, consultation, balanced participation law, training of workers and their representatives, and the general direction for implementing these principles.

It follows from the above that the State governing the security system and health and obligations to this effect on the employer, the bodies in the field, their employees and other participants in the work processes.

All State is the one who created specialized bodies with responsibilities in pursuing how they comply with safety and health. So, work safety and health is not left solely to the discretion of employers and workers, but, being implemented in all areas of economic and social life, the State shall ensure and control its fulfillment.

Improving safety and health at work is not only important in terms of human, to reduce the suffering of workers, but also as a way to ensure the success and sustainability of businesses in a better economic development in the long term.

Although considerable effort, the number of accidents at work and occupational diseases remains high, and the costs they pose to society, businesses and individuals is unacceptable. Accidents at work can have a major financial impact, especially for small businesses. Some costs are obvious, for example, loss of production and income, or the number of working days lost through sick leave and can be easily expressed in monetary terms. However, much of the consequences of accidents economically not immediately visible or cannot be easily quantified.

Businesses need to know not only the cost issues involved in accidents at work , but also those on benefits requires proper management can bring security and health.

Studies have clearly shown that effective management of safety and health is closely linked to profitability and business excellence. There is a direct relationship between a good working environment and good performance of the company.

Case studies have shown that investing in health and safety at work contributes to improving the performance of enterprises.

Employers in every field of activity, both public and private, are required to provide medical and psychological examination of employees. Organization of healthcare and insurance system for illness, accident, maternity and recovery, control the exercise of medical professions and paramedical activities, and other measures to protect the physical and mental health of the person is established by law.

Employees are entitled to social protection measures.

These health and safety of employees, working conditions for women and young people, establishing a minimum gross salary per economy, weekends, paid annual leave, work in special conditions, training, and other specific conditions set by law art. 13 letters. To ensure the security and health and preventing accidents at work and occupational diseases, employers must: only employ people, medical examination and, where appropriate, psychological testing skills, meet the task it is to enforce and ensure regular medical examination and, where appropriate, psychological control periodically thereafter employment. Due to changes in the labour market, employers are required to ensure the special protection of sensitive groups (pregnant women or nursing lehuze, young people with disabilities), to ensure the same level of protection for persons who are checking job skills for employment, those engaged in community service or volunteer activities under or unemployed, while participating in some form of training.

In drawing up safety and health law to take account of the current Romanian employer awareness of the importance of prevention and protection.

Also, by law no. 319/2006 was implemented fundamental principle according to which the European area the employer is responsible for safety and health at work, “The employer has an obligation to ensure the safety and health of workers in all aspects of work.” If an employer calls to external services, it is not relieved of its responsibilities in this area.

The obligations workers' health and safety at work do not affect the principle of employer responsibility.

2. RISK ASSESSMENT AND MANAGEMENT OF HEALTH AND SAFETY AT WORK

In essence, the principles underlying the law of safety and health at work in Romania can be expressed as:

- *Safety and health - general issues*. Constitution, affirming the right to social protection refers to measures of safety and hygiene. Specifically, Law no. 319/2006, Health and Safety at Work Act states that its provisions apply to all sectors, both public and private employers and workers, the law aims at the establishment of measures to encourage improvements in the safety and health of workers and establishes the general principles relating to the prevention of occupational hazards, health and safety of workers, the elimination of risk and accident factors, the informing, consultation, balanced participation law, training of workers and their representatives, and the general direction for implementing these principles. It follows from the above that the State governing the security system and health and obligations to this effect on the employer, the bodies in the field, their employees and other participants in the work processes. All State is the one who created specialized bodies with responsibilities in pursuing how they comply with safety and health. So, work safety and health is not left solely to the discretion of employers and workers, but, being implemented in all areas of economic and social life, the State shall ensure and control its fulfillment.
- *Indissoluble link between labor rights and occupational safety and health* - Romania is a state of law, democratic and social right to work is not only enshrined as a basic right of citizens, but it is in close correlation with the right to social protection of employees, which includes health and safety at work and guaranteed. Safety and health is an important institution of law, there is a connection between the right to work and the institution.
- *Mainstreaming occupational safety and health in the work* - It is a clear principle expressed in Law. 319/2006, which provides that the obligation to achieve occupational safety management were both legal entities (individuals) and at work - organizers and leaders work processes.
- *The preventive nature of security and health at work* - By essence, OSH has a preventive character, its purpose is preventing accidents at work and / or occupational diseases. Regulations in this field shall be such as to protect the life, health and bodily integrity of those involved in the production process. Theoretically, if the rules of safety and health at work are made and followed exactly, accidents and illnesses can be prevented. At the same time, various forms of liability for breach of health and safety work are intended to contribute effectively to the achievement of its preventive character. See the impact of the regulations on compensation for damages to the injured in accidents at work or occupational diseases which are likely to stimulate implement the rules of labor protection.
- *Approach to prevention of occupational accidents and occupational diseases that single issue* - Considering that, in terms of root causes, the event space, the subjects likely to bear, as the measures and means of combat, injury and disease phenomena are identical (more, in many cases the same factor risk - cause - may, depending on the concrete or the work accident or occupational disease), the legislature sought to treat them as a single issue. The two systems were not up legal documents, one covering prevention of occupational accidents and other disease prevention professional. Rather, the basic law defines occupational safety and health purposes as "Prevention of Accidents" and "occupational diseases" and mandatory measures aimed at achieving that objective are established by common rules (rules of safety and health at work are actions that both the elimination of accidents and occupational diseases).
- *Making health and safety measures at work - legal obligation of the employer*. In accordance with the provisions of Law no. 319/2006 achievement measures for safety and health at work is on the employer. While there are many positive aspects in terms of the legislative actions taken by the institutions involved in the field generating changing attitudes of employers and workers, however the results are still far from measuring up. In this regard, we consider it necessary: adopting practical guidelines to support the implementation of legislation on health and safety; regulation of the interest of employers incentives to implement the legislation in tax treatment of amounts invested in the training of staff, monitoring their health status, use of superior quality protective equipment, etc..

Risk assessment is a careful examination of what could cause harm to people in the work, so that you can decide whether sufficient measures were taken to protect or further action to prevent any damage. The aim is to avoid any injury or damage to health. Risk assessment involves identifying the hazards present in any undertaking and determining the extent of existing risks , taking into account existing precautions.

The results of a comprehensive assessment and appropriate to assist in the establishment of preventive measures and the selection of the most appropriate best practices. Risk assessment plays an important role to protect you, your employees, other workers from the site, and the public. Through good design and planning of the work , the risks can be avoided even before starting work on site. By proper selection of equipment and materials, through the planning of the work of the site , the risks can be reduced to a minimum, and the possibility of injury or reduce exposure of personnel to hazards. Measures to ensure the appropriate health surveillance of workers to the risks to safety and health at work are established according to legal regulations.

Measures to ensure the appropriate health surveillance of workers will be laid so that each worker can receive health surveillance at regular intervals.

Employers have a number of obligations covered by legislation on workers' health surveillance:

• The employer must be in possession of a risk assessment on workers' health;
• Health Risk Assessment updated if there have been significant changes which could render be exceeded or when the results of health surveillance requires;
• Employers in every field of activity, both public and private, are required to comply with regulations on workers' health surveillance;
• Employers are required to ensure that all funds and the conditions necessary for preventive health services health surveillance of workers, they are not involved in any way in the costs of specific occupational risks Preventive health surveillance;
• The technical and organizational preventive measures at the workplace, employers will take into account the results of health surveillance;
• Workers should be informed about the results of their own health surveillance .

Also for employees are provided rights and obligations in this regard:

• The worker is obliged to submit to medical examinations health surveillance in the workplace, according to the planning done by the occupational physician with the consent of the employer;
• Every worker has the right to consult occupational medicine physician for any symptoms which they attribute to working conditions and activity;
• Do workers have access, upon request, all information relating to their health;
• When changing jobs to another unit, the worker will be awarded, upon request, copies of his medical record and the

safety of exposure to occupational hazards, to be handed over to the occupational structure of the unit.

The legislation sets out minimum requirements for health surveillance of workers from risks to safety and health, disease prevention workers with occupational diseases caused by harmful agents chemical, physical, physico - chemical and biological characteristics of the workplace, as well as overloading of various organs or systems in the body work is GD. 355/2007. Health surveillance of workers representing all medical services to prevent, detect and placing occupational diseases and work-related diseases and maintain health and working capacity of workers. In Annex no. 3 GD .355/2007 regulates the minimum required elements for identification sheet risk factors. If the form originally adopted in 2007 among the factors that overload the risk of workers being exposed to stress are found mentally GD 1169/2011 has eliminated the concept of “stress mentally”. Currently statement identifying risk factors included “overuse psychoneurosensory mental, emotional or otherwise”.

We believe that the regulation expressly stress overload factor even as the laws of Romania is likely to demonstrate that the law relating to workers' health surveillance is correlated with the realities of labour relations.

Stress is second in the hierarchy of occupational health problems in the EU Tail after musculoskeletal disorders.

One of the most common causes is the lack of control over work. 35 % of employees stated that they have no say about their duties and 55 % complain that they have no influence on the duration of labour. Monotony, tight deadlines (29 % of staff said that working in these conditions) and bullying at work are other factors that cause stress professional.

Estimated that 16 % of men and 22 % of women with cardiovascular disease EU countries have illnesses caused by stress. Associated with occupational stress and other conditions, including musculoskeletal disorders and mental health problems.

3. BENEFITS CAN BRING ENSURING GOOD HEALTH AND SAFETY CONDITIONS AT WORK

The Single European Act of 1987 was agreed that in Europe the development of harmonized policies to realize the technical regulations and standards and the health and safety at work is required to “harmonize regulations on health and safety on a high level of protection “. Revision of the Treaty of Rome by the Single European Act and the introduction of Articles 100A and 118A meant the establishment of the legal basis of the internal market and achieve specific health and safety at work. Product safety directives derived from Article 100 users aim to protect against the risks that may arise from the use of products and establish security requirements that products must meet the information that edge should accompany them for free movement and trade in EU and procedures that the manufacturer or dealer must follow to certify the fulfillment of the mandatory requirements for identifying them by the “CE”.

Thus created specific legal basis tremendous job ensuring the safety and health of workers, the legal system established character system with minimum requirements which leaves Member States free to impose stricter rules legislated by law demic the Community.

Commission's Strategy was based on the adoption of Directive 89/391/EEC June 12 based on the EU directive that aims to cover all aspects of safety and health at work and providing a high level of protection and equal for all workers in the Member States. In this direction over all directives containing particular concerning the minimum safety and health requirements for specific areas.

Romanian health and safety are protected to the same extent as that of European workers from a legal perspective the entry into force of Law No safety and health. 319/2006, the Methodological Norms and GD appeared in 2006, which transpose directives in the field. Due to changes in the labor market, employers are required to ensure the special protection of sensitive groups (pregnant women or nursing lehuze, young people with disabilities), to ensure the same level of protection for persons who are checking job skills for employment, those engaged in community service or volunteer activities under or unemployed, while participating in some form of training.

In drawing up safety and health law to take account of the current Romanian employer awareness of the importance of prevention and protection. Also, by law no. 319/2006 was implemented fundamental principle according to which the European area the employer is responsible for safety and health at work, 'The employer has an obligation to ensure the safety and health of workers in all aspects of work. “

If an employer calls to external services, it is not relieved of its responsibilities in this area. The obligations workers' health and safety at work do not affect the principle of employer responsibility. Healthy workers are more productive and achieve superior quality products;

- Fewer accidents and illness contribute to reducing absenteeism. In other words, at lower cost and with reduced interruption of the production process;
- An equipment and working environment optimized to the needs of the labour process and maintained in good condition, contribute to better productivity and quality, and reduce risks to health and safety;
- Fewer accidents and illnesses means less damage and less risk in terms of liability.

Man is the decisive factor in the production process.

Without their active and conscious work processes cannot be achieved in an efficient manner. In these circumstances we consider that relevant legislation be amended to quantify and consider stress (professional or whatever neuropsychiatric experts consider that it is the correct name) an occupational risk factor. Quantifying the cost of low OSH standards in the construction sector is difficult, especially because of problems related to estimating the actual size that has this sector, with particular regard to potentially significant proportion of unregistered employees. These uncertainties are compounded by the fact that it is likely that a considerable proportion of OSH problems are not reported because many of the companies are small and could operate “outside the official system”. What other benefits can bring ensuring good health and safety conditions at work?

- Healthy workers are more productive and achieve superior quality products;
- A smaller number of injuries and diseases contribute to the reduction of absenteeism. In other words, at lower cost and with reduced interruption of the production process;
- Equipment and working environment optimized to the needs of the labor process and maintained in good condition, contribute to better productivity and quality, and reduce risks to health and safety;
- Fewer accidents and illnesses means less damage and less risk in terms of liability.

4. CONCLUSIONS

Concerns states to create a safe and healthy work environment increased with increasing efforts to develop economic, social and moral and, certainly, and the level of civilization attained, namely the right of each country to for fundamental human rights, between which and at the protection at work. European Union is the most active organization multisectoral integration of states parties to the treaties establishing, in the economic, social, political and civil rights of foreign relations. Legislative regulations, norms and standards, and monitoring their implementation through workplace controls are not the only means used to force enterprises to worry about the safety and health of their staff. Considering that, in terms of root causes, the event space, the subjects likely to bear, as the measures and means of combat, injury and disease phenomena are identical (more, in many cases the same factor risk - cause - may, depending on the concrete or the work accident or occupational disease), the legislature sought to treat them as a single issue. The two systems were not up legal documents, one covering prevention of occupational accidents and other disease prevention professional. Rather, the basic law defines occupational safety and health purposes as “Prevention of Accidents” and “occupational diseases” and mandatory measures aimed at achieving that objective are established by common rules (rules of safety and health at work are actions that both the elimination of accidents and occupational diseases). Initiatives are often used as “Sweet laws” and other tools to the legislation, such as economic incentives are generally implemented by governments, government or insurers, and can be applied nationally regional or sectoral.

Through these grants financial benefits businesses and organizations that improve the quality of working conditions, consisting of:

5. REFERENCES

[1] Law no. 319 of 14 July 2006, occupational health and safety law, Published in Official Gazette no. 646 of July 26, 2006;

[2] Resolution no. 1425 of 11 October 2006 approving the Methodological Norms for the application of health and safety at work Law no. 319/2006;

[3] Maastricht Treaty – 1992;

[4] European Community Treaty coal and steel – 1951;

[5] H. G. No. 1091 of 16.08.2006 concerning the minimum safety and health requirements for the workplace;

[6] Government Decision no. 971 of 26.07.2006 on the minimum requirements for the safety and / or health signs at work, which is based on Council Directive 92/58/EEC the minimum requirements for the safety and/or health at work published in the Official Journal of the European Communities (OJEC) no. L 245/1992;

[7] Government Decision no. 1218 of 06.09.2006 establishing minimum safety and health for the protection of workers from risks related to chemical agents.

CONTRACT MANAGEMENT - NEWS OR DISUSE?

GHEORGHE LUCIAN

Ovidius University of Constanta, Romania

ABSTRACT

In a world in constant change, the inertia generated by the function of leadership is sometimes more expensive than the change itself, whatever national origin would be. Currently, Romania has reached a point where the market economy depends to a large extent on how the activities are organized into an entity, organizational management and attitude change. Ferment market economy is the innovative ideas and managers think and act in new directions.

Of course, Romanian managers have the creativity needed to transition, but for its manifestation, it takes a release of intellectual impulses of the former type of a centralized leadership. Performance is a result of the operation of an organization, a consequence of the driving task. It reflects the degree to which the manager went to meet the objectives and performance criteria which were firmly committed by signing a contract to this effect. Performance can be measured both quantitatively by comparing quantifiable as those imposed by contract and in terms of quality, which involves a dose of subjectivity on the part of welcomes.

Keywords: *management, contract, manager, organization*

1. INTRODUCTION

Gradually Romania, after 1990, the market economy and the subsequent accession of Romania to the constituent treaties of the European Union enshrined in the Basic Law and (art. 35 par. 1 and art. 148 of the Romanian Constitution, 31 October 2003), was, undeniably, a serious challenge, guaranteeing great efforts to political leadership. The contract is central to the right material as shall be established by law and certain relationships “it plays a key role” in the establishment of economic relations. The contract is the agreement of wills between two or more persons with the intent to establish, modify or extinguish a legal relationship. The parties are free to enter into any contracts and determine their content, within the limits of law, public order and morals. Life has shown, however, that hopes were vain, therefore legislate on was staggered. Indeed, a number of laws, as applicable, or were repealed shortly after their adoption or amendments enacted looked more name than the legal content of the contracts to which we referred above, or, finally, it came to the establishment of legal institutions hybrid mongrels compared to the true classics in the field, which has generated and generates - as we show below - serious difficulties in precise legal characterization and their effects.

2. PLAIN TEXT

Managers are a group of persons appointed, specially prepared, which directs, coordinates and directs the work of all members of an organization to the fulfillment of the objectives.

Specifically, managers are people who hold in organizations, leadership positions involving tasks of coordination, organization, provision, control and management.

Managers should possess certain qualities that enable them to carry out management actions influence other people and get results through their activities. At the same time, managers must have a thorough management training, scientific, real capacity to lead and organizational talent.

They are key to any decision-making, influencing directly through their actions and behavior of others. The Law no. 66/1993 Contract Management management companies with fully or majority state, as well as autonomous administration was entrusted to managers, who had undertaken such an activity under the management contract, the contract indisputable commercial and not individual work.

The lower interval, as was the Law no. 49/1999 (April 22, 1999 - April 25, 2000) directing operators having owned/majority state is achieved by administrators (under a management contract) contract which was still legal, commercial, since this contract could conclude, where appropriate, with a natural or legal person (Article 1 of the Ordinance) and its provisions are supplemented by the provisions relating to directors under Law no. 31/1990, republished, (Article 3. 1 of the Ordinance).

Taking into account the theme of the present study, we note that, from 1993 to the present, they thought sometimes - regardless of the political color of the Parliament and Government - that the persons performing the activity for the management of economic operators (CEOs, and the comparable executives) having owned or majority state (national companies, national companies, other companies, autonomous) or of public institutions (the education or health) as managers (by signing management contracts) or administrators (by entering into management contracts) rather than as employees (under individual employment contracts) or, finally, the name of public officials of certain public authorities/institutions as “public managers” would be a panacea, capable of radically improve the efficiency of operators and budget units mentioned. Of course, the current legal precedence companies where the state holds shares for a share of at least 50% of the capital, including those resulting from the reorganization of autonomous administrations, but nothing can prevent the application of these provisions and the private sector, of course with agreement of the parties (which is not expressly forbidden, is permitted under law principles).

In this situational context, hiring managers and motivate accountability properly in financial terms by signing management contracts could be an effective solution in achieving superior results in an organization.

Utility management for contract management has been and is still supported by the practice of many industrialized countries who use this valuable tool. Managing such a contract includes performance monitoring and documentation.

In fact, managing a management contract is similar to managing a project. Each contract is a mini-project.

It has a unique purpose, consumes resources, has a beginning and an end and requires coordination and planning of relevant activities in order to achieve objectives.

Contract management is the contract by which the operations are performed by a third party who fulfills all the necessary managerial functions in return for a specified management fee. Unlike franchise where a product or know-how is given as a license to be used, the management contract involves the actual performance of operational activities.

Operational activities may cover a wide range of services such as facility management of production, supply and maintenance of human resources, marketing a product or plan.

The purpose of contract management is to ensure that all parties to the contract fully meet their obligations as efficiently and effectively as possible, providing business and operational outputs required by contract and providing value for money.

It also protects the rights of the parties and provides the necessary performance when circumstances change.

In our country, by Law no. 66/1993, management companies with fully or majority state, as the autonomous bodies entrusted to managers, who had undertaken such an activity under the management contract, the contract indisputably commercial, not individual work.

According to Article 1 of the aforementioned enactment, management contract is an agreement between a person engaged in an economic activity, as the owner and a manager who is entrusted with the organization, management and leadership owner on the basis of objective and measurable performance criteria, in return for payment.

From this definition it follows that contract characteristics, namely:

- organize, manage and lead a business
- payment
- manager
- owner
- objectives and performance criteria

The law states that in order to be selected, the candidate (individual or entity) must meet certain minimum conditions for participation in the selection.

There can not participate in the selection, Romanian individuals who:

a) they are managers or administrators to another company or autonomous and do not present a written statement that, if designated renounces to it;
b) underwent definitive convictions that make them incompatible with being a manager;
c) listed as managers and administrators who received the mandate revoked;
d) they have been convicted of tax statutory provisions;
e) holding shares or shares he's relatives, his wife and their affinity to the second degree in another company whose activity is similar to the utility for which the selection is made.

At the contest selection, individuals are written statement to the effect that they are not incompatible, submitting, where appropriate and supporting documents. There can participate in the selection of Romanian legal entities which:

a) were included in the insolvency proceedings;
b) have been convicted of tax statutory provisions.

Candidates submit bids in an endosed envelope sealed with the conditions and legal criteria, within 30 days of the last publication of the tender.

3. CONCLUSION OF CONTRACT MANAGEMENT

For the valid conclusion of the contract there must be met certain legal requirements. Indeed, this activity is an operation whose validity should be met by any person who is to perform these activity requirements.

Such conditions may be divided into several categories, as follows:

a) common conditions of all contracts: capacity, consent, object, cause and conditions of this contract (favorable professional references from past employers or managers, or managers of companies with identical or similar to the profile of the company for ending contract management, etc.).
b) formal requirements.

In any case, there can not be established conditions of employment based on race, nationality, religion, etc..
The rights, duties and obligations are stipulated in the content of the contract management. The terms are negotiable, and the contract may stipulate other causes agreed between the parties, according to the objectives. The management contract is concluded in writing. Manager has full power in leadership, organization and management of the institution/business unit. Manager, by signing management, becomes general director and chairman of the board. According to art. 4 Commercial Code management contract concluded pursuant to Law no. 66/1993 is the subjective act of commerce as one of the parties is a trader, being a self/company registered with the Trade Register.

4. PARTIES TO THE CONTRACT MANAGEMENT

They are part of the contract:

a) company - through its Board of Directors;

b) Manager - teams of up to seven persons, Romanian or foreign, or a natural or legal person, Romanian or foreigner.

Manager shall exercise the powers set out in the management contract. Manager part, without the right to vote and compensation, of the board of directors of the company who is a party to the management contract.

In terms of meeting the manager to exercise its obligations under the contract, the date stipulated, the parties may agree a contract extension. Indicators that define the company's business objectives should include elements of economic and financial situation of the company.

For their determination these will be take into account economic and previous financial year. In terms of objectives and performance criteria they are, in quantitative and value, the main results of the company that the manager undertakes to obtain the leadership, organization and management activity.

Objectives and performance criteria will include mandatory: turnover, profit or other financial indicator summary, balance of import-export volume of investment, labor productivity. Manager will submit monthly to the board of the company, for approval and inform the general shareholders/associates, financial and economic situation, the stage of the investment or any other requested documentation, endorsed and certified by auditors. To achieve the performance criteria specified in the contract, the manager is vested in the Board of Directors with full powers in the organization, management and leadership of the company, within the limits set by the management contract.

The main powers of the Manager are:

a) apply strategies and policies for development company, designed together with its board of directors;

b) selects, hires and fires personnel;

c) the manager negotiates collective bargaining agreement with respect of revenue and expenses approved by law;

d) negotiate individual employment contracts;

e) represents the company in its relations with third parties;

f) legal agreements and on behalf of the company, within the powers granted by the Board of Directors or management agreement;

g) other approvals established by contract, agreement.

Retribution Manager, under the contract of management, shall be as follows:

a) a monthly payment that supports the payroll of the company;

b) participation in the profits of the company, established in proportion to the degree of achievement of agreed objectives in the management contract.

Rights accruing to manager performance during annual leave, contributions to social security or health insurance due to the manager or management team members, and any other rights shall be determined by negotiation under the management contract. Note that failure to meet targets and performance criteria established by agreement entails liability management contract manager in accordance with the terms agreed to its conclusion or any addenda. Thus, given that there was an agreement between the parties, liability in connection with its failure can not be employed locally tort only in terms of contractual liability. This is because the common law torts is the tort and contractual liability is a liability to the special character derogatory injured Contracting Party may get compensation only on the basis and within the limits set by the contract, which is the law of parties. The contract is the act by which the parties have chosen to obey rules set by them, the acquisition of rights and fulfillment of obligations. As such, any party is bound and constrained, under the contract, to submit to the same legal and contractual disputes arising from failure or improper performance of the contract, so the responsibility to act with special character (the contract) and not the responsibility of common law (the tort). Management contract has indeed legal nature of an agency, but even in this case, only exceptionally gives rise to the warrant subordination relationships ie only where the warrant sets a fully subordinate to the principal trustee expressly. However, according to art. 14 of Law no. 66/1993, the manager in the performance management contract, has full power in leadership, organization and management of the company. In this regard, he has the powers to conceive and apply independently developing policies and strategies of the company and enjoy autonomy in the exercise of initiative and obligations under the management agreement. Administrator, the legal entity manager, is responsible wich Offences in relation to individual activities for the legal entity whenever exceed - the acts and deeds - the set by law, statute and decisions of bodies, as appropriate deliberative bodies of legal entity. In other words, by this criterion, he answers contravention whenever exercising abuse liability legislation through the tasks that make up their duties entrusted status of legal entity. In addition, the natural person responsible contravention in managerial duties, whenever enforce or allow to enforce the decisions of the deliberative bodies that manifest through their effects illicit Offences covered. The first is a direct liability resulting directly from its own wrongful act. The second is a vicarious liability because it ordered the manager, rather, he did not conduct legal entity regulated such that under the rules of offenses, but deliberative body. Looked through the entities involved in the illicit contravention is the deliberative body that has adopted a decision manifestly contrary to legal norms in a particular field of activity, or that, if executed, will lead to the commission of an offense. Administrator - although in principle is defended by the fact that enforcement of a judgment of a deliberative body, so as this is within the legal limits of his professional status - will respond by ricochet in this respect, since he, like any issue of law, is responsible to respect the law first. As such, the general abstention shall in all cases where such decisions that would put him in enforcing the illicit contravention sphere.

As noted, the liability is mediated only by reference to the judgment of a deliberative body, being one who “guides” to the illicit conduct Offences Manager. In light of the general duty of abstention from any violations of social norms established by laws, however, it is the direct responsibility, in other words is all personal.

Answer then, no doubt, and if the manager exercises incorrectly, inappropriate managerial duties.

This rule is customized by accounting law, which states expressly that the leadership of the head of the responsible accounting law. This example, in conjunction with other, more established criteria for determining the liability offenses manager of the legal person. The first will be held liable, any illegal act Offences Act and arising from current activity of the legal person, the right held common legal norms regulating the activity of all legal entities, ie the governing of their operation as such a legal person, exceeding its principle of specialty.

To be more specific, any person to act as such, must organize and manage the daily accounting, to organize in terms of fire safety rules and the rules regarding safety.

The same is true in the rules governing staff. It is obvious that the spectrum of relationships related to business management and for infringement aspect contravention of legal norms governing them, it is normal to intervene Manager responsibility. As normal as it seems that where offenses are set by the legislature pertaining to violation of the principle of speciality, answer contravention legal entity with a right of recourse against the real manager. This is because the violation of the provisions of the legal principle of its specialty intimately in order to keep the legal person. In other words, committing the contravention, failure to comply with the specialty and hence the purpose for which it was created as a fictional subject is so intimately tied to its being, that it can attract only liable. Examples of support criteria set above gives us even legislature. Thus, legal entities established in order to pursue activities of production or marketing of alcohol, in terms of breaking the rules of statutory contravention answer them, not the manager. Similarly, for businesses that have transport as activity, they answer as carriers and not their managers. In light of prementioned facts, it is natural to outline the principle that the individual engaged in a legal activity with the current activity management tasks, you must answer Offences only minor offenses that arise from such activity.

Otherwise, for other minor offenses that exceed the scope outlined above will be held liable contravention of the legal person.

5. TERMINATION OF MANAGEMENT

Management contract ended terminated by:

a) the expiration of the period for which it was completed and the parties have not renegotiated to extend;
b) the revocation manager in the event of failure of the contract;
c) forfeiture of quality manager in the law;
d) giving manager mandate when failure to conditions specified in the contract or in other situations;
e) the parties' agreement;
f) intervention of incompatibility;
g) the death or placing under judicial interdiction;
h) reducing state shareholding below 50% of the share capital of the company;
i) insolvency.

In cases where management contract terminated under subparagraph. b) and d), the notice shall be given at least 30 days. When the mandate ends, management team members may be employed on request in the company, for a period of at least 6 months in accordance with their professional training and availability of posts in the company. If one or more members of the management team become unavailable, the Board of Directors of the company:

a) may approve completion of the management team with the agreement and taking into account its proposals through an addendum to the existing management contract, while browsing the entire selection procedure;
b) may require the selection committee to organize a new contest for vacancy.

Where disputes arise stemming from the interpretation of clauses, the conclusion, amendment, execution or termination of the management contract, the parties may agree to make disputes through arbitration. The law provides certain safeguards manager in the sense that it can not be lifted until the reasons and under the conditions laid down by the management contract. The manager has the right to request mediation, advice or other protective measures of the general meeting of shareholders, confederation, federation or organization of which the employer company in resolving conflicts with unions and other organizations.

6. CONCLUSIONS

These are just some of the conclusions in practice today discussed above. To date, although we chose a palette managers more or less rich and relevant when leading some did what they wanted, considering only their own interests.

The manager has the right to request mediation, advice or other protective measures of the general meeting of shareholders, confederation, federation or employers' organization of which the company, in resolving conflicts with unions and other organizations. The law provides certain protection measures Manger in that it can not be revoked only for the reasons and under the conditions laid down by the management contract.

Not the interests of shareholders and the company.

It is possible that at some point the desire to be professionals, shareholders, members of an organization as those that lead to objectively analyze and obtain performance or achievement to be known early in takeover credentials manager, ab initio. We believe that we can develop a new concept, namely the need for management contract.

Where disputes arise stemming from the interpretation of clauses, conclusion, amendment, execution or termination of management may agree to resolve disputes by arbitration to be made.

7. REFERENCES

[1] Romanian Constitution, Published in Official Gazette no. 767 of October 31, 2003. Amended by revising the Constitution Act no. 429/2003, published in Official Gazette of Romania, Part I, no. 758 of 29 October 2003, republished by the Legislative Council

under Art. 152 of the Constitution, by updating the names and texts shall be renumbered (Article 152 became, as republished, art. 156). Revision of the Constitution Act no. 429/2003 was approved by national referendum of 18 to 19 October 2003 and entered into force on 29 October 2003, following its publication in the Official Gazette of Romania, Part I, no. 758 of 29 October 2003 the Constitutional Court Decision no. 3 of 22 October 2003 for the national referendum of 18 to 19 October 2003 on the Law amending the Constitution of Romania. Constitution, in its original form, was adopted at the meeting of the Constituent Assembly on 21 November 1991, was published in the Official Gazette of Romania, Part I, no. 233 of 21 November 1991 and entered into force after its approval by national referendum on 8 December 1991.

[2] Law nr.66/1993, management contract law, Published in Official Gazette no. 244 of October 13, 1993

[3] Emergency Ordinance no. 39 of July 10, 1997, amending and supplementing Law no contract management. 66/1993, Published in Official Gazette no. 151 of July 11, 1997

[4] Government Emergency Ordinance no.49/1999, the management companies/national companies, the companies in which the state or a local government authority is the majority shareholder and the autonomous bodies, Published in Official Gazette no. 170 of 22 April 1999

[5] COMMERCIAL CODE, Published in the Official Gazette of May 10, 1887

FUTURE TRENDS IN SUPPLY CHAIN EVOLUTION AND INFLUENCES ON THE TRANSPORTS

IORDANOAIA FLORIN

Constanta Maritime University, Romania

ABSTRACT

The transports now have are a number of difficult problems, from those related to the lack of customers, high cost of fuel, taxes, environmental pollution. In this case transport companies must follow and understand the evolution of logistics and supply chain, for to be part of these organizations. In this paper are presented some aspects of the changes that will affect future transports.

Keywords: *supply chain, logistics, transportation, trends.*

1. FACTORS THAT DEPENDS ON THE OPERATION OF THE SUPPLY CHAIN

Successful implementation of a supply chain depends on a number of factors, mainly the manner and extent to which these factors are approached by companies (David et.alt, 2008). The most important are:

- Logistics capabilities. The ability to provide effective and efficient flow of goods, services and information, the ability to provide a level of customer service and the ability to integrate internal and external.
- Cost/client, i.e. the cost of serving each customer. So not only is the total costs incurred by participating in the supply chain in order to understand customer profitability for the organization and identify ways in which it can improve the ratio of specific services offered to the customer and costs.
- Structure. Quitting traditional hierarchical and functional vision on organizational structure and moving to a process-based perspective, perspective which assumes horizontal relationships within the organization and teamwork.
- Provision of services “as” through customer segmentation and personalization service to every important customer part of avoiding in this way providing a unique level, standardized service, which would affect the competitiveness of the market.
- Obtaining the cooperation of suppliers, namely the development of a close relationship and true partnership.
- International cooperation. This means ensuring flexibility and acceptance of common goals and strategies, along with other members of the supply chain.

Today it is considered that there is a set of critical factors, guarantors of the success of which depends the smooth functioning of the supply chain, particularly internal and external integration as follows (Gattorna et.alt, 2001):

a).Harmonization Strategic Supply Chain. This means balancing between supply chain systems management on the one hand and strategic measures for each company on the other. The external integration in the supply chain strategic initiatives requires knowledge of each company and then achieves a certain balance between these initiatives aiming to achieve common objectives and implementation strategies of mutual interest.

b).Achieving integration with their suppliers and development of partnerships in the supply chain. It is intended that by cultivating such relationships to obtain notable advantages in terms of cost and in terms of quality, flexibility, speed of response to market demands and global competitiveness.

c).Certification providers. This is a way of ensuring the necessary conditions for achieving strategic objectives (RLA, 2012). Through certification allows for a common language between partners in the supply chain and facilitate increased trust between cooperating companies in the chain. In practice there are three levels of certification providers as follows:

- Detailed audits. Thereby assessing the ability of suppliers and identify possible synergies, before making the selection and certification.
- Operational revisions. Is done during the course of operations, so in collaboration, for recertification provider to ensure continuity of the parties.
- Any waiver of auditors when partner organizations know each other processes in an accurate and detailed level.

d).Calling information technology. This allows better integration with suppliers, there is the possibility of obtaining and providing real-time information in the supply chain. Given modern technology like the Internet, EDI (electronic data exchange), common platforms CAD/CAM (computer aided design/computer assisted manufacturing), management software (RJSC, 2013).

e).Improving manufacturing processes. All partners in the supply chain are interested to work for the production and supply of quality products to customers in the required quantities and at the required time.

f).Ensuring a high level of communication between supply chain partner organizations. In international practice were devoted to various forms of communication at different organizational levels as follows:

- Creating multi-organizational, multifunctional teams that facilitate the exchange of ideas and information in order to achieve common goals.
- Interaction with key suppliers at all levels organizational, especially at senior management level. This is reflected in the creation of advisory committees for solving problems.

- Posting to units producing providers own staff that aims to foster teamwork among all members of the organizations that make up the supply chain.

g).Tracking obtains mutual benefit of all members of the alliance. This provides several advantages such interrelated benefits: increasing confidence between the parties; reducing the number of potential providers; the development of strong relationships between the parties; reducing the total cost; decrease in inventories; increasing the efficiency of capital; increasing the quality of products and services; increasing customer satisfaction, etc.

2. IMPACT OF THE SUPPLY CHAIN ON THE TRANSPORT COMPANIES

According to practical experience gained from more powerful organizations, and research carried out by the "European Logistics Association" (ELA, 2013), supply chain strategy has a strong impact on the organization and on its economic and financial results. After more research and analyzes made on the results, the following aspects are important for the transportation companies:

a).All the top managers of the companies are concerned about supply chain management. These managers are the ones called to formulate overall objectives on the performance of the chain closely with the organization's goals and strategies and to support the achievement of such objectives (ILM, 2013).

b).Supply chain management is an important contribution to achieving the objectives of the companies, managers at higher levels of organization have leverages that support these objectives. Such levers refer to:

- Reduce inventory order cycle time reduction and improved asset utilization, all acting on leveraging capital.
- Increased diversification of production without conducting additional expenses and to improve services, both levers having the effect of increasing sales volume.
- Obtaining a flexible and shorten production cycles and integrated these two levers being able lead to improved cost structure.
- A number of electronic solutions such as electronic order planning, buying or selling electronics. They have the capability to support the strategic objectives of the organization.

c).As the scope and purpose of supply chain management is increasingly expanding. From this perspective, external integration is to be extended to other levels of the chain than the traditional suppliers that the suppliers and the customers of companies customers, putting emphasis on greater integration with the client. Regarding the order are taken into account issues such as improving customer service, reducing costs and improving their structure, development of logistic support and increase cash flow.

d).Continue investing in traditional and electronic solutions in the supply chain. These investments concern the major processes of supply chain management and study of markets in general, especially customer demand, production, marketing, selling products and services. It is expected that in the next period to increase the share of investment in electronic solutions, especially electronic purchasing applications.

e).Supply chain management remains a cross-functional task being involved in this field logistics, production, sales and finance, the key functions of the organization, but also other material or immaterial features investing in this area. Thus all the attributions and organization departments are responsible for the smooth operation of supply chain management, coordinated the activity of leadership at the top level of the company.

f).Communicating the results of supply chain management by the leadership of the organization is achieved by means of financial performance indicators that take into account the supply chain costs, return on assets and return on investment in the stock chain. On the other side the internal evaluation of the effectiveness and efficiency of the supply chain are using other indicators, this time non-financial, such as: execution of orders index; level of customer support; cycle controls; cycle payments; response time.

In conclusion can say that supply chain management has a major impact on the organization's strategy and its financial results. Also favorable development organization depends largely on the extent to which managers involve higher level in this area.

3. DESIGN ROLE IN OPERATION SUPPLY CHAIN

Currently there attention towards a modern concept, the reengineering, that can be translated as "reconfiguration" or "redesign" (Bacanu, 2006). Reconfiguration refers to reshaping, redesigning product lines, the production and distribution networks and operating systems. The current situation of the global economy and demonstrates the need re-thinking production, primarily products such as human resources, having the final purpose redesigning reconfiguration organization operationally, as a first step to take before following benefits and risks of collaboration within supply chain, this as a proper collaboration must participate in a strong position and not one weak.

Reconfiguration process has a very special role in the proper functioning of the supply chain, but it is not an easy process and companies can make anything with anyone anyway. In practice reconfiguration is conducted with the support of specialized operators in the provision of logistics services.

4. TRENDS IN SUPPLY CHAIN FOR THE TRANSPORTS

The main trends in supply chain refer to (Martin, 2010):

a).From the service to the customer to the relationship management. The new international economic conditions development of the supply chain centered on relational aspects, reference is customer success. Such success depends largely on its capacity to develop close relations with customers "key", with leading customers to be able to offer them profitable solutions, solutions that competitors can not offer the same cost or cost lower. Essentially relational management practiced in the proper functioning of the supply chain requires reporting certain customers. To achieve such an approach companies must consider two aspects:

- To recognize that there are differences in terms of customer requirements and therefore to identify those key customers for them.
- To create operating systems able to react quickly to changes, regardless of the nature of these changes, starting with a small number of customer requirements, sometimes unusual, unexpected and ending with the most sophisticated, more demanding.

However those systems must be radically different from the traditional way of appealing to stocks.

b).From the rival attitude of enmity to one of cooperation, mutual understanding, putting emphasis on the benefits that organizations can gain by achieving common goals and the permanent responsibility. In order to develop appropriate collaboration within the supply chain are necessary but three conditions:

- Stimulation trust.
- Creating structures and establishes evaluation methods for encouraging inter-organizational behavior.
- Formulating explicit procedures regarding the disintegration collaboration, establishing terms of duration and end cooperation relations aiming at in this way prevent disputes over assets and keep working as long as it proves useful parts.

c).From forecasting to the “Collaborative Planning Forecasting and Replenishment” (CPFR). CPFR acronym defines a collaborative process through which supply chain partners can jointly plan key activities. Collaboration is considering business planning, forecasting replenishment sale and all the necessary raw materials and finished products.

Supply chain management is to draw up plans aimed at better serving customers. In these circumstances it is necessary sharing of information, redesign products, processes and facilities for organizations to reap the benefits of quality information. In such a view, although the forecast will remain a milestone in planning future activities and identification requirements, it can not and should not be used in daily operations. There are opinions that the future is necessary to reduce the number and forecast horizon. Transforming reality of such trends is difficult to implement in terms of lack and systems required. For translation into practice of this trend is needed to fulfill three basic conditions:

- Increased control.
- Improvement of information technology systems.
- Increased trust between supply chain partners.

d).Based on experience from strategy to strategy transition, this utility under the traditional logistic models, existing infrastructure and experience acquired increasingly diminishes with the increasing complexity of the competitive environment in the chain supply. An example of a situation that calls for a new type of strategy is orientation only providing logistical services on a contractual basis by outsourcing such constitutes a serious challenge for organizations that do not have some experience in establishing and managing such relationships. Facilitating the event trend analysis, transition strategy based on the experience of transition involves three basic aspects:

- Creation of new business models.
- Skills development managers to solve punctual case studies.
- Calling the decision support systems to identify and evaluate alternatives for supply chains as strategic new models.

e).Since the absolute value, relative value, a new measure of success is the relative share that success has a supplier for a key client and resulting profitability. In this context the usefulness of the concept of relative value is to increase the share of profitable income within a certain arrangement with the customer, based on the availability to offer a wider range of value added services, under simultaneous increase marginal profitability. Transformation these lines in reality, due to its relative value to the absolute, it is possible by performing the following conditions:

- Apply a tracking system costs and segment activities.
- Logistics development practices that increase the relative value and effectiveness.
- Moving the emphasis on financial markets from market share to profit.

f).From functional integration to the process, integration process is characterized by the existence of self-managed teams. In this case to turn into reality the trend analysis is required to achieve the following conditions:

- Increase in asset management skills and activities that managers do not directly control. But managers are the “interface” with suppliers of materials and services.
- Develop a shared vision of the partners in the process of value creation and establishing responsibilities.
- Extend the integration at the suppliers of suppliers.

g).For the protection of information, the sharing of it, a trend which has been accentuated in recent years by developments in information technology (IT). In this case the proper manifestation of the trend analysis is necessary following four conditions:

- Development in the organization of trust between functional departments and between participants in the supply chain.
- Orientation strategy to obtain medium and long term benefits rather than those that could possibly get short term.
- Making exchanging information in confidence when working with client’s organization which are or may become his competitors.
- Developed several options for exchanging information such as: file sharing, direct access to databases, etc.

h).For the preparation of traditional knowledge-based learning (RJSC, 2013). In this case it is necessary for the organization to have people who understand the functioning of the supply chain, to know how to use tools based on information so that staff is able to develop and implement the most effective strategies. Such a behavior can only give the expected results due to the following two mutations:

- Increasing the manager's ability to manage a diverse workforce and complex, given that each employee should have the skills and knowledge to face activities that make up the chain.
- Knowledge development of managers at the top of the organization, managers “key” and planners to understand the risks and benefits of integration with other organizations in the supply chain.

i).Since managerial accounting, value based management. This is because it requires more sophisticated measurement systems than traditional ones, due to reconsideration of concepts such as economic value added and market value added. With value-based management are identified and supported activities that create value, as opposed to only income increases or decreases costs. Implementation trend of transition from managerial accounting value-based management involves the development of three main mutations follows:

- Identifying and assigning specific benefits of the various initiatives suitable partners in the supply chain so as to be able to correlate sales with profitability of each customer, to be able to assess the costs and outcomes of different options strategies programs to adopt practices in the supply chain.
- Changing ways of measuring benefits to provide higher levels of service to customers and reduce total cost of ownership over the product.
- Modification of the arrangements for reporting achievements, namely the pursuit of economic value added, which allows shareholders to monitor whether management creates or destroys value or conversely if the profit is greater than the cost of capital.

j).Other trends that influence supply chain refers to:

- Focusing retail units and the number of existing distribution centers in an organization. This is having a direct and dramatic impact on transport subsystem of the logistics system.
- Development of logistics services provided by third parties, with all the implications that flow from it.
- The balance between cost and customer service. This implies a certain increase in the importance of customer satisfaction measurement methods and quantification of the costs.
- Globalization.
- Develop Internet.
- Chain “green” supply concerns due to activities in compliance with the requirements of ecology and sustainable development.
- Reverse logistics in accordance with the legal provisions on increasing the manufacturers for their products.
- E-Logistics. Honoring electronic controls while the Internet makes possible collaboration between different partners in the supply chain and increasing consumer involvement in product development and interaction with the organization.
- Inter-organizational management costs along the supply chain, based on modern methods that allow estimating the selling price and the identification of materials that have the technical and quality requirements, the initial price set.

5. ELECTRONIC SOLUTIONS ARE THE FUTURE

In recent years an important trend manifested in logistics and supply chain is adapting electronic solutions, following the impact to manifest more strongly in those activities (Iordanoaia, 2011). The researches conducted to identify the stages of adoption of electronic solutions to organizations of reference and identify determinants are relevant. The first and most suggestive conclusion was that in most countries, regardless of the geographical area in which there are organizations use the Internet in various forms, but share the use of this modern tool is different. In organizations of these countries the number of distinct uses of the Internet is different. It should also be added that more companies use the Internet to communicate and collaborate with customers, more than to increase their internal efficiency and to prepare the staff.

The researches took into account the percentage of those who use the Internet for supply chain management. The share of Internet usage for customer relationship management and serving them is much higher today. Now can speak of a new trend, respectively segmented logistic management systems (Iordanoaia, 2012). Such systems correlate modern technologies, especially the Internet, with the most advanced techniques in logistics and chain management-delivery. Experts today believe that in the future apart from traditional distribution channels of suppliers and customers, will be created and electronic channels, internet opening an era of opportunities in the supply chain and supply.

6. CHANGES IN DISTRIBUTION EVOLUTION

Amplify the volume distribution activity involves mutations spectacular its internal structures, as expected in the not too distant future changes in terms of content, form and location of work, organizational structures, etc (Gattorna, 2001). Courses also will mutation occurs amid continuous changes in different categories of products and services that are subject distribution. This issue should be added that worldwide distribution became a very dynamic economic sector were improved methods of sale, distribution forms, management, etc. Such a development is the result of complex phenomena that relate to the changes taking place in the social, economic and technological changes then occurring in the distribution (Lee et.alt, 2008).

a).Regarding mutations in socio-economic life should be considered, at least the following three aspects:

- Demographic phenomena. Firstly continuously changing population structure by age and profession who have made their mark on the evolution of tastes, motivations and requirements on how to realize the distribution of goods, fueling a qualitative evolution of the distribution process, especially modernizations (Porter, 1980).
- Increasing the purchasing power of the population. This leads to increased diversification and multiplication of needs and ways of meeting their forms.

- Transforming lifestyle continues. This is a complex phenomenon with multiple influences on the evolution of the distribution of goods. We have the following issues: urbanization of rural areas; implantation related neighborhoods on the outskirts of large cities; introduction of towns; increasing motorization; evolution generally lifestyle, etc.

All these favor and further determine new forms and methods of distribution, which tend to integrate into the process itself or consumption pattern.

b).How to shape the commercial technologies and their impact on the evolution and distribution structure process has the following plans:

- On the management of new methods of modern management of inventory, supply, permanent change in stocks of goods generated refresh their continuing need: the optimization of the distribution circuit; increasing opportunities for flexible change them according to the geography, seasons and products; circuits by combining these segments of the population served.
- As the movement of goods, logistics distribution, improvement of transport, cargo handling operations modernization, sometimes automating them, rationalizing the use of human resources, material resources and the emergence of new materials and types of repackaging the product, led to a new content distribution process, becoming independent, penetrating, something that may thus nearer to consumers.
- Commercially-have imposed new vision such as: the methods and techniques of marketing; improving methods of packaging and presentation of goods; use of design and an appealing merchandising.

However favored extending short circuits and even directs the whole distribution process and modernizing forms of manifestation of these circuits.

7. CONCLUSIONS

Based on the phenomena presented in the future evolution of the distribution of a number of trends are emerging, the most important reference to:

a).Concentration of the distribution. It is actually a special case of concentration of economic activity that will occur under specific conditions particular. Have started from the idea that the degree of concentration in the retail sector is much lower than in production. This gap actually expresses intermediate position distribution, role of liaison between production tool with a high degree of concentration and consumption more generally fragmented with a large scattering in space. Concentration distribution will be different at the level of organizational and practical activities themselves. So if the company can achieve very high levels of concentration, the phenomenon of concentration of its operational units is much lower, the numbers of large units are still relatively low and limited growth opportunities.

b).Integration is manifested in the general fund of the concentration distribution. One particular form of this phenomenon is the vertical integration, consisting of the association of participants along the distribution channel, with the purpose of: streamlining the movement of product to the buyer; cost-reducing physical distribution; correlation of actions associated enterprises. Vertical integration knowledge specific to particular embodiments something that may thus speak about the total or partial integration, differentiation criterion in this case is the depth up to which it operates, the entire distribution channel or only part of it. Integration may organize any distribution channel forming participant, manufacturer, wholesaler or retailer, assuming different degrees of cohesion and autonomy of structural components "integrated". In this respect stand out three basic trends as follows:

- Ever increasing participation of producers in the distribution of goods by own units or in "collaboration" with commercial enterprises in various forms.
- Restricting the role of intermediary agents by taking over their functions to other members of the distribution channel.
- Fusion of functions with retail outlets in the work of a single company.

The second type of integration, the horizontal lies in the combination of intermediate links in the same distribution channel, in various forms such as: groups of retailers or wholesalers supply; chain voluntary; collective self-stores. This type of integration does not produce large mutations significant in the way of representation and performance of the distribution, but only enlarges the scale and therefore their effective exercise.

c).Specialization in the distribution is developing quite contradictory. Thus the concentration and integration could act to narrowing specialization. On the other side a wider range and deepening division of labor in production encourages specialization in the distribution. Also consumers increasing their demands, claiming more and more choice and this require a high degree of specialization, but on the other hand the same as the time spent watching consumers to purchase goods to be as short, preferring these major purpose commercial areas with a wide profile, designed to ensure "everything under one roof". With all these conflicting elements specialization in distribution is to a certain development, but characterized by a number of basic elements. Firstly it is the specialization criteria. Such traditional criterion, distribution functions, the nature of the goods, gives way to others. Essentially wholesale functions are kept separate from the retail, thus deepening specialization, but it being able to be carried out within the same structure if such a formula better meet organizational effectiveness criteria. Regarding grouping goods within retail establishments it has as a criterion in most cases, their use common kinship consumption, frequency of application. Sometimes, however, the basic profile of the units will be completed to mitigate seasonal variations or just random request and thus attracting increasing trading activities. In these circumstances additional goods added to those who give profile based units may come not only from neighboring areas, but can also be completely foreign destination so as well in the commodities terms. Such a phenomenon can be regarded as a "deviation" from normal profile of unit sales, is a pronounced trend in U.S. trade, a phenomenon known as "scrambled merchandising". At the same time there are changes in the very way embodiment of specialization, under the expansion of large units. Turnover is considered around 200,000-300,000 assortment of positions that make products sold through trade nomenclature large areas, this number covers almost all commodity groups. Even in such cases specialization is present only that it must be sought within the units, the managements of goods. At such specialization not only reach but sometimes even exceed the depth specified on the small specialized units. In such conditions can even say that the orientation distribution to units that would feed the ever increasing trend of specialization. In fact there is a form of deepening specialization, a new formula that would correspond multi-specialization term.

d).Markup distribution is a clear trend in future periods. In fact can say that the distribution be responsible for much of the final product price paid by the consumer, in developed economies representing about half the price of goods. The main cause of higher distribution, but no one is actually the evolution of “services” that intermediaries bring to society in general and consumers in particular. Looking at things from this point of view we can say that the distribution is a sphere producing a specific type of service, work in this area having productive character. Under these conditions increased distribution costs can be attributed to the increase “production” distribution. Such conditions benefiting from proximity and promptly supply a wide variety assortment, after-sales service, etc, the buyer will achieve substantial time savings and at the same time meet the requirements. The cost of such “benefits” must be included in the profit margin of the retailer. And given the increasing servicing has become a prerequisite for today's consumer, “production” distribution will in turn tend to frontload increase physical mass of goods in circulation. It is precisely the phenomenon mentioned above.

e).Decrease short circuits, circuits for direct or long circuits. We consider on the one hand around the trend of producers to consumers, practicing for this purpose forms of direct sales of its products, this leads to the elimination of intermediaries, on the other hand the development of large-scale commercial transactions, both in terms as well as the volume of their geographical area, a phenomenon that leads to the presence of various types of intermediaries.

f).Changing the size and the closeness of the points of trade flows that occur consumption processes. The same phenomenon acting on the length distribution channels its mark and the other two dimensions: width and their depth. We have mainly focused on the number of units by which the respective circuits and size of these units.

g).Strong trade development through franchising, so-called phenomenon of “franchising”. It is a commercial circuit made under license for commercial reasons given by another firm to exploit an original brand, methods or techniques particular trade, while providing technical and management required.

h).Expanding powerful integrated distribution systems. Such a kind of trade covering all areas or commercial branches tending to cover most commercial enterprises. In this area the most spectacular progress have been newly created enterprises that have established early on that objective, focusing mainly on the creation of modern shops with large areas of well-equipped and technologically capable to carry out specific activities for all stages of the movement and in the retail trade is something that may take responsibility for transmission to points of consumption goods.

i).Increasing scale vertical distribution, horizontal and multi-channel.

All these situations have to be known to the transport companies (sea, river, road, rail), but also by port operators, transport related companies, which may be part of “supply chain” an organization directly or be influenced indirectly by the activities of the supply chain. The global economy is fluctuating and this situation forcing transport companies to heed all the trends in the market, regardless of the industry.

8. REFERENCES

1. Bacanu B., (2006). *Strategic management practices*, ”Polirom” Publisher, Iasi.
2. Balan C., (2006). *Logistics*, “Uranus” Publisher, Bucharest.
3. Druker P.F., (1954). *The practice of Management*, pg.118-119, “Harper & Row” Publishers, New York and Evanston.
4. David P., Stewart R., (2008). *International Logistics.The management of International Trade Operations*, “Thomson” Corporation, Ohio.
5. Gattorna L.J., Alling C.P., Tyndall R.G., Cristopher M., Ehnbom S., Robinson C., Hatton G., (2001). *Logistics and distribution management*, pg. 223-224, “Teora” Publisher, Bucharest.
6. Iordanoaia F., (2011). *Logistics in the Supply Chain Management*, University note book, Maritime University, Constanta.
7. Iordanoaia, F., (2012). *Logistics in transports*, “Nautica” Publisher, Constanta.
8. Lee J. Krajewski, Larry P. Ritzman, Manoj K. Malhotra, (2008). *Operations Management: Processes and Value Chains*, Editura Prentice Hall, New York.
9. Martin Christopher (2010). *Logistics and Supply Chain Management*, Publisher: Financial Times/ Prentice Hall, New York.
10. Porter, M.E., (1980). *Competitive Strategy*, “Free Press” Publisher, New York, 1980.
11. European Logistics Association-ELA (2013), Official Documents, Brussels.
12. Romanian Association of Logistics-RLA (2012), Official Documents, Bucharest.
13. Intermodal & Logistics Magazine-ILM (2013), Bucharest.
14. Romanian Journal of Supply Chain-RJSC (2013), Bucharest.

Web sites visited:
www.arilog.ro/
www.cargolog.com/
www.clarksonresearch.com/
www.elalog.eu/
www.esupplychain.eu/
www.freightworld.com/

www.ics.org.uk/
www.intermodal-logistic.ro/
www.iso.org/
www.logisticsmgmt.com/
www.logisticsonline.com/
www.logisticssupplychain.org/
www.transport-business.ro/
www.un.org/
www.unctad.org/

DIFFERENT WAYS OF ANALYSING THE EFFECTS OF PUBLIC-PRIVATE PARTNERSHIP IN ORGANIZING PUBLIC SERVICES

[1]MINA SIMONA, [2]SURUGIU IOANA

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

ABSTRACT

Public-private partnership has been presented as an opportunity to improve the input and output legitimacy of global environmental governance. Functional decentralization can generate a considerable improvement in the quality of life of the population and in the functioning of a city and its services. We reported in this paper some conclusions regarding externalisation, public-private partnership and improving the quality of life of the correct organizing of public services. We exemplified the well practice examples from Canadian Experience, Northern Europe Experience, UK private sector participation in Governance, and the Romanian case. After an important qualitative analyse of all these results we established if the New Public Management ideas are correct, or not. Some of the results contradict the New Public Management ideas: mainly that private sector participation through public-private partnerships in the delivery of public services will inevitably lead to a better use of scarce resources, and consequentially to lower user prices and higher quality goods and services. Our empirical analysis demonstrates that user prices have a stronger relationship with the organizational costs than with property or the adopted management model in the delivery of public services. The article offers a view of understanding that any solution to rebalancing budgets and world markets or to improving jobs and incomes will involve the public sector will be key issues for all comparative political economists studying the fundamental conflicts over income, equality and jobs in the years to come.

Keywords: *decentralization, public services, public-private partnership, performance*

1. INTRODUCTION

The efficient implementation of decentralization is an effective path to raising our European standards regarding local governance, as well as a coordinate for improving the administrative activities at the internal level, by offering quality public services for everyone. Who knows best, if not the local authorities voted by the citizens and which answer to them, what the development priorities of the local communities are and accept the obligation to carry them out? We believe in decentralization, not because we have to answer to the European Union's, World Bank's or any other international organization's requirements, but due to the fact that we know that a whole series of public services are more efficiently offered at the local level. Pre-university education, social assistance, public utilities and road infrastructure are only a few of the public services in which the local public authorities are better positioned regarding the administration of the resources and are adapted to that specific community [1]. Just like the whole public administration process of reform, decentralization must not be viewed as the sole objective; it must be viewed as achieving clear objectives: improving quality, efficiency and public service equity. Unfortunately, the decentralization policy has been for a long time a constant in the public speeches of the politicians that leaves you with the impression that the interest in this area is only at the declarative level, and is not honest. The main assignment of decentralization is to consolidate the autonomy of the local governance within the regional administrative units, and this can be achieved by broadening the range of competences as well as the power of decision regarding the basic public services organized at the local level and the transfer of the indispensable financial resources. The rationales that justify decentralization are in reality a lot more: cutting down the public spending, improving efficiency in offering public services by passing them on to the local public administration, bringing the decisional act closer to the beneficiary, civil society's involvement in the governing process.

There can be multiple benefits if the rules of the game are followed: decentralized public services – allotted financial resources – transparency and civil society's involvement in the local decisional process – all of these activities carried out under the strict observation and control of the central public authorities through their regional delegates. We will closely analyse all of these stages in order to point out the importance of each component and to lay out the role for each actor involved in the proper functioning of certain fundamental activities for each community.

2. PROBLEM FORMULATION

Regarding the public services, a lot of them have been decentralized on paper, totally or in part, and presently the local public authorities exercise three categories of competences, according to art. 5 row 1 from Law no. 215/2001 and article no. 2 and no. 19-28 from Law no. 195/2006: exclusive, different and delegated. The exclusive competences are the ones attributed by law to the public local administration authorities, responsible for achieving them. In accordance with these attributed competences, the public administration authorities have the right to decide and have the necessary resources and means in achieving these competences, respecting the norms, criteria, and set standards by the law.

The different competences are exerted by the local public administration authorities jointly with other levels from the public administration (county or central), with a clear separation of financing and decisional power for each one responsible. The delegated competences are attributed by law to the local public administration authorities, simultaneously with the proper financial resources from the central public authorities, in order to exercise them on their behalf and implemented limits by them. The obligation to assure the total financial support regarding the delegated competences, belong to the central authorities, according to art. 6 row 2 from Law no. 195/2006. The newly proposed public services for decentralization according to the Governing Program 2013/2017, undertaken by the government, are:

- ✓ Pre-university education, by transferring to the local authorities' level (towns, communes, municipalities and counties) of competences regarding organization and functioning of the schools' network, naming/dismissing from post of directors, and at the educational establishments' level the dismissal of those involved in the management of the human resources.
- ✓ Public health, by transferring the management regarding the communes', towns', municipal' and counties' hospitals to the local authorities.
- ✓ Public order, by establishing commune's police with competences to include car traffic on the public roads within the townships
- ✓ Agriculture, by transferring the agricultural attributions of the counties' offices to the Counties' counsels, except those for inspection and control.
- ✓ Environment protection, by decentralizing the environment protection counties' offices attributions to the Counties' counsels, except those for inspection and control. Regarding the decentralization within the cultural sector, it will be continued by transferring the cultural institutions' competences to the National Ministry of Culture and Patrimony, and in the transportation sector, the fluvial ports' decentralization that were left under the subordination of the Ministry of Transportation and Infrastructure, as well as the subway system.
- ✓ Regarding the social assistance already decentralized, the objectives are the improvement of the financing framework and monitoring by laying out cost and quality standards.
- ✓ It needs to be pointed out the fact that the transfer of responsibilities will be assigned to the local authorities simultaneously with the right on land and buildings that are still under the administration of ministries or central institutions, as well as businesses with state capital.
- ✓ Increasing the decisional extent of the public administration authorities must involve the demand for accountability on behalf of the deciding players without the possibility of holding accountable other people, except in certain, clearly stated conditions, due to the fact that every authority wants to decide, but have the tendency "to run" from responsibilities.

In order to properly evaluate the chances the local public administration has in order to efficiently achieve the established competences In its task, we must objectively evaluate the financial resources they have available. The most sensitive and hard part of decentralization is the financial relation that must be established among the state and the local communities. Placing the new services in the hands of the local communities' management will obviously determine a rise in the local public spending, whilst the present tendencies are to reduce these spending. The preoccupation with determining the necessary financial resources in order to sustain the variety of public services is a characteristic of all the states, mainly because of the unfavorable international financial climate. This doesn't mean that in more favorable financial times, the problem financing the public services hasn't been a priority; it only means that in difficult financial times the solutions entail certain restrictions at the resources' level, which will be perceived in the quality level of the services offered.

The main hurdle of decentralization is in fact the financial aspect, representing a hindrance in more ways than one. A defective transfer, with none existing or lack of necessary resources, will undoubtedly lead to major imbalances of the local budgets, and the new services will become a burden for the local authorities. The problems are even much more difficult in the poor communities, where its own collection source is limited and are dependent on the financial sums from the state budget. Under these conditions, apart from decentralization's main objective to offer quality public services and to bring closer to the community the decisional factor, the situation will worsen.

The financial autonomy of the local communities is the premise for the success of decentralization, and because of that the local communities must have at their disposal their own adequate financial resources in order to deal with their responsibilities, to determine freely the revenues and spending and not to be subjected to inspections except a posteriori regarding their financial decisions[2]. The communities' right to financial autonomy must be respected since it is established by the legal dispositions: "the local autonomy is only administrative and financial, being exerted on the basis and within the limits of the law"[3]. Furthermore, the provisions of the "European Local Autonomy Charter" state that "the local public administration authorities have the right to their own, adequate funding, which will be at their disposal freely in order to fulfill their responsibilities", these resources "must be in direct accordance to the competences stated by the constitution or law", as well as "the protection of the administrative territorial units with an unfavorable financial situation, necessitate the implementation of balancing financial procedures or corresponding measures, in order to correct the effects of unequal allocation of the potential financing resources". (Article no. 9).

3. PROBLEM SOLUTION

We insist on the importance of establishing a balance among the competences of the local public authorities and the financial resources needed for exerting these competences. Not all the local communities have the same financial support, due to the fact that the own local revenue greatly depends on the degree of economic development of each community. The ability to gain its own revenue from "levies, taxes, contributions, other proceeds, other earnings and share splits from the income tax"[1]determine disparities at the communities' level from that territory or even in that region, thus the poorer communities are in a position of not being able to ensure the proper functioning of the decentralized public services. It is important that in these situations we have to make use of the different balancing mechanisms, which represent an indispensable, fundamental mechanism, its objective being the distribution of wealth and decreasing the inequalities among the local communities.

At this moment, the amended Law no. 273/2006 makes important disclaimers regarding the transfer strategy of the decentralized services to the local communities' management and that of the balancing budgets' policies. In order to ensure vertical and horizontal balancing budgets, the territorial administrative units will receive in the first case from certain state budget revenues, amounts deducted with a specific destination and amounts deducted for balancing the budgets, in the second case.

Therefore, according to article no.6, the government's transferring of the administration and financing of the local public administration authorities for certain public spending, as a result of decentralized activities, as well as other public new spending will be carried abide by the law, only if the necessary financial resources for accomplishing these tasks are ensured and they are as follows:

- ✓ In the first year, by distinctly encompassing in the budget's law annex of the deducted amounts with a special purpose, necessary for the financing of the transferred public spending or of the new spending, as well as that of the distribution criteria;
- ✓ In the following years, by encompassing those certain resources in the deducted amounts as a whole, for balancing the assigned local budgets of the territorial administrative units, except those distinctly specified by the state budget's law annex.

One argument of this research is made of the recent comparative literatures have yet to adequately consider governments themselves, and how changes to their budgeting, operation and collective bargaining structures have affected jobs and income inequality. Drawing on a range of recent OECD and trade union statistics, as well as qualitative studies, it is claimed that governments converged substantially over period 1990-2005, introducing fiscal austerity measures and making substantive changes to public sector management and operating through privatization, marketization and public-private partnership. Did left parties, partisanship or levels of corporatism affect the general patterns and variations in retrenchment, restricting and flexible employment?[4]

In Sweden and Finland, two countries formerly seen as upholding a social democratic model of welfare state services and public sector delivery, government have followed OECD trends of market oriented reform. In the wake of financial crises in the middle of 1990s, the size of the central government was shrunk to aprx.7-8 per cent of GDP and public government employment as a percentage of total public employment declined rapidly from 26 per cent in 1990 to 17 per cent in the middle of 1990s[5]. As in other countries that underwent rapid public sector reform, in Sweden and Finland decentralization was used to dump political problems onto municipal levels of government with fewer funds. Unsurprisingly, municipalities began to cut labor costs and benefits, and cities began to compete with one another competitive reductions. Decentralization also provided Social Democratic coalitions with the opportunity to streamline public services, especially in health and social services, by laying off public sector workers and having fewer people perform the same number of tasks.

Social democratic coalition governments in Finland and Sweden also dramatically scaled back social expenditure in the 1990's. In Finland, social expenditure fell from 34,9 per cent in 1992 to 24,5 percent in 2000. In Sweden, social expenditure declined from a high of 36 per cent of GDP in 1993 to 29,5 per cent in 2000. These were the largest declines from peak levels of spending in the OECD, well above the average decline in social expenditure of 3.2 per cent. "Public service employment also fell dramatically in Sweden by almost 7 per cent, a figure only matched by the declines in Austria, where privatization and cutbacks reduced public sector levels by 6,7 percent". In both countries, unions responded with official strikes, walkouts, work to rule, and overtime bans during the 1980s and 1990s in an attempt to protect public sector employment and better wages.[6]

Labor movements did launch advocacy campaigns and strikes against privatization, labor market deregulation, and low pay. Most notably in France and Italy, over the past 15 years, unions protested the right's sell off of the gas and electricity industries, and in 2003 in both countries public sector workers were at the forefront of general strikes against privatization, as well deteriorating public services and worsening pay and work conditions in the public sector.[7]

In Canada, the Canadian Union of Public Employees successfully blocked the privatization of an electricity company and was instrumental in leading the public campaign to return water facilities to municipal control.

4. CONCLUSIONS

Regarding the balancing local budgets' policies, the law establishes deducted amounts distributed to counties using the following criteria: on one hand, the financial ability determined by the income tax per capita, in the amount of 70%, and on the county's surface area, in the amount of 30% on the other hand. Public-private partnership is currently sought by scholars and policy-makers as a tool for overcoming the financial crisis of the State and low performance in public administration. "It is deemed as an opportunity to bring added value to projects and their contents in order to meet new, emerging social demands"[8]. Despite de growing attention paid to public-private partnership, international literature has been questioning their actual effectiveness and viability. Public-private partnership suffers from a lack of strategy-making and dynamism in public sector organization: public action geared towards public business cooperation requires advanced accounting, management and steering skills that cannot be usually developed. Such issues match with the latest developments in the field of urban regeneration and represent a major stake for local governments. Leaving aside the many facets of public-private cooperation, it is possible to notice two aspects of general interest which can be used mainly to signal the "rise of new tools" for government, that is, the discovery of alternate ways for local governments to take advantage of a third part either in the setting of their strategic agendas or the performance of particular tasks[9]. Secondly, the term public-private partnership can be referred to "any initiative, entailing the "pooling" of complementary resources held by several organizations, within a regulatory framework, setting shares of risks and responsibilities among the tires concerned"[10].

Public-private partnership is a well solution of implementing financial decentralization: it refers to new sources for financing the delivery of public utilities and the chance of loosening the grip on public budgets. It generates innovative solutions to the emerging issues of contemporary society, solutions that might be achieved in no other ordinary day.

To many, the recent global crisis has been the midwife for the return of "Leviathan" of "big government" that interferes with markets and economy efficiency. But a question little asked is *What kind of government?* Because throughout the past 25 years, advanced industrial governments have made substantive reforms. Today, the private sector-because of privatization and contracting out-provides more than 40 per cent of public goods. Public sector reforms have led to the widespread introduction of market competition throughout departments and governmental agencies. How these will reinforce market strategies for wage restraint and boost service or export growth or provide opportunities for parties and labour movements to explore alternative models could be uncertain.

5. REFERENCES

[1] Craciun Claudiu, Paul E. Collins, *The management of public policies, Transformations and perspectives*, Ed. Polirom, Iasi, 2008,p.239

[2] Profiroiu Alina, Profiroiu Marius, *Financial autonomy of local communities in Romania – a premise for the succes of decentralization*, published in The Transylvanian Administrative Sciences Journal, nr. 19, 2007, p.78

[3] Law nr. 273/2006, regarding the local public finances, amended through E.G.O 63/2010, art. 5

[4] John Peters, *Neoliberal convergence in North America and Western Europe: Fiscal austerity, privatization and public sector reform*, in Review of International Political Economy, 2011, 19:2, 208-235

[5] Micheletti M., *End of big government: is it happened in the Nordic Countries?*, in An International Journal of Policy and Administration 13(2), 2000, pp.265-278

[6] Stokke T.A., Thornqvist C., Strikes and collective bargaining in the Nordic countries, in European Journal of Industrial Relations, 7(3),2001, pp. 245-267

[7]Carley M., Developments in industrial action, 2003-2007, European Industrial Relations Observatory Online, http://www.eurofound.europa.eu/eiro/studies/tn0910050s/tn0910050s.htm, accessed on 28-th of September

[8] Guido Codecasa, Davide Ponzini, *Public-private partnership: a delusion for Urban Regeneration? Evidence from Italy, in* European Planning Studies, vol.19, no.4, April 2011, p.647

[9] Slamon L., *The tools of government: a guide to new governance*, New York, Oxford University Press, 2002, p.150

[10] Klijn, E.H., Edelenblos, J.&Hugues, M.P.(2006*), Public private partnerships: a hybrid reform idea? A comparation of PPP in England and in Netherlands*, paper presented at British Acacdemy of Management Conference, Belfast, 12-14 sept.

THE EUROPEAN DIMENSION IN EDUCATION. SOCIAL POLICY OF THE EUROPEAN UNION

NEN MADLENA

Military Technical Academy of Bucharest, Bucharest, Romania

ABSTRACT

Literature in public policies "revolves" around terms of decentralization and subsumed concepts (privatization, implementation of market mechanisms, contracting, etc.). In this work I analyzed a type of public policy, proposed at a "centralized" level as a European Community policy is coordinated by supranational institutions.

In this context, I refer to how evolved the approach of public policies in education at EU level, in terms of theoretical models operating in the public policy decision-making process and I also refer to some milestones of social policy of the European Union. The transition to a market economy has influenced, powerfully, the employment level of the population in terms of volume and structure, as determined the adaptation labour market policies, in parallel with the process of institutional reform.

Under the conditions of speed-up restructuring and increasing insecurity of the job, the labour market has accumulated a great number of social problems.

Keywords: *public policy, European dimension, social policy, .*

1. INTRODUCTION

1.1 Theoretical models:

Theoretical models of reference for the adoption of public policies are proposed by Simon H., respectively comprehensive rationalist model and incrementalist model developed by Lindblom Ch. The perspective of collective action/rational choice was adopted by many theorists and actually includes models with basic common features but distinguished by specific elements. These models share, however, assumptions and common key elements:

- governance can be explained by cognitive processes of individual type.
- individuals have the ability to compare and order sets of different preferences and thus may order options for action.
- individual order of preferences has internal consistency.
- individuals act to maximize the utility, considering the existent constraints. This is the meaning given rationality feature of individual decision-making, namely the action in terms of maximizing the net benefits.

Simon proposes in his work the distinction between "programmable" decisions and "non-programmable" decisions. These are not programmable to the extent that they are new and unstructured: the issue was not explored, its nature can be complex and may require a special treatment . This type of decision is expensive and risky and, therefore, an organization should try to reduce the issue to programmable decisions that describe specific procedures and criteria. Simon is looking at the posibilities of adopting scheduled decisions: mathematical techniques, linear and dynamic programming, probabilistic models, game theory, etc.

Organization as a decision-making structure has, in Simon's view, three levels:

1) the basal layer, where the work is done by gathering and storing data and information;
2) the intermediate level, where usual programmable decisions are made,
3) the level at which non-programmable decisions are made, the ones that can lead to reconsideration and restructuring of the entire system, decisions establishing the strategy and monitor the achievement of objectives .

In the case of Lindblom, incrementalist descriptive model proposed is also normative model. Incrementalism is characterized by the following:

- selecting goals and objectives overlaps with the empirical analysis of the situation and are therefore interdependent and not different stages of the decision process;
- the decision-maker considers only some of the possible alternatives for solving a problem and they belong to the neighborhood of the existing actions (policies), differing only marginally from them;
- for each alternative are evaluated only a limited number of consequences;
- the problem is redefined in the decision-making, it tends to be a continuum rather than a well-defined staging process. Incrementalism allows for readjustment goals-means and means-goals, in idea of the best possible investigation of the problem;
- incrementalism is more remedial and aims mainly to improve the current situation than promoting future social purposes .

2. SOCIAL POLICY OF THE EUROPEAN UNION

2.1 Key moments

Social policy of the European Community began with its setting up treaty, in 1957. The Treaty of Rome laid the foundations of social policy through its articles on the free movement of the workers and the freedom to establish them, in the context of creating the common market. The Treaty also provides for the creation of the European Social Fund, financing instrument of social policy and the oldest of the Structural Funds.

The next step was the ratification of the Single European Act, in 1986, which contains directives on health and safety at work, introduces the social dialogue and the concept of economic and social cohesion (materialized by establishing the Fund of Economic and Social Cohesion).

Year 1989 is a milestone of the european social construction by passing the first programmatic document of social policy - Social Charter - which sets out fundamental social rights and, with these, the action directives of the social policy.

A year later, in 1990, the Maastricht Treaty (ratified in 1992) states that one of the Union's objectives is to achieve a "high level of labor employment and social protection, equality between women and men [...] increasing standards of living and quality of life ... "(Art. 2).

In 1991 was passed the Social Policy Protocol, which was annexed to the Maastricht Treaty and which sets out the objectives of social policy (foreshadowed by the Social Charter): promotion of employment, improvement of living and working conditions, combating social exclusion, human resources development, etc. (signed by 11 Member States, not the United Kingdom).

Green Paper, launched in 1993, opened the discussion process on the future of social policies at EU level and was followed, in 1994, by the White Paper, which sets the priorities of social policy until 2000, embodied in social action programs for the periods 1995 - 1997 and 1998 -2000.

In 1997, by the Treaty of Amsterdam (ratified in 1999) is repealed Social Protocol, is released Social Policy Agreement and integrated a new article in EU Treaty, an article on employment and known as Title VIII. 1998 is the year when Great Britain signed the Social Policy Agreement and so participated at the social community policy.

Year 2000 is a major moment in the evolution of social policy through the development of the Lisbon Strategy, which is set 10-year goal of the European Union, represented by transforming its economy into the most competitive economy based on knowledge. Also this year, the Social Policy Agenda was adopted, which takes those specific objectives and strategy elements related to social policy and converts them into a 5-year action program, which is the current social policy framework.

In 2003 it held the intermediate evaluation of the Social Agenda, resulting the adjustment of Agenda priorities based on progress so far and the political, economic and social changes at the community level.

2.2 The changes brought by the Lisbon Treaty

1. An article at the beginning of the TEU (Treaty on European Union) defines clearly the values that underpin the Union. Another article sets Union targets;
2. Charter of Fundamental Rights becomes legally binding and has the same legal value as the Treaties, although its text will not be included in the Treaties;
3. draft Treaty provides a new legal basis for the EU's accession to the European Convention on Human Rights. Council will decide unanimously, with the approval of the European Parliament and the Member States;
4. although the provisions relating to citizenship will be in the TFEU (Treaty on the Functioning of the European Union), the concept of European citizenship has resumed the place it deserved and now, due to the insistence of EP representatives, is provided as follows, in Article 8 of TEU: "Every person holding the nationality of a Member State has EU citizenship. Citizenship of the Union shall be additional to national citizenship and shall not replace it";
5. participatory democracy is strengthened, particularly by citizens' right of initiative, which allows a number of at least one million citizens from a significant number of Member States to require the Commission to take an initiative in one area;
6. co-decision is substantially extended (as envisaged by the Constitution) and becomes the ordinary legislative procedure. As a result, the European Parliament is becoming a legislator standing on an equal footing with the Council for 95% of Community legislation. Parliament's involvement increases the democratic legitimacy of European law;
7. new budgetary procedure provides full parity between Parliament and Council in approving the general budget (not the distinction between compulsory and non-compulsory expenses) and the multiannual financial framework, which becomes legally binding;
8. qualified majority voting in the Council is a rule. Its definition as a double majority of 55% of states, representing 65% of the Union population, is the same as in the Constitution (requiring a minimum of 4 Member States to form a blocking minority), although it will not come into force than in 2014. It will also be subject to a transitional period of three years, until 2017, during which time a decision will be blocked from voting in accordance with the Treaty of Nice. Moreover, a new mechanism based on the "Ioannina compromise" provides that a minority of Member States may request review of a legislative proposal before its adoption. According to a statement annexed to the new Treaty, a Council decision grants legal status to this mechanism;
9. moreover, it will be easier than now to resort to enhanced cooperation. Parliament must give its consent;
10. a new permanent President of the European Council (elected for a term of two and half years by the Heads of State and Government) will chair and drive forward its work. This will ensure the preparation and continuity of the work of the European Council, in an attempt to facilitate cohesion and consensus within the Council and submit to the European Parliament a report after each of its meetings;
11. they agreed on a new Parliament composition, on a proposal made by Parliament with the addition of one seat. As a result, Parliament will be composed of 750 members, plus the President;
12. Chairman of the Committee shall be elected by the European Parliament by a majority of its component

members. The candidate will be proposed to the European Parliament by the European Council, which will nominate by a qualified majority, taking into account the results of the elections to the European Parliament and only after holding needed consultations. Parliament will also vote on the investiture of the entire Commission, including the High Representative for Foreign Affairs, who will also be the Vice-President of the Commission;

13. to ensure the efficiency of the Commission, the members number will be reduced. Thus, after 2014, it will consist of a number of commissioners who will represent two thirds of the Member States number. To ensure equality between Member States, is introduced a rotation system to ensure that each Member State is represented in two of the three colleges. Since the entry into force of the Treaty of Reform, until 2014, the Commission will be composed of one member per Member State (including Vice-President/ High Representative);

14. creation of a High Representative for Foreign Affairs with a dual role, which on the one hand, will chair the Foreign Affairs Council, and on the other hand, will be one of the Vice-Presidents of the Commission, shall ensure the consistency of all the Union's external policy. This will be appointed by the European Council with the consent of the President of the Commission. As Vice-President of the Commission, it will be subject to the investiture vote of the entire Commission of the Parliament;

15. progress in the field of foreign and security policy has been maintained in its entirety, including faltering progress in increasing the efficiency of decision-making and the creation of a European External Action Service which will assist the High Representative to ensure consistency throughout the Union's external action;

16. in defense area, Member States that have the capacity and needed desire can develop a structured cooperation that may lead to a common defense system. It introduces a solidarity clause: if a Member State is the victim of an armed aggression on its territory, the other Member States shall help and assist it by all means at their disposal;

17. area of freedom, security and justice comes into the scope of application of Community law and co-decision and qualified majority voting are extended, although initiatives by Member States remain possible in some cases. Integration within the scope of Community law is combined with certain "emergency brake" procedures to allow Member States to refer issues to the European Council, when their vital interests are at stake in this area. In these cases, enhanced cooperation is facilitated. Exceptions are provided for specific protocols: the United Kingdom and Ireland (opt-in/opt-out mechanism);

18. Court of Justice jurisdiction is extended to cover all activities of the Union, except the foreign policy and security policy (including, however, the control of measures which restrict the rights of citizens);

19. Union is single legal personality and structure on "pillars" disappears, so that common policies on freedom, security and justice to come within the scope of Community law. Common foreign and security policy is, however, approached in EUT-the European Union Treaty (while other areas of EU external action are addressed in TFEU – the Treaty on the Functioning of the European Union) and continues to be governed by specific decision-making procedures;

20. it is introduced a clear and precise division of powers, accompanied by a flexibility clause, similar to the existing one, but now Parliament must give its consent;

21. in addition to the so-called procedure of "yellow card" – where if a third of national parliaments reject a legislative proposal, the Commission will reconsider it -, was introduced a new mechanism to allow national parliaments to control the application of subsidiarity principle: if a simple majority of national parliaments adopt an opinion stating that a legislative proposal does not comply with the subsidiarity principle and either the Council or the Parliament agrees with those national parliaments, the proposal is rejected;

22. they have introduced new legal basis for energy (strengthened), patents, tourism, sport, space and administrative cooperation, and environmental policy was supplemented by a reference to climate changes;

23. a new horizontal "social" provision ensures that, in defining and implementing its policies, the Union shall take into account requirements such as promoting a "high level of employment," "adequate social protection", "fight against social exclusion" and a "high level of education, training and protection of human health";

24. a specific legal basis recognizes the specific characteristics of the services of general economic interest. A protocol complements the Union's concerns in this area;

25. hierarchy of norms is preserved through the distinction between legislative acts, delegated acts and implementing acts, although the terms "law" and "framework law" were abandoned in favor of keeping the current terminology (directives, regulations and decisions). The Parliament and the Council have equal powers with regard to the definition of control procedures of delegated and implementing acts (comitology);

26. European Parliament plays an enhanced role in the revision procedure of the treaty. It has the right of initiative, is part of the agreement underlying new ordinary procedure of review and its approval is required if the Council wishes not to convene a Convention in the case of minor changes;

27. simplified procedures for amending the treaties introduced by the Constitution, on policies and procedures, are maintained:

- the TFEU concerning internal policies and actions can be amended by unanimous decision of the European Council, with the agreement of the Member States (in which the European Parliament is consulted);
- a further simplified procedure allows moving from unanimity to qualified majority in the Council or from the special legislative procedure to the ordinary legislative procedure (co-decision) by unanimous decision of the Council, with the consent of the European Parliament. If a national parliament objects,

the decision can not be taken. In this case, can be applied only to regular revision of the Treaty;

• TEU will contain an exit clause, which defines the methods and procedure whereby a member state can leave the European Union and in this case i tis necessary the consent of the European Parliament.

2.3 Programming principles of Structural and Cohesion Funds

A. Complementarity: Community actions should complement or contribute to corresponding national operations

B. Partnership: Community action must be carried out in a close consultation with the Member States, together with the authorities and bodies designated by the Member States, as regional and local authorities, economic and social partners, etc.. The partnership shall cover the preparation, financing, monitoring and evaluation of financial assistance. Member States shall ensure the association of relevant partners at different stages of programming;

C. Subsidiarity: The Structural Funds are not directly allocated to the projects chosen by the Commission. The main priorities of development program defined by national/regional authorities in cooperation with the Commission, but the choice of projects and their management are under the sole responsibility of the national and regional authorities,

D. Additionality: Community support can not replace the public structural expenditures or others equivalent of Member States. Budgets of the Programme can include both the EU and national funds from public or private sources;

E. Compatibility: Operations financed by the Structural Funds shall comply with the provisions of the EU Treaty, as well as its policies and actions, including the rules on competition, public procurement, environmental protection, equality between men and women;

F. Scheduling: The joint action of EU and Member States should be implemented on a multiannual basis, through a process of organization, decisions adoption and funding based on the formulation of multiannual integrated and coherent strategies and defining concrete objectives;

G. Concentration: Structural Funds are focused on priority objectives, in fact, a majority of them cover a limited number of areas that need support for their development, and the remaining resources are devoted to certain social groups facing difficulties in throughout the EU without meet special geographical criteria.

EU structural instruments are designed to stimulate economic growth of the EU Member States and to enable the reduction of regional disparities. They do not act alone, but requiring the ensure of national contributions from all Member States concerned. They are co-financed mainly from public resources of the Member State, but in many areas is also necessary the private financial contribution.

2.4 Institutional actors in the EU social policy

The main institutional actors involved in decision making and implementation of social policy are represented by the European Commission, the European Parliament, the EU Council (Council of Ministers) and the Economic and Social Committee (ESC) supported in their work by three European agencies and an equal number of social partners.

The European Commission bears directly, the direct responsibility of preparing and ensuring the implementation of social policies, through the Directorate-General (DG) for Employment, Social Affairs and Equal Opportunities. Its role is to initiate and finalize new legislation in the field and to ensure that taken action will be implemented by the Member States. In this work, DG cooperates with DG Environment and DG for Regional Development.

The European Parliament is involved in decision-making by the Committee for Employment and Social Affairs, whose responsibilities are considering various aspects related to employment policy and social policy.

EU Council is equivalent to the European Council of Ministers, meeting in a few times a year to coordinate the Member States' social policies.

Economic and Social Committee (ESC) has an advisory role in the decision process and deliver opinions at the request of the European Commission which, however, only an informative character. ESC is the link with civil society, being represented various economic and social organizations of the Member States.

Employment Committee was established in 2000 (replacing the Employment and Labour Market Committee) has an advisory role and is actively involved in the development of the European Employment Strategy and in promoting coordination between Member States on policies related to employment and labor market.

European Monitoring Centre on Racism and Xenophobia, based in Vienna, was founded in 1997 (started its activity a year later) and supports decision making by providing data and information on the situation of racism, xenophobia, Islamophobia and anti-Semitism at Community level and the development of studies and strategies for action in this area.

European Foundation for the Improvement of Living and Working Conditions was established in 1975 and is based in Dublin; his work is oriented in two directions:

(1) research management;

(2) information and communication.

The Foundation also supports decision making by providing data on the improvement of living and working at European level.

European Agency for Safety and Health at Work, based in Bilbao, was established in 1996 in order to collect, disseminate and facilitate the exchange of information and best practices in the field. Its role in decision making is to provide information on health and safety at work, data on which are based the European Commission proposals and initiatives in this direction.

Alongside these community bodies, an important role in shaping social policy is played by the social partners, represented by the European Trade Union Confederation (ETUC), the Union of Industrial and Employer's Confederations in Europe (UNICE) and the European Centre of Enterprises with Public Participation and of Enterprises of General Economic Interest (CEEP). All these partners are actively involved in social dialogue and representing employees, employers and the professions.

2.5 Social Policy Agenda

Social policy priorities are:

- the high level of employment: aims to create and promote new jobs;
- the quality of work – is about better jobs and more balanced ways of combining personal and professional life;
- the quality of social policy itself - involves a high degree of social protection, the existence of quality social services across the Union and accessible to all, creating real opportunities for all individuals and safeguarding fundamental rights and social ones - aspects that play a basic role in achieving the ten-year objective of the social policy by combining productivity with personal and professional satisfaction;
- the quality of industrial relations - is to adapt successfully to industrial changes and reflect the impact of "knowledge" - that of new technologies and research – in the economic progress.

Courses of action of social policy. Solving the presented priorities is a major challenge to social policy at the beginning of the millennium and imposes structuring on specific objectives and taking concrete action and appropriate measures to the identified situations.

Thus, given that the first two priorities - the high level of employment and quality of work - related to labor market dynamics and the professional sphere, they are treated together and have common lines of action, that have to:

- creating more and better jobs, in order to increase the overall employment rate to 70% and the employment rate for women to 60%;
- anticipating and change management, and also adapting to the new work environment (represented by a society based on knowledge and technological development) – by the proper and efficient both employers and employees in order to moderate the flexibility and job security;
- exploiting the opportunities offered by a knowledge-based society – promoting lifelong learning, new forms of work organization and the employability of people with disabilities;
- promoting labor mobility by implementing the free movement of labor and removing geographical barriers by developing mechanisms that facilitate mobility (including new technologies);

Priority on improving the quality of social policy is represented by measures to various areas of social life and is closely linked to how it interferes with the professional life. Lines of action taken to address this need are:

- modernizing and improving social protection so as to ensure individuals a secure income, to achieve retirement security and creating sustainable pension systems, leading to the development of an health performance system;
- promoting social inclusion - what is to prevent and eradicating poverty and promoting everybody’s participation in the economic and social life;
- promoting gender equality by promoting women's participation in economic, scientific, social, political and civic life;
- strengthening fundamental rights and combating discrimination by ensuring the development and respecting the fundamental social rights.

Promoting quality in industrial relations is perhaps the priority area with the highest innovation character and aims strengthening the social dialogue, promoting competitiveness and solidarity at this level.

Those directions of action that correspond to specific priorities are added two other lines of development of social policy, which are corresponding to its Extra- Community dimension:

- preparation for EU enlargement;
- promoting international cooperation.

Strategies, tools and methods of implementation of social policy - how to implement the European social model - are among the most varied and correspond to the complexity of social policy, forming a wide variety of approaches that includes strategic elements, financial, legislative and analytical instruments, dialogue and coordination methods.

They act concertedly and together ensure the internal cohesion of social policy.

The European Employment Strategy was adopted with the introduction in the Treaty of Amsterdam (1997), of a chapter on employment (Title VIII).

The strategy aims to tackle unemployment in the EU and has been designed as a main tool for tracing and coordination of community priorities in this direction, priorities to be addressed by each member state. The role of this strategy is to coordinate, at Community level, the employment policies of the Member States. Depending on the identified priorities, the strategy is structured around four pillars, each representing a field of action of which development contributes to the better employment at Community level:

1) employability - is a new culture in the field of employment and refers to the ability to be employed, helping to combat youth unemployment and combating long-term unemployment;
2) entrepreneurship - promoting the creation of new jobs by encouraging local development;
3) adaptability - is considering modernization of the work organization and promotion of flexible employment contracts;
4) providing equal opportunities - refers in particular to the special measures for women to reconcile professional life with personal life.

The operation strategy is structured in several stages, as follows:

1) the establishment of the "Employment Guidelines", a document prepared annually and based on a European Commission proposal which is discussed and approved by the European Council (Council of Ministers);

2) the development of "National Action Plans" for each Member State separately, describing the application of the earlier document elements in the Member State;

3) the development by the Commission and the Council of a "Joint Employment Report" which is based on the national action plans;

4) drawing specific recommendations for each Member State (Council recommendations on the basis of Commission proposals).

The method on which to carry out the coordination of employment policies is initiated within the Strategy for Employment and is known as the "open method of coordination". Principles underlying this method are:

- the principle of subsidiarity, which is to establish/division of responsibility between the Community and national level establishing objectives at Community level by empowering the Member States in the implementation of action measures adopted for their implementation at national level;
- the convergence principle which consists in tracing common objectives by related actions;
- management based on objectives that relates to monitoring and assessing progress by establishing common indicators for all Member States;
- country monitoring, which consists of preparing reports which record progress and identify potential best practices at Member State level;
- integrated approach that involves expanding labor market policies within other policies (social, educational, entrepreneurial, regional and taxation).

The themes identified for the reform Employment Strategy are:

- establishing clear objectives,
- simplifying Employment Guidelines (but without reducing their effectiveness),
- Strengthening the role of the social partnership by implementing the strategy and increase the coherence and complementarity with other Community processes (Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on Taking Stock of Five Years of the European Employment Strategy).

3. CONCLUSIONS

In the context where the type of public policy, proposed at a "centralized" level as a European Community policy is coordinated by supranational institutions, I refered to how evolved the approach of public policies in education at EU level, in terms of theoretical models operating in the public policy decision-making process and I also refered to some milestones of social policy of the European Union. The transition to a market economy has influenced, powerfully, the employment level of the population in terms of volume and structure, as determined the adaptation labour market policies, in parallel with the process of institutional reform.

4. REFERENCES

[1] SIMON, H. - The New Science of Management Decision, Langelwood, New York, 1960,
[2] HOGWOOD, C., GUNN, D. - Policy Analysis for the Real World, New York Press Journal, 1984,
[3] ANDERSON, E.,J. - Public Policy-making, Birchall &Putman, New York, 1984,
[4] DIACONESCU, M. – Romania’s Association to the European Union. Economic and Trade Implications, Economic Publishing House, Bucharest, 2003,
[5] http://www.fonduri-structurale.ro
[6] Council Regulation (EC) No. 1083/2006,
[7] Commission Communication: Adapting and promoting the social dialogue at Community level

STATE REGULATION ISSUES OF INTERMEDIARY ACTIVITY OF CUSTOMS BROKERS IN UKRAINE

[1]ONYSHCHENKO SVITLANA, [2]KOROBKOVA OLENA

[1,2]*Odessa National Maritime University, Ukraine*

ABSTRACT

Regulatory influence in the sphere of service provision of customs affairs' business activity is reviewed in the article; the problem of structural change in customs authority, creation of conditions for foreign-economic activity and transfer of such activity's control function to Ministry of revenues and duties of Ukraine aiming at public interest protection; state regulation of customs intermediary's activity and enhancing control of intermediary activity in the customs affair branch, using effective measures to increase responsibility of intermediary enterprises for compliance with requirements of regulatory acts of Ukraine.

The importance of regulatory influence to customs intermediaries' activity, necessity of its transformation in conditions of general raise of foreign-economic activity effectiveness of market entities and state entities in whole are proved.

Keywords: *intermediary service, customs intermediary, customs affair, regulatory activity, customs broker.*

1. INTRODUCTION

International commerce – is an important factor of economic growth. Customs authorities, which control international flow of goods, are able to tighten security of international commerce and promote economic development of Ukraine by way of increasing revenues to budgets and facilitation of customs formalities. Besides, a necessary condition for foreign-commercial relations' development is creation of effective regulatory mechanism for subjects of foreign-economic activity and intermediary structures – customs brokers, which are connecting link between participants of foreign trade and customs authorities.

Presence of professional organizations – customs brokers – is a necessary condition for provision into customs activity practice of progressive forms of dealing with customs formalities, increasing guaranties of return of duties and fees to state budget revenues.

In conditions of globalization, internationalization and widening international connections, each country seeks to harmonization and standardization of customs procedures (Diop, 2007).

Researching customs brokers' activity mechanism is one of significant tasks, set to modern economic science in the sphere of foreign economic activity.

Separate aspects of intermediary activity in customs sphere were researched by V. Bogatov, I. Bondarenko, N. Goncharova, O. Spitsyn, O.V. Seryh, I.I. Svitlac, I.O. Fedotova and others.

Timely issues of up-to-date are changes in customs authorities' structure, creation of foreign-economic activity development conditions and transfer of such activity's control function to Ministry of Revenues and Duties of Ukraine aiming at public interest protection (Ministry of Revenues of Ukraine). Establishing Ministry of Revenues and Duties of Ukraine, which includes tax and customs services, – is the most important reform, approaching Ukraine to European standards. This way has already been worked up by leading countries, such as Canada, Italy, Latvia, Great Britain and others.

There is Customs and Tax Department in Great Britain, which deals with collecting duties and excises, controlling export and import operations. In Spain General Tax Direction carries out similar functions, being subordinate to Ministry of Industry, Commerce and Tourism. Department of Foreign Trade in Sweden, possessing wide autonomy within the framework of Ministry of Foreign Affairs of the country and forming foreign trade policy of Sweden, includes a department responsible for duties, controlling origin of goods and compliance with rules of fair competition. In most of the countries, e.g. in the USA, Finland, Japan, etc., customs authorities are included into Ministries of Finances of corresponding countries (Bogatov, 2003, p. 66).

2. MATERIALS AND METHODS

With the account of specifics and object of research the following methods were used: dialectic, comparative legal, systematic and structural, formal dogmatic.

Dialectic method was used to analyze the state and development of customs brokers' intermediate activity, of regulatory influence of state authorities to customs broker affairs. Comparative legal method permitted to analyze native legislation in the mentioned sphere as compared to foreign one. Use of systemic and structural method gave the possibility of identify the place and the role of normative acts, regulating procedure of carrying out customs broker's activity. With the help of formal dogmatic method content of intermediary services, executed by customs brokers, was defined.

3. RESULTS OF THE RESEARCH AND DISCUSSIONS

The notion of state regulatory police in the sphere of business processes, is defined in the legislation of Ukraine as a branch of state policy, aimed at advancing legal regulation of business relations, and also administrative relations between regulatory authorities or other state government authorities and business entities, at exclusion of drawing up inappropriate and ineffective regulatory acts, reducing state's intervention into business entities' activity and overcoming obstacles for business processes' development, carried out within, in the order of and by means, stipulated by the Constitution and laws of Ukraine.

In professor V.B. Averyanov's judgment, one should put away the expansion of any view of expediency of reducing connected with market transformation of state administrative and regulatory function economics (Averyanov, 1997, p. 3).

We consider that such regulation should be based upon legal principles and comply with tasks of Ministry of Revenues and Duties at the up-to-date stage.

Regulatory activity in general – is an activity, aimed at preparation of, acceptation of, monitoring effectiveness and reconsideration of regulatory acts, executed by regulatory authorities, individuals and legal entities, their associations, territorial communities within, in the order and by means, stipulated by the Constitution, this law and other normative acts.

So far the regulatory influence in the sphere of service provision business activity in customs affairs' branch is carried out by Ministry of Revenues of Ukraine.

Such activity in the sphere of business in Ukraine is based on the following principles:

expediency – grounded necessity in state regulation of business relations, aiming at solving existing problem;

adequateness – compliance of forms and level of business relations' state regulation with necessity of solving existing problem and with market requirements, taking into account all accepted alternatives;

effectiveness – guarantee of achievement as a result of regulatory act effect of maximal possible positive results on account of minimal possible resource spending by business entities, citizens and state;

balance – provision in regulatory activity of business entities', citizens' and state's interest balance;

predictability – regulatory activity succession, its completion with aims of state policy, and also with preparation plans of regulatory acts' projects, that permits business entities to carry out their operation plans;

transparency and account of public opinion – openness for individuals and legal entities, their associations of regulatory authorities' actions at all stages of regulatory activity; obligatory consideration by regulatory authorities of initiatives, comments and offers, given by individuals, legal entities, their associations in accordance with order, stipulated by law; obligation and timeliness of informing on regulatory acts' of individuals, legal entities, their associations, apprising publicity of regulatory activity execution.

I.O. Bondarenko notices, that administrative and legal regulation in the sphere of customs relations is executed with the help of organizational and legal means of customs affair business activity regulation, which can be defined as stipulated by legislation means of effecting business entities in the sphere of customs affair service provision and effecting other individuals, who enter customs relations in the process of receiving services on declaration of goods and vehicles and transportation of goods, sent abroad from Ukraine or being under customs inspection and keeping goods under customs inspection, the aim of which is regulation and control of proper exercise of rights and execution of obligations by subjects of these relations (Bondarenko, 2005, p. 26).

Thus, authorities of revenues and duties use legal means of customs broker activity regulation with the help of adoption and application of legal acts aiming at protection of rights, freedom and legal interests of customs relations' subjects. For achievement this objective means of administrative and legal regulation identify customs broker's status during customs formalities, limits of this activity and extent of possible conduct, control of their activity, and also application of security and obligatory measures in case of violation of stipulated obligations and prohibitions. These prohibitions are often connected with setting registration, notification and permission administrative and legal modes; the form of their expression, as a rule, is an individual adoptive act of executive authority, registration acts, etc.

State regulation of operations, connected with customs service provision, should be executed by way of state registration of enterprises and licensing their operations on customs service provision; normative and legal regulation of subjects' activity in provision of customs affair services; controlling enterprises' activity in customs services' provision; application of influence measures, stipulated in legislation and normative acts; conducting other state regulation measures of customs services' market (Bondarenko, 2006, p. 54).

Business activity organization measures in the sphere of customs services include obtaining qualification certificate of customs clearance agent, license for execution of customs broker intermediary activity, i.e. means aiming at legalization of this activity. State influence can be carried out by way of creation and dismissal of business entities.

Legalization of customs intermediation entity can be carried out according to such scheme: 1) acceptation and inspection of documents from candidate; 2) reliability assessment of his finances and business operations; 3) reliability assessment of candidate from the point of view of his completion with special requirements, imposed by customs legislation; 4) generalization of materials and preparation to decision making; 5) drawing up and issuing license (Goncharova, 2002, p. 56).

Permission and registration activity of customs broker allows guaranteeing professionalism and financial trustworthiness of organization and also its abiding requirements of legislative and normative acts. We consider appropriate methodical provision of process of identification of mechanisms and criteria of candidates' selection for customs broker activity to be necessary condition of customs intermediation regulation improvement. One of such criteria is determination of certain level of financial state, insurance fee payment, monitoring enterprise's financial state, which provides for customs broker activity execution (Fedotova, 2008, p. 55).

Control, as one of the functions of customs affair management, is aimed to identification and removal of deviations in customs system functioning from normative requirements, is the most important guarantee of setting (and maintaining) legal conditions in customs affair (Novikov, 1999, p. 4).

Means of control activity in customs affair service provision provide for customs regulation, control of service provision standards, their quality, prices, etc. (Bondarenko, 2006, p. 53).

Limits of state's interference in price formation and application in the sphere of customs services provided by intermediary subjects are not stipulated in normative acts. However, in connection with numerous violations by customs intermediation subjects, often due to ungrounded overpricing, the issue of prices for services in the sphere of customs affair should be circumscribed at normative level.

Among safeguarding means of securing adherence to legislation means of obliging nature are distinguished: means of administrative compulsion (sanctions), applied for violation of legislation, for instance, revoking enterprise license for numerous violations of customs legislation.

Thus, the issue of limits of state regulation of customs intermediates' activity and tightening control of intermediary operations in the sphere of customs affair, applying effective means for raising responsibility of intermediary enterprises for complying with normative acts' requirements of Ukraine needs to be resolved. Though certain steps have already been made in this direction – a system of constant control of business entities' operations, connected with intermediary services in the sphere of customs affair; a separate register has been introduced for intermediary enterprises, functioning in the area of customs authority activity, with obligatory entry to their registration forms of information about facts of violation of legislation requirements and monthly monitoring of the information connected with violations, which demand revoking license for intermediary activity in the sphere of customs affair, and also presence of repeated, systematic violations by an intermediary enterprise.

We should notice that introduction of additional control measures must comply with policy of «state regulation of business activity».

Before State Tax Service of Ukraine reorganization and establishing by Decree of the President of Ukraine as of December 24, 2012 of Ministry of Revenues of Ukraine the control of intermediary activity was carried out by department of organization and control of intermediary enterprises operations in customs affair of Customs Control Organization Department.

For the present, Customs Affair Department of Ministry of Revenues of Ukraine includes customs intermediaries' activity organization department of Customs Control and Clearance Organization Administration as corresponding structure.

Ministry of Revenues and Duties in Ukraine is the body of customs broker activity licensing. Thus, Ministry of Revenues and Duties of Ukraine should carry out legalization of customs brokers, control their abidance to customs legislation. And thus, this activity should be based on professionalism.

It is important to emphasize, that all these means are used in order to provide timely decision making concerning cancellation (annulment) of licensing documents for intermediary operations' execution in the sphere of customs affairs, issued by customs authorities, or entry of corresponding offers concerning cancellation (annulment) of these documents.

Control direction of operations of corresponding structural subdivisions' at customs intermediaries' activity organization should provide for holding measures aimed at abiding by these enterprises to normative acts concerning issues of customs affair. This activity should include observation of customs intermediaries, monitoring and other control measures, prevention, elimination of violations by way of controlling abidance to operational conditions, providing measures for determination and registration of law breaking, preparation of materials for withdrawal of customs broker license, i.e. application of enforcement measures.

In accordance with these basic activity directions a task, right and obligation list should be formed for corresponding subdivisions. We offer such list of rights of structural subdivision of customs intermediaries' work organization:

1.To accept, analyze, check, prepare materials and documents, necessary for legalization of enterprises, providing customs services (those of customs brokers, customs carriers, temporary storage areas, customs warehouses, freight customs complexes, vehicle fleets, vehicle terminals).

2.To take measures for preparation, education, advanced training, checking knowledge level on issues of customs affair of employees of customs service enterprises. To hold workshops, roundtable discussions of such enterprises' activity issues. To cooperate on these issues with educational establishments of Ministry of Revenues of Ukraine.

3.To provide legislation on regulation issues of structural subdivision activity concerning control of enterprises, which provide customs services, customs authority and also operations of these enterprises.

4.To coordinate work of enterprises, which provide customs services, on issues of disposition of entry points, introduction of informational technologies, new forms of customs control and clearance, etc.

5.To gather, analyze, record information about enterprises, which provide customs services. To request and receive in the stipulated order from subdivisions of regional customs, customs house, business entities, which provide customs services, information and materials, necessary for execution of tasks, assigned to sector.

6.To control activity of enterprises, which provide customs services (owners of freight customs complexes, customs licensed warehouses, temporary storage areas, customs brokers and customs carriers), by way of application of the following methods: observation, inspection, subjects, vehicles and goods audit concerning issues, in which specific sector is competent.

7.To take measures to avoid and prevent violations of legislation by enterprises, which provide customs services.

8.To prepare materials for disposition of documents, entitling an enterprise, which provides customs services, to conduct customs intermediate activity.

9.In cases, identified by state, to take enforcement measures against enterprises, which provide customs services.

10.To take part in functional inspections and investigations concerning officials of customs house, customs point on issues, in which specific sector is competent.

Thus, the authorities mentioned should be fixed in provision for structural subdivision on customs intermediaries' work organization. Correct legal securing competence of subdivision on customs service enterprise operations' control, customs authority, shall promote execution of tasks, assigned to customs authorities.

According to executed analytic work results of Customs control and customs intermediary affair organization department, insufficient level of customs brokers' and their representatives' intermediary activity control organization is determined.

Requirement, set by License conditions of customs broker intermediary activity in Ukraine, according to which fulfillment of these License conditions is obligatory during business entity's execution of customs broker intermediary activity, is not visible.

Among types of activity, execution of which is controlled by authorities of revenues and duties of Ukraine, are:
1) customs broker operations;
2) foundation and operation of duty free shop;
3) foundation and operation of customs warehouse;
4) foundation and operation of customs free zone of commercial or service type;
5) foundation and operation of temporary storage area;
6) foundation and operation of freight customs complex.

Central body of executive power secures formation and introduces state tax and customs policy, registers enterprises, which carry out such types of operations, and secures their publishing.

Inspections of fulfillment of License conditions by licensee are carried out by licensing authority according to annual inspection plan-schedule, which is approved by licensing authority order and published in the order, stipulated by law.

Period of planned inspection for a legal entity and/or its separate subdivision is no more than fifteen work days, and for an individual - business entity – five work days.

During unscheduled inspections issues, which became ground for such inspections are investigated.

Inspections can be carried out with participation of specialists of central and local executive power authorities (on agreement), and also representatives of regional customs, customs houses, etc. Period of unscheduled inspection for a legal entity and/or its separate subdivision is no more than ten work days, and for an individual - business entity – two work days.

Besides, prolongation of planned and unscheduled inspection is not allowed.

To carry out inspection head and members of license authority commission should show the director or authorized representative of a licensee their inspection certificate and documents, certifying their persons. At the same time licensee is given a copy of such inspection certificate.

The commission inspects: ability of licensee to ensure execution of License conditions, availability of corresponding documents, namely: license; personal activity insurance agreement for the sum not less than 2000 tax-exempt minimum of public income; state registration certificate of legal entity or individual – business entity; documents, regulating labor relations; information about separate subdivisions of legal entity (in case if these are present); provisions about separate subdivisions (in case if these are present); appropriate for licensee freight customs declarations' copies for last three months since these were drawn up or since the date the license became validity.

According to inspection results inspection act on fulfillment of License conditions by licensee is drawn up (further - inspection act) in two copies.

4. CONCLUSIONS

We consider proper systematical provision of identification of mechanisms and criteria of candidate selection for intermediary customs broker activity to be an obligatory condition of improvement of state control of customs broker activity. One of such criteria is determination of certain financial state level, payment of insurance fees, inspection of financial state of an enterprise – customs broker.

Depending on objectives and tasks enterprise's financial state inspection can be carried out according to one or all of these stages: prior testing, audit of financial and business activity of an enterprise, financial state analysis. On each of these stages different indicators of customs broker financial activity are applied.

An important condition of transparent customs service business relations' regulation is securing by Customs Code of Ukraine of authority of Ministry of Revenues of Ukraine, which carries out within its competency regulation of such activity, including customs broker operations, and also limits of this influence aiming at promotion of foreign economic activity. According to the Code's norms, it shall be appropriate to accept orders «On customs brokers' and their representatives' activity», «On control of customs brokers' and their representatives' activity».

Ministry of Revenues and Duties of Ukraine shall legalize customs brokers, control their keeping within customs laws, as activity of customs brokers should be based on professionalism. Development of administrative and legal regulation of customs broker activity is connected with active participation of customs brokers in customs formalities process, their involvement into application of modern information technologies in their operations.

State control of customs brokers' activity is a positive point, ant it is aimed at realization of policy of the President of Ukraine and the Cabinet of Ministers of Ukraine, which concerns licensing system and minimization of types of business activity, subject to licensing, and implementation of international good practices in customs legislation of Ukraine.

5. REFERENCES

[1] DIOP, A., *Customs-Trade Partnership Against Terrorism: cost/benefit survey,* Univ. of Virginia Center for Survey Research, 2007.
[2] BOGATOV V.A., *Improvement of customs services' and operations' management organization:* dissertation of economic sciences candidate, Moscow, RSL, 2003.
[3] AVERYANOV V.B., *Executive authorities in Ukraine*, Kiev: In Jure, 1997.
[4] BONDARENKO I.O., *Organization and legal measures of customs affair services' business activity regulation,* Customs affair of Ukraine 5,2005.
[5] BONDARENKO I.O., *Organization and legal measures of customs services' provision*, dissertation of legal sciences candidate, Irpyn, 2006.
[6] FEDOTOVA I.O., *Prospectives of administrative and legal regulation of customs broker activity*, Customs affair 4, 2008.
[7] NOVIKOV A.B., *Control in the system of customs affair regulation in Russian Federation*, dissertation of legal sciences candidate, Saint Petersburg, 1999.
[8] CUSTOMS CODE OF UKRAINE AS OF MARCH 13, 2012, Official bulletin of Ukraine (32), 2012.
[9] DECREE OF THE PRESIDENT OF UKRAINE AS OF DECEMBER 24, 2012 (726) "*On some measures on optimization of central executive authorities' system*", Governmental courier (238), 2012.
[10] GONCHAROVA N.G., *Administrative and legal aspects of customs sphere voluntary representation*, dissertation of legal sciences candidate, Moscow, 2002.
[11] LAW OF UKRAINE AS OF SEPTEMBER 11, 2003 № 1160-IV. "*On principles of state regulation policy in the sphere of business activity*": Verkhovna Rada data 9 (2004).
[12] "*Provisions on Ministry of Revenues and Duties of Ukraine*". Decree of the President of Ukraine as of March 18, 2013 №141: Governmental courier 51(2013).

THE QUALITY OF CORPORATE GOVERNANCE

[1]POPA DANIELA, [2]DOBRESCU GEORGETA

[1,2]*"TOMIS" University of Constanta, Romania*

ABSTRACT

The corporatist governing is the system based on which institutions are ruled and controlled. The corporatist administration implies a set of relations between the leaders of an institution, the unions and the economic agents. The corporatist administration also offers the structure according to which the goals of the institution are established, as well as the means to reach those goals and to monitor the gained performances. A good corporatist administration should offer the motivation to achieve the goals which are in the best interest of the institution and the tax payers and should also facilitate an efficient monitoring, thus encouraging the institutions to use the resources sufficiently.

The transparency and permanent informing are the main issues when talking about a real corporatist administration. These allow the unions as well as economic agents to assess the performances of the management with influence over their behaviour. Moreover, the information systems can form managers which will have access to more means so as to rule more efficiently. Last but not least, the transparency and providing information offer the tax payers the opportunity to understand the structure of the institution, its activities and policies so that he can understand the performances and ethical standards on which it is based.

Keywords: *corporate governance, internal audit, development, decisions, performance, management.*

1. INTRODUCTION

The quality of corporate governance is often reflected in the quality of decision making. Public sector bodies must combine reliable information produced by 'hard' systems and processes with the 'softer' issues of openness and integrity to inform their judgment on key decisions. The more open and honest organizations are with themselves about their performance, the more open and honest they can be with service users and the public. This honesty is the foundation for deciding appropriate action to remedy poor performance. Better quality services are then more likely; improved performance and being more open will increase public trust.

The next chapter looks at the quality of some of these aspects of corporate governance across the public sector and at the particular constraints and opportunities that different public bodies face when seeking to improve them.

2. INTERNAL AUDIT AND CORPORATE GOVERNANCE

Standard 2130 - Governance provides:

The internal audit activity must assess and make appropriate recommendations for improving the governance process to achieve the following objectives:

- ♣ Promoting ethical values appropriate to the entity;
- ♣ Ensuring accountability and the effective functioning of the management entity;
- ♣ Effective communication of risk and control information appropriate structures within the entity;
- ♣ Effective coordination of activities and communication of information among management, internal and external auditors and the Council.

2130.A1 - The internal audit activity must evaluate the design, implementation and effectiveness objectives, programs and activities related to ethics entity.

2130.C1 - Consulting engagement objectives must correspond to the values and objectives of the entity.

Internal audit has become increasingly important over the years, and both widening scope and coverage of auditable activities. Interest throughout the world for government in the past 25 years, fueled power internal audit.

Lately, internal audit has evolved a lot because the concept of corporate governance, which influenced and accountable in greater management assessment and risk management.

Internal audit will inevitably be under pressure, since it is the function that can bring an extra transparency. The presence of the internal auditor in this context answer both " corporate governance principles " of all transactions to ensure transparency and management need to bring extra security to allow him to have the courage to implement the strategy of the organization into practice correctly and effective.

Responsible for organizing and implementing internal control system is line management.

Governance is the term used to describe the role of persons entrusted with the supervision, control and management of an entity.

The entity must have a governance structure to enable the Board to exercise a judgment on objective public institutions, particularly independent management.

Structures of governance vary from country to country, cultural and legal reflecting:

- In some countries, a surveillance function and management function are legally separate into two separate bodies, such as a supervisory board (wholly or

mainly non-executive) and a management board (the executive);
- In other countries, both functions (supervisory and management) is the legal responsibility of a single unitary council, although it may still be an audit committee assists that board in its governance responsibilities, relating to financial reporting.

Those charged with governance are responsible for ensuring that the entity usually achieves its objectives regarding:
- Reliability of financial reporting;
- Effectiveness and efficiency of operations;
- Compliance with applicable laws;
- Reporting to stakeholders.

Audit matters of governance interest are those that arise from the audit of the financial statements and the auditor's opinion, are important to the relevant, those charged with governance in overseeing the financial reporting process and disclosure.

Such problems include:
- Uncertainties related to events or conditions that may cast significant doubt on the entity's ability to continue;
- Disagreement with management regarding certain matters, individually or together, may be important for the entity's financial statements or the auditor's report. These communications include specifications for solving or not solving the problem and its importance;
- Other matters warranting attention by those charged with governance, such as material weaknesses in internal control, questions regarding management integrity, and fraud involving management.

Essentially, internal audit can play two roles:

The first role is manifested in the early stages of introducing a sound system of governance, the internal audit is a great opportunity to advise and strengthen leadership in the advantages of introducing best practices and to support its efforts in introducing policies, mechanisms and procedures.

Internal audit can provide advice, training and facilitation. However, audits should assume an executive role in the design or implementation of policy governance - accountability must be clearly attributed to management. Internal audit must also ensure that it has engaged in reaching their own role in corporate governance, providing both assurance and consulting.

The second role internal audit plays when auditing the governance system under which provide assurance on the adequacy and effectiveness and make recommendations whenever necessary improvements in how the implementation or operation of the system. This will bring value not only improving the governance of the public entity, but also issuing a statement supporting sound on internal control in the annual report.

3. GOOD GOVERNANCE SUPPORTS EFFECTIVE DECISION MAKING

The development of a common understanding of corporate governance is generally agreed to have started with the Cadbury report, which identified the principles of good governance as integrity, openness and accountability. The report was the first of several on corporate governance in the private sector, the most recent contributions being the Higgs report on non-executive directors and the Smith report on audit committees. In the public sector, the Nolan Report was particularly important in setting out the principles of public fife. Appendix 2 contains a list of relevant reports on corporate governance.

The Audit Commission has developed its understanding and in this report defines corporate governance as:

The framework of accountability to users, stakeholders and the wider community, within which organizations take decisions, and lead and control their functions, to achieve their objectives.

Good corporate governance combines the ‘hard’ factors – robust systems and processes – with the ‘softer’ characteristics of effective leadership and high standards of behavior[1]. It incorporates both strong internal characteristics and the ability to scan and work effectively in the external environment. The internal combination of ‘hard’ and ‘soft’ characteristics involves:

- **Leadership** that establishes a vision for organizations, generates clarity about strategy and objectives, roles and responsibilities, and fosters professional relationships;
- **Culture** based on openness and honesty, in which decisions and behaviors can be challenged and accountability is clear;
- Supporting accountability through **systems and processes**, such as risk management, financial management, performance management and internal controls. They must be robust and produce reliable information to enable better decisions to be reached about what needs to be done in order to achieve objectives;
- **External focus** on the needs of service users and the public, reflecting diverse views in decision making, producing greater ownership among stakeholders and maintaining clarity of purpose[2].

Externally, an effective and **strategic regulatory regime** can promote better corporate governance, with appropriate targets and freedoms and flexibilities for organizations based on comprehensive information about their performance and capacity.

How well the internal characteristics are balanced is important: public sector organizations operate in complex legislative, political and local contexts, in which they have to make difficult decisions. Well – governed organizations balance their different responsibilities and use information to decide where to allocate effort and resources to meet competing demands. Good governance supports effective decision making; poor governance is often seen (in hindsight) as creating the climate, structures and processes that lead to poor decisions.

Decision making always involves risk, but this risk is reduced when an open culture exists in which challenge is accepted and supported. This challenge and openness must be underpinned by robust performance, financial and information management systems, the effective use of risk management and an accountability framework that is based on a clear communication and understanding across the organization of roles and responsibilities.

The importance of effective leadership in ensuring good governance is clear from inspection reports and from other reports generated across the public sector.

Ultimately, leaders are responsible for achieving the right balance of hard and soft factors and are accountable for the decisions they take, or fail to take. They set the strategy for organizations and give it a sense of direction and purpose. The relationships between those carrying out executive and non – executive roles are fundamental to setting the tone for the cultural aspects of organizations that can never be codified or set out in detailed guidance, but which are immediately recognizable to those who work in or deal with them.

The Audit Commission, in conjunction with the Improvement and Development Agency (I De A) is currently investigating the topic of leadership and will report later in 2003.

Increasingly, public sector services are delivered through contracts between public, private and voluntary sector organizations and through more informal collaborations with a range of partners across all sectors.

Organizations are unlikely to be able to ensure that partnership and contracts are effective unless their corporate governance is effective. How corporate governance affects the quality of partnership outcomes and how partnership affect organizations' own governance arrangements are both important issues that this report does not address in detail. The Audit Commission plans to carry out further work to specifically address the issues relating to governance of partnerships and multi – agency alliances[3].

In this report, the key governance roles are described in terms of the responsibilities of executive directors and non – executive directors (or N E Ds), following terminology used in the NHS and in the private sector. These terms are understood differently across public sector organizations, particularly in local government, reflecting the democratic foundations of local authorities.

To avoid confusion, the terms 'executive' or 'executive director' should be taken to mean the corporate management team in local authorities – that is, the chief executive and senior service directors. The term 'non - executive' or 'non – executive director' should be taken to mean those roles carried out by elected councilors. In policing, executives are the chief constable and his or her senior management team; the non – executive function is filled by members of the police authority. In probation, all board members except the chief officer are non – executives; the chief officer and his or her senior management team are the executives.

Organizations with good corporate governance have the capacity to maintain high – quality services and to deliver improvement. Poor corporate governance has contributed to serious service and financial failures. The growing debate about corporate social responsibility and corporate manslaughter bring this issue into stark perspective.

The quality of governance also affects levels of trust in public services:

"Trust is at the heart of the relationship berween citizens and government. It is particularly important in relation to services which influence life and liberty – health and policing. But it also matters for many other services – including social services and education. In these cases, even if formal service and outcome targets are met, a failure of trust will effectively destroy public value"[4].

Corporate failures in the private sector can have a catastrophic effect on public trust, leading to falls in share values, investor confidence and in the general public's trust in the stewardship and state of the economy. MORI's research for this study shows that public sector corporate failures also undermine trust. Nearly two – thirds of those asked (64 per cent) said that high – profile incidents, such as the death of Victoria Climbie or the Alder Hey organ retention scandal, had adversely affected their level of trust in public services.

Loss of trust will damage the Government's aim of modernizing public services. The public and service users can disengage, either by choosing other service options (where feasible), or by not wanting to participate in public service delivery. They might decide not to vote, fail to respond to consultation, or, more significantly, withhold information or participation that enables public services to be delivered effectively for the wider common good.

4. CONCLUSIONS

Trust in public bodies is principally affected by two things: the quality of services that individuals and their families receive; and how open and honest organizations are about their performance, including their willingness to admit to and learn from their mistakes. The public does not generally rate public bodies highly on the second of these attributes: only one in eight (13 per cent) believes that their local hospital, council or police service always admits when it makes a mistake; and only in four (22 per cent) believes that such organizations learn from the mistakes that they make.

Research for this study shows that public bodies fare badly on the 'negative' drivers of trust: having poor leaders and managers, and being uninterested in peoples' views.

Poor leadership and management is associated with poor communication, echoing research previously carried out for the Audit Commission that showed that the public believe: it is in the interest of the service provider to present figures and spending in a positive light.

5. REFERENCES

[1]. Balotă, Marius Dan, "*Innovation and Change Management*", Universitară Publishing, 2009.

[2]. Popescu, M., "*The Management of Research Processes"*, Universitătii Publishing, 2002.

[3].Ghiță, Marcel, ”*Internal Audit*”, Economic Publishing, 2009.

[4].Creating Public Value: An analytical framework for public service reform, Strategy Unit, Cabinet Office, November 2009

LEGAL PROTECTION SYSTEM OF NAVIGATION IN ROMANIA

POPA GEORGE-DOREL

"OVIDIUS" University of Constanta, Romania

ABSTRACT

Maritime navigation safety is a key element in the development of maritime transport of goods and passengers. For this reason, the Romanian authorities give high priority to the rules applicable to maritime transport. The Romanian state has granted permanent attention to this area taking into account the goals and principles of the United Nations concerning the maintenance of international peace and security, developing friendly relations and cooperation among states. Romania took into account international treaties preventing and combating acts of terrorism and those who threaten or destroy innocent human lives, jeopardize fundamental freedoms and seriously undermine the dignity of persons. The Romanian state started from premises that unlawful acts against the safety of maritime navigation jeopardize the safety of persons and property. Moreover, failure to obey the rules seriously affects the operation of maritime services and undermines the confidence of the people in safe maritime navigation.

Keywords: *Ship, Maritime safety, Crime, Punishment, Romanian law.*

1. INTRODUCTION

According to Romanian legislation and according to Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, rules of navigation in the territorial sea, internal waters and Romanian ports are set by the Ministry of Transport. These rules also take into account national regulations and international agreements and conventions to which Romania takes part. Monitoring and development of the navigation safety surveillance in national waters is in the hands of Civil Navigation Inspectorate. Inspection and supervision of development in navigation safety in national navigable waters is done by existing harbour masters in Romanian ports. This monitoring is permanently conducted (without any brakes).

2. GENERAL RULES CONCERNING THE SAFETY OF MARITIME NAVIGATION IN ROMANIA

The control of the navigation is in the hands of the harbor masters. The harbor masters have the right to visit any time any ship which is in Romanian territorial waters, regardless of flag. Harbor master may prohibit the free navigation in national waters and cargo operations for some ships. It's about those ships which have not or do not meet the Romanian requirements concerning the board acts [1]. In the same situation, are the ships which couldn't obtain mooring permit or the approval of the health authorities after visiting the ship. Harbor master are obligated to receive the complaints concerning violations of the navigation system which took place in ports or on shore. These institutions also receive reports of fires, collisions or other accidents and conducts research. It manages and approves expert evidence in case of inquiries. Port masters receive complaints about misconduct in connection with navigation. They settled and complaints related to existing vessels in territorial waters and conduct research within their competence. When complaints have criminal character, competence research returns to the local prosecutor. Port masters in cooperation with specialized prosecutors can investigate sailing accidents. Prosecutors and port master officers have the right to conduct investigations in other situations. For example, if a ship has been lost or abandoned by crew commander or after a shipwreck or a serious fire. When harbor master has the obligation to investigate the causes and circumstances in which it occurred. This investigation can be carried out in collaboration with the competent prosecutor. However when it comes to crimes, prosecutors are competent to carry out the investigation.

3. GENERAL INTERNATIONAL ROULS CONCERNING NAVIGATION SAFETY

One of the most important acts in this area is the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation adopted at Rome, March 10, 1988. This important international agreement has been adopted by the states of the world having in mind the purposes and principles of the Charter of the United Nations concerning the maintenance of international peace and security and the promotion of friendly relations and co-operation among States. This decision is starting taking in account that everyone has the fundamental right of life, liberty and security of person. From this point of view, any person committing unlawfully and intentionally one of these doings will be considered criminal [2]:

- seizes or exercises control over a ship using force or threats or any other form of intimidation.
- performs an act of violence against any person on board of a ship, likely to endanger the safe navigation of that ship.
- destroys totally or partially a ship or causes damage to a ship or to its cargo endangering the safe navigation of that ship.
- places on a ship, a device or substance which is likely to destroy that ship, or cause damage to

that ship endangering or is likely to endanger the safe navigation of a ship.

- destroys or seriously damages maritime navigational facilities or seriously interferes with their operation, seriously endangering the safe navigation of a ship.
- communicates false information endangering the safe navigation of a ship.

Each party should take necessary measures to establish its jurisdiction over the crime when the crime is committed against or on board a vessel flying the flag of the state at the time the offence is committed or in the territory of that state, including its territorial sea or by a national of that state. The state, in accordance with its law, should take the criminal into custody or take measures to ensure his presence for preliminary investigation or trial or to enable any criminal or extradition proceedings if it is necessary.

If one of this measures is taken against a person the nearest appropriate representative of the state of where he is a national is entitled to establish direct communication or to be visited by a representative of that state. The master of a ship should deliver to the authorities of any other state party any person who he has reasonable grounds to believe has committed a crime against maritime safety [3]. The receiving state may accept the delivery and any refusal to accept a delivery should be accompanied by a statement of the reasons for refusal.

4. TASKS OF ROMANIAN NAVAL AUTHORITY IN THE MARITIME SAFETY

Romanian Naval Authority verify that performance and any of the activities correlated with vessels operations and sea transportations of dangerous products is carried in a safe and responsible manner [4]. Ships coming in the Romanian ports are screened each and every time on the bases of the most recent information available. In the evaluation process, the Romanian Naval Authority use information and data from industry and administrations database. Investigations and inspections on board of the ship should be carried out, to the get all necessary information concerning the maritime safety.

In addition to the positive response produced by the above listed information sources, the “consideration for acceptability” of the vessel is based on her compliance to the Minimum Safety and Operating Requirements. Compliance with all Safety and Operational Requirements will ne always requested. Compliance with the minimum safety requirements should be doubled by permanent supervising of the ship during her cargo transfer operations.

Additional data and information about ship and crew will be another key elements when the Romanian authorities determinate the ship acceptability on the area of Romanian ports. All the ships that will try to enter in Romanian waters must comply with all applicable International Convention and Regulation, Flag State, Classification Society, Port State and local requirements and the additional MSOR rules [5]. Ships have to be operated in accordance with the legal provisions mentioned in the latest edition of ICS/OCIMF/SIGGTO “International Safety Guide for Oil Tankers and Terminals”, “Tanker Safety Guide for Liquefied Gases”, “Tanker Safety Guide for Chemicals”.

Safety and Prevention of pollution of the ship have to comply as a minimum with the standards defined in the IMO ISM Code. Shipboard Safety Management System documentation (Ship Procedures Manual, Company instructions, Safety Manuals, Bridge Organization Manual, Cargo Handling Manual, Machinery Operation Instructions, Equipment Maintenance Procedures, Training and Emergency Manual, Reporting Forms, records of drills and test, and whatever required) should confirm a satisfactory implementation of a reliable Safety Management System. The File of Enhanced Survey Program should be properly maintained on board. Emergency Procedures must be available on board covering, as a minimum, steps to be taken in the event of pollution, fire, explosion, toxic cargo spill and vapour emission [6].

Vessels must have deck peripheral fishplate enclosing the main deck area from bow to stern in case a fixed piping arrangement is fitted and authorized in the IOPP Certificate, for the transfer of the engine room bilge water to the cargo slop tank [7].

5. THE PENAL OFFENCES RELATED TO SAFETY OF MARITIME NAVIGATION IN ROMANIA

The main law that regulates this area is Act no. 191 of 13 May 2003 on shipping penal offences. Taking in account the importance of this doings, this law establishes the main crimes against civilian navigational safety. Thus, a vessel driven by an unlicensed person or without the appropriate certificate of competency shall be punished with imprisonment from 2 to 7 years. It is evident that the Parliament tried to restrict the possibility of such ship to be driven only by well-trained persons. They must have adequate training and very good knowledge in this regard. The same punishment is the act of the captain or other person entrusted with the lead of the ship to give the coordination of the ship to a person without a patent or proper certificate. It is considered an offense a similar acts committed by a person having the exercise of the right to drive suspended for a certain period of time. The doings descripted above is punished and the person, who entrusts intentionally ship management to a people suffering from mental illness or under the influence of narcotics, will be sentenced to prison.

Another crime is to drive a ship sailing without the minimum safe manning. It is punishable by imprisonment in the same way due to its gravity. The staff carrying out their duties under the influence of alcohol or other substances prohibited by the regulatory authority shall be punished with imprisonment from three months to one year or a serious fine. It is natural to be provided and sanctioned in this way such a deed. Carrying out professional activities being drunk represents great danger in this domain. If the act referred is committed by seafarers directly or other staff providing safe navigation more severe punishment is given by Romanian law. The question is - what is meant by "being drunk"? This law makes it clear that being drunk is to have alcohol in the blood of up to 0.80 g / l of pure alcohol in the blood. Another crime is to perform the duties intoxicated or under the influence of substances or narcotic drugs or drugs with similar effects of drunkenness. This offense is punishable by up to five years in prison. In this case, if the act is committed by direct affecting the safety of navigation, the punishment is more severe going up to seven years of deprivation of liberty. To avoid any misinterpretation, Act no. 191 of 2003 states that it is considered intoxicated person having alcohol concentration in the blood exceeding 0.80 g / l of pure alcohol in the blood. Concentration of the alcohol may be lower, but the results should be impairing faculties of balance or movement of that person. Intoxication can be defined as well by speech difficulty or inconsistency in ideas. This physical condition must be confirmed clinically or by any other evidence. In practice, there have been cases in which seafarers refused to undergo harvesting of biological samples to determine alcohol. Therefore, the law has defined that refusal, opposition or removal of persons from the obligation of collection of biological samples to determine alcohol is punishable with imprisonment up to seven years. It is well known that professional crew must operate continuously. Cannot be accepted under any circumstances the brake in fulfilling of the attributions. This is because it might create situations of great danger. Therefore, the legislator has agreed to sanction a sailor leaving his post without approval. The ship abandoned by a crew member or by the pilot during the service, without approval shall be punished by imprisonment of up to five years. It is important to note that leaving could interrupt or endanger the safety of navigation of the vessel, cargo or crew. Grave situation appears when the abandon is committed by the master or his deputy. This is because they have the most important role in terms of safety of the ship or crew. There are a number of actions considered crimes for the ship safety [8]:

- Sleep whilst the sailor is on watch or on call, if this would have endangered the safety of the vessel, cargo or crew.
- Leaving the vessel by the master in case of danger, before exercising call of duty to save the ship and crew.
- Refuse for the master of a ship to accord rescue assistance for vessels and persons in distress or in the event of collision. Equally serious is refuse to communicate to the other ships, the data needed for identification of own ship.
- Changing position, decommissioning, serious damage or destruction of coastal navigation signal or float.
- Removal of a signal or floating coastal waterway or of its components.

If the actions listed have resulted in a boating accident, consisting of collision with significant damage, serious damage to a ship are punished more severe. Equally serious is punished the destruction or significant degradation of facilities and goods of any kind concerning safety of navigation. The most serious punishment of 25 years imprisonment to be sanctioned the doings which led to sinking of a ship or death or serious injury to one or more persons. Moreover, the court may prohibit certain rights of those who have committed such acts.

Committing of any of the following acts [9] is punishable with imprisonment up to 12 years:

a) preventing the fulfillment of duties of crew on the ship management;

b) falsifying a written order or logbook;

c) communication of information, knowing that they are false;

d) taking the command or control of a ship using the force;

e) the destruction or damage of a ship or its cargo, navigation equipment or disrupting their functioning;

f) destroyed logbooks and cars.

Romanian law sanctioned seriously any acts affecting order and discipline on board. For this reason, the following acts are considered crimes and are punishable by imprisonment of up to 3 years [10]:

- Refusing to execute an order on official duties, affecting in this way the vessel safety and navigation;
- Hitting the lower officer.
- Hitting the upper officer.
- Refusal to follow an order by a passenger during the process of saving the ship (during the rescue missions).

Criminal proceedings for offenses mentioned above shall be initiated by the master or owner or operator of the vessel, as appropriate.

6. CONCLUSIONS

Sea and river sections of the Romanian courts are obliged to judge offenses abovementioned. Courts should judge other crimes in connection with marine activities. In addition, their competence is extended to work safety offenses committed by crews. Add to these, civil disputes that originate in different monetary nature, including the ship accidents and we will have the full picture of the procedural legal competence in Romania.

Nevertheless, anytime a juridical dispute appears between the different states of the world, the diplomacy and the international law rules applicable should always be the point of solving for any state [11]. The force position proved to be a wrong approaching always. For the future, it is necessary to modify few legal provisions in the area o maritime safety to be set up accordingly to the latest evolution in this domain.

7. REFERENCES

[1] GRIGORUT, C., *Marketing,* BREN Publishing House, Bucureşti, 2004.
[2] Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation adopted at Rome, March 10, 1988.
[3] Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation adopted at Rome, March 10, 1988.
[4] www.rna.ro
[5] www.rna.ro
[6] www.rna.ro
[7] www.rna.ro

[8] Act no. 191 of 13 May 2003 on shipping penal offences in Romania.
[9] Act no. 191 of 13 May 2003 on shipping penal offences in Romania.
[10] Act no. 191 of 13 May 2003 on shipping penal offences in Romania.
[11] BRASOVEANU, F. *Dreptul international intre stiinta, diplomatie si politica*, In Honorem Dumitru Mazilu, Universul Juridic Publishing House, 2011.

EUROPEAN MARITIME SAFETY AGENCY

POPA GEORGE-DOREL

"Ovidius" University of Constanta, Romania

ABSTRACT

This European Agency has been established in 2002 through Regulation (EC) no 1406/2002 of the European Parliament and of the European Council. The main mission of European Maritime Safety Agency is to prevent and combat the risk of maritime accidents, maritime pollution from ships and to prevent the loss of human life during the navigation. This agency represents the technical institution providing the European Union with the necessary means to enhance maritime safety and to prevent and combat ship pollution. European Maritime Safety Agency should assist the European Commission in developing European Union legislation in the area of navigation safety and prevention of pollution by vessels. E.M.S.A. should provide the necessary support to ensure the implementation of European legislation in this area by assisting the European Commission. European Maritime Safety Agency is performing the tasks assigned by the European Union legislation on navigation safety and prevention of the vessels pollution.

Keywords: *Vessels, Maritime safety, European Union, Maritime pollution.*

1. INTRODUCTION

"Maritime security"[1] is the combined preventive measures taken in order to protect shipping and port facilities against threats of intentional unlawful acts. The security objective should be achieved by adopting appropriate measures in the field of maritime transport policy, without prejudice to the rules of the Member States in the field of national security, defence and public security, and in combating financial crimes against the States. Taking in account the main goal of the Agency, it is necessary to explain in detail the term of vessels pollution, used in the context of maritime law accepted on international level. European Maritime Safety Agency has been founded in 2002. The establishment of the Agency was possible after adoption of European Union of many acts and legislation related to maritime security. These measures have been taken because of major shipping disasters in the area of European waters, such as those involving the ferry Estonia and the oil tankers Erika and Prestige. It was felt that a specialised European Agency should be created to permanently overview the implementation of this legislation and help in maritime supervision of the European seas. Marine pollution is caused mainly by oil and gas installations and should be understood as pollution by oil or any substance other than oil considered dangerous. This kind of substance, introduced into the sea water, might create serious hazards for human health or affect living resources and marine life. According to the European Law, the Agency is obliged to provide operational assistance to the Member States and European Commission. This assistance includes services such as the Union Maritime Information and Exchange System, the European Satellite Oil Monitoring Service, the European Union Long Range Identification and Tracking Data Centre and the EU Port State Control inspection data base (Thetis). Another aim of Agency is to fight using its own ways the growing risk of piracy. In this respect, the Agency is obliged to forward immediately to competent national authorities and other relevant bodies, detailed information about the position of vessels under the flag of Member States transiting through dangerous areas. In this regard, the Agency could provide, upon request, relevant vessel positioning and other geographical data to competent national authorities and European Union institutions (e.g. FRONTEX and Europol). This information and data might facilitate preventive measures against worldwide piracy and other sea dangerous situations having in mind the salvation of the crew and of the load transported at that moment.

2. EUROPEAN MARITIME SAFETY AGENCY STRUCTURE

In order to accomplish its tasks established by Regulation (EC) no 1406/2002 of the European Parliament and of the European Council, the Agency is led by an Executive Director reporting to the Administrative Board. The Executive Director is responsible for the setting up, running and development of the Agency. The good functioning of the Agency requires that its

Executive Director is appointed on the grounds of merit and documented administrative and previous managerial skills. The competence and experience relevant for maritime safety and prevention of pollution by ships are other key elements in the appointment decision. The executive Director should perform his duties with complete independence and flexibility as to the organisation of the internal functioning of the Agency. The Executive Director should prepare and take all necessary steps to ensure the proper accomplishment of the working programme of the Agency. The Executive Director should yearly prepare a draft general report to be submitted to the Administrative Board, should thinking out the estimates of the revenues and expenditure of the Agency and should implement the budget immediately after its approval. The Administrative Board consist of one representative of each Member State and four representatives of the

European Commission. Each member has a high level of expertise in this area. In order to ensure the appropriate level of expertise and experience in the Administrative Board, the European Commission should nominate independent professionals from these sectors as board members without the right to vote. These specialists on the basis of their personal merit and experience in the field of maritime safety and prevention of pollution by ships are very useful tools for Agency. It is important to be mentioned that they are not representatives of any particular professional organisations or other institutions.

The Agency [2] is made up of following units:
Department A: Corporate Services[3] having as main goal to provide high quality and timely support to European Maritime Safety Agency's core operational business, and to assist management and staff in the areas of human resources, legal and financial affairs, information technology, facilities and logistics, meeting and conference management, protocol, and budget planning and monitoring.

Department B: Implementation Service [4] having as main mission verification and monitoring of the implementation of maritime safety legislation falling under the umbrella of Agency. This department is responsible for the activities in the fields of classification societies, the training of seafarers, navigation security and monitoring their implementation of European Union maritime legislation. This department assists the Commission in its monitoring of Member States' implementation of the maritime security requirements, by providing technical assistance in its inspections of vessels, companies and security organizations.

Department C: Operations Service [5] having as main goal providing of operational assistance to Member States and the European Commission in the field of preventing and combating sea pollution. Department C facilitates technical cooperation in the area of European Union vessel traffic and satellite monitoring.

3. GENERAL INFORMATION ABOUT EUROPEAN MARITIME SAFETY AGENCY

According to Regulation (EC) no 1406/2002 of the European Parliament and of the European Council, the Agency is obligated to work with the European Commission and with the Member States.
Cooperation with the European Commission should take place in various areas. First of all, the Agency should be part in the necessary activities for updating and developing relevant legal acts of the European Union. In this domain Agency will permanently follow up the development of international legislation.

The Agency will supervise the effective implementation of relevant legal provision by carrying-out visits and inspections in the ports and at relevant ships. As well the Agency should provide technical assistance to the Commission in the performance of the inspection tasks in maritime areas and should carry out the identification of possible follow-up measures resulting from specific research projects in its area of responsibility. As have been mentioned the cooperation with the Member States of European Union have an important place within Agency’s tasks. From this point of view, the Agency is called to develop technical solutions and provide technical assistance, to the building up of the necessary national capacity for the implementation of relevant legal provisions of the European Union in maritime domain. To achieve this goal EMSA periodically organize, relevant training activities in areas situated on the responsibility of the Member States.

Taking in account the latest evolutions, the Agency periodically issue common rules and standards for ship inspection and survey organizations, as well, for the relevant activities of maritime administrations. When a Member State request, the Agency support with additional means pollution response actions in case of pollution caused by ships or marine pollution caused by oil and gas installations. In the area of maritime traffic monitoring, the Agency shall in particular promote cooperation between riparian States in the shipping areas concerned, as well as develop and operate the European Union Long-Range Identification and Tracking of Ships European Data Centre and the Union Maritime Information and Exchange System. In the area of the investigation of marine casualties and accidents the Agency will provide operational support to these Member States concerning investigations related to serious casualties and it will carry out safety investigation reports. It is very important to identify and to permanently add value at European Union level in terms of avoiding causalities and maritime incidents.

Each year the Agency should present a yearly report concerning the marine casualties and incidents in the European seas. Another important task of the agency is to provide, upon request, the relevant information about vessel positioning to the competent national authorities and relevant Union bodies. This information will be used to facilitate measures against threats of piracy and of intentional unlawful acts. Another important task of the Agency is to collect record and evaluate the technical data in the maritime area and to develop the additional databases in this respect. Providing objective, reliable information and data, will allow the European Commission and the Member States of European Union to take the necessary steps to improve their actions and measures [6].

As well, the Agency will have permanently in its attention improving the identification and pursuit of ships causing troubles or being pollution source. In this respect, EMSA is allowed to propose penalties for incidents and infringements. Using the European Satellite Oil Monitoring Service, the marine oil pollution caused by oil and gas installations will be monitored by the Agency. In such cases, EMSA will analyze the extent and environmental impact of the pollution the environmental perspective. The Agency examines IMO requirements and gathers basic information on potential threats to maritime transport and the marine environment. When is requested, European Maritime Safety Agency carry out examination of the feasibility and the implementation of projects supporting the establishment of the European maritime transport space without any barriers.

Last but not least, the Agency is facilitating exchange of best practices in maritime training and education in the European Union territory. This goal is accomplished by providing information on European Union exchange programs relevant for maritime training and education [7]. The Agency should, sometime carry out visits to Member States in accordance with the methodology established by the Administrative Board. The Agency will inform the Member State the aim of the mission, the names of the officials and the date on which the visit starts and its expected duration. These inspections carried out by the Agency will aim the implementation of the common rules and standards for ship inspection and survey organizations.

As well, the verifications are targeting the training and certification of seafarers in third countries. At the end of each inspection the Agency will edit a report. The report will contain the main aspects of the verifications, the conclusions and shortcomings discovered during the visit. The report will be send to the European Commission and to the Member State. The Commission based on the report analyses and recommendations of EMSA will engage further discussions with Member States in order to facilitate the dissemination of good working practices and to correct the eventually gaps and errors [8].

4. FINANCIAL ASPECTS CONCERNING EUROPEAN MARITIME SAFETY AGENCY

The main part of the budget of European Maritime Safety Agency is coming yearly from the European Union budget. Nevertheless, according to the European law is allowed the participation of third countries in the activity of Agency. The mentioned third country should conclude agreements with the European Union. According to the adopted agreements the third country is applying the Community law in the field of maritime safety, maritime security, prevention of pollution and response to pollution caused by ships [9].

In these cases is possible a financial contributions from any third country which participates in the work of the Agency. And the third financial source of the European Maritime Safety Agency is the fees and charges for publications, training and any other services and technical advices provided by the Agency. Yearly, the Agency's budget is adopted in such way that expenditures should cover all the expenses for staff and administrative, infrastructure and operational costs. The Executive Director of the European Maritime Safety Agency should elaborate a draft of estimates of the Agency's revenue and expenditure for the following year, on the basis of activities carried out in the present year and a draft establishment plan. Yearly, the Administrative Board, on the basis of a draft statement of estimates of European revenues and detailed expenditures, produces a statement of estimates of revenue and expenditure for the European Maritime Safety Agency for the following financial year [10].

The statement of estimates costs and revenues should be forwarded by the European Commission to the European Parliament and the European Council (is the budgetary authority, according to the European legal provisions) together with the draft general budget of the European Union. On this basis, of the statement of estimates, the European Commission should enter in the draft general budget of the European Union the estimates it deems necessary for the establishment plan and the amount of the subsidy to be charged to the general budget, together with a description of and justification for any other difference.

The budget of the European Maritime Safety Agency will be adopted by the Administrative Board of the Agency. The draft of the budget will be final following final adoption of the general budget of the European Union. If it is necessary, the budget will be adjusted accordingly, in the same time with the annual working program of the Agency. After the adaptation of the budget, the Executive Director is responsible for its permanent implementation according to the approved plan. The control of the budget lied in the hands of the Executive Director, European Commission and Court of Auditors. Yearly, the Agency's accounting officer should communicate the provisional accounts to the European Commission's accounting bureau together with a detailed report on the budgetary and financial management of the year. The financial report concerning the budgetary and financial management will be also forwarded to the European Parliament and the European Council.

The Court of Auditors and OLAF may carry out, if necessary, various verifications concerning the Agency's funding and the agents responsible for allocating it. The European Anti-fraud Office (known as OLAF, due to the French language: Office Européen de Lutte Antifraude) is charged by the European law with the protection of the financial interests of the European Union. Among its important tasks are: the fight against fraud affecting the European Union money, the prevention and fight against corruption and any other irregular activity, including misconduct, within the institutions of the European Union. OLAF is permanently supervising the European Union money to be used in a transparent and cost-effective manner.

5. CONCLUSIONS

In the future, the European Maritime Safety Agency will pay a special attention on its priority tasks in the area of maritime safety. Nevertheless, the Agency should receive a number of new priority and tasks reflecting the development of maritime safety policy and the general marketing strategies at European Union and worldwide level [11]. In the present context, of the worldwide financial and economic crisis and taking in account the budget constraints of the European Union, serious screening and redeployment activities are necessary to ensure cost and budget efficiency. Moreover, the restructuring of the Agency is necessary to avoid any overlapping between its tasks and other agencies tasks. Staffing needs for the new core and ancillary tasks should, as a matter of principle, be covered through internal redeployment by the Agency.

At the same time, the Agency should receive, where appropriate, funding from other parts of the Union budget, in particular from the European Neighborhood Policy instrument. The carry out any new tasks by the Agency should be undertaken measures taking in account the budgetary limits. The operational activities should be carrying out within the limits of the current financial possibilities and the Agency's budget. Therewith, the operational tasks should take into consideration the necessity of avoiding prejudice to the negotiations and decisions concerning the future multiannual financial plan. Recent worldwide events emphasized the risks of offshore oil and gas exploration. The activities in the area of the maritime transport and the marine harvesting took new form lately.

The Agency's response capabilities for pollution should increase in the nearest future. As well, its expertise in the field of pollution by hazardous and noxious substances should be increased. In this context, this expertise will be used to cover pollution cases originating from such activities, at the request of any affected member state of the European Union. Periodical evaluation should take place to evaluate the impact of Agency activity as well as the utility, relevance, added value and effectiveness of the its working procedures. The evaluation shall take into account the opinions of stakeholders, at both European and national level [12]. From this point of view the assessments might end the possible need to modify the Agency's tasks and function ways.

These types of evaluations and recommendations regarding European Maritime Safety Agency should be periodically analyzed by the each Member State. Based on this analyzes, may be elaborated changes to the rules and regulation and implemented good practices within the activity of the Agency. The evaluations and recommendations should be made public, to ensure the transparent process in the activity of European Maritime Safety Agency. Additionally to the obligation of the European Commission to submit an annual report to the European Parliament and the European Council regarding the activity of the Agency may be take in consideration the annual opinion of the Member State in this regard. Each Member State should have the opportunity to present in public its opinion about the activity of the Agency identifying further efficiency gains and to issue proposals for modifying its objectives and tasks.

6. REFERENCES

[1] Regulation (EC) No 725/2004 of the European Parliament.
[2] Regulation (EC) no 1406/2002 of the European Parliament and of the European Council.
[3] www.emsa.europa.eu
[4] www.emsa.europa.eu
[5] Regulation no 100/2013 of the European Parliament and of the Council of 15 January 2013 amending Regulation (EC) no 1406/2002 establishing a European Maritime Safety Agency
[6] Regulation (EC) no 1406/2002 of the European Parliament and of the European Council.
[7] Regulation (EC) no 1406/2002 of the European Parliament and of the European Council.
[8] Regulation (EC) no 1406/2002 of the European Parliament and of the European Council.
[9] Regulation (EC) no 1406/2002 of the European Parliament and of the European Council.
[10] Regulation (EC) no 1406/2002 of the European Parliament and of the European Council.
[11] GRIGORUT, C., Marketing, BREN Publishing House, Bucharest, 2004.
[12] BRASOVEANU, F. International law among sciences, diplomacy and politics, In Honorem Dumitru Mazilu, Universul Juridic Publishing House, 2011.

TAX HAVENS AND THE TERRORISM

POPA GEORGE-DOREL

"Ovidius" University of Constanta, Romania

ABSTRACT

In everyday language the term "tax haven" means economic and geographical area that offers a wide range of tax benefits where so called offshore companies are registered and carry on financial activities related to money laundering. Basically, an offshore company could operate under conditions of favorable tax only if it is recorded in a "tax haven." Using those companies situated in "tax havens", today, billons of US dollars are "recycled" in complicated financial operations supported by well-organized mechanisms and then, after "the black money" having origin in organized crime activities are reinserted in the legal economy and very often used to finance the terrorism.

Keywords: *tax heaven, organized crime, money laundering, offshore company.*

1. INTRODUCTION

The terrorism can be defined as a set of actions or threats endangering public order and affecting national security of a state [1]. These terrorist actions are always premeditated. Actions are motivated by extremist attitudes and aim to achieve political goals. These threats of terrorist targets both human and material factors in the sphere of state authority and civil society, as well. However, terrorist groups seek to capture public attention on them. For this, their actions were intended to produce psychological effects and strong emotional feelings. Basically, terrorist actions aimed at creating a state of fear, uncertainty and public panic. At present, the terrorist threat has gained a strong character borders. This is due to globalization, erasing the borders between states and enhanced mobility of people. In this situation actually add exacerbating ethnic and religious tensions in some areas of the world. Terrorist organizations are criminal groups that have a specific organization, logistics, recruitment and training system specific. They cannot operate without the necessary financial and material resources. For this reason, one of the most effective ways to fight terrorism is to prevent the financing of terrorist groups. Because of the way of action and immediate effects terrorist phenomenon has some similarities with the phenomenon of cross-border organized crime. However, beyond these similarities aims are totally different. Transnational organized crime is seeking financial or material benefits. Terrorist groups are pursuing political objectives - the destabilization of governments, winning autonomy or independence of territories, the release of imprisoned comrades etc. Cross border organized crime does not follow existing political and social system. Criminal activities must be conducted in a particular social setting. Therefore it takes a certain level of economic stability and social order to "thrive". There is direct links between money laundering and proceeds of crime and financing of terrorist groups. Profits from criminal activities are put in recycling circuit, so in the end the money appear legal and "honorable". Some of this money is sometimes used to finance terrorist groups. There are many theoreticians and experts estimate that there are many cases in which money from recycling funds are used to finance terrorism. The terrorist activities can be divided into two different types: "individual initiative" and "organized initiative". A terrorist group interested to fulfill its aim planning in a rigorous way the final attack. But from thinking out the attack plan to the moment of the attack is a long way. In this period of time the group should gather intelligence, the technical means, and training of the terrorists and to have permanently the financial support. The financial support is a key element for terrorist groups.

Although there are many opinions, terrorist financing has two main sources:

a) the first source is the financial support given by different countries or organizations sympathetic. Organizations should have a large enough infrastructure to collect funds for terrorist groups. However, in recent years, sponsoring countries of the terrorism have come in decline. The place of these states was taken by wealthy sponsors. A rich person may provide substantial financial resources for funding terrorist groups. Terrorist groups differ from other criminal organizations taking in account the motivation and purpose. Organized crime groups are pursuing the profit and operate discreetly. The terrorist groups are operating not for financial purposes but for political aims. Terrorist groups are seeking to impose ideology and faith, using violence, threats and intimidation. Terrorist groups operate "on demand" and do everything possible to attract public attention about "operations" performed. For terrorist financing, funding source is usually "legal". The ultimate goal is not necessarily to attract more funds. Terrorist groups make calls to the community to raise funds for various purposes declarative. Most often goals are forged. Such fundraising is conducted on behalf of charitable organizations or charitable status. The collection is done by using patriotic, humanities, ethnic, national or historical reasons. Community members are convinced that giving money is for a good cause. In most cases, the charity is apparently legal for community that gives funds. Unfortunately, the money thus raised will be used to end lives and destroy property.

b) the second major source of money for terrorist groups is the profit from work that generates revenue.

Often, terrorist groups are owner of factories, shops, transport means, real estate goods etc.

Of course, there are other possibilities for terrorist financing. Similar to criminal organizations, terrorist groups may gather money using different crimes or other illegal activity. After that, usually the money obtained from illegal activities is whitening and used in legal domain. Money obtained will be subjected to a recycling process. Basically, money laundering will intervene in this case. This is because black money proceeds of crime should be given an aura of respectability. Then they are returned to the legal circuit it and used in legal way. These banks, in pursuit of profit many years have refused to collaborate with state agencies. Most often, banks invoked in their secret banking operations. The banks put the conspiracy of the financial operations over law. Since 1980, the states of the world beginning to put the issue of customer identity checks on first place. Thus, gradually, countries have begun to introduce mandatory the identity checks for banks and financial institutions. Secondly, it was erased the limiting of the use of the safety deposit boxes. These boxes are attributed only to persons with whom the bank that was in business relationships or were reliable. In addition, has been established special training program for the stuff of the banks. Staff must undergo training for identity control and to detect suspicious behavior of the customers. Also, for the first time, has been established for the first time the cooperation of banks with administrative and judicial authorities. To counter the financing of terrorism through money laundering is important to establish the criminalization of few actions. The conversion or transfer of property knowing that is originated from crimes is one of the priorities. Today, the money laundering is a complex activity involving many operators and the export of the funds in tax havens, using off shore companies [2].

2. TERRORISM ACTIONS IN WORLD

The terrorism can be defined as a set of actions or threats endangering public order and affecting national security of a state [1]. These terrorist actions are always premeditated. Actions are motivated by extremist attitudes and aim to achieve political goals. These threats of terrorist targets both human and material factors in the sphere of state authority and civil society, as well. However, terrorist groups seek to capture public attention on them. For this, their actions were intended to produce psychological effects and strong emotional feelings. Basically, terrorist actions aimed at creating a state of fear, uncertainty and public panic. At present, the terrorist threat has gained a strong character borders. This is due to globalization, erasing the borders between states and enhanced mobility of people. In this situation actually add exacerbating ethnic and religious tensions in some areas of the world. Terrorist organizations are criminal groups that have a specific organization, logistics, recruitment and training system specific. They cannot operate without the necessary financial and material resources. For this reason, groups. Because of the way of action and immediate effects terrorist phenomenon has some similarities with the phenomenon of cross-border organized crime. However, beyond these similarities aims are totally different. Transnational organized crime is seeking financial or material benefits. Terrorist groups are pursuing political objectives - the destabilization of governments, winning autonomy or independence of territories, the release of imprisoned comrades etc. Cross border organized crime does not follow existing political and social system. Criminal activities must be conducted in a particular social setting. Therefore it takes a certain level of economic stability and social order to “thrive”. There is direct links between money laundering and proceeds of crime and financing of terrorist groups. Profits from criminal activities are put in recycling circuit, so in the end the money appear legal and "honorable". Some of thismoneyis sometimes used to finance terrorist groups. There are many theoreticians and experts estimate that there are many cases in which money from recycling funds are used to finance terrorism. The terrorist activities can be divided into two different types: “individual initiative” and “organized initiative”. A terrorist group interested to fulfill its aim planning in a rigorous way the final attack. But from thinking out the attack plan to the moment of the attack is a long way. In this period of time the group should gather intelligence, the technical means, and training of the terrorists and to have permanently the financial support. The financial support is a key element for terrorist groups.

Although there are many opinions, terrorist financing has two main sources:

a) the first source is the financial support given by different countries or organizations sympathetic. Organizations should have a large enough infrastructure to collect funds for terrorist groups. However, in recent years, sponsoring countries of the terrorism have come in decline. The place of these states was taken by wealthy sponsors. A rich person may provide substantial financial resources for funding terrorist groups. Terrorist groups differ from other criminal organizations taking in account the motivation and purpose. Organized crime groups are pursuing the profit and operate discreetly. The terrorist groups are operating not for financial purposes but for political aims. Terrorist groups are seeking to impose ideology and faith, using violence, threats and intimidation. Terrorist groups operate "on demand" and do everything possible to attract public attention about "operations" performed. For terrorist financing, funding source is usually "legal". The ultimate goal is not necessarily to attract more funds. Terrorist groups make calls to the community to raise funds for various purposes declarative. Most often goals are forged. Such fundraising is conducted on behalf of charitable organizations or charitable status. The collection is done by using patriotic, humanities, ethnic, national or historical reasons. Community members are convinced that giving money is for a good cause. In most cases, the charity is apparently legal for community that gives funds. Unfortunately, the money thus raised will be used to end lives and destroy property.

b) the second major source of money for terrorist groups is the profit from work that generates revenue. Often, terrorist groups are owner of factories, shops, transport means, real estate goods etc.

Of course, there are other possibilities for terrorist financing. Similar to criminal organizations, terrorist groups may gather money using different crimes or other illegal activity. After that, usually the money obtained from illegal activities is whitening and used in legal domain. Money obtained will be subjected to a recycling process. Basically, money laundering will intervene in this case. This is because black money proceeds of crime should be given an aura of respectability. Then they are returned to the legal circuit it and used in legal way. These banks, in pursuit of profit many years have refused to collaborate with state agencies. Most often, banks invoked in their secret banking operations. The banks put the conspiracy of the financial operations over law. Since 1980, the states of the world beginning to put the issue of customer identity checks on first place. Thus, gradually, countries have begun to introduce mandatory the identity checks for banks and financial institutions. Secondly, it was erased the limiting of the use of the safety deposit boxes. These boxes are attributed only to persons with whom the bank that was in business relationships or were reliable. In addition, has been established special training program for the stuff of the banks. Staff must undergo training for identity control and to detect suspicious behavior of the customers. Also, for the first time, has been established for the first time the cooperation of banks with administrative and judicial authorities. To counter the financing of terrorism through money laundering is important to establish the criminalization of few actions. The conversion or transfer of property knowing that is originated from crimes is one of the priorities. Today, the money laundering is a complex activity involving many operators and the export of the funds in tax havens, using off shore companies [1]. One of the most effective ways to fight terrorism is to prevent the financing of terrorism and to cut the necessary money used to organize and initiate the different terrorist attacks, all over the world.

3. TAX HAVENS AND THE OFFSHORE COMPANIES

For complex financial activities, the operators involved in money laundering use the countries and geographical areas that the law provides favorable financial and tax conditions for offshore companies [2]. It should be emphasized that these offshore companies will not pay taxes not because they are using fraudulent accounting operations to get rid of the tax system, but because the applicable law in these countries and geographical areas provide the opportunity to avoid full or partial payment of taxes in the legal way. The tax havens have a crucial role in the mobility increasing of the fluxes of capitals and the interdependencies between different states, companies and citizens. In these complex equations, a key role is played by offshore companies. Offshore companies are companies created by the money laundering operators used to reduce taxes on profits of the “mother companies”. The “mother company” is located usually in areas of high taxation and in its effort to maximize the profits of these companies in tax haven areas. Often in practice, the “mother company”among other commercial operations “sells” to offshore company certain goods or capitals at a minimum price and offshore company will “resell” the goods or the mentioned money at a higher price. “Mother company” because minimum price charged will have a very small profit and therefore taxes will decrease considerably. On the other hand, offshore company will sell its products at a substantially higher price and will have a serious profit but not subject to high taxation, because the tax haven has a really low taxes system or even none. The creation of offshore investment companies is dedicated to provide more options in choosing investment objectives, allowing investors to focus on the best projects and to select areas that offer high potential income. Also, it guarantees the confidentiality of transactions concluded between the company and its clients. The offshore companies make favorable conditions for investment in offshore company and ensure the possibility of transferring resources available without violating currency laws and fiscal monetary circulation. Ownership of offshore company’s credit allows you to lead a profitable credit policy, minimizing taxes and loans and improving credit and financial services for different customers. In addition, using an offshore company might be provided loans to businesses located in an area with higher taxes. In this way it is carrying out the transfer of foreign currency resources in a third country, without violating tax laws and monetary circulation and reduction or exemption from tax on profits earned in a country with high taxation. The off shore companies can be used, also, to minimize the different taxes without violating the law. Very often, in these cases, the same citizen is the owner and manager of companies, one local and one in another country. This creates the opportunity to transfer to a third country profits in the form of taxable dividends. Later, the money may be returned to the country in which the joint venture is registered as investment or as preferential loans.

An offshore holding company can be used to finance its subsidiaries under different jurisdictions in order to obtain tax reductions for interest on loans granted by the “mother company”. In this case, it is holding off shore companies in an area where it will not pay any taxes. The profit obtained using this method can be used to finance other activities performed by holding or be reinvested for other purposes. Insurance companies working using an offshore company registered in a country with high taxation can be used to ensure risks of “mother company” in conditions more favorable than those offered by regular insurance companies. This method, using offshore insurance company may be used by insurance companies to ensure their risks and thus to achieve efficient tax planning. Offshore banking companies can be created by banks in order to accumulate profits in low-tax countries, as well as by group companies in order to unify financial resources and facilitate the movement of money within the group. An offshore bank can be used to finance international operations conducted by the founders of the bank, in order to avoid problems related to currency law. In the area of tax havens could be created *c*ompanies designed to be owner of different inherited properties. These companies offer the possibility of reducing or even eliminating inheritance taxes and fees and to increase the value of "profit". In this way it is simplifies the sales process of a property if the owner is a company. In this case, only the company's shares are sold and transferred to the new owner but the company remains the owner of that property. If the property is to be sold or donated will not be imposed by taxes for this process.

Offshore private funds provide partial or total reduction of income tax, capital or inheritance. Moreover, it is guaranteed distribution of income in strict accordance with the desire of the owner. Offshore investment funds pay no tax and no higher legal fees. In addition, dividends and interest are taxed at a very low level or are exempt from taxes. Bringing retail investors offer the opportunity to participate in different projects and save many costs related to study of the market.

In this context, founder enjoys the greatest benefits having the flexibility to conduct abroad sealing proceedings. Manager could invest in many countries without paying taxes and can perform multiple commercial activities. Offshore company registered in a tax haven is the company or the company having a wide range of uses that are specifically established by the owners and much less outside existing regulations. Of IMF data, today, about 7,000 billion dollars in financial assets are owned by different categories of offshore companies. It is estimated that the United States of America loses each year between 54 and 70 billion dollars from the budget because of tax exemptions [3] and therefore the U.S. government pays special attention to these issues. The international community is pushing for several years as offshore areas to become more transparent. Only five of 30 areas become more transparent because of these pressures. The invoked reason by those who refused "the pressure" is the transparent regions are considered discriminated among all these nations. Among those who made concessions in this domain are included Switzerland and Cyprus.

4. CONTEMPORARY GLOBAL ECONOMY AND OFFSHORE COMPANIES

At the first sight, setting up an offshore company is hard enough, but in reality the establishment and management of offshore companies is no more difficult than that of ordinary companies. After the moment of the establishment of the company is possible to increase or decrease the company's registered capital, transfer of shares and change managers more easily. These operations will take place under the umbrella of the local law. Can be relatively simple, both fusion and division of the offshore companies. Official cancellation is possible for the offshore companies without the need for submission of final accounting records in the jurisdiction in which it was initially registered. Currently in the world there are more than 40 "offshore regions" offering considerable tax and financial advantages. These traditional tax havens are located mainly in archipelagos (eg British Virgin Islands), the island republic (eg the Republic of Naur) or small countries (eg Panama).

Permissive legislation and the independence of these countries, encourage foreign investors to set up various companies on that territory. In most "offshore areas" serious business operation, security and protection of the secret foreign investments are guaranteed by law. What provide favorable tax status for a company? In all tax havens, tax benefits have a legal basis. For example, for companies registered in the British Virgin Islands, the tax benefits are provided by a law passed in 1984. Thus, offshore companies do not pay other types of taxes except 300 U.S. dollars, regardless of turnover. Islands as Bahamas and Belize established an annual tax amounted to 100 U.S. dollars and 150 U.S. dollars in Panama. It is clear that these tax benefits are substantial compared to what is required tax in European countries. Granting tax benefits to offshore companies is considered an advantage for a tax haven area? Tax havens are usually small countries with small population and the tourism and various services play the most important role [4]. Offshore companies in these countries provide substantial income. On one hand, it creates jobs because it requires the existence of firms, institutions registration, registered agents and banks recorded on this territory. On the other hand, due to payment and other financial obligations to the state (tax registration and re-registration) and other charges, the population gets a considerable income. Let's see some statistics. British Virgin Islands has 17,000 inhabitants and presently 300,000 offshore companies are registered in this country. If every company registered on the territory pays an annual tax of 300 U.S. dollars, the fees paid by offshore companies is 5,200 U.S. dollars per capita. The main purpose of setting up offshore companies in tax havens is to reduce taxes and take advantage of direct or indirect taxation. It should be emphasized that despite the fact that offshore companies are often considered tax-exempt companies in any part of the world there are companies fully and legally exempted from any tax and financial tasks. In general, the following principles apply in areas of the offshore companies: the company is obliged to pay a fixed annual fee, independent of turnover and profit society. These areas are: Virgin Islands, Bahamas, Belize, etc. The tax does not depend on turnover, but the registered capital of the company. The Liechtenstein Foundation annually pays 0.1% of the share capital. They are exempted from tax only incomes derived from activities performed abroad. In countries like Panama and Hong Kong companies can carry on domestic business activities and incomes are taxed based on a linear rate, while income from abroad are exempt from tax. In Hong Kong companies must declare separate internal revenue in its annual report, without other financial obligation. Taxation is all the time based on a linear rate. One of the most popular areas is Cyprus, where offshore companies pay 4.25% of the total net profit. In these areas, accounting and delivery of annual reports is mandatory. These facts and more other make the offshore companies very attractive for the operators involved in money laundering. Directly related to money laundering, the terrorism found out a very attractive financing source in this complex phenomena [5].

5. CONCLUSIONS

The complex issue of terrorism and the ways of funding has been and will remain in the attention of specialists. Even if the blocking of the terrorist financing remains in each state of the world's attention, only the international cooperation is able to solve the problem. Cooperation between law enforcement agencies, the establishment of common rules regarding tax havens and not least criminalizing of any actions related to recycling of funds is the only way to stop terrorist groups. All future actions to prevent and combat terrorism directly bind international legal, administrative and operative cooperation.

6. REFERENCES

[1]Act no.535 from 2004 concerning the prevention and combating of the terrorism.
[2] POPA GEORGE DOREL, *International Cooperation in the Struggle against Trans-border Organized Crime and Money Laundering*, Contemporary Readings in Law and Social Justice, 2012.
[3]http://www.fatf-gafi.org
[4] Popa Stefan, Dragan Gheorghe, *Money laundering and the financing of the terrorism*, Expert Publishing House, Bucharest, ISBN 973-618-081-6, 2005.
[5] POPA GEORGE DOREL, *International Crisis in the Context of Globalization and Money Laundering* – “Ovidius” University Annals, Economic Sciences Series, 2011.

CHANGING OPTIMAL PRODUCTION VOLUME IN CONDITIONS OF INTERNATIONAL ECONOMIC INTEGRATION

SHPAK NATALIYA

Odessa National Maritime University, Ukraine

ABSTRACT

The objective of this article is to reveal expediency of launching customs unions in the international economic system and to ascertain the indicators, above all influenced by presence of customs barriers between countries.

Keywords: *international economic integration, supply volume, national producer, foreign producer.*

1. INTRODUCTION

Formation of stable economic ties between countries, based on international division of labor, in up-to-date conditions became global. More and more open national economics, international commerce, modern transport, communication and information systems contribute to development of international economic integration. Reproduction processes coalesce and economic, science-productive and commercial connections appear during the process of international economic integration. Such integration is carried out gradually, from simple forms to more complicated [1].

One of the forms of international economic integration is launching customs unions. Customs union is an interstate agreement between two (or more) states on imposing an external tariff and cancellation of trading constraints for members of union. Free, non-taxable product, labor power and capital transfer is permitted within territory of customs union.

However, there is no unambiguous opinion, whether such customs unions between states are always advantageous for all members. Thus, identifying conditions of expediency of launching customs unions is an important science and practical issue.

Description of conditions and advantages of launching customs unions is given in numerous political economics, economic theory, international economics publications [2, 3, 4]. According to the theory of customs union its launching is an important condition for achieving high level of states' social and economic development.

Today the issues of integration, and launching customs unions in particular, are often discussed and they are controversial. Customs unions are often considered and analyzed from the point of view of consolidating national sovereignty and increasing political authority in interstate relations [5]. Besides, it is stated, that customs union is a collective monopolistic protectionism, designed, first of all, to give national producer opportunity to strengthen for competitive activity in the world market, and secondly, to create new finance and economic centre of power.

It is noted in some sources, that entering customs unions is reasonable only for countries with similar development level [6].

However, sometimes processes of economic integration are explained by other reasons, different from level of economic development. Economically highly developed regions connect with less developed flows of primary materials, energy and labor power forming definite symbiosis [7]. In this case, common economic space consists of countries, which differ in economic development level (or any other territorial economic formations - regions, citied, etc.) and supplement each other in accordance with established specialization and cooperation of production. And vice versa, those countries which have similar economic development level usually compete in production of the same types of goods, keeping away from each other by customs barriers and taking various safeguard actions. Exactly between countries with similar economic development level trade wars take place time after time, as they cannot take place between producers of final products and primary material manufacturers [8].

Let us examine international economic system (Figure 1), consisting of two producers: aggregate national and aggregate foreign ones, which supply goods to both national end market in quantities of q_{11} and q_{21} correspondingly, and to foreign end market in quantities of q_{12} and q_{22} correspondingly. Each of the producers on the way to the end market, which is not in his country, faces customs clearance in import country. Thus, goods of foreign producer are subject to customs clearance, including levying customs payments, when they enter national market, and goods of national producer are subject to similar customs clearance when they enter foreign market.

2. BASIC MATERIAL OF RESEARCH

For the sake of simplicity let us consider expenses of national and foreign producers for output and delivery of production to be specified by linear functions, therefore:

$$W_1(q_{11}, q_{12}) = c_1 q_{11} + c_1 q_{12} + e_1,$$

$$W_2(q_{21}, q_{22}) = c_2 q_{21} + c_2 q_{22} + e_2,$$

where $c_1, c_2 > 0$ – variable expenses per unit,

$e_1, e_2 > 0$ – fixed expenses.

Let price for production in national and foreign end markets be also specified by linear functions, therefore:

$$p_1 = b_1 - k_1(q_{11} + q_{21}), \quad p_2 = b_2 - k_2(q_{12} + q_{22}),$$

where $p_1, p_2 \geq 0$ – price of goods in national and foreign markets,

$b_1, b_2 > 0$ – maximum possible prices in national and foreign markets.

$k_1, k_2 > 0$ – indicators of demand elasticity in corresponding markets.

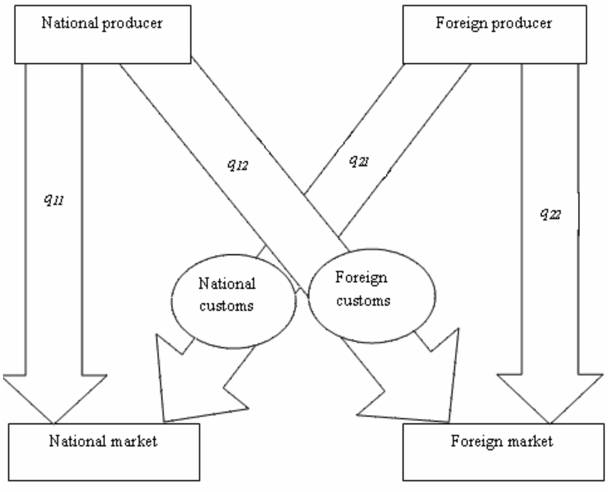


Figure 1. International economic system with regard to customs factor

Conditions of solvability should be satisfied:

$$b_1 > c_1, \quad b_1 > c_2 + z_1, \quad b_2 > c_2, \quad b_2 > c_1 + z_2,$$

where z_1, z_2 – unit expenses of national and foreign customs authorities, which can include salary of customs officials, expenses for purchase of customs equipment, such as means of communication, various installations for finding contraband.

Let us denote $Q_1 = q_{11} + q_{21}$ – volume of production supplied to home market by both national and foreign producers $0 \leq Q_1 \leq b_1 / k_1$.

$Q_2 = q_{12} + q_{22}$ – volume of production, supplied to foreign market by both national and foreign producers $0 \leq Q_2 \leq b_2 / k_2$.

Import country can influence this economic system by way of changing its customs tariff (duty rate, imposed on goods transferred through customs border of country).

Let us denote $t_1, t_2 \geq 0$ – duty rates, imposed correspondingly by national and foreign customs authorities at arrival of import to their country.

Each of the members of the system maximizes his profit. As fixed expenses do not influence optimization, we shall omit them.

National producer's profit F_1 is formed as difference between profit from realization of national production in both national and foreign markets and expenses for manufacturing and delivery of this production, with regard to the fact, that supply to foreign market becomes more expensive because of customs expenses:

$$F_1(q_{11}, q_{12}) = p_1 q_{11} + p_2 q_{12} - c_1 q_{11} - c_1 q_{12} - t_2 q_{12} =$$
$$= (b_1 - k_1 (q_{11} + q_{21})) q_{11} + (b_2 - k_2 (q_{12} + q_{22})) q_{12} - \tag{1}$$
$$- c_1 q_{11} - c_1 q_{12} - t_2 q_{12} \to \max_{q11, q12}$$

To find maximum of this function let us equate corresponding partial derivatives to zero:

$$\frac{\partial F_1}{\partial q_{11}} = b_1 - 2k_1 q_{11} - k_1 q_{21} - c_1 = 0,$$
$$\frac{\partial F_1}{\partial q_{12}} = b_2 - 2k_2 q_{12} - k_2 q_{22} - c_1 - t_2 = 0 \tag{2}$$

This implies that optimal volume of production supply of national producer to national and foreign markets shall make up:

$$q_{11} = \frac{b_1 - k_1 q_{21} - c_1}{2k_1}, \quad q_{12} = \frac{b_2 - k_2 q_{22} - c_1 - t_2}{2k_2} \tag{3}$$

Similarly, profit of foreign producer is formed:

$$F_2(q_{21}, q_{22}) = p_1 q_{21} + p_2 q_{22} - c_2 q_{21} - c_2 q_{22} - t_1 q_{21} =$$
$$= (b_1 - k_1 (q_{11} + q_{21})) q_{21} + (b_2 - k_2 (q_{12} + q_{22})) q_{22} - \tag{4}$$
$$- c_2 q_{21} - c_2 q_{22} - t_1 q_{21} \to \max_{q21, q22}$$

Hence we get optimal volumes of production supply of foreign producer to national and foreign markets:

$$q_{21} = \frac{b_1 - k_1 q_{11} - c_2 - t_1}{2k_1}, \quad q_{22} = \frac{b_2 - k_2 q_{12} - c_2}{2k_2} \tag{5}$$

Let us find known in microeconomics Cournot equilibrium, at which it is not advantageous to any member having equal rights to deviate from his own equilibrium volume at corresponding equilibrium volume of the competitor. Inserting received expressions (3) and (5) into each other, we find Cournot equilibrium volumes through initial parameters of the examined economic system.

Let us examine the situation from the point of view of customs authorities, applying common approaches concerning optimization of customs tariffs to this specific model.

Actions of customs authorities reflect interests of import country, as customs authorities are a state structure, which carries out control over goods transferred beyond customs border, including control over completeness and timeliness of customs payments receipt to state budget.

Import country can influence this economic system by way of changing customs tariff.

Formation of receipts through imposing customs duties to state budget of national producer F_3 acquires the form:

$$F_3(t_1) = (t_1 - z_1) q_{21} \to \max_{t_1} \tag{6}$$

State represented by customs authorities defines in this formula only its tariff t_1. Amount of production transferred q_{21} is set by foreign supplier due to conditions, found by us in (11). Inserting (11) into (13), we get:

$$F_3(t_1) = (t_1 - z_1)\frac{b_1 - 2c_2 + c_1 - 2t_1}{3k_1} \to \max_{t_1} \quad (7)$$

To find maximum of this function its partial derivative is equated to zero and we get optimal customs tariff t_1^K. Similarly, we find optimal customs tariff t_2^K for foreign producer too.

Having found equilibrium customs tariffs for each of considered countries, let us find equilibrium volume of production.

We can note, that condition of competitiveness (positivity of supply volume $q_{11}^K > 0$) for national producer in his market shall have the form:

$$c_1 < \frac{5b_1 + 2c_2 + 2z_1}{7} \quad (8)$$

And thus, condition of competitiveness for foreign producer in national market (positivity of supply volume $q_{21}^K > 0$) acquires the form:

$$c_2 < \frac{b_1 + c_1 - 2z_1}{2} \quad (9)$$

There is no sense in entering markets at a loss for producers (if import country imposes too high duties, or if cost value of other producer is quite low), that is why if the above mentioned conditions are not satisfied, corresponding supply volume shall equal zero.

If both producers work in national market, i.e. national and foreign producers are competitive in national market, conditions (8) and (9) must be satisfied simultaneously. Hence:

$$2c_2 + 2z_1 - b_1 < c_1 < \frac{5b_1 + 2c_2 + 2z_1}{7} \quad (10)$$

If c_1 falls into interval (10), then amount of production supplied to national market by both national and foreign producers shall make up:

$$Q_1^K = q_{11}^K + q_{21}^K = \frac{7b_1 - 5c_1 - 2c_2 - 2z_1}{12k_1} \quad (11)$$

Let us insert left and right parts of inequality (10) by turns into (11) instead of c_1, and find that at $c_1 = 2c_2 + 2z_1 - b_1$:

$$Q_1^K = \frac{7b_1 - 10c_1 - 2c_2 - 2z_1 - 10z_1 + 5b_1}{12k_1} = \frac{b_1 - c_2 - z_1}{k_1} > 0, \quad (12)$$

and at $c_1 = \dfrac{5b_1 + 2c_2 + 2z_1}{7}$:

$$Q_1^K = \frac{2}{7}\frac{b_1 - c_2 - z_1}{k_1} > 0 \quad (13)$$

Thus, we got interval of changing aggregate production amount in national market at competitiveness in it of both producers, depending on cost value of manufacturing by national producer c_1:

$$\frac{2}{7}\frac{b_1 - c_2 - z_1}{k_1} < Q_1^K < \frac{b_1 - c_2 - z_1}{k_1}, \quad (14)$$

If foreign producer is noncompetitive in national market, i.e. $q_{21}^K \le 0$, then:

$$c_2 \ge \frac{b_1 + c_1 - 2z_1}{2}, \quad (15)$$

and this means that only national producer shall be present in this market, and his profit in this market shall be formed as follows:

$$F_{11}(q_{11}) = p_1 q_{11} - c_1 q_{11} = (b_1 - k_1 q_{11})q_{11} - c_1 q_{11} \to \max_{q_{11}}. \quad (16)$$

Hence:

$$q_{11} = \frac{b_1 - c_1}{2k_1} \quad (17)$$

We can note, that if cost value of national producer c_1 is near zero, then supply volume q_{11} shall approach the value $\dfrac{b_1}{2k_1}$.

And in case when national producer is not competitive in his market, i.e. $q_{11}^K \le 0$:

$$c_1 \ge \frac{5b_1 + 2c_2 + 2z_1}{7}, \quad (18)$$

i.e. only foreign producer shall be present in this market, with profit F_{21} in this market being formed as follows:

$$F_{21}(q_{21}) = (b_1 - k_1 q_{21})q_{21} - c_2 q_{21} - t_1 q_{21} \to \max_{q_{21}} \quad (19)$$

Hence we get:

$$q_{21} = \frac{b_1 - c_2 - t_1}{2k_1} \quad (20)$$

Let us insert the received in (20) expression into (6):

$$F_3(t_1) = (t_1 - z_1)\frac{b_1 - c_2 - t_1}{2k_1} \to \max_{t_1} \quad (21)$$

We can observe that when national producer is noncompetitive in national market, optimal customs tariff t_1^K equals:

$$t_1^K = z_1 + \frac{b_1 - c_2 - z_1}{2} \quad (22)$$

Thus, production volume supplied in this case to national market by foreign producer shall make up:

$$q_{21} = \frac{b_1 - c_2 - z_1 - \dfrac{b_1 - c_2 - z_1}{2}}{2k_1} = \frac{1}{4}\frac{b_1 - c_2 - z_1}{k_1} \quad (23)$$

Let us consider how optimal production volume shall change in such conditions in national market when customs union is launched between resident countries of national and foreign producers.

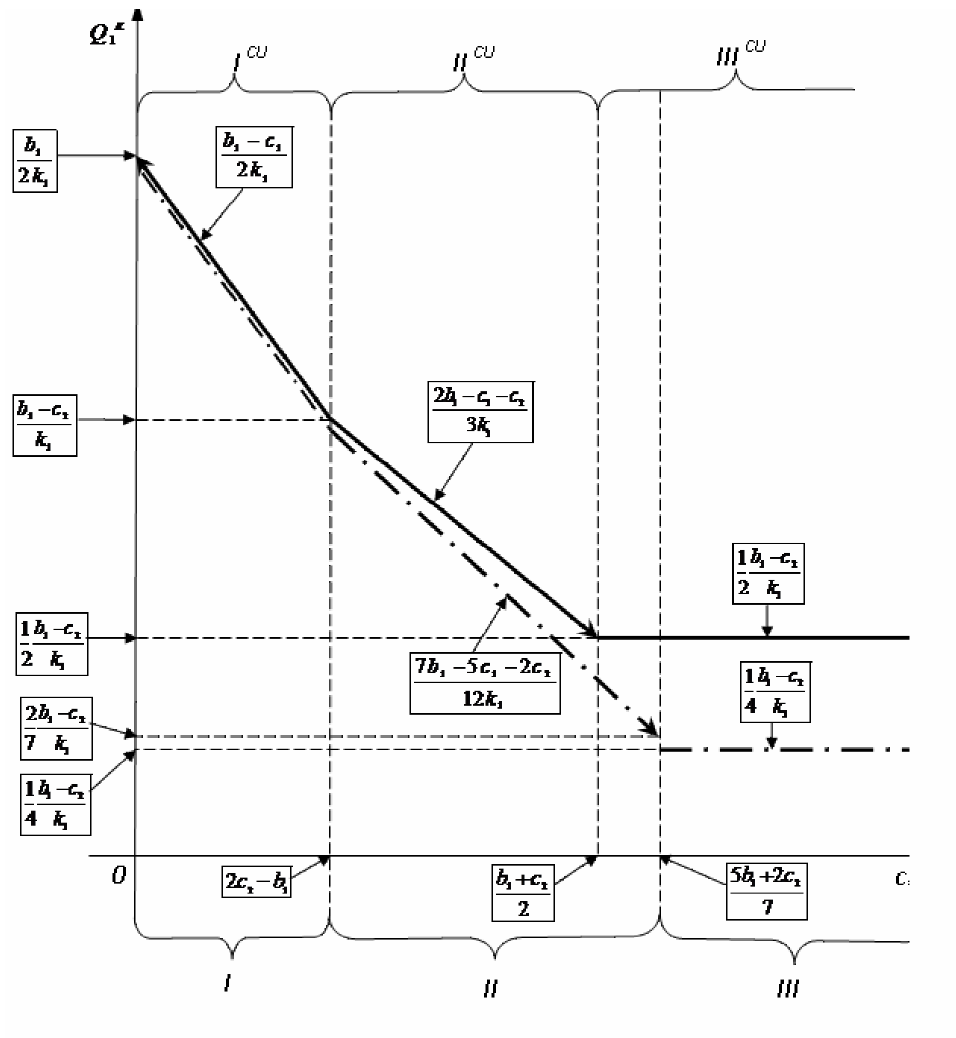
When customs union is launched, customs barriers are removed; therefore national and foreign producers shall supply production to both markets under the same conditions. For example, formation of profit of national producer when resident countries of national and foreign producers enter into customs union shall be represented by function (superscript «CU» denotes indicators when countries enter into customs union):

$$\begin{aligned} F_1^{CU}(q_{11}, q_{12}) &= (b_1 - k_1(q_{11} + q_{21}))q_{11} + \\ &+ (b_2 - k_2(q_{12} + q_{22}))q_{12} - c_1 q_{11} - c_1 q_{12} \to \max_{q_{11}, q_{12}} \end{aligned} \quad (24)$$

By doing research similarly to one of situation with presence of customs barriers, we shall find optimal production volumes in national market when countries enter into customs union.

In Figure 2 we can see comparison of dependence of optimal production volume in national market from cost value of production of national producer before and after entering customs union. As unit expenses of national and foreign customs authorities (z_1 and z_2

correspondingly) are rather low, we shall omit them for the sake of convenience.



line of optimal production volume in national market at presence of customs barriers between countries.

line of optimal production volume in national market when countries enter into customs union.

Figure 2 Comparison of dependencies of optimal production volume in national market from cost value of national producer's output before and after entering into customs union

Depending on value of unit variables of expenses for manufacturing production by national producer (c_1) we can single out three intervals, in which various parities of competitiveness of national and foreign producers will be observed. Therefore, let us mark the following intervals in Figure 2:

I **–** foreign producer is noncompetitive in national market,

II **–** national and foreign producers and competitive in national market,

III **–** national producer is noncompetitive in his market.

If national producer's output has such low cost value that foreign producer is noncompetitive in national market, then launching customs union does not change either production volume, or value of corresponding interval, i.e. absence of customs borders does not give opportunity to relatively "weak" foreign competitors to supply national market with production. Thus, when cost value of national producer's output is low, when foreign producer, which is not able to compete in such conditions with the national one, is driven out from national market – production amount in national market is maximal.

In case when presence in national market becomes expedient for foreign producer (when cost value of national producer increases), difference between situations before entering into customs union and after it becomes obvious.

First of all, the interval of competitiveness of both producers in national market reduces at launching customs union, i.e. customs barriers give national producer opportunity to remain competitive in his market. And secondly, after launching customs union production volume in national market, with increase of cost value of national producer's output, will decrease not so rapidly as before launching it.

When output cost value of national producer increases again, when the latter becomes noncompetitive in his market, production volume in national market, when customs union is launched, shall be twice bigger than it was before its launching, and this shall lead to considerable reduction of prices and rising of living standards of common native consumer.

It is interesting, that in interval ***III***, when customs barriers are present between countries, drop of production volume in national market is observed, i.e. abrupt change of production volume corresponds to slight increase of cost value of national producer's output – «a catastrophe» according to terminology of corresponding mathematical theory [9].

Thus, population of a country should be interested in state's entering into customs union. Firstly, this obliges national producer to take care of reducing cost value of his output, as in this case he can faster become noncompetitive in his market, and secondly, production volume in market even when national producer is noncompetitive shall not fall below rather high level.

At the same time launching customs union is not expedient for national producers, as they become noncompetitive much earlier (at lower cost value of their production) even in national market, and this fact cannot be compensated by way of expanding activities in foreign markets.

3. CONCLUSIONS

Thus, having examined the situation, connected with expedience of launching customs union, we can draw a conclusion, that entering into customs union is advantageous for both budget of integrated countries, and population of these countries. However, not all members of the system will find advantages of entering customs union. Launching customs union is not profitable for producers of import countries, as their activity after it is carried out in conditions of stiffer competition.

4. REFERENCES

[1] Viner J., The customs union issue, The Carnegie Endowment for International Peace, New York, 1950.

[2] Dovring F., The Open Field System and Beyond: a property rights analysis of an economic institution, Cambridge University Press, Cambridge, 1965.

[3] Krugman P. R., Obstfeld M., International Economics: Theory and Policy. Prentice Hall, 2008. — 712 p.

[4] Belyaev O. O., Political economy, in: O. Belyaev (Ed.), Study guide, KNEU, Kiev, 2011, p. 328.

[5] Karelin G.V., Modern value and features of customs unions as forms of economic integration, World economy and international economic relations in: A.S. Melnik (Ed.), Textbook, INKOR, Kiev, 2010, pp. 213-235.

[6] Suetin A.A., World economy. International economic relations. Globalistics, Knorus, Moscow, 2008.

[7] Lukyanenko D.G., Economic integration and global problems of modern time in: D.G. Lukyanenko (Ed.), Study guide, Professional, Kiev, 2011, p. 360.

[8] Allan M. Feldman, International Economics, 10th Editin, John Wiley Sons., 2010.

[9] Arnold V.I., Theory of catastrophes, Science, Moscow, 1990.

ASPECTS RELATED TO RISK MANAGEMENT IN OIL AND GAS INDUSTRY

[1]STANCA COSTEL, [2]ANGHEL ELENA-CRISTINA

[1]Constanta Maritime University, [2]Atlas Research, Romania

ABSTRACT

The presence of risk in almost every human situation, activity and sector has determined the increasingly rapid development of the risk management discipline. Depending on the context, there are various descriptions of what risk management involves. Like in many other industries, oil and gas companies are facing many kinds of risks and uncertainties that make the execution of projects more and more complex and difficult. Taking into consideration the fact that in risk evaluation and treatment the potential impact is a key issue the oil and gas industry is one of the fields where addressing risks will remain one of the major concerns in order to assure the limitation of human life and environmental damages.

Keywords: *risk management, risk evaluation, oil and gas industry*

1. INTRODUCTION

Risks have been a part of our everyday life from ancient times to the present day. While the risks assumed by primitive people were mostly physical, today people can risk their money or business without putting their lives into danger.

The oil and gas industry is one of the most exposed to high risks with potential effects on human life and environmental impacts.

2. RISK MANAGEMENT – CONCEPTS AND PRINCIPLES

2.1. What is Risk?

Considering the presence of risk in almost every activity and the large literature on risk covering a range of disciplines from mathematics to psychology, we find ourselves in front of a multitude of definitions for this term. Here are just a few of the numerous perspectives that may contribute to a better understanding of the risk notion:

"The objective uncertainty as to the occurrence of an undesirable event. It varies with uncertainty and not with the degree of probability the greater the probable variation of the actual loss from the average, the greater the degree of uncertainty" (Willet, 1951)

"Hazard, danger, chance of loss, failure or injury; the degree of probability of loss; a person, thing or factor likely to cause loss or danger.- to expose to risk; to incur the chance of unfortunate consequences, loss or danger by (doing something)" (Chambers dictionary, 1992)

"Risk is a combination of the chance of a particular event, with the impact that the event would cause if it occurred. Risk therefore has two components – the chance (or probability) of an event occurring and the impact (or consequence) associated with that event. The consequence of an event may be either desirable or undesirable…In some, but not all cases, therefore a convenient single measure of the importance of a risk is given by: Risk = Probability ×Consequence." (Sayers *et al.* 2002)

"Risk is the actual exposure of something of human value to a hazard and is often regarded as the combination of probability and loss". (Smith, 1996)

"Risk might be defined simply as the probability of the occurrence of an undesired event [but] be better described as the probability of a hazard contributing to a potential disaster…importantly, it involves consideration of vulnerability to the hazard". (Stenchion, 1997)

"The possibility of an event occurring, that will have an impact on the achievement of objectives. Risk is measured in terms of impact and likelihood" (The Institute of Internal Auditors).

2.2. Role of risk management

*In order to have g*ood management and decision-making at all levels it is important for an organization to have an effective risk management. All the departments of an organization handle risks permanently in less or more rigorous ways and sometimes even without knowing it.

For years, companies faced different types of risks in a slightly disorganized way. Today, instead, there are methods of *"definition and control"*, which are put together in a systematic approach known as "Risk Management", which provides improved defense against harmful events.

One of the most prominent frameworks of risk management ISO 31000 refers to risk management as a central part of the strategic management of any organization. It is the process whereby organization methodically address the risks attached to their activities. A successful risk management initiative should be proportionate to the level of risk in the organization, aligned with other corporate activities, comprehensive in its scope, embedded into routine activities and dynamic by being responsive to changing circumstances.

2.3. Contemporary perspective on risk management

"Risk is like fire: If controlled it will help you; if uncontrolled it will rise up and destroy you." (*Theodore Roosevelt)*

Until now we have considered that the purpose of risk management is to remove and reduce the risk exposures without considering successful firms in any industry get there not by avoiding risk but by actively seeking it out and exploiting it to their own advantage.

Risk management should be a continuous process that supports the development and implementation of the strategy of an organization. It should methodically address all the risks associated with all of the activities of the organization. In all types of undertaking, there is the potential for events that constitute opportunities for benefit (upside), threats to success (downside) or an increased degree of uncertainty.

3. RISK MANAGEMENT PROCESS

3.1. Establishing context

This first step consists in closely understanding both the external environment and the internal culture of the organization .This analysis requires:

− to establish the strategic, organizational and risk management context of the organization

− to identify the opportunities and constraints of the environment.

The culture and context of the organization are established through a number of environmental analyses including standards and codes, previous risk management and business plans, relevant corporate documents, industry guidelines, imposed laws and restrictions.

Another important aspect of this stage is developing risk criteria that will reflect the organizational context, often depending on the strategic direction, objectives and goals of the organization, internal policies, interests and expectations of stakeholders.

3.2. Risk identification

In this phase the potential risks are determined and described by analyzing all possible sources of risk, within the areas of risks that where identified when defining the context. Using the information gathered from the context, particularly from the SWOT and PEST analysis, the next step is to identify the risks that are likely to affect the achievement of the goals of the organization, activity or initiative. It should be underlined that a good exploitation of risks can become opportunities for the organization.

Key questions to identify risks:

− When, where, why, and how are risks likely to occur while achieving our goals?

− What are the risks related with achieving each established priority?

− What are the risks that could prevent us from achieving these priorities?

− Who might be involved (for example, suppliers, contractors, stakeholders)?

3.3. Risk analysis

Risk analysis involves prioritizing risks for further analysis in order to determine their consequences, their probability of occurrence and their impacts. Risks will receive priority with regard to how they will be managed considering their likelihood and consequences.

The level of risk is analyzed by combining estimates of likelihood and consequences to determine the priority level of the risk. Once this analysis has been made, action plans can be formulated and controls implemented to eliminate or reduce the risks.

Depending on the risk, the purpose of the analysis and the information and data available there are different types of analysis techniques than can be used.

Lower risks are estimated using qualitative and semi-quantitative techniques (hazard matrices, risk graphs, risk matrices) while higher risks require more expensive quantitative techniques.

3.4. Risk evaluation

Once the risk has been analyzed the next step is to compare it with the previously established risk criteria and decide whether it can be accepted or not. If the risk is considered acceptable, it may be accepted with minimal treatment or with no further treatment beyond the current controls. These risks should be monitored and periodically reviewed to ensure they remain acceptable. If the level of the risk is higher than the accepted level, additional control measures and improvements are required to reduce risk as low as is reasonably possible.

The person responsible for managing the risk, known as the risk owner, will decide whether the risk should be accepted, avoided or treated. The risk decision weights the issues of risk and opportunity. An organisation cannot develop without capitalising on opportunities that will always have associated risks

3.5. Risk treatment

In the previous step, risks were assessed and decisions were made concerning the acceptability of risks. While in theory ceasing the activity that generates the risk may be considered as an option, it is rarely applied in practice. In case the risk cannot be accepted as it is or the existing controls are not efficient enough, the formulation of risk treatments will be required.

Risk treatment involves identifying the range of options for treating risks, evaluating these options and preparing and implementing treatment plans. The selection of the option will correspond with the significance of the risk and the cost-benefit analysis of treatment. The purpose of a risk treatment is to decrease the expected level of an unacceptable risk.

3.6. Monitoring and review

There are a few aspects of the risk management process that need to be systematically monitored and reviewed: the risks, the treatment strategies and general progress on the project.

Monitoring and review should be a planned part of the risk management process and involve regular checking or surveillance. Although they are similar processes, the differences between monitoring and review are important in the situation of risk management. While monitoring is a continuous surveillance of the internal and external environments, the review is a periodic analysis of the current status or situation, usually having a specific focus.

The information gathered during monitoring and review activities help an organization determine whether or not the risk management approach and process are achieving expected outcomes and provide warning about potential gaps, inefficiencies, and opportunities for improvement.

3.7. Communication and reporting

The communication and reporting of risk information to the appropriate levels of the organization is essential for the decision-making process. Risk information can be communicated not only internally, to employees across different operational areas of the organization, but also externally with clients and stakeholders concerned by the organization's actions and decisions.

Risk communication and reporting has the purpose to make stakeholders aware of the risk management process, practices and to clarify the outcomes and limitations of the risk assessment.

Risk information can also be used for other processes in order to avoid useless risk assessments on the same area for different purposes.

4. RISKS IN OIL AND GAS INDUSTRY

4.1. Importance of risk management in oil and gas industry

The large amounts of fuel consumed and the use of energy in nearly every industry makes gas and oil essential in our modern society.

Nowadays oil and gas companies are facing many kinds of risks whether operational, man-made or natural. If not properly planned, executed and controlled the activities in oil and gas industries could result in accidents involving death or physical injuries, financial catastrophes, delayed operations and other severe consequences. Therefore risk management is fast becoming an integral part of everyday business activities in this industry.

Risk management is imperative in this industry because:

- both upstream and downstream risks must be managed to ensure commercial viability of an oil and gas project
- the upstream sector is characterized as "high-risk" industry as a result of the sizeable investment level, geological uncertainties and risks associated with fiscal and political uncertainties with host producing countries,
- the downstream sector faces risk associated with uncertainty of the crude supply and the marketing of products.
- risk management can also be used for making marginal oil and gas fields (projects) more viable.

4.2. Top 10 risks

The following list presents the Top 10 risks identified in the oil and gas sector using Ernst & Young's radar:

- the risk of a health, safety or environmental incident, and in ensuring regulatory compliance ;
- price volatility; managing long-term investment with the potential for extreme price volatility;
- access to reserves or markets;
- cost escalation and inflation;
- uncertain energy policy;
- worsening fiscal terms;
- human capital deficit (e.g., skills shortages, aging workforce);
- competition from new technologies and new sources (e.g., alternative fuels);
- IT security;
- increasing project scale and complexity.

As we can see in the above risk ranking, health, safety and the environment remain a priority in oil and gas industry. At the same time new risks such as IT security are added to the list as companies realize they need to do more to protect against data theft and cyber-attacks. Managing the increasingly interconnected supply chains in the oil and gas industry, while dealing with the different and changing policies and regulations of the multiple governments involved is another important aspect. These risks and many others such as regulatory compliance, price volatility and the increasing challenge associated with accessing reserves and markets need to be taken into consideration for facing today's and tomorrow's challenges.

5. CONCLUSIONS

"Risk" is a frequently used term in the present society. Although not all the activities involving risks require risk management, for some of them it is considered a very important issue. It is the case of oil and gas industry where effective risk management all levels is essential.

The potential results of accidents in this industry such as explosion of Deepwater Horizon which killed 11 men working on the platform and injured 17 others, when oil spill flowed for three months, becoming the largest accidental marine oil spill in the history of the petroleum industry, are strong arguments in taking all possible measures in limitation of risks impact.

6. REFERENCES

[1] Baker, S.W., *Risk Management In Major Projects*, University of Edinburgh, 1997

[2] Berg, H.P., *Risk management: procedures, methods and experiences*, RT&A #2 (17) (Vol.1), June 2010, *http://gnedenko-forum.org*

[3] Bigliani, R., Feblowitz, J., *Minimizing Operational Risk in the Oil and Gas Industry*, White Paper sponsored by EMC, IDC Energy Insights, July 2011, *www.hydrocarbonprocessing.com*

[4] Damodaran, A., *Strategic risk taking- A framework for risk management*, Pearson Prentice Hall, 2007

[5] Kenzhetayeva, Z., *Project Management Methodology and Tools for Oil Field Development: from investor point of view*, Master Thesis, Faculdade de Engenharia da Universidade do Porto, 2013, *http://repositorio-aberto.up.pt*
[6] Sayers, P.B., Gouldby B.P., Simm J.D., Meadowcroft, I., Hall, J., *Risk, Performance and Unertainty in Flood and coastal defence – A Review*, R&D Technical Report FD 2302/TR1, London, 2002
[7] Smith, K., *Environmental Hazards: Assessing Risk and Reducing Disaster*, second edition, Routlege, London/USA/Canada, 1996
[8] Stenchion, P., *Development and disaster management*, The Australian Journal of Emergency Management, vol. 12, no. 3, Spring, 1997
[9] *** *A structured approach to Enterprise Risk Management (ERM) and the requirements of ISO 31000*, The Public Risk Management Association, AIRMIC, Alarm, IRM, 2010, *www.eisf.eu*
[10] *** *Business Pulse Exploring dual perspectives on the top 10 risks and opportunities in 2013 and beyond, Oil and gas report*, Ernst & Young, 2013, *www.ey.com*
[11] *** *How to Reduce Costs and Manage Risk in the Upstream Oil & Gas Industry with Enterprise Project Portfolio Management Solutions*, An Oracle White Paper February 2011, *www.worldoil.com*
[12] *** The Institute of Internal Auditors, *https://na.theiia.org*
[13] *** *WA Government Risk management guidelines*, second edition, RiskCover / a Division of Insurance commission of West Australia, August 2011, *www.riskcover.wa.gov.au*

MONITORING SEAFARERS' COGNITIVE PERFORMANCE UNDER STRESSOR FACTORS DURING A VOYAGE BY AUTOMATED NEUROPSYCHOLOGICAL ASSESSMENT METRICS

[1]UMUT TAC, [2]LEYLA TAVACIOGLU, [3]PELIN BOLAT, [4]OSMAN KAAN KORA, [5]FIRAT BOLAT

[1, 2, 3] Istanbul Technical University Maritime Faculty, Turkey
[4] Marmara University, Department of Psychiatry, Turkey
[5] Turkish Republic Ministry of Transport, Maritime Affairs and Communications Tuzla Port Authority, Turkey

ABSTRACT

Cognitive science is a multidisciplinary science area that identifies the mental processes by checkout the actions of mind and intelligence through understanding the dynamics of interactions between them. In this study, based on the definition of cognitive science, the effect of cognition of the seafarers during the operational processes are evaluated under certain stressor factors such as fatigue-sleepiness, noise and thermal strain. Research was conducted on the bridge and engine room during the voyage of a short route container vessel. Test results showed that, (a) the cognitive tests performance and the reaction response times decline through fatigue and sleepiness during the watchkeeping period (b) increasing temperature and noise causes to decline the reaction time and the cognitive performance.

Keywords: *Seafarer, cognitive performance, stressor factor*

1. INTRODUCTION

The acceleration of marine traffic due to the globalization forces the maritime regulatory agencies and policy making institutions to systemize maritime safety and security. These systemizings are generally based on the maritime accidents or incidents which had negative impacts on environment or/and which were resulted with loss of lifes such as accidents of Torrey Canyon, Exxon Valdez and Titanic. When the investigation reports of maritime accidents of recent years are analyzed, it is seen that defects in human factor for operational tasks during maritime transportation process has been rising as one of the main causes of marine accidents. Accordingly International Maritime Organization (2004) adopted a resolution about focusing on the human related activities and need of high standards during ship operational tasks. IMO also has taken a decision which implies that IMO would give priority to the subjects related with human factors in its work plan [52]. So here it is important to define what the human factor is from the perspective of safety issues.

The relation between safety and human factor is definitely relied on a known fact that states humans -as operational members of a system- can make errors (Wiegmann and Shappell, 1999; 2001). However, the important question is what the risk level of these errors. Answers for this question can be given by evaluating the criticality of the errors, which is a function of the variables in the performed operational task. These variables can be the conditions, task intensity and psychological/ physical state of the individuals that constitute "human factor" theme. Concepts of "Human Factor" can refer to the area of psychology that deals with ergonomics, workplace safety, human error, product design, human capability and human-computer interactions. On the other hand, from a managerial perspective, human factor concept has arisen as a multidisciplinary area that deals with the human capability and limitations during the period of information acquiring and processing. Consequently the aim of the researches on human factor is to produce safe, comfortable, and effective human performance within an operational tasks that include the equipment, systems, software, facilities, procedures, environments, training, staffing, and personnel management [33].

In this context, based on the definition of human factor, human factor-based error can root in the loss of information and capabilities during the information processing cycle of an operational task, which can refer to giving a response to environment after acquiring and transforming data to information. Thus, performing a given task or solving an operational problem is a function of capacity of information processing which can also be defined as cognitive ability [41]. Cognitive ability is associated with four main capacities [71];

- o Capacity of learning
- o Capacity of acquiring knowledge
- o Capacity of adaptation to unfamiliar conditions
- o Capacity of configuration of knowledge for future events

Apparently, environmental, psychological and physiological variations that occur during execution of these four main abilities will affect the cognitive process of the individual who is performing the task. From the perspective of maritime transportation process, the reasons for these variations that are experienced by seafarers are generally outcomes of the stress on them. Stress can be defined as the consequence of the stressor factors which can easily arise in during a sea voyage due to the reason that ships are complex and closed systems. Accordingly for maritime safety researches, human factors related safety issues turn into human based error subjects and human based error subjects can shift to cognition gaps in a stressful environment.

When the transportation literature is analyzed, it is seen that the studies for cognition-stress have been done for road and air transportation processes. For example, Hutckin and Klausen (1996) studied on the cognition in a cockpit by focusing on the activies between the captain pilots and airplane crew and they stated that the cognitive processes had been shared during information exchange, cooperation and coordination. Cassiabue et al. (2004) analysed the cognitive behaviors with COSIMO, a cognitive simulator, during an accident management operation of a system operator. Anstey et al. (2005) also found that there were important impacts of cognitive, sensitive and physical functions for developing the safest drive behavior for road transportation.

The studies for maritime transportation have been generally focused on only the stressor factors that form the basis of stress on individuals and in environment. Fatigue has commonly arisen as a main topic of human based errors studies in maritime transportation literature [4]. In most of these studies, it is obviously seen that fatigue has only been approached with its definition that can be called as the tip of iceberg. The mechanism of the fatigue on human error as a stressor factor has not been studied. There are also few studies that tried modeling the cognitive processes in maritime transportation. For example Embrey and et al. (2006) developed cognitive based work load model, CLIMATE, to evaluate the maritime accidents from the perspective of cognitive processes. Horizon Project (2012) is also one of key studies for cognition-safety in maritime transportation. This project has been conducted to analyse the cognitive processes of seafarers under fatigue in a simulator environment.

It should be emphasized that studies on seafarers have been generally experienced with the experiments that have done in simulator environment. Few studies have analyzed the cognitive performance of the seafarers in the real dynamic work space. It is a known fact that experimental stressors are the factors that are temporary, have low intensity and have generally no long term impacts on the individuals while real stressors are the factors that are intensive, have long term impacts and continual. Anxiety, fright, mental stress and alertness are thought of assumptions in simulator environment. Accordingly a connection problem arises between the simulator and real world for the experimental operational processes. For example Woods and Patterson (2001) observed that continual increase in the demand for cognitive processes could only be seen in the real world, not in the laboratory environments.

In the forementioned circumstances, the aim of this study to monitor the seafarers' cognitive performance under various stressor factors such as noise, thermal stress and fatigue. For this purpose, Automated Neuropsychological Assessment Metrics (ANAM) was applied to seafarers during a voyage under stressor factors. ANAM is a library of sensitive, scientifically-proven computer-based tests designed to detect speed and accuracy of attention, memory, and thinking ability. There are various studies done with ANAM4™ for complex situations [2].

In this context, this paper is consisted of five parts. After introduction, in the second part, theories and maritime transportation regulations that motivate us for this research are given. Thirdly methodology is explained. In the fourth part, results are introduced. Lastly a brief conclusion is presented.

2. MOTIVATION

2.1 Regulations on Stressor Factors in Marine Transportation

Each ship personnel should complete a series of required training in order to work on board. With regard to the STCW 95 Convention of IMO and to the ship crew agreement the conditions are determined, regarding on which ships, the crew could be positioned and how they could increase their qualification, and which trainings they should have been completed. In addition, the certificates required for various ship types and duties are determined along with the trainings for obtaining these certificates. With respect to the instructions compatible with the international agreements (IMO and ILO agreements), the EU and the member states determine the conditions about the training and employment of ship crew and enact these conditions in their national legislation system. Each ship has a Minimum Safe Manning certificate about the manning of ships with the crew. The number and quality of ship crew are determined in these certificates [75]. Some duties on board require 24 hours continuity. Therefore, shift working is administered for duties that require this kind of continuity.

Chapter VIII of the STCW explains the shift working standards. When the convention is examined with regard to work and rest hours; it is seen in Section AVIII Article 1 that the management is asked to consider the fatigue of the shipman could pose danger for ship security and safe operation. Again, according to AVIII Article 1, the shifter officer or crew should be provided a 10 hours rest for a 24 hours period, and 77 hours of rest for a 7 days period. The daily rest period may be divided into two parts, but one of them should be at least 6 hours and the period between resting hours should not exceed 14 hours. This regulation could be violated in cases of emergency. However, the muster, fire fighting and lifeboat drills required by international and national regulations and orders should not disrupt rest hours and should not trigger fatigue [86].

According to the Seafarers' Hours of Work and the Manning of Ships Convention 1996, established in the 84th conference by International Labour Organization, ILO in Genoa on 8 October 1996, the term 'work hours' states the period a shipman is required to work for the ship. The term 'rest hours' state the period excluding the work hours; however, this term does not cover the short breaks.

According to the provisions of Section II, Article 5 Paragraph 1 of this convention, work and rest hours should be as below:

(a) Maximum work hours;
  i. should not exceed 14 hours in a 24 hours period,
  ii. should not exceed 72 hours in a 7 days period.

(b) Minimum rest hours;
  i. should not be less than 10 hours in a 24 hours period,
  ii. should not be less than 72 hours in a 7 days period.

According to Article 2 Paragraph 5, rest hours can be divided into two, maximum, and one of these should not be less than 6 hours. The interval between successive periods should not exceed 14 hours [12].

According to ILO C180 Article 7, the shipmaster may put seafarers to work to ensure the immediate safety of the people on board, the ship and the cargo or to help to other ships or people at risk. However, the shipmaster should be certain that the seafarers get adequate rest period after the emergency [12].

In national legislation, according to Chapter 5 Section 1 Article 1 of the Seafarer Regulation on taking shifts, maritime liners conduct the regulations about shift taking on board, in a way that they would not decrease the performance of seafarers due to fatigue and in line with the following principles below,

Seafarers who take shifts on board;

i. rest at least 10 hours a day.

ii. Their rest period could be divided into two, maximum. In this condition, one of the rest periods could not be less than 6 hours.

iii. The 10 hours per day rest period may be restricted to a time, not less than 6 hours, in cases of emergency and relay drills. However, the shortened rest hours could not be repeated more than twice in consecutive days, and the rest period could not be less than 70 hours per week (Seafarer Regulation, 2002).

As required by Labour Law no 1475, and Article 22 of the Occupational Health and Safety bylaw, noise levels should not exceed 80 dB in places where heavy and dangerous duties are performed, in order not to cause industrial accidents and not to cause the employers to lose their hearing. The noise level can be 95 dB maximum in places which require noisy labour conditions such as ships. Article 20 of the same bylaw, the temperature levels in the indoor workplaces should be between 15°C and 30°C.

2.2 Cognitive Dimension of Stressor Factors in Maritime Transportation

2.2.1 Fatigue

When the effects of fatigue and restlessness on cognitive processes are investigated, it is seen, from the studies on fatigue and performance, that fatigue is inclined to reduce performance. However, it is unclear if these effects originate from stress or directly from fatigue. This study accepts fatigue as a stressor factor, considering the literature on stress and performance.

Before interpreting the studies on the effects of fatigue, it is appropriate to focus on the concept of fatigue. Most probably, the simplest definition was made by NASA (1996) in a way that fatigue covers the feelings of weariness, sleepiness and exhaustion. Job and Dalziel (2001) defined fatigue as inadequacy of cellular capacity and systemic energy in maintaining the normal levels of activity and/or processes using normal resources, in cases where the muscles, internal organs or the central nervous system of an organism lack adequate levels of rest for an activity and/or mental process.

Gawron et al. (2001) developed a general perspective for fatigue studies and proposed two types of definition for fatigue. The first type of fatigue is the physical fatigue; it is environmental in nature and is the decrease in capacity of performing physical labor using physical effort. The second type is mental fatigue defined as the decrease in the performance in, manipulation of and access to the data stored in the memory, in tasks that require awareness. Hancock and Desmond (2001), too, defined two types of fatigue; however, they categorized fatigue as active fatigue and passive fatigue and related passive fatigue with attention. Active fatigue, on the other hand, results from the continuous prolonged interactions with the system.

Matthews and Desmond (2002) observed that fatigue is generally related to concepts based on energy (effort, power, activation, etc.) [84]. Matthews and Desmond pointed out to two hypotheses. In the first hypothesis, fatigue is accepted as the direct consumption of power or indirect redirection of power towards coping strategies. Thus, labor capacity decreases with regard to the decrease in power. With reference to this view, tasks that are more complex are also more sensitive to the effects of fatigue; because these kinds of tasks require more power. However, the second hypothesis argues that fatigue should be related to the effort expended. Some resources define fatigue as a condition of under stimulation, the inability to actively deploy the power or to provide the effort required for obtaining and maintaining a powerful performance. This second condition reflects inadequacy in activation rather than inadequacy of power. Consequently, the combination of these two hypotheses is used as the best expression in defining the effects of fatigue [84].

The controversy and disagreement in defining fatigue caused difficulties in measuring fatigue. In many examples, fatigue is expressed as present or not present; however, it should be considered as a continuous variable. Haslam and Abraham (1987) studied fatigue using continuous tasks which last 90 hours. According to the findings of Haslam and Abraham, while the psychological status and mental skills detoriate, physical form is relatively noneffective. Mental indicators show that attention and complex cognitive performance is more sensitive in simple and learned tasks. Job and Dalziel (2001) argued that this issue aggravates assessing fatigue and developing measures. These findings are compatible with the view that well learned and procedurized tasks are more resilient to the effects of stress.

Buck-Gengler and Healy (2001) investigated a data entry (writing) task and found that response time decreased with the increase in mastery in the task, and correct writing decreased as the fatigue stepped in. Matthews et al. conducted an exhaustive study on driving time and fatigue [70]. Behavior tests for drivers under fatigue induced stress revealed deficiencies such as lane changes and maintaining lateral positioning [8; 9]. Matthews and Desmond (2002) designed an experiment under simulated driving conditions to evaluate the objective and performance based measures for fatigue. During driving, drivers were subjected to high workload pedestrian detecting tasks to induce fatigue. This procedure was continued for 24 minutes by reducing two-way requests (The subjects continued to drive but pedestrian detecting task was stopped). Lateral detection and steering wheel changes were included in the objective measures of performance. Subjective measures were evaluated using the task-induced fatigue scale, Dundee Questionnaire (emotion and motivation) and NASA-TLX (workload) [84].

The results of this study showed that the motivation required for achieving the task decreased with the continuation of the fatigue induced conditions. Following fatigue, direction errors increased, steering wheel control and perceptional sensitivity decreased.

2.2.2 Thermal Stress (Hot and Cold)

Under thermal stress, losses are experienced in many cognitive processes and it is seen that these losses are directly related to the intensity of the stressors. Losses in cognitive functions occur more in cold environments than in hot environments. Literature reviews on this topic evaluated the psychomotor and perceptual motor tasks, but could not evaluate complex cognitive processes. In this respect, the path followed by the losses is tried to be connected with psychomotor skills. However, mixed results were obtained in studies conducted for high order cognitive tasks.

When considered biologically or neurologically, thermal stress causes a detoriation in the thermal order of the individual. On the other hand, thermal difficulty induced distress causes interruption in the information processing required by the task. Focusing on the personal conditions and distraction from the task to be completed can be given as an example to this situation. In studies on thermal stressors, evaluations on how the stressors affect performance were conducted on various cognitive processes. First studies were conducted on attention requiring processes, and tasks which psychomotor and perceptual motor skills [56; 91]. Grether (1973) accepted attention behaviors and response time as basis, and found that temperature did not influence performance up to some certain point and decreased performance after that point. Giebstrect et al. (1993) revealed that there was not any performance loss in low order cognitive processes under cold environment conditions; and there were some difficulties in processes which required high order cognitive processes. Ellis et al. (1985) showed that exposure to cold weather caused errors in selection-reaction time tasks. Driskel et al. (1992) found that hot environments did not influence performance speed, but decreased performance accuracy; and cold environments decreased performance speed and accuracy at the same time. Pilcher et al. (2002) conducted mathematical analyses on how exposure to high and low temperatures influenced performance and found that high and low temperatures negatively affected the performances related to the tasks. Seppänen et al. (2006) found a correlation between temperature and performance. In their studies they revealed that a 2% decrease in performance occurred at each 1 degree increase in the temperature between 25 and 32°C, and there was not any change in performance between 21 and 25 °C. Seppänen investigated the effect of temperature in the workplace on performance and found that the performance was at its maximum level at 22°C. They also found that 91.1% of the maximum performance was obtained at 30°C. Myers et al. (2009) studied on the effect of cold on post-transit run performance of marine high-speed craft passengers and they stated that a three-hour exposure to a cold environment came out with a large post-transit degradation in physical performance about 40%.

2.2.3 Noise

With the industrial development, noise has become a factor that threatens the psychological and physiological health of individuals. Along with the negative effects of noise on hearing, there are some physiological problems such as muscle tension, narrowing of blood vessels, decrease in heart volume, dilation in pupils; and neurological problems such as fear, anxiety, slowing in mental skills, restlessness [63].

As required by Labour Law no 1475, and Article 22 of the Occupational Health and Safety bylaw, noise levels should not exceed 80 dB in places where heavy and dangerous duties are performed, in order not to cause industrial accidents and not to cause the employers to lose their hearing. The noise level can be 95 dB maximum in places that require noisy labour conditions such as ships. At such conditions, individuals should use protective gear such as earplugs or noise cancelling headsets. In the measurements conducted during our research, the average noise level in the engine room was found 108 dB.

Table 1: Some Peak Levels of Industrial Noise in dB(A) (Koçak, G., 2008)

Noise Source	**Noise Level, dB(A)**
Gunshot, motor test mechanism	130
Pneumatic hammer	120
Electric chainsaw, pneumatic riveting machine, electric cutter	115-120
Milling machine, boiler room, weaving loom, punching machine	105-115
Electric engine	100-105
Jet engine	120

The limits for noise level and working hours defined by OSHA (Occupational Safety and Health Organization) are as below:

Table 2: Working hours limits for various noise levels (Koçak, G., 2008)

Intensity of Noise	**Time (hours)**
90	8
92	6
95	4
97	3
100	2
102	1.5
105	1
110	0.5

Generally, exposure to sound causes decrease in performance. Despite the results are variant; it is found in most studies that discontinuous noise is more destructive than continuous noise. However, it is quite difficult to obtain precise results on which decibel level reduces performance, because the findings of the studies in this area show a great variance. As the structure of the task changes, the effects change too. For instance, psychomotor tasks are influenced from noise less than cognitive tasks. Naturally, it is possible for these findings are related to flexibility (resilience) or covert knowledge and skills.

Studies on the effects of noise generally investigate the relationship of noise with performance and they were conducted in many areas including tasks based on awareness and attention [84]. For example, Errett et al. (2006) studied on the noise of HVAC systems in the office environment to understand the effects of noise on the productivity and annoyance. They stated that prolonged effects of noise were seen on the productivity and annoyance of the workers. Ljunberg (2007) also investigated the effects of high level noise and vibration on cognitive tasks. The study found that high stress levels were achieved when there was only noise or there were noise and vibration together. Although noise caused a highly stressed environment, in this study it was argued that noise did not have any direct effect on performance.

The noise in the engine room may negatively influence the performances of the seafarers especially in the process of perceiving information and processing it. More specifically, activities such as communicating by talking and identifying signals may be obstructed by the suppression feature of noise. This situation not only influences the activities of perceiving and applying information negatively, but also it influences the way the task is carried out.

3. METHODOLOGY

This study focuses on the factors that influence the cognitive processes and the results of the change in cognition in maritime transportation using the Cognitive Information Processing Theory, Transactional Stress Theory by Lazarus and Cognitive Continuum Theory by Hammond. In our study, the processors that could influence cognition during maritime transportation were hypothesized and the methods of measurement were planned according to these three theories. Before taking the measurement, ethical permissions were taken from Marmara University Etic Commission. The measurements were conducted on a 1022 TEU container ship which sailed clouse-course (İstanbul – Gebze – Gemlik – İzmir – Mersin – Kıbrıs) and which harboured frequently. The execution of all test lasted 7 days, from İstanbul to Mersin.

3.1 Theories

3.1.1 Information Processing Theory

Information Processing Theory (IPT) gives us an opportunity to measure the cognitive processes with our perceptions. It focuses on two main parts, which are shown in Figure 1.

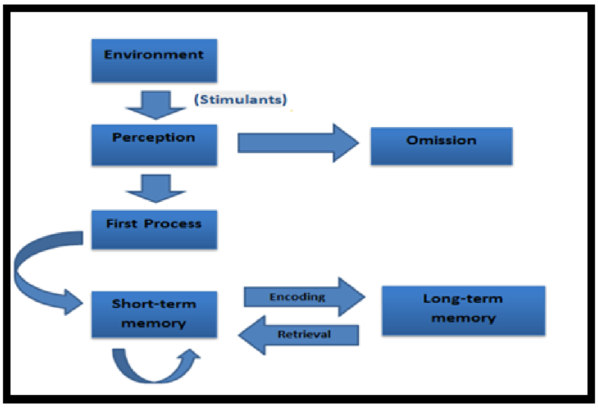


Figure 1: Information Processing Theory (Tac, U., 2012)

The first part is formed by three structures. These are [32 ; 26] :

- Sensory memory gets information related with the senses just long enough for the information to be processed further (mere seconds).
- Short term memory acts as a temporary working memory that gets information for a limited time and holds a limited amount of information.
- Long term memory is the permanent store center of information, capable of retaining an unlimited amount and variety of information.

Second part includes the cognitive processes which are used as a way of transporting the knowledge from sensory memory to short term memory, from short term memory to long term memory. These cognitive processes are [26]:

- attention;
- rehearsal;
- chunking;

- encoding; and
- retrieval.

In this study, based on IPT theory, ANAM is used to measure these cognitive processes of seafarers. The results of the ANAM can give possibility of evaluation of seafarers' cognitive performance during a voyage.

3.1.2 Transactional Stress Theory

Transactional Stress Theory (TST) states that stress is a result of a transaction between a person and his or her environment [66]. It also emphasized that stress contains cognitive, affective and coping factors. According to TST, three appraisals can cause a transaction that is resulted with stress. These appraisals are [66;68]

- Primary Appraisal is a judgment about what the person perceives a situation holds in store for him or her. The individual may determine that the situation represents (a) a potential for harm or loss (threat) or that (b) actual harm has already occurred (harm) or (c) the situation has potential for some type of gain or benefit (challenge).
- Secondary Appraisal is the process of determining what coping options or behaviors are available to deal with a threat and how effective they might be.
- Reappraisal Appraisal is the process of continually evaluating, changing, or relabeling earlier primary or secondary appraisals as the situation evolves.

3.1.3 Continuum Cognitive Theory

In Continuum Cognitive Theory (CCT), stress is resulted due to the breakdowns in continuity, harmony or balance of cognition and environment [44]. Hammond (2000) pointed that all the living beings tend to establish a stable relationship with their surroundings. According to CCT, corruption of this stable relationship results with stress. In this context, CCT defines the area between stress and cognition. This area is constructed over three main proposals (Hammond, 2000) which have arisen as a base for this study. These proposals are:

i. Environmental events and cognitive events have equal role on the determination of the behaviors
ii. Stressor factors should always analyzed with cognitive activities
iii. Breakdowns in balance and harmony of individual with its surroundings defines the current cognitive state of the individual

3.2 Hypothesis

The hypothesis developed for the study is presented below and illustrated in the Figure 2.

i. Antecedents
   - Fatigue and restlessness influence cognition in maritime transportation negatively.
   - Noise influences cognition in maritime tr ansportation negatively.
   - Thermal environment other than normal conditions (27°C) maritime transportation negatively.

ii. Consequent

In maritime transportation, cognition under stressor factors (fatigue-restlessness, high or low temperatures, noise) influences the cognitive performance negatively.

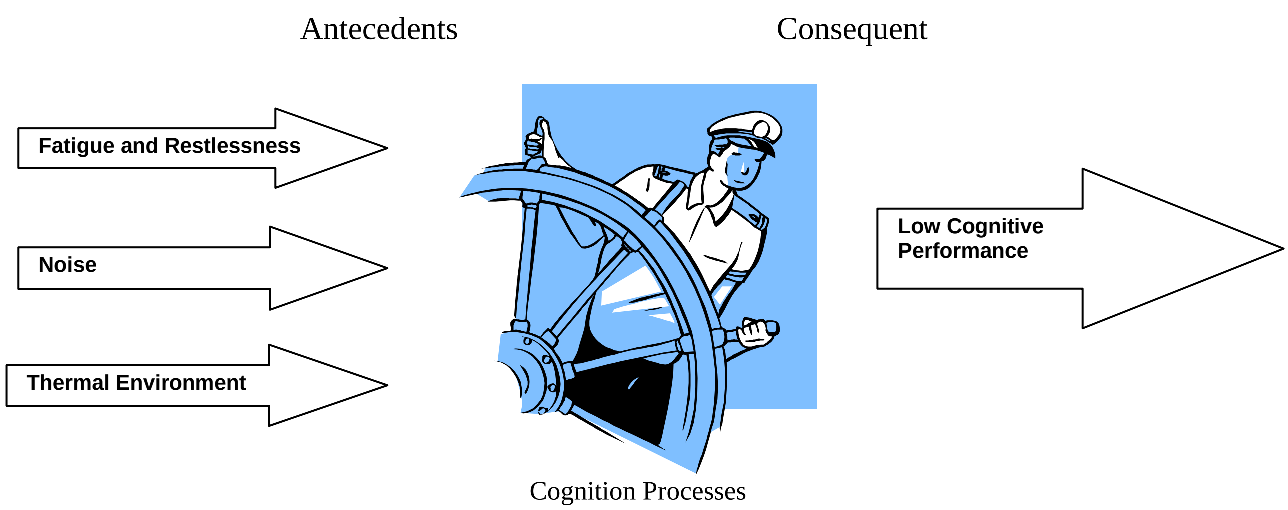


Figure 2: Hypothesis of the study

3.3 Data Collection: Automated Neuropsychological Assessment Metrics (ANAM4™)

The measurements were conducted at the navigating bridge and in the engine room of a ship. Data were collected from seafarers in these areas under stressor factors and without stressor factors, using scientific methods (computer based cognitive tests). These data which would encompass various real-time situations during navigation enabled the researchers to analyze the effects of cognition on operational processes. In order to investigate the effects of fatigue on cognitive performance, measurements were taken at the beginning, in the middle and at the end of the shifts of deck officers and their trainees. The investigation of effects of noise and temperature on cognitive performance, on the other hand, was conducted on marine mechanical engineers and their trainees, during operational processes around the main engine and in the engine control room.

The physical and mental statuses of the seafarers were tracked during navigation. The levels that these physical and mental statuses turn into stress factors were evaluated and a threshold values were defined. Cognitive tests appropriate for the operational processes on the ship were selected for applying the threshold values on seafarers, with reference to the cognitive studies on military personnel by Wayne C. Harris (2003)

The equipments used in data collection were Automated Neuropsychological Assessment Metrics (ANAM4™), Noise Measurement Device, Thermometer.

In order to evaluate the cognitive performances of the individual, the last version of the Automated Neuropsychological Assessment Metrics, ANAM4™, used by the USA Defense Department in 1970 for the first time. ANAM4™ is a test library used to conduct computer based evaluations for cognitive processes such as attention, reaction speed, memory, mathematical skills, executive functions and decision making. ANAM4™ applications are widely used in the literature, especially in military and clinical applications.

ANAM4™ enables the researchers to collect data for evaluating the cognitive status changes and the cognitive performance of an individual in a given time frame. ANAM4™ comprises of 22 performance assessment tests, which are very sensitive with regard to cognition. Researchers build a battery of tests, from the 22 different tests, considering the cognitive status they want evaluate, and the environmental conditions.

ANAM4™ test library investigates the cognitive changes using the parameters below:

- Attention
- Concentration
- Reaction Time
- Memory
- Processing Speed
- Decision Making
- Executive Function
- Mathematical Ability

Along with the 22 cognitive tests, ANAM4™ includes forms such as the symptom assessment test and the emotional status assessment form. These forms are used, before the cognitive tests, to assess the instantaneous emotional statuses and the obstacles that would influence cognitive performance.

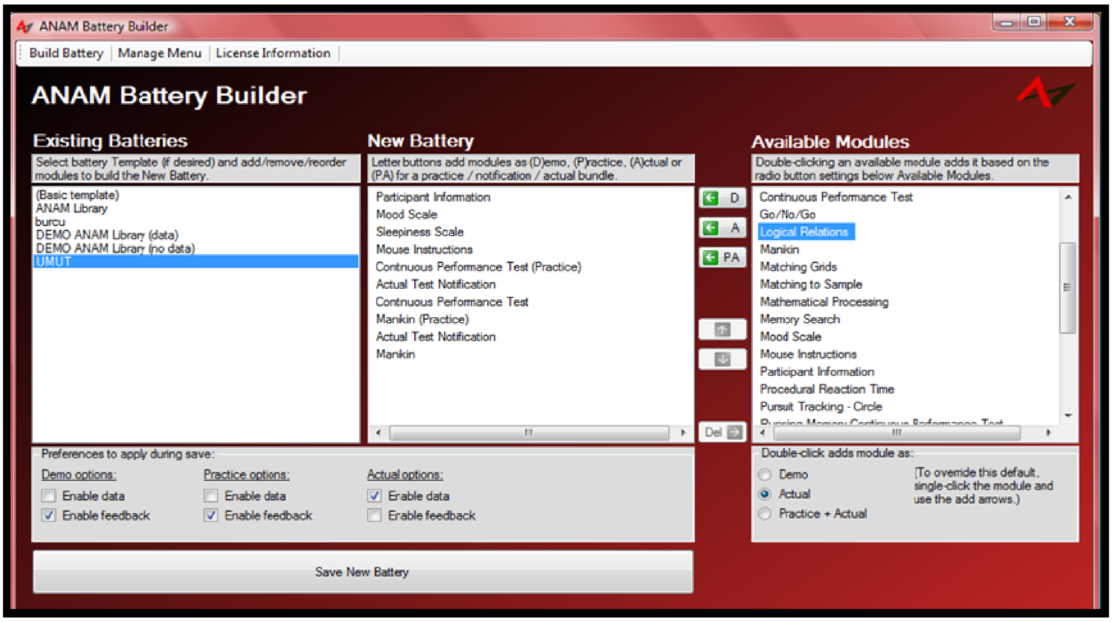
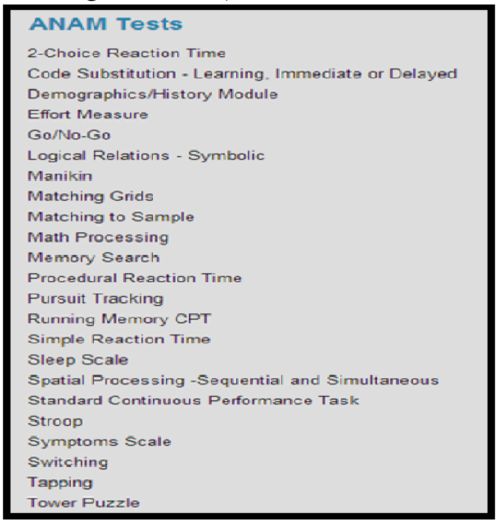


Figure 3: Battery building (ANAM4™ User Guide, 2012)

The 22 different cognitive tests which are used to build a battery in ANAM4™ are presented in Table 3.

Table 3: cognitive tests (ANAM4™ User Guide,2012)



ANAM Tests

2-Choice Reaction Time
Code Substitution - Learning, Immediate or Delayed
Demographics/History Module
Effort Measure
Go/No-Go
Logical Relations - Symbolic
Manikin
Matching Grids
Matching to Sample
Math Processing
Memory Search
Procedural Reaction Time
Pursuit Tracking
Running Memory CPT
Simple Reaction Time
Sleep Scale
Spatial Processing -Sequential and Simultaneous
Standard Continuous Performance Task
Stroop
Symptoms Scale
Switching
Tapping
Tower Puzzle

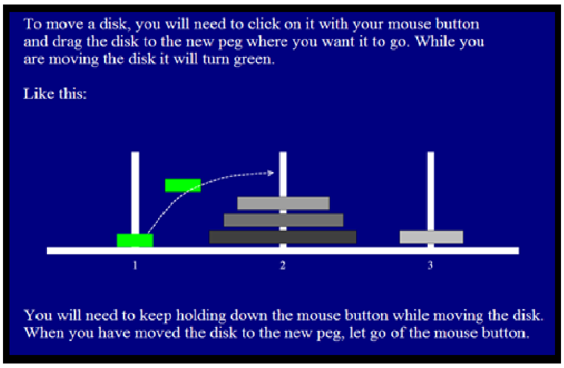


Figure 4: 'Tower puzzle' test (ANAM4™ User Guide,2012)

In our study, ANAM4™ test battery comprising of 5 different tests were built to be conducted on seafarers, considering the requirements of the operational processes and the situations encountered in sea environment. The tests selected for the battery are as below.

- Simple Reaction Time
- Mathematical Processing
- Matching Grids
- Logical Relations
- Running Memory- Continuous Performance Task

3.3.1 'Simple reaction time' Test

'Simple reaction time' test results are used to evaluate attention (reaction time and awareness) and visiomotor (visual and motor) response time.

The test presents the user a series of (*) symbols on a screen, and aims at measuring the reaction time. The user completes the test by giving the most rapid reaction possible when the stimulus appears on the screen.

Figure 5: 'Simple reaction time' test

3.3.2 'Mathematical processing' Test

This test results are used to evaluate the basic computer skills, concentration and running memory of the individuals.

During the test, equations comprising of 3 one-digit numbers and two operations (such as 5-2+3) appear on the screen. The used completes the test by deciding, in the shortest time possible, whether the result of the equation is greater than 5 or not.

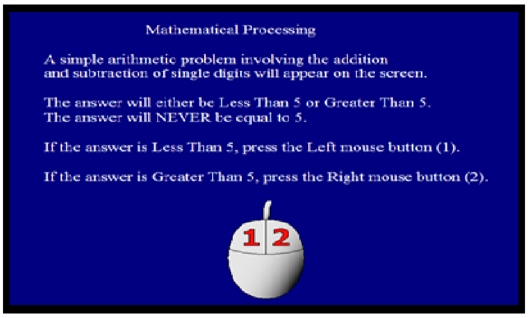


Figure 6 : 'Mathematical processing' test

3.3.3 'Matching grids' Test

'Matching grids' test results are used to evaluate the visio-spatial (visual and spatial) thinking skills of the individuals.

This test aims at taking responses from the user on the condition that the two figures, comprising of small squares on a grid, appearing on the screens are exactly the same, when one of the figures is rotated 90 degrees. The grids to be compared are presented in the screen side by side and at equal sizes. The user completes the test by responding whether the grids are the same or not.

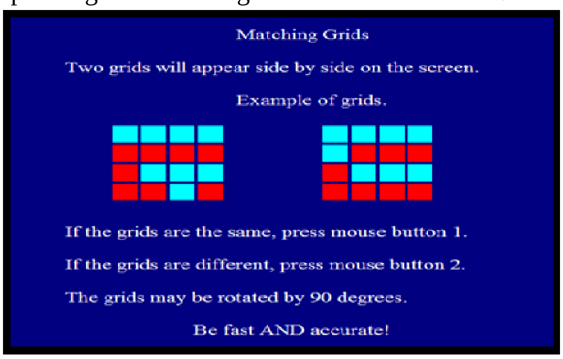


Figure 7: 'Matching grids' test.

3.3.4 'Logical relation' test

The results of this test are used to evaluate the perception and reasoning of the individuals.

During the test, expressions (such as "& comes after #") appear on the screen. Differently from other tests, in this test, the software itself answers the question. The user gives responses, in the possible time shortest and as soon as the response of the software appears on the screen, whether the software has given the right answer or not.

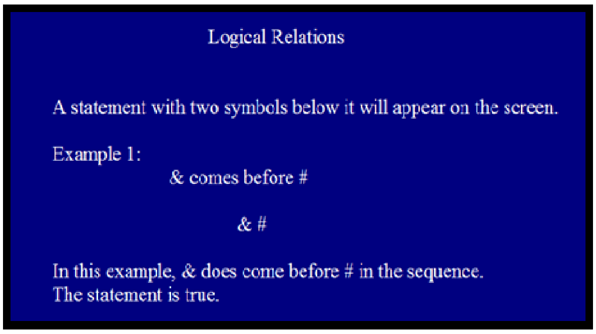


Figure 8: 'Logical relations' test.

3.3.5 'Running memory- continuous performance task' test

The results of this test are used to evaluate attention, concentration and memory skills of the individuals.

During 'Running Memory- Continuous Performance Task' test numbers appear on the screen one after another. The user completes the test by responding, in the shortest time possible, whether the previous number is the same as the one on the screen.

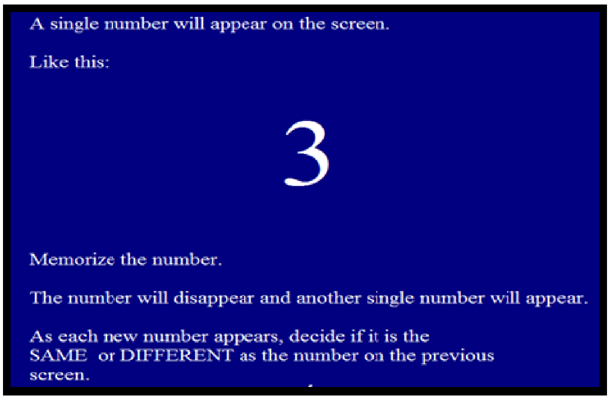


Figure 9: 'Running memory- continuous performance task' test.

4 RESULTS

4.1 Effects of Fatigue and Restlessness on Cognitive Processes and Performance

In order to evaluate the effects of fatigue and restlessness on cognitive performance and operational processes, a ANAM4™ battery comprising of 5 different tests was built, considering the operational processes encountered in navigation shifts and making use of the cognitive study conducted by Wayne C. Harris (2003) on military personnel. The battery was applied to 6 seafarers; the shipmaster, three deck officers and two deck trainees. The battery comprising of 5 different tests was applied to the volunteers at the beginning, in the middle and at the end of their 4 hours shift; their reaction times and test performances were analysed comparatively.

4.1.1 'Simple Reaction Time' Test Results

The results of the 'Simple reaction time' test, which was administered to evaluate the attention (reaction time and awareness) and visiomotor (visual and motor) response time of the seafarers, are presented below.

Table 4: 'Simple reaction time' test results

	Average Correct Response Time (msec)	Number of Correct Responses / 40
1st measurement	26257	38
2nd measurement	25761	38
3rd measurement	33203	35

When the correct response time and the number of correct responses are evaluated according to the results of the test, a statistically significant difference could not be found between the beginning of the shift and the middle of the shift. The measurements at the end of the shift revealed that the reaction times and test performances of the seafarers significantly detoriated compared to the first two measurements. Thus, the possibility of human induced errors to occur would increase in operational tasks which require the attention and rapid decisions of the officers, towards the end of the shift.

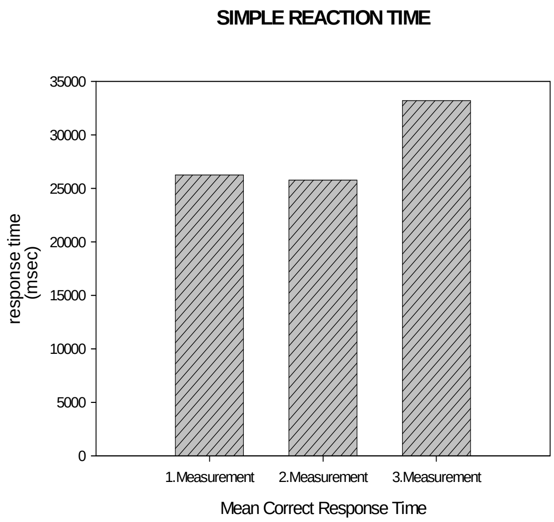


Figure 10: Average Correct Response Time (SRT)

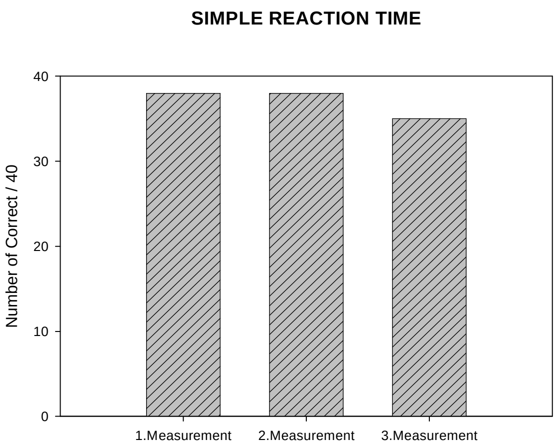


Figure 11: Average Number of Correct Response (SRT)

4.1.2 'Mathematical Processing' Test Results

The results of the 'Mathematical processing' test, which was conducted to evaluate the computer skills, concentration and running memory of the seafarers, are presented below:

Table 5: 'Mathematical processing' test results

	Average Correct Response Time (msec)	Number of Correct Responses / 20
1st measurement	135896	19
2nd measurement	140332	20
3rd measurement	174916	17

Among all the tests that were conducted to evaluate the effect of fatigue and restlessness on cognitive function, the 'Mathematical processing' test was the test in which the cognitive performance at the end of the shift presented the most significant decrease compared to the beginning of the shift. In this respect, fatigue and restlessness would cause a negative effect on the activities of using electronic navigation equipment, concentration and memory performances of seafarers, as such that it would pose a risk in operational processes.

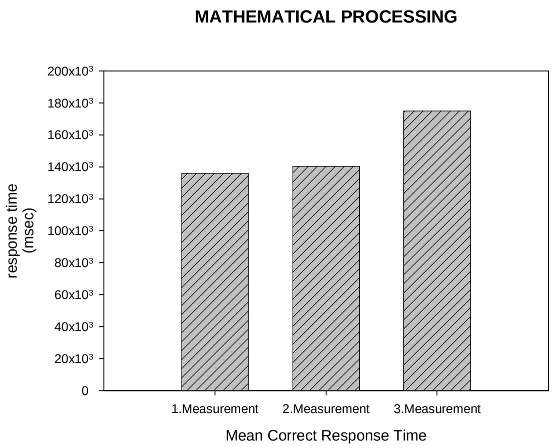


Figure 12: Average Correct Response Time (MP)

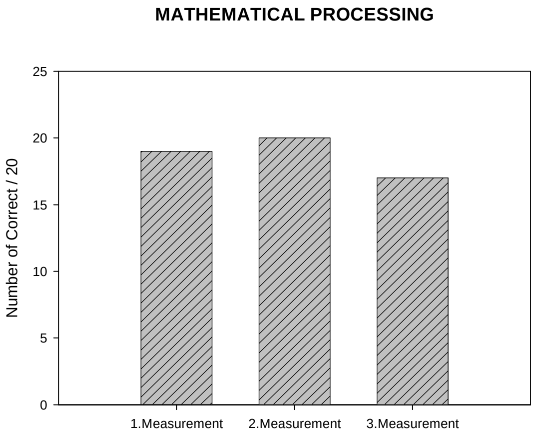


Figure 13: Average Number of Correct Response (MP)

4.1.3 'Matching Grids' Test Results

The results of the 'Matching Grids' test, which was conducted to evaluate the visiospatial skills of seafarer, are presented below. The results revealed a statistically significant slowing in the reaction times and a significant decrease in the test performances of the seafarer in the third measurement compared to the first and the second measurements.

Table 6**:** 'Matching grids' test results

	Average Correct Response Time (msec)	Number of Correct Responses / 20
1st measurement	147865	19
2nd measurement	151332	19
3rd measurement	166225	18

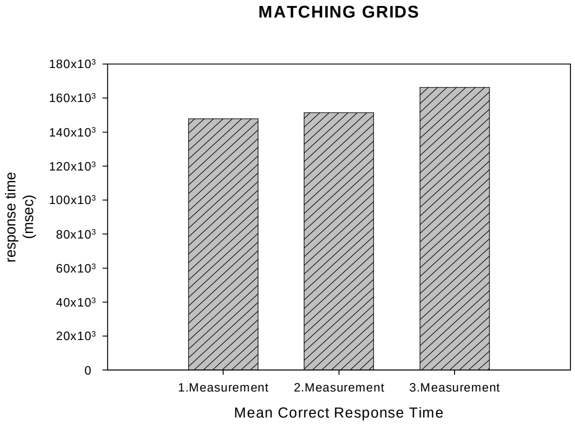


Figure 14: Average Correct Response Time (MG)

As it can be seen in Figure 14, ‘Matching grids’ test was the most influenced one among all test conducted to evaluate the effects of fatigue and restlessness on cognitive performance, with regard to reaction time and test performance. In this respect, the visiospatial thinking of seafarers was found to be the most rapidly decreasing cognitive function due to fatigue.

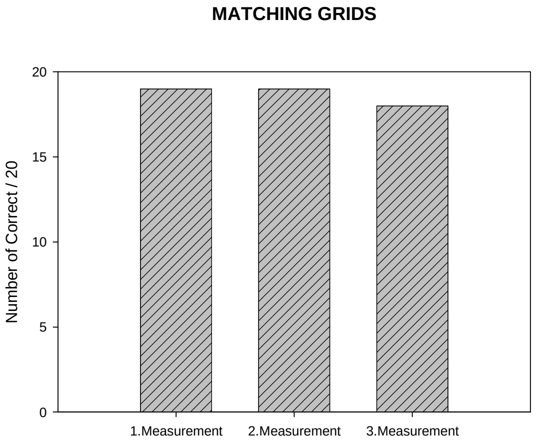


Figure 15: Average Number of Correct Response (MG)

4.1.4 ‘Logical Relations’ Test Results

The results of the ‘Logical relations’ test, which was conducted to evaluate the perception and reasoning skills of seafarers, are presented below.

Table 7: ‘Logical relations’ test results

	Average Correct Response Time (msec)	Number of Correct Responses / 24
1st measurement	230338	20
2nd measurement	205275	18
3rd measurement	206183	18

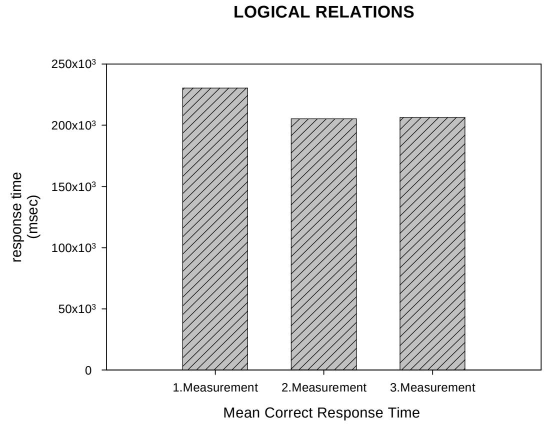


Figure 16: Average Correct Response Time (LR)

As it is seen in Figure 16, the least performance changes during shift are seen in perception and reasoning skills. According to the test results, less decrease was found in both reaction times and test performances, when compared to other test results.

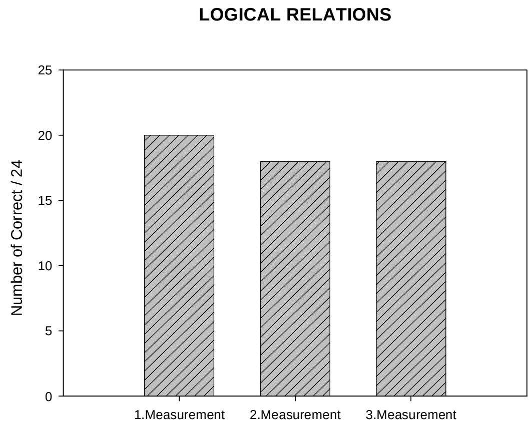


Figure 17: Average Number of Correct Response (LR)

4.1.5 ‘Running memory- Continuous Performance Task’ Test Results

The results of the ‘Running memory- continuous performance task’, which was conducted to evaluate the attention, concentration and memory skills of seafarers, are presented below.

Table 8: ‘Running memory- continuous performance task’ test results

	Average Correct Response Time (msec)	Number of Correct Responses / 80
1st measurement	51480	71
2nd measurement	53126	69
3rd measurement	57691	62

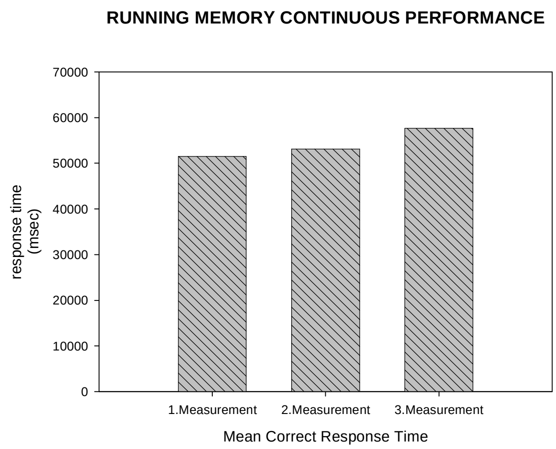


Figure 18: Average Correct Response Time (RM)

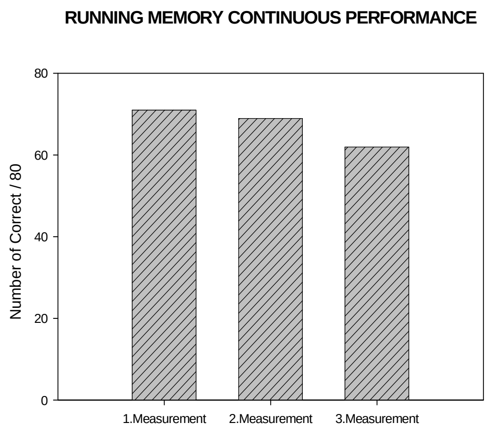


Figure 19: Average Correct Response Time (RM)

4.1.6 Comparative Analysis of the Tests

The comparative analysis of the 5 different ANAM4™ tests which were used to evaluate the effects of fatigue and restlessness on cognitive performance and operational processes, are presented below.

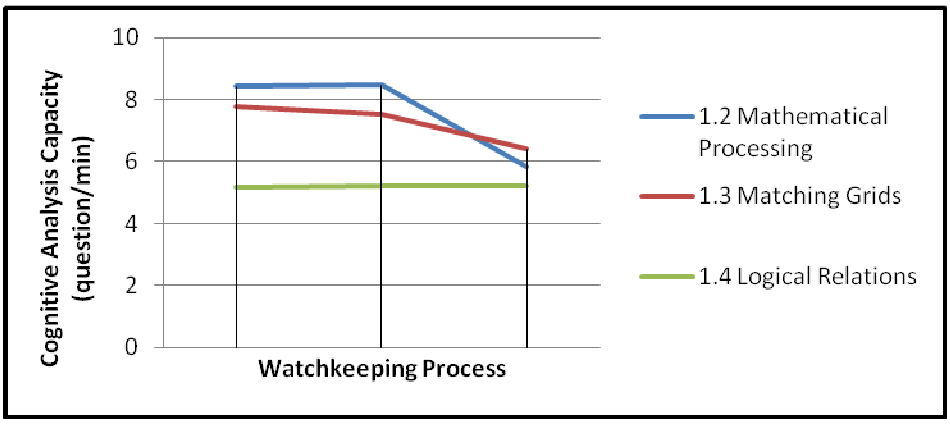


Figure 20: Cognitive Analysis Capacity (MP-MG-LR)

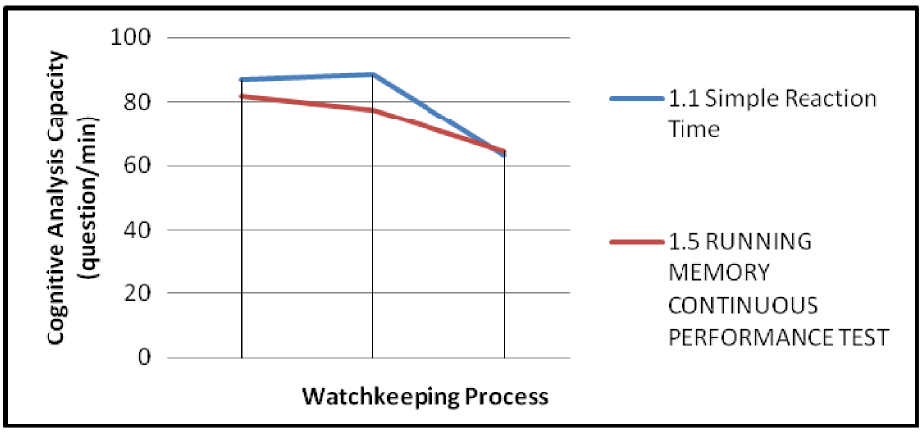


Figure 21: Cognitive Analysis Capacity (SRT-RM)

According to the results of the test, which were conducted to evaluate the effects of fatigue on cognitive performance, the highest influence on cognitive performances of the seafarers is observed in running memory, basic computer skills and attention; the least influenced parameter, on the other hand, is visiospatial thinking.

4.2 Monitoring the Thermal Stress on Cognitive Performance during a Voyage

In order to evaluate the effects of thermal stress on cognitive performance and operational processes, ANAM4™ battery comprising of three different tests was built. The battery was applied to six seafarers, a chief engineer, three engineer officers and two engine cadets, under two different thermal conditions, 40 C° and 27 C° (normal conditions). The reaction times and test performances were analysed comparatively.

4.2.1 Mathematical Processing Test Results

The results of mathematical processing help us to evaluate the concentration capability and working memory of the seafarers. Reaction times and the number of correct answers are given in Table 9, Figure 21 and Figure 23.

Table 9: ‘Mathematical processing’ test results

	Mean Correct Response Time (msec)	**Number of Correct / 20**
1st Measurement (27°C)	145364	18
2nd Measurement (40°C)	151261	18

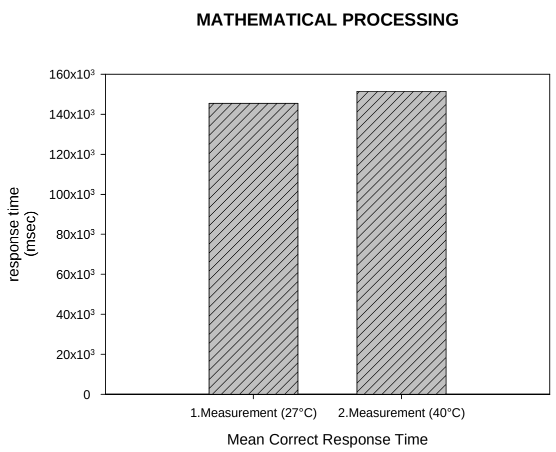


Figure 22: Average Correct Response Time (MP)

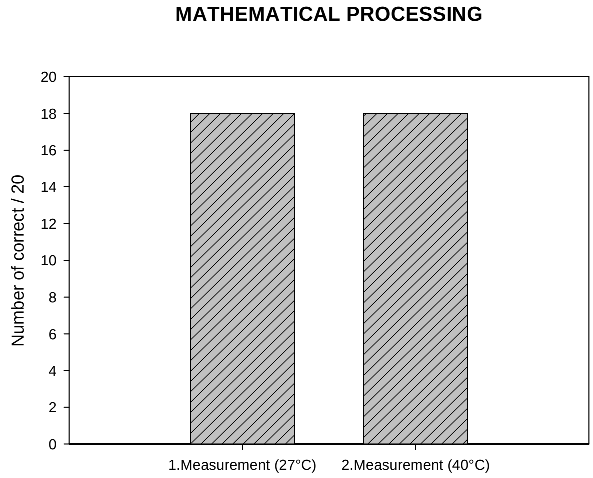


Figure 23: Average Number of Correct Response (MP)

Based on the results, it ıs monitored that thermal stress has no significant effect on the concentration and work memory capabilities of the seafarers.

4.2.2 ‘Running memory- Continuous Performance task’ Test Results

Running memory test is used for evaluating the cognitive processesof attention and memory of the seafarers. The values of reaction time and correct answers to the running memory tests for different temperature levels are given in Table 10, Figure 24 and Figure 25.

According to the test results, it is seen that cognitive processes has decreased under the thermal stressor factors.

Table 10: ‘Running memory- continuous performance task’ test results

	Mean Correct Response Time (msec)	Number of Correct / 80
1st Measurement (27°C)	54692	73
2nd Measurement (40°C)	54124	70

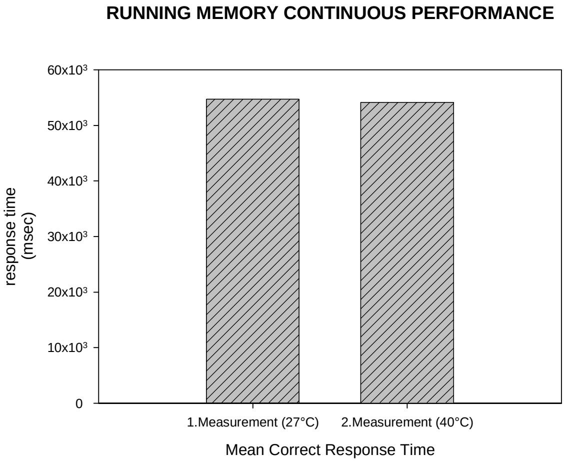


Figure 24: Average Correct Response Time (RM)

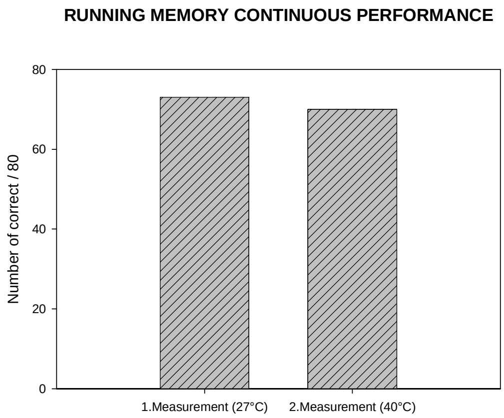


Figure 25: Average Number of Correct Response (RM)

4.2.3 Logical Relations Test Results

Logical relations test was used to understand the perceptional and reasoning capabilities. The results of this test is given with Table 11, Figure 26 and Figure 27.

Table 11: 'Logical relations' test results

	Mean Correct Response Time (msec)	Number of Correct / 24
1st Measurement (27°C)	210964	21
2nd Measurement (40°C)	226989	21

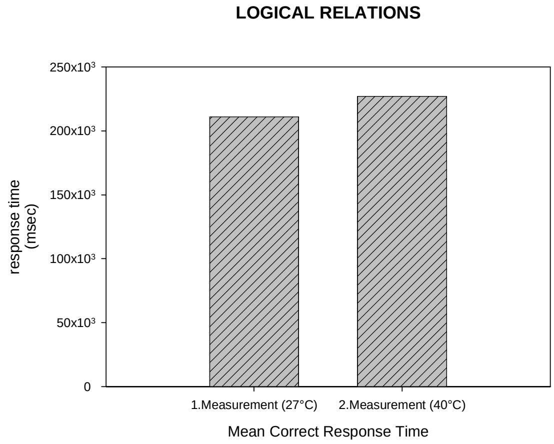


Figure 26: Average Correct Response Time (LR)

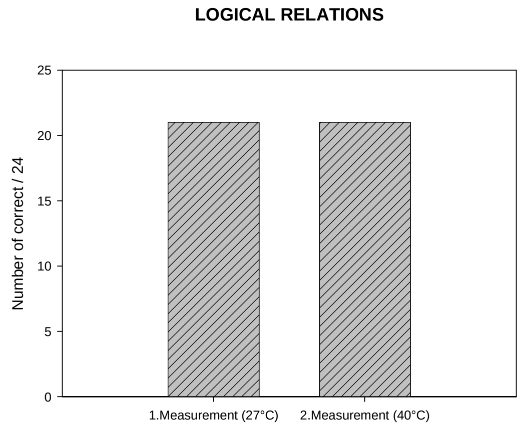


Figure 27: Average Number of Correct Response (LR)

4.2.4 Comparative Analysis of the Tests

The comparative analysis of the results of ANAM battery that was conducting for monitoring the thermal stress effects on the cognitive processes of the seafarers on a voyage are given in Figure 28.

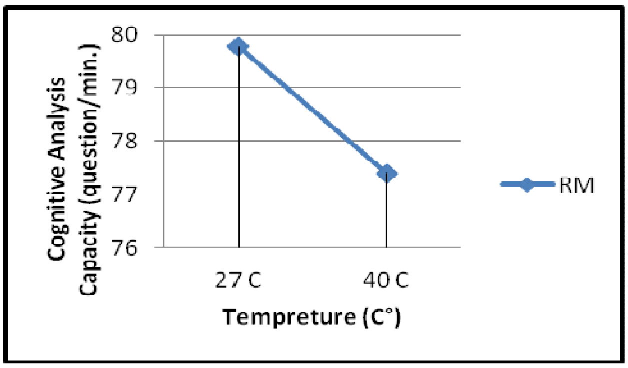


Figure 28: Cognitive Analysis Capacity (RM).

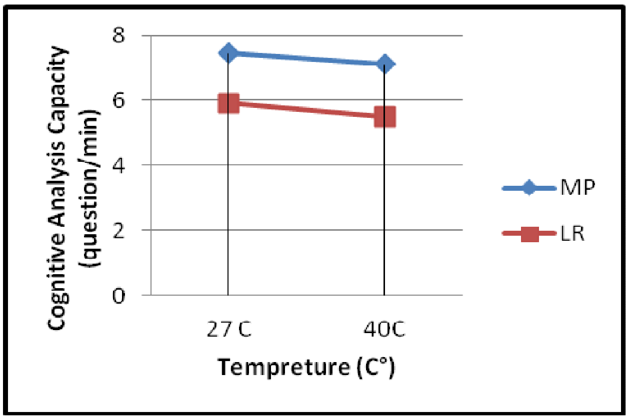


Figure 29: Cognitive Analysis Capacity (MP-LR).

It is monitored that cognitive processing capacity has been decreasing when the environment was 40 C° instead of 27 C°.

4.3 *Monitoring the Noise on Cognitive Performance during a Voyage*

Three different ANAM battery tests were applied to a chief engineer, three engineer officers and two engine cadets under 60dB and 108 dB sound levels. Then the results of tests were analysed comparatively.

4.3.1 *'Mathematical Processing' Test Results*

Mathematical Processing test was experienced for monitoring the working memory, concentration and information technology capabilities of seafarers under noise as a stressor factor. The results are given in Table 12, Figure 30 and Figure 31.

Table 12: 'Mathematical processing' test results

	Mean Correct Response Time msec)	Number of Correct / 20
1st Measurement (60dB)	145364	18
2nd Measurement (108dB)	210317	14

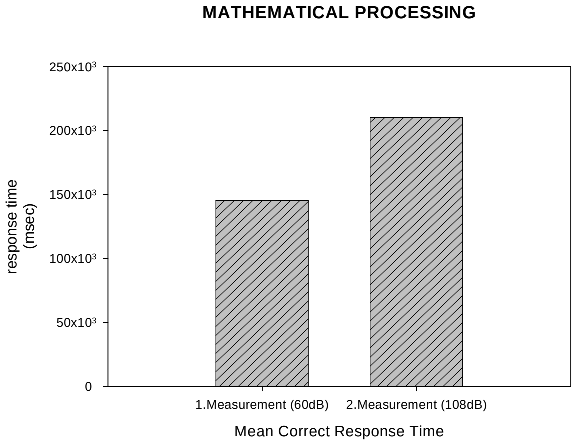


Figure 30: Average Correct Response Time (MP)

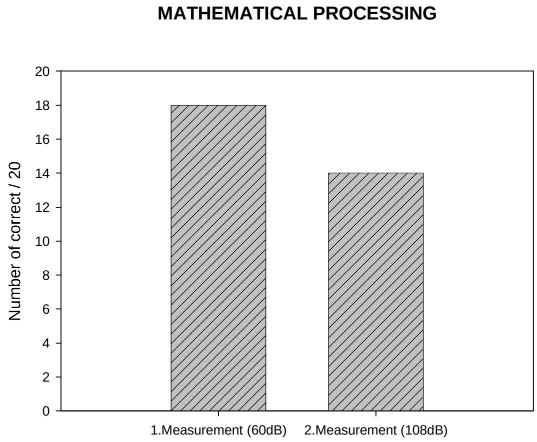


Figure 31: Average Number of Correct Response (MP)

4.3.2 *'Running memory- Continuous Performance Task' Test Results*

Running memory test was used to monitor the attention, concentration and memory capabilities under two different leves of noise. The results are given in Table 13, Figure 32 and Figure 33.

Table 13: 'Running memory- continuous performance task' test results

	Mean Correct Response Time (msec)	Number of Correct / 80
1st Measurement (60dB)	54692	73
2nd Measurement (108dB)	66591	61

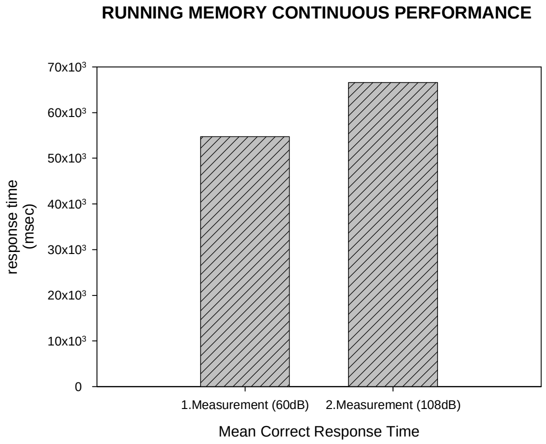


Figure 32: Average Correct Response Time (RM)

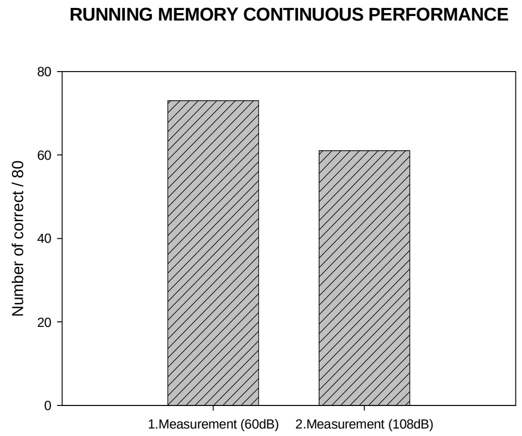


Figure 33: Average Number of Correct Response (RM)

4.3.3 'Logical Relations' Test Results

This test was applied to understand the perceptional and reasoning capabilities of the seafarers under noise as a stressor factor. The results are given in Table 14, Figure 34 and Figure 35.

Table 14: 'Logical relations' test results

	Mean Correct Response Time (msec)	Number of Correct / 24
1st Measurement (60dB)	210964	21
2nd Measurement (108dB)	265251	18

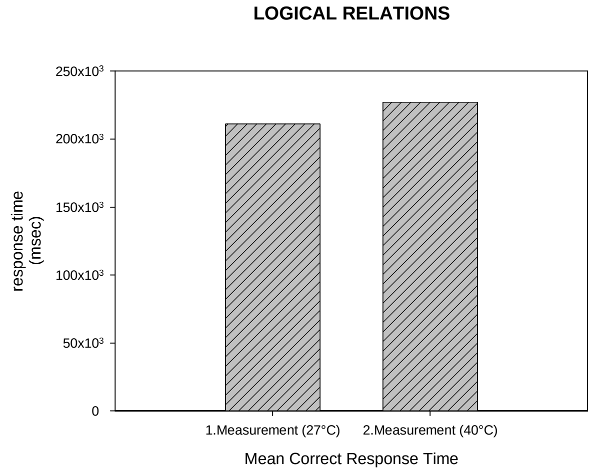


Figure 34: Average Correct Response Time (RM)

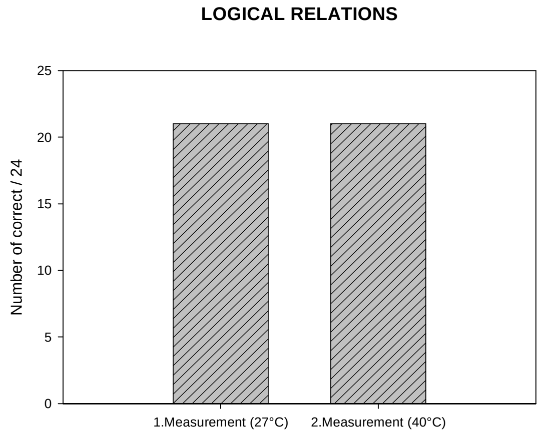


Figure 35: Average Number of Correct Response (LR)

4.3.4 Comparative Analysis of the Results

The comparative analyses of the three different tests for two different levels of noise are given with Figure 36 and Figure 37.

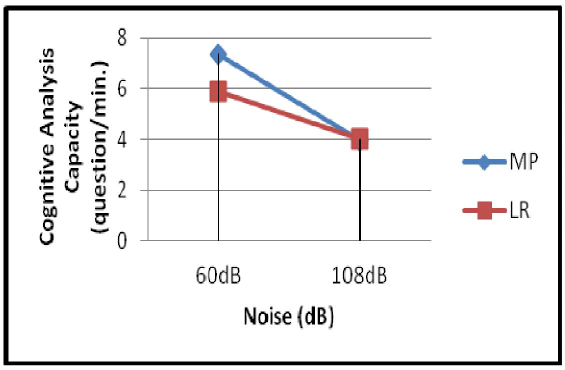


Figure 36: Cognitive Analysis Capacity (MP-LR)

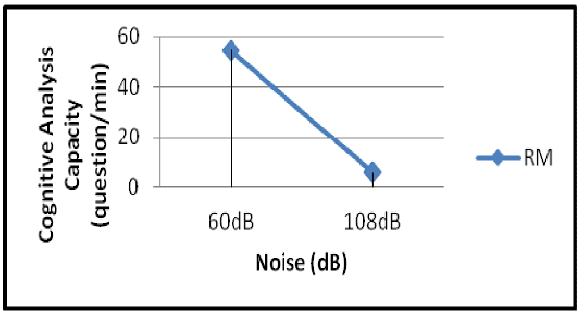


Figure 37: Cognitive Analysis Capacity (RM)

5. CONCLUSIONS

In this study, it is aimed to monitor the seafarers' cognitive performances under stressor factors on a voyage by using ANAM and the cognitive theories in the literature. Three stressor factors are used as driving factors. These are fatigue, thermal stress and noise. As fatigue inherently occurs for the seafarers in a voyage, we did not force anything to create fatigue as a stressor factor. However we changed the temperature and noise levels to be able to measure the responses of the seafarers in different mediums. Actually one of the aims of this study is to be able to conduct the measurements for seafarers in a real environment, not a simulator. For this purpose, using ANAM test batteries is not may be the same issue with a real environment, but this study is being one of the initial studies on the purpose of catching the real environment variables.

The results show that (a) the cognitive tests performance and the reaction response times decline through fatigue and sleepiness during the watchkeeping period (b) increasing temperature and noise causes to decline the reaction time and the cognitive performance. It is obviously seen that noise as a stressor factor has much more effects then the two other stressor factors on the cognitive processes. The monitored facts are consisted with the initial three hypothesis of this study.

7. REFERENCES

[1] Ainsworth, L.L., & Bishop, H.P. (1971). The effects of a 48-hour period of sustained field activity on tank crew performance (HumRRO TR No. 71-16). Alexandria, VA: Human Resources Research Organization.

[2] ANAM4™ User Guide., (2012) Automated Neuropsychological Assessment Metrics, Retrieved from : http://www.vistalifesciences.com/anam-intro.html

[3] Anderson, N. (2001) Handbook of industrial, work and organizational psychology, Sage Publishing ISBN: 9789750404764

[4] Bal, E., (2011) Gemiadamlarında Yorgunluğa Neden Olan Etkenlerin Analitik İncelenmesi, (Master's thesis, İstanbul Technical İstanbul, İstanbul, Turkey).

[5] Banks, J.H., Sternberg, J.J., Farrell, J.P., Debrow, C.H., & Dalhamer, W.A. (1970). Effects of continuous military operations on selected military tasks (BESARL TR No. 1166). Arlington, VA: U.S. Army Organizational and Systems Research Laboratory.

[6] Baradell, J.G., & Klein, K. (1993). Relationship of life stress and body consciousness to hypervigilant decision making. Journal of Personality and Social Psychology, 64(2), 267–273.

[7] Broadbent, D.E. (1971). Decision and Stress. London: Academic Press.

[8] Brookhuis, K.A., & de Waard, D. (1993). The use of psychophysiology to assess driver status.Ergonomics, 39, 1099–1110.

[9] Brookhuis, K.A., & de Waard, D. (2001). Assessment of driver's workload: Performance and subjective and physiological indexes. In P.A. Hancock, & P.A. Desmond (Eds.), Stress, workload, and fatigue. Mahwah, NJ: L. Erlbaum.

[10] Brown, I.D. (1994). Driver fatigue, Human Factors, 36, 298–314.

[11] Buck-Gengler, C. J., & Healy, A. F. (2001). Processes underlying long-term repetition priming indigit data entry. Journal of Experimental Psychology: Learning, Memory, and Cognition, 27,879–888.

[12] C180, (1996). Seafarers' Hours of Work and the Manning of Ships Convention

[13] Cacciabue, P.C., Decortis, F., Drozdowicz, B., Masson, M.,& Nordvik, J.-P. (2004) Comm. of the European Communities Joint Res. Centre, Ispra,

[14] Cannon-Bowers, J. A., Salas, E., & Converse, S. A. (1993). Shared mental models in expert team decision-making, in N. J. Castellan, Jr (ed.), Individual and Group Decision Making (Hillsdale: Lawrence Erlbaum), 221-246.

[15] Cercarelli, L.R., & Ryan, G.A. (1996). Long distance driving behaviour of Western Australian drivers. In L.R. Hartley (Ed.), Proceedings of the second international conference on Fatigue and Transportation: Engineering, enforcement and education solutions (pp. 35–45). Canning Bridge, Australia: Promaco.

[16] Chvaneveldt, R. W., Durso, F. T., Goldsmith, T. E., Breen, T. J., Cooke, N. M., Tucker, R. G., & DeMaio, J. C. (1985). Measuring the structure of expertise. International Journal of Man-Machine Studies, 23, 699-728.

[17] Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs), from the IMO (The International Maritime Organisation). Retrieved February 13, 2006.

[18] Cooke, N. J. (2005). Measuring Team Knowledge. Handbook on Human Factors and Ergonomics Methods, pp. 49-1-49-6. Boca Raton, FL: CLC Press, LLC.

[19] Cooke, N. J., & Breedin, S. D. (1994). Constructing naive theories of motion on-the-fly. Memory and Cognition, 22, 474-493.

[20] Cooke, N. J., & Gorman, J. C. (2004). Assessment of team cognition. In P. Karwowski (Ed.), 2nd Edition-International Encyclopedia of Ergonomics and Human Factors. Taylor & Francis Ltd.

[21] Cooke, N. J., Durso, F. T., & Schvaneveldt, R. W. (1994). Retention of skilled search after nine years. Human Factors, 36, 597-605.

[22] Cooke, N. J., Kiekel, P. A., & Helm E. (2001). Measuring team knowledge during skill acquisition of a complex task. International Journal of Cognitive Ergonomics: Special Section on Knowledge Acquisition, 5, 297-315.

[23] Cooke, N. J., Kiekel, P.A., Salas, E., Stout, R.J., Bowers, C., & Cannon-Bowers, J. (2003). Measuring Team Knowledge: A Window to the Cognitive Underpinnings of Team Performance. Group Dynamics: Theory, Research and Practice, 7, 179-199.

[24] Cooke, N. J., Stout, R.J., & Salas, E. (2001). A knowledge elicitation approach to the measurement of team situation awareness. In M. McNeese, M. Endsley, & E. Salas, (Eds.), New Trends in Cooperative Activities: System Dynamics in Complex Settings, pp. 114-139. Santa Monica, CA: Human Factors.

[25] Driskell, J.E., Mullen, B., Johnson, C., Hughes, S., & Batchelor, C. (1992). Development of quantitative specifications for simulating the stress environment (Report No. AL-TR-1991- 0109). Wright-Patterson AFB, OH: Armstrong Laboratory.

[26] Driscoll, M. P. (1994). Psychology for Learning Instruction. Needham; MA. Allyn & Bacon.

[27] Drucker, E.H., Cannon, L.D., & Ware, J.R. (1969). The effects of sleep deprivation on performance over a 48-hour period (HumRRO TR No. 69-8). Alexandria, VA: Human Resources Research Organization

[28] Ellis, H.D. (1982). The effects of cold on performance of serial choice reaction time and various discrete tasks. Human Factors, 24, 589–598.

[29] Ellis, H.D., Wilcock, S.E., & Zaman, S.A. (1985). Cold and performance: The effects of information load, analgesics, and the rate of cooling. Aviation, Space, and Environmental Medicine, 56, 233–237.evidence from Turkish maritime business,IAMU Maritime congress, Korea

[30] Embrey, D. (2006) Development of a Human Cognitive Workload Assessment Tool, MCA Final Report

[31] Errett, J.,Bowden, E.E., Choiniere, M., Wang, L.M. (2006). Effects of Noise on Productivity: Does Performance Decrease Over Time? Architectural Engineering -- Faculty Publications.Paper 13.

[32] Ertmer, P., & Newby, T. (1993). Behaviorism, Cognitivism, Constructivism: Comparing Critical Features from an Instructional Design Perspective. Performance Improvement Quarterly, 6(4), 50-72.

[33] FAA., (2005) Federal Aviation Administration, Human Factors Policy, FAA Order 9550.8A.

[34] Fairclough, S.H., & Graham, R. (1999). Impairement of driving performance caused by sleep depreivation or alcohol: A comparative study. Human Factors, 41, 118–128.

[35] Fink, A. M., Eckhardt, A. L., Fennessy, M. M., Jones, J., Kruse, D., VanderZwan, K., J., Ryan, C. J., & and Zerwic, J. J. (2010): Psychometric Properties of Three Instruments toMeasure Fatigue With Myocardial Infarction. Western Journal of Nursing Research, 32(7) 967–983.

[36] Fisher, S. (1984). Stress and the perception of control. London: Lawrence Erlbaum Associates, Ltd.

[37] Gaillard., A. W. K., & Wientjes, C. J. E., (1994). Mental load and work stress as two types of energy mobilization, Work & Stress, 8, 141–152.

[38] Gawron, V.J., French, J., & Funke, D. (2001). An overview of fatigue, In P.A. Hancock, & P.A. Desmond (Eds.), Stress, workload, and fatigue. Mahwah, NJ: L. Erlbaum.

[39] Giesbrecht, G.G., Arnett, J.L., Psych, C., Vela, E., & Bristow, G.K. (1993). Effect of task complexity on mental performance during immersion hypothermia. Aviation, Space, and Environmental Medicine, 64, 201–211

[40] Gorman, J.C., Foltz, P.W., Kiekel, P.A., Martin, M.J., & Cooke, N.C. (2003). Evaluation of latent semantic analysis-based measures of team communications content. Proceedings of the Human Factors and Ergonomics Society 47th Annual Meeting.

[41] Gregory, R. L. (1994). Mind in science: a history of explanations in psychology and physics, London, UK: George Weidenfeld and Nicholson.

[42] Grether, W.F. (1973). Human performance at elevated environmental temperature. Aerospace Medicine, 44, 747–755.

[43] Halverson, C.A. (1995) Inside the Cognitive Workplace: New Technology and AirTraffic Control. (PhD Thesis, Dept. of Cognitive Science, University of California, San Diego).

[44] Hammond, K. R. (2000). Judgments under stress. New York; Oxford University Press.

[45] Hancock, P. A., & Desmond, P. A. (2001) Stress, workload, and fatigue. Mahwah, NJ: L. Erlbaum.

[46] Harris W.C, & Hancock P.A. (2003). Field Assessment of Cognitive Performance Under Stress. IN Proceedings of the Human Factors and Ergonomics society 47. Annual Meeting - 2003

[47] Haslam, D.R., & Abraham, P. (1987). Sleep loss and military performance. In G.L. Belenky (Ed.),Contemporary studies in combat psychiatry (PP. 167–184). New York: Greenwood Press.

[48] Hockey, G. R. J. (1979). Stress and the cognitive components of skilled performance. (pp. 141–177) In V. Hamilton & D. M. Warburton (Eds.) Human stress and cognition: An information processing approach. New York: John Wiley & Sons.

[49] Howell, W. C., & Cooke, N. J. (1989). Training the human information processor: A look at cognitive models. In I. L. Goldstein and Associates (Eds.), Training and development in organizations (pp. 121-182). New York: Jossey Bass.

[50] Hunter, J. E. (1986). Cognitive ability, cognitive aptitudes, job knowledge, and job performance. Journal of Vocational Behavior, 29, 340-362.

[51] Hutchins, E. & Klausen, T. (1996). Distributed Cognition in an Airline Cockpit. In Communication and Cognition at Work, eds. D. Middleton and Y. Engeström,Cambridge: Cambridge University Press.

[52] IMO, (2004). Human Element Vision, Principles and Goals for The Organization, Resolution A.947(23).

[53] Job, R.F.S., & Dalziel, J. (2001). Defining fatigue as a condition of the organism and distinguishing it from habituation, adaptation, and boredom. In P.A. Hancock, & P.A. Desmond (Eds.), Stress, workload, and fatigue. Mahwah, NJ: L. Erlbaum.

[54] Kaarin J. Anstey, Joanne Wood, Stephen Lord & Janine G. Walker, (2005). Cognitive, sensory and physical factors enabling driving safety in older adults, Clinical Psychology Review, Volume 25, Issue 1, January 2005

[55] Kaplan, H.J., & Sadark, B.J. (1985) Test book psychiatry. United States.

[56] Keiss, H.O., & Lockhart, J.M. (1970). Effects of level and rate of body surface cooling on psychomotor performance. Journal of Applied Psychology, 54, 386–392.
[57] Kiekel, P. A., Cooke, N. J., Foltz, P. W., & Shope, S. M. (2001). Automating measurement of team cognition through analysis of communication data. In M. J. Smith, G. Salvendy, D. Harris, and R. J. Koubek (Eds.), Usability Evaluation and Interface Design, pp. 1382-1386, Mahwah, NJ: Lawrence Erlbaum Associates.
[58] Kiekel, P. A., Cooke, N.J., Foltz, P.W., Gorman, J. C., & Martin, M.J. (2002) Some promising results of communication-based automatic measures of team cognition. Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting, 298-302.
[59] Kiekel, P.A. & Cooke, N. J. (2004). Human factors aspects of team cognition. In R. W. Proctor and K. L. Vu (Eds.), The Handbook of Human Factors in Web Design, pp. 90-103, Mahwah, NJ: Lawrence Erlbaum Associates.
[60] Kiekel, P.A., Gorman, J. C., & Cooke, N. J. (2004). Measuring speech flow of co-located and distributed command and control teams during a communication channel glitch. Proceedings of the Human Factors and Ergonomics Society 48th Annual Meeting, 683-687.
[61] Kim H., Kim H.-J., & Hong S. (2010) Collision Scenario-based Cognitive Performance Assessment for Marine Officers. TransNav - International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 4, No. 1, pp. 73-77
[62] Kingstone, A., Smiek, D., Ristic, J., Frieden, C.K., & Eastwood, J.D. (2003). Attention, researchers! It is time to take a look at the real-world. Current Directions in Psychological Science, 12(5), 176–180.
[63] Koçak, G., (2008). Gemi Makineleri İşletmesinde Ergonomik Analiz, (Master's thesis, İstanbul Technical University, İstanbul, Turkey).
[64] Kroemer, K.H.E., & Grandjean, E., (1997). Fitting the Task to the Human: Textbook of Occupational Ergonomics, 5th Edition, Taylor & Francis, London.
[65] Lane, T,P., & Bloor, M., (2001). Fatigue Offshore: A comparison Offshore Oil Support Shipping and the Offshore Oil Industry (SIRC Report). Cardiff: Seafarers International Research Centre (SIRC) / Centre for Occupational and Health Psychology Cardiff University.
[66] Lazarus, R.S. (1966). Psychological Stress and the Coping Process. New York: McGraw-Hill.
[67] Ljungberg K, J. (2007). Cognitive degradation after exposure to combined noise and whole-body vibration in a simulated vehicle ride. International Journal of Vehicle Sound and Vibration, 3, (2), 130-142.
[68] Lyon, B., & Werner, J. (1987). Stress. In J. Fitzpatrick & R. Taunton (Eds.), Annual review of nursing research. New York, NY: Springer
[69] Maas, J., Dillen, S., Verheij, R., & Groenewegen, P. (2009). Social contacts as a possible mechanism behind the relation between green space and health. Health and Place:, 15(2), 586-595.
[70] Matthews, G., & Desmond, P. A. (2002). Task-induced fatigue states and simulated driving performance. Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 55, 659–686.
[71] McMaster M. D. (1996). The intelligence advantage: organizing for complexity, Newton. MA: Butterworth-Heinemann
[72] Myers SD., Withey WR., Dobbins TD., Dyson R. (2009) Effect Of Cold On Post-transit Run Performance Of Marine High-speed Craft Passengers. Med Sci Sports Exerc 2009, 41(5):58
[73] Muscio, B. (1921). Is a test of fatigue possible? British Journal of Psychology, 12, 31–46.
[74] Mukhtar, Z. B. Z. (2009). A comparison of fatigue levels among Malaysian seafarers of different maritime sector, (Msc Thesis, Master of Engineering, Marine Technology, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia).
[75] Muslu, A. (2008). Denizcilik Sektöründe İnsan Kaynakları Yönetimi ve Çalışma İlişkileri, (Master's thesis, Marmara University, İstanbul, Turkey)
[76] NASA. (1996). Fatigue resource directory. In L.R. Hartley (Ed.), Proceedings of the second international conference on Fatigue and Transportation: Engineering, enforcement and education solutions (pp. 67–135). Canning Bridge, Australia: Promaco
[77] Pilcher, J.J., Nadler, & E., Busch, C., (2002). Effects of hot and cold temperature exposure on performance: a meta-analytic review , Ergonomics, 2002, VOL. 45, NO. 10, 682 -698
[78] Ream, E., & Richardson, A. (1996). Fatigue: A concept analysis. International Journal of Nursing Studies, 33, 519-529.
[79] Reyner, L., & Baulk, S. (1998). Fatigue in ferry crews: a pilot study. Cardiff University: Seafarers' International Research CentreSmith,
[80] Scheerer, M. (1954). Cognitive theory. In G. Lindzey (Ed.), Handbook of Scoial Psychology. Vol. 1. Cambridge, Addison-Wesley.
[81] Salyga, J., & Jouzulynas, A. (2006) Association between environment and psycho-emotional stress experienced at sea by Lithuanian and Latvian seamen. Medicina (Kaunas) ; 42(9), pp 759-769.
[82] Selye, H. (1985) Stress Without Distress. Philadelphis. United States.
[83] Seppänen, W. J. Fisk, & Q. H. Lei (2006) Effect of temperature on task performance in office environment", 5th International Conference on Cold Climate Heating, Ventilating and Air Conditioning. p. 53-16, 2006.
[84] Staal, M.A. (2004) Stress, Cognition, and Human Performance: A Literature Review and Conceptual Framework. National Aeronautics and Space Administration
[85] Strater, O. (2005) Cognition and safety an intigrated approach to systems design and assesment, Ashgate Publishing, ISBN: 0754643255
[86] STCW., (1978). International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, IMO Publications..
[87] Tac, U., (2012). Deniz ulaştırmasında Gemiadamlarının Bilişsel Performanslarının Stresör Faktörler Altında Modellenmesi ve Operasyonel Süreçlere Etkisi (Master's thesis, İstanbul Technical İstanbul, İstanbul, Turkey).
[88] Tac,U., & Tavacioglu, L. (2012). The Role of the Cognitive Assessments in Maritime Education and Training, IMLA 20, Terscheling, Netherlands.

[89] Tavacioglu, L., (1996). Artistik Cimnastikte Bilişsel (Cognitive) Değerlendirmeler, Duygu Durumundaki Değişmeler ve Beden Yapısının Performansa Etkileri, (Phd thesis, Marmara University, İstanbul, Turkey).
[90] Tepas, D.I., & Price, J.M. (2001). What is stress and what is fatigue?. In P.A. Hancock, & P.A. Desmond (Eds.), Stress, workload, and fatigue. Mahwah, NJ: L. Erlbaum.
[91] Vaughan, J.A., Higgins, E.A., & Funkhouser, G.E. (1968). Effects of body thermal state on manual performance. Aerospace Medicine, 39, 1310–1315.
[92] Vaughan, W.S. (1977). Distraction effect of cold water on performance of higher-order tasks. Undersea Biomedical Research, 4, 103–116.
[93] Wilson, G., Skelly, J., & Purvis, B. (1989, October). Reactions to emergency situations in actual and simulated flight. In Proceedings of the Aerospace Medical Panel Symposium, 1-13. The Hague, Netherlands.
[94] Woods, D.D., & Patterson, E.S. (2001). How unexpected events produce an escalation of cognitive and coordinative demands. In P.A. Hancock, & P.A. Desmond, Stress, workload, and fatigue. Mahwah, NJ: L. Erlbaum.
[95] Yates, J. F., Klatzky, R. L., & Young, C. A. (1995). Cognitive performance under stress. In R. S. Nickerson (Ed.), Emerging needs and opportunities for human factors research (pp. 262-290). Washington, D.C.: National Academies Press.
[96] Yılmaz P., (2006). Yeni Ürün Geliştirme Projelerinde Takım Zekasının Önemi ve Proje Başarısına Katkısı. (Master’s Thesis, Gebze Instıtute of Technology, İzmit, Turkey)

TRANSPORTATION SYSTEM DEVELOPMENT MODELING SUBJECT TO CUSTOMS CONTROL OF CARGO FLOWS

VARVARA PITERSKAYA

Odessa National Maritime University, Ukraine

ABSTRACT

The article is dedicated to the elaboration of the model for predicting transportation volumes taking into account the influence of customs control on the process of cargo transportation. The use of the above-mentioned method based on situational approach to prognostication ensures a high level of the forecasts adequacy required for the analysis and solution of the tasks of the transportation system development.

Keywords: *transportation system, cargo flow, customs control.*

1. INTRODUCTION

The level of a state development depends on many factors, one of the most important places among them being occupied by the state of the transportation system. The process of international relations globalization leads to quantitative and qualitative increase of commodity, informational and financial flows worldwide.

In the situation of international trade globalization, active development of interstate integration processes, as well as the need for ensuring the protection of economic interests, there arises the necessity to transform the role of customs institutions and the essence of their tasks when performing control procedures.

Various methods – the theories of transport processes and systems, mass servicing, investigation of operations, project management subject to their adaptation to contemporary conditions of customs service functioning as the structure which ensures the protection of economical safety of the country can serve as the basis for solving the questions connected with working out optimal technology of performing customs formalities.

These methods allow effective management of temporal, cost-based and qualitative parameters, this is why it is appropriate to use them when carrying our re-organizational measures in the customs sphere.

2. REVIEW OF PUBLICATIONS ON THE ISSUE

Lately, the research in the sphere of state regulation of foreign trade activity has shifted from the determination of effective strategies of customs bodies development based on scientifically grounded instruments to the consideration of technological processes [1].

The prospects of further development of maritime transportation complex of a country in modern situation are in the first place determined by the state of sea trade ports and the activity of control bodies [2].

The problem of forecasting has become particularly complex during the last decade as the result of rapid changes of the environment [3].

In addition to obtaining possible future estimations of the parameters being studied, forecasting suggests the motivation to speculations on the suggestions of what may occur in the environment and what results may follow [4].

The majority of mathematical methods of forecasting based on the models of cargo transportations can be conditionally divided into the following classes: probabilistic, differential calculus, expert, etc. All of them have multiple limitations and drawbacks which make there use for the prognostication of cargo transportations unproductive or inefficient at all. From the mathematical point of view, the following should be marked: it is not always that adequate formalization of object domain is provided for when creating a forecast. Practically all methods assume the invariance of conditions during the period of prognostication, which does not conform to reality. All methods are grounded on the paradigm "the past determines the future"; that is they suggest that the previous state of the system uniquely defines its next state. Uncertainty, indistinctness of information used in such object domain as prognostication of cargo transportations are not taken into account [5].

The aim of the research – working out methodical principles of forecasting the transportation complex development subject to the influence of customs control over the process of cargo transportations.

3. BASIC RESEARCH MATERIAL

One of the major tasks of control bodies is the protection of economical interests of the state by way of tariff regulation of import and export duties rates, which influence the quantity of the cargo being transported and, consequently, on the workload of the cargo transportation process.

Therefore, it is expedient to elaborate the method which allows forecasting the volumes of cargo flows – the fundamental basis for designing the development of transportation system. At the same time it is important to take into account connections in the system "traffic center – external environment", as well as the availability of multiphase structural scheme of cargo flows passage (Figure 1).

Forecasting cargo flows is an example of a complex prognostication task which cannot be solved with the use of any single method. Expert estimations formulated by specialist are based on the information collected at the stage of preliminary analysis and they take into account statistical data of the volumes of cargo flows of various goods, the capacity of potential market, the prospects of development of a certain sphere of economics inside the country, general demand, shares of goods of various brands on the market, level of accessibility of sales networks.

The effect of external factors in the model of forecasting cargo flows reveals itself through the influence on the current estimation of input characteristics of the model, which are formalized by membership functions of the corresponding fuzzy sets.

Active development of international transportation system demands taking new effective managerial solutions aimed at the formation of the system of customs and transportation servicing of physical distribution able to make provisions for increasing cargo flows subject to maximal protection of the state interests.

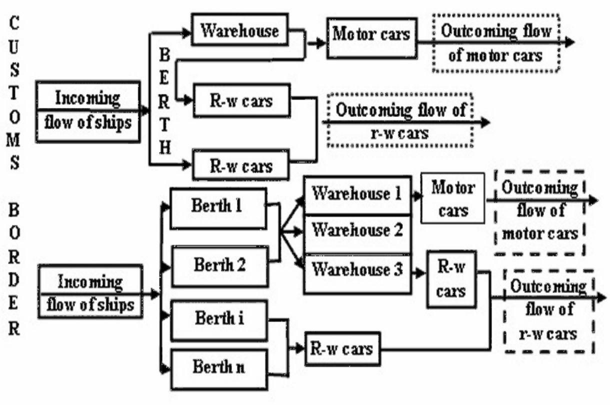


Figure 1 Multiphase scheme of cargo passage

The system of transportation complex management should assist in reaching maximal effectiveness when using geo-political position of the state, its participation in international transportation process, as well as in satisfying the needs of the economics in transportation service provided the influence of customs control of the cargoes delivery.

The necessity of the transportation system integration in the international system of cargoes delivery is aimed at attracting additional volumes of carriages and currency inflows, lowering transportation expenses, approaching to the world standards of cargoes and passenger carriages, to ecological characteristics of the work, as well as to increasing the share of export potential on the international market of transportation services by way of competitive recovery of national carriers. In its turn, this necessitates the use of rational technologies for prognosticating cargo flows with the purpose of effective use of existing transportation networks infrastructure, as well as for its prospective development.

The level of transportation system development is defined by its capacity to handle all available cargo flows.

It should be noted that the transportation system development is determined by the directions and the quantity of cargo flows.

This calls for the necessity of performing proper procedures of state control of the process of moving goods across the border, namely the realization of effective customs control and registration of goods and transport means.

The most often used regimes of moving cargo are: import, export and transit. The existence of other additional regimes, such as, for example, handling cargoes beyond the limits of customs territory, re-export, re-import, should not go unnoticed though their share in the total volume of moving cargoes is insignificant.

The following factors influence the formation of cargo flows: for import carriages: purchase requirement of population, the level of the national economic integration in the world economy, customs tariff; for export carriages; competitive ability of enterprises in the world market, domestic demand, customs tariffs; for transit carriages: the rate of handling cargoes, safety of transportation, customs registration.

In all three cases, the state of customs regulations and control system influences the formation of cargo flow.

For the elaboration of the model of forecasting import cargo flow we shall introduce the following designations:

P_i – average world price of an i – goods unit, conventional units;
W_{Pi} – price of an i – goods unit on domestic market, c.u.;
C_i – duty rate for i – goods;
Q_{Si}' – total supply of i – goods in the absence of import customs tariff, units;
Q_{Si}'' – total supply of i – goods at the introduction of import duty, units;
Q_{Di}' – total demand for i – goods at the introduction of import duty, units;
Q_{Di}'' – total demand for i – goods in the absence of import customs tariffs, units;
Q_{DMAX} – maximal total demand for i – goods, units;
Z_i – prime cost of production of an i – goods unit, c.u.;
t – tax rate on the profit of enterprise;
K_i' – factor accounting for the dynamics of changing total demand for i – goods;
K_i'' – factor accounting for the dynamics of changing total supply of i – goods.

The import volume of i – goods shall comprise:

$$
\begin{aligned}
Q_{IM_i} &= \sum_{i=1}^{n}\left(Q_{Di}{}' - Q_{Si}{}''\right) = \\
&= \sum_{i=1}^{n}\left(\left(Q_{D_{MAX}} - K_i{}' W_i\right) - Q_{Si}{}''\right) = \qquad (1)\\
&= \sum_{i=1}^{n}\left(\left(Q_{D_{MAX}} - K_i{}' P_i(1+C_i)\right) - Q_{Si}{}''\right),
\end{aligned}
$$

At that the volume of supply of i – goods shall be determined in the following way:

$$
Q_{Si}{}'' = \begin{cases} 0, \ if \ \ 0 \le W_i \le Z_i; \\ K_i{}''(W_i - Z_i), \ if \ \ Z_i \le W_i \le W_{P_i}; \\ Q_{Di}{}', \ if \ \ W_i \ge W_{P_i}. \end{cases} \qquad (2)
$$

The value of the forecasting import cargo flow subject to customs tariffs control of the process of moving cargoes across the border shall be calculated using the following formula:

$$
Q_{IM} = \sum_{i=1}^{n} \begin{pmatrix} Q_{D_{MAX}} - K_i{}' P_i - K_i{}' P_i C_{OPT} - K_i{}'' P_i - \\ - K_i{}'' P_i C_{OPT} + K_i{}'' Z_i \end{pmatrix} \qquad (3)
$$

In this case the optimal rate of import duty C_{OPT}, ensuring the maximal level of the national economic welfare must meet the structural limit of $0 \le C_i \le C_i^{GATT}$, where C_i^{GATT} – marginal tax rate for i – goods, specified by General agreement on tariffs and trade.

Also one should take into account that there is secured the maximum income of the state budget:

$$
R = \sum_{i=1}^{n} \begin{pmatrix} \begin{pmatrix} Q_{D\,MAX} - K_i{}' P_i - K_i{}' P_i C_i - \\ - K_i{}'' P_i - K_i{}'' P_i C_i + K_i{}'' Z_i \end{pmatrix} P_i C_i + \\ + \left(K_i{}'' P_i + K_i{}'' P_i C_i - K_i{}'' Z_i\right) P_i t \end{pmatrix} \to \max \qquad (4)
$$

Forecasting transit cargo flows assumes the interaction of two components: economic and transport. Economic component provides for forming the possibility of cargo flows emerging in the aspect of foreign economic activity of the country. Transport component provides for the assessment of transit cargo flows possibility in the transportation network subject to its throughput. The forecast of transit cargo flows is realized in the form of interconnected modules, the interaction whereof suggesting logical realization of the results in the context of qualitative and quantitative characteristics subject to possible spectrum of events.

To determine the traffic center facilities as the element of transportation system required for processing the cargo flow, the following actions should be performed: when importing cargo – to determine the volume of import cargo flow subject to the calculation of optimal import tariff; when exporting cargo – to estimate the expediency of export tariff and to determine the volume of export cargo flow; in case of transit cargo – to forecast transit cargo flow.

After obtaining the corresponding values of the above-mentioned characteristics the total cargo flow to be used for forecasting the necessary capacities of transportation system shall be calculated, including the number of units of transportation, transshipment means, as well as the warehouse areas required for processing the cargoes being moved.

From the point of view of technology the following characteristics should be also taken into account: macroeconomic potential capacities of the countries in connection with import-export of goods; estimated cargo flow between the countries according to groups of goods in the aspect of transportation network; possibilities of transiting goods by international transport corridors; throughput of infrastructure of international transport corridors.

The suggested method of determining the capacity of transportation system required for the processing of the cargo flow includes the following stages: planning incomes; building the model of “demand – supply” for the given goods; determining the average world price for the goods; calculation of optimal import tariff or the assessment of the expediency of export tariff; determination of the volume of import, export or transit cargo flow; determination of the total cargo flow; planning the necessary facilities of the transportation system.

4. CONCLUSIONS

The workload of the transportation system depends on the volume of the existing cargo flow, which is influenced to a insignificant extent by the level of the duty rate depending on the direction of moving cargoes across the border. Based on the study by the method of forecasting in the terms of the analysis of gross domestic product, as well as the forecasted model of demand and supply, the model of forecasting the volume of cargo flow subject to the influence of customs control of the process of cargoes transportation was elaborated. The use of the above-mentioned complex of actions taking into account situational approach to prognostication shall ensure the high degree of the forecasts adequacy, which is necessary for the analysis and solution of the tasks of the state transportation system development.

5. REFERENCES

[1] Piterskaya, V.M., *Optimization of technological processes in the customs bodies activity,* Problems of technology, Scientific-industrial magazine, Issue 3, Khmelnitskiy: Kh. N. U. 2007

[2] Shakhov, A.V., Piterskaya, V.M., *Methods of transportation-customs support of ports development in Ukraine,* Bulletin of ONMU, Collection of scientific works, Issue 26, Odessa, ONMU, 2009

[3] Golz, G.A., M*ain-line cargo carriages and gross domestic product: historiometric research for forecasting purposes,* Problems of forecasting, 2005
[4] Marshall, A., *Principles of economic science,* M., Progress, 1993
[5] Bocharnikov, V.P., *Fuzzy-technology: Mathematical principles. Modelling practice in economics: Monograph,* S.Pb, Science, 2001

GLOBAL CRISIS, CHANGE IN OIL PRICES AND ITS EFFECTS ON TURKISH EXPORT

[1]ZELHA ALTYNKAYA, [2]GEORGESCU STEFAN, [3]DRAGAN CRISTIAN

[1]Aydin Istanbul University, Turkey, [2,3]Maritime University in Constanta, Romania

ABSTRACT

In the fourth year of great global crisis, many leading pessimists economist have been forecasting deeper economic crises with low growth rates. The sharp foreign exchange volatility was one of the main reasons of the financial crisis in the earlier years of last century and till 2007, however, this time crisis emerged in housing and especially in mortgage market in the USA. It spill over to the other markets and other countries later. Although, Turkish economy was very sensitive to the volatility of foreign exchange for many decades and experienced many crises due to sharp volatility of foreign exchange within last 30 years, Turkish economy followed high growth rates during the last four years. It would not be possible to follow high growth rates, high export opportunities in coming years. In this paper, the volatility of exchange rates and its effects on Turkish Economy will be analysed by wavelet methods.

Keywords: *oil, price, Turkish Economy, price*

1. THE VOLATILITY OF FOREIGN EXCHANGE AND OIL PRICES AND EXPORT

The volatility of foreign exchange has been subject to great interest among economist for a long time. Exchange rate volatility, the unexpected movements in the exchange rate has great impact not only on interest rate, inflation rate but also international trade. Especially, due to large volume of global trade, any kind of unexpected movement in the exchange rates results large effects on the general economy.

The large number of studies focused on the effect of effect of foreign exchange volatility on the economy. Their results differentiated due to sample country features or the model used, however, some of the them find out that negative effects, some of them find out negative effects and some of them concluded positive effect (Ozturk, 2006:92).

In recent years, increased mobility of capital and goods increased sensitivity on exchange rate regimes. Due to the changes in exchange rates, there would be large fluctuations in on export and import. In their papers, Bubula and Otker Rodi (2008) found out that countries have tended to move more flexible forms of intermediate regimes away from less flexible ones, in part to minimize potential trade-offs between competing policy objectives in a world with growing mobility of capital.

Obstfeld and Rogoff (2007) evaluated effect of real depreciation of the dollar across Asian and Non Asian Currencies. They assumed the current account deficit would be closed by the rise in the relative US saving and this implies a negative demand shock for US produced non-traded goods and a positive demand shock for foreign non traded goods (Obstfeld and Rogoff, 2007). Obstfeld and Rogoff (2007) also argued this general equilibrium effects turns out to imply an even larger depreciation in the real dollar exchange rate. They also expected some of the potential rebalancing shocks are considerably more adverse in 2008 crisis than one might have imagined in 2000 also (Obstfeld and Rogoff, 2007).

In large country and small country comparison, Obstfeld and Rogoff (2007) argued a global rebalancing in demand risks setting off a dollar depreciation that might be catastrophic for Europe and Japan since Europe's product and labour markets and Japan's credit markets are much less flexible than those in the US. Dollar depreciation likely shifts demand toward the US exports and away from exports in the rest of the world.

Obstfeld and Rogoff (2007) show that the relative productivity jump was in non- tradable goods production, rather than tradable goods production where generalized productivity gains often first show up. Therefore, contrary to conventional wisdom, as global productivity rebalances toward Europe and Japan, the US current account deficit could actually become larger rather smaller. They assumed labour and capital cannot move freely across sectors in the short run and found out that the US current account may amount to only 6 per cent of total US production, but it is likely 20 per cent or more of US traded goods production. Edwards's survey of current account reversals in emerging markets finds an economy's level of trade to be the major factor in determining the size of the requisite exchange rate adjustment with larger traded goods sectors implying a smaller currency adjustment on average.

The end of the 1980 witnessed a 40 per cent of decline in the trade weighted dollar as the Reagan era current account deficit closed up. Yet the change was arguably relatively being that Japan's macroeconomic responses to the sharp appreciation the yen in the late 198s0 helped plant the seeds of the prolonged slump that began in the next decade.

Obstfeld and Rogoff also asked what happens if the US accounts for roughly a quarter of world GDP and a relative demand shock abruptly closes its current account deficit from 5 per cent of GDP to full balance. Suppose that an end to the housing boom in the United States reduces consumption there while improving growth expectations lead to a higher consumption levels in Europe, Japan and China (Obstfeld and Rogoff, 2007).

In their study, they also focused on small country case. They allow for general equilibrium effects due to price movements outside of the United States. The elimination of the current account deficit implies something like a 20 per cent fall in the demand for traded goods (as the current account deficit is 5 per cent of GDP while traded goods production accounts for about 25 per cent of GDP). The relative price of a non-traded goods needs to fall by 20 per cent when the elasticity of intra-national substitution is 1. They also recommended to pay attention to the fact that abroad, the price of non-traded goods must rise in parallel to the effect in the United States. If the world economy's two regions were roughly equal in size and there were no terms of trade effects, then in our general equilibrium model, the real exchange rate change would have to be twice that in the partial equilibrium model. But if the US accounts for only 1 / 4 of global traded output so that a US current account deficit of 5 per cent of GDP corresponded to a foreign current accounts surplus of 1.67 per cent of foreign GDP the effect would be about 33 per cent instead of 100 per cent larger in the component of the dollar real exchange rate attributable exclusive to relative non-tradable and tradable prices at home and abroad.

2. GLOBAL CRISIS

Until 2007, all financial and economic crises were related to the less developed countries or developing. Early 1990s were the boom years for foreign direct investments and portfolio flows to emerging markets at East Asia and the other leading emerging markets. After Latin American Crisis, 1997 East Asia Crisis was the second important crisis the emerging markets in the last decades after collapse of Bretton Wood system at 1973. In the literature, leading monetarists considered banking panics as a major reason of first contraction on globalization (Mishkin,1992:2). Kindleberger and Minsky viewed financial crises as sharp declines in asset prices, failures of both large financial and nonfinancial firms, deflations or disinflations, disruptions in foreign exchange markets or some combinations of all these at the same time(Mishkin, 2010). These were due to persistent capital market segmentation, home country bias and correlation between domestic saving and investment (Mishkin,2003). However, a large room should be devoted to fluctuations of exchange rate and oil prices for explaining the crises.

When a financial and economic crises occurs, much more expanded role for government intervention. While all governments were following the policies necessary for participating on the globalized word, after 2003 the rapid growth of financial markets, raising volume of capital mobility and trade. However, Mishkin (2012) criticized this view on determining the optimum size of intervention to the markets. Stiglitz (2005) used globalization for refer not only to closer integration of the countries and peoples of the world that has resulted from lowering of transportation and communication costs and man-made barriers but also to the particular policies, like "Washington Consensus

Greenspan (2010) argued geo-political changes starting by collapse of Soviet Socialist States Union, unification of Germany, the end of the Cold War, reduced the threat of diversification on economic systems and risk on this region Real long term interest rates all over the world. produced a new bubbles in different countries like home price. This is new World order. Especially, China and the other successful export-oriented countries, the Asian Tigers and the Eastern European countries, supplied well educated, low cost workforces, in addition to highly developed world technology and protected by the rule of law, unleashed explosive economic growth. The International Monetary Funds (IMF) figure out that in 2005 more than 800 millions of labour force engaged in export oriented and therefore competitive markets. Additional hundreds of millions became subject to domestic competitive forces, especially in the former Soviet Union (Greenspan, 2010).

The first signs of crises came in early 2007 from losses at the US subprime loan originators and institutions holding derivatives of securitized subprime mortgages. However, these first signs were limited to problems in the subprime mortgage market till late 2007. Lehman Brothers bankruptcy was the trigger for the financial crisis, AIG and the Reserve Primary Fund collapsed on September 16, 2008 (Greenspan, 2010:12).

Although, capital flows were limited to a few countries and a few sectors at the beginning, capital flows is a central issue for centuries. Similarly, the collapse of the World Economy is not a new phenomenon. The World Economy contracted at 1914, just before the World War I. It was the end of the gold standard era, the end of free trade and free capital mobility for a period of time. Economic globalization starting after industrial revolution and with the support of Adam Smith's and his followers philosophers since early 18th century, had raised the prosperity in advanced countries and many other poor countries. The liberal economists argued markets should be free and the governments should not intervene to the markets and they consider a role for government restricted with national defence or justice only. Although, world trade had expanded approximately 1 per cent year during the seventeenth and eighteenth centuries it raised 4 per cent during nineteenth century due to rapid changes and globalization (Rodrik, 2012:24). Three important changes have been defined within this period: use of stream on transportation and industry and the invention of telegraph made revolutionary change on global economy. Especially, the widespread adoption of the gold standard made capital to move internationally easily. It was the realization of Adam Smith and his follower's philosophy and making the world prosper (Rodrik, 2012:22).

Tables below (table 1, table 2, table 3)would show the economic performance of the world economy. One of the main indicators is the short term interest rate. After, short term interest rates were quite much high until 2008. Just before the 2007, the Advanced Market Economies were following very strong monetary policies. Expansionary monetary policies during the recent crises were critical in supporting banks and markets. Monetary policy was relaxed significantly early on by quickly adjusting short-term interest rates to historical lower levels. Here, are the rates applied in some of the countries. It was under 1 per cent at 2009. In Turkey, the short term interest rate just reduced from 18.84 per cent in 2008 to 10.98 per cent in 2009. This is very serious decline in for Turkish economy. After many decades since 1980s, the interest rate declined to 10% in Turkey at 2009. It continued to decrease until now (Table1)

Table 1: Short Term Interest Rates

	2003	2004	2005	2006	2007
Turkey	38.52	23.84	15.87	17.93	18.25
U. S.	1.17	1.58	3.53	5.17	5.28
Euro 15	2.36	2.13	2.20	3.09	4.28
Germany	2.33	2.11	2.18	3.08	4.28
Greece	2.33	2.11	2.18	3.08	4.28
U.K.	3.67	4.57	4.70	4.80	5.96
Spain	2.33	2.11	2.18	3.08	4.28
Sweden	3.25	2.31	1.89	2.56	3.89
Japan	0.04	0.03	0.03	0.25	0.66
Switzerland	0.33	0.48	0.81	1.56	2.57
	2008	2009	2010	2011	2012
Turkey	18.84	10.98	7.81	8.74	8.00
U. S.	3.20	0.94	0.53	0.42	0.43
Euro 15	4.63	1.24	0.81	1.39	0.59
Germany	4.63	1.23	0.81	1.39	0.58
Greece	4.63	1.23	0.81	1.39	0.59
U.K.	5.49	1.20	0.69	0.89	0.91
Spain	4.63	1.23	0.81	1.39	0.59
Sweden	4.74	0.92	0.93	2.45	2.07
Japan	0.74	0.35	0.16	0.12	0.16
Switzerland	2.48	0.36	0.19	0.12	0.07

Source: http://stats.oecd.org/Index.aspx?DataSetCode=EO92_INTERNET

The second important indicator is inflation rate. In general, almost all countries had very low interest rates due to low demand after crisis. However, only in Turkey, the inflation rate was 46 per cent in Turkey at 2003. This is the highest rate among the developed and developing countries just after 2001 financial crisis experienced in Turkey. However, at 2009, it decreased to 11.6 per cent for the first time (Table 2).

Table 2.: Inflation Rates

Time	2003	2004	2005	2006	2007
Country					
Germany	4.1	4.0	3.4	3.8	4.2
Greece	**4.3**	**4.3**	**3.6**	**4.1**	**4.5**
Italy	4.3	4.3	3.6	4.0	4.5
Japan	1.0	1.5	1.4	1.7	1.7
Spain	4.1	4.1	3.4	3.8	4.3
Switzerland	2.7	2.7	2.1	2.5	2.9
Turkey	46.5	25.2	16.5	17.9	18.3
U.K.	4.5	4.9	4.4	4.5	5.0
U. S.	4.0	4.3	4.3	4.8	4.6
Euro 15	4.2	4.1	3.4	3.8	4.3
Time	2008	2009	2010	2011	2012
Country					

Source:OECD Statistics, http://stats.oecd.org/Index.aspx?DataSetCode=EO92_INTERNET

1.1.2. Growth

The World Economy suffered highest contraction at 2009. The World economy and the USA had experienced recovery and expansion since 2009, although, this expansion was slow. The demand is still weak. The US housing market, tight credit conditions in "some sectors" and spillovers from the situation in Europe just avoid more fiscal contraction at all levels of government and concerns about the medium term US fiscal outlook were considered as the main barriers preventing fluent performance of the US economy (Bernanke, 2012 October 14).So, the households and businesses still are very careful for raising either individual or corporate spending. The economic growth has been insufficient to stimulate the employment (Table 3).

Table 3.: Growth Rates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
World	3,4	4,6	4,3	5,0	5,1	2,5	-1,1	4,9	3,7	2,9
Euro 15	0,7	2,0	1,8	3,4	3,0	0,3	-4,3	1,9	1,5	-0,4
OECD – Total	2,1	3,1	2,7	3,2	2,8	0,2	-3,6	3,0	1,8	1,4
China	10,0	10,1	11,3	12,7	14,2	9,6	9,2	10,4	9,3	7,5
Turkey	5,3	9,4	8,4	6,9	4,7	0,7	-4,8	9,2	8,5	2,9
U.K.	3,8	2,9	2,8	2,6	3,6	-1,0	-4,0	1,8	0,9	-0,1
U.S.	2,5	3,5	3,1	2,7	1,9	-0,3	-3,1	2,4	1,8	2,2

Source:OECD Statistics, http://stats.oecd.org/Index.aspx?DataSetCode=EO92_INTERNET

In the table below, it would be seen the growth of Turkish export rapidly. Although, the USA economy suffered from the financial crisis, they had large increased in their export following the China and the USA.

Table 5: Export

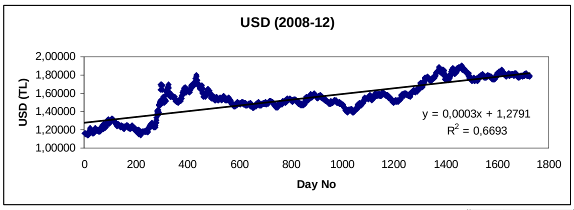
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Turkey	88	98	106	113	121	124	118	122	130	150
China	545	678	837	1.036	1.242	1.347	1.211	1.544	1.681	1.774
U. K.	541	567	618	693	676	684	628	668	698	697
U.S.	1.116	1.222	1.305	1.422	1.554	1.650	1499	1.665	1.777	1.842
Euro- 15	3.395	3.644	3.841	4.193	4.472	4.511	3952.7	4.387	4671.2	4.802
World	10.785	11.917	12.878	14.148	15.237	15.723	14.127	1.595	16.903	17412

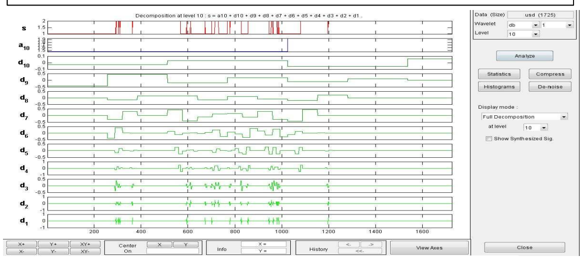
Source: Economic Outlook, No.92 December 2012 OECD Annual Export Data

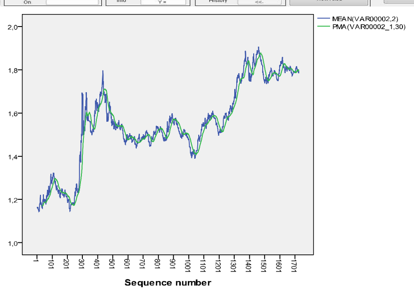
The price reflects both total world demand for oil and total supply by all of the oil-producing countries since the oil prices are global, in different places, prices are identical.

3. ANALYSIS OF USA DOLLAR, EURO, CRUDE OIL PRICES VARIATIONS IN TURKEY

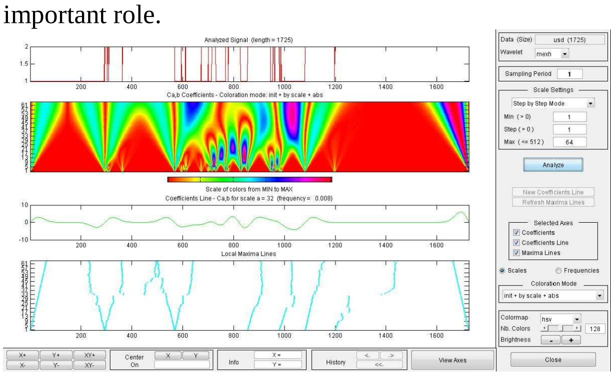
In this paper, the influence of volatility of USA dollar, Euro, the crude oil prices on Turkish Export and import and logistics. Previously, Melek et al (2008) made similar analysis of Dollar values against Turkish Lira between January 1950 and June 2006 by wavelet methods. That study showed the large scale variation in 1960, 1976 and 1985. Here, in this paper, the latest USD dollar, Euro and crude oil prices between 2008-2012 have been used in the wavelet model.







Moving Average Lag=30days (approx. Monthly)
Beginning from March 2011, there is an important increasing trend 1Dwavelet, db, level:10 (USD, 2008-12)October 2010 no small (high frequency influences), commonly large scale (long-term) fluctuations play an important role.



1D Continuous wavelet, Mexh, Sampling Period: 1, USD, 1

July, August 2007 the role of meso scale factors (local) 2009 end, 2010 and beginning of 2011 (data no: 730 - 1095)

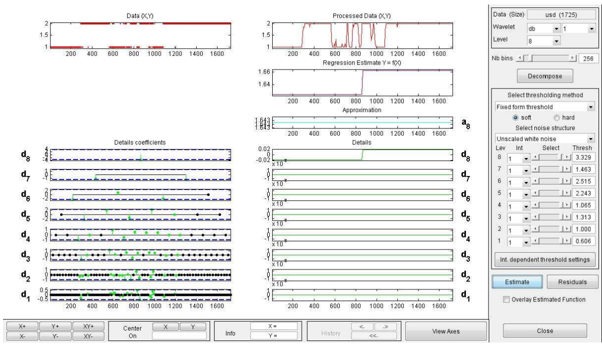
September 2008, The Lehman Brothers, the large investment bank of the World announced its bankruptcy, bank and other financial institutions in 2010:

The role of small (local, regional), meso (country scale) and large scale (global) events play an important role on daily USD Exchange rates (purchasing parity TL). Frequency of occurrence of meso and large scale influences vary between a week and one and a half month. At the end of the year 2010 it increased up to two months.

In March 2011, there are small scale factors with the frequency up to 30 days play an important role on the daily variation of USD exchange rate.

Beginning from approximately April 2011, stable, the role of large scale influences are dominant.

Blue bars show extrems (min or max); beginning from March 2011 no strong minimums.



The financial crisis started by 2008 in the USA. Although, the crisis was due to mortgage crisis, the first impact of the crisis on Turkish market was depreciation of TL against USA dollar. The first impact was on October 2008, the TL / USA Dollar changed 20% against TL. However, the at the end of 2008, the TL / USD Dollar parity changed %45 in comparison to the beginning of 2008. This was the first attack, this large change pushed the domino chain, all other important parts of Turkish economy has been affected.

The primary demand for oil is as a transport fuel, with lesser amounts used for heating, energy,
and as inputs for petrochemical industries like plastics. The increasing demand for oil from all
countries, but particularly from rapidly growing emerging-market countries like China and India, has therefore been, and will continue to be, an important force pushing up the global price (Feldstein,2008:1).

Firstly, after the first year of the global crisis, export declined %30 per cent due to the sharp decrease in the demand of Turkish products on export markets in 2009. The European Union countries are the main trade partner of Turkey for both export and import. In contrast to the 1997 Asia Crisis, or Argentina Crisis, similarly to the great depression of 1929, the crisis has been started from the USA and spill out the European Union countries. The crisis was a radical decrease in Turkish export.

Similarly, import also decreased 30 % per cent. In 2009, the quantity of minibus, truck and lorry production also decreased 30% in comparison to 2008 while export decreased approximately 50%. Sharp decrease on either of these items were due to decrease on demand to the Turkish products in the European Union countries
The economic reforms and stability package applied by the government in the USA; the European Union countries recovered their economies for a while. Due to the recovery, Turkish economy performed better in 2010 and 2011 in comparison to 2009.

However, the depreciation of TL continued during the 2008-2012 period. However, after raising to 1.750 TL for each USA dollar, it decreased to 1.35 TL for each dollar at the end of 2010.

In 2011, due to the crisis in Euro area, the depreciation of TL against USD and Euro was accelerated.

However, the investment to the road has been increased from 2,233 million Euro in 2008 to 2,918 million Euro in 2009 and 5,419 million Euro in 2010 (OECD Statistics, 2012).This can be considered as very surprising development. Although, crisis, the investment to infrastructure continue to increased. This may be also considered as reason of recovery of Turkish economy at a shorter time and getting high growth rates even at the time of global crisis.

4. CONCLUDING REMARKS

In this study, the volatility of foreign exchange has been analysed and the relationship between the volatility of foreign exchange and the investment has been analysed. Although, in the first year of crisis, there was large fluctuation on volatility of USD dollar, Euro and sharp decreases on export and import of Turkey, the only positive development was the increase in investment of infrastructure of road, so the logistic industry and international economy. This can be considered as the first and strong stimulus for the following years high growth rates of Turkey.

5. REFERENCES

[1] BERNANKE, BEN (2012;October,14)“ *U.S.Monetary Policy and International Implications”* Remarks by Ben.S.Bernanke, Chairman of Board of Governmors of the Federal Reserve System. ”Challenges of Global Financial System: Risks and Governance under Evolving Globalization”. A High Level Seminar Sponsored by Bank of Japan and International Monetary Fund, Tokyo, Japan, October 14, 2012

[2] BUBULA, ANDREA and INCI ROBE-OTKER (2002). *The Evolution of Exchange Rate Regimes Since* 1990: Evidence from the De Factor Policies. IMF Working Paper. Working Paper No: 02155 http://www.imf.org/external/pubs/ft/wp/2002/wp02155.pdf

[3] DOOLEY, M. L., FOLKERTS AND PETER GARBER BRETTON Woods II Still Defines *The International Monetary System”*. National Bureau of Economic Research. Working Papers. No.14731, 2009 .http://www.nber.org/papers/w14731

[4] FELDSTEIN, MARTIN ” *The Dollar and the Price of Oil”* National Buraue of Economic Research Working Papers, 2008
http://www.nber.org/feldstein/dollarandpriceofoil.syndicate.08.pdf

[5] GREENSPAN, ALAN (2010). “ *The Crisis*”. Seminar Paper. Brooking Institute.
http://www.brookings.edu/~/media/projects/bpea/spring%202010/2010a bpea green span.pdf

[6] International Monetary Fund (2009),” *Review of Recent Crisis Programs”* Approved by Reza Moghadam, R. International Monetary Fund

[7] MELEK, M., A. TOKGOZLU AND Z.ASLAN “*Wavelet Analyses of Oil Prices, USA Variations and Impact On Logistics.*” International Wavelet Congress, 2008

[8] MISHKIN, F. “*Over The Cliff: From The Subprime To The Global Financial Crisis*”. NBER Working Paper Series.No.16609, 2010
http://www.nber.org/papers/w16609

[9] MISHKIN, F. “*Anatomy of a Financial Crisis”*. Journal of Evolutionary -Verla Economics”. p: 115-130, 1992

[9] OBSTFELD, M. AND KENNETH ROGOFF, The Unsustainable US Current Account Position Revisited URL: (2007).
http://www.nber.org/chapters/c0127
[10] Obstfeld, M and Kenneth Rogoff(2007) G7 Current Account Imbalances: Sustainability and Adjustment. Volume URL: http://www.nber.org/books/clar06-2
[11] OZTURK, İ., *"Exchange Rate Volatility and Trade* : A literature Survey" International Journal of Applied Econometrics and Quantitative Studies Vol.3-1, 2006
[12] RODRIK, DANIEL., *The Globalization Paradox.* W. W. Norton Company Ltd.ISBN978-0393-7161-0, 2011
[13] OECD Statistics Department. Statistics(2013 http://stats.oecd.org/Index.aspx? DataSetCode =EO92_INTERNET
[14] SIDDIQI, A., ASLAN, Z. AND TOKGOZLU,A. *Wavelet based computer simulation of some meteorological parameters:* Case study in Turkey", Trends in Industrial and Applied Mathematics. H. Siddiqi and M. Kocvara (Editors), pp. 95-105, Kluwer Academic Publishers, London, 2002.
[15] STIGLITZ, JOSEPH., " *The Overselling of Globalization*" Seminar Paper, 2005
http://cgt.columbia.edu/files/papers 2005_Overselling_Globalization.pdf
[16] WHITE, WILLIAM" *Credit Crises and the Shortcomings of Traditional Policy Responses*" OECD Economics Department Working Papers".No.971, OECD Publishing. OECD Economic Department Working Papers No.971, 2012)
http://www.oecdilibrary.org/ docserver/ download/5k97gkd582vb.pdf?expires=136407436 5&id=id&accname= guest&checksum=18491D59EEB4AF53269BCFB39694 6ED8

Annex A: Data used in Analysis

		EXPORT	CRUDE OIL	Foreign exchange
		USD $	USD $	TL- $ Parity
2003	1	353,370,600	273.92	1.63
	2	292,346,000	293.75	1.64
	3	390,825,600	275.88	1.65
	4	366,218,300	239.99	1.65
	5	386,047,100	207.42	1.67
	6	379,611,400	213.77	1.43
	7	423,611,400	239.05	1.40
	8	382,872,600	229.66	1.40
	9	411,467,800	211.88	1.38
	10	482,438,800	231.62	1.43
	11	396,969,700	195.98	1.48
	12	459,504,200	191.98	1.43
2004	1	461,966,100	203.93	1.35
	2	366,450,300	197.81	1.33
	3	521,804,200	201.24	1.33
	4	507,246,300	242.8	1.36
	5	517,006,200	238	1.52
	6	528,438,300	243.43	1.50
	7	563,213,900	253.63	1.45
	8	470,749,100	253.63	1.48
	9	565,628,400	270.87	1.51
	10	586,734,200	241.72	1.49
	11	573,390,900	206.7	1.45
	12	654,087,400	213.43	1.40
2005	1	499,728,000	230.14	1.36
	2	565,174,100	265.97	1.31
	3	659,185,900	321.04	1.31
	4	612,813,200	327.39	1.36
	5	597,722,600	333.79	1.37
	6	603,853,400	347.7	1.36
	7	576,346,600	351.82	1.34
	8	555,286,700	387.36	1.34
	9	681,426,900	398.84	1.34
	10	677,217,900	369.84	1.36
	11	594,257,600	343.78	1.36
	12	724,627,900	353.46	1.35
2006	1	513,304,900	397.46	1.33
	2	605,825,100	426.75	1.33
	3	741,110,200	453.28	1.32
	4	645,609,000	497.21	1.34
	5	704,154,300	527.55	1.43
	6	781,543,400	491.71	1.60
	7	706,741,100	437.04	1.55
	8	681,120,200	413.88	1.47
	9	760,655,100	398.63	1.43
	10	688,881,300	389.32	1.48
	11	864,147,500	364.65	1.46
	12	860,375,300	363.64	1.43
2007	1	656,455,900	405.67	1.43
	2	765,695,100	437.36	1.40
	3	895,785,100	437.36	1.41
	4	831,331,200	437.36	1.36
	5	914,762,000	452.21	1.34
	6	898,024,700	454.46	1.32
	7	893,774,100	480.17	1.28
	8	873,668,900	501.14	1.32
	9	903,874,300	498.04	1.26
	10	989,521,600	516.19	1.20
	11	1,131,879,800	585.54	1.20

	12	972,401,700	557.86	1.18
2008	1	1,063,220,700	537.52	1.00
	2	1,107,789,900	528.72	1.20
	3	1,142,858,700	599.61	1.24
	4	1,136,396,300	660.54	1.30
	5	1,247,796,800	706.99	1.25
	6	1,177,063,400	770.13	1.23
	7	1,259,542,600	861.93	1.21
	8	1,104,683,000	771.87	1.18
	9	1,279,314,800	723.87	1.24
	10	972,270,800	630.76	1.50
	11	939,587,200	480.04	1.60
	12	772,194,800	324.2	1.54
2009	1	788,449,300	362.2	1.60
	2	843,511,500	419.37	1.66
	3	815,548,500	430.58	1.71
	4	756,169,600	477.81	1.61
	5	734,640,700	530.86	1.56
	6	832,969,200	615.44	1.55
	7	905,573,300	618.14	1.52
	8	783,990,800	671.29	1.49
	9	848,070,800	673.5	1.49
	10	1,009,576,800	655.73	1.49
	11	890,301,000	717.44	1.49
	12	1,005,459,100	717.44	1.51
2010	1	783,600,700	729.54	1.47
	2	826,901,300	715.07	1.52
	3	989,208,100	715.07	1.53
	4	940,227,400	738.14	1.49
	5	980,095,900	731.93	1.55
	6	954,182,100	702.86	1.58
	7	957,654,800	710.22	1.54
	8	852,478,100	720.56	1.51
	9	891,207,900	705.01	1.49
	10	1,096,803,600	705.01	1.42
	11	939,184,500	721.16	1.44
	12	1,186,015,900	759.11	1.52
2011	1	9551000000	813.41	1.60
	2	10059000000	685.7	1.55
	3	11811000000	738.3	1.55
	4	11873000000	824.9	1.51
	5	10943000000	805.2	1.59
	6	11350000000	739.2	1.63
	7	11860000000	732.6	1.67
	8	11245000000	753.2	1.75
	9	10751000000	719.9	1.85
	10	11907000000	789	1.75
	11	11079000000	755.8	1.84
	12	12477000000	733.2	1.91
2012	1	10349000000	802.4	1.78
	2	11749000000	825.3	1.76
	3	13210000000	827.6	1.77
	4	12632000000	875.7	1.75
	5	13133000000	833.1	1.83
	6	13234000000	760.6	1.82
	7	12833000000	665.7	1.81
	8	12834000000	724.6	1.81
	9	12960000000	794.9	1.78
	10	13205000000	802.4	1.79

Source: Export and Crude Oil Prices Turkey Statistics Institutions, www.tuik.gov.tr ;

TL –Parity: Central Bank of Republic of Turkey www.tcmb.gov.tr

ISSN 1582 – 3601

„Nautica" Publishing House,
Constanta Maritime University

Editura
NAUTICA