Henri COANDA 100: Celebrating 100 years
from the first jet flight
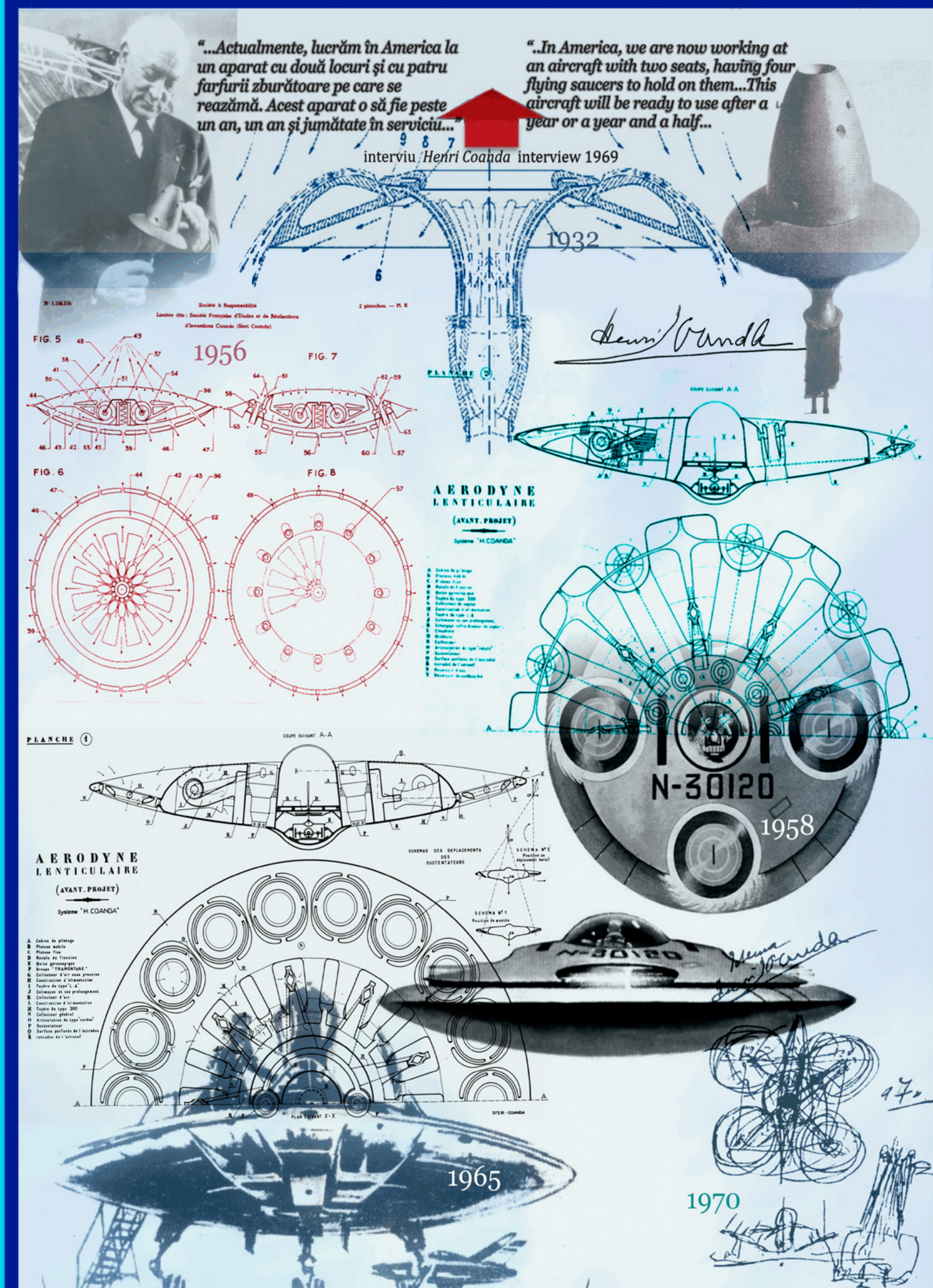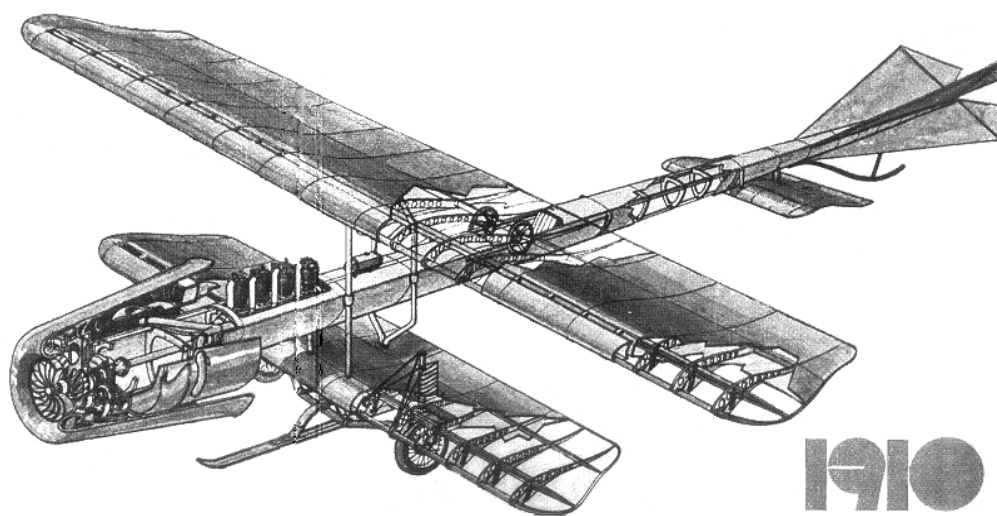
BRAŞOV

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Henri Coanda 100 - Celebrating 100 years from the first jet flight

Braşov

Henri Coanda is not important for the simple fact that he made a plane, but for the fact that this very plane managed to revolutionize all the existent concepts up to that moment: it did not have a propeller. There were, of course more prototypes, on cold and thermal propulsions. The results of his research at that time were initially modest, as it usually happened with any one of us, but it was important that he came up with a new idea. Moreover, Henri Coanda's name is not associated with this field of research only. He was a polyvalent personality. I personally had the chance to meet him and collaborate with him and I appreciated his competences in various areas, regarding both technical issues and general knowledge. He was an enthusiastic supporter of inventors, a zealous person, described by one of his professors as an "eager beaver". The jet propulsion was not necessarily something new – it had been in place thousands of years ago before Christ: Ezekiel's cart, Heron of Alexandria, the Chinese or the Mandarins' inventions -; the novelty consisted of Coanda's idea of applying it to a flying machine. And it was Henri Coanda's revolutionary contribution to the future of the jet propulsion in aircraft construction. I could as well compare Coanda with Beethoven, who, in his time, was severely criticized by contemporaries for discrediting the German music school. Similarly, Henri Coanda launched new concepts, namely, the water crystallization systems, containers (tubes), concrete wagons and many other inventions… It is really hard to remind all of his inventions… Coanda involved himself in a multitude of research fields and raised intelligent issues in most of them…

Justin Capra, Romanian inventor

The opening speech delivered at The Polytechnic University Museum, Bucharest

June, 8, 2010

C O N T E N T S

Contents

"COANDA 1910" JET AIRCRAFT – THE FIRST JET AIRCRAFT OF THE WORLD

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Abstract: We are now celebrating one hundred years from the test of the world first jet aircraft. This aircraft was designed, built and tested in France by the Romanian inventor and engineer Henri Coanda, at the age of only 24 years. The moment we consider that attests the first run of this jet aircraft, seems to be the test of the aircraft from the 16th of December 1910, from Issy les Moulineaux, near Paris, France. It wasn't really a controlled certified flight, because Henri Coanda didn't intend to fly in that day, but we believe that the plane left the ground for a moment, before it hit the wall around Paris, and caught fire.

Keywords: Henri Coanda, "Coanda 100" Jet Aircraft, first jet aircraft.

1. THE INVENTOR

Henri Coanda was born in Bucharest in 1886 on 7th of June.

Fig. 1 Henri Coanda at the 24 years old [1]

At the 24 years old, at the moment of the testing of the first jet aircraft, Henri Coanda was qualified as aero-engineer, licensed of Paris and Liège Faculties, as it was mentioned inside the paper presented that next to his jet aircraft.
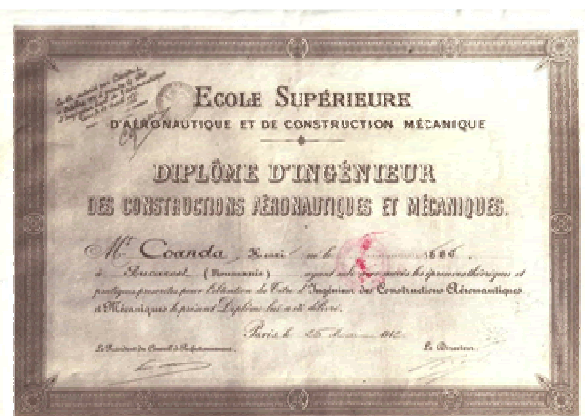
Fig. 2 Henri Coanda's *Diplôme d'ingénieur* [2]

At only three years after the test of the first jet aircraft, Henri Coanda was designated the MEN of the MOMENT IN THE WORLD of FLIGHT – 1913 as a technical director at *British and Colonial Aeroplane Co.*

Fig. 3 Henri Coanda's *Diplôme d'ingénieur* [3]

Henri Coanda was Rodin's student and he was friend with Constantin Brancusi. One of Coanda's sculpture, made near after the dead of his first child Monique (possible 1911), is „Christ en Croix", from Migne Auxaunce Church, near Poitier, France.

Fig. 4 Christ en Croix

It was the first ever jet aircraft ever built and presented at *The Second Aeronautical Exhibition* from Paris, in October 1910.

The first jet aircraft in the world was designed, built and tested by the briliant inventor and engineer Henri Coanda, when he was only 24 years old.
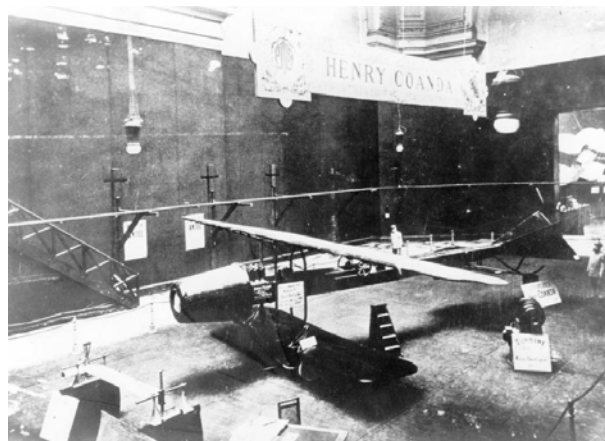
Fig. 5 Coanda 1910 [4]

Type of the aircraft:
- biplane with two known places (maybe even three places or luggage place);
- jet without propellers, using „turbine" (in according with the name that Coanda gave it in 1910), means centrifugal compressor after nowadays name.

Dimensions and performances:
Span: 10,3m,
Chord: 1,75m,
Length of the aircraft: 12,5m,
Lift surface: 32sqm,
Wing charge: 33kg/sqm
Weight, without pilot: 420kg,
Thrust turbine: 220kg at 50HP

Main structure:
- wood and steel fuselage, covered with thin wood plates;
- rounded triangular fuselage sections, having in the back of it, a tail having the St Andrei cross shape;
- airfoil that has a central moving point;
- unequal wings;
- aerodynamic nervures at the down part of the wing;
- landing system with two wheels and two slades in front and the back of the plane.
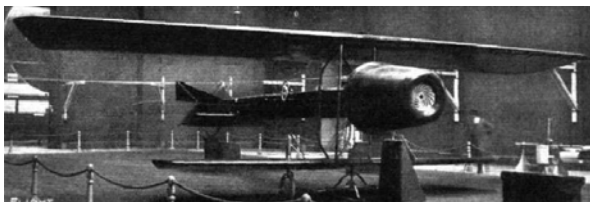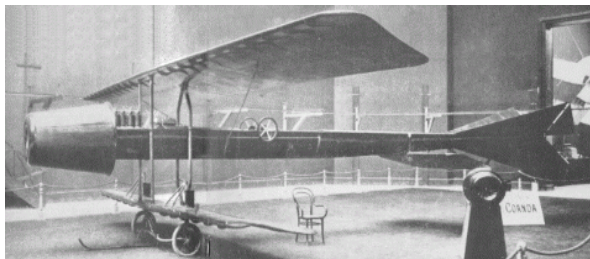
Fig. 6 Coanda 1910 [4]

- longitudinal stability done by the St Andrei cross shape of the tail, for vertical and horizontal movements;
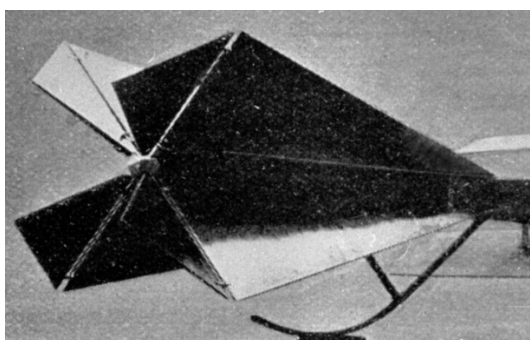
Fig. 7 Coanda 1910's tail [4]

- two separate hand wheel for tail control, that if they were simultaneous acting, were done up and down movements and if they were differential acting, were done lateral movements.
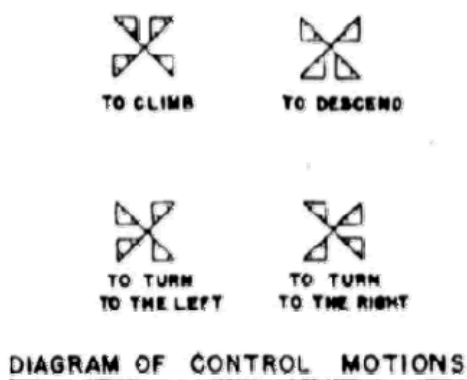
Fig. 8 Diagram of control motion [5]

Thrust:
- thrust done by turbine reaction inside the engine(in according with the name done by H. Coanda back in 1910);
- jet thrust (in according with the actual definitions).

2. 50HP CLERGET TYPE 4V PISTON ENGINE

The jet system were made from a single 50HP CLERGET type 4V piston engine +multiplicator speed up to 4000rpm +metal centrifugal compressor (two known variants) +injectors and burners (in according with Coanda says).
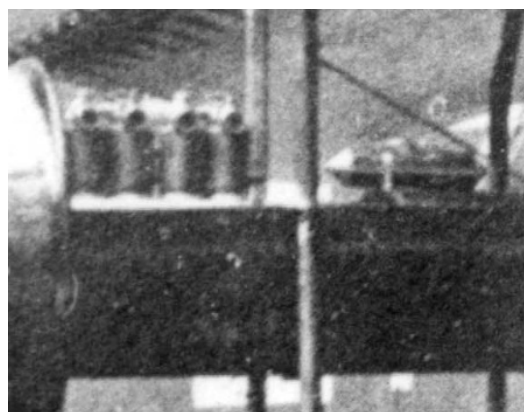
Fig. 8 50HP CLERGET type 4V piston engine

A similar engine from 1909, is now expose at the Technic Museum fromVienna, in according with Aircraft Engine Historical Society - AEHS.

Fig. 9 A similar engine [6]
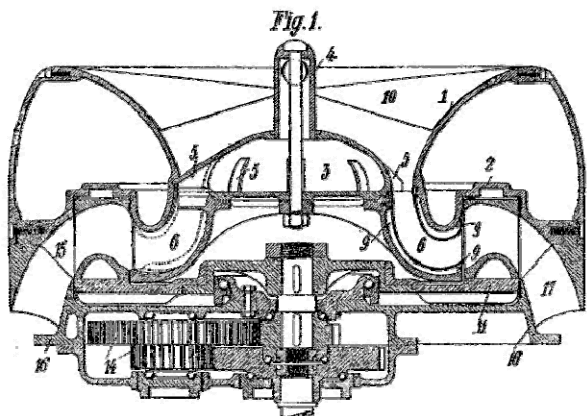
Fig. 10 Multiplicator speed up to 4000 rpm
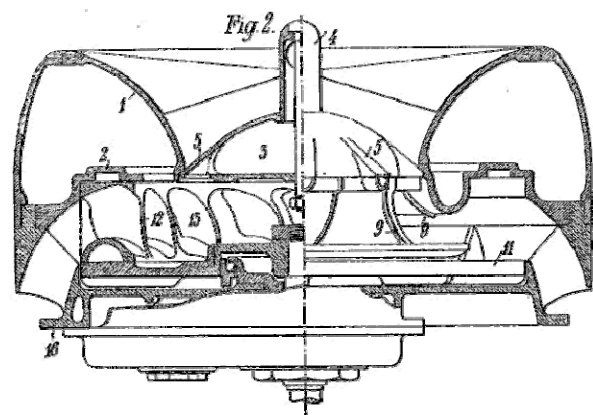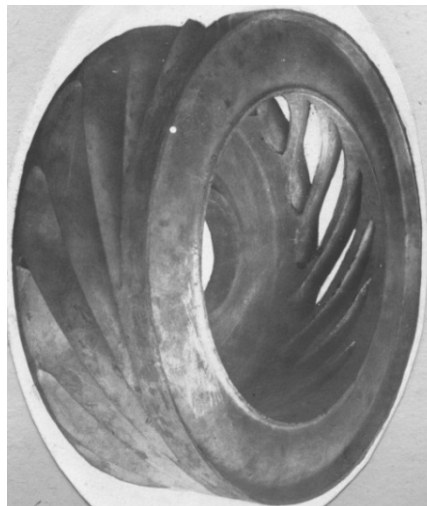
Fig. 11 Metal centrifugal compressor (two known variants)

Fig. 12 The rotor and static parts

The rotor of the Coandă 1910 jet aircraft was made to accelerating air, similar to a centrifugal compressor, with rotation per minute up to 4000, placed in a conique shape.

The second way for building the 1910 jet thruster was indicated by Coanda, late in December 1910, similar to next one, indicated below.
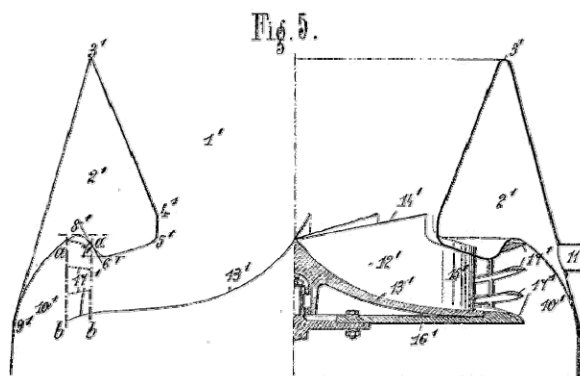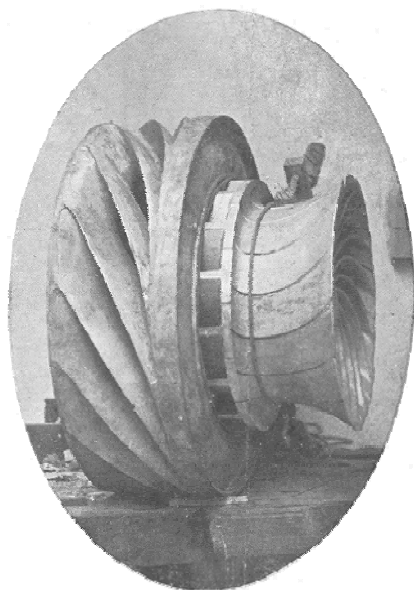
Fig. 13 The second way for building [7]

This device was used to thrust the Gregoire-Coanda slade, with a 30HP Gregoire engine, with near to 50 miles/houre, in according with its marketing texts back to December 1910.
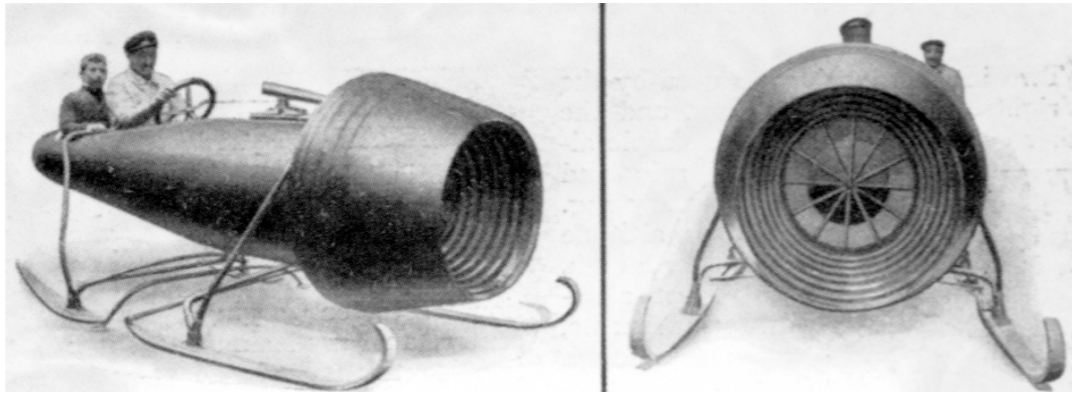
Fig. 14 Drawings from popular Mechanism from March 1911

The slade was a special order from the Grande Duke Cyril of Russia and was baptized by the priests of the Russian Church.
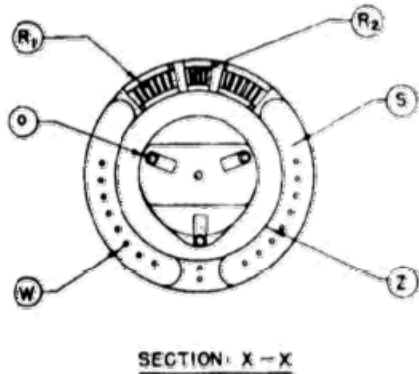
Fig. 15 Injectors and burners (in according with Coanda says later in 50's) [5]

The jet system According to what Coanda says later, after the World War II, the 1910 thrusters has after the turbine (rotor) a burner having two „reactive tubes" placed in „both parts" of the wooden fuselage.

In these tubes probably were placed a burning process capable to generate two „powerful flames" that produces a „temperature that feels too much" enough to determine the young pilot (Henri Coanda) to „cover these flames, up and down, using two mica plates".

It seems to be the main cause of burning the hole aircraft. We believe that during May 1910 and December 1910 the jet aircraft *Coanda 1910* had supported many updatings, many of this never had been drawn or patented.

3. THE TEST MOMENT

Place. In according with Coanda says the main test was at the 16th of December 1910 at Issy les Moulineau near Paris.

Fig. 16 Issy les Moulineux [8]

Weather. In the 1910 was recorded grate floods in Paris and Issy les Moulineaux.

Fig. 17 Airfield in fold [9]

According to Mr. Cyril Dupont researches about the weather in Paris of 1910, it had been raining every day between 1st and 15th of December and between 18th and 19th of December. In the 16th and in the 17th the weather was calm with no rain. The 16th of

December was the date of the first test of the first jet aircraft. It was Friday.

The test. In according with Coanda says, the main test done in a December cold morning, without any officials because he didn't intend to make any decisive test, but to move the aircraft with the turbo engine in running. For the time being, we have only Coanda's testimony during recorded and written interviews, late after the World War II. This first flight was described by Coanda in 1964 as follows [10]:

"The machine gained height much faster than I thought; it was not my fault, but after a while it entered a glissade, stroke the ground and burned completely. I was very lucky I was not tied on the chair, such that I was pushed out when the airplane stroke the ground; otherwise I would have burned with it.
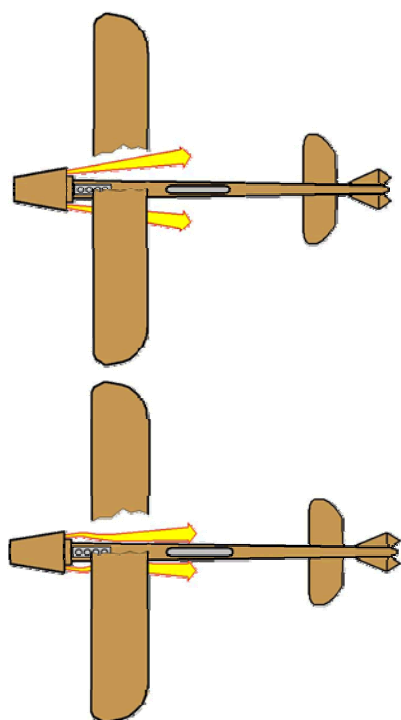
Fig. 18 The first flight

In 1910, the wind tunnel was unknown but I found a way to test the design. I mounted the wings on a railroad locomotive and was able to watch their performance in this fashion. Finally, after all the tests were over and the machine assembled, we prepared for the first experiments. In December, we brought the air plane out of its hangar at Issy-les-Moulineaux and, after a bit of coaxing, started the motor.

I must admit that I was never a very outstanding pilot. I always seemed unable to shake off a vague apprehension and, that morning, in addition to my usual uneasiness, I was rather excited.

I climbed into the cockpit, accelerated the motor, and felt the power from the jet thrust straining the plane forward. I gave the signal to remove the wheel blocks, and the plane started moving slowly ahead. I had anticipated that I would not attempt to fly today, but would make only ground tests on the small field at Issy-les-Moulineaux.

The controls seemed too loose to me, so I injected fuel into the turbine. Too much! In a moment I was surrounded by flames! I had to cut back and reduce my power quickly.

I worked the throttle and the flames subsided. Only then did I have opportunity to lift my head. I saw that the plane had gained speed, and that the walls of the ancient fortifications bordering the field were lunging toward me. I pulled back on the stick, only much too hard.

In a moment, the plane was airborne, lunging upward at a steep angle. I was flying . . . I felt the plane tipping . . . then slipping down on one wing.

Instinctively, I cut the gas with my left hand and the jet fuel with my right. The next thing I knew, I found myself thrown free of the plane, which slowly came down, and burst into flames. It was impossible to determine from the wreckage whether the celluloid or the fuel was the cause of the fire.

But the test was over. I had flown the first jet airplane." [11]

3. THE TIME AFTER THE TEST

A financial disaster

"… I was lucky, so very lucky to have general Coanda for my father. He was not only a father to me, but also a friend, a counselor; he used to be a professor at the Polytechnic School, he had a PhD at Sorbonne, although he had been an officer, he graduated from the Polytechnic School in

Paris, all in all, he was a man of an extraordinary refinement and quality. And, at that time, having this opportunity, all that came to my mind could be achieved due to him. Americans asked me about the way I managed to sustain the construction of my first jet airplane financially. I could only tell them that it was achievable once I had started to write...

'Oh..., they wondered, so you are a writer!'

I replied 'No, I am not.' I was writing to my father! The truth is that but for my father and family – who disappeared – I could not possibly build my first jet airplane... I did not only make the whole reactor, by drawing it and building it, but I had to design the entire airplane system – at a time when nobody had any idea of how it can be made. I used to have a friend, named Bleriot, who used to manufacture car headlights and was also trying to make an airplane, but to me, building the first jet airplane turn into a disaster, form a financial point of view. From the technical perspective, it was extremely interesting, though, because only after I had built it I realized what was that we, today, call the Coanda effect... It was an accident... I could see the flames coming out towards the fuselage. This system proved to be the Coanda effect later on, but it took me 20 years until I realized what phenomenon had caused the flames to be led from their axis towards the wooden fuselage of my airplane." [12]

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2. "Dimitrie Leonida" National Technical Museum, Bucharest;
3. Flight Revue, 24th of May 1913, p. 557;
4. www.jet100.com;
5. Dudko drawing, 1965;
6. http://www.enginehistory.org/technical_m useum.htm;
7. Suisse patent CH58323 from 26th of May 1911;
8. http://maps.google.com/;
9. http://inondation1910.free;
10. http://www.ctie.monash.edu.au/hargrave/br istol.html;
11. Flying Revue from 1956;
12. *Excerpt from an interview with Henri Coanda, soon after his return to Romania, probably in 1967.*

REVIEW OF APPLICATIONS ON COANDĂ EFFECT. HISTORY, THEORIES, NEW TRENDS

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Abstract: The Coandă effect is an interesting phenomenon in fluid mechanics discovered by the Romanian inventor Henri Marie Coandă. The physics of the Coandă effect is based on the property of a jet flow to attaches itself to a nearby surface and to remain attached even when the surface bends away from the initial jet direction. In free surroundings, a jet of fluid entrains and mixes with its surroundings as it flows away from a nozzle. The final result is the deflection of the external flow and generation of lift forces. After 2000, the Coandă legacy was valued by researchers from many countries, mostly by developments and patents in the field of small Unmanned Aerial Vehicles (UAVs).

Keywords: Coandă effect, attached jet, ejectors, UAVs, lift forces.

1. INTRODUCTION

The purpose of this article is to highlight that the utilization of the Coandă effect is still a present-day subject in the propulsion area, in spite of all the theoretical and experimental analyses conducted the last years we cannot claim that a definitive conclusion has been made regarding the capabilities, the application possibilities and the performance of the devises that use the Coandă effect.

Henri Coandă (1969) defined the phenomenon: "… the Coandă effect relies on the principle of creation a depression zone in the air, along a wall, which allows the fluid to project itself onto and take the direction of the wall were the depression was generated… which can be used in various applications…"

Coandă effect is a classic phenomenon in fluid mechanics and one of the fundamental discoveries of the Romanian inventor Henri Marie Coandă (1886-1972). Henri Coandă was a Romanian inventor, aerodynamics pioneer and the designer and the builder of the world's first jet powered aircraft, the Coandă-1910, a revolutionary plane of the 20th century beginning.
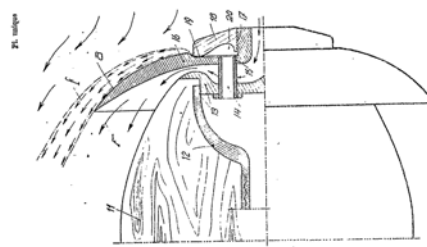
Fig. 1 Coandă patent "Perfectionnement aux propulseurs" [4]

In his first patents related to Coandă effect applications, in order to generate the jet of fluid over the upper surface of the fuselage, H. Coandă was using mainly other means than a rotor, i.e. a burner or a combustion chamber. But in a patent he obtained in 1935 [4], he was enumerating the possibility to use also a centrifugal fan for supplying the necessary air flow.
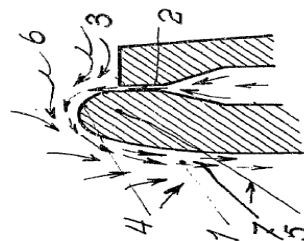
Fig. 2 Coandă patent "Procédé et dispositif pour faire dévier une veine de fluide pénétrant dans un autre fluide" [6]

Immediately after the phenomena discovery, the inventor H. Coandă took into consideration the problem of physical and mathematical modeling of the effect in order to control and to determine its limitations.

The phenomena being extremely complex he had to seek aid from renowned theoreticians of that time. In the chronological sense it was the first attempt of theorizing the phenomena. In aeronautics, this effect is already used to expand the performances of small helicopters, in the no tail rotor (NOTAR system) configuration [13].

2. BASIC THEORETICAL ASPECTS

We are considering that the opening slit width of the section is b_0, it has its normal line perpendicular on the jet axes (Fig. 3) and because of the presence of the Coandă profile on one of its sides that limit's it an asymmetrical flow appears (Fig. 4) which remarks itself trough an asymmetrical distribution of the gasodynamic parameters in that section.
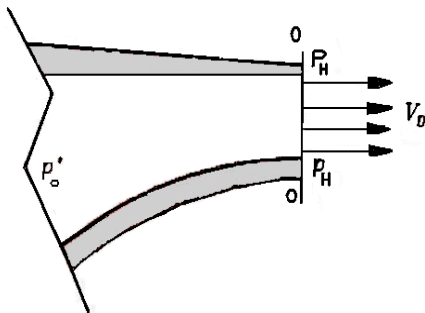
Fig. 3 Slit flow of free jet
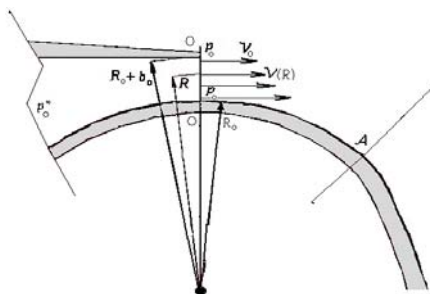
Fig. 4 Flow with Coandă effect

The distribution of the speed of slackening V_0 from p_0^* to the ambient pressure p_H is:

$$V_0 = \sqrt{2\left(i_0^* - i_H\right)} = \sqrt{2i_H^*\left[\left(\frac{p_0^*}{p_H}\right)^{\frac{k-1}{k}} - 1\right]} \quad (1)$$

The variation of speed depending on the radius, it is thought to be:

$$V(R) = V_0\left(\frac{R_0 + b_0}{R}\right)^n , \text{ and we have}$$

$$V_0 = V\left(R_0 + b_0\right) \qquad (2)$$

In the case were the radius of the slit curb is bigger compare to the slit opening, we can make the approximation that the brake enthalpy is constant on the radius and the asymmetrical effect is caused by the variation of the static pressure from p_H in the upper part of the slit, till p_0 on the wall in the lower part of the slit.

3. THE PHYSICAL-MATEMATICAL MODELS OF THE COANDĂ EFFECT

As a natural phenomenon, Coandă effect describes the tendency of a fluid jet to be attracted to a nearby surface (flaps or airfoils), consecutively his profile being characterized by a significant asymmetry.

In free surroundings, a jet of fluid entrains and mixes with its surroundings as it flows away from a nozzle. When a surface or another stream is placed close to the jet, this restricts the entrained air flow from surroundings into that region. As flow accelerates trying to equalize the transfer momentum, a loss of pressure results across the jet and the jet is deflected closer to the surface, up to attaching to it.

The global stream that results from the mixing between the main flow and the displaced one is adherent to the wall and is characterized by a lower temperature than the initial one.

When studying Coandă effect, it is possible to notice the following aspects (Fig. 5):

The depressurized zone (3) has as effects:

- Flow acceleration upstream in the slot (1), without increasing upstream pressure or temperature,

- Displacement of the local fluid.

15

Detaching and re-attaching is characterized by hysteresis (i. e. the reattaching is produced at smaller angles than the detaching).
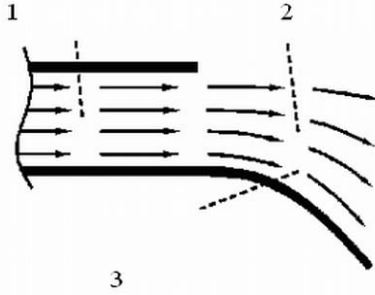
Fig. 5 Coandă effect (2D)

3.1. Metral Model (1938). From all the effects generated by the asymmetrical flow (Fig.6), this study focuses mainly on "increasing the flow speed of a fluid which passes from a pressure p_R in a reservoir, to a pressure p_0 in another fluid environment, without increasing its original pressure or temperature", as mentioned before the starting the analysis, namely on the acceleration of the flow in the channel situated upstream to the split.

The calculation assumptions were those of a perfect and incompressible fluid, for a 2D flow. We can claim that: "it is useless to determine the thrust of the ejection device through the integration on the pressures along the flap". It will be sufficient because the analysis is made on a static fluid (environment), to calculate the impulse per second on a cross section of the jet speed V_0:

$$M = b \cdot h \frac{V_{01}}{V_0} \sqrt{2\rho_H (p_{01} - p_0)} = p_H \cdot b \cdot h \frac{V_{01}}{V_0} V_0 \tag{3}$$

where M is the mass flow [kg/s], h is the gap width [m] (perpendicular to the horizontal plane):

$$F = M \cdot V_0 = p_H \cdot b \cdot h \frac{V_{01}}{V_0} V_0^2 \tag{4}$$

F = thrust of the ejection device [N]

$$P = F \cdot V_0 = p_H \cdot b \cdot h \frac{V_{01}}{V_0} V_0^3 \tag{5}$$

P = necessary power [W]
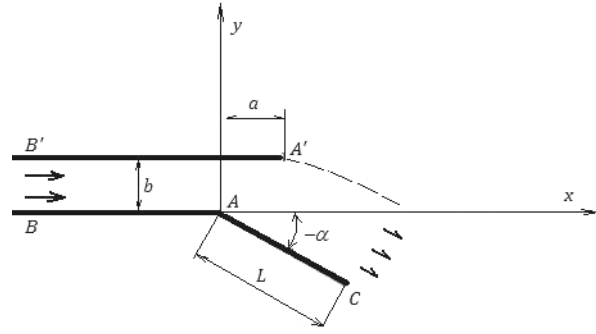
Fig. 6 The flow scheme and notations used by Metral

We can point out the mode in which the calculation of the ejection device is made, taking in account only the rise in flow inside the slip alimentation channel, but not the interaction between the primary fluid and the environmental one.

Actually this aspect derives from the working conditions.

The idea that can be extracted here is that "the ejection device produces the same thrust as a tube at which the opening (slip) is with V_1/V_0 bigger", therefore it necessitates an analysis in which the compressibility factor is taken into account, as it will be the case later.

3.2. Teodorescu-Țintea Abordation (1965). In the Teodorescu-Tintea model, (1964) presented in Fig. 7, the trajectory of the curved jet axes was studied, and the gasodynamic forces, the center of pressure and the acceleration of the flow in the channel were all determined, this leading to a rise of flow which .

In the study of the equilibrium condition for the circular flap is noticeable that the centrifugal force and the pressure force are in equilibrium. According this, the condition for radial equilibrium looks like:

$$dm \frac{V^2}{R} = R \cdot d\theta \cdot dp \tag{6}$$

The conclusions are that the jet trajectories are parabolic and the flow characteristics and the forces that stress the flap are affected by the initial parameters of the flow and the flap form.

a) planar flap

b) parabolic flap

c) circular flap
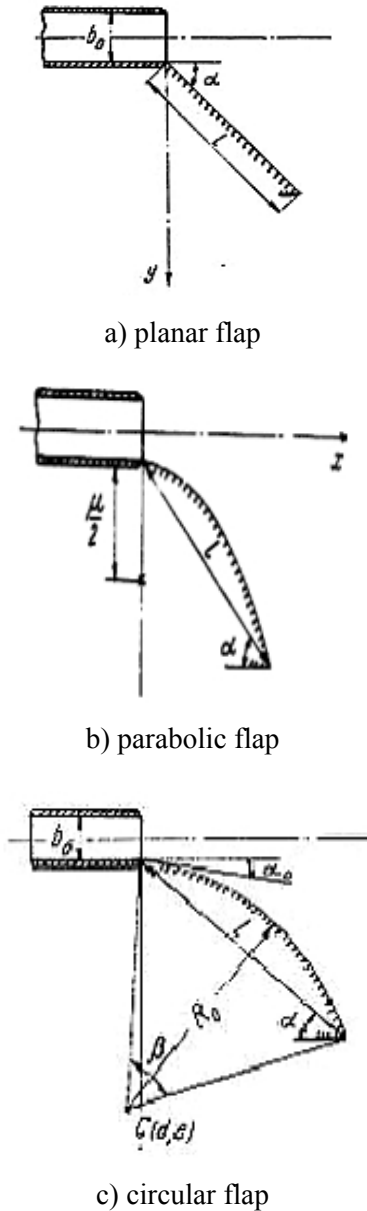
Fig. 7 The trajectory of the curved jet axis

3.3. The Medeot approach (1971). In his paper (1971), Renzo Medeot, researcher at the Research Center in Padua, Italia, studied the phenomenon of jet attachment for a device which allows the obtaining of a combustion with a bluish flame produced without any mechanical parts in motion (the drawings in Fig. 8 are those of the author).

$$\frac{dp}{dR} = \frac{\rho \cdot V^2}{R} \qquad (7)$$

Supplying with pressure from usual blowers (40 mmH$_2$O) it is possible to produce a sufficient recirculation for obtaining bluish flame combus.
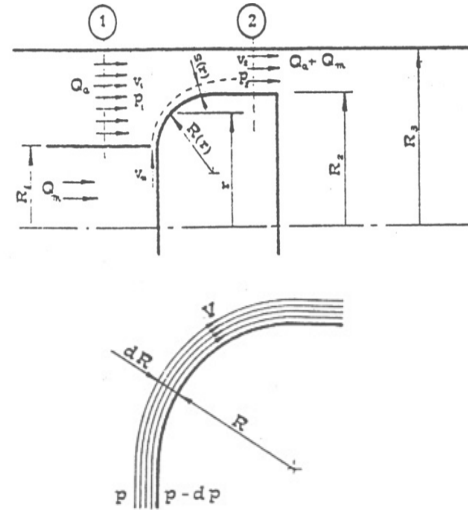
Fig. 8 The Medeot approach

4. MODERN APPLICATIONS OF COANDĂ EFFECT

Flaps and wing flow control based on Coanda effect.

In 1964 - the original Boeing 387-80, the prototype of the famous 707, in a very easy flight uses, for the first time, flaps driven by the Coandă effect (Fig.9).
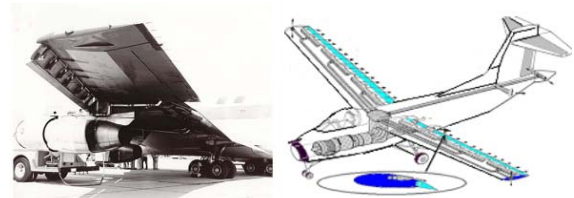
Fig. 9 Flaps driven by the Coandă effect

2004 - In [11], Rogers and Donnelly presented experiments of controlling the flow on the wing, using the Coandă effect (Fig. 10).
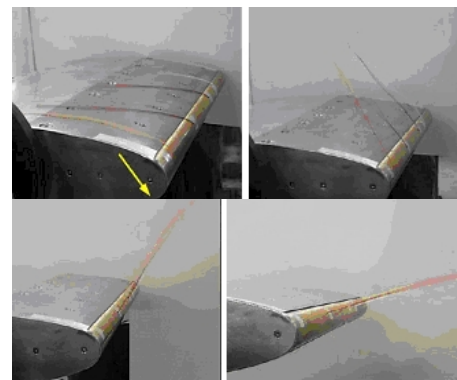
Fig.10 View of the resulting trajectory (Rogers, et al. 2004)

No tail rotor. December 1981 – NOTAR (No Tail Rotor) system helicopter (MD Helicopters, NOTAR 1981) is a prestigious accomplishment of McDonnell Douglas Helicopter Systems in the application of Coandă effect (Fig. 11).

In 1992, took place the first NOTAR helicopter flight. The air pumped through the tail beam exits through slits forming two jets which together with the airflow induced by the lift rotor form a boundary layer's had takes the beam tail, creating an area of depression on the right side.
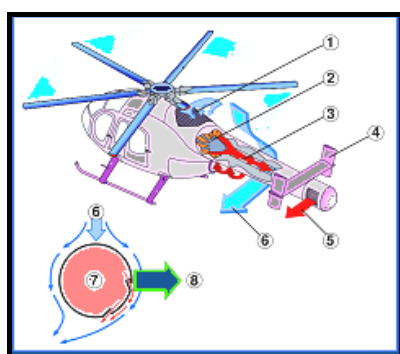
Fig. 11 The NOTAR system: 1 - air admission,
2 - fan pitch, 3 - beam slits, 4 - stabilizer,
5 - directed jet, 6 - air induced by the main rotor
7 - low pressure air through the tail beam,
8 - anti-torque force

The advantage of this system is that the anti-torque force is directly proportional to main rotor lift, the system has self compensation, resulting from the fact that when the rotor produces a higher moment, results in a stronger downward current, resulting in amplification of anti-torque force (Fig. 12).
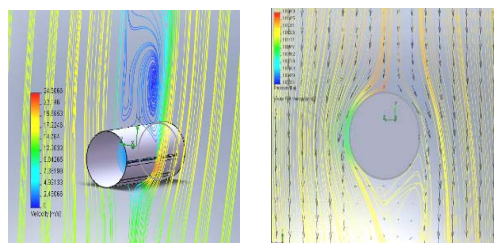
Fig. 12 The NOTAR system - 3D view of the Coandă effect on the flow on the tail beam

This optimization allows the suppression of the anti-torque rotor, thus eliminating its disadvantages.

This leads us to benefit from a new favourable arrangement for creating higher lateral forces with lower energy consumption, compared to those data used in basic formulas describing the efficiency of the helicopters.

The boundary layer driven by Coandă effect changes the direction of airflow around the tailboom, creating a lateral force F, high enough to oppose to the torque effect created by the main rotor and to the motion imparted to the fuselage.

Directional yaw control is gained through a vented, rotating drum at the end of the tailboom, called the jet thruster [9].

Coandă ejectors, 2001. Disposal of smoke and toxic air is another one of the Coandă ejectors applications (Fig. 13).

a) Internal DC with two steps

b) Section throughout a Coandă ejector
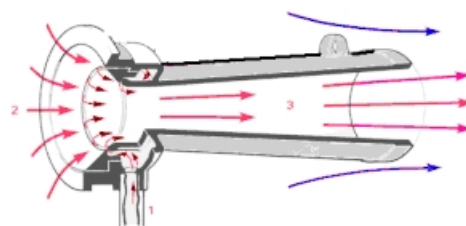
c) Operating principle of a Coandă ejector

Fig. 13 Coandă ejectors

Lack of mechanical moving parts enables the movement of various categories of contaminated air, without danger of destroying the ejection device. Contamination may therefore be the result of the existence of:
1. Toxic gases: paint fumes, alcohol, adhesives, fuel fumes, vapours of various

chemicals, effluents of sewage, smoke, automobile gas and other undesirable emanations;

2. Suspended solids: powder, rubber, plastics, cement, wood, grasses, paper, flour, detergents, coal mines air;

3. Air with an excess of temperature.
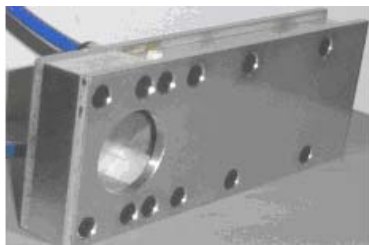
a) level ejection device

b) cylindrical ejection device

Fig. 14 Ejection devices

Such a system has recently (2001) been conceived by a Romanian private company (AERODIN srl) and has obtained at 4.7 bar a flow of 2750 m^3/h at a medium pressure loss of 90 mmH2O having an ejection coefficient of 60 (4) [10].
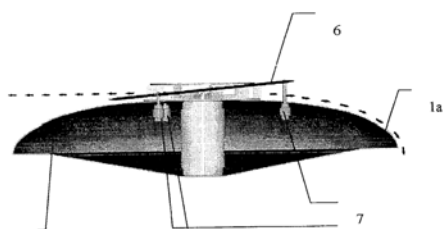
Fig.15 Robert Collins's GB patent no. 2387158, granted in 2003, for a Coandă effect aerial Vehicle

Fig. 16 Geoff Hatton and his VTOL Coandă UAV

Applications on small unmanned aerial vehicles (UAVs). After 2000, individual inventors and innovative SMEs developed a new class of aerial vehicles, based on the use of the Coandă effect. Among them, are Robert Collins (Fig15) [7], Geoffrey Hatton (Fig. 16) [12], GFS Projects Ltd., and AESIR Ltd. The MEDIAS-UAV (Fig. 17) concept is developed by a Romanian academic consortium [13].

In 2006, in France, Jean-Louis Naudin made and tested his first GFS-UAV (N 01A).

This one, propelled by an electric engine, was using the Coandă effect to take off vertically, fly, hover and land vertically.

Fig. 17 The Romanian MEDIAS-UAV Coandă effect aerial vehicle meant for environmental surveillance (2009)

Other applications are dedicated to the ground effect vehicles (GEV). The KM Ekranoplan (Fig. 18) is also based on Coandă effect, because the water acts as a limiting wall in a Coandă flow and therefore the ground effect vehicle is moving as a wing at a certain distance of several meters above the water.

Fig. 18 KM Ekranoplan

In conclusion, ground effect vehicles are considered to be good transportation vehicles, fast and economical. Other emerging applications are (Fig. 19).
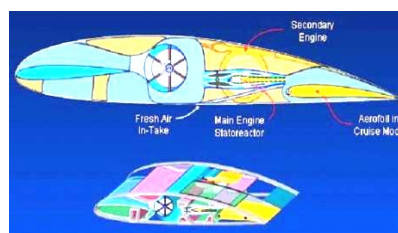
a) Flying device using the Coandă ejection device

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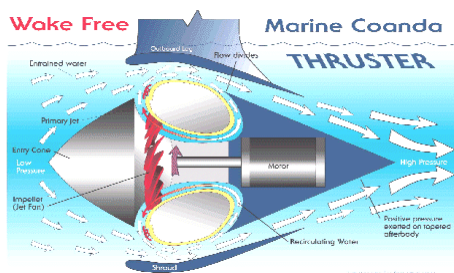
b) Underwater propulsion system based on the
Coandă effect

Fig. 19 Future projects using the Coandă effect

At these projects we can firstly observe the highlighting of the flow using the Coandă effect.

5. CONCLUSIONS

The theoretical models of Coandă effect should also be continuously developed, in order to allow the complete understanding of this important fluid mechanics phenomenon.

This useful phenomenon is therefore not yet used at its full potential and capabilities.

Coandă Effect applications developed so far proved to be very efficient from energetic point of view. In the conclusion we can state that for the same energy available P_0, the D_f force gain can be obtained by decreasing the speed $V_D < V_M$, similarly to an increase by ejection of the mass flow evacuated.

In order to obtain the highest force possible for an available used energy it is preferable to put into motion the highest amount of fluid possible with the lowest speed possible instead of a small amount of fluid put into motion with a high speed.

From the energetic point of view, for a helicopter, Coandă effect is a more efficient method than the tail rotor to obtain the lateral force needed to control the horizontal maneuverability and stabilizing in the same time the aerial platform created by a flying mono rotor helicopter.

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COANDA EFFECT UAV – A NEW BORN BABY IN THE UNMANNED AERIAL VEHICLES FAMILY

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Abstract: Most of the (UAVs) accomplishing their specific missions are designed to have propulsion according to one of the following two schemes. First, some of them have a fixed wing design, which resembles the one of a traditional plane. However, they offer a limited maneuverability and payload capacity. They also require a runway to take off and land, since the lift force is created by the plane's wings only as they move through the air. Others are employing rotors just as helicopters, thus achieving better results as far as hovering is concerned. This is important because the Vertical Take Off and Landing (VTOL) capability plays also a key part for an UAV. Nevertheless, their autonomy is highly diminished, the vehicles being dependent on the fuel amount or the energy accumulators carried on board. If we analyze the above mentioned demands for an efficient UAV, we may come to the idea of searching for a new design. Fluid mechanics is still offering interesting solutions which could overcome the differences between these two distinct heavier-than-air flying machines categories. During the past decade a new class of VTOL vehicles in the UAVs field, using the Coandă Effect has appeared. These have evolved to generate lift and maneuverability forces in a more efficient manner. Just as the first Coandă Aerodyne, more than 50 years ago, these flying machines use a central rotor fan to create the air movement over their fuselage. In the last decade, inspired by Coandă legacy, aroused in Europe a wave of new UAVs.

Keywords: UAV, classification, Coandă Effect, propulsion, VTOL, aerodyne.

1. AIMS AND BACKGROUND

In the last years, no more than a decade, we were the eyewitnesses of the development of a new family of UAVs, having new propulsion and lift systems, as a synergy to the requests of the main two methods widely used to create lift and propulsion.

It is known that a fixed wing design similar with that of a traditional plane, even it is the most and widely used among the large or small aerial vehicles, even it has many advantages, is also marked by some disadvantages.

For example, the fixed wing design offers limited manoeuvrability for the platform and require a runway to take-off and land and.

Besides, they are unable to hover, or, for a UAV, to be VTOL (Vertical Take-Off and Landing) is a must, and also to be able to hover around the target is a very important aspect. So far, VTOL UAVs get around these problems, usually by employing rotors like a helicopter.

This paper aims to presents the evolution of the characteristics of this new class of aerial vehicles, with a close look on the main advantages and strengths and of the most adequate missions.

Apparently lifted by the propeller, as mini-choppers are, the lift forces of the new-born member of aerial vehicles family comes – mainly – from deflecting and streamlining the generated air flow along the outside upper curved surface, even the device is at rest.

This is because all this vehicles use a phenomenon known as the Coandă effect to create lift.

The upper propeller (it may be also a rotor or a fan) creates an airstream, adherent to the upper curved surface, where the Coandă Effect applies also and gets more air from above.

In the same time, the Coandă effect speeds up the air over the upper surface, and so lowers the air pressure next to it, which in turn generates more lift in this region, creating the necessary lift forces.

The Coandă UAV is compensating in this way its own weight and hovers along the direction of the resultant lift forces generated on the upper surface of the fuselage. In this way, the aerial vehicle generates buoyancy, and is able to take off or land vertically.

Coandă Effect is a classic phenomenon in fluid mechanics and one of the fundamental discoveries of the Romanian inventor Henri-Marie Coandă (1886-1972).

Henri Coandă was a Romanian inventor, aerodynamics pioneer and the designer and the builder of the world's first jet powered aircraft, the *Coandă-1910* a revolutionary plane of the 20th century beginning.

Fig. 1 In 1910, Henri Coandă built and flew the world's first jet aircraft

The Coandă effect became an obvious effect exactly 100 years ago, in 1910; at that time, Henri Coandă tested in a short flight an early type of jet engine aircraft, near Paris, France. The effect presently named after Coandă Henri Coandă described 20 years later, when he made public his discoveries.

In aeronautics, this effect is used today primarily in helicopters that have no tail rotors.

The first design of a Coandă UAV was created in 1932 [3], by the Romanian inventor Henri Marie Coandă.

In his first patents related to Coandă effect applications, in order to generate the jet of fluid over the upper surface of the fuselage, he was using mainly other means than a rotor, i.e. a burner or a combustion chamber.

But in a patent he obtained in 1935 [1], he was enumerating the possibility to use also a centrifugal fan for supplying the necessary air flow.

Fig. 2 Coandă patent "Perfectionnement aux propulseurs" [1]

Fig. 3 Extract from a later Coandă patent with reference to his first Coandă effect patent [3]
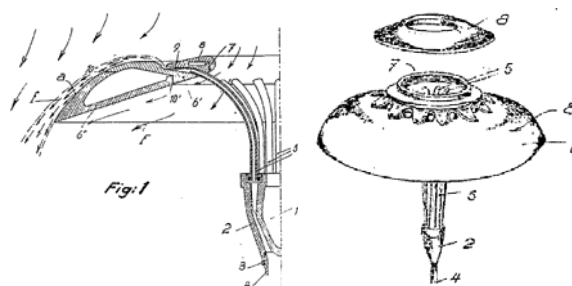
Fig. 4 Perfectionnement aux propulseurs [3]
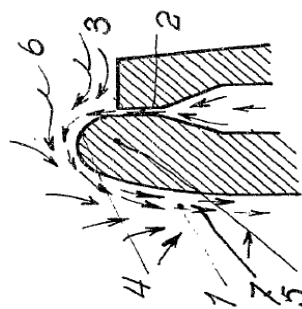
Fig. 5 Procédé et dispositif pour faire dévier une veine de fluide pénétrant dans un autre fluide [2]

In UK, 50 years later, Robert Collins valued Coandă effect capabilities in one of his inventions, which obtained a GB patent no. 2387158, granted in 2003.

This new Coandă application was already presented in his paper „Coandă - A New Airspace Platform for UAVs" at the Bristol International UAV Conference, in April 2002 [4].
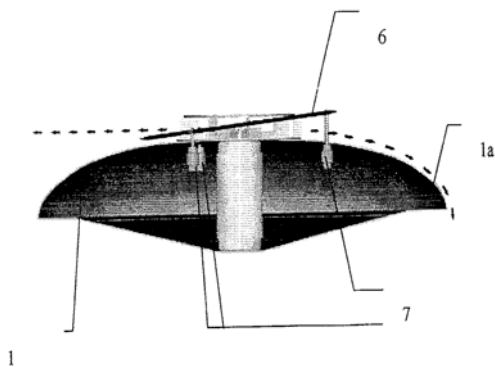
Fig. 6 Robert Collin's Aerial Flying Device [4]

In the design of a Coandă UAV the rotor at the center of the hollow fuselage canopy pulls air in from above the craft and blows it out radially, over the top of the curved body. Because of the Coandă effect, the airstream remains 'stuck' to the canopy and follows the curved surface, leaving the body at its base. This, along with the downwards thrust of the fan, pulls the aircraft upwards.
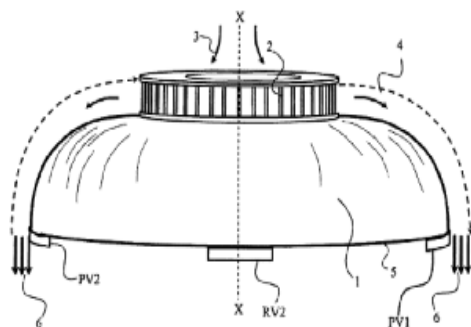
Fig. 7 Geoff Hatton's first Coandă UAV (2005)

Also in the 90's, another inventor from UK, Geoffrey Hutton, together with the GFS projects team, promoted also an aerial Coandă device, with a circular shape canopy.
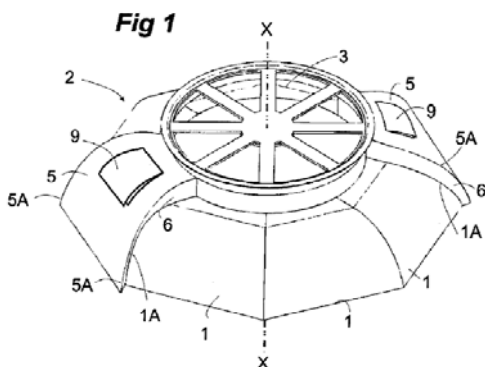
Fig. 8 Geoff Hatton's 2007-UAV model

GFS Projects is the final chosen name for Geoff's Flying Saucers - a new company created in 2002 with a £43,000 grant obtained from the UK Department of Trade and Industry.

When GFS projects built their first model, the circular shape turned to be octagonal, with flat flaps on four opposite sides of the trailing edge.

In 2006, Jean-Louis Naudin made and tested his first UAV (GFS-UAV model N-01A). This one, propelled by an electric engine, was using the Coandă effect to take off vertically, fly, hover and land vertically (VTOL).


Fig. 9 J.-L. Naudin's first GFS-UAV (N-01A)

The design of the GFS-UAV N-01A was based on the Geoff Hatton' flying saucer from GFS Project limited.

In the next year, Jean-Louis Naudin freely published the full plan of the GFS-UAV N-01A and a detailed tutorial to help UAV fans to replicate his GFS UAV [7].

Fig. 10 Geoff Hatton's GFS-02

In 2007 Geoffrey Hatton presented an optimized control for his family of Coandă UAVs, this time improving the airflow over

23

the outer surface, especially in open air, when it may be disturbed by a lateral wind [8].

In 2008, in Romania, an academic consortium, with researchers from Galați, Iași and Bacău universities, coordinated by the author, obtained, for the researches on Coandă effect, a national grant from CNMP, for the surveillance and protection of the natural environment, using a Coandă UAV.
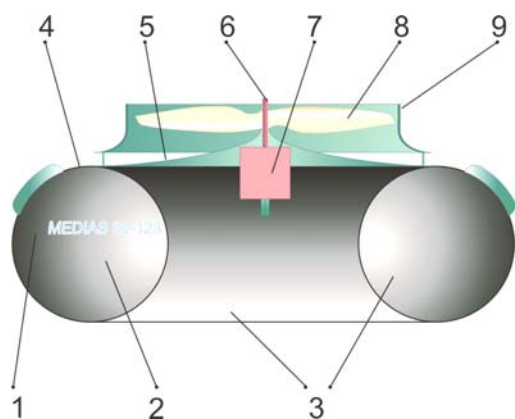
Fig. 11 MEDIAS components [10]
1 - curved upper surface; 2 - steering flaps;
3 - toroidal He chamber; 4 - counter-rotating fins;
5 - inner exhaust profiled cap; 6 - propeller's shaft;
7 - electrical motor and batteries; 8 - propeller; 9 - propeller duct

According the contract, this new UAV, named MEDIAS, had to be in the same time a modern and a nonpolluting aerial vehicle, easy to maneuver and safe to the environment and people.

As a main characteristic, MEDIAS with his adequate shape, uses the Coandă Effect (I) for lift and maneuverability. An air flow created by an electrically driven propeller (II) flows over the upper surfaces of a curved radial canopy and changes the pressure field above and under the vehicle, creating more lift and improving the stability of the flight.

A toroidal Helium optionally added inflatable chamber (III) is increasing the buoyancy and functionality of the MEDIAS VTOL UAV design and is increasing also the UAV's mission autonomy.

This high propulsion efficiency will be obtained because, besides using Coandă effect, the vehicle has an innovative design, MEDIAS being a hybrid between the following:

1. An aerial vehicle - propelled and steered by Coandă effect and vertical air jets,
2. An aerial platform - which ensures its sustentation by using a propeller, preferably ducted, for a greater efficiency,
3. An aerostat - preferably filled with Helium - which improves some of the flight parameters.
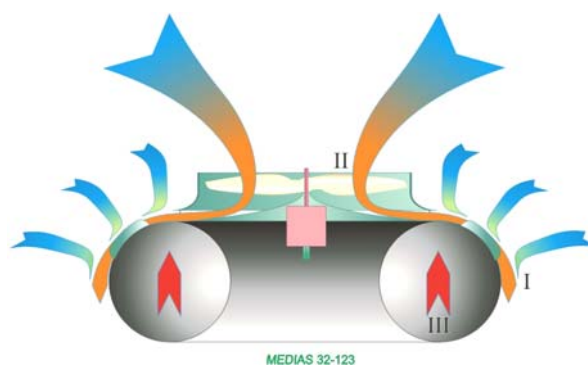
Fig. 12 The sustentation and propulsion components of MEDIAS UAV

However, the Coandă effect, as physical phenomenon used for sustentation, should allow it to lift and carry a significant weight compared to its estimated energetic consumption.

For an increase in efficiency, the electrical driven propeller itself was mounted in a central duct. In this particular arrangement, also the air volumes entrained by the Coandă effect became several times multiplied.

Meanwhile, on January 28th 2009, AESIR Ltd, a privately owned company, established to develop a family of Coandă effect VTOL UAVs, inherited GFS Projects Ltd legacy.

Fig. 13 GFS/AESIR Coandă-effect UAV

With a military support, this time, AESIR Ltd presented in September 2009, at Defence & Security Equipment International, London, a new VTOL-UAV, (named ODIN, after the

chief god in the Viking mythology, in accordance with the company's name AESIR, considered to be the Pantheon of the Viking gods).

Fig. 14 ODIN – The AESIR's demonstrator for a military Coandă UAV

This new-born Coandă UAV was a 1...1.5 meter diameter octagonal craft, fitted with a Wankel Rotary internal combustion engine. It weighs up to 10kg and can carry a maximum of 10kg payload for up to an hour.

Fitted with an autonomous flight control system and managed through a simple to operate ground control system, ODIN has been primarily designed to operate as an Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) platform, a logistics craft or as an aerial communications re-broadcast station.

Fig. 15 AESIR's VIDAR UAV

Also, due its versatility, it may participate in missions of electronic warfare, asset protection, IED detection, or even being used as a weapon or loitering munitions.

In the same exhibition stand at London DSEi, AESIR presented VIDAR, a 300 mm, man portable craft designed to provide surveillance and situational awareness inside buildings and in-close-confined spaces.

It has an electric engine powered by Lithium Polymer batteries to provide up to 15 minutes of flight time. It weighs 400g and is capable of carrying a 100g payload.

The next project of VTOL UAVs that AESIR Ltd. was developing were EMBLA, a 600mm diameter electric engine craft which has been developed to show the militaries the capabilities of a Coandă effect VTOL UAV.

Fig. 16 EMBLA, an emblematic Coandă UAV

Fig. 17 EMBLA - in its counter IED role on top of a Northrop Grumman Remotec Mk 8 EOD Wheelbarrow

HODER is the larger UAV from AESIR family, but it is a heavy lift craft, with two or more engines, with a mass of 1500 kg and is capable of carrying a 1000 kg as a payload, for up to eight hours.

Fig. 18 HODER – A cargo transport VTOL-UAV

As the main mission, HODER it is intended for cargo transport and resupply vehicle for front line forces, but can be adapted to become a long endurance craft by reducing the payload and increasing the fuel.

(As an anecdotic aspect, Hoder is the name of the strongest of all the Norse gods).

All these VTOL UAVs are using the Coandă effect in order to generate lift and have an excellent stability in their role as a surveillance platform.

2. STRENGTHS AND ADVANTAGES

All these VTOL UAVs are using the Coandă effect in order to generate lift and gain an excellent stability in their role as a surveillance platform.

Missions that a Coandă UAV will be capable to accomplish will diversify in the time to come, both in civil and in the military field.

The design of the Coandă UAV's has many strengths and advantages and that's why, in the next years, we could be the witnesses of a fast spreading of new models from this new class of vehicles.

Their strengths and advantages are:

1. First, a Coandă UAV it is not as vulnerable to impacts against walls, ceilings etc., as a more conventional unmanned plane or helicopter, so it may bump into horizontal or vertical walls, or other kind of obstacles, without losing altitude or being damaged

2. A Coandă UAV has no external rotating parts, so the vehicles could survive to low speed impact with the ground, buildings and other fixed objects.

3. Due to the elasticity of the toroidal He chamber, located at the inferior part of vehicle, the MEDIAS UAV has a better approach in landing on ground, with the payload unaltered, in very different weather conditions or locations, even if the approaching manoeuvres are not well conducted.

4. The optional added / filled He chamber improves the autonomy of the MEDIAS UAV because the MEDIAS design has a better ratio payload vs. total weight.

5. The air masses entrained by the Coandă effect flow over the upper surfaces are changing the both pressure fields, of above and under the vehicle, thus creating more lift and improving the stability of the flight.

6. Coandă effect amplifies and even multiplies the lift forces due the increased air volume entrained.

7. The payload is not located directly in the stream of air responsible for creating lift forces.

8. The airflow necessary to create lift forces is not as dependent of the altitude or the angle of attack as fixed-wing UAVs are, so the vehicles are more stable during the flight.

3. MISSIONS

The current main market for UAVs is in defence, with 57% of UAVs being classed as military according a 2009 study. [12].

They are often used to spy on hostile situations from a distance, to watch the area around a soldier or troops and have the potential to search for IEDs (Improvised Explosive Devices). This eliminates the need for the soldier to take any unnecessary risks.

A more desirable capability for a UAV in many of these situations is VTOL (Vertical Take Off and Landing) which gives the ability to hover and perch, and monitor an area from a fixed position, but this usually results in reduced flight times and Coandă UAVs are prepared to have a large autonomy.

A small UAV, as so far VIDAR is, with its 0.3 m diameter and 0.5kg of weight (payload included), could be flown into an unknown building in order to generate floor plans ahead of an infantry assault, for instance.

A larger Coandă UAV, as EMBLA or MEDIAS are, could be sent out for about an hour to scout out the territory, flying at an altitude from few meters to up to 1000m, and bring it back.

Because 71% of all UAVs are fixed-wing [12], they have to keep flying / moving to avoid landing. Unlike fixed wing UAVs, Coandă UAVs don't have to keep flying, because they may land and take off whenever it will be needed.

As well as providing surveillance images, day or night, the UAV could also act as a communications relay, hovering to keep the

communication for a strategic location or transmitting live information from troops onthe ground. It could also accomplish a logistics role, for example, by bringing ammunition or other small supplies/packages to forward operations posts.

In the civil field, the VTOL capability of the Coandă UAVs will offer them the possibility to accomplish missions with a great diversity. Besides the measurement of the environmental parameters and monitoring of the nature reserves as a non-polluting UAV (e.g. MEDIAS) could accomplish, the civil Coandă UAVs shall be able to carry out a large variety of missions such as:
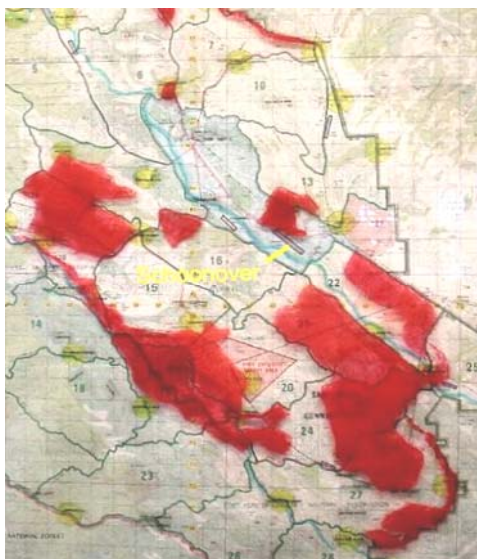
Fig. 19 Forest fire detection representation on a hybrid map (map + aerial IR image)

1. Fire and Rescue
   - Forest and crops fire detection and fire fighting management
   - Other major incidents
   - Emergency rescue (e.g. Mountain rescue)
2. Government
   - Law enforcement (Police, Civil Security)
   - Border security
3. Energy Sector
   - Oil and gas industry distribution infrastructure monitoring
   - Electricity grids / distribution network monitoring
   - Coastguard

4. Agriculture, Forestry and Fisheries
   - Environmental monitoring
   - Forest and crops disease management
   - Forestry or fishery protection and aerial inspection
   - Optimizing the use of water and soil resources

Fig. 20 Civil/Military Applications IR picture

5. Communications and Broadcasting
   - Camera aerial platforms (e.g. broadcasting, and film industry)
6. Earth Observation and Remote Sensing
   - Climate monitoring
   - Aerial photography, mapping and surveying
   - Natural disasters monitoring (water flows, avalanches, oil leak tracking, seismic events) etc.

4. CONCLUSIONS

1. As a recent application of 100 years old discovery, Coandă UAVs are in a position of winning terrain in front of other light UAVs (under 150kg).

2. There is a growing and stimulating competition for innovating and demanding patents, where for now, Europe is in pole position, but new signals of interest come from Middle East and US.

3. The early start was made by independent inventors and civil companies, but in the next ten years, maybe, the militaries will be those to keep going the engine of the R&D for Coandă UAVs.

4. As the UK and Romanian research teams showed, the hovercraft legacy could be valued again in this new field of research.

5. ACKNOWLEDGEMENTS

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α-DISCOUNTING METHOD FOR MULTI-CRITERIA DECISION MAKING (α-D MCDM)

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Abstract: In this paper we introduce a new procedure called α -Discounting Method for Multi-Criteria Decision Making (α-D MCDM), which is as an alternative and extension of Saaty's Analytical Hierarchy Process (AHP). It works for any set of preferences that can be transformed into a system of homogeneous linear equations. A degree of consistency (and implicitly a degree of inconsistency) of a decision-making problem are defined. α-D MCDM is generalized to a set of preferences that can be transformed into a system of linear and/or non-linear homogeneous and/or non-homogeneous equations and/or inequalities. Many consistent, weak inconsistent, and strong inconsistent examples are given).

Keywords: Multi-Criteria Decision Making (MCDM), Analytical Hierarchy Process (AHP), α-Discounting Method, Fairness Principle, parameterize, pairwise comparison, n-wise comparison, consistent MCDM problem, weak or strong inconsistent MCDM problem.

1. INTRODUCTION

α-Discounting Method for Multi-Criteria Decision Making (α-D MCDM) is an alternative and extension of Saaty's Analytical Hierarchy Process (AHP). It works not only for preferences that are pairwise comparisons of criteria as AHP does, but for preferences of any n-wise (with $n \geq 2$) comparisons of criteria that can be expressed as linear homogeneous equations.

The general idea of α-D MCDM is to assign null-null positive parameters $\alpha_1, \alpha_2, \ldots, \alpha_n$ to the coefficients in the right-hand side of each preference that diminish or increase them in order to transform the above linear homogeneous system of equations which has only the null-solution, into a system having. After finding the general solution of this system, the principles used to assign particular values to all parameters α's is the second important part of α-D, yet to be deeper investigated in the future.

In the current paper we herein propose the Fairness Principle, i.e. each coefficient should be discounted with the same percentage (we think this is fair: not making any favoritism or unfairness to any coefficient), but the reader

can propose other principles. For consistent decision-making problems with pairwise comparisons, α-Discounting Method together with the Fairness Principle give the same result as AHP. But for weak inconsistent decision-making problem, α -Discounting together with the Fairness Principle give a different result from AHP.

α-Discounting/Fairness-Principle together give a justifiable result for strong inconsistent decision-making problems with two preferences and two criteria; but for more than two preferences with more than two criteria and the Fairness Principle has to be replaced by another principle of assigning numerical values to all parameters α's. Since Saaty's AHP is not the topic of this paper, we only recall the main steps of applying this method, so the results of α-D MCDM and of AHP could be compared. AHP works for only for pairwise comparisons of criteria, from which a square Preference Matrix, A (of size $n \times n$), is built. Then one computes the maximum eigenvalue λ_{max} of A and its corresponding eigenvector.

If λ_{max} is equal to the size of the square matrix, then the decision-making problem is consistent, and its corresponding normalized

eigenvector (Perron-Frobenius vector) is the priority vector. If λ_{max} is strictly greater than the size of the square matrix, then the decision-making problem is inconsistent. One raise to the second power matrix A, and again the resulted matrix is raised to the second power, etc. obtaining the sequence of matrices A^2, A^4, A^8, …, etc.

In each case, one computes the maximum eigenvalue and its associated normalized eigenvector, until the difference between two successive normalized eigenvectors is smaller than a given threshold.

The last such normalized eigenvector will be the priority vector.

Saaty defined the Consistency Index as:

$$CI(A) = \frac{\lambda_{max}(A) - n}{n - 1} \qquad (1)$$

Where n is the size of the square matrix A.

2. α-DISCOUNTING METHOD FOR MULTI-CRITERIA DECISION MAKING (α-D MCDM)

2.1. Description of α-D MCDM

The general idea of this paper is to discount the coefficients of an inconsistent problem to some percentages in order to transform it into a consistent problem.

Let the Set of Criteria be $C = \{C_1, C_2, …, C_n\}$, with $n \geq 2$, and the Set of Preferences be $P = \{P_1, P_2, …, P_m\}$, with $m \geq 1$.

Each preference P_i is a linear homogeneous equation of the above criteria $C_1, C_2, …, C_n$:

$$P_i = f(C_1, C_2, ..., C_n) \qquad (2)$$

We need to construct a basic belief assignment (bba):

$$m : C \to [0,1] \qquad (3)$$

such that $m(C_i) = x_i$, with $0 \leq x_i \leq 1$, and

$$\sum_{1=1}^{n} m(x_i) = 1 \qquad (4)$$

We need to find all variables xi in accordance with the set of preferences P. Thus, we get an $m \times n$ linear homogeneous system of equations whose associated matrix is $A = (a_{ij})$, $1 \leq i \leq m$ and $1 \leq j \leq n$.

In order for this system to have non-null solutions, the rank of the matrix A should be strictly less than n.

30

2.2. Classification of linear decision-making problems

a) We say that a **linear decision-making problem is consistent** if, by any substitution of a variable x_i from an equation into another equation, we get a result in agreement with all equations.

b) We say that a **linear decision-making problem is weakly inconsistent** if, by at least one substitution of a variable x_i from an equation into another equation, we get a result in disagreement with at least another equation in the following ways:

$$(WD1)\begin{cases} x_i = k_1 \cdot x_j, k > 1 \\ x_i = k_2 \cdot x_j, k_2 > 1, k_2 \neq k_1 \end{cases} \qquad (5)$$

or

$$(WD1)\begin{cases} x_i = k_1 \cdot x_j, 0 < k < 1 \\ x_i = k_2 \cdot x_j, 0 < k_2 < 1, k_2 \neq k_1 \end{cases} \qquad (6)$$

or

$$WD(3)\{x_i = k \cdot x_i, k \neq 1\} \qquad (7)$$

(WD1) - (WD3) are weak disagreements, in the sense that for example a variable $x > y$ always, but with different ratios (for example: $x = 3y$ and $x = 5y$). All disagreements in this case should be like (WD1) - (WD3).

c) We say that a **linear decision-making problem is strongly inconsistent** if, by at least one substitution of a variable xi from an equation into another equation, we get a result in disagreement with at least another equation in the following way:

$$(SD4)\begin{cases} x_i = k_1 \cdot x_j \\ x_i = k_2 \cdot x_j \end{cases} \qquad (8)$$

with $0 < k_1 < 1 < k_2$ or $0 < k_2 < 1 < k_1$ (i.e. from one equation one gets $x_i < x_j$ while from the other equation one gets the opposite inequality: $x_i < x_j$). At least one inconsistency like (SD4) should exist, no matter if other types of inconsistencies like (WD1)-(WD3) may occur or not. Compute the determinant of A.

a) If det(A) = 0, the decision problem is consistent, since the system of equations is dependent. It is not necessarily to parameterize the system. (In the case we have parameterized, we can use the Fairness Principle - i.e. setting all parameters equal $\alpha_1 = \alpha_2 = … = \alpha_p = \alpha > 0$). Solve this system; find its general solution. Replace the

parameters and secondary variables, getting a particular solution. Normalize this particular solution (dividing each component by the sum of all components). Wet get the priority vector (whose sum of its components should be 1).

b) If det(A) ≠ 0, the decision problem is inconsistent, since the homogeneous linear system has only the null-solution.

b1) If the inconsistency is weak, then parameterize the right-hand side coefficients, and denote the system matrix $A(\alpha)$. Compute $det(A(\alpha)) = 0$ in order to get the parametric equation. If the Fairness Principle is used, set all parameters equal, and solve for $\alpha > 0$. Replace α in $A(\alpha)$ and solve the resulting dependent homogeneous linear system. Similarly as in a), replace each secondary variable by 1, and normalize the particular solution in order to get the priority vector.

b2) If the inconsistency is strong, the Fairness Principle may not work properly. Another approachable principle might by designed. Or, get more information and revise the strong inconsistencies of the decision-making problem.

2.3. Comparison between AHP and α-D MCDM:

a) α-D MCDM's general solution includes all particular solutions, that of AHP as well;

b) α-D MCDM uses all kind of comparisons between criteria, not only pairwise comparisons;

c) for consistent problems, AHP and α-D MCDM/Fairness-Principle give the same result;

d) for large inputs, in α-D MCDM we can put the equations under the form of a matrix (depending on some parameters alphas), and then compute the determinant of the matrix which should be zero; after that, solve the system (all can be done on computer using math software); the software such as MATHEMATICA and APPLE for example can do these determinants and calculate the solutions of this linear system;

e) α-D MCDM can work for larger classes of preferences, i.e. preferences that can be transformed in homogeneous linear equations or in non-linear equations and/or inequalities - see more below.

2.4. Generalization of α -D MCDM

Let each preference be expressed as a linear or non-linear equation or inequality. All preferences together will form a system of linear/non-linear equations/inequalities, or a mixed system of equations and inequalities. Solve this system, looking for a strictly positive solution (i.e. all unknowns' $x_i > 0$). Then normalize the solution vector. If there are more such numerical solutions, do a discussion: analyze the normalized solution vector in each case. If there is a general solution, extract the best particular solution. If there is no strictly positive solution, parameterize the coefficients of the system, find the parametric equation, and look for some principle o apply in order to find the numerical values of the parameters α's. A discussion might also be involved. We may get undetermined solutions.

3. DEGREES OF CONSISTENCY AND INCONSISTENCY IN α-D MCDM/ FAIRNESS-PRINCIPLE

For α-D MCDM/Fairness-Principle in consistent and weak consistent decision-making problems, we have the followings:

a) If $0 < \alpha < 1$, then α is the **degree of consistency** of the decision-making problem, and $\beta = 1 - \alpha$ is the **degree of inconsistency** of the decision-making problem.

b) If $\alpha > 1$, then $1/\alpha$ is the **degree of consistency** of the decision-making problem, and $\beta = 1 - 1/\alpha$ is the **degree of inconsistency** of the decision-making problem.

4. PRINCIPLES OF α-D MCDM (SECOND PART)

a) In applications, for the second part of α -D Method, the Fairness Principle can be replaced by other principles.

Expert's Opinion. For example, if we have information that a preference's coefficient should be discounted twice more than another coefficient (due to an expert's opinion), and another preference's coefficient should be discounted a third of another one, then appropriately we set for example: $\alpha_1 = 2\alpha_2$ and respectively $\alpha_3 = (1/3)\alpha_4$, etc. in the parametric equation.

b) For α-D/Fairness-Principle or Expert's Opinion.

Another idea herein is to set a **threshold of consistency** t_c (or implicitly **a threshold of inconsistency** t_i). Then, if the degree of consistency is smaller than a required t_c, the Fairness Principle or Expert's Opinion (whichever was used) should be discharged, and another principle of finding all parameters α's should be designed; and similarly if the degree of inconsistency is bigger than t_i.

c) One may measure the system's accuracy (or error) for the case when all m preferences can be transformed into equations; for example, preference P_i is transformed into an equation $f_i(x_1, x_2, \ldots, x_n) = 0$; then we need to find the unknowns $x_1, x_2, \ldots, x_n$ such that:

$$e(x_1, x_2, \ldots, x_n) = \sum_{i=1}^{m} \left| f_i(x_1, x_2, \ldots, x_n) \right|$$

is minimum (9)

where "e" means error.

Calculus theory (partial derivatives) can be used to find the minimum (if this does exist) of a function of n variables, $e(x_1, x_2, \ldots, x_n)$, with $e: R_+^n \rightarrow R_+$. For consistent decision-making problems the system's accuracy/error is zero, so we get the exact result. We prove this through the fact that the normalized priority vector $[a_1 \ a_2 \ \ldots \ a_n]$, where $x_i = a_i > 0$ for all i, is a particular solution of the system $f_i(x_1, x_2, \ldots, x_n) = 0$ for $i = 1, 2, \ldots, m$; therefore:

$$\sum_{i=1}^{m} \left| f_i(a_1, a_2, \ldots, a_n) \right| = \sum_{i=1}^{m} |0| = 0 \qquad (10)$$

But, for inconsistent decision-making problems we find approximations for the variables.

5. EXTENSION OF α-D MCDM (NON-LINEAR α-D MCDM)

It is not difficult to generalize the α-D MCDM for the case when the preferences are non-linear homogeneous (or even non-homogeneous) equations.

This non-linear system of preferences has to be dependent (meaning that its general solution - its main variables - should depend upon at least one secondary variable). If the system is not dependent, we can parameterize it in the same way. Then, again, in the second part of this Non-Linear α-D MCDM we assign some values to each of the secondary variables (depending on extra-information we might receive), and we also need to design a principle which will help us to find the numerical values for all parameters. We get a particular solution (such extracted from the general solution), which normalized will produce our priority vector. Yet, the Non-Linear α-D MCDM is more complicated, and depends on each non-linear decision making problem. Let's see some examples.

6. CONSISTENT EXAMPLE 1

6.1. Let the Set of Preferences be: {C1, C2, C3}, and The Set of Criteria be:
1. C1 is 4 times as important as C2.
2. C2 is 3 times as important as C3.
3. C3 is one twelfth as important as C1.
Let $m(C1) = x$, $m(C2) = y$, $m(C3) = z$.

The linear homogeneous system associated to this decision-making problem is:

$$\begin{cases} x = 4y \\ y = 3z \\ z = x/12 \end{cases} \qquad (11)$$

whose associated matrix A1 is:

$$\begin{pmatrix} 1 & -4 & 0 \\ 0 & 1 & -3 \\ -1/12 & 0 & 1 \end{pmatrix} \qquad (12)$$

Whence det(A1) = 0, so the DM problem is consistent.

Solving this homogeneous linear system we get its general solution that we set as a vector [12z 3z z], where z can be any real number (z is considered a secondary variable, while x = 12z and y = 3z are main variables). Replacing z = 1, the vector becomes [12 3 1], and then normalizing (dividing by 12 + 3 + 1 = 16 each vector component) we get the priority vector: [12/16 3/16 1/16], so the preference will be on C1.

6.2. Using AHP, we get the same result.
The preference matrix is:

$$\begin{pmatrix} 1 & 4 & 12 \\ 1/4 & 1 & 3 \\ 1/12 & 1/3 & 1 \end{pmatrix} \qquad (13)$$

Whose maximum eigenvalue is $\lambda_{max} = 3$ and its corresponding normalized eigenvector (Perron-Frobenius vector) is [12/16 3/16 1/16].

6.3. Using Mathematica 7.0 Software:

Using MATHEMTICA 7.0 software, we graph the function:

$h(x,y) = |x-4y| + |3x+4y-3| + |13x+12y-12|$,
with $x,y \in$ [0,1], which represents the consistent decision-making problem's associated system: $x/y = 4$, $y/z = 3$, $x/z = 12$, and $x + y + z = 1$, $x > 0$, $y > 0$, $z > 0$.

In[1] := Plot3D[Abs[x − 4y] + Abs[3x + 4y − 3] + Abs[13x + 12y−12], {x,0,1}, {y,0,1}]
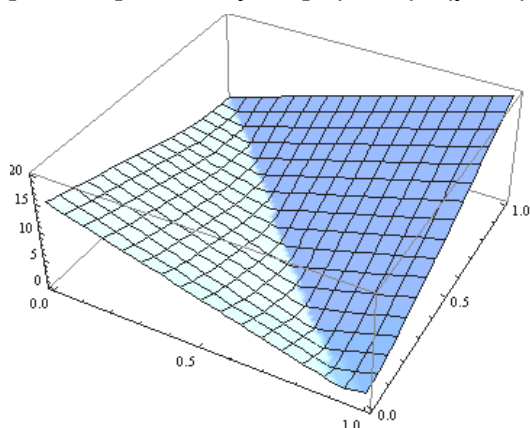
The minimum of this function is zero, and occurs for $x = 12/16$, $y = 3/16$. If we consider the original function of three variables associated with $h(x,y)$ we have: $H(x,y, z) = |x − 4y| + |y − 3z| + |x − 12z|$, $x + y + z = 1$, with $x,y,z \in$ [0,1], we also get the minimum of $H(x,y,z)$ being zero, which occurs for $x = 12/16$, $y = 3/16$, $z = 1/16$.

7. WEAK INCONSISTENT EXAMPLE WHERE AHP DOESN'T WORK

The Set of Preferences is: {C1, C2, C3}.

7.1. Weak Inconsistent Example 2
7.1.1. α-D MCDM method
The Set of Criteria is:
1. C1 is 2 times as important as C2 and 3 times as important as C3 put together.
2. C2 is half as important as C1.
3. C3 is one third as important as C1.
Let m(C1) = x, m(C2) = y, m(C3) = z.

$$\begin{cases} x = 2y + 3z \\ y = x / 2 \\ z = x / 3 \end{cases} \quad (14)$$

AHP cannot be applied on this example because of the form of the first preference, which is not a pairwise comparison. If we solve this homogeneous linear system of equations as it is we get $x = y = z = 0$, since its associated matrix is:

$$\begin{pmatrix} 1 & -2 & -3 \\ -1/2 & 1 & 0 \\ -1/3 & 0 & 1 \end{pmatrix} = -1 \neq 0 \quad (15)$$

but the null solution is not acceptable since the sum $x + y + z$ has to be 1. Let's parameterize each right-hand side coefficient and get the general solution of the above system:

$$\begin{cases} x = 2a_1 y + 3a_2 z & (16) \\ y = \dfrac{a_3}{2} x & (17) \\ z = \dfrac{a_4}{3} x & (18) \end{cases}$$

where: $\alpha_1, \alpha_2, \alpha_3, \alpha_4 > 0$.

Replacing (17) and (18) in (16) we get $x = 2\alpha_1 (\alpha_3 x/2) + 3\alpha_2(\alpha_4 x/3)$,
whence

$$\alpha_1\alpha_3 + \alpha_2\alpha_4 = 1 \text{ (parametric equation) } (19)$$

The general solution of the system is:

$$\begin{cases} y = \dfrac{\alpha_3}{2} x \\ z = \dfrac{\alpha_4}{3} x \end{cases} \quad (20)$$

whence the priority vector

$$\left[x, \frac{\alpha_x}{2} x, \frac{\alpha_4}{3} x \right] \to \left[1, \frac{\alpha_x}{2}, \frac{\alpha_4}{3} \right] \quad (21)$$

Fairness Principle: discount all coefficients with the same percentage: so, replace $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha > 0$ in (19) we get

$\alpha^2 + \alpha^2 = 1$, whence $\alpha = \dfrac{\sqrt{2}}{2}$. Priority vector

becomes: $\left[1, \dfrac{\sqrt{2}}{4} x, \dfrac{\sqrt{2}}{6} \right]$

and normalizing it:

$$[0.62923 \quad 0.22246 \quad 0.14831]$$
$$C1 \qquad C2 \qquad C3 \qquad\qquad (22)$$
$$x \qquad\quad y \qquad\quad z$$

Preference will be on C1, the largest vector component. Let's verify it: $x/y \cong 0.35354$ instead of 0.50, i.e. $\sqrt{2}/2 = 70.71\%$ of the original. $z/x \cong 0.23570$ instead of 0.33333, i.e. 70.71% of the original. $x \cong 1.41421y + 2.12132z$ instead of $2y + 3z$, i.e. 70.71% of 2 respectively 70.71% of 3. So, it was a fair discount for each coefficient.

7.1.2. Using Mathematica 7.0 Software:

Using MATHEMTICA 7.0 software, we graph the function:

$g(x,y) = |4x - y - 3| + |x - 2y| + |4x + 3y - 3|$, with $x,y \in [0,1]$, which represents the weak inconsistent decision-making problem's associated system: $x - 2y - 3z = 0$, $x - 2y = 0$, $x - 3z = 0$, and $x + y + z = 1$, $x > 0$, $y > 0$, $z > 0$. by solving $z = 1 - x - y$ and replacing it in $G(x,y,z) = |x - 2y - 3z| + |x - 2y| + |x - 3z|$ with $x > 0$, $y > 0$, $z > 0$.

In[2] := Plot3D[Abs[4x − y − 3] + Abs[x − 2y] + Abs[4x + 3y − 3],{x,0,1},{y,0,1}]
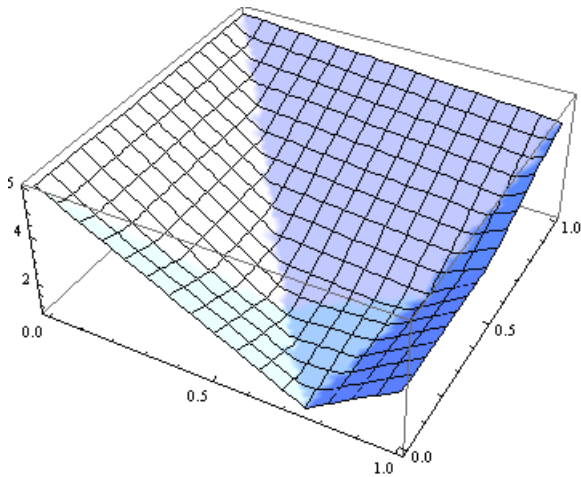
Then find the minimum of g(x,y) if any:

In[3] := FindMinValue[{Abs[4x − y − 3] + Abs[x − 2y] + Abs[4x + 3y − 3], x + y ≤ 1, x > 0, y > 0}, {x,y}]

The following result is returned:

Out[3] := 0.841235.

FindMinValue::eit: The algorithm does not converge to the tolerance of 4.806217383937354`*^-6 in 500 iterations. The best estimated solution, with feasibility residual, KKT residual, or complementary residual of {0.0799888, 0.137702, 0.0270028}, is returned.

7.1.3. Matrix Method of using α - Discounting.

The determinant of the homogeneous linear system (16), (17), (18) is:

$$\begin{vmatrix} 1 & -2\alpha_1 & -3\alpha_2 \\ -\dfrac{1}{2}\alpha_3 & 1 & 0 \\ -\dfrac{1}{3}\alpha_4 & 0 & 1 \end{vmatrix} \qquad (23)$$

or $\alpha_1\alpha_3 + \alpha_2\alpha_4 = 1$ (parametric equation).

The determinant has to be zero in order for the system to have non-null solutions.

The rank of the matrix is 2.

So, we find two variables, for example it is easier to solve for y and z from the last two equations, in terms of x:

$$\begin{cases} y = \dfrac{1}{2}\alpha_3 x \\ z = \dfrac{1}{3}\alpha_4 x \end{cases} \qquad (24)$$

and the procedure follows the same steps as in the previous one.

Let's change Example 1 in order to study various situations.

7.2. Weak Inconsistent Example 3, which is more weakly inconsistent than Example 2.

1. Same as in Example 1.
2. C2 is 4 times as important as C1.
3. Same as in Example 1.

$$\begin{cases} x = 2\alpha_1 + 3\alpha_2 z \\ y = 4\alpha_3 y \\ z = \dfrac{\alpha_4}{3}x \end{cases} \qquad (25)$$

$$x = 2\alpha_1(4\alpha_3 x) + 3\alpha_2\left(\dfrac{\alpha_4}{3}\right)x$$

$$1 \cdot x = (8\alpha_1\alpha_3 + \alpha_2\alpha_4)$$

$$8\alpha_1\alpha_3 + \alpha_2\alpha_4 = 1 \text{(parametric} \qquad \text{equation)}$$
(26)

$$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha > 0$$

$$9\alpha^2 = 1 \Rightarrow \alpha = \dfrac{1}{3}$$

$$\begin{bmatrix} x & 4\alpha_3 x & \dfrac{\alpha_4}{3} x \end{bmatrix} \to \begin{bmatrix} 1 & 4\alpha_3 & \dfrac{\alpha_4}{3} \end{bmatrix} \quad (27)$$

$$\begin{bmatrix} 1 & \dfrac{4}{3} & \dfrac{1}{9} \end{bmatrix} \to \begin{bmatrix} \dfrac{9}{9} & \dfrac{12}{9} & \dfrac{1}{9} \end{bmatrix}$$

normalized: $\begin{bmatrix} \dfrac{9}{22} & \dfrac{12}{22} & \dfrac{1}{22} \end{bmatrix}$, $\dfrac{y}{x} = 1.333$

instead of 4; $\dfrac{z}{x} = 0.111$ instead of 0.3333;

$x = 0.667y + 1 \cdot z$ instead of 2y + 3z.

Each coefficient was reduced at 1/3 (= 33.33%). The bigger is the inconsistency ($\beta \to 1$), the bigger is the discounting ($\alpha \to 0$).

7.3. Weak Inconsistent Example 4, which is even more inconsistent than Example 3.
　1. Same as in Example 1.
　2. Same as in Example 2.
　3. C3 is 5 times as important as C1.

$$\begin{cases} x = 2\alpha_1 y + 3\alpha_2 z \\ \quad y = 4\alpha_3 x \\ \quad z = 5\alpha_4 x \end{cases} \quad (28)$$

$$x = 2\alpha_1(4\alpha_3 x) + 3\alpha_2(5\alpha_4)x$$

$$1 \cdot x = (8\alpha_1\alpha_3 + 15\alpha_2\alpha_4)$$

whence

$8\alpha_1\alpha_3 + 15\alpha_2\alpha_4 = 1$ (parametric equation) (29)

$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha > 0{,}23 \ \alpha^2 = 1$, $\alpha = \sqrt{23}/23$

$$\begin{bmatrix} 1 & 4\alpha_3 & 5\alpha_4 \end{bmatrix} \to \begin{bmatrix} 1 & \dfrac{4\sqrt{23}}{23} & \dfrac{5\sqrt{23}}{23} \end{bmatrix}$$

Normalized: $\begin{bmatrix} 0.34763 & 0.28994 & 0.36243 \end{bmatrix}$

$\dfrac{y}{x} \cong 0.83405$ instead of 4, i.e. reduced at

$\sqrt{23}/23 = 20.85\%$;

$\dfrac{z}{x} \cong 1.04257$ instead of 5;

$x = 0.41703y + 0.62554$ instead of 2x + 3y.

Each coefficient was reduced at $\alpha = \sqrt{23}/23 \cong 20.85\%$.

7.4. Consistent Example 5.
　When we get $\alpha = 1$, we have a consistent problem.
　Suppose the preferences:
　1. Same as in Example 1;
　2. C2 is one fourth as important as C1;

3. C2 is one sixth as important as C3.
The system is:

$$\begin{cases} x = 2y + 3z \\ y = x/4 \\ z = x/6 \end{cases} \quad (30)$$

7.4.1. First Method of Solving this System
　Replacing the second and third equations of this system into the first, we get:

$$x = 2\left(\dfrac{x}{4}\right) + 3\left(\dfrac{x}{6}\right) = \dfrac{x}{2} + \dfrac{x}{2} = x,$$

which is an identity (so, no contradiction).

General solution: $\begin{bmatrix} x & \dfrac{x}{4} & \dfrac{x}{6} \end{bmatrix}$. Priority vector:

$\begin{bmatrix} 1 & \dfrac{1}{4} & \dfrac{1}{6} \end{bmatrix}$. Normalized is: $\begin{bmatrix} \dfrac{12}{17} & \dfrac{3}{17} & \dfrac{2}{17} \end{bmatrix}$

7.4.2. Second Method of Solving this System. Let's parameterize:

$$\begin{cases} x = 2\alpha_1 y + 3\alpha_2 z \\ \quad y = \dfrac{\alpha_3 x}{4} \\ \quad z = \dfrac{\alpha_4 x}{6} \end{cases} \quad (31)$$

Replacing the last two equations into the first we get:

$$x = 2\alpha_1\left(\dfrac{\alpha_3}{4} x\right) + 3\alpha_3\left(\dfrac{\alpha_4}{6} x\right) = \dfrac{\alpha_1\alpha_3}{2} x + \dfrac{\alpha_2\alpha_4}{2} x$$

$$1 \cdot x = \dfrac{\alpha_1\alpha_3 + \alpha_2\alpha_4}{2} \cdot x$$

whence $1 = \dfrac{\alpha_1\alpha_3 + \alpha_2\alpha_4}{2}$ or $\alpha_1\alpha_3 + \alpha_2\alpha_4 = 2$.

Consider the fairness principle:
$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha > 0$, then $2\alpha^2 = 2$, $\alpha = \pm 1$, but we take only the positive value $\alpha = 1$ (as expected for a consistent problem). Let's

check: $\dfrac{y}{x} = \dfrac{3/17}{12/17} = \dfrac{1}{4}$, exactly as in the

original system; $\dfrac{z}{x} = \dfrac{2/17}{12/17} = \dfrac{1}{6}$, exactly as

in the original system; $x = 2y + 3z$ since

$x = 2\left(\dfrac{x}{4}\right) + 3\left(\dfrac{x}{6}\right)$; hence all coefficients were

left at $\alpha = 1$ (= 100%) of the original ones. No discount was needed.

7.5. General Example 6

Let's consider the general case:

$$\begin{cases} x = \alpha_1 y + \alpha_2 z \\ \quad y = \alpha_3 x \\ \quad z = \alpha_4 x \end{cases} \qquad (32)$$

where $\alpha_1, \alpha_2, \alpha_3, \alpha_4 > 0$. Let's parameterize:

$$\begin{cases} x = \alpha_1\alpha_1 y + \alpha_2\alpha_2 z \\ \quad y = \alpha_3\alpha_3 x \\ \quad z = \alpha_4\alpha_4 x \end{cases} \qquad (33)$$

with $\alpha_1, \alpha_2, \alpha_3, \alpha_4 > 0$.

Replacing the second and third equations into the first, we get:

$$x = \alpha_1\alpha_1(\alpha_3\alpha_3 x) + \alpha_2\alpha_2(\alpha_4\alpha_4 x)$$

$$x = \alpha_1\alpha_3\alpha_1\alpha_3 x + \alpha_2\alpha_4\alpha_2\alpha_4 x$$

Whence

$\alpha_1\alpha_3\alpha_1\alpha_3 + \alpha_2\alpha_4\alpha_2\alpha_4 = 1$ (parametric equation) (34)

The general solution of the system is:
$(x, a_3\alpha_3 x, a_4\alpha_4 x)$

The priority vector is: $[1, a_3\alpha_3, a_4\alpha_4]$.

Consider the fairness principle:

$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha > 0$ we get:

$$\alpha^2 = \frac{1}{\alpha_1\alpha_3 + \alpha_2\alpha_4} \text{ so, } \alpha = \frac{1}{\sqrt{\alpha_1\alpha_3 + \alpha_2\alpha_4}}.$$

i) If $\alpha \in [0,1]$, then α is the degree of consistency of the problem, while $\beta = 1 - \alpha$ is the degree of the inconsistency of the problem.

ii) If $\alpha > 1$, then $1/\alpha$ is the degree of consistency, while $\beta = 1 - 1/\alpha$ is the degree of inconsistency.

When the degree of consistency $\rightarrow 0$, the degree of inconsistency $\rightarrow 1$, and reciprocally.

Discussion of the General Example 6

Suppose the coefficients $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ become big such that $\alpha_1\alpha_2 + \alpha_3\alpha_4 \rightarrow \infty$, then $\alpha \rightarrow 0$, and $\beta \rightarrow 1$.

Particular Example 7

Let's see a particular case when $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ make $\alpha_1\alpha_2 + \alpha_3\alpha_4$ big: $\alpha_1 = 50$, $\alpha_2 = 20$, $\alpha_3 = 100$, $\alpha_4 = 250$, then

$$\alpha = \frac{1}{\sqrt{50 \cdot 100 + 20 \cdot 250}} = \frac{1}{\sqrt{10000}} = \frac{1}{100} = 0.01$$

= degree of consistency, whence $\beta = 0.99$ degree of inconsistency.

The priority vector for Particular Example 7 is $\begin{bmatrix} 1 & 100(0.01) & 250(0.01) \end{bmatrix} = \begin{bmatrix} 1 & 1 & 2.5 \end{bmatrix}$ which normalized is: $\begin{bmatrix} \dfrac{2}{9} & \dfrac{2}{9} & \dfrac{5}{9} \end{bmatrix}$.

Particular Example 8

Another case when $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ make the expression $\alpha_1\alpha_2 + \alpha_3\alpha_4$ tiny positive number:

$\alpha_1 = 0.02$, $\alpha_2 = 0.05$, $\alpha_3 = 0.03$, $\alpha_4 = 0.02$, then

$$\alpha = \frac{1}{\sqrt{0.02(0.03) + 0.05(0.02)}} = \frac{1}{0.04} = 25 > 1.$$

Then $1/\alpha = 1/25 = 0.04$ is the degree of consistency of the problem, and 0.96 the degree of inconsistency.

The priority vector for example 5.2 is $\begin{bmatrix} 1 & a_3\alpha & a_4\alpha \end{bmatrix} = \begin{bmatrix} 1 & 0.03(25) & 0.05(0.02) \end{bmatrix} = \begin{bmatrix} 1 & 0.75 & 0.50 \end{bmatrix}$

which normalized is $\begin{bmatrix} \dfrac{4}{9} & \dfrac{3}{9} & \dfrac{3}{9} \end{bmatrix}$.

Let's verify: $\dfrac{y}{x} = \dfrac{3/9}{4/9} = 0.75$ instead of 0.03, i.e. $\alpha = 25$ times larger (or 2500%);

$\dfrac{z}{x} = \dfrac{2/9}{4/9} = 0.50$ instead of 0.02, i.e. 25 larger;

$x = 0.50y + 1.25z$ instead of $x = 0.02y + 0.05z$ (0.50 is 25 times larger than 0.02, and 1.25 is 25 times larger than 0.05) because

$$\frac{4}{9} = 0.50\left(\frac{3}{9}\right) + 1.25\left(\frac{2}{9}\right).$$

8. JEAN DEZERT'S WEAK INCONSISTENT EXAMPLE

8.1. Jean Dezert's Weak Inconsistent Example 9. Let $\alpha_1, \alpha_2, \alpha_3 > 0$ be the parameters. Then:

$$\begin{cases} \dfrac{y}{x} = 3\alpha_1 & \qquad (35) \\[2mm] \dfrac{x}{z} = 4\alpha_2 & \qquad (36) \\[2mm] \dfrac{y}{z} = 5\alpha_3 & \qquad (37) \end{cases}$$

$(35),(36) \Rightarrow \dfrac{y}{x} \cdot \dfrac{x}{z} = (3\alpha_1) \cdot (4\alpha_2) \Rightarrow \dfrac{y}{z} = 12\alpha_1\alpha_2$

In order for $\dfrac{y}{z} = 12\alpha_1\alpha_2$ to be consistent with

$\dfrac{y}{z} = 5\alpha_3$ we need to have $12\alpha_1\alpha_2 = 5\alpha_3$ or

$2.4\alpha_1\alpha_2 = \alpha_3$ (parametric equation) $\qquad(38)$
Solving this system:

$$\begin{cases} \dfrac{y}{x} = 3\alpha_1 \Rightarrow y = 3\alpha_1 x \\ \dfrac{x}{z} = 4\alpha_2 \Rightarrow x = 4\alpha_2 z \\ \dfrac{y}{z} = 5\alpha_3 \Rightarrow y = 12\alpha_1\alpha_2 z \end{cases} \qquad(39)$$

we get the general solution:
$$\begin{bmatrix} 4\alpha_2 z & 5(2.4\alpha_1\alpha_2)z & z \end{bmatrix}$$
$$\begin{bmatrix} 4\alpha_2 z & 12\alpha_1\alpha_2 z & z \end{bmatrix} \qquad(40)$$

General normalized priority vector is:
$$\left[\dfrac{4\alpha_2}{4\alpha_2 + 12\alpha_1\alpha_2 + 1} \quad \dfrac{12\alpha_1\alpha_2}{4\alpha_2 + 12\alpha_1\alpha_2 + 1} \quad \dfrac{1}{4\alpha_2 + 12\alpha_1\alpha_2 + 1} \right]$$

where $\alpha_1, \alpha_2 > 0$; $(\alpha_3 = 2.4\alpha_1\alpha_2)$

Which α_1 and α_2 give the best result? How to measure it? This is the greatest challenge!

α-Discounting Method includes all solutions (all possible priority vectors which make the matrix consistent).

Because we have to be consistent with all proportions (i.e. using the Fairness Principle of finding the parameters' numerical values), there should be the same discounting of all three proportions (35), (36), and (37), whence
$\alpha_1 = \alpha_2 = \alpha_3 > 0 \qquad(41)$
The parametric equation (38) becomes

$2.4\alpha_1^2 = \alpha_1$ or $\alpha_1(2.4\alpha_1 - 1) = 0$

whence $\alpha_1 = 0$ or $\alpha_1 = \dfrac{1}{2.4} = \dfrac{5}{12}$

$\alpha_1 = 0$ is not good, contradicting (41).
Our system becomes now:

$$\begin{cases} \dfrac{y}{x} = 3\dfrac{5}{12} = \dfrac{15}{12} & (42) \\ \dfrac{x}{z} = 4\dfrac{5}{12} = \dfrac{20}{12} & (43) \\ \dfrac{y}{z} = 5\dfrac{5}{12} = \dfrac{25}{12} & (44) \end{cases}$$

We see that (42) and (43) together give

$\dfrac{y}{x} \cdot \dfrac{x}{z} = \dfrac{15}{12} \cdot \dfrac{20}{12}$ or $\dfrac{y}{z} = \dfrac{25}{12}$

so, they are now consistent with (44).

From (43) we get $x = \dfrac{20}{12}z$ and from (44)

we get $y = \dfrac{25}{12}z$.

The priority vector is:
$$\left[\dfrac{20}{12}z \quad \dfrac{25}{12}z \quad 1z \right]$$

which is normalized to:

$\dfrac{20}{57} \quad \dfrac{25}{57} \quad \dfrac{12}{57}$
$C_1 \quad C_2 \quad C_3$

$$\left[\dfrac{20}{57} \quad \dfrac{25}{57} \quad \dfrac{12}{57} \right]^T \qquad(45)$$
$C_1 \qquad C_2 \qquad C_3$

$\cong \begin{bmatrix} 0.3509 & 0.4386 & 0.2105 \end{bmatrix}^T$
C_2 value represents the highest priority.
Let's study the result:
$C_1 \quad C_2 \quad C_3$

$$\left[\dfrac{20}{57} \quad \dfrac{25}{57} \quad \dfrac{12}{57} \right]^T$$
$\begin{bmatrix} x & y & z \end{bmatrix}$
Ratios:
$\dfrac{y}{x} = \dfrac{25}{20} = 1.25$ instead of 3

$\dfrac{x}{z} = \dfrac{20}{12} = \dfrac{5}{3} = 1.\overline{6}$ instead of 4

$\dfrac{y}{z} = \dfrac{25}{12} = 2.08\overline{3}$ instead of 5

Percentage of Discounting:

$\dfrac{\frac{25}{20}}{3} = \dfrac{5}{12} = \alpha_1 = 41.\overline{6}\%$

$\dfrac{\frac{20}{12}}{4} = \dfrac{5}{12} = \alpha_1 = 41.\overline{6}\%$

$\dfrac{\frac{25}{12}}{5} = \dfrac{5}{12} = \alpha_1 = 41.\overline{6}\%$

Hence all original proportions, which were respectively equal to 3, 4, and 5 in the problem, were reduced by multiplication with

the same factor $\alpha_1 = 5/12$ i.e. by getting 41.6% of each of them.

So, it was fair to reduce each factor to the same percentage 41.6% of itself.

But this is not the case in Saaty's method: its normalized priority vector is

$$\begin{array}{ccc} C_1 & C_2 & C_3 \end{array}$$
$$\begin{bmatrix} 0.3509 & 0.4386 & 0.2105 \end{bmatrix}^T$$
$$\begin{array}{ccc} x & y & z \end{array}$$

Where:

Ratios:

$$\frac{y}{x} = \frac{0.6267}{0.2797} \cong 2.2406 \text{ instead of 3}$$

$$\frac{x}{z} = \frac{0.2797}{0.0936} \cong 2.9882 \text{ instead of 4}$$

$$\frac{y}{z} = \frac{0.6267}{0.0936} \cong 6.6955 \text{ instead of 5}$$

Percentage of Discounting:

$$\frac{2.2406}{3} \cong 74.6867\%$$

$$\frac{2.9882}{4} \cong 74.7050\%$$

$$\frac{6.6955}{5} \cong 133.9100\%$$

Why, for example, the first proportion, which was equal to 3, was discounted to 74.6867% of it, while the second proportion, which was equal to 4, was discounted to another percentage (although close) 74.7050% of it?

Even more dough we have for the third proportion's coefficient, which was equal to 5, but was increased to 133.9100% of it, while the previous two proportions were decreased; what is the justification for these?

That's why we think our α-D/Fairness-Principle is better justified. We can solve this same problem using matrices (35), (36), (37) can be written in another way to form a linear parameterized homogeneous linear system:

$$\begin{cases} 3\alpha_1 x - y = 0 \\ x - 4\alpha_2 z = 0 \\ y - 5\alpha_3 z = 0 \end{cases} \quad (46)$$

Whose associated matrix is:

$$P_1 = \begin{bmatrix} 3\alpha_1 & -1 & 0 \\ 1 & 0 & -4\alpha_2 z \\ 0 & 1 & -5\alpha_3 z \end{bmatrix} \quad (47)$$

a) If $\det(P_1) \neq 0$ then the system (42) has only the null solution $x = y = z = 0$.

b) Therefore, we need to have $\det(P_1) = 0$, or $(3\alpha_1)(4\alpha_2) - 5\alpha_3 = 0$, or $2.4\alpha_1\alpha_2 - \alpha_3 = 0$, so we get the same parametric equation as (38).

In this case the homogeneous parameterized linear system (46) has a triple infinity of solutions. This method is an extension of Saaty's method, since we have the possibility to manipulate the parameters α_1, α_2 and α_3. For example, if a second source tells us that x/z has to be discounted 2 times as much as y/x, and y/x should be discounted 3 times less than y/x, then we set $\alpha_2 = 2\alpha_1$, and respectively $\alpha_3 = \alpha_1/3$, and the original (35), (36), (37) system becomes:

$$\begin{cases} y/x = 3\alpha_1 \\ x/z = 4\alpha_2 = 4(2\alpha_1) = 8\alpha_1 \\ y/z = 5\alpha_3 = 5(\alpha_1/3) = (5/3)\alpha_1 \end{cases} \quad (48)$$

and we solve it in the same way.

8.2. Weak Inconsistent Example 10.

Let's complicate Jean Dezert's Weak Inconsistent Example 6.1 with one more preference: C_2 is 1.5 times as much as C_1 and C_3 together. The new system is:

$$\begin{cases} y/x = 3 \\ x/z = 4 \\ y/z = 5 \\ y = 1.5(x+z) \\ x, y, z \in [0,1] \\ x + y + z = 1 \end{cases} \quad (49)$$

We parameterized it:

$$\begin{cases} y/x = 3\alpha_1 \\ x/z = 4\alpha_2 \\ y/z = 5\alpha_3 \\ y = 1.5\alpha_4(x+z) \\ x, y, z \in [0,1] \\ x + y + z = 1 \end{cases} \quad (50)$$

$$\alpha_1, \alpha_2, \alpha_3, \alpha_4 > 0$$

Its associated matrix is:

$$P_2 = \begin{bmatrix} 3\alpha_1 & -1 & 0 \\ 1 & 0 & -4\alpha_2 \\ 0 & 1 & -5\alpha_3 \\ 1.5\alpha_4 & -1 & 1.5\alpha_4 \end{bmatrix} \tag{51}$$

The rank of matrix P_2 should be strictly less than 3 in order for the system (50) to have non-null solution.

If we take the first three rows in (51) we get the matrix P_1, whose determinant should be zero, therefore one also gets the previous parametric equation $2.4\alpha_1\alpha_2 = \alpha_3$.

If we take rows 1, 3, and 4, since they all involve the relations between C_2 and the other criteria C_1 and C_3 we get

$$P_3 = \begin{bmatrix} 3\alpha_1 & -1 & 0 \\ 0 & 1 & -5\alpha_3 \\ 1.5\alpha_4 & -1 & 1.5\alpha_4 \end{bmatrix} \tag{52}$$

Whose determinant should also be zero:

$$\det(P_3) = [3\alpha_1(1.5\alpha_4) + 5\alpha_3(.5\alpha_4) + 0] - [0 + 3\alpha_1(5\alpha_3) + 0] = 4.5\alpha_1\alpha_4 + 7.5\alpha_3\alpha_4 - 15\alpha_1\alpha_3 = 0 \tag{53}$$

If we take

$$P_4 = \begin{bmatrix} 1 & 0 & -4\alpha_2 \\ 0 & 1 & -5\alpha_3 \\ 1.5\alpha_4 & -1 & 1.5\alpha_4 \end{bmatrix} \tag{54}$$

Then

$$\det(P_4) = [1.5\alpha_4 + 0 + 0] - [-6\alpha_2\alpha_4 + 5\alpha_3 + 0] = 6\alpha_2\alpha_4 - 12\alpha_1\alpha_2 + 1.5\alpha_4 = 0 \tag{55}$$

If we take

$$P_5 = \begin{bmatrix} 3\alpha_1 & -1 & 0 \\ 1 & 0 & -4\alpha_2 \\ 1.5\alpha_4 & -1 & 1.5\alpha_4 \end{bmatrix} \tag{56}$$

Then

$$\det(P_5) = [0 + 0 + 6\alpha_2\alpha_4] - [0 + 12\alpha_1\alpha_2 - 1.5\alpha_4] = 6\alpha_2\alpha_4 + 12\alpha_1\alpha_2 - 1.5\alpha_4 = 0 \tag{57}$$

So, these four parametric equations form a parametric system:

$$\begin{cases} 2.4\alpha_1\alpha_2 - \alpha_3 = 0 \\ 4.5\alpha_1\alpha_4 + 7.5\alpha_3\alpha_4 - 15\alpha_1\alpha_3 = 0 \\ 1.5\alpha_4 + 6\alpha_2\alpha_4 - 5\alpha_3 = 0 \\ 6\alpha_2\alpha_4 - 12\alpha_1\alpha_2 + 1.5\alpha_4 = 0 \end{cases} \tag{58}$$

which should have a non-null solution.

If we consider $\alpha_1 = \alpha_2 = \alpha_3 = 5/12 > 0$ as we got at the beginning, then substituting all α's into the last three equations of the system (58) we get:

$$4.5\frac{5}{12}\alpha_4 + 7.5\frac{5}{12}\alpha_4 - 15\frac{5}{12}\frac{5}{12} = 0$$

$$\Rightarrow \alpha_4 = 0.5208\bar{3} = \frac{25}{48}$$

$$1.5\alpha_4 + 6\frac{5}{12}\alpha_4 - 5\frac{5}{12} = 0 \Rightarrow \alpha_4 = 0.5208\bar{3}$$

$$6\frac{5}{12}\alpha_4 - 12\frac{5}{12}\frac{5}{12} + 1.5\alpha_4 = 0 \Rightarrow \alpha_4 = 0.5208\bar{3}$$

α_4 could not be equal to $\alpha_1 = \alpha_2 = \alpha_3$ since it is an extra preference, because the number of rows was bigger than the number of columns.

So the system is consistent, having the same solution as previously, without having added the fourth preference $y = 1.5(x + z)$.

9. JEAN DEZERT'S STRONG INCONSISTENT EXAMPLE

9.1. Jean Dezert's Strong Inconsistent Example 11

The preference matrix is:

$$M_1 = \begin{pmatrix} 1 & 9 & \frac{1}{9} \\ \frac{1}{9} & 1 & 9 \\ 9 & \frac{1}{9} & 1 \end{pmatrix} \tag{59}$$

so,

$$\begin{cases} x = 9y, x > y \\ x = \frac{1}{9}z, x < z \\ y = 9z, y < z \end{cases} \tag{60}$$

The other three equations: $y = 1/9x$, $z = 9x$, $z = 1/9y$ result directly from the previous three ones, so we can eliminate them.

From $x > y$ and $y > z$ (first and third above inequalities) we get $x > z$, but the second inequality tells us the opposite: $x < z$; that's why we have a strong contradiction/ inconsistency. Or, if we combine all three we have $x > y > z > x\ldots$ strong contradiction again.

Parameterize:

$$\tag{61}$$

$$\tag{62}$$

$$\tag{63}$$

$$\begin{cases} x = 9\alpha_1 y \\ x = \dfrac{1}{9}\alpha_2 z \\ y = 9\alpha_3 z \end{cases}$$

Where: $\alpha_1, \alpha_2, \alpha_3 > 0$.

From (61) we get: $y = \dfrac{1}{9\alpha_1} x$, from (62)

we get $z = \dfrac{1}{9\alpha_2} x$, which is replaced in (63)

and we get: $y = 9\alpha_3 \dfrac{9}{\alpha_2} x = \dfrac{81\alpha_3}{\alpha_2} x$.

So $\dfrac{1}{9\alpha_1} x = \dfrac{81\alpha_3}{\alpha_2} x$ or $\alpha_2 = 729\alpha_1\alpha_3$

(parametric equation)   (64)

The general solution of the system is:

$$\left(x \quad \dfrac{1}{9\alpha_1} x \quad \dfrac{9}{\alpha_2} x \right) \tag{65}$$

The general priority vector is:

$$\left[1 \quad \dfrac{1}{9\alpha_1} \quad \dfrac{9}{\alpha_2} \right]$$

Consider the fairness principle, then $\alpha_1 = \alpha_2 = \alpha_3 = \alpha > 1$ are replaced into the parametric equation: $\alpha = 729\alpha^2$, whence $\alpha = 0$ (not good) and $\alpha = 1/729 = 1/9^3$.

The particular priority vector becomes $\left[1 \quad 9^2 \quad 9^4 \right] = \left[1 \quad 81 \quad 6561 \right]$ and normalized $\left[\dfrac{1}{6643} \quad \dfrac{81}{6643} \quad \dfrac{6561}{6643} \right]$.

Because the consistency is:

$\alpha = \dfrac{1}{729} = 0.00137$ is extremely low, we can disregard this solution (and the inconsistency is very big $\beta = 1 - \alpha = 0.99863$).

9.1.2. Remarks:

a) If in M_1 we replace all six 9's by a bigger number, the inconsistency of the system will increase. Let's use 11.

Then $\alpha = \dfrac{1}{11^3} = 0.00075$ (consistency), while inconsistency $\beta = 0.99925$.

b) But if in M_1 we replace all 9's by the smaller positive number greater than 1, the consistency decreases. Let's use 2.

Then $\alpha = \dfrac{1}{2^3} = 0.125$ and $\beta = 0.875$.

c) Consistency is 1 when replacing all six 9's by 1.

d) Then, replacing all six 9's by a positive sub unitary number, consistency decreases again. For example, replacing by 0.8 we obtain $\alpha = \dfrac{1}{0.8^3} = 1.953125 > 1$, whence $1/\alpha = 0.512$ (consistency) and $\beta = 0.488$ (inconsistency).

9.2. Jean Dezert's Strong Inconsistent Example 12

The preference matrix is:

$$M_1 = \begin{pmatrix} 1 & 5 & \dfrac{1}{5} \\ \dfrac{1}{5} & 1 & 5 \\ 5 & \dfrac{1}{5} & 1 \end{pmatrix} \tag{66}$$

Which is similar to M_1 where we replace all six 9's by 5's. $\alpha = \dfrac{1}{5^3} = 0.008$ (consistency) and $\beta = 0.992$ (inconsistency).

The priority vector is:

$\left[1 \quad 5^2 \quad 5^4 \right] = \left[1 \quad 25 \quad 625 \right]$ and normalized $\left[\dfrac{1}{651} \quad \dfrac{5}{651} \quad \dfrac{625}{651} \right]$.

M_2 is a little more consistent than M_1 because $0.00800 > 0.00137$, but still not enough, so this result is also discarded.

9.3. Generalization of Jean Dezert's Strong Inconsistent Examples
General Example 13

Let the preference matrix be:

$$M_t = \begin{pmatrix} 1 & t & \dfrac{1}{t} \\ \dfrac{1}{t} & 1 & t \\ t & \dfrac{1}{t} & 1 \end{pmatrix} \tag{67}$$

with $t > 0$, and $c(M_t)$ the consistency of M_t, $i(M_t)$ inconsistency of M_t.

We have for the Fairness Principle:

$$\lim_{t \to 1} c(M_t) = 1 \text{ and } \lim_{t \to 1} i(M_t) = 0$$

$$\lim_{t \to \infty} c(M_t) = 0 \text{ and } \lim_{t \to \infty} i(M_t) = 1 \qquad (68)$$

$$\lim_{t \to 0} c(M_t) = 0 \text{ and } \lim_{t \to 0} i(M_t) = 1$$

Also $\alpha = \dfrac{1}{t^3}$, the priority vector is $\begin{bmatrix} 1 & t^2 & t^4 \end{bmatrix}$ which is normalized as

$$\left[\frac{1}{1+t^2+t^4} \quad \frac{t^2}{1+t^2+t^4} \quad \frac{t^4}{1+t^2+t^4} \right].$$

In such situations, when we get strong contradiction of the form x > y > z > x or similarly x < z < x, etc. and the consistency is tiny, we can consider that x = y = z = 1/3 (so no criterion is preferable to the other − as in Saaty's AHP), or just x + y + z = 1 (which means that one has the total ignorance too: C1 ∪ C2 ∪ C3).

10. STRONG INCONSISTENT EXAMPLE

Let C = {C1, C2}, and P = {C1 is important twice as much as C2; C2 is important 5 times as much as C1}.

Let m(C1) = x, m(C2) = y. Then: x = 2y and y = 5x (it is a strong inconsistency since from the first equation we have x > y, while from the second y > x).

Parameterize: $x = 2\alpha_1 y$, $y = 5\alpha_2 x$, whence we get $2\alpha_1 = 1/(5\alpha_2)$, or $10\alpha_1\alpha_2 = 1$.

If we consider the Fairness Principle, then $\alpha_1 = \alpha_2 = \alpha > 0$, and one gets $\alpha = \sqrt{10}/10 \approx$ 31.62% consistency; priority vector is [0.39 0.61], hence y > x. An explanation can be done as in paraconsistent logic (or as in neutrosophic logic): we consider that the preferences were honest, but subjective, therefore it is possible to have two contradictory statements true simultaneously since a criterion C1 can be more important from a point of view than C2, while from another point of view C2 can be more important than C1. In our decision making problem, not having any more information and having rapidly being required to take a decision, we can prefer C2, since C2 is 5 times more important that C1, while C1 is only 2 times more important than C2, and 5 > 2.

If it's no hurry, more prudent would be in such dilemma to search for more information on C1 and C2. If we change Example 14 under the form: x = 2y and y = 2x (the two coefficients set equal), we get α = ½, so the priority vector is [0.5 0.5] and decision-making problem is undecidable.

11. NON-LINEAR/LINEAR EQUATION MIXED SYSTEM EXAMPLE

Let C = {C1, C2, C3}, m(C1) = x, m(C2) = y, m(C3) = z. Let F be:
1. C1 is twice as much important as the product of C2 and C3.
2. C2 is five times as much important as C3.
3. C1 is less important than C3.

We get the system: x = 2yz (non-linear equation) and y = 5z (linear equation). The general solution vector of this mixed system is: [10z² 5z z], where z > 0.

A discussion is necessary now.

a) You see for sure that y > z, since 5z > z for z strictly positive. But we don't see anything what the position of x would be?

b) Let's simplify the general solution vector by dividing each vector component by z > 0, thus we get: [10z 5 1].

If z ∈ (0, 0.1), then y > z > x.

If z = 0.1, then y > z = x.

If z ∈ (0.1, 0.5), then y > x > z.

If z = 0.5, then y = x > z.

If z > 0.5, then x > y > z.

12. NON-LINEAR/LINEAR EQUATION/INEQUALITY MIXED SYSTEM EXAMPLE

Since in the previous Example 15 have many variants, assume that a new preference comes in (in addition to the previous two preferences):

The mixed system becomes now: x = 2yz (non-linear equation), y = 5z (linear equation), and x < z (linear inequality).

The general solution vector of this mixed system is: [10z² 5z z], where z > 0 and 10z2 < z. From the last two inequalities we get z ∈ (0, 0.1). Whence the priorities are: y > z > x.

13. FUTURE RESEARCH

To investigate the connection between α-D MCDM and other methods, such as: the technique for order preference by similarity to ideal solution (TOPSIS) method, the simple additive weighting (SAW) method, Borda-Kendall (BK) method for aggregating ordinal preferences, and the cross-efficiency evaluation method in data envelopment analysis (DEA).

14. CONCLUSION

We have introduced a new method in the multi-criteria decision making, α-Discounting MCDM. In the first part of this method, each preference is transformed into a linear or non-linear equation or inequality, and all together forms a system that is resolved – one finds its general solution, from which one extracts the positive solutions. If the system has only the null solution, or it is inconsistent, then one parameterizes the coefficients of the system.

In the second part of the method, one chooses a principle for finding the numerical values of the parameters (we have proposed herein the Fairness Principle, or Expert's Opinion on Discounting, or setting a Consistency (or Inconsistency) Threshold).

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COMPUTATIONAL METHODS FOR THE AERODYNAMIC DESIGN

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Abstract: *The interest for efficient methods for aerodynamic design is expressed by a better use of the panel method applications, based on the property that no volumetric grid is require. In this case, only the bounding surface should be discretized. This paper deals with the Maple soft applications for numerical panel method for incompressible flows. Based on this powerful mathematical computation tools, several numerical solutions were obtained for different body shapes, in a simple but intuitive manner.*

Keywords*: the panel method, boundary elements, Maple soft applications, flow simulation.*

1. INTRODUCTION

Despite advances in the development of sophisticated grid generation techniques and compressible flow modeling methods, analyses based on incompressible and inviscid potential flow assumptions continue to remain a very good technique for aerodynamic computation.

Compared to the generation of a good quality volumetric grid, construction of a surface mesh for a complex geometry is a simpler problem especially since the required geometric information is often already available in the form of CAD files and efficient grid generation techniques for curved surfaces have been developed.

The incompressible potential flow model provides reliable flowfield predictions over a wide range of conditions. For the potential flow assumption to be valid for aerodynamics calculations, the primary requirement is that viscous effects are small in the flowfield, and that the flowfield must be subsonic everywhere. If the local flow is at such a low speed everywhere that it can be assumed incompressible, Laplace's Equation is an exact representation of the inviscid flow. For higher subsonic mach numbers with small disturbances to the freestream flow, the Prandtl-Glauert Equation can be used and converted to Laplace's Equation by a simple transformation. This provides the basis for estimating the initial effects of compressibility on the flowfield, namely liniearized subsonic flow. In both cases, the flowfield can be found by the solution of a single linear partial differential equation. One of the key features of Laplace's Equation is the property that allows the equation governing the flowfield to be converted from 3D problem throughout the field a 2D problem for finding the potential on the surface.

The solution is then found using this property by distributing singularities of unknown strength over discredited portions of the surface: panels. Hence the flowfield solution is found by representing the surface by a number of panels and solving a linear set of algebraic equations to determine the unknown strengths of the singularities.

2. PROBLEM FORMULATION

The equation for the potential is the following

$$\varphi = V_\infty \left(x \cos\alpha + y \sin\alpha \right) +$$

$$+ \sum_{j=1}^{N} \int_{\text{panel } j} \left[\underbrace{\frac{q_j(s)}{2\pi}}_{\substack{q_j \text{ is the 2D} \\ \text{source strength}}} - \underbrace{\frac{\gamma_j}{2\pi}\theta}_{\substack{\text{vortex singularity} \\ \text{of strength } \gamma_j(s)}} \right] \quad (1)$$

where V_∞ is the free stream velocity, α the angle of attack and $\theta = \tan^{-1}(y/x)$.

The numbering system starts at the lower surface trailing edge and proceeds forward, around the leading edge and aft to upper surface trailing edge, so N + 1 points define N panels. The approach is to break up the surface into straight line segments, assume the source strength $q(s)$ is constant over each line segment (panel), but with different value for each panel, $q(s) = q_j$, $j = 1, 2......N$, and the vortex strength γ is constant and equal over each panel.

Most airfoils are not described by equations but are defined by a table of coordinates. Frequently, these coordinates are the results of a computational aerodynamic design program, and simple algebraic formulas can not be used to define the shape. The representation of a smooth surface by a series of line segments is presented in Fig. 1.
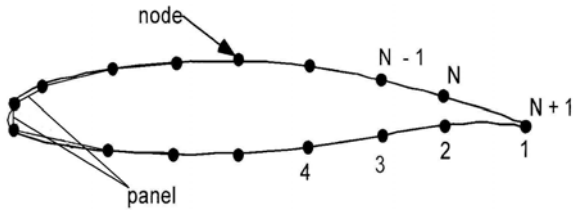
Fig. 1 Representation of nodes

If the ith panel is between the ith and $i+1^{th}$ nodes and the ith panel's inclination to the x axix is θ_i (Fig. 2), then the sin and cos of θ are given by
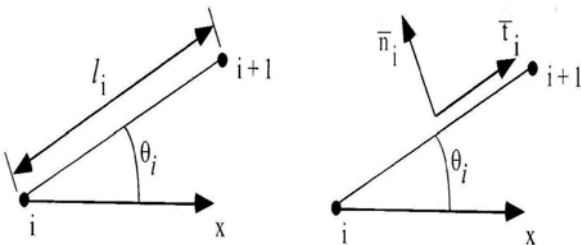
Fig. 2 Nomenclature for coordinate system

$$\begin{cases} \sin\theta_i = \dfrac{y_{i+1} - y_i}{l_i} \\ \cos\theta_i = \dfrac{x_{i+1} - x_i}{l_i} \end{cases} \quad (2)$$

and the normal and tangential unit vectors are

$$\begin{cases} \vec{n}_i = -\sin\theta_i \vec{i} + \cos\theta_i \vec{j} \\ \vec{t}_i = \cos\theta_i \vec{i} + \sin\theta_i \vec{j} \end{cases} \quad (3)$$

The unknowns have to satisfy the flow tangency condition on each panel at one specific control point and the solution has to satisfy the Kutta condition. The control point is the mid-point of each panel as shown in Fig. 3.
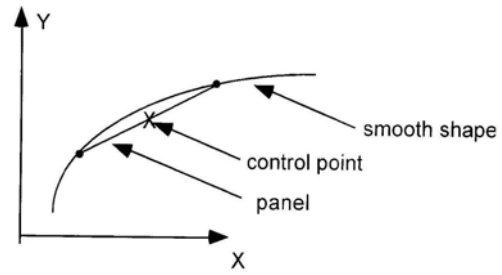
Fig. 3 Control point representation

The coordinates of the control point are

$$\begin{cases} \overline{x}_i = \dfrac{x_i + x_{i+1}}{2} \\ \overline{y}_i = \dfrac{y_i + y_{i+1}}{2} \end{cases} \quad (4)$$

and the velocity components at the control point $(\overline{x}_i, \overline{y}_i)$ are $u_i = u(\overline{x}_i, \overline{y}_i)$ and $v_i = v(\overline{x}_i, \overline{y}_i)$.

The flow tangency boundary condition is given by $\vec{V} \cdot \vec{n} = 0$,

$$(u_i \vec{i} + v_i \vec{j}) \cdot (-\sin\theta_i \vec{i} + \cos\theta_i \vec{j}) = 0 \quad (5)$$

or

$$-u_i \sin\theta_i + v_i \cos\theta_i = 0$$

for each i, $i = 1, 2,..., N$.

The remaining relation is found from the Kutta condition. This condition states that the flow must leave the trailing edge smoothly. Because of the importance of the Kutta condition in determining the flow, the solution is extremely sensitive to the flow details at the trailing edge, and for this reason the last panels on the top and bottom are small and of equal length.

The trailing edge panel nomenclature is presented in Fig. 4.
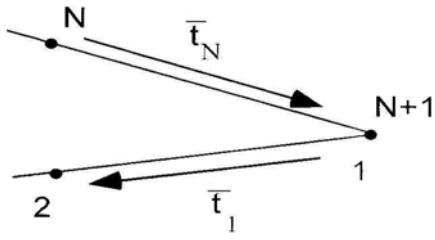
Fig. 4 Trailing edge

Also, the magnitude of the tangential velocities on the upper and lower surface is equal

$$u_{t1} = -u_{tN}$$

or

$$\vec{V} \cdot t \Big|_1 = -\vec{V} \cdot t \Big|_N \tag{6}$$

Carrying out the operation one gets the relation

$$\left(u_1 \vec{i} + v_1 \vec{j}\right) \cdot \left(\cos\theta_1 \vec{i} + \sin\theta_1 \vec{j}\right) =$$
$$-\left(u_N \vec{i} + v_N \vec{j}\right) \cdot \left(\cos\theta_N \vec{i} + \sin\theta_N \vec{j}\right) \tag{7}$$

which is expanded to obtain the final relation:

$$u_1 \cos\theta_1 + v_1 \sin\theta_1 =$$
$$-u_N \cos\theta_N + v_N \sin\theta_N \tag{8}$$

The expression for the potential in terms of the singularities on each panel and the boundary conditions derived above for the flow tangency and Kutta condition are used to construct a system of linear algebraic equations for the strengths of the sources and the vortex. The velocity components at any point i are given by contributions from the velocities induced by the source and vortex distributions over each panel,

$$\begin{cases} u_i = V_\infty \cos\alpha + \sum_{j=1}^{N} q_j u_{sij} + \gamma \sum_{j=1}^{N} u_{vij} \\ v_i = V_\infty \sin\alpha + \sum_{j=1}^{N} q_j v_{sij} + \gamma \sum_{j=1}^{N} v_{vij} \end{cases} \tag{9}$$

where q_i and γ are the singularity strengths and the $u_{sij}, v_{sij}, u_{vij}$ and v_{vij} are the influence coefficients (for instance, the influence coefficient u_{sij} is the x-component of velocity at x_i due to a unit source distribution over the jth panel).

In order to find $u_{sij}, v_{sij}, u_{vij}$ and v_{vij} it is necessary to work in a local panel coordinate system $\left(x^p, y^p\right)$ which leads to a straightforward means of integrating source and vortex distributions along a straight line segment. The system is locally aligned with each panel j, and is connected to the global coordinate system, like in Fig. 5.
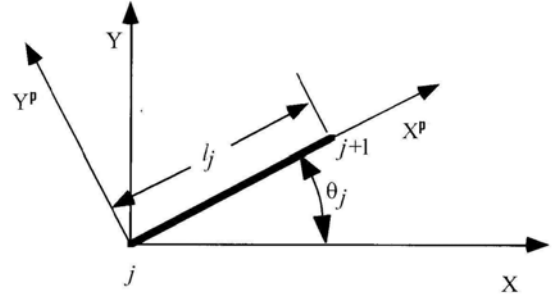
Fig. 5 Local panel nomenclature

The influence coefficients determined in the local coordinate system aligned with a particular panel are $u^{(p)}$ and $v^{(p)}$ and are transformed back to the global coordinate system by

$$\begin{cases} u = u^{(p)} \cos\theta_j - v^{(p)} \sin\theta_j \\ v = u^{(p)} \sin\theta_j + v^{(p)} \cos\theta_j \end{cases} \tag{10}$$

The velocity field induced by a source in its Cartesian coordinates (taking into account that the source is located at the origin, $r = 0$) is

$$\begin{cases} u(x, y) = \dfrac{Q}{2\pi} \dfrac{x}{x^2 + y^2} \\ u(x, y) = \dfrac{Q}{2\pi} \dfrac{y}{x^2 + y^2} \end{cases} \tag{11}$$

If the source is located along the x-axis at a point $x = t$, the velocities induced by the source distributions are

$$u_s = \frac{1}{2\pi} \int_{t=0}^{t=l} \frac{q(t)}{2\pi} \frac{x - t}{(x-t)^2 + y^2}$$

$$v_s = \frac{1}{2\pi} \int_{t=0}^{t=l} \frac{q(t)}{2\pi} \frac{y}{(x-t)^2 + y^2} \tag{12}$$

To obtain the influence coefficients, one can write u_s and v_s in the local panel

45

coordinate system with $q(t) = 1$ (unit source strength):

$$u^{(p)}_{sij} = -\frac{1}{2\pi}\ln\left(\frac{r_{i,\,j+1}}{r_{ij}}\right)$$

$$v^{(p)}_{sij} = \frac{v_1 - v_0}{2\pi} = \frac{\beta_{ij}}{2\pi}$$

(13)

where r_{ij} is the distance from the jth node to the point i, which is taken to be the control point location of the ith panel. The angle β_{ij} is the angle subtended at the middle of the ith panel by the jth panel (Fig. 6).
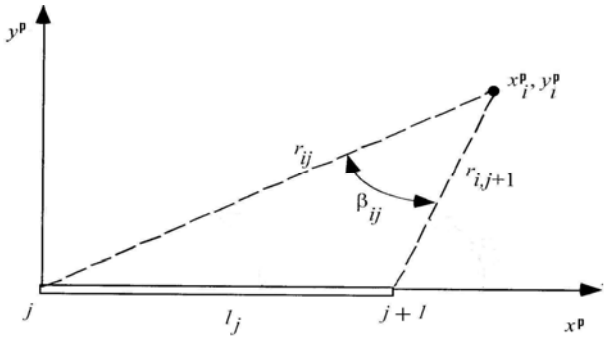
Fig. 6 Angles and radius

The source induces normal velocities and no tangential velocities. Thus, $u^{(p)}_{sii} = 0$ and $v^{(p)}_{sii}$ depends on the side from which the panel control point is approached. Approaching the panel control point from the outside leads to $\beta_{ii} = \pi$, while approaching from the inside leads to $\beta_{ii} = -\pi$.

Based on the same analysis used for the source singularities one can get the formulas for the influence coefficients due to the vortex distribution

$$u^{(p)}_{vij} = +\frac{1}{2\pi}\int_{t=0}^{t=l_j}\frac{y_i^{(p)}}{\left(x_i^{(p)}-t\right)^2 + y_i^{(p)2}}dt = \frac{\beta_{ij}}{2\pi}$$

$$v^{(p)}_{vij} = \frac{1}{2\pi}\int_{t=0}^{t=l_j}\frac{x_i^{(p)}-t}{\left(x_i^{(p)}-t\right)^2 + y_i^{(p)2}}dt = \frac{1}{2\pi}\ln\left(\frac{r_{i,\,j+1}}{r_{ij}}\right)$$

(14)

where the definitions and special circumstances described for the source singularities are the same in the current case of distributed vortices. In this case the vortex

distribution induces an axial velocity on itself at the sheet and no normal velocity.

In order to get a system of equations of the form

$$\sum_{j=1}^{N}A_{ij}q_j + A_{i,\,N+1}\gamma = b_i \quad i = 1,2,...,N \quad (15)$$

which are solved for unknown source and vortex strengths, it is necessary to write the flow tangency conditions

$$-u_i\sin\theta_i + v_i\cos\theta_i = 0 \quad (16)$$

for each i, $i = 1, 2,..., N$, where the velocities are given by:

$$u_i = V_\infty\cos\alpha + \sum_{j=1}^{N}q_j u_{sij} + \gamma\sum_{j=1}^{N}u_{vij}$$

$$v_i = V_\infty\sin\alpha + \sum_{j=1}^{N}q_j v_{sij} + \gamma\sum_{j=1}^{N}v_{vij}$$

(17)

Taking into account formulas for u_{sij}, v_{sij}, u_{vij}, v_{vij}, one can get the system

$$\begin{cases} A_{ij} = \frac{1}{2\pi}\ln\left(\frac{r_{i,\,j+1}}{r_{i,\,j}}\right)\sin(\theta_i - \theta_j) + \frac{\beta_{ij}}{2\pi}\cos(\theta_i - \theta_j) \\ A_{i,\,N+1} = \frac{1}{2\pi}\sum_{j=1}^{N}\left[\ln\left(\frac{r_{i,\,j+1}}{r_{i,\,j}}\right)\cos(\theta_i - \theta_j) - \beta_{ij}\sin(\theta_i - \theta_j)\right] \\ b_i = V_\infty\sin(\theta_i - \alpha) \end{cases}$$

The final equations associated with the Kutta condition are

$$\begin{cases} A_{N+1,\,j} = \frac{1}{2\pi}\left[\sin(\theta_1 - \theta_J)\beta_{1,\,j} + \sin(\theta_N - \theta_J)\beta_{N,\,j}\right] - \\ -\frac{1}{2\pi}\left[\cos(\theta_1 - \theta_J)\ln\left(\frac{r_{1,\,j+1}}{r_{1,\,j}}\right) + \cos(\theta_N - \theta_J)\left(\frac{r_{N,\,j+1}}{r_{N,\,j}}\right)\right] \\ A_{N+1,\,N+1} = \sum_{j=1}^{N}\left[\sin(\theta_i - \theta_j)\ln\left(\frac{r_{1,\,j+1}}{r_{1,\,j}}\right) + \sin(\theta_N - \theta_j)\right]\cdot \\ \cdot\ln\left(\frac{r_{N,\,j+1}}{r_{N,\,j}}\right) + \sum_{j=1}^{N}\left[\cos(\theta_1 - \theta_j)\beta_{1,\,j} + \cos(\theta_N - \theta_j)\beta_{N,\,j}\right] \\ b_{N+1} = -V_\infty\cos(\theta_1 - \alpha) - V_\infty\cos(\theta_N - \alpha) \end{cases}$$

The coefficients derived above provide the required coefficients to solve a system of

linear algebraic equations for N + 1 unknowns q_i, $i = 1, 2,..., N$ and γ,

$$\begin{cases} \sum_{j=1}^{N} A_{ij}q_j + A_{i,\,N+1}\gamma = b_i & i = 1, 2,..., N \\ \sum_{j=1}^{N} A_{N+1,\,j}q_j + A_{N+1,\,N+1}\,\gamma = b_{N+1} \end{cases}$$

(18)

At each control point, $v_n = 0$ and the tangential velocity is

$$u_{t_i} = V_\infty \cos(\theta_i - \alpha) +$$

$$+ \frac{1}{2\pi} \sum_{j=1}^{N} \left[\beta_{ij} \sin(\theta_i - \theta_j) - \ln\left(\frac{r_{i,\,j+1}}{r_{i,\,j}}\right) \cos(\theta_i - \theta_j) \right] q_j +$$

$$+ \frac{\gamma}{2\pi} \sum_{j=1}^{N} \left[\ln\left(\frac{r_{i,\,j+1}}{r_{i,\,j}}\right) \sin(\theta_i - \theta_j) + \beta_{ij} \cos(\theta_i - \theta_j) \right]$$

and the pressure coefficient,

$$C_{p_i} = 1 - \left(\frac{u_{t_i}}{V_\infty}\right)^2$$

(19)

3. MAPLE SOLUTION

Maple provides an interactive environment for solving symbolic, numeric and graphical computations. A simple way to solve the system of equations for q_i, $i = 1, 2,…, N$ and γ, is to build a procedure $\mathbf{proc}(V_\infty, \alpha)$ which gives the results for the inputs: free stream velocity V_∞ and angle of attack α. After declaring the local and global variables one can choose the number of panels, N and write the coordinates of nodes i, where i = 1, 2,…, N + 1. The matrix M of coefficients A_{ij} and vector B of b_i, are written in the following form:

M := Matrix([seq(L[i], I = 1…N + 1)])

where

L[i] := [seq(A[i,j], j = 1…N + 1)]

And

B := Vector([seq(b[i], I = 1…N + 1)]).

With the package LinearSolve one can get the solution of the equation

$$A \cdot x = B$$

(20)

namely,

$$x = [q_1, q_2, ...q_N, \gamma]$$

(21)

and after that, the tangential velocity u_{t_i} at each control point and the pressure coefficient C_{p_i}.

In the following figures are presented the NACA 4415 airfoil (Fig. 7) and some results for C_{p_i} (Fig. 8, Mach number 0.2, Fig. 9, Mach number 0.4).
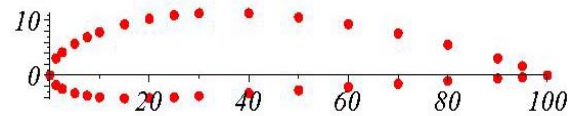
Fig. 7 Airfoil coordinates
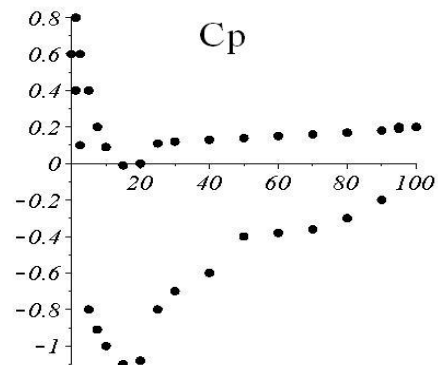
Fig. 8 Pressure coefficient
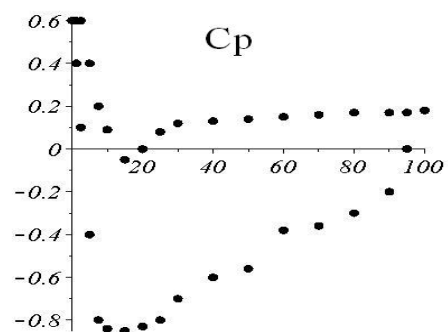
Fig. 9 Pressure coefficient

Also, a very simple way to solve the system of equations for the numerical source panel method (analyzed very well in the Fundamentals of Aerodynamics – fourth edition by John D. Anderson Jr.) is allowed by Maple soft.

For the flow around the circular cylinder, the equation for the source panel strengths $\lambda_1, \lambda_2,...,\lambda_N$ is:

$$\frac{\lambda_i}{2} + \sum_{\substack{j=1 \\ (j \neq i)}}^{N} \frac{\lambda_j}{2\pi} \int_{j\,panel} \frac{\partial}{\partial n_i}\left(\ln r_{ij}\right) ds_j + V_\infty \cos\beta_i = 0$$

The velocity tangent to the surface at each control point can be calculated as a sum of the contribution from the freestream and from the source panels,

$$V_{ti} = V_\infty \sin\beta_i + \sum_{j=1}^{N} \frac{\lambda_j}{2\pi} \int_{j\,panel} \frac{\partial}{\partial s}\left(\ln r_{ij}\right) ds_j$$

where β_i is the angle between V_∞ and normal vector to the panel i.

In Fig. 10 are presented the control points (1, 2,..., 12) for source panel distribution around a circular cylinder.
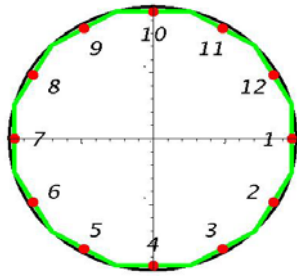
Fig. 10 Control points representation

Results for the pressure coefficients obtained from Maple calculation (red points in Fig. 11) are compared with the exact analytical result (black line). The numerical pressure coefficient result is placed on the analytical line, that is the maple calculation is right.
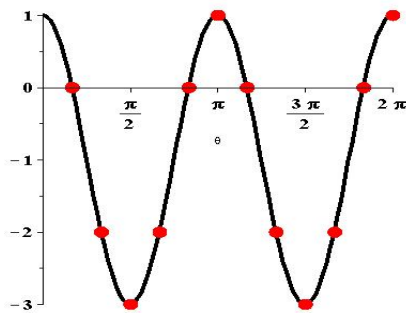
Fig. 11 Numerical and analytical results

4. CONCLUSIONS

The linear nature of the potential flow allows the principle of superposition in order to construct solutions to problems of interest by summing simpler solutions. Flows due to sources, doublets and vortices are the elementary building blocks out of which general solutions are constructed. Conventional computational fluid dynamics (CFD) methods require calculation for the entire three-dimensional field about the body, while the panel method also can calculate the entire three-dimensional field but it requires only calculation over the surface of the body.

One major computational task in a panel method is to obtain the matrices of panel influences at each others' control points. The key formulas are obtained by integrating over a panel the point source and doublet formulas weighted by the proper polynomial variations. These integrations, which express the panel influences at a general field point in space, may be performed analytically over a plane panel to obtain exact closed form expressions, which however are rather complicated. Maple software is an efficient tool capable to solve different types of problems and to explore mathematical models for computational aerodynamics.

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LOW POWER WIRELESS PULSE OXIMETER TERMINAL

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Abstract: *The implemented solution is part of the BIOMED-TEL project and this system combines two methods that represent the basis pulse-oximetry: spectrophotometry with role in measuring the concentration of hemoglobin (the light absorption is a function that depends on the level of blood oxygenation) and optical pletismography with role in measuring the pulsatile changes in the level of arterial blood (changes that are due to the variations in the level of arterial blood in tissues and dependent on the systolic-diastolic cardiac regime). This way the pulse-oximetry is defined as being o method noninvasive of monitoring the saturation with oxygen of the hemoglobin (blood component that has the role of transporting oxygen through tissues). The product is remarkable trough it's small dimmensions, mobility offered to the patient and low power consumption that makes possible the long on-time of the device.*

Key words: *pulse-oximetry, wirelesss terminal, sensor, battery powered.*

1. INTRODUCTION

The optical proprieties of the tissues are used in biomedical applications for diagnosing, treatment and surgery. Certain processes can take place as many times as the tissue is irradiated with light, these processes being able to include reactions: photo-thermic, photo-chemical, fluorescence, reflection and optical transmittance. These processes are not dependent on energy, for example the incidental power is equal to the sum of reflectance, absorption and transmittance.

For the pulse-oximetry application, the interesting term is the one of the time dependent absorption, by blood, due to the pulse, this way generates a lack of transmittance. The oxygen saturation from blood, SO_2, is defined by the concentration of oxygenated hemoglobin (HbO_2) related to the sum of oxygenated and unoxygenated hemoglobin (HB):

$$SO_2 = \frac{C_{HbO2}}{C_{HBO2} + C_{Hb}} \qquad (1)$$

The result given by a pulse-oximeter is an estimation of the concentration of functional arterial oxygen and should be interpreted as "the concentration of arterial oxygen measured by pulse-oxymetry" or S_pO_2. In total there are three terms that denote the saturation of functional oxygen from blood:

- SO_2: the saturation of oxygen from blood;
- S_aO_2: the saturation of oxygen from the arterial blood;
- S_pO_2: the saturation of oxygen from the arterial blood measured by the pulse-oximeter.

Fig. 1 presents the optical measure of the cardiac rhythm that is also called photopletismogram, where photo denotes (shows) the fact that an optical method is used, and pletismogram refers to the fact that the variations are caused by changes in volume (here of blood vessels) due to blood pressure.
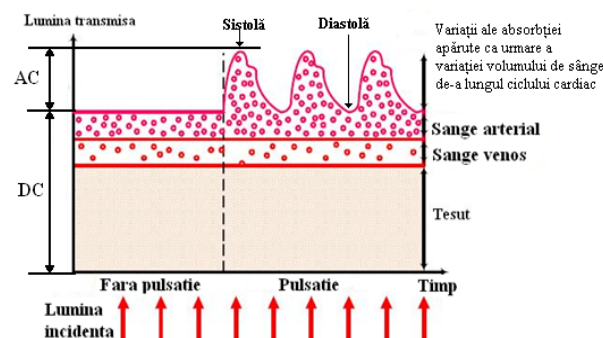
Fig. 1 Changes in the areterial volume caused by the arterial pulse

The blood as well as the skin, bones and tissue concur to the absorption. Only the arterial blood has an AC component because of the pulse. On the graphic, diastole state (the minimum) and systolic state (the maximum) can be observed together with the dicrotic notch (small plateau at the middle of the descent). The signal presented is inversed in comparison with the signal from the photo-detector, inversion made to determine a rise of the signal of the increasing pressure in blood (which is more intuitive for medical use).

2. PULSE-OXIMETER SpO$_2$

The bio-physical signal is captured at the level of a segment of the body (the forefinger or the earlobe) through the use of the pair LED-photodiode (optical principle). Two LEDs with two different wave lengths 660 nm (red) and 940 nm (infrared) are used due to the light absorption's different coefficients of the component elements of the hemoglobin: oxyhemoglobin (HbO$_2$) and the reduced hemoglobin (Hb). The LEDs work alternatively, the duration of the light pulse/LED is of 50 µs, and the work frequency is of 1kHz (much bigger than the cardiac frequency). The resulted signal, synchronous systolic-diastolic cardiac cycle is processed through levels of conversion, amplification, gear and filtration, like this result the signal needed for the subsequent processes.

2.1. RED/INFRARED SENSOR

The central element of the pulse-oxymetrical system is the acquisition sensor. This is provided with two leds, a red one and an infra-red one and a photo-detector diode, Fig. 2.
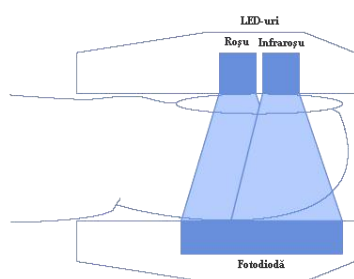
Fig. 2 Sensor with LEDs and photodiode

The sensor must be of high quality, and for this purpose a well compatible with a series of commercial pulse-oximeter was acquisitioned. It was done this way because we wish for the acquisition of a precision and quality of the bio-physical signal as high as possible.

Its purpose is to emit two different wave lengths through the tissue. The red led emits 660 nm and the infra-red one emits 940 nm. Depending on the level of blood oxygen a certain part of the light beam will be absorbed by the tissue, the rest being detected by a photo-diode.
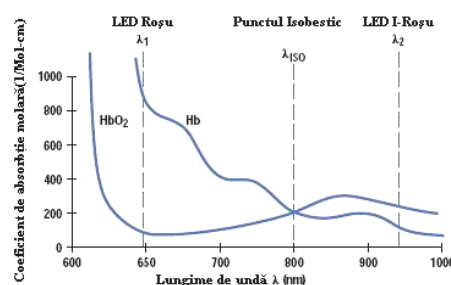
Fig. 3 Light absorbtion at different wave lenghts

2.2. METHOD

To capture the useful/practical signal a non-invasive method is used because of the use as an acquisition sensor of the signal of the well provided with two LEDs and a photo-detecting diode, elements that don't produce a violation of the integrity of the human body nor contraindications or adverse effects subsequent to their use.

The method is based on the *Beer-Lambert principle*, Fig. 4, according to which the signal detected by the photo-detector (transmitted light) is the difference between the emitted signal (incidental light) and the tissue absorber.
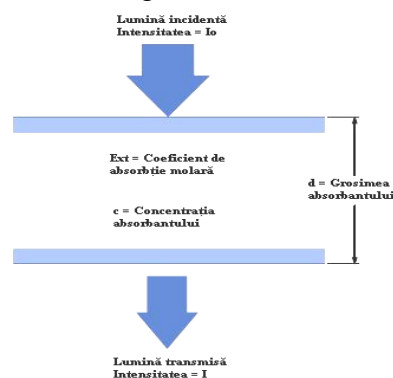
Fig. 4 The light absorbtion in tissue

The absorber holds a series of tissue intrinsic factors: the coefficient of the molar absorption, the concentration of the tissue, the thickness of the tissue.

In the project it was used a sensor (SF-1011N) that has the following characteristics:

Measurement techniques	Dual wave length
Cable length	1,0 m
Connector	Sub-D9 header
Measurement range	0-100% SpO2
Pulse range	20-250 bpm
Precision	80%-100% $\pm$ 2 digits, 70%-79% $\pm$ 3 digits, 0%-69% NA
Operating temperature	5-40 ^{0}C
Application	Adult, > 40kg, forefinger

3. PULSE OXIMETER HARDWARE

The current to voltage amplifiers have a double role: to *convert* the current detected by the photo diode in voltage and to *amplify* the detected signal. The signal detection will be made with the photo diode reverse polarised, in photoviltaic mode (Fig. 5).
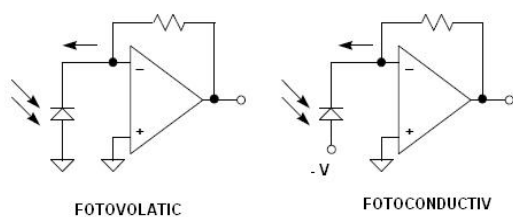
Fig. 5 Operating modes of the photodiode

This setting in comparison to the photo-conductive mode presents the advantage of linearity, Jonson noise elimination and signal precise measurement at the expense of the acquisition speed. The detected signal is of the order of tens of 10^{-9} amperes.

The operational amplifier in this level is AD8618. Compared with the operational amplifiers with bipolar transistors on input, this operational amplifier with CMOS has a few advantages: very high entry impedance, very low/small values of the voltages and offset currents, a very good value of the

rejection report of the common mode and also very good slew rate and gain-bandwidth product. The detected signal will so be amplified and displayed at the exit AD8618. Due to the use of the diode as well as of the amplifier in reverse configurations, the signal phase will not be modified. The estimated current consumption is of 1.7 mA.

3.1. ANALOGUE SIGNAL FILTERS

To configure the filters some information offered to the collaborator doctors' team of this project referring to the values of cardiac pulse must be taken into account:
- Adult, healthy person: 60-100 beats per minute (BPM)
- Athlete, standing: under 60 BPM
- Athlete, in case of physical effort: 150-200 BPM
- Adult, during sleep: 40 BPM
- New-born and children: average 110 BPM

Considering all these information we have configured the central frequencies of the filters as follows: low pass filter 0.1 Hz and band pass filter 1.2 Hz (72 BPM).

The operational amplifiers of the filter are differentially powered at $\pm$5 V. The estimated consumption is of 1mA.

3.2. LOW PASS FILTER

The low pass filter presents importance in the *separation of the direct component* of the signal (DC) from the rest of the detected signal. The continuing value will be processed the microcontroller and will be used to calibrate the value of the current through leds depending on the patient's tissue characteristics.

A second order filter, Sallen-Key, with a falling slope of 40 dB/decade will be used. The Sallen-Key topology allows a better independence of the filters performance compared to the amplifiers performance, other topologies have a lower independence. The filter with *Bessel* answer for its characteristics at pulse like signal will be configured.

The operational amplifiers of the filter are differentially powered at $\pm$5 V. the estimated consumption is of 1 mA.
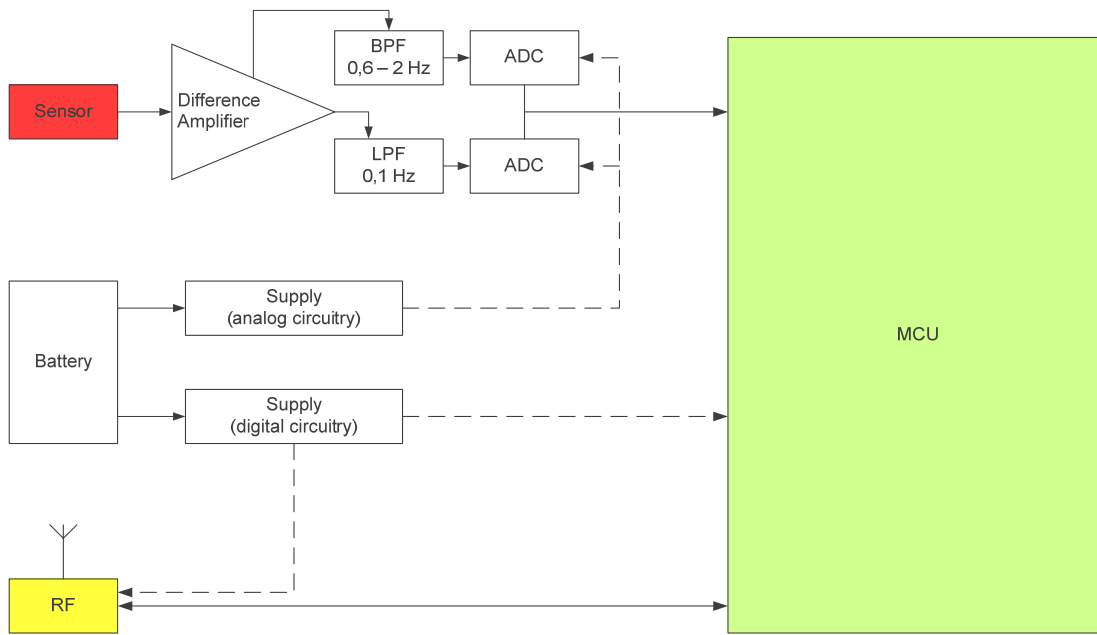
Fig. 6 Block diagram of the wireless pulse-oximeter

3.3. BAND PASS FILTER

The band pass filter has a role in the weakening of the direct component (DC) of the signal and the *separation of the pulse component* (AC) that follows the systolic-diastolic cardiac system. This value will be amplified, processed and used in the determination of the value of the blood oxygen saturation.

A fourth order filter Sallen-Key, with a falling slope of 80 dB/decade will be used. The filter with *Bessel* answer for its characteristics at pulse like signal will be configured. The reasons for choosing this type of filter were presented in the Low Pass Filter.

To configure a fourth order filter, two second order filters will be serial connected.

3.4. DIGITAL ANALOG CONVERTOR

The Digital-to-analog converter has the role of converting the analogue signals, red and infrared. The digital signals will be used further by the microcontroller and passed trough the wireless module to the data centralizer (PDA).

For this project the A/D converter AD1110 was used.

Samples / seccond	Bits
15	16
30	15
60	14
240	12

3.5. LEDS CONTROL AND CURRENT SOURCE CIRCUIT

This circuit is realized with two complementary pairs of transistors configured in H-bridge which has a double role:
- Alternate command for the LEDs;
- Constant current trough the LEDs.

The supply of the current source is made unipolar with +5 V. Current consumption of this block is 3 mA.

3.6. RADIO FREQUENCY CIRCUIT

Has the role of transmitting the data gathered from the pulse-oximeter sensor to the data centralizer of the entire system?

For this interface we have decided to use the CC1000 circuit because of its nice to have features: low power consumption, possibility of manual configuration and lack of low level stack implemented on the RF controller and high enough data transfer rate (76.8 kbps).

This circuit is supplied with 3.3 V and it uses SPI interface for data communication.

3.7. CONTROL CIRCUIT

In order to be able to keep the power consumprion of this module as low as possible we have used an Atmel microcontroller from picoPower familly, which uses only 0.5 mA.

This device has the role of handling the data taken from the ADCs and transmitt them trough the SPI interface to the wireless module, it also handles the power management of the entire system and process information comming from the centralisator of the system.
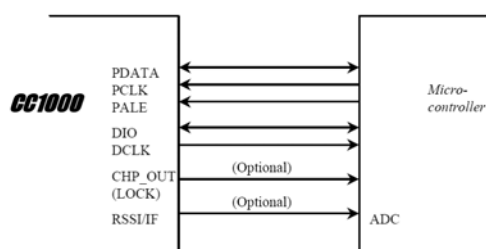
Fig. 7 Interface MCU – CC1000

3.8. THE SUPPLY CIRCUIT

The supply circuit converts the voltage from the two Li-Ion batteries.

In order to obtain the three voltages required for the entire system there were used switiching regulators, which have a greater efficiency than the linear regulators.

The two LT1615 are generating:
- +3,3V, efficiency 70-75% ;
- +5V, efficiency 75-80% ;

The LM2611A is generating:
- -5V, efficiency 75-80%.

The performace of this supply is remarcable also trough the low noise at the output of the regulators 1 mVp-p.

4. RESULTS

The results which have to be obtained on a healty person by the analog system of this pulse oximetter at sea level 94%-98% and at 1500 metters altitude are betwen 92% and 94%.

Fig. 8 Wave representation of SPO_2 measurement
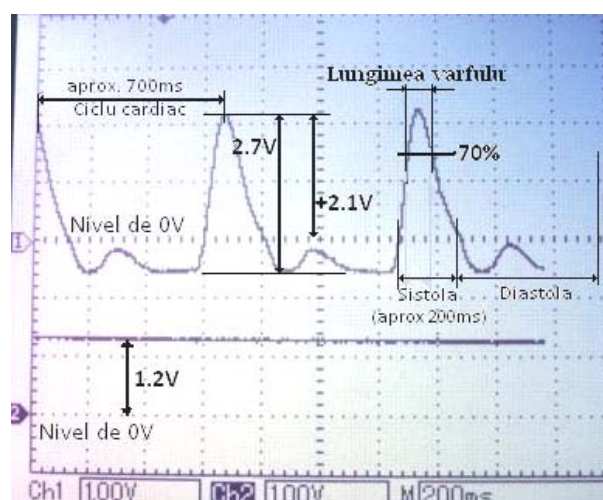
Fig. 9 Measurement of AC signal obtained with IR LED on
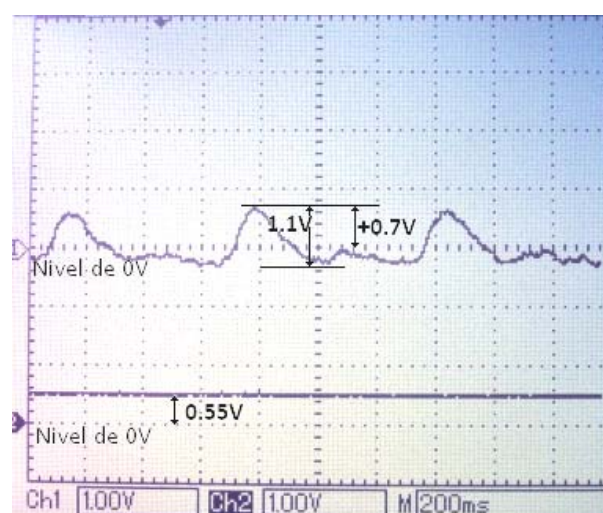
Fig. 10 Measurement of AC signal obtained with red LED on

Experimental results of measurement of SPO_2 have generated the following results:

$T_{Cardiac\text{-}cycle} = 700$ ms

53

AC_IR = 2.1 V
DC_IR = 1.2V
AC_R = 0.7V
DC_R = 0.55

4. CONCLUSIONS

This puls e-oximeter is a wireless solution embedded intro the BIOMED TEL research project, which will monitor along with this biomedical parameter other important characteristics of the patient and all of them will be centralized and will be available in real time to the medic in charge. This design will provide this information wirelessly giving flexibility to the patient. The modern product displays information in a straightforward manner to ease interpretation of the information by the users.

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NEW METHODS OF OPTIMIZATION SHAPE FOR MAXIMAL DRAG OR LIFT FORCE AIRFOILS

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Abstract: *Direct and inverse boundary value problems are solved and the solution of an optimization shape problem is obtained analytically in the case of some nonlinear integral functionals. The plain potential flow of an inviscid fluid is considered in the absence of mass force (Hyp). The flow – unlimited jet – encounters a symmetrical curvilinear obstacle (the Helmholtz scheme). For invers problems there are derived singular integral equations and the movement is obtained in the auxiliary canonical half plane. Next, a new method of optimization problem is solved analytically. The design of the optimal airfoil is performed. The drag/lift coefficient, nonlinear integral functionals and other geometrical parameters are computed in the case of a given distribution of the velocity or angle on the profile/airfoil. The main applications of this contributions are related to the optimization of leading edges, modeling special airfoils for different categories of low speed small UAVs, but also in determining efficient systems for recovery of light UAVs (deflectors, special braking parachute, determal systems).*

1. INTRODUCTION

The aerodynamic performances are given by a nonlinear functional [1,2]. We use the Maklakov-Jensen inequality and the inverse methods for singular integral equations, [3,4]. The velocity field in the physical domain $w(z) = u(x; y) + iv(x; y)$.

The complex potential $f(z)$ and the complex velocity $w(z)$ are defined:
$$f(z) = \varphi(x, y) + i\,\psi(x; y);$$
$$\overline{w} = u - iv = \frac{df}{dz} = Ve^{-i\theta} \qquad (1)$$

with $\varphi(x, y)$, $i\psi(x, y)$ the velocity potential and the stream function. The velocity is:

$$V = (u^2 + v^2)^{\frac{1}{2}} \text{ and } \theta = \arg \overline{w}$$

Let $D_\zeta, \zeta = \xi + i\eta, \eta \ge 0$ a canonical auxiliary domain which corresponds to the plane $D_z, y \ge 0$ and $D_f, \psi \ge 0$. The aim is to determine $f = f(\zeta), D_f \leftrightarrow D_\zeta$, with $f_{\overline{\zeta}} = 0$.

Let the Jukovski function $\omega = \omega(\zeta)$.

Along the free lines $V = V^0$, we have:
$$\omega = t + i\theta, \quad \overline{w} = V^0 e^{-\omega}, \quad t = \ln\frac{V^0}{V},$$
$$0 \le V \le V^0, \quad w_{\overline{\zeta}} = 0 \qquad (2)$$

$f = f(\zeta)$, $\omega = \omega(\zeta)$ and $z = z(\zeta)$ corresponds to the conformal mappings $D_f^+ \leftrightarrow D_\zeta^+$, $D_\omega^+ \leftrightarrow D_\zeta^+$, $D_z^+ \leftrightarrow D_\zeta^+$, and it is found $f = f(\zeta) = A\zeta$. In addition: $\eta = 0, \psi = 0$ and $\frac{\delta\varphi}{\delta\eta}|_{\eta=0} = 0$. The boundaries of D_z, D_f correspond to the boundary of $D_\zeta, \eta = 0$, $\xi \in (-\infty, \infty)$, on which we have t $\psi = \text{const}$. On $\eta = 0$ we have:

$$z(\xi) = \int \varphi'_\xi \frac{e^{i\theta}}{V} d\xi, \quad V = V(\xi), \quad \theta = \theta(\xi) \qquad (3)$$

Using $\omega(\zeta)$ and (3) we find the ecuation of the obstacle and the freelines. The flow encounters a curvilinear symmetrical obstacle

(BOB'), in the points B, B' the free streamlines $(BC), (B'C')$ are detached; $\vec{V}(C) = \vec{V}(C') = V^0 \vec{i}$ (*downstream*). Between D_z^+ and D_ζ^+, we suppose that the boundary (A_0OBC) corresponds to $\eta = 0, \xi \in (-\infty, \infty)$. The obstacle (OB) is the segment $(-1,1)$ (Fig. 2) and the length of (OB) in D_z is L.

The integral equations. The aim is to find $\omega = \omega(\zeta)$ defined in $D\zeta$ analytically in two cases: (1) if $\omega(\xi) = t(\xi) + i\theta(\xi)$ is known on $\eta = 0 : \theta = 0, \xi \in (-\infty, -1); \theta = \theta(\xi)$ or (2) if it is given $t = t(\xi), \xi \in (-1,1), t = 0, \xi \in (1,0)$. These mixed problems have the solutions (Dirichlet, Volterra, Riemann-Hilbert [1]):

$$\omega(\zeta) = \frac{\sqrt{\zeta+1}}{\pi i} \int_{-1}^{1} \frac{t(s)}{\sqrt{s+1}} \frac{ds}{s-\zeta},$$

$$\omega(\zeta) = \frac{\sqrt{\zeta-1}}{\pi} \int_{-1}^{1} \frac{\theta(s)}{\sqrt{1-s}} \frac{ds}{s-\zeta},$$

$$\lim_{\zeta \to \infty} \omega(\zeta) = 0, \quad \zeta \in D_\zeta^+ \qquad (4)$$

Applying the Sohotski-Plemelj relation [5], it results the following singular integral equations:

$$\omega = t + i\theta,$$

$$\theta(\xi) = -\frac{\sqrt{\xi+1}}{\pi i} \int_{-1}^{1} \frac{t(s)}{\sqrt{s+1}} \frac{ds}{s-\xi},$$

$$t(\xi) = \frac{\sqrt{1-\xi}}{\pi} \int_{-1}^{1} \frac{\theta(s)}{\sqrt{1-s}} \frac{ds}{s-\xi}, \xi \in (-1,1) \quad (5)$$

The practical importance of these inverse problems is that if it is known *a priori* the distribution of the velocity, or of the pressure, or of the angle, on the profile then the shape of the profile may be computed *a posteriori*. Finally the pressure, the drag coefficient and the length of the profile are respectivelly:

$$P = \frac{\rho V^{o^2} L}{2} I[t], \quad I[t] = \frac{\left(\int_{-1}^{1} \frac{t(s)}{\sqrt{s+1}} ds\right)^2}{\pi \int_{-1}^{1} e^{t(s)} ds} \quad (6)$$

$$C_x = \frac{2P}{\rho V^{o^2} L} = I[t], L = A \int_{-1}^{1} \frac{ds}{V(s)} = \frac{A}{V^o} \int_{-1}^{1} e^{t(s)} ds$$

We obtain the profile with the distribution of $V(\xi), t(\xi)$ or $\theta(\xi)$ linked to a parameter selected in order to extremize the aerodynamic drag. The distribution of the velocity on the profile must satisfy the Brillouin-Villat (B-V) conditions:

$$V(0) = V(\xi = -1) = 0, \quad V(B) = V(\xi = 1) = V^0$$
$$V'(\xi) > 0, \ \xi \in (-1,1) \qquad (7)$$

2. BASIC ASPECTS OF DIFFERENT SIMPLE AERODYNAMIC SHAPE OPTIMIZATION

Let the curvilinear axis-symmetric profiles, with a given speed distribution (Fig. 1).
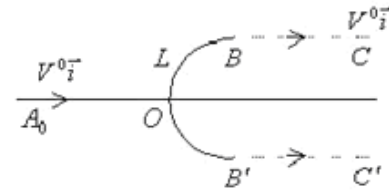
Fig. 1 Curvilinear axis-symmetric profiles

In the inverse problem, let the following distribution of the velocity on the obstacle:

$$V = V(\xi) = V^0 \sqrt{\frac{1+\xi}{2}}, \quad t = t(\xi) = \ln \frac{V^0}{V} = \ln \sqrt{\frac{2}{1+\xi}},$$
$$\xi \in (-1,1) \qquad (8)$$

Where:

$$V(O) = V(\xi = -1) = 0, \quad V(B) = V(\xi = 1) = V^0$$

This distribution is motivated by the fact that the function $V = V(\xi)$ must satisfy the condition $V(-1) = 0$ and the convergence of the integrals. In this case:

$$V(\xi) = (1+\xi)^\alpha \cdot h(\xi), \ 0 \prec \alpha \prec 1, \ h(-1) \neq 0.$$

Thus, (8) is a choice with $\alpha = 1/2$ and $V'(\xi) \succ 0$. From (8) and (5) we obtain the velocity angle along (OB):

$$\theta(\xi) = \frac{\pi}{2} - T\left(\sqrt{\frac{1+\xi}{2}}\right), \xi \in (-1,1) \qquad (9)$$

Here,

$$T(a) = \frac{2}{\pi} \sum_{n=0}^{\infty} \frac{a^{2n+1}}{(2n+1)^2} = \frac{1}{\pi}[Li_2(a) - Li_2(-a)]$$

$$Li_2(a) = \sum_{n=1}^{\infty} \frac{a^n}{n^2}, \qquad |a \prec 1| \qquad (10)$$
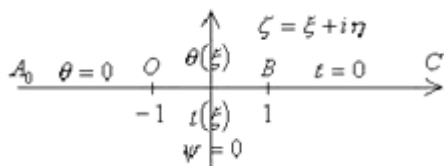
Fig. 2 Obstacle OB and free line BC

It's easy to see that:

$$\frac{dT}{da} = \frac{1}{\pi a} \ln \frac{1+a}{1-a}, \quad T(a) = \frac{1}{\pi} \int_0^a \ln \frac{1+a}{1-a} \frac{da}{a},$$

$$T(\pm 1) = \pm \frac{\pi}{4}, \quad T(0) = 0$$

From (9) we have $\theta(O) = \theta(\xi = -1) = \frac{\pi}{2}$,

$\theta(B) = \theta(\xi = 1) = \frac{\pi}{4}$ and we observe that the curve (BOB') has a continuous tangent with $\theta'(\xi) \prec 0$ which assure the downstream convexity. We remark that (8) and (9) are inversion formulae for the integral singular equations (5), and we have in the hodograph plane (V, θ) on the profile:

$$\theta(V) = \frac{\pi}{2} - T\left(\frac{V}{V^0}\right), \quad 0 \leq V \leq V^0,$$

$$\theta = \theta(V), \quad V = V(\theta) \tag{11}$$

We consider the general case:

$$V = V(\xi) = V^0 \left(\frac{1+\xi}{2}\right)^\alpha, \quad \alpha \in (0,1),$$

$$t = t(\xi) = \ln \frac{V^0}{V} = \left(\frac{2}{1+\xi}\right)^\alpha, \quad \xi \in (-1,1) \tag{12}$$

From (5) and (12) we obtain the velocity angle along (OB):

$$\theta(\xi) = \alpha\pi - 2\alpha T\left[\sqrt{\frac{1+\xi}{2}}\right]; \xi \in [-1,1] \tag{13}$$

From (13) we have:

$$\theta(0) = \theta(\xi = -1) = \alpha\pi; \quad \theta(B) = \theta(\xi = 1) = \frac{\alpha\pi}{2}$$

Knowing L and V^0 from (6) and (13) it is possible to determine the parameter A:

$$L = \frac{A}{V^0} \int_{-1}^1 e^t d\xi = \frac{A}{V^0} \frac{2}{1-\alpha}, \alpha \in \left[0, \frac{1}{2}\right] \tag{14}$$

It results the equations of the obstacle (OB):

$$X(\xi) = \frac{x(\xi)}{L} = \frac{\sqrt{2}}{4} \int_{-1}^\xi \frac{\cos\theta(s)}{\sqrt{1+s}} ds,$$

$$Y(\xi) = \frac{y(\xi)}{L} = \frac{\sqrt{2}}{4} \int_{-1}^\xi \frac{\sin\theta(s)}{\sqrt{1+s}} ds, \quad \xi \in (-1,1) \tag{15}$$

One similarly obtains the equations of the free line (BC). Next, we compute the resultant of pressures for the whole profile (BOB') and the drag coefficient C_x (6):

$$P = \frac{\rho(V^0)^2 L}{2} \frac{16\alpha^2(1-\alpha)}{\pi} \tag{16}$$

The case in which we have just one parameter with $C_x(\alpha) \Rightarrow C_x(\alpha)$ is maximal.

$$C_x = \frac{P}{\frac{\rho(V^0)^2 L}{2}} = \frac{16\alpha^2(1-\alpha)}{\pi}$$

$$C'_x(\alpha) \equiv 0, C'(\alpha) > 0 \tag{17}$$

If we take $\alpha \in [0, \frac{1}{2}]$ the $C_{max} = C_x(\alpha = \frac{1}{2}) =$

$= \frac{2}{\pi} = 0,638$ (edges concave, Fig. 3) and for $\alpha \in (0,1)$ we obtaining (edges accolade, Fig. 4):

$$C_{max} = C_x(\alpha = \frac{2}{3}) = \frac{64}{27\pi} = 0,75.$$

In Fig. 3 and Fig. 4 we present the profiles for maximal drag.
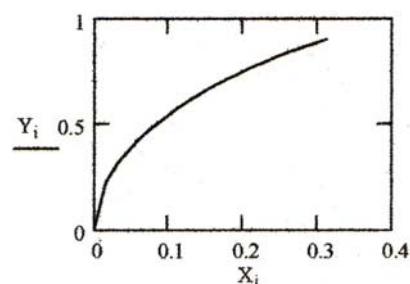
Fig. 3 Profile with concave edges
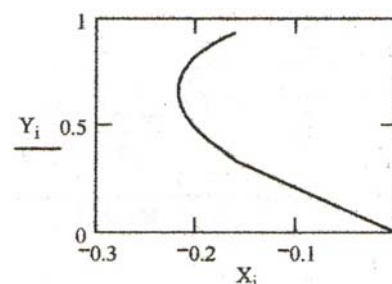
Fig. 4 Profile with accolade edges

The general optimization problem of shape of the wing with subsonic leading edge (sail prove):

A) Profiles with velocity distribution $V(\xi)$, (8) (12), [8].

B) Profiles with angles distribution $\theta(\xi)$, **plate or ogival profiles.** In this case distribution angle $\theta = \theta(\xi)$ from ogival profiles:

$$\theta(\xi) = \alpha\pi + \pi(\gamma - \alpha)\sqrt{\frac{1+\xi}{2}},$$

$$\theta(O) = \theta(\xi = -1) = \alpha\pi,$$

$$\theta(B) = \theta(\xi = 1) = \gamma\pi, \; \gamma < \alpha \le \frac{1}{2} \quad (18)$$

Replacing $\theta(\xi)$ in the integral equations (5) obtained distribution velocity on the ogival profile with:

$$V(O) = 0, \; V(B) = V^0,$$

$$t = \ln\frac{V^0}{V} = \pi(\gamma - \alpha)\sqrt{\frac{1-\xi}{2}} + \ln\frac{\sqrt{2}+\sqrt{1-\xi}}{\sqrt{2}-\sqrt{1-\xi}},$$

$$V = V^0 \quad (19)$$

Calculating the pressure and C_x (6), we obtain:

$$P = \frac{\rho V^0 A\pi}{4}(4\alpha - \delta)^2,$$

$$U(\xi) = \sqrt{\frac{1-\xi}{2}}, \delta = \pi(\alpha - \gamma),$$

$$C_x(\delta) = \frac{1}{2}\frac{(4\alpha - \delta)^2}{\int_{-1}^{1} e^{-\delta U}\left(\frac{1+U}{1-U}\right)^2 d\xi} \quad (20)$$

a) Considering $\alpha = \gamma = \frac{1}{2}$, $\theta = \frac{\pi}{2}$,

$t = \frac{1}{2}\ln\frac{1+U}{1-U}$ and $V = V^0\sqrt{\frac{1-U}{1+U}}$, we have

"Helmholtz plate" and

$$C_x^H = \frac{2\pi}{4+\pi} \approx 0{,}87980 \quad (21)$$

b) Considering $\alpha = \gamma < \frac{1}{2}, \theta = \alpha\pi < \frac{\pi}{2}$ it is a triangle profile for the Newton problem (i.e. to minimal drag ogival profiles):

$$C_x^*(\alpha) = \frac{4\pi\alpha^2}{\left[1 + 2\alpha + 4\alpha^2 \cdot \beta(1-\alpha)\right]\sin\alpha\pi} \le C_x^H,$$

$$\beta(x) = \int_0^1 \frac{t^{x-1}}{1+\lambda}d\lambda \quad (22)$$

Particularly, $\alpha = \frac{1}{2}, \beta(\frac{1}{2}) = \frac{\pi}{2}, C_x^*\left(\frac{1}{2}\right) = C_x^H$.

For polygonal profiles, the integral equation method is more efficient than the hodographic method from the theory of jets.

C) Parametric profiles. The best deflector

We consider profiles with the distributions:

$$V = V^0 e^{-\delta\sqrt{\frac{1-\xi}{2}}}\sqrt{\frac{1+\xi}{2}},$$

$$t_0(\xi) = \delta\sqrt{\frac{1-\xi}{2}} - \ln\sqrt{\frac{1+\xi}{2}}, \; \xi \in (-1,1),$$

satisfying the (B-V) conditions. Using $t_0(\xi)$ within (5), it results:

$$\theta(\xi) = \frac{\pi}{2} + \delta\sqrt{\frac{1+\xi}{2}} - T(\sqrt{\frac{1+\xi}{2}}),$$

where: $T(\alpha) = \frac{2}{\pi}\sum_{n=0}^{\infty}\frac{\alpha^{2n+1}}{(2n+1)^2} = \frac{1}{\pi}\int_0^\alpha \ln\frac{1+s}{1-s}\frac{ds}{s},$

$$T(\pm 1) = \frac{\pi}{4}, T(0) = 0.$$

For $\delta \in [0, \frac{2}{\pi}]$, the profile is prove type, while for $\delta \in (\frac{2}{\pi}, \frac{3\pi}{2})$ the profile is deflector. With (6), it results:

$$C_x = I(t) = \frac{(\delta\pi + 4)^2}{8\pi\int_0^{\frac{\pi}{2}} e^{\delta\sin\theta}\sin\theta d\theta}, C_x(\delta) \quad \text{is}$$

increasing and consequently

$$C_x^P(\delta = 0) = \frac{2}{\pi} \approx 0.638, C_x^M(\delta = \frac{2}{\pi}) \approx 0.86053.$$

For $\delta > \frac{2}{\pi}$ we find the maximal resistance deflector. The main tool is the Jensen inequality: if $f(x) \ge 0$ and $g(x)$ are integrable functions in α^{2n+1}, then

$$\int_a^b f(x)e^{g(x)}dx \ge \int_a^b f(x)dx \exp\frac{\int_a^b f(x)g(x)dx}{\int_a^b f(x)dx}$$

Where the inequality occurs if g is constant $(g \equiv g_0)$, [2,3,4]. The major idea to maximize a functional I[u] is based on the use of Jensen inequality, I[u] < J[u], whose maximal point U_0 is constant.

$$I[u] \leq J[u] \leq J[U_0] = I[U_o] = max.$$

For $t(\xi) = t_0(\xi) + u(\xi), \xi \in (-1,1)$, where $u(\xi)$ is disturbed velocity applying the Jensen inequality to the denominator of C_x (6), it

results $C_x = I(t(u)) \leq J(U(u)) = \dfrac{(U + 2\sqrt{2})^2}{4\pi e^{\frac{\sqrt{2}}{4} U}}$,

with $U = \displaystyle\int_{-1}^{1} \dfrac{u + \delta\sqrt{\dfrac{1-\xi}{2}}}{\sqrt{1+\xi}} d\xi$. The maximum

value of J(U) (where $J'(U_0) = 0$) is obtained

for $U_0 = 2\sqrt{2} = g_0 \displaystyle\int_{-1}^{1} \dfrac{d\xi}{\sqrt{1+\xi}}$. The equality

case of the Jensen's inequality implies

that $g_0 = 1$, $u = 1 - \delta\sqrt{\dfrac{1-\xi}{2}}$ maximizes the

functional I(t(u)). Further, we obtain:

$$t = 1 + \ln\sqrt{\dfrac{2}{1+\xi}}, \quad V = \dfrac{V^0}{e}\sqrt{\dfrac{1+\xi}{2}},$$

$$I_{max} = J(2\sqrt{2}) = \dfrac{8}{\pi e} = C_x^D \approx 0.936797.$$

The obtained distribution of $V(\xi)$ gives the best deflector of the family $V(\xi, \delta)$. For $\delta = 0$ the impermeable parachute is found again, [3,4]. This result is in agreement with that $(\delta = 0)$ obtained by Maklakov before using Levi-Civita method [2].

For 3D axis-symmetric profiles:

$$C_x^* = \dfrac{8}{\pi} \dfrac{(\delta\pi + 2)^2}{\displaystyle\int_0^{\pi} e^{\delta\sin\theta}(\sin\theta + \sin^2\theta)d\theta},$$

$$\delta = \dfrac{1}{2} - \gamma, C_x^*(max) \approx C(\delta = 0.410916) \approx 0.911$$

For $\alpha = \gamma = \dfrac{1}{2}$, $\delta = 0$, $\theta = \dfrac{\pi}{2}$, it is

obtained the Helmholtz plane plate, with $C_x^H = \dfrac{2\pi}{\pi + 4} \approx = 0.87980$. It may be observed

that $C_x^P < C_x^M < C_x^H < C_x^* < C_x^D$, $A_P = \dfrac{LV^0}{4}$,

$$A_M = \dfrac{LV^0}{2(\pi + 4)}, \quad A_H = \dfrac{LV^0}{\pi + 4},$$

$$A^* \approx \dfrac{LV^0}{4(1 + 0.410916)}, \quad A_D = \dfrac{LV^0}{4R}.$$

For the minimal drag case it results: $\theta(\xi) = \alpha = \gamma < \dfrac{\pi}{2}$ and

$$\min C_x^*(\alpha) = \dfrac{4\pi\alpha^2}{(1 + 2\alpha + 4\alpha^2\beta(1-\alpha))\sin\alpha\pi} < C_x^H$$

Where $\beta(x) = \displaystyle\int_0^1 \dfrac{t^{x-1}}{1+t}dt$ (triangle airfoil).

3. THE LIFT MAXIMIZATION

Let a symmetrical curve plate (AB) in a paralel flow with the chord. Let be L(AB) length of (AB) and l length of chord knowns again A_0A, BB_0 free lines with A_0AMBB_0 stream line $\psi = 0$ (Fig. 5, 6).
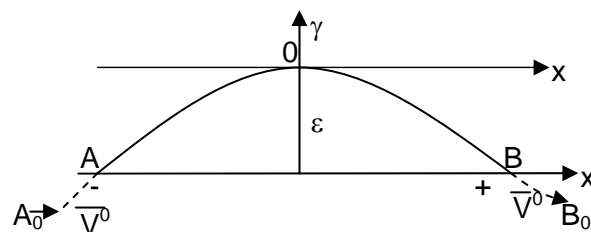
Fig. 5 Symmetrical curve plate (AB)
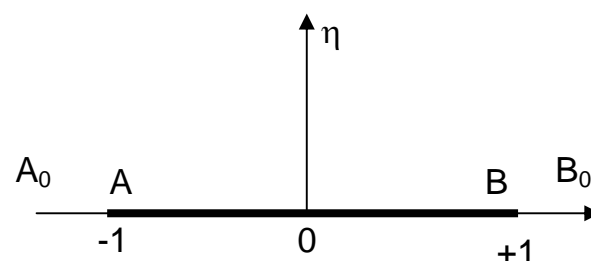
Fig. 6 Free lines A_0A, BB_0

We denote by $k = \dfrac{L-l}{l}$ and we will must to determine optimal geometrical shape for maximum lift P (rectangular on chord). We

consider T1, T2 theorems with integral equations and we will determine potential function $f = f(\zeta)$ and $\overline{\omega} = \overline{\omega}(\xi)$ in the upper half plane, $\eta \geq 0$; the plate (AB) being lateral acting of wind with the speed $V^0\overrightarrow{i}$. Let be $f(\zeta)$ complex potential and $\overline{\omega} = \dfrac{df}{dz} = \dfrac{df}{d\zeta}\dfrac{d\zeta}{dz}$,

$f(\zeta) = AV^0\zeta;\ dz = \varphi'_\xi e^{i\theta}d\xi,\ \psi = 0,\ \eta = 0$.

In this case:

$\omega(\zeta) = -\dfrac{1}{\pi i}\displaystyle\int_{-1}^{1}\dfrac{t(s)}{s-\zeta}$ and the profile angle:

$\theta(\xi) = \dfrac{1}{\pi}\displaystyle\int_{-1}^{1}\dfrac{t(s)}{s-\xi}ds,\ \xi \in (-1,\ 1).$

$z(\xi) = \displaystyle\int_{-1}^{\xi}\varphi_\xi\dfrac{e^{i\theta}}{V(\xi)}d\xi, dS = \varphi_\xi\dfrac{d\xi}{V(\xi)}$ \qquad (24)

$L = AV^0\displaystyle\int_{-1}^{1}\dfrac{d\xi}{V(\xi)} = A\displaystyle\int_{1}^{1}e^{t(S)}dS$ \qquad (25)

The resultant of pressures is:

$X + iY = i\rho V^{0^2}A\displaystyle\oint e^{\omega(\zeta)}d\zeta$ \qquad (26)

And because the symmetry,

$X = 0,\ Y = \rho V^{0^2}A\displaystyle\int_{-1}^{1}t(S)dS$

The lift will be:

$Y = \rho V^{0^2}LJ(t),\ J(t) = \dfrac{2\int_{-1}^{1}t(S)dS}{\int_{-1}^{1}e^{t(S)}dS}$

We search the velocity distribution on (AB) by using Jensen's inequality at the denominator of $J \leq I$ so that the functional $J(t)$ to be maximum. $H = \displaystyle\int_{-1}^{1}t(S)dS$ we will obtain

$J \leq I = He^{-\frac{H}{2}}$ in the case equal the functional is I_{max}.

For obtaining the maxim, $I'(H) = 0$, with

$H \succ 0, I' = e^{-\frac{H}{2}}\left(1 - \dfrac{H}{2}\right)$.

For $H = 2$, $I_{max} = \dfrac{2}{e}$ and $t(\xi) = 1$.

In this case:

$A = \dfrac{L}{2e},\ V = \dfrac{V^0}{e},\ \theta(\xi) = \dfrac{1}{\pi}\displaystyle\int_{-1}^{\xi}\dfrac{dS}{(S-\xi)} =$

$= \dfrac{1}{\pi}\ln\dfrac{\sqrt{2}+\sqrt{1+\xi}}{\sqrt{2}-\sqrt{1+\xi}},\ \xi \in (-1,1)$

And with

$\dfrac{1}{L} = \displaystyle\int_{-1}^{1}\cos\theta(\xi)d\xi = \dfrac{2e}{e^2-1},\ k = sh(e-1)$.

From Y with I_{max} we obtain the lift coefficient:

(23)
$C_y = \dfrac{Y}{\rho V^{0^2}L} \leq C_{y\,max}, C_{y\,max} = \dfrac{2}{e}(1+k).$

The optimal lift for plate will be:

$P_{max} = C_{y\,max}\cdot S,\ k = 0,175,$

$C_{y\,max} \approx 0,876$ \qquad (28)

Wu and Whitney have study this problem with application for the case of "para-slope".

4. LIFT MAXIMIZATION FOR THE CASE OF PARAMETRICAL VELOCITY DISTRIBUTION INPUT

It was demonstrate that for obtaining the maximal lift, we analyzed the distribution of speeds on the A_0AOBB_0 line:

$V(\xi) = V^0,\ \xi \in (-\infty, -1) \cup (1, \infty)$ and

$V(\xi) = \dfrac{V_0}{e},\ \xi \in (-1, 1)$. In this case we have a

constant speed $\dfrac{V_0}{e} < V_0$ with discontinuities at A, B borders (Fig. 1).

Because AB is curvilinear, in O the speed should be maximal and the profile is near the segment AB.

That is why, to create a depressure and to obtain the maximal lift we consider a speed distribution without discontinuities at A, B, and $V(\xi) \leq V^0,\ V(\pm1) = V^0$,

$V(\xi) = V^0\dfrac{1}{1+a\sqrt{1-\xi^2}},\ \xi \in (-1, 1), a \geq 0$

$t = \ln\dfrac{V^0}{V} = \ln\left(1 + a\sqrt{1-\xi^2}\right)$ \qquad (29)

If we know $V^0, 2L = \overline{AB}$, is possible to compute the parameter a, $2l = AB$ and the parameter k for obtaining the optimality. The relationships and the rationing are similar

those presented in Section 3, for a condition of optimality: $t = t(\xi, a^*)$, $\theta = \theta(\xi, a^*)$, with $a = a^*$ corresponding to the maximal lift $C_y(a = a^*)$.

In this case

$$2L = A \int_{-1}^{1} e^{t(s)} ds = A\left\{2 + \frac{a\pi}{2}\right\}, \quad A = \frac{4L}{4 + a\pi} \quad (30)$$

The lift $Y = \rho V^{0^2} A \int_{-1}^{1} t(s) ds$, $1 + k = \frac{L}{l}$ and the lift coefficient are:

$$C_y = \frac{Y}{\rho V^{0^2} l}, \quad C_y(a) = I(t(a))(1+k),$$

$$I(a) = 2\frac{\int_{-1}^{1} t(s) ds}{\int_{-1}^{1} e^{t(s)} ds}$$

(31)
The optimization is done according $I(a) = \frac{2I_1(a)}{I_2(a)}$, and the integrals $I_1(a)$, $I_2(a)$ are computed for $a \in (0, 1]$ and $a \in (1, \infty)$.

1st case: For $a \in (0,1)$ we have:

$$I_1 = \frac{\pi - 2a - 2\sqrt{1 - a^2} \arccos(a)}{a},$$

$$I_2 = 2 + \frac{a\pi}{2}, \quad a \in (0, 1] \quad (32)$$

It results $I = I(a)$, $I'(a) > 0$ upward and,

$$C_y(max) = C_y(a_1^* = 1)$$

$$C_y(max) = \frac{4(\pi - 2)}{\pi + 4}(1 + k) = 0.639405(1 + k)$$

(33)
In addition $(1 + k) = \frac{L}{l}$ is done according

$$\frac{1}{L} = \int_{-1}^{1} \cos \theta(\xi, a^*) d\xi,$$

where:

$$\theta(\xi, a = a^*) = -\frac{1}{\pi} \int_{-1}^{\xi} \frac{t(s, a^*)}{s - \xi} ds, \quad \xi \in (-1, 1) \quad (34)$$

2nd case: When $a > 1$, the maxim of the function $I = I(a)$:

$$I_1(a) = \frac{\pi - 2a - \sqrt{a^2 - 1} \ln\left[-1 + 2a\sqrt{a^2 - 1}\right]}{a},$$

$$I_2 = \frac{4 + a\pi}{2} \quad (35)$$

From $I = I(a)$, $I'(a^*) = 0$, $I(a)$ it results a maximum in $a_2^* = 2.16393$ and, because $I(a)$ is continue in $a = 1$, for $a \in (0, \infty)$ the global maximum will be obtained for $a^* = 2.16393$, or $I = I(a^*)$ and

$$C_y(max) = 0.72122(1 + k) \quad (36)$$

The numerical computation for $(1+k)$ will be made for this value, a^* and the optimal geometric shape is:

$$X = \frac{x(a^*, \xi)}{L}, \quad Y = \frac{y(a^*, \xi)}{L}, \quad \xi \in (-1, 1)$$

The numerical result is:
k+1=1.19206 and $C_y(max) = 0.86948$, (37) very near the previous 0.86468 [2], and corresponds to:

$$\frac{V^0}{e} \approx \frac{V^0}{1 + a^*\sqrt{1 - \xi^2}},$$

$$a^* \approx 2.18878 \quad (38)$$

5. CONCLUDING REMARKS

The inverse method and the integral singular equations presented here is a general one, and permits to determine the geometric design of aerodynamic airfoils in an exact manner.

The solutions that represents the distribution of speeds, angles or pressures on the determined profile are also cases that optimizes the aerodynamic forces: the maximal drag or the maximal lift.

The optimization is proceeed by extreming the non- linear integral operators, obtaining the analytic exact solutions. The applications are important in the aerodynamics of low speed small UAVs [9,10] and these results could be extended to the case of compressible

subsonic regime, [11] or the case of axysimmetric shapes.

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STABILITY ANALYSIS OF IMPULSIVE NEURAL NETWORKS WITH SUPREMUM

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Abstract: *In this paper, we study the problem of global asymptotic stability of the equilibrium of a class of neural networks with supremum and fixed moments of impulsive effect. We establish stability criteria by employing Lyapunov functions and Razumikhin technique.*

Keywords: *Neural networks, Impulses, Global asymptotic stability, Lyapunov method, Supremum.*

1. INTRODUCTION

Since cellular neural networks (CNNs) were introduced by Chua and Yang in 1988 [3], they have been widely studied both in theory and applications [4,6,7]. Although electronic circuits of CNNs can be fabricated into chips by very large scale integration technology, the finite switching speed of amplifiers and communication time will introduce the time delays in the interaction among the cells. Moreover, to process moving images, one must introduce the time delays in the signals transmitted among the cells. These lead to the model of CNNs with delay (DCNNs). They have found applications in different areas such as classification of patterns and reconstruction of moving images.

Motivated by the above consideration, Gopalsamy and Leung [5] considered the following scalar autonomous delay equation with dynamical thresholds:

$$\dot{x}(t) = -x(t) + a \tanh(x(t) - bx(t-\tau) - c), \quad t \geq 0$$

Where $x : R_+ \to R$, a is a positive constant, b, c and τ are nonnegative constants. By using Lyapunov functions, Gopalsamy and Leung established a sufficient condition for global asymptotic stability of the equilibrium $x^* = 0$ for the case $c = 0$.

For the case $c \neq 0$ some stability criteria are investigated in [11] for the equilibrium of the following more general model:

$$\dot{x}(t) = -x(t) + a f(x(t) - bx(t-\tau) - c), \quad (1)$$
$$t \geq 0, \ f : R \to R$$

On the other hand, the state of electronic networks is often subject to instantaneous perturbations and experience abrupt changes at certain instants, which may be caused by switching phenomenon, frequency change or other sudden noise, that exhibit impulsive effects [1,2,6,8,9]. Impulses can make unstable systems stable so they have been widely used in many fields such as physics, chemistry, biology, population dynamics, and industrial robotics.

In the mathematical simulation in various important applicable branches one has to analyses the influence of both the maximum of the function investigated and its impulsive changes. An adequate mathematical apparatus for simulation of such processes are the impulsive differential equations with supremums.

In this paper, we study the global asymptotic stability of the following impulsive generalization of the model (1) with supremum

$$\begin{cases} \dot{x}(t) = -x(t) + a f(x(t) \\ \quad - b \sup_{s \in [t-\tau, t]} x(s) - c), \quad t \neq t_k, \\ \Delta x(t_k) = I_k(x(t_k)), k = 1, 2, ..., \end{cases} \quad (2)$$

Where: $t \geq 0$, $\Delta x(t_k) = x(t_k + 0) - x(t_k)$,

$I_k : R \to R$, $k = 1, 2, ...,$

$$0 < t_1 < t_2 < ... < t_k < t_{k+1} < ..., \quad \lim_{k \to \infty} t_k = \infty.$$

The numbers $x(t_k)$ and $x(t_k + 0)$ are respectively, the states of the network before and after the impulsive perturbation at the moment t_k, and the functions $I_k(x)$ characterize the magnitude of the impulse effect at the moments t_k.

By using of piecewise continuous Lyapunov functions and the Razumikhin technique [9,10] we establish criteria for global asymptotic stability.

2. STATEMENT OF THE PROBLEM. PRELIMINARIES

Let $R_+ = [0, \infty)$ and $J \subseteq R$. Define the following class of functions:

$$PCB[J, R] = \left\{ \sigma \in PC[J, R]: \quad \sigma(t) \text{ is bounded on } J \right\}.$$

Let $\varphi \in PCB[[-\tau, 0], R]$. Denote by $x(t) = x(t; 0, \varphi), \ x \in R$ the solution of (2), satisfying the initial conditions:

$$\begin{cases} x(t; 0, \varphi) = \varphi(t), \quad t \in [-\tau, 0], \\ x(0^+; 0, \varphi) = \varphi(0) \end{cases} \quad (3)$$

Let $|\varphi|_\tau = \sup_{s \in [-\tau, 0]} |\varphi(s)|$ be the norm of the function $\varphi \in PCB[[-\tau, 0], R]$.

Introduce the following conditions:

H1. There exists a constant $L > 0$ such that $|f(u) - f(v)| \le L|u - v|$ for all $u, v \in R$.

H2. There exists a constant $M > 0$ such that for all $u \in R$, $|f(u)| \le M < \infty$.

H3. $a > 0, \ b \ge 0, \ a(1 - b) < 1$.

H4. For any $k = 1, 2, ...$, the functions I_k are continuous in R.

H5. $0 < t_1 < t_2 < ... < t_k < t_{k+1} < ...$ and $t_k \to \infty$ for $k \to \infty$.

Let $y(t) = x(t) - b \sup_{s \in [t-\tau, t]} x(s) - c$. We transform (2) into the form

$$\begin{cases} \dot{y}(t) = -y(t) - c + a f(y(t)) \\ \quad - abf(\sup_{s \in [t-\tau, t]} y(s)), \quad t \ne t_k, \quad (4) \\ \Delta y(t_k) = J_k(y(t_k)), \quad k = 1, 2, ..., \end{cases}$$

Where:

$$J_k(y(t_k)) = I_k(y(t_k) + b \sup_{s \in [t-\tau, t]} x(t_k) + c)$$

$$- I_k(b \sup_{s \in [t-\tau, t]} x(t_k) + c, \quad k = 1, 2, ...$$

We will use the following lemma.

Lemma 1. Let the conditions H1-H5 hold. Then:

(a) there exists a unique equilibrium point x^* of (2), defined for $t \in [0, \infty)$.

(b) $\lim_{t \to \infty} x(t) = x^*$ as $\lim_{t \to \infty} y(t) = y^*$,

where y^* is the equilibrium of (4).

Proof. Under the hypotheses H1-H3, the equation without impulses

$$\dot{x}(t) = -x(t) + a f(x(t) - b \sup_{s \in [t-\tau, t]} x(s) - c), \quad t \ge 0$$

has [9,11] a unique equilibrium x^* on the interval $[0, \infty)$. That means that the solution x^* of (2) is defined on each of the intervals $(t_{k-1}, t_k], \ k = 1, 2, ...$ From the conditions H4 and H5 we conclude that it is continuable for $t \ge 0$. The proof of Lemma 1 follows from the fact that if y^* denotes an equilibrium of the equation (4), then:

$$J_k(y^*) = 0, \quad k = 1, 2, ...$$

Remark 1. The problems of existence, uniqueness, and continuability of the solutions of impulsive functional differential equations has been investigated in the monograph [9].

Definition 1. The equilibrium x^* of the equation (2) is said to be:

a) *globally stable*, if

$$(\forall \varepsilon > 0) \ (\exists \delta = \delta(\varepsilon) > 0)$$

$$(\forall \varphi \in PCB[[-\tau, 0], R]: \ |\varphi - x^*|_\tau < \delta)$$

$$(\forall t \ge 0): \ |x(t; 0, \varphi) - x^*| < \varepsilon;$$

b) *globally asymptotically stable*, if it is globally stable and

$$\lim_{t \to \infty} x(t; 0, \varphi) = x^*.$$

3. MAIN RESULTS

In this section we will prove sufficient conditions for the global asymptotic stability of the equilibrium x^* of (2). We will use piecewise continuous Lyapunov functions.

Introduce the class V_0 of all functions $V : [0, \infty) \times R \to R_+$, which are continuous in $(t_{k-1}, t_k) \times R, k = 1, 2, \dots$ and locally Lipschitz continuous on R, there exist the finite limits:

$$\lim_{\substack{t \to t_k \\ t < t_k}} V(t, x) = V(t_k - 0, x)$$

$$\lim_{\substack{t \to t_k \\ t > t_k}} V(t, x) = V(t_k + 0, x)$$

and $V(t_k, x) = V(t_k - 0, x)$ for all $k = 1, 2, \dots$

For $t \neq t_k, k = 1, 2, \dots$ and $V \in V_0$ we define

$$D^+ V(t, x(t)) =$$

$$= \limsup_{h \to 0^+} \frac{1}{h} [V(t + h, x(t + h)) - V(t, x(t))].$$

Set $u(t) = y(t) - y^*$ and consider the following equation

$$\begin{cases} \dot{u}(t) = -u(t) \\ \quad + a[f(u(t) + y^*) - f(y^*)] \\ \quad - ab[f(\sup_{s \in [t-\tau, t]} u(s) + y^*) \\ \quad - f(y^*)], \quad t \neq t_k, \\ \Delta u(t_k) = P_k(u(t_k)), \end{cases} \quad (5)$$

Where: $t > 0$,

$$P_k(u) = J_k(u + y^*) - J_k(y^*) = J_k(u + y^*),$$
$$k = 1, 2, \dots.$$

Theorem 1. Assume that:
1. Conditions H1-H5 hold.
2. There exists a constant d such that:
$0 < d \leq 1 - La(1 + b)$.
3. The functions P_k are such that:
$$P_k(u(t_k)) = -\sigma_k u(t_k), \quad 0 < \sigma_k < 2,$$
$$k = 1, 2, \dots$$

Then the equilibrium x^* of the equation (2) is globally asymptotically stable.

Proof. We define a Lyapunov function:

$$V(t, u) = \frac{1}{2} u^2.$$

Then for $t \geq 0$ and $t = t_k$, from the condition 3 of Theorem 1, we obtain:

$$V(t + 0, u(t) + P_k(u(t))) = \frac{1}{2}(u(t) + P_k(u(t)))^2 =$$

$$= \frac{1}{2}(1 - \sigma_k)^2 u^2(t) < V(t, u(t)), \quad (6)$$

$$k = 1, 2, \dots.$$

Let $t \geq 0$ and $t \neq t_k$. Then for the upper right-hand derivative $D^+ V(t, u(t))$ of the function $V(t, u(t))$ with respect to equation (5) we get:

$$D^+ V(t, u(t)) = u(t) . \dot{u}(t) =$$

$$= u(t)(-u(t) + a[f(u(t) + y^*) - f(y^*)] -$$

$$- ab[f(\sup_{s \in [t-\tau, t]} u(s) + y^*) - f(y^*)]) =$$

$$= -u^2(t) + a u(t)[f(u(t) + y^*) - f(y^*)] -$$

$$- abu(t)[f(\sup_{s \in [t-\tau, t]} u(s) + y^*) - f(y^*)]$$

Since for the function f assumption H1 is true, then for $t \geq 0$ and $t \neq t_k$ we have:

$$f(u(t) + y^*) - f(y^*) = u(t) f'(\xi_1(t)),$$

$$f(\sup_{s \in [t-\tau, t]} u(s) + y^*) - f(y^*) =$$

$$= \sup_{s \in [t-\tau, t]} u(s) f'(\xi_2(t))$$

where $\xi_1(t)$ lies between y^* and $u(t) + y^*$, and $\xi_2(t)$ lies between y^* and $u(t - \tau(t))$.

Then

$$D^+ V(t, u(t)) \leq -u^2(t),$$

$$+ a L u^2(t) + a b L u(t) \sup_{s \in [t-\tau, t]} u(s)$$

for $t \geq 0$ and $t \neq t_k$.

From the last estimate for any solution $u(t)$ of (5), that satisfies the Razumikhin condition [9,10]:

$$V(t, u(s)) \leq V(t, u(t)), \quad t - \tau \leq s \leq t,$$

$$t \geq 0, \quad t \neq t_k,$$

we have:

$$D^+ V(t, u(t)) \leq$$

$$\leq (-1 + a L(1 + b)) V(t, u(t)) = -dV(t, u(t)),$$

where, by condition 2 of Theorem1 $d > 0$.

From the above inequality and (6), we have

$$V(t, u(t)) \leq e^{-dt} V(0, u(0)), \quad t \geq 0.$$

which means that the zero solution of the equation (5) is globally asymptotically stable.

Therefore, the equilibrium x^* of the equation (2) is globally asymptotically stable.

4. CONCLUSIONS

In this paper, by using a suitable piecewise continuous Lyapunov function and the Razumikhin technique, the sufficient condition for global asymptotic stability of the equilibrium point of a neural network model with supremum and nonlinear impulsive operators is obtained. Since delays and impulses can affect the dynamical behaviors of the system, it is necessary to investigate both delay and impulsive effects on the stabilization of neural networks. These play an important role in the design and applications of asymptotically stable neural networks with delays. The technique can be extended to study other impulsive delayed systems.

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AN ESTIMATE OF DIFFERENCE BETWEEN THE SZASZ - INVERSE BETA OPERATORS AND THE SZASZ - MIRAKJAN OPERATORS

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Abstract: In this paper we give an estimate of difference between the Szasz-Inverse Beta operators and the Szasz-Mirakjan operators.

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Keywords: Szasz-Inverse Beta operators, Szasz-Mirakjan operators, Inverse Beta operators, estimate.

1. INTRODUCTION

We deal in this paper, with an approximation operator linear positive, namely Szasz-Inverse Beta operator, which is a mixed summation-integral type operator and we give an estimate, in the terms of modulus of continuity, of the difference between this operator and the Szasz-Mirakjan operator.

2. PROBABILISTIC REPRESENTATION OF SOME OPERATORS

In our paper [1] we consider a probabilistic representation of the Szasz - Inverse Beta operators, which were defined and investigated by V. Gupta, M.A. Noor, [4] and iterative constructions of these operators were studied recently by Z. Finta, N.K. Govil, V. Gupta [3] :

$$L_t(f;x) =$$

$$= e^{-tx} f(0) + \sum_{k=1}^{\infty} s_{t,k}(x) \int_0^{\infty} b_{t,k}(u) f(u) du =$$

$$= \int_0^{\infty} J_t(u;x) f(u) du, \quad x \geq 0 \qquad (1)$$

with

$$s_{t,k}(x) = e^{-tx} \frac{(tk)^k}{k!} \qquad (2)$$

$$t > 0, \ x \geq 0, k \in N \cup \{0\}$$

$$b_{t,k}(u) = \frac{1}{B(k,t+1)} \cdot \frac{u^{k-1}}{(1+u)^{t+k+1}} \qquad (3)$$

$$u > 0, \ t > 0$$

$$B(k,t+1) = \int_0^{\infty} \frac{u^{k-1}}{(1+u)^{t+k+1}} du \qquad (4)$$

being Inverse- Beta function,

$$J_t(u;x) = e^{-tx} \delta(u) + \sum_{k=1}^{\infty} s_{t,k}(s) b_{t,k}(u) \qquad (5)$$

$\delta(u)$ being the Dirac's delta function, for which $\int_0^{\infty} \delta(u) f(u) du = f(0)$.

So, these operators are represented as, the mean value of the random variable $\dfrac{U_{N(t \ x)}}{V_{t+1}}$ which has the probability density function $J_t(u;x)$ defined as (5) :

$$L_t(f;x) = E\left[f(Z_{t \ x}) \right] = E\left[f\left(\frac{U_{N(t \ x)}}{V_{t+1}} \right) \right] \qquad (6)$$

$$t > 0, \ x \geq 0$$

with $\{N(t) : t \geq 0\}$ a standard Poisson process and $\{U_t : t \geq 0\}$, $\{V_t : t \geq 0\}$ two mutually independent Gamma processes defined all on the same probability space.

Note that, the Poisson process is a stochastic process starting at the origin, having stationary independent increments with probability:

$$P(N(t) = k) = \frac{e^{-t} t^k}{k!}, \ t \geq 0, \ k \in N \cup \{0\} \ (7)$$

and the Gamma process is a stochastic process starting at the origin $(U_0 = 0)$, having stationary independent increments and such that, for $t > 0$, U_t has the Gamma probability density function:

$$d_t(u) = \begin{cases} \dfrac{u^{t-1} e^{-u}}{\Gamma(t)}, & t > 0, \ u > 0 \\ 0, & u \leq 0 \end{cases} \quad (8)$$

and without loss of generality [5] it can assumed that $\{U_t : t \geq 0\}$ and $\{V_t : t \geq 0\}$ for each $t > 0$ have a.s. no decreasing right-continuous paths.

On these operators it is know, that:

$$L_t(e_i; x) = e_i(x), \ i = \overline{0,1}, \ x \geq 0$$

$$L_t(e_2; x) = \frac{t}{t-1} x^2 + \frac{2}{t-1} x, \ t > 1, \ x \geq 0$$

$$L_t(e_2 - x^2; x) = L_t((e_1 - x)^2; x) =$$

$$= D^2 \left[\frac{U_{N(t\,x)}}{V_{t+1}} \right] = E\left[\left(\frac{U_{N(t\,x)}}{V_{t+1}} - x \right)^2 \right] =$$

$$= \frac{x(2+x)}{t-1}, \ t > 1, \ x \geq 0$$

and

$$L_t(f; x) = (S_t \circ T_t)(f; x) = S_t(T_t)(f; x),$$

$$t > 0, \ x \geq 0 \quad (9)$$

with

$$\begin{cases} T_t(f; x) = \dfrac{1}{B(tx, t+1)} \displaystyle\int_0^\infty \dfrac{u^{t\,x-1}}{(1+u)^{t\,x+t+1}} f(u)\,du \\[4mm] T_t(f;0) = f(0) \end{cases}$$

$\Rightarrow$

68

$$\begin{cases} T_t(f; x) = \displaystyle\int_0^\infty f(u) b_{t\,x,t+1}(u)\,du, \ t > 0, \ x > 0 \\[4mm] T_t(f;0) = f(0) \end{cases}$$

$$(10)$$

the Inverse-Beta operators or the Stancu's operators of second kind [6] having $b_{t\,x,t+1}(u)$ as (3).

The Inverse-Beta operators $T_t(f; x)$ preserve the affine functions on $[0,\infty)$:

$$T_t(e_0; x) = e_0(x) = 1$$

$$T_t(e_1; x) = e_1(x) = x$$

$$T_t(e_2; x) = x^2 + \frac{x(x+1)}{t-1}, \ t > 1$$

Using the classical estimate for the linear positive operators:

$$|(Lf)(x) - f(x)| \leq$$

$$\leq \left(1 + \delta^{-2} L\big(e_1 - x e_0\big)^2(x)\right) \omega(f; \delta),$$

$$f \in C_B(I), \ I \subset R, \ \delta > 0$$

we have for these operators:

$$\left| T_t(f; x) - f(x) \right| \leq \left(1 + \delta^{-2} \frac{x(x+1)}{t-1}\right) \omega(f; \delta),$$

$$(\forall) \ f \in C_B[0, +\infty), \ t > 1$$

$$(11)$$

These operators can be probabilistic represented as the mean value of the random variable $f(W_{t\,x,\,t+1}) = f\left(\dfrac{U_{t\,x}}{V_{t+1}}\right)$, where $U_{t\,x}, V_{t+1}$ are two independent random variables, having Gamma distribution with density $d_{t\,x}(u)$ respectively $d_{t+1}(u)$ defined as (8):

$$\begin{cases} T_t(f; x) = E\big[f(W_{t\,x,t+1})\big] = E\left[f\left(\dfrac{U_{t\,x}}{V_{t+1}}\right) \right] \\[4mm] \qquad\qquad\qquad t > 0, x > 0 \\ T_t(f;0) = f(0) \end{cases}$$

The well known Szasz-Mirakjan's operators:

$$S_t(f;x) = \sum_{k=1}^{\infty} s_{t,k}(k) f\left(\frac{k}{t}\right) \qquad (12)$$

with $s_{t,k}(x)$ defined as (2) can be represented as the mean value of the random variable $f\left(\frac{N(t\ x)}{t}\right)$, $t > 0$, $x \geq 0$, where the random variable $N(t\ x)$ has the Poisson distribution and take the value k with probability $s_{t,k}(x)$ as (2).

So, these operators:

$$S_t(f;x) = E\left[f\left(\frac{N(t\ x)}{t}\right)\right],$$

$$t > 0, \ x \geq 0 \qquad (13)$$

are well defined, if f is a real measurable function on $[0,\infty)$ such that:

$$E\left[\left|f\left(\frac{N(t\ x)}{t}\right)\right|\right] < \infty \text{ for each } t > 0$$

and

$$S_t(e_0;x) = e_0(x) = 1$$

$$S_t(e_1;x) = e_1(x) = E\left[\frac{N(t\ x)}{t}\right] = x$$

$$S_t(e_2;x) = E\left[\left(\frac{N(t\ x)}{t}\right)^2\right] = x^2 + \frac{x}{t}$$

$$t > 0, \ x \geq 0 \qquad (14)$$

Using our paper [1, Th.3.2] and a result of De la Cal, J., Carcamo J., [2] we have for all convex functions in the domain of these operators $\mathcal{L}_{cx}[0,\infty)$ that,

$$L_t f \geq S_t f, \ f \in \mathcal{L}_{cx}[0,\infty) \qquad (15)$$

For this, in the next section we give an estimate for the difference $\left|L_t(f;x) - S_t(f;x)\right|$.

3. AN ESTIMATE OF DIFFERENCE $L_t(f;x) - S_t(f;x)$

In view of (15) using the representation (9) for the Szasz-Inverse Beta operators, the estimate (11) for the Inverse-Beta operators and the Szasz-Mirakjan`s properties (14) we have:

Theorem 3.1 If $f \in C_B[0,\infty) \cap \mathcal{L}_{cx}[0,+\infty)$ then for every $x \in [0,+\infty)$ and $t > 1$

$$\left|L_t(f;x) - S_t(f;x)\right| \leq$$

$$\leq \left(1 + \delta^{-2}\left(\frac{x(x+1)}{t-1} + \frac{x}{t(t-1)}\right)\right)\omega(f;\delta)$$

Proof.

$$\left|L_t(f;x) - S_t(f;x)\right| = \left|S_t(T_t(f;x)) - S_t(f;x)\right| \leq$$

$$\leq \sum_{k=1}^{\infty} s_{t,k}(x)\left|T_t f\left(\frac{k}{t}\right) - f\left(\frac{k}{t}\right)\right| \leq$$

$$\leq \sum_{k=1}^{\infty} s_{t,k}(x)\left(1 + \delta^{-2}\frac{\frac{k}{t}\left(\frac{k}{t}+1\right)}{t-1}\right)\omega(f;\delta) \leq$$

$$\leq \sum_{k=1}^{\infty} e^{-tx}\frac{(tx)^k}{k!}\left(1 + \delta^{-2}\frac{k(k+1)}{t^2(t-1)}\right)\omega(f;\delta) \leq$$

$$\leq \left(1 + \frac{\delta^{-2}}{t^2(t-1)}\left((tx)^2 + tx + t^2x\right)\right)\omega(f;\delta)$$

$$\left|L_t(f;x) - S_t(f;x)\right| \leq$$

$$\leq \left(1 + \delta^{-2}\left(\frac{x(x+1)}{t-1} + \frac{x}{t(t-1)}\right)\right)\omega(f;\delta)$$

For

$$\delta = \frac{1}{\sqrt{t-1}}, \ t > 1, \ x \geq 0, \ f \in C_B[0,+\infty)$$

we obtain

$$\left|L_t(f;x) - S_t(f;x)\right| \leq$$

$$\leq \left(1 + \left(x(x+1) + \frac{x}{t}\right)\right)\omega\left(f;\frac{1}{\sqrt{t-1}}\right)$$

Using the probabilistic representation (6), (13) of these operators, we can to give an estimate with the aid of the variances of the

random variables $\dfrac{U_{t\,x}}{V_{t+1}}$ and $\dfrac{N(t\;x)}{t}$.

So that, result for $t > 1,\; x \geq 0,\; \delta > 0$

$$\left| E\left[f\left(\frac{U_{N(t\;x)}}{V_{t+1}} \right) \right] - E\left[f\left(\frac{N(t\;x)}{t} \right) \right] \right| \leq$$

$$\leq \left(1 + \delta^{-2}\left(D^2\left(\frac{U_{t\,x}}{V_{t+1}} \right) + \frac{1}{t-1} D^2\left(\frac{N(tx)}{t} \right) \right) \right) \cdot$$

$$\cdot\, \omega(f;\delta)$$

4. CONCLUSIONS

This study is interesting because presents an estimate of a difference between the images of the same function with the aid of two different operators but one of them is a mixture of the other operator and another one.

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AUTOMATIC GENERATION CONTROL USING GENETIC ALGORITHM

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Abstract: The generation control is becoming increasingly important in view of increased load demand and reducing generating resources. The increasing load demands are posing serious threats to reliable operation of power systems. This is because the increasing load demand leads to lowering of turbine speed (N_s) and therefore reduction of frequency (f) of output voltage of the generator. The healthy operation of generators feeding powers to various types of load is filled with challenges as the generating resources are cooping up to keep pace with increasing load demand. Under the situation a great care is needed in maintaining load under the size of generating capacities on the one hand and also maintaining healthy and undamaged operation of generators on the other hand. Working singularly or in parallel with other unit, the healthy and undamaged operation of generator needs the control of the following parameters: frequency to be maintained constant; the tie line power to be maintained between specified limits.

Keywords: crossover, economic operations, frequency, genetic algorithm, mutation, reproduction.

1. INTRODUCTION

There are many reasons, which justify that frequency of the power systems be maintained constant at 50 Hz [8]. The most serious effect of Subnormal frequency is on the operation of thermal power plants. With reduced frequency the blast by ID and the FD fan decreases, as a result of which the generation also decreases & thus it becomes a cumulative action & may result in complete shut-down of the plant if corrective measures like load Shedding is not taken up well in time. Load shedding is done with the help of under frequency relay, which automatically disconnects at a relatively higher frequency and vice-versa. This justifies the need for constant speed.

Further to meet the changes in load demand in particular area. The tie line load frequency controller adjusts the frequency to a particular value, for a given tie line power flow or tie line loading. This in turn decides the size of power which any particular generator in the interconnected system to raise its output for meeting the load demand in any area at the interconnected system. It is therefore necessary to maintain the power flow through tie line to some correct value. If the power flow is not maintained at predetermined value, it will cause any particular generator to give power output beyond its capacity to meet the increased load demand for restoration of normal frequency. As a result there is every possibility that the generator may over exert & get damaged. It is therefore always necessary to maintain a tie-line load bias. This is achieved through load frequency controller, which adjusts the operating frequency for a given tie line load bias power level. This in turn provides a great safety provider to costly generators [20]. It is therefore necessary to maintain the tie line power flow to some correct value.

The tie line power works as governor characteristic for maintaining constant frequency at desired power demand in an interconnected system. It takes into account the changes in load that takes place in a load area irrespective at the power generator, which is feeding the load. Also the economic load dispatch is one of the vital criteria that need to be satisfied for economic operation of any

power station. This justifies the need for tie line control.

Studies have revealed that the economic operation when the multi generators in a particular area is feeding the load demand, requires all the units maintain the ratio of increment in fuel supply to increment in power output should be equal i.e.

$$\frac{dF_1}{dP_1} = \frac{dF_2}{dP_2} = ... = \frac{dF_n}{dP_n} = \lambda \qquad (1)$$

This condition is required to be achieved for most economical operation of power system [22].

This needs proper allocation of loads to all the generators working to meet the entire load demand. Thus it can be concluded that the generation control is needed to ensure the power system stability. This justifies the need of economic operation generators.

2. PROBLEM

It is aimed to develop a programmable logic, which leads control of:
1. Frequency,
2. Tie line power and
3. Economic load dispatch, within prescribed limits, when they fail to be in such limits due to abnormal changes in loading. However the necessity of Automatic Generation Control is realized.

3. SOLUTION

A system, which issues command of control action to ensure:
1. Frequency control,
2. Tie line power control and
3. Economic load dispatch has been developed using a programmable logic and genetic algorithm. Also the same when tested gives better results over the mathematical approach.

4. STEPS OF SOLUTION

1. Collection of data from sub-station.
2. Development of software for implementation of proposed controls.

3. Testing of software and its comparison with mathematical approach.

5. WHY GENETIC ALGORITHM

- The genetic algorithm is preferred over traditional methods because they work with coding and are free from limitations like continuity, derivation and un-modality.
- It provides a model free approximation of the problem and has proved to be best technique in obtaining the best solutions.
- Genetic algorithm searches from population of point rather than a single point. It is known as build as well as robust tool for maxima.
- Genetic algorithm use payoff information not derivation or other auxiliary knowledge.
- Genetic algorithm use probabilistic transmission rules instead of deterministic ones. Therefore it can search a non-convex area to find the global optimum.

6. WORKING OF GA

GAs work from a rich database of points simultaneously (a population of strings), climbing many peaks in parallel; thus, the probability of finding a false peak is reduced over methods that go from point to point[10]. The mechanics of a simple genetic algorithm involves nothing more complex than to copy strings and swap partial strings. The explanation of why this simple process works is subtle and yet it is extremely powerful. Simplicity of operation and the power of the effect (speed and accuracy) are two of the main attractions of genetic algorithms. A simple genetic algorithm that yields good results in many practical problems is composed of three operators [5]:
1. Reproduction;
2. Crossover;
3. Mutation.

Reproduction is a process in which individual strings are selected according to their objective function value f (biologists call this function - the fitness function). Intuitively, we can think of the function f as some measure of profit, utility, or goodness that we want to maximize. Selecting strings according to their

fitness values means that strings with a higher value have a higher probability of contributing offspring to the next generation.

After reproduction, **crossover** proceeds in two steps. First, members of the newly reproduced strings in the mating pool are mated at random.

Second, each pair of strings undergoes crossover as follows: an integer position k along the string is selected uniformly at random between 1 and the string length less one [1, l-1]. Two new strings are created by swapping all characters between position k+1 and l inclusively. Mutation plays a decidedly secondary role in the operation of genetic algorithms.

Mutation is needed because, despite the fact that reproduction and crossover search and recombine existent notions, occasionally they may lose some potentially useful genetic material.

The mutation operation involves periodically selecting one individual at random, selecting one position on the chromosome string and transposing it from 0 to 1 or vice-versa.

Mutation restores diversity but does not provide a logical approach to optimization. Its use should be restricted to situations where a local minimum (or maxima) has trapped the algorithm and a new population member is required to trigger the crossover operator on to a better result. Fig. 1 shows the general flow chart for GA.
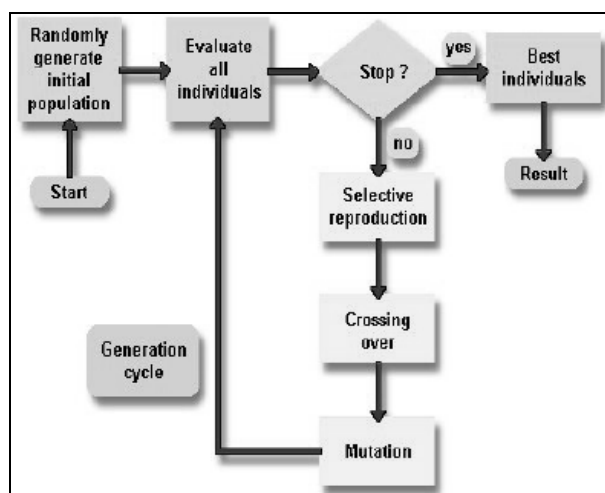
Fig. 1 General Flowchart of Genetic Algorithm

Algorithm for AGC

Step 1: Set the values of $\omega_{scheduled}$ and P_{tie};

Step 2: Get the values of ω_{actual} and $P_{tie\ actual}$ and then calculate $\Delta\omega$ and ΔP_{tie};

Step 3: With the values of $\Delta\omega$ and ΔP_{tie} decide the control action to be taken;

Step 4: Send the control action in the particular area and apply Economic Load Dispatch using Genetic Algorithm;

Step 5: Represent the problem variable domain as a chromosome of a fixed length, choose the size of a chromosome population N, the crossover probability pc and the mutation probability pm;

Step 6: Define a fitness function to measure the performance, or fitness, of an individual chromosome in the problem domain. The fitness function establishes the basis for selection of chromosomes that will be mated together during reproduction;

Step7: Randomly generate an initial population of chromosomes of size N: x_1, $x_2,\ldots, x_N$;

Step 8: Calculate the fitness of each individual chromosome: $f(x_1), \ldots , f(x_N)$;

Step 10: Create a pair of offspring chromosomes by applying genetic operator's crossover and mutation;

Step 11: Place the created offspring chromosomes in the new population;

Step12: Repeat Step 9 until the size of the new chromosome population becomes equal to the size of the initial population, N;

Step 13: Replace the initial (parent) chromosome population with the new (offspring) population;

Step 14: Go to Step 8, and repeat the process until the termination criterion is satisfied. Check the feasibility of the solution corresponding to the satisfaction of the equality constraint.

7. ILLUSTRATION

Fuel inputs for generators G1&G2 of AREA 1, G3&G4 of AREA 2 are given below:

Area 1:

$$F_1 = 0.2P_1^2 + 40P_1 + 120 \text{Rs. per hour} \qquad (2)$$

$F_2 = 0.25P_2^2 + 30P_2 + 150$Rs. per hour   (3)

Area 2:

$F_3 = 0.15P_3^2 + 30P_3 + 90$Rs. per hour   (4)

$F_4 = 0.2P_4^2 + 25P_4 + 120$Rs. per hour   (5)

Maximum generating capacity of G1 & G2 is 100MW each & of G3 & G4 is 60MW each. Max. & Min.

Load on each generator of AREA 1 is 100 MW & 25MW respectively. Max. & Min. Load on each generator of AREA 2 is 60MW & 10MW respectively. Transmission losses are neglected. Assume that tie line power flow is from area1 to AREA 2 & of 10MW constantly.

To determine the control action, load allocation to individual generator and most economical cost of generation for economic load dispatch, when the system frequency, tie line power is changed due to changes in load as per case I and II. System frequency is scheduled at 50Hz, so $\omega_{sched} = 314.16$ rad.

Table 1 Parameters (P) - Case I: At time: 14 Hrs.

P \ State	ω (rad.)	P$_{tie}$ (MW)	Total Load (MW)	Load on A 1 (MW)	Load on A 2 (MW)
Expected Conditions	314.16	10	250	150	100
Actual Condition	326.7	15	245	-	-

Table 2 Parameters - Case II: At time: 18 Hrs.

P \ State	ω (rad)	P$_{tie}$ (MW)	Total Load (MW)	Load on A 1 (MW)	Load on A 2 (MW)
Expected Conditions	314.1	10	190	110	80
Actual Condition	301.6	5	195	-	-

8. RESULT COMPARISON

Case I

Cost from mathematical approach = = 7706.19 Rs./hour = 7706.19*24Rs./day = = 184948.56 Rs. /day.

Cost from Genetic Algorithm approach = = 7639.24 Rs./hour = 7639.24*24Rs./day = = 183341.76 Rs./day.

Net Saving per day = 184948.56-183341.76 = 1606.8 Rs.

Net saving per year = 1606.8*365 = = 586482 Rs.
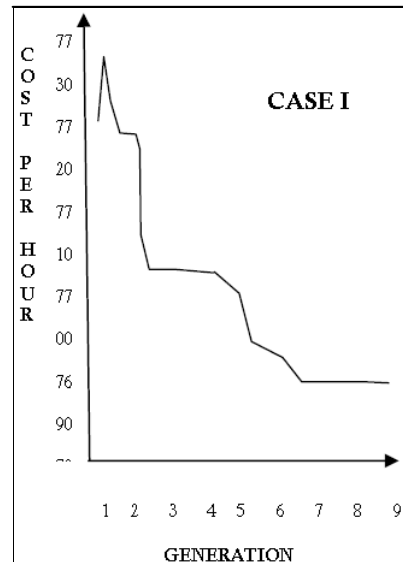
Case II

Cost from mathematical approach = = 3178.82 Rs. /hour = 3178.82*24 Rs. /day = = 76291.68 Rs. /day.

Cost from Genetic Algorithm approach = = 3116.92 Rs. /hour = 3116.92*24 Rs. /day = = 74806.08 Rs. /day.

Net Saving per day = 76291.68-74806.08 = = 1485.6 Rs.

Net saving per year = 1485.6*365 = = 542244 Rs.
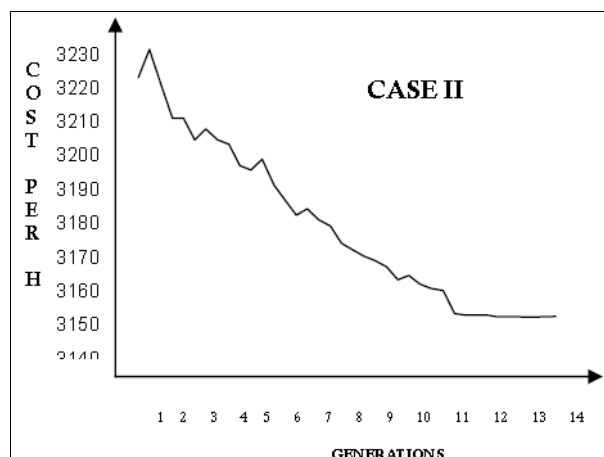
9. CONCLUSIONS

The Present research work has been aimed to provide comprehensive control strategy for generators working in a particular area, so that the conditions caused by unusual changes in load is met by the generators without becoming inoperative. The outcomes of the present work are:

- A programmable logic has been developed and tested for varying load conditions to ensure automatic generation control.
- The three parameters viz frequency (f), tie line power flow (P_{tie}) and economic load dispatch have been maintained within prescribed limits without shutdown of generators under varying load conditions.
- The control strategies have been presented in the algorithm as well as flow chart form. This has given a rich base for development of programmable logic.
- The results have been obtained by mathematical as well as programmable logic control.
- The concept of genetic algorithm has been applied to obtain economic load dispatch conditions. This goes a long way in improving the economy, as the solution provided by it is global one vis-a-vis the local one as provided by the mathematical approach.

Using the techniques of soft computing and artificial intelligence it is possible to improve the smartness and reliability of controls to be exercised for automatic generation control.

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TRAINING THROUGH SIMULATION IN THE AIR DEFENCE ARTILLERY. FIRE CONTROL SYSTEM GUN*STAR NIGHT SIMULATOR

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Abstract*: In the last decade technology has seen an unprecedented development. Engineering, served by the human factor is becoming more complex, increasingly automated, with an extremely high factor of reliability and accuracy. The operator must be well prepared in terms of theoretical and practical, to serve its maximum possibilities. Good preparation is achieved through training, service improvement and automation technology and skills through many hours of theoretical, but practical, and in some areas by practicing specific simulator. As in most areas, military simulators began to occupy a leading place in preparation of serving a particular type of technique. Practical training is based, in large measure, on the training on simulator and in final stage is passed to operation on fighting technique. In the Air Defence field there are little simulation programs, few programs of military training, and the existing ones require a relatively high cost for implementation, maintenance and use. In the present project we established a program simulation for the fire control system Gun*Star Night, a modern air defence complex caliber 35 mm.*

Keywords*: simulator, simulation program, air defence, fire control system.*

1. INTRODUCTION

The model is a physical representation, mathematical or logical of a system, entity, phenomenon or process.

NATO classified simulations into three categories:

a) the actual simulation: a simulation in which real people are operating real systems;

b) virtual simulation: a simulation in which real people operate simulated systems. Simulations play a central role in exercising motor skills and control, decision-making skills and communication skills;

c) constructive simulation: simulation in which people simulate operating simulated systems. Real people providing input for these simulations, but are not involved in the simulation output.

The scope of modeling and simulation [1] levels: strategic, operational, tactical and individual, is shown simultaneously in the matrix below (Table 1).

Table 1 Scope of modeling and simulation

Rescue factor	25:1	10:1	Leader-ship
	Acquisition Development	*Exercise Education Practice*	*Planing Analisys*
Strategic	Acquisions simulations	Related and combined operations	Decision making support
Opera-tional	Operational research studies	Tactical simulation	
Tactical	Development of operational research	Simulators	
Indivi-dual		Simulatos equipments	

Currently, given the short time that troops should be out training, it is necessary to show more responsiveness to all means to reduce training time, in order make this one accurate, allowing the training tasks maximal parameters, but with minimal expenditure and

consumption. By using simulators, fighters are put in complex situations and realistic training [2].

Particularly in the NATO armies in certain specialties, there aldready exist simulators for military training under conditions similar to the theaters of operations. With the american pilots known position before the actual performance of a combat mission, pilot that made hundreds of hours of training on the simulator, the mission itself will not be anything other than a training „somewhat serious". The pilot knows to perfection every step mission. This explains the success of NATO fighter-bomber aviation plays out the tasks and missions unfulfilled very low rate.

Simulation training as a modern and efficient methods of training, is already a reality in our army [3]. This method provides an efficient and inexpensive tool that allows training to meet specific missions.

2. SPECIFIC REQUIREMENTS

Oerlikon Contraves air defence complex caliber 35 mm is an automated system, and is meant for the Air Defense Forces troops, control points and the points required for passage.

From the action point of view it is intended to control air targets closely spaced, low and very low height and light armored ground targets.

Fig. 1 Fire control system

The complex has anti-aircraft automatic guns comprises two 35 mm caliber, and a fire control system (Fig. 1), for detection, identification and automatic target accompany.

Also, this system is designed to combat air targets when working in a centralized manner.

Fire control system Gun*Star Night is a optronic system based on electro-optical tracking system and equipped with a computer to calculate ballistic trajectory and timing of fire release.

Fire control system Gun*Star Night provides the following main operations:

a) receiving data on air targets at Radar Research Station (CRS) or its digital optical viewfinder;

b) assess potential air attack in the area of responsibility (in decentralized mode);

c) seek, find and identify the target;

d) accompanying three-dimensional target (finders using laser and electron-optical system);

e) calculated angles of sight for guns;

f) forward angles in gun sights.

The whole system (two sets cannons and fire control system) is powered by electricity, with voltages of 220V AC and 110V DC.

In order to work independently of the national electricity network in any place and time conditions, voltages are provided by two sets, running on leaded petrol, with a consumption of 24 l\h, and a generating set of low power, functional unleaded petrol, with a consumption of 1.5 l\h Thus we can realize the costs involved in preparing a one man operator, since the basic and advanced skills needed at least three training phases, each phase is taking place over a period of 1-3 weeks [4].

This project has at least two reasons:

a) the operator during the preparation of a fire control system greatly shortens the stages of initiation, training and perfecting their skills being done with the simulation program, thus changing the actual fighting technique will be very easy, the operator benefiting from experience gained on the simulator;

b) it costs a lot less to train an operator, as the first two stages of training can be conducted using the simulation program and only the third stage fighting technique to use. Thus, instead of preparing a single operator there can be trained three operators in three stages.

3. FIRE CONTROL SYSTEM GUN*STAR NIGHT SIMULATOR

Simulation program for fire control system Gun*Star Night is destined for learning and involvement of operators, training and improving their skills in order to shorten the preparation time and training costs.

Simulation software can be a way to train even when for some reason, the technique is unable to efficiency. It also represents a necessary learning tool for the main menus and submenus and the presentation of the art verification algorithms.

In current conditions, modern combat no longer leads through direct contact with the enemy, but it is based on information received from higher echelons or the discovery and tracking its equipment.

Respecting the laws of modern conflict, fire control system Gun*Star Night flies over the target information from the research station (radar) to senior and displays them on the video display. Data on target are displayed while the operator has selected the option of designating the target by radar and has been aligning with the radar. If operations were not performed, the display will show data on the flight parameters of the target. Besides fire control interface device, the frame main menu we created a help menu designed to facilitate understanding the operation of the simulator, everything here may be introduced by the instructor or operator of the target flight parameters to evolve.

In what follows I will present two options menu target data and target route.

- *Target Date*: This opens a dialog where you will enter flight parameters of the target to move (the designated target number - this number is given, usually by radar direct distance to the target speed target, azimuth and elevation angle below which sees the target, etc.).

Flight of the target parameters are also valid when running the application and fixed, usually before the simulation. When the operator began checks and alignments, it is desirable flight parameters to be introduced so that the evaluator should not influence the operator [5].

- *Route target*: at home option is the development target. From this time the target can be intercepted by the operator and is taken to cover the camera automatically fire control system.

Target will appear on the video display and will be accompanied by camera stable only if the operator has set the target designation radar DOS and has been aligning with the two subsystems. Otherwise, the target will not come into sight of the camera, so video will not show the target.

Flight parameters of the target (set before running the application) will be displayed on fire control system only if the alignment was made with radar. If this alignment was not done, then do not submit data to the radar system.

If during development target alignments or operator fails to select target designation by one of the two elements, then it will come in sight of the camera (the target was automatically taken to cover) and therefore the signal will be displayed and on the video display.

Frames were created about the size of the actual opening to the center of the screen, with the possibility of moving them on screen. Closing is the upper right corner. Since the application is intended as an educational program in the upper left we have listed and open submenu name, although not firing system displays the names of submenus.

Frame home is Gun*StarNight.frm and is the main menu on your panel TACH firing system (Fig. 1). Each opens a submenu to access different frames, frame parent Hide worth taking.

The main frame contains four main submenus (Status, Settings, Alignment and Check), show only the value of having access submenu. Each of the submenu command opens another frame other than the principal, the latter taking the value of Hide. Back in frame main frame where he worked Hide value.

On the main frame were created other shortcuts on the panel TACH namely:

- Designation - target designation, which has values: Both, Optical Sight, Search Radar, None;

- Elevation Scan - searching in elevation, which has values: Manual, Automatic, Constant Height;

- Gate – "gate" to accompany the target, which has values: Armed, Disarmed;

- Field of View - view the plan target, with two values: Narrow, Wide;

- Tracking - how to cover the target, with two values: On, Off;

- Ranging - how to select the amount of distance to target, with the following: Near, Mid, Far, Straight, Lasers (which gives exact distance to target), Radar, Auto Select;

- Gun Mode - how to work with fire control system, with two levels: On Line, Zero Test;

- Gun Alarm - the alarm guns, with two values: Auto, Manual.

Any option selected on the main frame will be displayed on the video display of other frames.

On the video display device of fire control system Gun*Star Night are displayed information about the target. This information is vital in engaging the fight, so the operator needs to know and know how to interpret them very well. Next we will present information and their interpretation.

Information designated by the senior research station, Shorar-TCP, which appear on the video display:

- TR / Track Number: number of targets designated by unit fire

- AR / Radar Azimuth: angular position value Shorar-TCP research station to the fire control system;

- RD / Radar Distance: parallax offset distance in feet from the research station;

- TH / Target Height: once target height in meters;

- TV / Target Velocity: speed in m / s target.

Information designated by the discovery and identification of its equipment:

- HD / HIT Distance: distance measured to the point of impact between the target and the projectile beam, calculated in meters;

- EL / Line of Sight Elevation: elevation angle of the target to fire control system;

- AZ / Line of Azimuth: azimuth angle of the target to fire control system;

- DI / Target Distance: distance inclined to direct fire control system to the target;

- T / Distance Tracing Mode: how to determine the distance to the target.
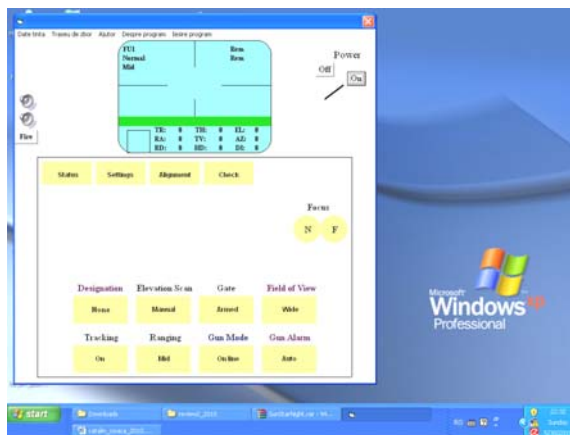
Fig. 2 Running program

Information on identifying fire control device:

- UNIT - how to work independently;

- FU1 - FU4 - centralized mode.

Information on how to determine the distance of the accompanying target:

- Radar - distance is determined by the research station;

- Laser - distance is determined by laser telemetry;

- Near - near distance fixed plan;

- Mid - Fixed remote environmental plan;

- Far - Plan fixed distance away;

- Straight - fixed remote tracking function.

For fire control system operator to carry out its mission, the algorithm must meet strict training and technique to go through each stage separately. Every step of preparation is well esta blished and not taking each step leads to errors and failure to tackle the target.

With the simulator developed algorithm we take into account the preparation technique. Thus, if the operator does not align with the north and DOS, then it will not receive information on target position will not be able to identify its signal will not appear on the video display.

If the operator does not align with the radar, then you will receive information on flight parameters of the target and the operator is unable to open fire, not knowing if entered into the possibilities of control.

Fire control system alignment with guns is another vital part of the preparation for war, since, if not running at this stage, fire channels will not be synchronized with the fire control system and therefore the volley of fire shooting will not be directed on target, but will take any direction.

If during the development of the target the operator will fix any error in the preparation technique to combat, the simulator will take into account and correct in real time, shooting fire on air targets.

It must be noted in anti-aircraft defense, because the fight is going to target aircraft (airplanes and helicopters, high speed and high precision), it can not take more than a few tens of seconds, ie the time required for an airplane or helicopter carrying out a mission (launch a rocket or a bomb self-directed). Therefore the fight goes "with the seconds".

Time evolution of the target zone of fire is random, the maximum being about 50 seconds. During the time evolving target, the operator can open fire at any time. Length volley fire was set at 1.5-2 seconds, during actual firing.

Depending on the number of volleys to open fire on target and taking into account the probability of destroying its target will be reduced.

If the operator, for various reasons, do not open fire on the target when given flight route (Route Target to hold option on the menu), then opened fire on the target fire control system.

Next I will present several lines of code used in the simulator [6].

```
Private Sub Timer1_Timer()
If traseuzbor = 1 Then
        Timer1.Interval = 2000
If gun1fire.Caption = "REM-Fire" Then
        nrfoc = nrfoc + 1
        gun1fire.Caption = "REM"
        gun2fire.Caption = "REM"
        Line15.Visible = False
        Line16.Visible = False
        Line17.Visible = False
        Line18.Visible = False
    End If
    End If
    End Sub
```

Since air combat with the enemy takes more than a few tens of seconds (considering the speed of development targets hundreds of meters per second), in the home page we introduced two types timer components, components that are designed to limit while certain actions.

The first function, timer type is to display the video screen for two seconds; the message to open fire, Fire REM, the message means that the two channels of running fire on target (Fig. 2).

After two seconds the channels cease fire first volley of fire and prepare for the next opening volleys. Video screen, this message is reflected by the fact that REM-REM thread is replaced with the message. Here we introduced a variable fire number, variable that is to count the number shoot fired.

If the operator was able to open more than four volleys on target at the end of its evolution will show a message which will confirm its destruction: Mission Complete!, Otherwise, the message of failure of the mission, "You have been destroyed !".

```
Private Sub Timer2_Timer()
If zbor.Playing = True Or traseuzbor = 1 Then
        Timer2.Interval = 49000
If nrfoc > 3 Then
        zbor.Playing = False
        zbor.Visible = False
        Text1.Visible = True
Text1.Text = "Mission complete!!!"
Else
Text1.Visible = True
        Text1.Text = "You have been
    destroyed!!!"
    End If
    End If
    gun1fire.Caption = "Rem"
    gun2fire.Caption = "Rem"
    zbor.Playing = False
    zbor.Visible = False
    Line15.Visible = False
    Line16.Visible = False
    Line17.Visible = False
    Line18.Visible = False
    End Sub
```

All conditions outlined in the above procedures are intended to approximate actual conditions and simulator to demonstrate that

any operation should be performed with a sense of responsibility and must respect the art training algorithm, otherwise the effects could be devastating: combat mission will not be met, the target will reach its aim, fire unit will be removed from combat.

4. CONCLUSIONS

One of the roles that simulation can play is to save financial resources, materials, time and, not least, human. Also, the diversity decision algorithms can be tested using the simulator, just respecting the initial conditions. In this way you can find, without spending any additional resources or alternative optimal algorithm to obtain optimal peak performance.

Also, if the actual technique wears as a result of overloading it, there is no question in simulators. Regardless of the number of hours they spend in front of an operator simulator practicing, regardless of its level of preparation (simple or advanced student) technique will not suffer as a result of "experiments" that could be taxed.

When the operator is well prepared, when discovered, through experience, which is the best algorithm to follow, which is the best decision to be taken at a given time, then he can shift the actual equipment in the best conditions.

Military educational institutions in the field have not, at present, a simulation program of fire control system Gun*Star Night, so the present program could be a useful tool for training and improving students or trainee officers.

Currently, in the Romanian army anti-aircraft artillery gun there is a program for simulation equipment operators anti-aircraft

artillery, the only occasions for training in real conditions as those of the polygon of drawdowns conducted missions in very good conditions, but as cost. Therefore, simulation software is intended as a first step in the field.

And in the future, a collaborative project with the Faculty of Informatics, when we are able to create a 3D simulation, with possible targets in real-time combat, we will be able to create a simulator which includes other subsystems that run on multiple workstations connected to network operators served by serving those subsystems, and we will be able to say that we -and also anti-aircraft artillery- did a first step towards the future.

And then, finally we can say that the passion for this weapon, for the air defence artillery has regained the place it deserves: a weapon of first-class falling in battle, umong weapons that can decide, in just the first two hours armed conflict, whether the fight is won or not.

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FUSELAGE AIRSTREAM SIMULATION FOR A COANDĂ UAV

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Abstract: The objective of this paper is a study regarding the design of an unmanned aerial vehicle to ensure security by monitoring and collecting data from the atmosphere. Flight autonomy is realized using a propeller and additional for sustentation, thrust and orientation it uses the well Coandă effect. Atmospheric parameters are monitored by special gadgets, maintained by the ground operated vehicle. Flow dynamics study on the vehicle's cap during the auto-sustainable process is realized using Fluent 6.3 software.

Keywords: *UAV, self propelled, aerial surveillance, Coandă effect.*

1. AIMS AND BACKGROUND

Aerial surveillance of the environment, especially of the protected areas, is done to ensure their preservation. This surveillance is a part of the structural and functional bio and ecological diversity dynamics studies. Thus can monitored – without human presence – different ecosystems, under, sometimes, hostile weather conditions and in locations hard to reach by human observers.

UAVs as solution will offer to the researchers interested in monitoring the ecosystems, a possibility of aerial surveillance with a vehicle with self-sustentation and an alternative propulsion method. Also the aerial surveillance will increase the ability to detect polluters better than ever, over land or wet areas and even over oceans, with smaller expenses and without endangering the human observers.

In this paper will be presented a new UAV type, designed for environmental surveillance, so called Coandă UAV.

A limitative condition for this new UAV type, condition that define it among others, is to use not for thrust an internal combustion engine – which is pollutant and noisy.

The same importance has the condition that the vehicle should be compliant with other several requirements considered normal for the observer. Thus, the vehicle has to have the ability to hover and to maintain its position and altitude over the area that needs monitoring.

The thrust and vertical movement system uses a ducted propeller, driven by an electric motor, and in order to improve the thrust and sustentation efficiency, as well as the horizontal maneuverability the well-known, but not so widely spread, Coandă effect is used.

This UAV type uses the propeller not only in the classic way, for sustentation, but also for creating air jets, vertically redirected by the upper vehicle fuselage surface, with the help of Coandă effect.

A study regarding the dynamic behavior of such new vehicle requires, at first, an analysis on a scale model.

The model simulation may determine and predict the contribution of the Coandă effect when modifying the flow parameters over the vehicle' cap surface.

For the wind tunnel tests, at first, the contribution of the ducted propeller was done using air with an adjustable flow. Air is to be supplied through a central vent and then guided by a round nozzle over the curved surface of the models, where the Coandă effect creates additional lift and increases the sustentation capability as in Fig. 1.
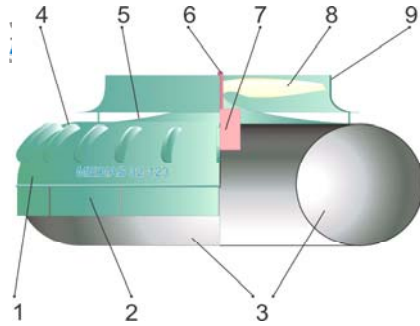
Fig. 1 UAV components, [1]
1 - curved upper cap; 2 - steering flaps; 3 - toroidal He chamber; 4 - counter-rotating fins; 5 - inner exhaust profiled cap; 6 - propeller's shaft; 7 - electrical motor and batteries; 8 - propeller; 9 – nozzle

2. AIR FLOW SIMULATION OVER THE UAV'S CURVED UPPER SURFACE

To realize a complete study on the flow over the curved upper surface of the fuselage, three vertical adjustable conic nozzles were fitted, with different diameters (respectively 90, 130 and 170 mm), in order to create jets with different dynamic characteristics, Fig. 2, Fig. 3, and Fig. 4. Also, as seen in Fig. 5, was tested a Laval adjustable nozzle, with 90 mm diameter.
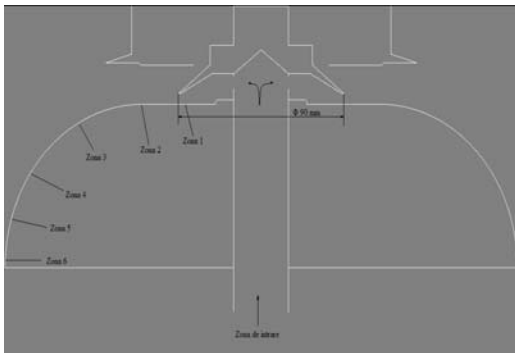
Fig. 2 Positions for the flow parameters
(diameter D = 90 mm)
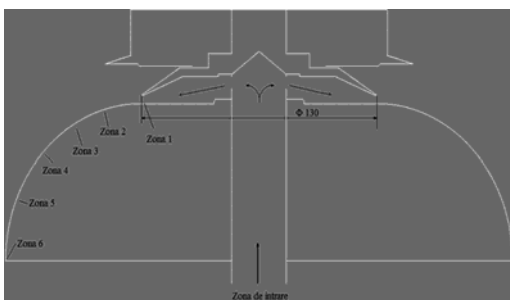
Fig. 3 Positions for the flow parameters
(diameter D = 130 mm)

The flow simulation was realized using the Fluent 6.3 software.

We were tracking the parameter values in the flow direction for six representative positions, from the nozzle exit area to the exit off the curved upper surface.

Various values for the static pressure on the flow surface, for dynamic pressure and for flow speeds were taken, using as input the air flow through the central section.
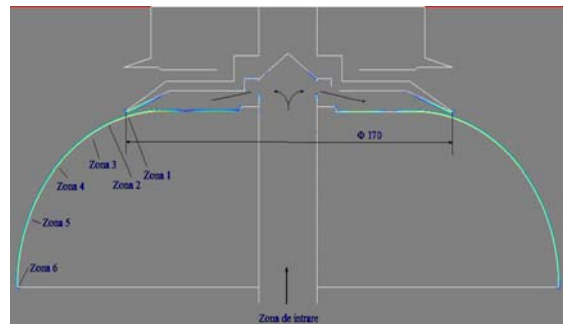
Fig. 4 Positions for the flow parameters
(for diameter D = 170 mm)
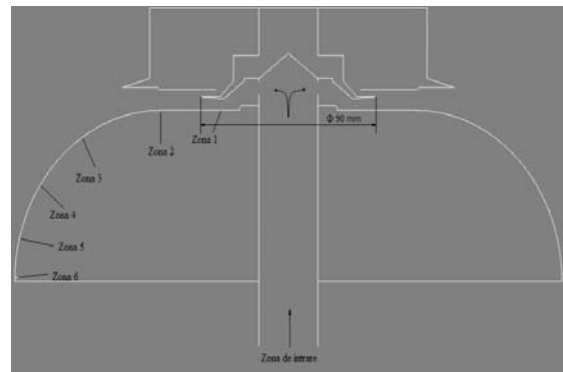
Fig. 5 Positions for the flow parameters
at the Laval adjustable nozzle
(diameter D = 90 mm)

Static pressure and air flow speed for the three values of the nozzle diameter and for the three values required for the flow through the nozzle are plotted in 6 and 7 for Laval nozzle, and 8 and 9 for conic nozzles.

Tab. 1 presents all this data for Laval nozzle, taking into consideration that air density at 20ºC is 1.2 kg/m^3.

Tab. 2, Tab. 3 and Tab. 4 present the same data for conic nozzles.

Fig. 6 and Fig. 7 present, respectively, the air jet speed variation and the static pressure variation for Laval nozzle.
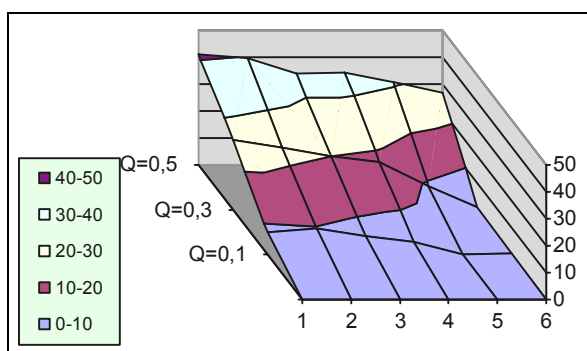
Fig. 6 Air jet speed variation for Laval nozzle with a diameter D = 90 mm
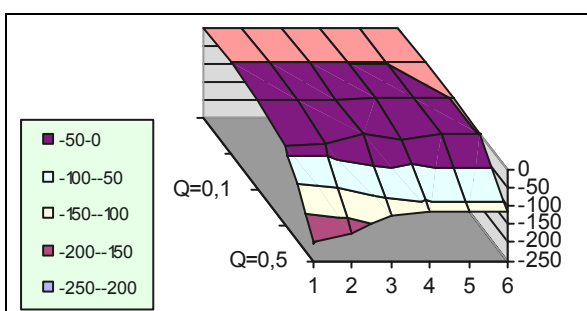
Fig. 7 Static pressure variation for Laval nozzle with: D = 90 mm

Tab. 1 Static pressure, dynamic pressure and air jet speed for Laval nozzle (diameter D = 90 mm)

D	Q = 0,1 m³/s		
mm	Ps	Pd	v
90	Pa	Pa	m/s
Z 1	-4.0	42.7	8.3
Z 2	-3.9	37.0	9.7
Z 3	-3.8	27.0	6.8
Z 4	-1.2	15.0	4.7
Z 5	-0.1	0.0	0.3
Z 6	0.0	0.0	0.5
D	Q = 0,3 m³/s		
mm	Ps	Pd	v
90	Pa	Pa	m/s
Z 1	-35.0	508.0	26.1
Z 2	-30.0	410.0	23.0
Z 3	0.0	254.0	20.0
Z 4	-15.0	400.0	17.8
Z 5	-1.0	244.0	9.0
Z 6	0.0	0.0	1.0
D	Q = 0,5 m³/s		
mm	Ps	Pd	v
90	Pa	Pa	m/s
Z 1	-201.0	961.0	41.0
Z 2	-175.0	850.0	39.7
Z 3	-126.0	750.0	34.0
Z 4	-115.0	700.0	34.3
Z 5	-114.0	414.0	30.7
Z 6	-114.0	380.0	27.0

Tab. 2 Static pressure, dynamic pressure and air jet speed for conic nozzles (diameter D = 90 mm)

D	Q = 0,1 m³/s		
mm	Ps	Pd	v
90	Pa	Pa	m/s
Z 1	110.0	4.0	9.1
Z 2	-1.5	57.0	9.7
Z 3	-3.0	58.0	9.0
Z 4	-7.2	55.0	8.7
Z 5	0.0	40.0	8.2
Z 6	0.0	0.0	0.5
D	Q = 0,3 m³/s		
mm	Ps	Pd	v
90	Pa	Pa	m/s
Z 1	70.0	450.0	26.9
Z 2	-30.0	510.0	29.0
Z 3	-37.2	582.0	30.0
Z 4	-15.0	400.0	27.8
Z 5	-50.0	244.0	25.0
Z 6	0.0	130.0	15.0
D	Q = 0,5 m³/s		
mm	Ps	Pd	v
90	Pa	Pa	m/s
Z 1	248.0	128.0	45.0
Z 2	-175.0	150.0	49.7
Z 3	-100.0	134.0	52.9
Z 4	-150.0	900.0	46.3
Z 5	-150.0	614.0	34.7
Z 6	0.0	400.0	26.5

Tab. 3 Static pressure, dynamic pressure and air jet speed for conic nozzles (diameter D =130 mm)

D	Q = 0,1 m³/s		
mm	Ps	Pd	v
130	Pa	Pa	m/s
Z 1	7.0	50.0	9.3
Z 2	-4.4	55.0	9.0
Z 3	0.0	35.0	10.0
Z 4	-3.0	27.0	7.8
Z 5	-5.0	30.0	7.0
Z 6	0.0	13.0	4.5
D	Q = 0,3 m³/s		
mm	Ps	Pd	v
130	Pa	Pa	m/s
Z 1	84.0	389.0	27.0
Z 2	-30.0	520.0	30.0
Z 3	-17.0	560.0	30.0
Z 4	0.0	210.0	19.5
Z 5	-17.0	150.0	17.5
Z 6	10.5	200.0	18.0
D	Q = 0,5 m³/s		
mm	Ps	Pd	v
130	Pa	Pa	m/s
Z 1	200.0	110.0	43.0
Z 2	120.0	140.0	50.0
Z 3	0.0	130.0	44.0
Z 4	-10.0	600.0	31.0
Z 5	0.0	430.0	26.0
Z 6	658.0	518.0	28.5

Tab. 4 Static pressure, dynamic pressure and air jet speed for conic nozzles (diameter D =170 mm)

D	Q= 0,1 m³/s		
mm	Ps	Pd	v
170	Pa	Pa	m/s
Z 1	-15.0	24.7	6.3
Z 2	-20.0	23.0	6.3
Z 3	-25.0	23.0	6.1
Z 4	-29.0	23.0	6.3
Z 5	-0.3	3.0	3.1
Z 6	-0.3	0.0	0.3
D	Q= 0,3 m³/s		
mm	Ps	Pd	v
170	Pa	Pa	m/s
Z 1	-10.0	240.0	19.1
Z 2	-15.0	207.0	19.0
Z 3	-15.0	207.0	18.5
Z 4	-20.0	200.0	18.1
Z 5	-20.0	220.0	18.5
Z 6	-5.0	180.0	17.0
D	Q= 0,5 m³/s		
mm	Ps	Pd	v
170	Pa	Pa	m/s
Z 1	0.0	670.0	33.0
Z 2	-61.0	590.0	29.5
Z 3	-61.0	570.0	30.0
Z 4	-36.0	550.0	30.0
Z 5	-61.0	560.0	29.5
Z 6	-30.0	470.0	28.5
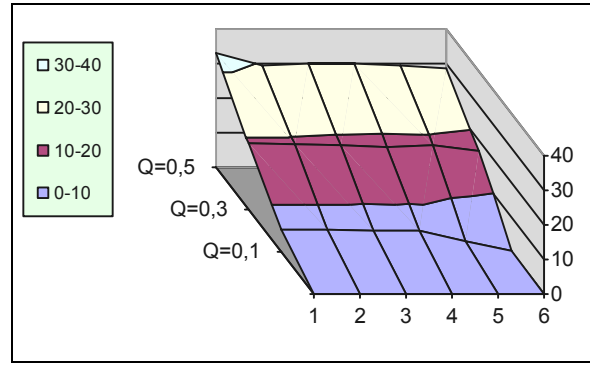
c) D = 170 mm

Fig. 6 Air jet speed variation for conic nozzles
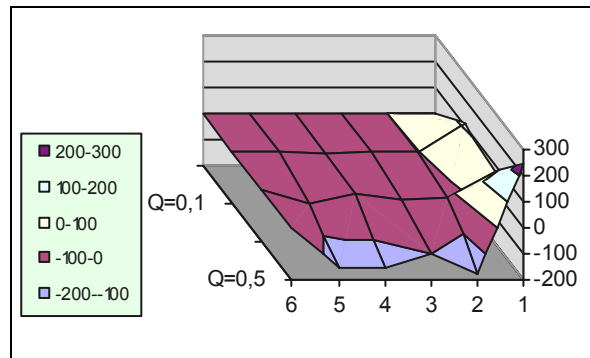
a) D = 90 mm
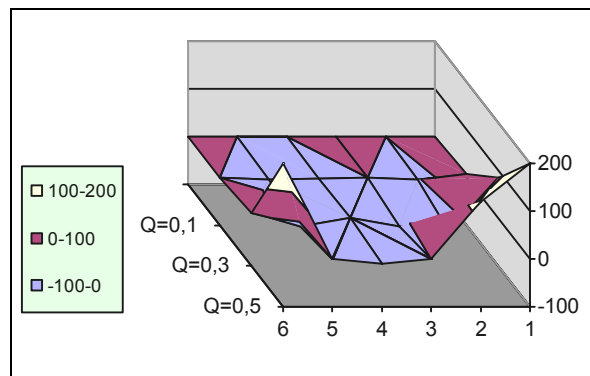
b) D = 130 mm
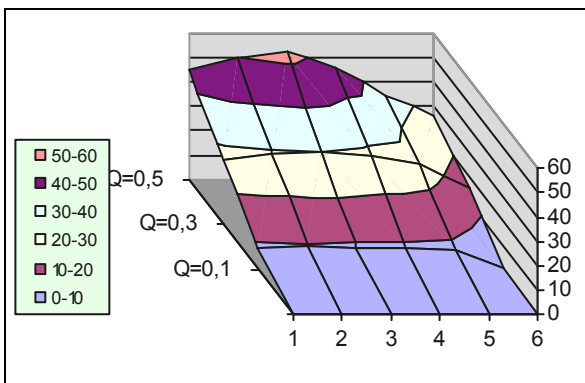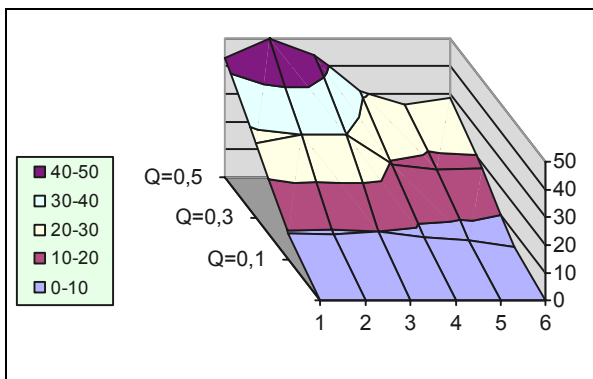
a) D = 90 mm
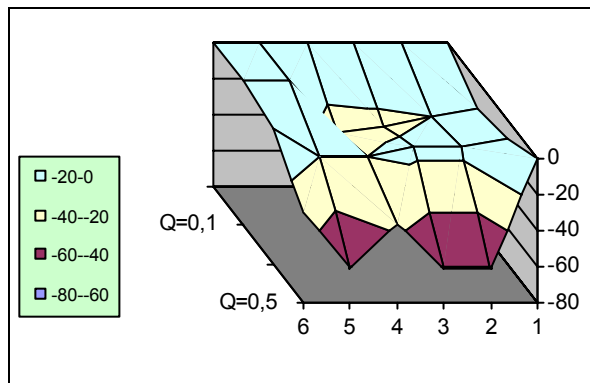
c) D = 170 mm

Fig. 7 Static pressure variation for conic nozzles

b) D = 130 mm

3. DISCUSSIONS

Based on the values presented in Tab. 1 we can conclude:
- The static pressure under surface of the flow, for Laval nozzle, is smaller than static pressure for the conic nozzle. The observations are valuable only for 90 mm diameter;
- The air jet speeds for conic nozzles are higher than air speed for Laval nozzle;
- At the higher values of the air feed, the air jet speeds are approximate equals;
- The loss of energy at the changes of the directions of the flow of the nozzle's out generated the difference of the known values.
- The experimental testes will be confirmed or infirmed the differences between theoretical and experimental studies.

Based on the charts analysis and data presented in Tab. 2, Tab. 3 and Tab. 4 the following conclusions can be drawn:
- Along the six areas studied, along the motion direction, the flow is approximately even, while the increase of speed with the increase of current flow may be observed. The top speed of 53 m/s is obtained for a nozzle diameter of D = 90 mm while the minimum speed is obtained for a nozzle with a larger diameter (D = 170 mm).
- At higher flow values, it is noticed that the current lines reach the extremity of the surface (area 6), following its curvature. The turbulence motion generated by high values for the Reynolds number has areas with whirlwinds which go with the flow and produce irregularities in static pressure values.
- On the vehicle surface, static pressure is minimum for D = 90 mm diameter and maximum for D = 170 mm diameter.
- Static pressure values increase with the increase of air flow values, being connected with the rise of speed values, and dynamic pressure values respectively.
- Static pressure variation along the flow is relatively uniform for a flow value of Q = 0,3 m^3/s and it's less predictable for a flow value of Q = 0,5 m^3/s. The software we used highlighted whirlwind variation, which create areas with static pressures lower than the medium values.
- Low static pressure values on the flow

surface are also highlighted, which leads to the idea of reducing upper thrust, due to the vehicle's shape and the flow of the air jet on the vehicle.
- Laboratory tests will verify the predictions generated by the theoretical study of the flow on the vehicles' surface.

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DEFENSE RESOURCES MANAGEMENT IN CRISIS SITUATIONS

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Abstract: Defense resources management should be a matter of interest for everybody and not only for experts and decision-makers as long as the effects of any decision in this domain can be perceived by the entire society. NATO's umbrella has not to be the only way of thinking security because any member nation of the organization has the obligation to be both a security provider and consumer. Global security environment is now safer than during the Cold War but there are still many risks and threats at regional and local level. Every crisis encompasses a hope and we all have the responsibility to search for and discover as soon as possible, the turning point between the decline and progress and then to proceed for recovery. The best way for managing defense resources during economic and financial crisis is to think and act considering the future. That is to say by investing especially in research and development, in order to find new ways of protecting and developing society through active participation of all the citizens.

Keywords: defense resources, global security environment, risks, threats, defense planning.

1. INTRODUCTION

The direct connection between resources and combat capabilities of armed forces is, or at least should be, well-known not only by the military and politico-military experts but also by the decision-makers in politics and military field; and this because the responsibilities of each of us will increase gradually in direct proportion to our level of understanding. As everybody knows, all the citizens have the obligation to pay taxes for ensuring good functioning of the state, including the structures whose key responsibility is national defense and security. In conclusion, all the citizens should be well-informed on the effects upon them as a result of the decisions made with reference to the state resources and the way the government chooses to distribute them in different fields of activity. Nation's defense and security is a common responsibility for all of us – and I refer to all the adult citizens – and not only for those working within the state's structures involved in defending and securing the nation. As a result, all of the adult citizens of this country should know and acknowledge the short, medium and long term effects of any

decision which may exist upon her defense and security capability and even her credibility among all the allied and partner countries.

Usually, all the decisions related to the defense resource allocation have both an immediate and long term impact on state's structures, especially on those with direct responsibilities for defending and securing the country. The majority of the effects will play upon the entire country on medium and long term and that is why less informed people may think that any postponement of a certain program of acquisition and modernization for defense and security field could be easily recovered next time (year, decade, and so on) and country's defense capabilities might not suffer. The same decision must have a different interpretation from an expert and a respected decision- maker who will be able to see the medium and long term negative consequences from loosing credibility as a partner for defense trade to diminishing military personnel and other state employee's moral. On the other hand, any program or activity postponement will certainly increase the burden for the next fiscal years in order to introduce the delayed programs and activities.

Most probably, this situation might generate a review or even the restarting of the entire defense planning process. In other words, to review and reassess all the objectives, guidelines, priorities and deadlines in order to correlate them with the actual allotted resources.

The effects of any change in defense resource allocation will affect the entire state institutions because any downsizing or increasing of the one's budget has to be balanced with all the others' budget. At the same time, the effects of a defense budget reduction will affect (impact upon, bear on) relations with the allies and partners because they need, in their turn, to review postponed common activities with Romania, and then the credibility of our country might be negatively affected.

Romania's NATO and E.U. membership is a strong argument for discouraging any potential aggressor, if it exists. On the other side, this is not enough and normal to cover country's security deficit using only NATO's umbrella. Some American politico-military experts consider that burden sharing among allies is not equitable [1]. If we add differences in attitude between USA and her European allies related to security environment requirements, then it is possible to discover that all those facts may contribute to deep the existing gap between America and Europe. In the essence, some politico-military experts and even a part of American public opinion are tempted to withdraw their support for keeping an extended military contingent in Europe [1]. This attitude is caused by the dimension of E.U.'s GDP, which is greater than the US's and the E.U.'s defense expenditures which are less than America's with about 60% [1] and risk and threats against Europe which are considered less dangerous than the ones against US and less even than the ones during the Cold War.

According to NATO's basic documents, any member state has to be both a provider and benefactor of the Alliance defense capabilities. It means that all member nations have to build their own defense for ensuring their national sovereignty and territorial integrity as well as the Alliance's. It is important to mention that if any NATO member is attacked, then all the other allies will sustain it in a period of time that lasts from days to months, pending on the situation the Alliance is at that moment. In conclusion, in the uncovered period of time, the aggressed state has to have enough combat capabilities to defend its independence, sovereignty and territorial integrity.

All these elements that describe international security environment and its mechanisms to ensure security at NATO and E.U. level, should be enough both for public opinion and decision makers to start searching for solutions to avoid those decisions which must cause downsizing of country's defense capabilities and even its credibility among its allies and partners. In order to fulfill this objective it will be necessary that political decision-makers and the adult citizens also to acknowledge that a credible defense and security cannot be achieved with less than necessary budget.

Moreover, all the political decision-makers have to understand that there are certain limits under which the defense expenditure cannot fall unless they deliberately assume the negative effects which might become catastrophic in case of an armed aggression against our country.

2. A BRIEF ANALYSIS OF THE REGIONAL SECURITY

Although it is considered that „*territorial integrity of the most European states is not questionable and Europe defense is in Hindu Kush mountains, the security of most of the European states is yet threatened*" [2].

Having these considerations in mind and assessing the current effects of the existing world economic and financial crisis that affects bear on the entire fields of activities, we need to see that some of the risks and threats against word's security, such as terrorism, organized crime and tendency not to recognize the existing state's borders, have been amplified by crisis.

Normally, this prognosis has to lead to initiation of the appropriate measures in order to prevent risk to become threats and threats to

become conflicts because it is well known that preventing is more profitable than countering. Unfortunately, some of the measures, such as defense budget downsizing, cannot contribute to preventing risks and threats and, of course, cannot discourage any potential aggressor to make its plans come true.

According to one international security expert, the greater threat against European citizens is *"not terrorism, not organized crime, not drug trafficking, not even political blackmail, based on energy, utilized by Russia. The most important threat is the question: European Security Defense Initiative or NATO or a pro or anti-American Europe"* [3]. This way of thinking is close to the one belonging to lord Palmerton who stated that *"Great Britain never had permanent friends, but only permanent interests"* [4]. Also, there are some American experts who believe that *"the existence of a trans-Atlantic schism could be lethal to the Alliance in case of a conflict with WMD…*[but – a.n.] *the long term danger represented by the differences* [between USA and her allies considering WMD utilization during the war - a.n.] *have not to be underestimated"* [1].

It seems to me that as long as we are going far from the events on September, 11th 2001, the public opinion tends to forget all the dangers and threats to national and collective defense and security, until some other undesirable events happen, having similar effects or even worse ones. If such an event will happen, then all the assumed responsibilities and unaccomplished promises will become "hot potatoes" and we could assist to a new "witches hunting," in order to discover "the scape goats" and to diminish fury, disappointment, protests and dissatisfaction of the public opinion. The people have the right to ask but, at the same time has the obligation to understand that a country defense and security cannot be build only with good intentions and promises. Also, the people have to acknowledge that any country needs security in order to build a more developed and prosperous society and a better life for her citizens. The investments in security could be compared with the investment in a house. If we decide to build a

house then we may need to make some sacrifices until the house is completed. The house is the most important objective because it protects us both against Mother Nature's extreme events and against some bad people who desire to attempt to our goods or even to our life.

The similar way of thinking has to be applied to defense and security building because security has the role of protecting all of us against any risk and threat caused by the Nature or by some human beings, no matter who they are, and offers us the right shelter in case of a conflict. Like any house, security needs investments to keep it in very good conditions in order to accomplish its missions. If we do not invest in security, then it will be eroded and will not offer the shelter and support we need.

Most probably there are many citizens from all NATO and E.U. member states who must ask themselves: Who could dare to attack us, once we belong to the most powerful politico-military organization in the world? Why do we need to insist for developing defense and security capabilities because the Cold War has been finished? How could be sustained the requests for increasing the defense and security budget whilst long term prognosis estimates that the risk for a major armed conflict is reduced to a minimum?

The answers are easy to be given but for now, the most important is the way the public opinion think, and this is shaped by some patterns such as: *"The Evil (USSR) has been destroyed"; "There is no major threat against NATO and E.U. security"; "A major armed conflict is less likely for the next decades"* and so on. As a result of this way of thinking about security, majority of the people would like to live in normal conditions without risks, threats and conflicts and some events related to those threats and conflicts such as gunfire, bombs and car traps, and blows have to belong to a history that have not be resurrected. Unfortunately, desires cannot solve problems; they can only initiate the process of solutions identification.

So, in order to find a solution for a better and safer world it is necessary to better study the one we live.

After that we may understand its evolution mechanisms and the horizons it is heading to. As a result of the analysis we have to estimate our own capabilities to influence the security environment's evolution for accomplishing our objectives.

If our capabilities are insignificant or even null, then we need to adjust our nation and international organizations' evolution we belong to, to the international security environment trends, in order to avoid or to minimize the negative effects.

The world seems to be safer and the recent signed agreement between USA and Russia for reducing the nuclear weapons is a new hope. Unfortunately still there are some other matters of concern such as:
- many ongoing conflicts and also many dormant conflicts that could be easily reactivated;
- current economic and financial crisis did not amplify international cooperation in order to find available solutions for everybody;
- some country political leaders try to throw their own responsibility for inefficient governance on the others shoulders by blaming them for interfering into their internal affairs with bad intentions;
- the fight for power in some countries like Iraq, Afghanistan, Sudan, Sri Lanka look more like a civil war than a democratic fight.

Focusing our attention on security of the region Romania belongs to; there is a conclusion that needs to be drawn: here there exist some risks which need to be solved timely and in an appropriate manner; otherwise they might create conflicts and their consequences are hard to be estimated. Some of the most important risks are the following:
- unjustified rising tensions between Ukraine and Romania after The International Court of Justice decision to approve Romania's request to consider Serpent Island a rock and to share accordingly the Black Sea continental plateau between the two countries;
- political instability and social riots from Ukraine, caused by political fight for power between pro-NATO and pro-Russia parts, on the economic, financial and energy crisis amplified by the disappointment of not having received the NATO's MAP (Membership Action Plan) for its accession on the occasion of 2008 Bucharest Summit;
- the existence of tensions between Ukraine and Romania, on the one side, and Moldova and Romania, on the other side, generated by *"ethnic Moldavian...multiple citizenship... illegal immigration, and allegation of political discrimination...frustrations in borders regime because of the visas required for Ukrainian citizens"* [5];
- after spring elections in Moldova, and massive street protests violently reprimanded by the communist regime, and tensions raised unjustified between Moldova and Romania as a result of allegations formulated by President Voronin who blamed Romania for interfering in his country internal affairs, and followed by expelling of Romanian ambassador and her military attaché;
- allegations against Romania made by some Russian politico-military analysts for so-called interferences in Moldova's internal affairs, with the most probable objective to blame NATO and E.U. using one of their member because of their support for Georgia during Russian-Georgian conflict in August 2008;
- Kosovo self-proclaimed independence from Serbia is not satisfactorily solved since Romania did not recognize her as an independent country;
- the existing freezing conflicts from Transnestria, Caucasus, Balkans and Middle East could be activated and extended at any time to include Romania;
- cross-border organized crime has intensified its activity in Romania [6] and some of her neighboring countries;
- the existing ethnic-religious tensions from some of Romania's neighbor countries have been amplified.

The existence of the risks and threats already presented here and of others, too - less dangerous for the national defense and security - should not be interpreted as a sign of a coming war, although history says that major crisis were followed by major conflicts (The World War II is one the most obvious examples to confirm this assertion). Our intention with this risk analysis to our national defense and security is to make every citizen aware of the security situation and to motivate

political decision-makers to take prudent but firm and discouraging measures to prevent any aggression against our country, even if it is not so likely.

2. THE EFFECTS OF A LESS THAN REQUIRED BUDGET ON THE COUNTRY'S DEFENSE CAPABILITIES

The most significant consequences of a less than required budget are the following:

a) In human resource domain:
- intensification of potential exodus from Armed Forces – especially the high qualified ones – towards other Governmental structures and private sector that offer better salaries and benefits than Department of Defense (DoD), whilst the DoD keeps the same restrictions for its employees and risks that they have to face remain higher than the ones from private sector and other government's entities;
- possible reduction in number and quality – from education level and personal competence point of view – of the candidates for military education institutions, and even of the volunteer because of uncertain carrier perspectives such as: job stability and market existing jobs; professional development; less attractive salary than in another organizations; high risks of the jobs etc.;
- partial reduction of the professional competence, both at individual as well as at the organization level, as a result of the high qualified people's exodus and because of scarce resources for performing training exercises in an appropriate number and complexity;
- unsafe level of security as well as incidents and accident likelihood rising during live exercises and activities with high pace, risk and complexity because of reducing in number and complexity of the training activities which, at their turn, generate partial reduction of the personnel's skills, especially the leading and combatant one;
- potential rising risk for not accomplishing live missions and the ones assumed within NATO - such as Air Policy, which is a part of NATINAD; Operation Active Endeavor; Operation Enduring Freedom etc.- as a result of diminished skills of military personnel;

- increasing risk for diminishing the Armed Forces credibility as a whole, because of: the high likelihood not to accomplish NATO and E.U. standards and even minimum military requirements for personnel, equipment and infrastructure; reduced level of readiness for many military units; possible failure to affirm military units committed to NATO and E.U. missions; possible failing for not being able to fulfill obligations assumed to NATO and E.U.;
- possible reduction in winning chance during live and simulated fights and firings because of partial reduction of the personnel's skills and because of physical and moral degradation of the most equipment which may not function at desired performances or may not function at all;
- potential rising risk for failing to participate in Alliance's live exercises as a result of personnel's training level and skills which might be under the safety standards required by the organizers.

b) In the field of material resource:
- rapid physical and moral degradation of the weapon systems, fighting and logistics equipment because of the postponed or downsizing of the acquisition and modernization programs, situation that could lead to a more intense utilization of operational equipment, in order to fulfill training standards and missions requirements;
- more advanced moral degradation of the major equipment belonging to all the Services, as a result of the postponement or even cancellation of the acquisition, modernization and repairing programs, and from bad to worse, because there are not enough possibilities to replace the old and obsolete equipment;
- continuous increasing expenses for maintaining and keeping operational all the equipment because of their physical degradation and intense utilization that cause an increased likelihood for incidents, accidents and any kind of troubles;
- continuous reduction of fighting and other types of performances of all types of equipment as a result of their physical degradation;
- continuous reduction of equipment' effectiveness and precision because of their

weariness.

c) In the field of financial resources:

- a potential increased risk for getting into impossibility to pay all the debts to the Services and products providers, situation that may cause extra payments as penalties and even potential reducing of the DoD's credibility as a trade partner;

- continuous infrastructure's degradation because of the postponement, downsizing or even cancellation of the investment, modernization and repairing programs with direct consequences consisting of reduced or even null possibilities to use it during training process and in live operations;

- possible reduction of the interoperability level with the allies and partners which may cause an amplified risk for failing to achieve the assumed commitments against UN, NATO, E.U., OSCE and other international organizations because of less than necessary funds for taxes, annual contribution, training, acquisitions, modernizations and investments;

- possible reduction of living and working standards for the personnel.

3. POSSIBLE SOLUTIONS FOR MINIMIZING NEGATIVE EFFECTS

Any reduction of the defense resources' quality and quantity requires reviewing the entire defense resources management process from the risk and threat evaluation against nation's defense and security till the defense planning and programs implementation. That is to say the experts and decision makers have to consider conclusions related to risks and threats - types, domains of activity, level of the danger, magnitude, prognosis for evolution etc. - and then to create scenarios and to play them in order to identify the best courses of action for making decisions which have to:

- keep the objectives of the defense and security and level of ambition at the initial level, or to adjust (formulate other ones) them in accordance with the resources allotted;

- keep the availability of the strategies, concepts, plans and programs for acquisition, modernization, investment, training trough transforming nation's entities responsible for her defense and security or to recommend other defense planning documents to address the challenges and to efficiently manage the security situation;

- establish new guidelines for maintaining nation's defense and security capabilities as high as possible;

- reassess and reschedule deadlines for plans and programs in such a manner that can allow nation to get an acceptable level of risk for her defense and security in case of a conflict or even in an aggression;

- identify new priorities for nation's defense and security;

- fructify the existent experience and lessons learned with greater efficiency and to create the appropriate conditions for involving all the political and military leaders who lead governmental entities with responsibilities for nation's defense and security, into the process of defense resources management;

- identify new and more efficient ways to perform daily and long term activities, considering: resources consumption; quality of the products – material and intellectual ones; reassessment of the proportion between live and simulated activities; reviewing the methods, standards, tactics, techniques and procedures in order to optimize them to be more cost-effective; scientific research intensification in order to fructify nation's creative potential etc.

4. CONCLUSIONS

Defense budget reduction has important negative effects that will be more intense in the future.

During any crisis, the best solution to overcome is to concentrate all the nation's efforts for identifying new ways to transform the society as a whole because the solutions we have followed led us to the economic and financial crisis. On the other side, any crisis encompasses the nucleus of opportunity and chance to:

- search and find out new and more efficient solutions to the problems we face;

- rethink the existing objectives, plans and programs in order to optimize them;

- push the known limits of human beings creativity toward new horizons;

- promote people who prove competence, professional skills and performance;
- discourage promotion of the people who display bad behaviors;
- increase speed of adapting people's mentality to the new reality, which is characterized by often and sometimes sudden modifications of the situation; risks and threats amplification both at individual as well as at nation and euro-Atlantic organizations level etc.

Our ancestors' heritage consists of many wise proverbs such as "*after bad weather will come the nice one*." This proverb has to be connected to another one "*the need teaches us.*" Both proverbs have to make up our mind to find out solutions for helping ourselves because the divine help exist but we need to be involved not only physically but also mentally and emotionally otherwise the result may not be as we planned to be.

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INTEGRATED APPROACH TO SECURITY SECTOR REFORM

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Abstract: It could be argued that Security Sector Reform has been implemented for several years but the terminology "Security Sector Reform" has emerged from the post-Cold War security debate. The collapse of the Soviet Union considerably changed security needs of states and ushered the democratization of post-soviet security apparatuses. Moreover, the expansion of EU and NATO, the adoption of code of conduct for the democratic control of armed forces by the OECD, and the joint work of security and development agencies in some African and European states created a basis for the development of SSR. In the same way, developed countries and stable democracies are facing new security challenges. The emergence of terrorism, the resurgence of human trafficking and organised crime as well as illegal immigration made it necessary to change their security sector structures. Finally, it is both a donor-driven policy and a request from receiving countries engaged in general democratization reforms and/or facing new security threats. Securitising development, developing the governance of the security sector, and preventing conflict seem to be the matrix towards which the security debate is shifting.

Keywords: Democratic Oversight and Accountability, Comprehensive Approach, Civilian Control, Democratic Principles, Human Rights, Defence Institutions Building.

1. INTRODUCTION

Security Sector Reform (SSR) is a highly sensitive and politically-driven topic. Therefore, securing the acceptance and building a favourable political environment to run an SSR programme is one of the most difficult challenges to overcome. Building grounds for an SSR strategy in a country should take into account the sensibilities of the members of the society, engaging them into consultation in order to build confidence, secure their will and mitigate spoilers' actions. Second, there is a constant challenge to avoid counterproductive results. Stakeholders' needs should be addressed in a way that does not fuel conflict and hurt the environment. Third, the variety of actors with different political agendas and mandates calls for coordination of activities to avoid overlapping programmes and competition. There should be a continuous confidence building, common understanding, and division of labour in order to capitalise on strengths and complement weaknesses. The fourth challenge to overcome is the stigma around SSR. In many African countries, SSR is associated to defence downsizing and is felt as imposed by the West. Thus, international partners should support, not direct the process by providing financial and technical assistance to states. Local ownership goes hand in hand with the sustainability and management of the process. Finally, donors and internal actors should understand that SSR is a long term process. Resource management and mobilisation, public and stakeholders' expectations should be handled accordingly.

2. CONTROL AND ACCOUNTABILITY

There are different kinds of oversight mechanisms that depend on the authority of the oversight organisation and the one which is overseen. They include:

- Civilian and democratic: One of the most important features of SSR governance is the control and oversight of security institutions by democratically elected authorities.
- Executive, legislative and judicial: The

executive is both oversight and overseen body as authorities from the government can exert their control on security institutions and be accountable to the parliament. The judiciary is vested with the powers of conflict resolution, human rights protection and investigation on potential offenses committed by security sector personnel.

- Independent and public: Regular citizens have the right to be informed on the security and defence strategies, and to seek remedies in case of any abuse from security sector institutions. The media and other civil society organisations exert the control independently. Independent bodies such as Ombudsmen, Police Commissioners and Human Rights Commissions are playing a key role in the process.
- Internal and external: Internal oversight is ensured by the hierarchy and chain of command whereas external oversight is carried out either transversally by oversight bodies with the same level of authority or vertically by superior civilian institutions (e.g. the President/Prime Minister over the Armed Forces).
- Vertical and horizontal self control: Organisations operate control and oversight from within. It can be peer horizontal control as officers or organisations watching over each other's shoulder or vertical oversight exerted by the hierarchy.
- Proactive and reactive operational control: At the operational level, horizontal or vertical controls can be made either proactively, beforehand in order to prevent any abuse, or reactively to correct, reward or punish any action according to the law.
- National and foreign: All the oversight mechanisms presented above are exerted by organisations within the jurisdiction of the country. Oversight can also be made by external actors such as donor organisations, international judicial bodies, international financial institutions, etc. Foreign oversight bodies follow a strict legal framework agreed upon with the

receiving state, or a resolution of the Security Council or any other regional organisation.

3. DEMOCRATIC CONTROL OF ARMED FORCES (DCAF)

Democratic control of armed, forces constitutes norms and standards governing the relationship between the armed forces and society, whereby the armed forces are subordinated to democratically-elected authorities and subject to independent oversight. It started with the military to expand to other security forces. It is based on the principle that the military should serve the society and not the regime. At the end of the cold war the concept of democratic control emerged mainly in former soviet states and encompasses now the governance of the entire security sector.

3.1. KEY FEATURES

They include civilian control (control of the Armed Forces by elected civilian regime), democratic governance (oversight by the judiciary and parliament in accordance with the constitution and/or relevant laws), civilian expertise (civilian personnel attached to the administration of security sector agencies), non politicisation (non-interference of the armed forces in domestic politics. They should be neutral and independent both ideologically and politically from political parties), minimum role in national economy, effective chain of command and the respect for human rights of Armed Forces personnel.

In democratic societies, the sole legitimacy lies in the people's will. Therefore, democratically elected officials should have supremacy in the political life. The Armed Forces should serve the Nation and be subjected to the due authority of its representatives. DCAF's principal goal is to build favourable political grounds for the respect of this fundamental democratic principle. Also, the respect of the rule of law and good governance of the security sector subjects its institutions to the laws and oversight of civilians, important conditions for

the respect of human tights. Finally, the non-involvement of armed forces in the political life protects them from being abused and driven into the use of violence for political purposes.

DCAF is implemented through different processes including reforms aimed at changing institutional mechanisms and procedures, creating a legal framework, building capacity of staff and creating new institutions (ombudsperson, commissions, etc). These processes go hand in hand and should take into account the long term aspect of SSR and the difficulty to build consensus around it. For instance, it is not enough to adopt new legislation to ensure full control of armed forces. Capacity of civilian personnel should be built to bear their new responsibilities as budgeting mechanisms, inquiries, understanding international standards, handling complains, etc. and a culture of human rights is build upon long term programmes within SSR core institution themselves.

3.2. NORMS AND STANDARDS

- NATO: Carnovalo-Simon test (entrance requirement) 2001: According to this series of documents, there should be on the institutional point of view clear division of authority between executive members in charge of security forces, supervision of the executive branch over general staff and commanding cadre through the defence ministry, which is competent to take decisions on the size, form, equipment and engagement of armed forces and efficient parliamentary oversight. These reforms should be strengthened by the overall acceptance of the notion of democratic civil control.
- EU: Copenhagen criteria for Accession (1993) and the Treaty of the EU (2002): The Copenhagen Criteria or Accession requires at the institutional level that a candidate to EU membership should be able to assume responsibilities of states according to the EU Treaty (to have stable institutions able to guaranty democracy, human rights, and the respect of minorities, etc).

- OSCE Code of Conduct of Politico-Military Aspects of Security (1994): The OSCE requires democratic control and effective guidance of military, paramilitary, internal security forces, intelligence and police by constitutionally established authorities vested with democratic legitimacy. In this regards, civilian authorities should be able to restrain in military expenditures, ensure political neutrality of armed forces, to protect the rights of personnel serving in the armed forces and the integration of armed forces with civil society.

4. SSR AND GENDER INTEGRATION

Gender refers to socio-culturally constructed roles and relationships, or popularly attributed characteristics of men and women in the society. Gender is different from sex as it is not based on biology, but on cultural settings and is bound to change with time and space. It is a common view that adopting a gender-sensitive programme consists solely of empowering women in the society. Gender goes far beyond women to encompass the needs, experiences and priorities of all members of the society-women, men, girls, boys, and HBTs (homosexuals, bisexuals, and transsexuals) - and to give them equal opportunities.

Gender issues erupted in the international debate in the 1970s at the UN level and lead to the adoption of the "Convention on the Elimination of All Forms of Discrimination Against Women" (1979) completed by the "Beijing Declaration and Platform of Action" (1995).

Despite the usefulness of this legal framework in the participation of women in public life, it was not until 2000 that the UN Security Council adopted a resolution to involve women in conflict resolution, peace-building and reconstruction. UN SCR 1325 on "Women, Peace and Security" is a result of a combination of many factors, including increased reporting of and intolerance towards gender-based violence (GBV) in conflict and non conflict settings, advocacy for increasing presence of women in peace negotiations and

conflict resolution, increasing analysis of the different impact of conflicts on men, women, girls and boys as well as a shift from the standard perception of women as victims in conflict to considering them as agents of change.

Running gender-sensitive SSR is a requirement of many national, regional and international instruments and laws. Handbooks, codes of conduct, and other SSR manuals are increasingly building gender strategies to ensure the comprehensiveness and level of representation of programmes. As SSR programmes should be locally owned and participatory, involving organisations relevant to women in consultations and implementation of programmes is a useful tool to that end. The example of the South African defence review process highlights the importance of engaging discussions with women organisations. Also, gender sensitive programmes increase effectiveness of security and justice delivery through representation. It helps for instance to increase the overall security of the population (e.g. in Afghanistan mix patrols will allow searches on women and prevent attacks from men disguised as women) and effectively preventing and responding to GBV. Finally, gender mainstreaming and equal participation enhance oversight and accountability of security institutions.

Two complementary strategies can be used to incorporate gender in the SSR programme cycle: gender mainstreaming and the equal participation of men and women. Gender mainstreaming in SSR starts from the programming phase and goes through the implementation phase to the monitoring and evaluation phases of the programme. It can consist of assessing gender needs and taking into account cultural considerations, designing in gender-sensitive ways, and developing sound indicators for monitoring and evaluation.

As for equal participation for men and women, it is a useful tool to ensure gender sensitivity of programmes. It could be achieved through staffing and wide consultation of women organisations in the assessment phase and cooperating with them in the implementation phase.

98

5. POLITICAL ENVIRONMENT IMPACT

Providing security to citizens and protecting their needs and interests are fundamental responsibilities of states and is attached to their sovereignty. The defence force is thought of as a shield that protects a nation from external threats. The police and other security agencies protecting citizens and protecting law and order whereas justice institutions are in charge of legal disputes. The central role played by these institutions (Armed Forces, Police and justice) makes any reform of the sector impossible if imposed from abroad. Due to its sensitivity, SSR should be locally owned and be a driver for change towards democratisation, respect of human rights, peace and stability instead of being sources of controversy and conflict. Actors involved in the designing and implementation of SSR programmes should bear this reality in mind and act towards creating a favourable political environment for programmes.

5.1. CASE STUDY: SRI LANKA

In order to understand how difficult it is to foster a favourable political environment for SSR and identify entry points and tips to encourage confidence building and secure political will, the Sri Lanka case study is of great relevance. An analysis of the context will lead us to drawing hypothesis for possible entry points for SSR.

Strengths: Sri Lanka is a strong state with flexible structures and robust legislation. It can adapt easily to any reform aimed at enhancing governance of security institutions, and be supported by resilient security and judicial structures. The end of difficult collaboration between two parties at the head of government will prevent unnecessary debate and facilitate agreement upon a policy. This political momentum is further enhanced by the joining of the political process by several radical groups that joined forces to work together during the 2004 Tsunami. Last but not least, Sri Lanka has one of the most vibrant Diasporas and enjoys scrutiny of media and hard work of engaged and active civil societies

at home. This is more likely to engage constructive political debate around SSR issues.

Weaknesses: Probably due to the protracted conflict, the executive has far-reaching powers over other branches of government, with high politicisation of the army. The political situation is also weakened by populist discourses of the president who refuses to acknowledge the LTTE (armed group known as the Tamil Tigers) as a key SSR actor.

The legislature is ineffective with weak oversight mechanisms of the SSR programme which is incoherent and carried out according to political and military compulsions of the government. SSR issues are not widely known throughout the country and the increasing cost of living and high inflation rates might divert attention from SSR which is not likely to be priority because of the intensification of the conflict.

Opportunities: The recent military victory of the National Army over the LTTE established the government's authority over the whole territory and is likely to engage measures to manage "liberated" areas, including civil administration, security and justice. There will be increasing scrutiny of the government and this opportunity constitutes a viable entry point for SSR. The current transition will provide opportunity to: increase public confidence in local institutions, especially in liberated areas; increase effectiveness of the functioning of the security sector; increase transparency of oversight mechanisms; demilitarize the society, and move towards a peaceful solution and long-term economic development.

Threats: The government military victory over opposition and its insistence on military means of resolving the conflict is an illustration of the difficulty of reaching consensus. It is not likely to have a viable alternative in the near future nor in the local civil society, nor in the political sphere. The presence of paramilitary groups in the country as well as a high number of deserters in the army aggravates the caseload of SSR and makes stability even more fragile. The public confidence in security institutions is very low,

corruption and involvement in business rampant, oversight by the judiciary impossible due to politicisation, presence of Tamils in armed forces limited, language barrier between the North and the South, lack of financial and financial resources and no concrete involvement of the international community are some of the most important threats faced by the country.

6. COMPLEX MILIEU OF SSR

As a politically driven topic, locally owned and people centred process, SSR's success lies on a thorough understanding of the socio-political context in which it is implemented. It is important for SSR planners to be acquainted with cultural considerations of the role of security institution in some countries, and decide on teams, programmes and strategies based on the domestic legal framework, the country's history and political environment. Having a context-specific approach helps mitigate risks and identify priorities and opportunities by adapting the programmes to the size, state of infrastructure, availability of human resources, and equipment of the country.

Last but not least, understanding the contextual dynamics enhances the peace-building capacity of SSR programmes in post-conflict settings and facilitates the correlation between security and development that SSR tends to build.

SSR is designed and implemented for and in countries with different political situations and conflict levels. Contexts differ according to the level of economic development, the nature of political system, the specific security situation of the country, and the political will of actors.

Security sector pathologies are different in countries with different level of development. In poor or developing contexts, SSR may have to redress issues such as corruption, lack of transparency and management of security institution, inadequacy and unavailability of funding, whereas developed countries may require some changes in the security environment to adapt security agencies to new threats. Additionally, developing countries

often face internal security threats such as social unrest and conflict while developed countries may face external threats such as terrorism (in cases where terrorists are operating from abroad). Last but not least, planning SSR in developing and developed countries will have to take into account the availability of resources dedicated to them. In developed countries, SSR would focus on adequacy of funding whereas developing countries might be seeking financial assistance from donors and external partners.

Differences of political contexts define the security situation and architecture of the security sector in countries. Political situations could be classified as follows: post-conflict countries, transitional countries, conflict countries, stable democracies, authoritarian regimes, and failing, fragile or failed states. Issues related to this classification are: democratic deficit, good governance, instability, oversight, security levels, political will, etc.

SSR is not designed only for democratically challenged countries. In stable democratic and developed countries, needs for establishing mechanisms to enhance the operational efficiency and governance of the security sector are present.

For instance, Canada had to readapt its security sector after 9/11 and its involvement in Afghanistan. Governance, efficiency and coordination of actors in the field and at headquarters' levels had been the key features of post 9/11 reforms. Additionally, the absence of internal security threats allows time for developed countries to address some internal issues such as addressing effectively gender-based violence or defending and promoting human rights of security sector professionals.

7. REFORM OPTIONS

There is a structure upon which SSR could be built. There is no need to build state's institutions from the outset but to undertake necessary reforms to enforce democratic oversight and enhance service delivery of security sector institutions. However, uncertainty could undermine efforts politically

and the security situation is fragile. This obstacle can be faced by engaging in discussions with relevant actors on the necessity for change and providing extra funding for SSR by using discussions on poverty reduction strategy papers as an entry point.

There are many opportunities to introduce SSR in conflict societies, including during cease fire and peace agreement negotiations and Disarmament, Demobilization and Reintegration (DDR) planning. It is also the opportunity to identify drivers of change and potential spoilers, and envisage measures to buy them in. SSR might not be a priority in such situation where parties still lack confidence in each other and militarization is a means to protect themselves from each other and organised crime. Engaging dialogue with stakeholders, mobilizing civil society organisation, and advocating for transitional justice mechanisms could be ways of mitigating the risks. Ceasefire monitoring, training on international humanitarian law, humanitarian assistance could be used as entry points.

Compared to conflict situations, post-conflict settings experience rebuilt confidence among actors, minimum security conditions, presence of peacekeeping missions and international NGOs. The country is also under international media scrutiny that could be used for SSR publicity and mobilisation around reconstruction. The main obstacles of this kind of contexts are the scarcity of resources allocated to SSR which is not much of a priority, the existence of spoilers who might see in SSR a way of losing their power and disrupting their traffics. However, through confidence building, negotiation and involvement of peacekeepers and SSR champions, favourable grounds could be built for SSR development. SSR potential is high during transition periods. Transitional governments are sworn in and enjoy public support as they are often the result of wide consensus.

The political agenda revolves around DDR, transitional justice, reforms of the civil administration and reconstruction, and potential entry points for SSR.

8. LEGAL JUSTICE OF SSR

Transitional Justice (TJ) refers to mechanisms used in post-conflict or post authoritarian regimes to face a past characterised by gross violations of human rights. The principal aim of TJ is to seek recognition for victims by rehabilitating them and providing them with material and symbolic remedies. TJ also aims at rebuilding the social fabric of communities by establishing responsibilities and rebuilding relationships between victims and those who have been responsible for their harms. It is also looks at the future as a principal objective is to prevent the recurrence of abuses in the future. To this end, it establishes, among others, records (for instance through truth seeking mechanisms hearings and reports and criminal justice trials) and visible symbols (monuments and memorials) for collective memory.

Moreover, TJ provides states with favourable grounds for reform towards democracy and respect of human rights. Legally, states have an international legal obligation to stop, investigate and prosecute violations of human rights and humanitarian law, and TJ help states to achieve that.

There are specific transitional Justice Mechanisms as:
- Criminal prosecutions: prosecute those who bear the greatest responsibility for human rights and humanitarian law violations;
- Truth commissions: reveal and acknowledge the truth, and provide recommendations for reconciliation and stability;
- Reparation programmes: material (restitution, compensation) and symbolic (official apologies) benefits;
- Efforts to prevent recurrence: educational and institutional reforms;
- Memorialisation efforts: all kinds of efforts to memorialize and acknowledge in a physical form. Raising the moral consciousness on past abuses and education. Use museums, memorials and other symbolic efforts.

By addressing violence and human rights abuses from the past, justice mechanisms are not just backward looking. Prevention is a key element in a comprehensive conception of justice. Many truth seeking institutions provide recommendations for reforms to prevent resurgence of violence. As far as most serious abuses are committed by security sector professionals, as states failed to fulfil their responsibilities to protect its citizens from human rights abuses, TJ without SSR is incomplete.

It has already been stated that SSR is not only dedicated to post-conflict societies but is also relevant to more stable and developed contexts. However, in transitional settings, SSR and TJ have overlapping mandates, actors and institutions. They take place alongside each other and TJ has the potential to prepare favourable ground for SSR.

9. CONCLUSIONS

The security sector can be divided in many subsectors: the defence sub-sector (which includes the military and other armed groups), the law enforcement sub-sector (including police, intelligence, border management, narcotics and anti-trafficking agencies, financial brigades, etc), and the justice sub-sector (courts, mediation bodies, and conflict resolution institutions), and the oversight bodies.

There are also cross-cutting issues that should be taken into account from the assessment to the monitoring and evaluation of the implementation of the programme. They include gender mainstreaming, DDR, mine actions, small arms and light weapon control, the rule of law, good governance, human rights, fight against corruption, transitional justice, media and communication strategy (balanced, critical, and independent), missing persons, mass graves, forensics, refugees, health and food security, education, public administration (bureaucracy), nation building, public safety/disaster preparedness, etc.

Safeguarding the security of the state and securing the livelihood of people are the main function of law enforcement agencies and justice institutions. In order to enhance the effectiveness and governance of these

institutions, there is a need to engage reforms both internally and externally to them. SSR therefore helps to achieve the following: ensuring internal and external security; enhancing human security by promoting and respecting non-discrimination measures and human rights protection; securing ownership by creating conditions for confidence building; creating good conditions for economic activities and business opportunities; treating security sector as public service; providing stability, preventing the return of conflict and promoting regional stability; ensuring that efficiency and good governance go together; and making sure that threats public resources are used efficiently.

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WHAT DO THE STUDENTS THINK ABOUT VOLUNTEERS AND VOLUNTEERING?

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Abstract: *The reminiscences of the communist period make their presence being felt even 20 years later after the revolution, in many areas of the social, economic and political life in Romania as in the volunteering context. The field researches certify the fact that in the communist countries, the number of volunteers is much lower than in countries with a long history of capitalism, for which the non-governmental organizations, particularly, seek to promote volunteerism, especially, among youngsters, because they are considered the most willing to offer others of their time and experience. Starting from this last idea I made an exploratory study among students from Social Work specialization, students that represent the subjects of the present article. What means the volunteering for students? What is the volunteering profile in their vision? Are there any costs and/or benefits of this type of activity and if so which ones? These are the key questions that will find their answers in the content of the article.*

Keywords: *volunteering, volunteer's profile, costs-benefits.*

1. CONCEPTUAL DELIMITATION

According to the French-Romanian Dictionary (1967 p. 339) the word „volunteer" has its origins in the French adjective „volontaire" which means voluntary, willful and by extension of meaning it becomes the noun, masculine „voluntarily" (in army) [1]. In the „Explanatory Dictionary of Romanian Language" (1998) we find two definitions of the noun „volunteer". In the first of these, the word retains the meaning in French, noted above, while the second definition is less specific regarding the domain or the type of action, referring to a „person who makes a service willingly and selflessly" [2]. Once with the macro-social awareness of certain issues of public interest, which directly or indirectly affects the living conditions, the level of civilization, it has imposed the concept of *volunteering* that means any type of involvement in a matter of public interest, without requiring a fee.

To become operational the term „volunteering" represents the subject of law no. 339/2006, amending and supplementing

the volunteering Law No. 195/2001. According to this, the volunteering is „the public work carried out on its own initiative by any person in the benefit of others, without receiving a material consideration". In the art. 2, b) the law specifies the areas where activities can take place in the public interest. These are: „the assistance and the social services, the protection of human rights, healthcare, cultural, artistic, religious, educational, scientific, humanitarian, philanthropic, sporting, environmental, social and community, and many others similar" [3].

2. ASPECTS REGARDING THE IMPORTANCE OF VOLUNTEERING

In any modern society have the social policies have as an ending the social welfare redistribution. Along with the social policies, the voluntary exercised in non-governmental organizations, which belongs to the civil society represents a complementary means of redistributing the welfare. It should be noted that between the two types of activities (voluntary and circumscribed social policies)

are interrelated despite the fact that they are distinct in structure and mode of settlement.

Thus, NGOs can take in consideration the achieving of the set targets for the social policies or they can work together in achieving the same goals. In this way, it is achieved a mix state / civil society which increases the effectiveness of activities in social services [4]. In the next lines I will examine the role of volunteering focusing on social and economic benefits of this type of activity.

By participating in activities and programs, in the social field, volunteers have the possibility to learn the problems with whom people are facing with in their community, they have the opportunity to contribute directly to resolve or improve these problems. Volunteering promotes social cohesion and solidarity. Those who carry on volunteer activities have the opportunity to develop new relationships between people, to meet people who claim the same interests and, why not, they have the opportunity to know themselves better. But this type of activities does not bring only benefits for the volunteer but also for the beneficiaries and the organizations who provide social services. And I will explain immediately why. The number of staff of NGOs increases not only quantitatively with the involvement of volunteers but also qualitatively, there are big chances that the tasks that have to be completed by an employee or by a volunteer to be fewer and more specific. Beneficiaries may be given in this way, more time and attention.

According to certain studies conducted abroad (project Jonhns Hopkins Center for the comparative study of the nonprofit sector, 1999 and „The Canadian Nonprofit and Voluntary Sector in Comparative Perspectives", 2005), the volunteering is a „significant economic force" [5]. In Canada, for example, voluntary work in 2005 brought, according to the estimations, a contribution of nearly $ 14 billion, representing 1.4% of GDP. Romania data, unfortunately, are not as current or as encouraging. So, from the estimated 5.6 million volunteers for 1996, it was 2.7 a year later. The hours of work supporting various causes have dropped from over 1 billion to about 255 million. Accordingly, the financial

104

value of this work came in 1997 to 0.35% of GDP from 1.7 as was the previous year [6].

3. THE EXPLORATORY STUDY

This article is the output of a research made by me two years ago among students from Social Work specialization within the University of "Transilvania" Brasov. The subject of volunteering was and it still is a peculiar professional interest because social work is a vocational occupation, defined by the social and individual sense of responsibility, by the empathic capacity and helping sense and I personally consider that one of the university specialist' s role from this specialization is to stimulate students to involve themselves in volunteering activities; within the framework of these activities students may enhance the value of their intellectual, aesthetical and spiritual potential and in the same time they may complete their practical experience obtained within the practice period (which I, personally, consider to be insufficient).

Moreover, a future social worker should experience before employment, the work with different categories of users in order to discover not only the specific problems with whom each group is facing but also the place where he finds himself well, philosophically speaking. In addition, the personal professional experience, showed me that those students who were involved in volunteering were more likely to be employed after graduating the studies.

These latter considerations formed the basis for the study undertaken by me, which I wanted to know what students from social work specialization think about volunteering.

The exploratory study targeted especially the students (mostly female) which I coordinated during their professional practice, 54 of them, from the years II, III and IV of the study. The data collecting method consisted in a semi-structured interview and regarded the following themes: the definition of "volunteering", portraying the profile of the social volunteer, the identification of the advantages and disadvantages, in terms of costs and benefits, that volunteering can have.

In the following lines I will summarize the answers offered by students on each issue separately.

3.1. Defining the volunteering activity. The definitions given by the interviewed students are part of a diverse range of both quantitatively and qualitatively. Thus we have persons who consider that volunteering can be summarized to something made "willingly and not forced by anyone" or "unconditional support". Moreover, all the interviewed students considered that volunteering is a "gratuitous" activity, "an act of charity", for which you don't expect a reward, a material or financial payment. Although none of these are wrong, volunteering can be summarized only through these characteristics because it could be confused with mercy (giving a loaf of bread to a bagger) or with altruism (helping an elderly person to cross the street or carrying the shopping bags). According to the law no.195/2001 volunteering is "the activity of public interest developed unurged by any natural person, for the benefit of others, without receiving a material consideration" [3].

Much more complete definitions were given by students who were volunteers in at least one public or private organization, who succeeded to capture the fact that volunteering is an activity organized and developed in an institution: *"Volunteering is an activity run by a person in an organization, without receiving financial or material rewards; an activity developed in order to support or to help a person or a vulnerable group"*.

Regarding the goal of volunteering activities, this doesn't appear explicitly in all definitions, but where it was mentioned, the answers can be divided in two categories:
1. those which regard the beneficiaries: *"helping the under-privileged persons", "activity run for the sake of the community", "to help those who need it"*
2. those which regard the volunteer: *"aiming to gain new knowledge, developing abilities already gained or build up through experience", "aiming to offer personal satisfaction"*. When the volunteer is self centered and not centered on the other, the person who needs help, the following question

arises: can we still talk about selfless and voluntary involvement? It seams that as long as the personal interest is followed (no matter its nature) and not the one of those we help.

3.2. The volunteer profile in the social field. If I compiled all the volunteer attributes I would say that this is "the Good Samaritan" never interested in itself, just interested in the good of others, difficult a person which is difficult to be identified in our social reality. But if we analyze each feature of the volunteer in the social field, as it is perceived by students from social work, we find out that the volunteer has no supernatural qualities at all. What distinguishes them from other volunteers is the fact that the first of them can simultaneously hold a series of social and moral characteristics.

Without claiming to establish the exact percentage of these traits in the whole „portrait" of the volunteer, I will try to emphasize the most common answers given by my respondents, the students. In their opinion, people empathy and willingness to help others are the most important elements that characterize the volunteer from social field. Also, the answers show that a volunteer should have certain psychological traits such as patience, willingness to learn, motivation (and here, students have referred to intrinsic motivation) and the will. In this regard, studies in the psycho-sociology field attest the existence of the altruistic personality, which explains why some people are more often involved in offering help to others [7].

Although, there are found in a smaller proportion, certain items that are related to the value field are not missing from the volunteer portrait. So, the volunteer in the social field „must" be a person with a sense of responsibility, selfless, honest and capable of sacrifice for others.

Interesting to note is that some respondents, probably led by the phrase „time is money", consider that leisure time is an important resource that should be possessed by the volunteer. However, for other students, team spirit, objectivity, self-knowledge and creativity are the characteristics which a volunteer should have or which we can find in a person who is engaged in the social field.

105

3.3. Advantages / disadvantages of volunteering. Students' responses focused on two aspects: one of them was regarding the advantages / disadvantages of volunteering for the person performing such work and the other one was regarding advantages / disadvantages of volunteering for public or private institution in which the volunteer operates. In an overall analysis of the responses, I noticed that, at least in quantitative terms, the list of benefits identified by students is more „generous" than the disadvantages, fact which proves, to some extent, that students have a „positive" image on volunteering, although they are or they are not currently involved in such activity.

Students consider that a volunteer may have many benefits but the first three (in frequency) are: experience, new contacts and the joy of helping others. Also it must not be neglected the personal development, communication relationships, self esteem, job employment opportunity, information regarding the problems of others and personal responsibility.

If the answers regarding the benefits, which a volunteer may have, were extremely varied, the things simplify when we talk about the benefits that volunteering can bring to public and private institutions. In this case, the volunteer may be a human resource for the certain institution, which gives help to beneficiaries without remuneration and ultimately he may contribute to more efficiency in providing the services.

Regarding the disadvantages, volunteers may face one or more of the following situations: for the smooth operation of the activity they need to use personal financial resources (eg. transport), they must give up to some of their spare time and finally they can be ignored or insufficiently appreciated by the institution staff, situation that can be felt by the volunteer as a failure or as a disappointment. Also, at institutional level, disadvantages are present. So, working with volunteers organizations assume the risk of an unsafe collaboration over time (you do not know if the volunteer will come next week too) and a fluctuation among the latest (a group of volunteers spent 2-3 months, and another one is to come) fact which involves

new costs for the organization. Also, students consider that a disadvantage of the volunteering which is experienced by the institutions is the lack of experience in the field where the volunteer operates.

4. CONCLUSIONS

The data of this study could come, primarily, in supporting the nongovernmental organizations that want to attract as many young people as possible in volunteering. These can build viable strategies for attracting and keeping volunteers or they may improve the existing ones therefore youngsters, despite the fact that they do not gain material or financial benefits, they want to participate in such activities.

Synthesizing the data from this study, I can affirm that although we stand on a maiden stage for volunteering in Romania, things can be improved through the combined efforts of three actors: individual - who may be involved in volunteer activities as far as he has the right skills and spare time, public and private institutions - by building strategies for attracting and keeping volunteers, and finally, the state - by creating a clear and consistent legislation in order to motivate people to get involved.

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PROFESSIONAL SOLDIER'S FAMILIY

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Abstract: The content of the article is an approach into the problems of military families nowadays, since Slovak Armed Forces became fully professional. The article briefly defines possible approach to the families of professional soldier (military family) and it indicates problems which Armed Forces of the Slovak Republic must address in order to remove tension. This tension arises not only from the impact of military occupation to a family of professional soldier (especially fulfilling the core functions of the family), but also the impact of a professional soldier's family to this profession.

Keywords: professional army, professional soldier, family, characters of the family, functions of the family, military family, professional soldier's family, families of military professionals volunteering, volunteer's profile, costs-benefits.

1. INTRODUCTION

At present, professional army has to face among other problems also the new forefront issues that affect the lives of military families - the social group of professional soldiers. If we want to solve problems of a military family - or families of professional soldiers, it is necessary not only to define a military family, but also to define the approach to the analysis of this social phenomenon. **Family** affects every human being. On one hand, as the closest possible binding with the experience from childhood, where it seems to be as the *orientation family* to which the person was born. On the other hand, as a *reproduction family*, that is closely linked with the experience of most adults from its establishment and development.

The family is the basic social group, which represents certain unit of the society. Its structure is realized as a family relationship and society as a whole, or as a relationship - family and other social groups. It can be shaped even by both mentioned relations. The structure leads to the fact that its objectives are fundamental in nature and coincide with primary and secondary needs and interests. The objectives of the family may or may not share the objectives of whole society. This depends primarily on the social level and the nature of the patterns of social action / behaviour (roles) that are accepted and recognized in the family. The social basis of the family is in the relation of people as an expression of their interpersonal needs and not as an expression of service to the society. The family also reflects the complexity of societal social structure.

The family can not be treated just as a social group. Since it is involved through its core functions [1] in the various social processes (from economic to bio-reproductive), it is also a social institution. The family itself has its own laws and regularities of its functioning, but these are limited to the valid laws of the society. Therefore, family receives institutional character, although it is by its nature more like a unit of natural private life of people.

Nowadays, the prevailing concept of family is seen as complex and multifaceted socio-social phenomenon, the essence of which two types of horizontal are and one vertical type interpersonal relationships. The horizontal relationships in the family are the relations between spouses (parents) and the relations among children. The vertical

relationships are relationships between parents and children.

There are various definitions of family. Sociologists define a family in two senses: *in a broader sense* as the so-called *multi-generational family*, which include besides parents and children, also other relatives, and *in the strict sense* as the so-called *nuclear family*, which consists of only parents and children [2]. The most commonly quoted are these basic features of the family:

- family is socially approved form of steady coexistence;
- it is composed of persons related to one another by blood, marriage or adoption;
- its members usually live under one roof;
- its members cooperate among themselves in a socially recognized division of roles, while the emphasis is put on subsistence and upbringing of children;
- the greater the movement of family members, the family ties are weaker, and the less it contributes to maintaining of its social position, because the social roles of its members are not fulfilling;
- mental disturbance of one family member is distracting to the whole family;
- in every type of society there is a child care, and care for aging relatives as part of family relationships;
- in all civilized societies, there is a prohibition of incest (sexual intercourse between blood relatives).

The family is a small social group distinct from marriage, which implements the basic functions (bio-reproductive, socializing, economic and emotional). Its members follow persistent patterns of behaviour, which are defined not only by personal and emotional relationships among them, but they are also formed from outside by broader structural system and its level of development. Family has been and always will be the object of institutionalization and has strong features of formalization.

The family is the basic social unit. It arises from informal relationships (love, acquaintance of two people) which formalize by marriage. Families also arise without the

formalization of ties (as official marriage). Hermaphrodite couple living in a particular relationship "unmarried couple" or unisexual couple (two men or two women) living in a particular relationship "registered partnership".

2. THE MILITARY FAMILY

Specific type of family is a military family, more specifically: *military multi-generation family*, *professional soldier's family* and a specific type of professional soldier family - *family of professional soldier participating in mission*. In defining the term "military family" it is necessary on one hand to consider the fact that the family significantly affects the performance of military occupation by military professional (may be the accelerator or the retarder of performance.

On the other hand, it is necessary to consider that this type of family has not only all the general features of the family, but also meets all the basic functions. Certain features, which result from carrying out the military profession by some family members in general or even by crucial person (parent) who guarantees the basic functions of the family especially, do not allow entirely or at least without problems to fulfil some of the basic functions of family. In order to identify the specifications, it is necessary to define the term "military family".

Existing different approaches to solving the problem will allow even greater differentiation in military families. Military family can be defined from two basic aspects (approaches): *broader* or *narrower*.

In *broader sense* military family is understood as group of people consisting of all the relatives living in the family, where at least one of them is a professional soldier. Since this family includes more generations (parents, grandparents, uncles, aunts, cousins) it can be identified by the term *"multi-generation military family"*.

In narrower sense military family is understood as a social group, which includes relations between husband and wife as well as parents and children. The fact that at least one

parent is a professional soldier partially modifies these relationships. Although this group bonded by marriage, by blood or adoption lives in the same household and the members cooperate with each other according to jointly determined and internally defined roles, the fact that at least one parent is a professional soldier, significantly affects the essential function of the family.

This military family can be described by the term "professional soldier's family" [3].

3. THE PROFESSIONAL SOLDIER'S FAMILY

Professional soldier's family as one type of military family can be further differentiated in the following way:

• from the aspect of achieving the level of professionalism (the level of identification with the military occupation, the degree of adaptation to the military environment and the level of military training) of professional soldier, who is a parent of the family: *family of military professional*, or just *professional soldier's family;*

• from the aspect of parents in professional service to a family of professional soldier, in which a military professional is: *only one parent*, either father or mother (may be signs of further differentiation - gender) or *both parents [4];*

• *from the aspect of the length of professional services* of one or both parents to: a *family of beginning professional soldier* (there can also be a specific type of beginning professional soldier's family - a family of military cadet), or a *family of military professional* (long-serving career soldier who achieved the quality of military professional and the family accepts or at least does not reject this status);

• *from the aspect of types of troops or military professions*: family of military aviator, member of air defence, family of military doctor, etc.

• *from the aspect of combat deployment to: military family outside the combat deployment* or *family of a soldier deployed for an operation* (military mission).

The above aspects show that a particular type of military family considered in the strict sense - professional soldier's family, is a *family of military professional*, and *professional military family engaged in a military mission*. Gradually it is more admitted and accepted that every military family professional will be in the period when the military professional would be deployed in military missions (combat deployment cycle). Family of military missionary is just a temporary category covering only the current status.

Nowadays, a new term is being created to designate a *family of military veteran*, military professional family (parent) who participated in several military missions. It will be necessary to give special attention to these families, because especially the deployment of military professional in a military mission and the return from it to a large extent influences the fulfilling of basic family functions. This impact should be properly eliminated or at least partially compensated by appropriate social programs. This requires a change of view to compensations.

Compensations should not be considered just as an objective of a certain social program to alleviate the impact of professional service to a family of professional soldier. It is necessary to consider them especially as a means of maintaining quality of life of military families.

Compensations do not mean just higher costs of the military profession, but they are an integral part of the costs, because the lifestyle of a professional soldier and his family needs to be guaranteed in order for the compensation at all three levels (societal, military and individual) would become part of it. Compensations are not offerings, which the military organization as an employer would give when it wants or can. Compensations must become part of provision in every process within armed forces. Only such comprehended approach with compensations will provide creative nature. This means that they will create an impulse for inventiveness (creativity). They will allow each member of a military professional's family and military

professional to develop creative thinking and not just quantitatively but also qualitatively. Compensations will enable them to develop fluency (number of ideas), flexibility (variety of ideas), originality (originality of ideas) and elaboration (the ability to further develop creative ideas and implement them).

4. CONCLUSIONS

The issue of family military professional is very complex. Theoretical reflection on this matter should become the basis for practical measures in the field of defence with a particular emphasis on comprehensive social security approach of the Slovak Armed Forces members and their families in the future. In real life this means to map the needs and interests of military families, because even this type of family is not snatched up from the fixation on:

- need of further socializing (strengthening as a social group and gradual integration into the army and society);
- care to ensure the livelihood;
- care about survival - social security of a family [5].

In my speech I could not resolve the issue for obvious reasons. I only suggested some possible approaches to defining these complex social phenomena in the Armed Forces of the Slovak Republic.

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SAFEGUARDING THE RIGHT TO LIBERTY AND SECURITY IN THE EUROPEAN CONTEXT

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Abstract: The present paper focuses on presenting the legal guarantees which accompany the lawful arrest or detention, especially as they are configured in Article 5 of the European Convention of Human Rights and the related case law of the European Court of Human Rights. The right to liberty and security of person, acknowledged in all the major international instruments, is a key component of the European culture of protecting the human rights, which has also been minutely incorporated into the Romanian legislation. Although the right to liberty and security is considered inviolable in all democracies, there can be justified exceptions in which the exercise of this right is limited; it is not only required for them to be lawful, but also any derogation must strictly conform to the provisions laid down by the law so as to avoid any arbitrary act from the part of the authorities.

Keywords: right to liberty and security, lawful arrest, criminal proceedings, European Convention of Human Rights, European Court of Human Rights.

1. INTRODUCTION

Throughout the past decades, the imperative of safeguarding the fundamental rights and freedoms has gradually led towards the consolidation of several efficient instruments at international level, which promote 'a common law of the trial' [6], here included the criminal matters.

In this respect, in order to create a European pattern of criminal proceedings, both universal and regional sources of law manifested significant relevance.

As far as the former category is concerned, the *Universal Declaration of Human Rights*, adopted by the United Nations General Assembly on the 10th of December 1948, is essential as it is of great moral force [2]; based on it, the *International Covenant on Civil and Political Rights* was adopted in 1966 and it came into force in 1976.

The main regional sources for the European area are the following ones: the *European Convention for the Protection of Human Rights and Fundamental Freedoms* (the *European Convention on Human Rights* in short), signed in Rome on the 4th of November 1950 within the Council of Europe (ratified by Romania in Law no. 30/1994), together with the Additional Protocols amending it, as well as the European Union law on human rights, notably the *EU Charter of Fundamental Rights*, which was proclaimed in 2000 and has become binding since December 2009, when the *Lisbon Treaty* came into effect.

The 1991 *Constitution* of Romania, revised by Law no. 429/2003, has also acknowledged the value of the aforementioned instruments. Thus, according to Article 20 par. 1 and 2 of the Romanian fundamental law, 'constitutional provisions concerning the citizens' rights and liberties shall be interpreted and enforced in conformity with the *Universal Declaration of Human Rights*, with the covenants and other treaties Romania is a party to. Where any inconsistencies exist between the covenants and treaties on fundamental human rights Romania is a party to, and internal laws, the international regulations shall take precedence unless the Constitution or national laws comprise more favourable provisions'.

Concerning the legal force of the *European Convention on Human Rights* and the related case law developed by the European Court of Human Rights in the Romanian internal legal order, pertaining to the aforementioned constitutional provisions, they benefit from a constitutional and over-legislative force; also, they have direct applicability, being integrated into the constitutional block of the domestic system [2].

2. LEGAL ESTABLISHMENT OF THE RIGHT TO LIBERTY AND SECURITY

Individual freedom is considered inviolable in all democratic regimes, its guarantees being established by law. In the criminal process, an important consequence of the individual freedom is embodied in the rule which states that the process is to take place with the defendant enjoying his/her freedom, which is the natural state of every person. However, it is equally true that the legislation of all countries has admitted exceptions regarding the deprivation or restriction of liberty aiming at the evolution of the criminal process in appropriate conditions [11].

The Universal Declaration of Human Rights states, in Article 9, that 'no one shall be subjected to arbitrary arrest, detention or exile'. The right to liberty and security of person is also established, in a more detailed manner, in Article 9 of the *International Covenant on Civil and Political Rights*.

Within the *European Convention on Human Rights*, Article 5 deals with the right to liberty and security, as well as the limitations that can affect it. This article has been attributed, within the framework of the doctrine [4], to the so-called 'strong nucleus' of the Convention, together with Article 6 (the right to a fair trial), Article 8 (right to respect for private and family life), and Article 10 (freedom of expression). It follows that upholding the right to liberty and security is absolutely necessary in a democratic society.

Finally, Article 6 of the *EU Charter of Fundamental Rights* proclaims that 'everyone has the right to liberty and security of person'. As observed in the Council's *Explanations* [14] relating to the Charter, the rights comprised therein are the rights guaranteed by Article 5 of the *European Convention on Human Rights* and, in accordance with Article 52 par. 3 of the *Charter*, they have the same meaning and scope. Thus, the limitations which may be imposed cannot exceed those permitted by the *Convention*. At the same time, this provision shall not prevent EU law from providing more extensive protection.

It must be underlined that any limitation brought to the exercise of the fundamental rights and freedoms must meet four essential conditions, namely: to be provided for in the specific national legislation, which must be not only accessible to everyone, but also predictable; to pursue a legitimate purpose, such as the protection of the territorial integrity of the state, public safety, preventing the commission of certain crimes, defending the public order or the rights of others; to be necessary in a democratic society; and, lastly, to be proportional with the pursued legitimate purpose [2].

3. KEEPING THE DEPRIVATION OF LIBERTY WITHIN THE LAW

The right to liberty and security of person is an inalienable right, which cannot be waived and which concerns every person, whether at liberty or in detention. The main objective of these provisions is to protect the individual against the arbitrariness of State authorities [2]. The Court has constantly held that the terms 'liberty' and 'security' are to be read as a whole. While the *liberty of person* refers to 'freedom from arrest and detention', the *security of person* means 'the protection against arbitrary interference with this liberty' [13]. The lawfulness regarding the privation of liberty implies two aspects.

On the one hand, the cases in which the derogation from the principle mentioned at the beginning of Article 5 of the *European Convention on Human Rights*, stating that 'everyone has the right to liberty and security of person', are expressly and restrictedly provided for in par. 1 letters a)-f) of Article 5. Hence, this enumeration represents in itself a guarantee for maintaining the legality of the detention. As the text of the *Convention*

shows, 'no one shall be deprived of his liberty save in the following cases and in accordance with a procedure prescribed by law (…)'. The list is exhaustive and encompasses situations which are only susceptible of a restrictive and strict interpretation [2, 6].

The six hypotheses representing exceptions to the prohibition of deprivation of liberty are the following ones: a) the lawful detention of a person after conviction by a competent court; b) the lawful arrest or detention for non-compliance with the lawful order of a court or in order to secure the fulfillment of any obligation prescribed by law; c) the lawful arrest or detention of a person effected for the purpose of bringing him before the competent legal authority on reasonable suspicion of having committed an offence or when it is reasonably considered necessary to prevent his committing an offence or fleeing after having done so; d) the detention of a minor by lawful order for the purpose of educational supervision or his lawful detention for the purpose of bringing him before the competent legal authority; e) the lawful detention of persons for preventing the spreading of infectious diseases, of persons of un-sound mind, alcoholics, drug addicts or vagrants; lastly, f) the lawful arrest or detention of a person to prevent his effecting an unauthorised entry into the country or of a person against whom action is being taken with a view to deportation or extradition.

On the other hand, the deprivation of liberty must be carried out, as stated in par. 1 of Article 5, only 'in accordance with a procedure prescribed by law' ('selon les voies légales'). For such a measure to be consonant with the *Convention*, it must fulfill a double prerequisite: the observance of the domestic law which, in its turn, must be in complete accord with the *Convention* [3].

For this reason, as far as the criminal process is concerned, the guarantees set out by the *Convention* have been consolidated in both the Romanian Constitution (Article 23) and the Criminal Procedure Code (Article 5, Articles 504-507, etc.) so as to ensure the means of safeguarding the rights and freedoms of the participants in the criminal case, especially those of the defendant [6].

4. SAFEGUARDING THE RIGHT TO LIBERTY AND SECURITY IN THE CRIMINAL PROCESS

As it can be noticed from the previous sections, there are 'three situations in which deprivation of liberty may be justified as part of the criminal process: the apprehension of someone suspected of involvement in committing an offence (para. *c*); the imprisonment of someone as a penalty for having committed an offence (para. *a*); and the detention of someone pursuant to a request for his or her extradition to another country (para. *f*)' [5].

There are three hypotheses of detention on remand, mentioned in Article 5 par. 1 letter c), namely the commission of an offence, the prevention of committing an offence or the flight after committing the offence. Detention on remand is a complex institution taking into consideration its implications, which are of both a social and a personal nature. After the conviction by a court of first instance, detention on remand turns into detention after conviction [13].

In the case of convicted offenders, the conviction must be ruled by a 'competent court'. Decisions adopted by the police, by a public prosecutor, a military commander or by an administrative body do not meet the requirements. The term 'conviction' implies both the finding of guilt and the imposition of a penalty [13].

In the situation of extradition, the Court often distinguished between the lawfulness of the detention and the lawfulness of the extradition [5].

As it stems from the case law of the European Court (in ECHR, *De Jong, Baljet, and Van Den Brink v. The Netherlands*, 22 May 1984; ECHR, *Engel and others v. The Netherlands*, 8 June 1976), with reference to the criminal process for the purpose of the *Convention*, discrete military criminal offences and proceedings are also included [5].

5. THE RIGHT TO BE INFORMED

According to Article 5 par. 2, 'everyone who is arrested shall be informed promptly, in

a language which he understands, of the reasons for his arrest and of any charge against him'.

Generally, only the communication of the grounds for the arrest is necessary, but, in some exceptional cases, when the measure taken is not obvious, it is also required to inform the arrested person regarding the arrest itself [3].

Furthermore, in *Van Der Leer v. The Netherlands* (22 January 1990, par. 27), the Court draws attention to the fact that the terms 'arrested' and 'charge' are to be interpreted autonomously, extending 'beyond the realm of criminal-law measures' and consequently applying to all types of deprivation of liberty.

By virtue of this provision, 'any person arrested must be told, in simple, non-technical language that he can understand, the essential legal and factual grounds for his arrest, so as to be able, if he sees fit, to apply to a court to challenge its lawfulness in accordance with Article 5 § 4. Whilst this information must be conveyed "promptly", it need not be related in its entirety by the arresting officer at the very moment of the arrest. Whether the content and promptness of the information conveyed were sufficient is to be assessed in each case according to its special features' (ECHR, case of *Saadi v. The United Kingdom*, 11 July 2006, par. 51).

6. DETENTION ON REMAND

Article 5 par. 3 of the *Convention* provides for the following: 'Everyone arrested or detained in accordance with the provisions of paragraph 1 (c) of this Article shall be brought promptly before a judge or other officer authorised by law to exercise judicial power and shall be entitled to trial within a reasonable time or to release pending trial. Release may be conditioned by guarantees to appear for trial'.

It must be mentioned that this text refers explicitly only to the provisions of par. 1 letter c) of Article 5, thus it is inapplicable for the detention in the case of extradition [2, 3].

In the case law of the Court, four fundamental reasons have been developed which are considered acceptable for the

detention on remand of an accused suspected of having committed a crime, mentioned in *Calmanovici v. Romania* (1 July 2008, par. 93) [9]: the danger that the accused might escape; the risk that, once released, the accused can tamper with the course of justice; the risk of committing new crimes or, finally, presenting danger for the public order.

The term 'promptly' does not have in view a minimum, but an undetermined period of time. The celerity is estimated by taking into consideration all the circumstances of the cause.

In the previously mentioned case of *De Jong, Baljet, and Van Den Brink v. The Netherlands*, 'the three applicants were referred for trial before the Military Court seven, eleven and six days respectively after their arrest'. The Court decided that 'in the particular circumstances, even taking due account of the exigencies of military life and military justice (…) the intervals in question cannot be regarded as consistent with the required promptness' (par. 51 and 52) [6].

Regarding the 'judge or other officer authorised by law to exercise judicial power', three cumulative conditions must be met: first, to be independent of the executive and of the parties; second, to have the legal obligation to hear the person brought before him/her; third, to be required to analyse all the circumstances, both in favour and against the detention, and in the absence of the reasons justifying it, hence the detention proves groundless or unlawful, to be able to decide the release of the person [6].

The guarantee consisting in the entitlement to trial within a reasonable time or to release pending trial must be interpreted in the following way: detention on remand cannot be maintained beyond its reasonable limits. This is extremely important as it is a well known fact that the liberty of person constitutes the rule, whereas the deprivation of freedom before conviction represents the exception, being a serious derogation from the principles of individual freedom and the presumption of innocence [2]. There is a genuine presumption in favour of freedom, as the Court noted in *Calmanovici v. Romania* (par. 90).

The evaluation of the 'reasonable time' of the detention on remand is marked by two

points in time, namely: the initial moment (*dies a quo*), when the person is arrested or detained, and the final moment (*dies ad quem*), when the person is either released or convicted [4].

The duration of the trial proceedings at this stage falls under the incidence of Article 6 of the Convention [2].

7. THE RIGHT TO JUDICIAL REVIEW CONCERNING THE LAWFULNESS OF THE DETENTION

The content of Article 5 par. 4 – 'everyone who is deprived of his liberty by arrest or detention shall be entitled to take proceedings by which the lawfulness of his detention shall be decided speedily by a court and his release ordered if the detention is not lawful' – has its origin in the institution called *habeas corpus* belonging to the Anglo-Saxon system. The *Habeas Corpus Act* was adopted by the English Parliament in 1679, aiming at preventing the abusive detention of persons [16].

The text quoted above does not imply an automatic control, but it rather institutes the obligation for the Contracting States to offer the opportunity for proceedings to be initiated by the detained person himself or herself [3].

This procedure, in which an appeal against a detention order is being examined, must have a judicial character and ensure guarantees appropriate to the kind of deprivation of liberty in question, such as the 'equality of arms' between the parties, the prosecutor and the detained person (ECHR, *Gorshkov v. Ukraine*, 8 November 2005, par. 40).

Also, as shown in cases such as *X. v. The United Kingdom* (5 November 1981, par. 53) or *Weeks v. The United Kingdom* (2 March 1987, par. 62), 'the word "court" is not necessarily to be understood as signifying a court of law of the classic kind, integrated within the standard judicial machinery of the country' and the members making up the 'court' must fulfill the requirements of independence as well as impartiality in the performance of their duties [6]. In the absence of all these guarantees, this right would be only theoretical and illusory [4].

As observed in *Hutchison Reid v. The United Kingdom* (20 February 2003), the proceedings have to comply with the right to a speedy judicial decision. In the same case, the Court notes that the burden of proof lies on the authorities, which are not allowed to place it on the applicant.

8. THE RIGHT TO COMPENSATION

The final paragraph of Article 5 provides that 'everyone who has been the victim of arrest or detention in contravention of the provisions of this Article shall have an enforceable right to compensation'.

As the Court ruled in cases such as *Tase v. Romania* (10 June 2008), this right has a subsidiary nature, whose premise is the violation of one of the preceding provisions, namely paragraphs 1 to 4, of the article under discussion, which has already been established by a national authority or by the European Court.

Moreover, the right must be certain. In the cited case, the Court 'concluded that the applicant had no effective remedy by which to challenge the lawfulness of his detention' (par. 46), which triggered the applicability of Article 5 par. 5.

The Court does not rule out the possibility of Contracting States to condition the award of compensation by the ability of the person concerned to show damage resulting from the breach. In the context of Article 5 par. 5, 'the status of "victim" may exist even where there is no damage, but there can be no question of "compensation" where there is no pecuniary or non-pecuniary damage to compensate', as the Court argued in the case of *Wassink v. The Netherlands* (27 September 1990, par. 38) [3].

9. CONCLUSIONS

The fundamental rights and freedoms lie at the very foundation of democracies around the world and must always be looked upon as a lighthouse in the midst of moral darkness.

Thus, the *European Convention of Human Rights* is attached to a certain philosophy and a certain commitment, which is common to all Contracting States.

Since the right to liberty and security is vital for any human being, it is essential that the legal principles and derogations be thoroughly studied and applied.

Future work should analyse the challenges of applying the guarantees proclaimed by the *Convention* in the case of serious crimes, such as those involving organised crime and terrorism [8].

Also, it should further consult the case law of the European Court of Human Rights in order to capture the dynamism of how the field of human rights evolves and also how the States relate to these aspects.

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COMMUNICATION DURING CRISIS SITUATIONS

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Abstract: *Crisis communication is necessary assume in area of crisis management and in emergency planning. If we don't start to solve crisis as soon as possible let us say that communication process failed it is hard to eliminate loses and after - effect. In condition of this article, we can applied this model like to communicate emergency units between each other, like to communicate with media and like to communicate to external environment.*

Keywords: *communication, crisis communication, emergency planning.*

1. INTRODUCTION

Crisis communication include like communicate organization with their employee, like organization communicate with external and like to communicate with media. For good operation in emergency system is necessary to have an excellent communication system.

We can characterize crisis communication like „renewal of information between responsible authorities, organizations, media, individuals and groups before special incident, during the special incident and after it" (Vymětal, 2009).

2. COMMUNICATION AND CRISIS

Communication is term which is used in many sciences. There are many views on it. We can define communication like process of transmission from one person (group) to another person (group).

It is instrument which people use on communication. This instrument exists from the beginning of evolution.

Communication content giving and receiving information like influence on communicate persons. Communication is instrument, which has target. We can communicate by speech, by script, by picture, by dress, by custom, but silence too.

Communication process like process of change information has own regularity, instruments and conditions. Matulčíková (2002) present that communication process has following three conditions:
- Process includes minimum two people;
- We must to have information, which is object of communication;
- We must to do transmission of information.

Except this view are many other scales of approaches from many authors to communication conditions, too.

Communication during the crisis is different from casual communication. In crisis situation we have to take in many fast resolutions and in this time we need information from communication process. This type of communication is irreplaceable.

Crisis communication is irreplaceable aspect in area of crisis management. If we don't have arrangements on the time to solve crisis, let us say if communication process abort it is hard to eliminate effect.

Crisis communication include how communicate organization with employee, like organization communicate out of organization and like communicate with environment and like organization communicate with media.

We can characterize like "change of information between responsible authorities, organizations, media, individuals and groups before special incident, during the special

incident and after special incident" (Vymětal, 2009).

In these days of information technologies we don't have problem in few minutes give information to media, which consequently distribute information to public. In the case of crisis communication we have to have any plan of activities, because in crisis situation we don't have time for human error and not always we have second chance to rectify a mistake.

Nowadays crisis communication in democratic society respect following main principle (OECD, in Vymětal, 2009):
- Accept public like legal partner;
- Make plans and evaluation of communication process;
- Hear what the people say;
- Coordinate all activities and cooperation with other trustworthy people;
- Get along with necessary of media;
- Talking clear, comprehensible and with empathy.

Chosen theoretical models of crisis situation (Vymětal, 2009):

1. **Risk perception theory** - this approach identifies 15 factors which have straight relationship to crisis communication. It is include following factors: spontaneity, controllability, knowing, right rule during distribution, profit, understanding, unsoundness, terribleness, trust in institution, reversibility of consequence, personal treat, ethical and moral disposition, environment or human origin, identity of victims, catastrophic potential.

2. **Negative dominance theory** - interpret process of making negative and positive information in crisis situation. This theory predict that people give more value to loses (negative result) like addition (positive result). We can use this in praxis when we want to tell something during the crisis in the following way: Every negative report we have to balance by positive report.

3. **Mental noise theory** - this approach identifies like people under pressure and in stress use information. If the people are in phase of high anxiety for known high risk their effect of use information is very low. If the people are under the stress their perception is

118

bad and 80 % of information is ignored, forgotten or bad interpreted.

4. **Trust determination theory** - it is the base of crisis communication. It is result of subject activity and communication skills. If the people are dishabille, in many way don't trust in that the other people hear, what they said, help them, they don't believe they are empathic, trustfully, open – mind, competent, hands – on and cheerful for help to each other. In this case is very important to strengthen these 4 factors: empathy (50%), competencies (science, qualification, organization skills, - 15-20%), free – heartedness (sincerity and fair negotiation – 15-20%), responsibility (involvement – 15-20%).

During the crisis communication is very important only few clearly formulated information and is recommended so-called *layered model* – every information have very short (10 seconds or 3 – 12 worlds). And information has to be repeat – Triple T – model.

Triple T model characterized by Vymětal (2009):
1. Tell what we are going to say;
2. Tell information;
3. Tell what we said.

This models included only verbal information but Welzant and Kolosová (2007) made **STARCC principle**, which said that information have to be simple, timely, accurate, relevant, credible and consistent.
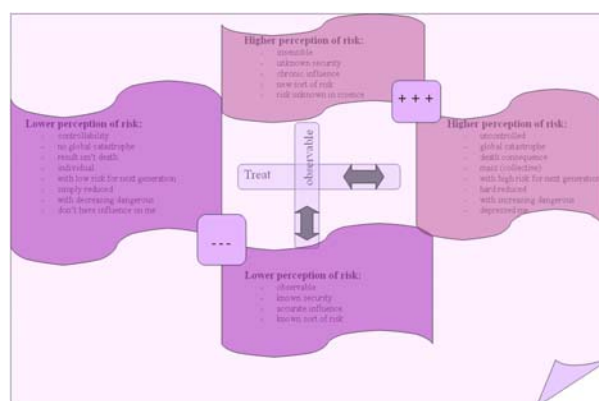
Fig. 1 Model of risk perception [10]

In nowadays world of information technologies is no problem between few second send information to media, which follow distribution this information to public.

In the case of crisis communication have to exist some plan of activities. It exists because we don't have time for errors and we don't have always second change to retrieve.

3. INTEGRATED RESCUE SYSTEM IN CONDITION OF SLOVAK REPUBLIC

The part of integrated rescue system are Police forces of Slovak republic, Fire and rescue brigade of Slovak republic, Rescue ambulance service of Slovak republic and Armed forces of Slovak republic. There are main parts of integrated rescue system.

Integrated rescue system is coordinating action his parts (rescue component), as in provision their readiness like in making activities and measure with giving help in emergency.

Štěpán Vymětal (2009) characterize integrated rescue system like "coordinate way of component of integrated rescue system in prepare to special incident and in realization rescue and liquidating work including manage their interactivity."

The term "integrated rescue system" according to law 129/2002 Z.z. IRS ensures:
- Fast information, activation and effective using and coordination forces and resources of rescue subjects;
- IRS gives first aid, if life is in treat, health and property or environment;
- IRS ensures if it is dangerous of special incident or during special incident.

Integrated rescue system in Slovak republic includes:
- Department of Home Affairs;
- Department of Health;
- Regional authority;
- Emergency components.

Department of Home Affairs manages and coordinate filling task on the sector of Integrated rescue system (IRS). Department of Home Affairs makes conception of organization and development of IRS with cooperation by Department of Health. Cover special preparation of person, which is integrated to coordinating and operational centre of SOS and dispatch section in cooperation with Department of Health. Cooperate with state administration on prepare and creation of automatic support system of manage and information processing. Cover to send IRS to give help in SOS between district, like send emergency components within international help and humanitarian operation. Ensure voice and data process of information by telecommunication network and telecommunication equipment or by radio net and sending IRS in area of international and humanitarian help. Consequently give technical and operative condition to support manage and coordinate IRS and to communication and information infrastructure activity support, if the individual by –law inordinate something other.

Ministry of Health coordinate prepare of traumatology plans. The plans are made by institution of health care to support task which pertinent to SOS. These plans are used in special situation with high count stricken in life treat or with injury of health and included plans of first aid, which are made by district. Ministry of Health cooperates with concept of organization and development of IRS.

District manage by methodical way fulfill task on IRS. To fulfill these tasks were made coordinate centre, which make technical support, decide of reimbursement of expenses and allowance and cooperate on concept of organization and development of IRS.

The base emergency parts of IRS on the base aforesaid law are:
- Fire and rescue brigade of Slovak republic and Town Fire and rescue brigade of capital city of Slovak Republic;
- Rescue ambulance service of Slovak Republic;
- Police forces and air force of ministry;
- Military safety force of civil safety and control chemical laboratory of civil guard;
- Mine rescue service.
Others emergency parts are:
- Army of Slovak Republic;
- Council fire brigade;
- Factory fire brigade;
- Place of work which make state inspection or other activities;
- Mountain service;
- Unit of civil guard;
- Town police;
- Railroad police;

- Slovak red cross;
- Another legal person and natural persons, who subject of activity is giving help in safe life, health and property.

I think that is good idea make programs for crisis preparedness and information materials which help to component of integrated rescue system. This program is made for example by public health co. in USA. It is made for children crisis preparedness for earthquake in area of Los Angeles and they made it in 12 language variations. In our country we have some of these programs but we don't have good propagation between children. The treat by earthquake is in our country low, but we have other treats like floods, fires, and so on.

Fig. 2 10 essentials items for an emergency kit [15]

In nowadays technical and modern world is needed to evaluate external influence of environment to start crisis situation. From the reason of using inflammable, explosive or toxic materials is necessary to undertake measure in crisis prevention. Potential source of crisis is nuclear energetic, too.

Following risk area, which is needed to know, is transport. Modernization in area of car industry, railway industry acquiesces to fast tempo of life with faster ride. The result of make transport faster is higher accident rate on freeway or area of railway transport.

In respect of global warming we have more frequently disaster damage.

If we have special incident (situation) we have system which support inhabitants security which have to respect following principle (Šimák, 2001):
- principle of subordinates (crisis have to be solving in lower level of state administration);
- principle of centralization (during solving crisis is for lower levels of state administration and executive units of emergency systems absolutely binding proposal of higher level);
- principle of maintenance competencies (operation, organization and competencies whole organs of public administration is the same like in period before crisis, variance is only in conditions which is made in and in tools which is used);
- principle of support prevent measures (every organ of public administration have to be prepare during the crisis and before crisis and make prevent measures);
- principle assurance of control (make good system of control and preparedness of solve crisis situations and efficiency of prevent measure);
- principle of complex readiness (appropriate organ of public administration will be ready to solve crisis effect when will be ready all his parts and on the other side when will be able to activate crisis manage mechanism of institution like whole);
- principle of statutory deputy responsibility (for crisis preparedness and for manage during crisis is responsible statutory deputy appropriate institution);
- principle of make individual organizational unit (for ensure discharge individual activities in prevention and solving crisis effect is created manage branch and executive branch of crisis management);
- principle of adequacy (organization of special schedule in area of crisis effect, operation of adequate count of employee and technical instrument, recall of crisis steps as soon as it possible);
- principle of observance rules in every situation (always respect and apply law progress, basic human rights and liberty and limit only in measure of list of basic human rights and liberty).

4. COORDINATE CENTRE OF EMERGENCY SYSTEM

Coordinate centre of emergency system has following tasks:

- ensure transmission of information between participant in emergency system;
- shape plan of first aid;
- making database of emergency participants and save documentation;
- make special preparing of emergency unit;
- need help from another participant in emergency system.

Authority:

- give signal to basic emergency unit to make intervention;
- call another emergency unit to make intervention,
- redirect SOS to appropriate call centre,
- demand data about operating forces and resources.

System of support manage integrated answer on incident

Organizational view:
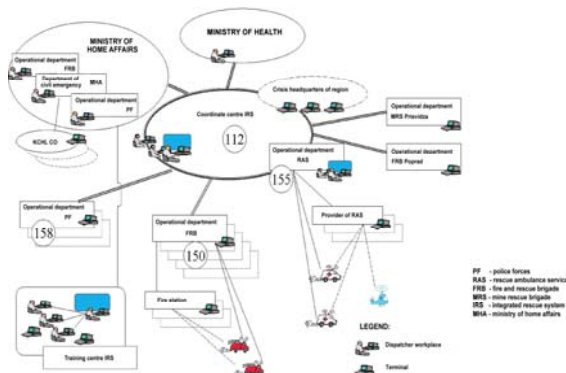
Fig. 3 Organizational view of coordinate centre of emergency planning [9]
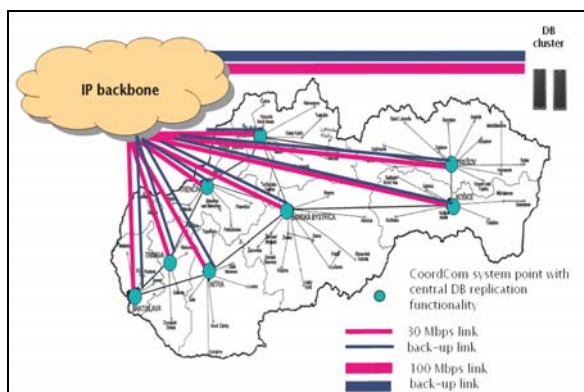
Fig. 4 Two self-contained communication links between network node and centre [9]
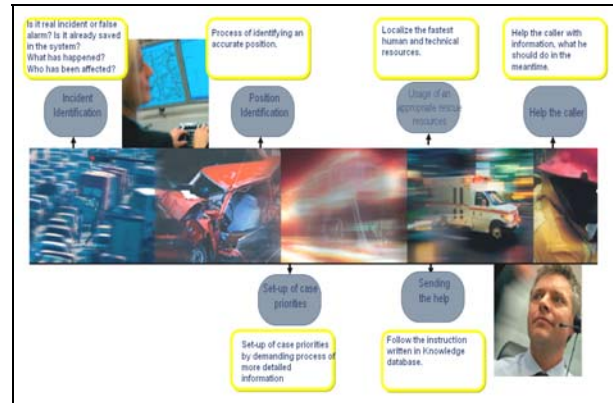
Fig. 5 Software functionality [9]

Services by SW functionality:

- Integrated communication – telephone, radio and data;
- Integrated receiving calling;
- Integration between existing and new infrastructure;
- Maximal support of operators in critical phases of solving incident;
- Interchange information between external sources.

5. CONCLUSION

Problem of crisis communication is very wide problematic, which need to solve. It is very important to unify crisis communication plans, solve problem of crisis communication, evaluate operation communication process and unify behavior of IRS during the crisis situations.

Necessary premise of IRS operation is higher technical services like develop each worker on education courses. It is needed that each part of IRS has to have knowledge from theory and they confront with praxis.

I think it is important to make new study program which will be calling "operator of emergency number 112". It is important to have experienced and well – educated people like operators, because they are first who communicate with people who are in crisis situation and need help immediately.

In these days of fast tempo of life changes and work responsibilities we can not eliminate crisis from our life and it is needed be facing with it. Necessary is cooperation with international institutions in result of

globalization and terrorism. Slovak republic is member of European Union and NATO. On this base is needed cooperation with political security committee, OSN, OBSE like cooperation with Red Cross, WHO and other organization.

For effective system activity like whole is needed to watch new trends in this area and apply new trends in praxis.

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ADULT EDUCATION BETWEEN ETHNOCENTRISM AND ALTERITY

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Abstract: In a context marked by unpredictable changes, it is obvious that adults' access to education is a necessary requirement for (re)adjustment. According to Roger Mucchielli (1982), the adult can achieve performance in learning if: he/she focuses from the very beginning on a well-defined purpose (a), by participating and being made responsible during all of his/her preparation stages (b), one is part of a learning group (c), and one's life experience is appreciated. These principles will be detailed in the hereby paper and supported by the relevant theories that justify the need to observe the teaching rules of Mucchielli, from the viewpoint of the intercultural education.

Keywords: adult education, intercultural competencies, previous experience.

1. INTRODUCTION

The times we live in is marked by the speed of the information, beliefs and the divergent attitudes attacking us that should worry us. We do not have the privilege to stop and let the messages settle down, or to decide whether they are relevant or not. These moments of reasoning lead to maladjustment and to the incapacity of keeping pace with another person. The relative and consensual truths have replaced the solid and irrevocable ones. The realities are built and deconstructed in order to be reconstructed in a convenient and easy to assimilate manner.

Eduard Spranger [22] considered that a nation's culture depends on the space. The education also catches up the patterns of the territory, and thus the content becomes the dissemination instrument of values in a specific area.

The school is no longer seen as a simple place for instruction and acquisition of knowledge, but it becomes "a space for living, experience, solidity and mutual acceptance" [8]. Moreover, the role of the teacher has also changed. Having in view that the teacher's cognitive superiority - due to the multiple sources of information -, and the epistemological authority - since he/she is no longer the sole owner of the knowledge he/she

cannot provide a global, absolute, encyclopedic and referential vision of the truth anymore - are more questionable nowadays, the teacher simply mediates the access to information, by decoding and interpreting it, due to his/her verified and certified credibility.

In this context marked by unpredictable changes, it is obvious that adults' access to education, in its different forms, is a necessary condition for (re)adjustment, because "education has to draw the maps of a world in permanent movement, but in the same time, to make available for people the tools of orientation which lead to finding one's way" [8].

In 1982, Roger Mucchielli [17] identified the rules necessary to design a set of adult teaching procedures. According to Mucchielli, *the adult achieve performance in learning if: he/she focuses from the very beginning on a well-defined purpose; by participating and being made responsible during all his/her preparation stages; he/she is part of a learning group; one's life experience is appreciated.* These principles will be detailed in this paper and supported by the relevant theories that justify the need to observe the teaching rules of Mucchielli, from the viewpoint of intercultural education.

In this article of synthesis, we attempt to contribute to the elaboration of a framework

favorable to the development of adult intercultural programs by highlithing and classifying theoretical and conceptual aspects.

2. THE RE-INTERPRETATION OF THE TEACHING NORMS PROPOSED BY ROGER MUCCHIELLI, FROM THE POINT OF VIEW OF INTERCULTURAL EDUCATION THEORIES

2.1. The adult achieves performance if he/she focuses from the very beginning of the learning process on a well-defined purpose

It has been scientifically proven that the perception of learning results has a positive impact on the adults' performances. Learning takes place when the adult understands that one's needs can be satisfied by specific ways of action. The subjects who have been informed about the expected results from the beginning have recorded a significant progress in the learning activities, proving that the efficiency is conditioned by the acknowledgment of the purpose of an activity that requires a "specific situation, a practical well-defined behavior" [14]. Moreover, a context in which the adult's interest in learning is based on satisfying a need, regardless the importance of that need, will lead to performance in teaching. At this level, it is possible to invoke George Leonard's [15] theory of ecstatic education. Satisfying the need for knowledge determines the voluntary and unconditioned learning.

In this respect, according to *The Recommendation of the European Parliament* [26], the development of axiological, value or intercultural competencies represents one of the educational objectives. The capacity to communicate, to socialize in various contexts represents a transversal competence which should be integrated in educational actions.

In this context, Poland's experience is relevant and proves its undeniable educational aspects, because its curriculum includes specific topics which enable students to determine their identity and cultural background. Students are asked to design their family tree, even from their first study years, so they become aware of their cultural,

emotional and material inheritance from their predecessors, and to make them responsible for how to develop the inherited gifts. Education should make individuals "aware of their own roots, so that they have landmarks when they are supposed to integrate themselves in any place on this Earth" [8].

This permanent reference the roots enables the definition of one's identity. Lee Rainwater [19] introduces the concept of *valid identity*, which is at the crossroads between *who you are and what you feel you are, who you are and what you show to the others*, being thus defined by four elements:
- *how we see ourselves;*
- *how we behave, so that we are known by the others;*
- *how we are perceived by the others;*
- *how we are treated by the others.*

The access to alterity is not possible without knowing your own identity. Shapour Rassekh, UNESCO consultant, was asked about what we should do to become European and he answered: "Before doing anything else, be Romanian!" Thus, it becomes possible to reduce the tension between global and local, and "people should become citizens of this planet, without losing their roots" [8]. By constant reporting oneself to the evolution in time, it is possible to go through the phase of knowing oneself; once this stage is over, the person gains access to the phase of knowing and accepting the others, in order to achieve autonomy.

To summarize the above theories, we propose the following evolutionary perspective, in establishing intercultural competencies in adulthood:
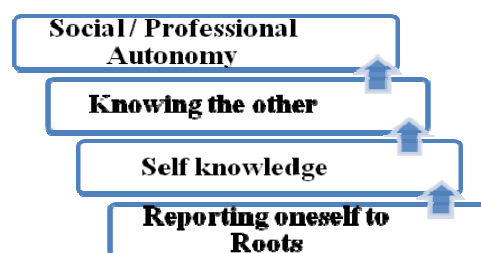

Fig. 1 Evolution of Identity towards Social/Professional Autonomy

To learn how to live together is one of the pillars of education, underlined by The

European Commission [26], and *the understanding of the others* becomes a specific form of self knowledge: "every form of identity is complex, because individuals are defined in connection to other people" [8]. The relationship with the others usually involves the adoption of a responsible behavior. The first thing to do, in order to restore education its central role among the social powers that act in a society, should be "the preservation of its function as a melting pot, by fighting against any form of exclusion" [8].

The followers of the individualist current consider that it is necessary to permanently compare oneself to the other; the quality of the relationship among participants represents a condition for efficient learning. The adult's insertion into a learning group represents an opportunity for practicing the social roles, the skill of participating through cooperation to the personal education, thus determining the progress.

2.2. The adult achieves performance in learning if he/she takes part and becomes responsible for all the preparation stages.

In the 5th century B.C., the Chinese philosopher Lao-Tse defined the experiential learning: *If you explain to me, I will listen, I will understand, but if you let me experiment, then I will learn.*

The adult learning process is reported to the changing tasks or roles a person has to deal with. The evolutional changes vary: "the adult becomes independent, thus identifying and maintaining one's existence means, one chooses a life partner, one becomes a parent and behaves accordingly, one interacts with community and society, one enlarges one's citizen responsibilities, getting satisfaction later, when one becomes old" [14]. Every such change of one's economic or social role requires learning through deconstruction and reconstruction.

The use of such strategies determines opportunities for involvement, participation, making the adult responsible by discovery; knowledge validation is the basic step for the active learning in adulthood.

Relevant studies confirm that the capitalization of the previous experience plays an important role in the development of intercultural competencies.

The intercultural education is not "an extension of the curriculum for teaching cultures, nor a process of transformation into folk culture" [7]. The teacher who provides intercultural teaching "must effectively take advantage of the presence of students having different roots in order to re-put value on their root culture and to make other people aware and sensitive to cultural diversity" [7]. By reporting oneself to the social and cultural experiences outside school, the teacher takes into account "the emphasis on every participant's acquisition which may help one find one's personal ground, which is familiar for a new process of elaboration of knowledge" [7].

Shifting the focus of interest from *how much it is learned* to *how it is learned*, the responsibility of the *followed path* finally determines the self-instruction, self-teaching. The path and the target coexist. It is recommended to have a logical transformation instead of an individual-based one. The priority, in this case, is represented by the eternal truths, defined as movements of active reversible search: "no individual, no group will be judged based on a fixed result, but according to the direction towards which their actions are oriented" [9].

2.3. The adult achieves performance in learning if he/she is part of a learning group.

Recent studies (CEDEFOP, 2008) show that the adults with poor theoretical knowledge are seven times less open to participating in a lifelong learning program compared to those with higher degrees of education [25]. These realities lead to an unequal education: the individuals with the highest level of initial training are more likely to continue their studies, while people with lower competencies face difficulties while attending a learning program *(Matthew Effect)* [27]. This is one of the reasons why "educational systems have the mission to become more open and relevant, this happening in the context of a predicted lack of balance between the level of competencies and demands at job, this process will be present and frequently met before 2020" [25].

In 1999, Micheline Rey said that "the formation of social and socio-cognitive representations" depends on the contacts established among cultures or cultural groups" [7].

Based on the economic changes that have taken place in the last years, it has been noticed that there is a tendency of societies towards closing, for the purpose of maintaining monopoly on resources, thus contributing to the appearance of exclusion and social alienation.

On the other side, recent studies (Ballard and Clanchy, 1997; Jin and Cortazzi, 2006; Jones, 1999) emphasize the fact that the individuals themselves, through their cultural membership, choose to adopt an active or passive behavior when starting an intercultural dialogue. Thus, the studies conducted by Jones [12] prove that students belonging to cultural environments where the teacher-student dialogue is not encouraged will consider free discussions, based on interaction, as disturbing and capable of influencing in a negative way one's cognitive balance. Moreover, Wong [29] establishes the connections between the teaching style and the students' approach to learning. Thus, Wong states that the societies which do not encourage the teacher-student dialogue have academic objectives centered on evaluation, results, products, and passing the exams.

In this way, memory and attention are being favored, without paying too much attention to creativity and critical thinking.

These realities generate a social phenomena based on exclusion/self-exclusion, alienation /self-alienation, and the role of education systems is to show responsibility when dealing with them.

2.4. The adult achieves performance in learning if his/her life experience is valued.

In adulthood, the experience of the past becomes a source for increasing knowledge. The individual introduces specific notes in his/her educational development. This is why the new knowledge of adults should be permanently connected to the previous life and learning experiences.

To learn to know and *to learn to do* are "aspects which cannot be separated" [8]. The development of knowledge reduces the importance of professional qualification in favor of competencies. Instead of a special skill, of a particular "know-how", the competence is highly appreciated, meaning "a specific skill obtained through training, regarding social behavior, team spirit, initiative and ability of taking full responsibility for actions" [8].

The term of *globalization* seems to have gained more advantages nowadays than the *mono, ethnocentrism*. Therefore, more and more people, mostly from the poor countries, emigrate to the regions of a wealthier world in their search for a new job and successful opportunities. In 2004, the number of persons living in the countries, other than their native ones, was 175 millions, i.e. double, compared to the number recorded in 1972. These real facts request for the immediate re-thinking of the programs designed for adults, focused on the development of intercultural skills and the ability to work, productively, with persons with different values, background, and customs.

The major objectives of adult training systems should be the provision of real opportunities for acquiring practical experience, and the direct contact with the professional life. In this respect, the learning process at the work place, in internships and under programs based on voluntary actions are not only real ways of matching the demand and offer of competencies, the real situations of interaction, knowledge and mutual acceptance.

Starting from the variety of learning situations, the paradigm of lifelong learning education assesses the necessity for reaching educational goals through permanent reporting to different circumstances: formal, non-formal, informal. Though non-formal and informal education does not necessarily involve an official qualification at the level of The European Union policies, there is a clear tendency of recognizing the knowledge, abilities and competencies acquired, through the identification, recognition, crediting and

certifying results regardless the time, place or way they have been obtained.

In the same time, the experience of countries that have already used complementary methodologies for measuring results, such as the portfolio of competencies, individual plans, project-based evaluations, should be analyzed and used as resources in the national curricula.

The evaluation is not limited to the information acquired, but it also applies to the attitudes and abilities developed as a result of attending a training course.

The elaboration of a flexible curriculum through educational programs focused on the development of competencies, the approach of *inter pares* evaluation methodologies*,* the use of educational portfolios to assess the learning progress and last, but not least, the encouragement of schools and universities to assume the role of a centre of lifelong adult education are the provisions of the education law in force, in line with the Community tendencies [26].

3. CONCLUSIONS

We believe that our analysis will contribute to a better understanding of the need for formative approaches focused on the development of intercultural competences of adults, for a real social and professional integration.

The educational practice encourages reconstructions and deconstructions, in the same time supporting reflexive learning that makes people aware of the constructive character of their world.

The usage of those strategies that stimulate teaching and learning as processes, which encapsulated the participation of educational actors, the solving of problems and the discovery of them *being together,* conditions though its own experience the final phase of knowledge, being qualities which favour the attainment of social and professional autonomy for adults.

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THE IMPLEMENTATION OF SPECIFIC DIDACTIC STRATEGIES CONCERNING THE EDUCATIONAL COMMUNICATION AS A TECHNOLOGY OF TRAINING THE STUDENT FROM THE MEDICAL SCHOOL

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Abstract: *Hypothesis: We started from the point that, in training a medical school student, who takes in consideration the use of the instrument of training technology, then, by applying the teaching strategies concerning the educational communication, we obtain the anticipated results. Purpose: In achieving the purpose we kept in mind the implementation of some elements of educational communication concerning the professional training of the student in medical school. Objectives: To validate the stated hypothesis we followed: developing the abilities of communication and interrelation between doctor-patient versus patient- doctor; decoding the specific didactic strategies of educational communication. Methods: In this case were instrumented and materialized by application: the conversation, the observation and the explanation. Target group: It was constituted from the 6th years' students from the medical school. Interpretation: The data pursued a change in the optics of acceptance and awareness in the relationship of communication, for the future, between physician (doctor) and patient; a new concept in the didactical strategy implemented to the students from the medical school. Conclusions: Those pointed out the necessity of: awareness of the student from the medical school and the improving through educational communication, of the relationship physician (doctor) - patient; the importance of the existence of a conception in trans-disciplinary educational training; the achievement of a genuine professional profile of the future physician (doctor).*

Keywords*: student, educational communication, relationship physician (doctor) - patient, didactical strategies, the technology of instruction.*

1. INTRODUCTION

Communication [1] represents the fundamental way of individuals' psychological interaction, realized through symbols and significations social- generalized of the reality, in order to obtain stability or some individual behavior changes or at group level. Human communication is realized in systems and complex languages through:
a. verbal symbols, oral or written;
b. body language, gesture, mimics, posture;
c. standardized affective expressions;
d. action realizing;
e. attitudes;
f. multiple artificial created languages logical - mathematical, artistically - suggestive.

Thus, through human communication, significance changes are operated, changes found in a complementary and reciprocity report with the economical- material changes, running in time, behavioral attitudes bounded to accentuate the necessity of human relationship.

We can also appreciate the fact that, a special place in communication, take attitudes and behavior. We can distinguish here, [2] the attitudes which are a certain position assumed towards an individual or an object. In the sequel, through them, the individual always expresses directly under certain forms: the word, tone, gesture, actions, such as the absence of actions may be another form of manifestation.

Giving an importance to the attitudes [3], includes in this series, which manifest cognitive, evaluation and adjustment, help and counseling, integrative and comprehension functions. Through these modalities it is proposed to the interlocutor, non-dramatizing any situation, canalizing him through other own resources; conscious and unconscious manipulation, reformulating to understand, but not to judge with cessation over thoroughgoing the themes, situations.

Attitudes become in this case, important in the process of communication, influencing behavior and causes or not of its distortion, being remarked the way in which, the former mentioned, influence the quality of the relations in efficient human communication.

2. THE ROLE OF INTERPERSONAL COMMUNICATION IN EDUCATION

In process, the human activity of communication consists in transmitting information and messages between individuals, in impressions and commands circulation, in sharing some affective states, rational decisions and valuable judgments, with an express finality in obtaining effects in individual representations and opinions, in social practice that they make. That's why, optimum human communication, takes into consideration conditions like:

a. message's consistency contents, given by the quantity of main information included in the message and significant for both speakers;
b. message's consistency contents, given by the quantity of main information included in the message and significant for both speakers;
c. communication's expressivity, social elaborated and assured by para-verbal and non-verbal;
d. the comprehensibility of communication, dependent not only by the organization of information but also of the level of access of the speakers to them, of the communicational compatibility of the partners.

Therewith, human communication [3], means the courage **to offer yourself** to the others without being afraid of exhaustion. Who communicate, communicates itself because he comes at the meeting with the partner not as an information bearer, but as a bearer of multiple an decipherable messages. **To communicate is a transitive and intransitive verb,** to fulfill everyone's needs and expectations. Any form it takes, direct or indirect, intermediated by written or other techniques**, human communication means the science of using the means of expressing** (words, gesture, techniques) because they are oriented one to the other, with a wry precise purpose.

Communication is **the trial of self existence** given by rhetoric. Is the **ability of receiving, deciphering and fructifying** the feed-back, **the answer**? Therefore, communication also means**: the will and capacity of orienting the message** towards the other understanding the ones needs; searching the understanding and **the need to be understood**.

Starting from the minimum theoretical exploration of the phenomenon of human communication is the time to particularize the action, the segment of educational communication making possible the understating of some attitudinal manifestations in a certain human structure.

In the context, if we start from the elements that involve in educational communication:

a. fundamental concepts regarding the process of communication;
b. exercising some specific behaviors;
c. and forming and developing some efficient skills.

We manage to decode the moment in which, the accumulated experience, implies attitude, as we already mentioned.

Still, don't forget that, for a fruitful communication [1], it is good to know and to apply the ten rules, coded as follows:

a. clarify your ideas before expressing them;
b. examine the real objective of each communication;
c. take into consideration the whole physical an human ambiance;
d. consult others if possible;
e. communicate only useful and valuable things;

f.   pay attention on your voice tone;

g.   follow the efficiency of your communication;

h.   try not only to be understood but also to understand;

i.   communicate for tomorrow also;

j.   personal example to support your communication.

3. EDUCATIONAL COMMUNICATION IN THE MEDICAL SCHOOL

Thus, the student in medicine, participant to the "Educational Communication" course, manages to accumulate the attended knowledge, in his future relation doctor-patient, making from education of communication a certainty of success.

The implementation of some educational guidance in the relation, make not only from psycho-linguistic point of view, the words to codify a manner, attitude and/ or behavior, but also to represent a strategy of trans-disciplinarily concerning the necessity of qualifying with responsibility the future profession.

As a practical expression of those former mentioned, come, by co-participating at the act of communication doctor-patient, seven key words which, taken mostly from the educational domain, find here and now the place, through personalized notification that was given to them.

Thus, not in an accidental order, the seven key words are:

1) - acceptance;
2) - patience;
3) - listening;
4) - understanding;
5) - collaboration;
6) - appreciation;
7) - responsibility;

will close the circle making a viable relation, and certifying the resultant which represents the coefficient of efficient communication, measurable through a new attitude towards the human.

Passed through the view of the two affective participation and co-participation**: doctor - patient - relation of transmitter (T) and receiver (R),** the key words former

mentioned, are governed by the feedback phenomenon:
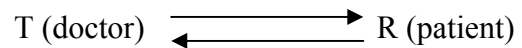
T (doctor) ⇄ R (patient)

Thus:

1) - **acceptance** = is identified starting from "Primo non nocere" being needed both in an attitudinal relation: doctor - patient versus patient- doctor, giving value to the act itself, of reciprocal relation, being the first step to success;

2) - **patience** = certifies the way of approaching the person for whom, the experience of a state of hospitalizing in general, bring modifications in patient's reference to a new social role. Patience is necessary to manifest from the doctor but also from the patient, giving to communication the accuracy that is needed.

The doctor "educates" its patience, and the patient finally conforms to the situation created between the two;

3) - **listening** = comes as a consequence of being aware of the disease etiology and symptomatology, thing that denotes moments of maximum professional gravity, in the correct diagnosis of the pathogen state.

Listening manifests as a successful condition in our case. That's why, from the multitude of its qualities, for the future doctor, it is necessary to practice the efficient listening and also the active one. Efficient and also active listening uses the following:

a) - **efficiency**:
- stopping your own verbal flow;
- facilitating emitter's situation;
- expressing the whish of listening;
- avoiding distractive elements;
- hypothetically placing in the place of emitter:
- the use of patience and calm;
- temper control;
- avoiding arguments and critical attitude;
- limited number of questions;
- use of silence;

b) - **active**:
- manifesting interest by non- verbal behavior;
- the use of neutral word for encouragement;
- sustaining by repeating the last sequence;
- periodical summarizing;

- paraphrasing usage;
- auxiliary question use;
- understanding verifying and certification;

4) - **understanding** = it takes to fruitful results implementation of acquisitions of "ego" sphere, where self esteem and trust, can start an evaluation, from other positions of knowledge, giving credibility to the dialogue between the two parties: doctor and patient vs. patient and doctor;

5) - **collaboration** = it is based on the partnership of the two, giving value the medical act itself not- giving and not- bringing damage of his personality;

6) - **appreciation** = it consists in the number of affective- volitional investments and strictly professional in realizing an efficient communication between emitter (doctor) and transmitter (patient) through feed-back, positive result being brought to the credibility element, the success in the realized investigation;

7) - **responsibility** = getters the elements of ethics and professional deontology, intended to mark the success in the act of communication realized in such created conditions, being in the same time the "identity card" of the one who assumes "the health burden" of the one submitted to medical diagnosis.

Decoded under the form of some "**inputs**" with educational signals value, the word become "**workable**", bringing a new technology of positive - attitudinal approach of the relation doctor - patient.

Only through implementing such didactical strategies, specific to the medical academic environment, will create the moment in which identifying the relation of communication, will replace "the syncope" of inadaptability and human impersonality.

4. CONCLUSIONS

Under these grievances, the student in medical school learns to give credibility to the interactive relation intended to deepen the tasks of an efficient communication in a domain in which the human factor is essential.

In this moment **"time has its own clock"** and between people **"winter itself is colder"** when, the relation of communication suffers a minor **"accident",** transferring human through mechanization.

And I give myself the right to ask the rhetorical question: **"Where are man and communication?"**, meaning that we forget to report to the elements that shape new technologies of instructing expression, still considering, above all, our quality of human beings and not objects.

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THE EVOLUTION OF THE EUROPEAN SECURITY DEFENCE POLICY (ESDP) IN THE CONTEXT OF THE DYNAMIC GLOBAL SECURITY ENVIRONMENT

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Abstract: The ESDP allows the EU to develop military and civilian crisis management and conflict prevention capabilities at international level, helping to maintain peace and security under the Charter of the United Nations, according to its economic and demographic strength. In fact, the ESDP has not involved the creation of a European army, but it has evolved in a consistent and coordinated manner with the North Atlantic Treaty Organization. Instead, a consensus can be reached between the member states, by the content of the Treaties, which could gradually lead to the emergence of a common defense, including a common European army, this being stipulated in the latest EU Treaty of Lisbon.

Keywords: ESDP, EU Treaties, mission, security, defense, strategy.

1. COVERAGE OF CFSP / ESDP IN THE EUROPEAN UNION TREATIES

With the adoption of the ***Treaty of Maastricht*** (February 1992) and the creation of the European Union, the European security and defense dimension has developed more pronounced features. The institutional transformation that the European Economic Community has been through by the new treaty allowed the EU to assume the Common Foreign and Security Policy - CFSP (pillar II), which also included „a potential framework for a common defense policy" that „would have lead in time to common defense". For the first time since the end of the Second World War, the European security and defense dimension qualified for a legal framework that would allow institutional development. Under these auspices, the Western European Union (WEU) became part of the EU development, being actually, the main instrument for implementing decisions and actions with defence implications.

Soon after the adoption of the Treaty of Maastricht, the foreign and defense ministers of WEU were meeting in Germany, in Bonn (June 1992, Petersberg Hotel), to analyze how the organization will be responsible for the Treaty. The Declaration adopted on that occasion stated that the range of tasks which the WEU would meet: humanitarian and rescue tasks, peacekeeping missions and tasks for combat forces during the course of crisis management operations (later known as the ***Petersberg tasks***). Following this decision, the WEU was involved in the next period in a series of missions such as: the monitoring mission embargo against Yugoslavia (1993 - on the Adriatic Sea and on the Danube), the support for the EU Administration Mission in Mostar - 1995; the contribution to the police training mission in Albania MAPE - 1999-2001; the demining assistance mission in Croatia - 1999-2001.

The Treaty of Amsterdam, adopted in 1997, brings new dimensions to the Common Foreign and Security Policy. Thus was created the post of High Representative for Common Foreign and Security Policy, and the European Council have gained increased competence in defining strategic guidelines on security and defence. At the same time, the Treaty of Amsterdam included the status of the EU as beneficiary of the WEU capacity (compared with the preceding provisions which regarded the EU to appeal to the assets and capabilities of the WEU). Consequently, the EU took over the Petersberg

tasks that were included in the Treaty, thereby expanding the size of the Security and Defence at the level of the Union.

The tragic events held in the Balkans have reiterated the need to assume a much more assertive role by the EU in managing security issues in Europe, including the perspective of developing the European defence capabilities. In this context, during the *Franco-British summit at Saint-Malo (December 1998),* both states have decided to launch an initiative designed to strengthen the EU profile on security and defence. In these circumstances, for the first time, the Joint Declaration on European Defense, adopted by the two heads of state at St. Malo, clearly outlined the need for the European Union „to have the capacity for autonomous action, backed by credible military forces, by means of deciding their use and by the necessary training in order to respond to the international crises". It also provided that „the Union would create the appropriate structures, the ability to analyze situations, the sources of intelligence and the capacity for its own strategic planning". Escalation of the crisis in Kosovo has created preconditions for *Europeanizing* the bilateral Franco-British initiative, the German Presidency of the EU Council taking responsibility for its implementation in the European Union.

This approach has managed to capture the support of EU Member States in order to create a consolidated security and defence dimension of the Union. In this meaning *the European Council in June 1999, which took place in Cologne (Köln)*, adopted the political platform of action so that "the European Union would have the ability to conduct autonomous action, backed by credible military forces, appropriate decision tools and availability of using them in order to respond to international crises without prejudice to NATO". To achieve this goal there were adopted several measures regarding the EU institutional adaptation such as: the nomination of J. Solana to the post of High Representative for Common Foreign and Security Policy and General Secretary of the EU Council; the creation of structures responsible for managing the EU security and defence issues - Political and Security Committee - PSC, Military Committee (EUMC) and Military Staff

(EUMS); regulation of the consultation system by conducting regular meetings of the EU General Affairs Council.

2. HELSINKI HEADLINE GOAL - THE MILITARY COMPONENT OF ESDP

Decisions adopted by the European Council in Cologne, *marked the practical beginning of the European Security and Defence Policy (ESDP)*, institutional developed as part of the EU Pillar II - Common Foreign and Security Policy. Under these auspices, the Finnish Presidency of the EU Council (July-December 1999) has claimed responsibility for the structured development of ESDP. In this respect, *the European Council in Helsinki (December 1999) adopted the overall objective of ESDP - Helsinki Headline Goal (HG 2003)* which aimed at making for the EU a set of forces and capabilities to enable the Union to conduct Petersberg missions. From this perspective, Member States committed themselves to create, by 2003, an EU Rapid Reaction Force (corps level, military forces which can achieve the level of 15 brigades, around 50-60.000 people, equipped with C2, logistics, combat support, naval and air elements), capable of deployment within 60 days, and being able to be maintained in the theater for at least a year.

In essence, the ESDP involves developing an autonomous decision-making capability, and where NATO as a whole is not engaged, launching and coordinating military operations under the authority of the EU, as response to crisis situations, the employment of resources by Member States to such operations based on sovereign decisions. The latter view outlines that the ESDP is an intergovernmental process, ESDP political control being exercised by the heads of state and by the government of the member states, and the financial control being exercised by national parliaments.

Since the European Council meeting in Helsinki, there has also been addressed the issue of the EU institutional capacity to facilitate the decision-making process, this leading to an agreement regarding the establishment of permanent political and military bodies like - the Political and Security Committee, the Military Committee and Military Stuff.

In late 2000, the French Presidency of the EU Council organized the first Conference of Commitment to meet Helsinki Headline Goal, which later developed the first EU Force Catalogue, including offers made available by the member states. Following the analysis of the EU members commitments made by the Military Staff, it was revealed that, in quantitative terms, the necessary forces was covered, however, existing shortcomings in various areas such as strategic air transportation, C3I, information and others. To address these issues, in November 2001 was launched a new initiative - *the European Action Plan Capacity (ECAP).* The working philosophy of ECAP process was based on assuming greater responsibilities by the member states, by coordinating the activity of some analysis mini-structures (panels, developed now into project groups - PG) whose objective was to provide solutions to eliminate deficiencies. Following the ECAP evaluations, in May 2003, there was held a new Conference of Commitment where member states were required to structure their commitments by running specific programs, focusing on areas identified as deficient.

Simultaneously, the European Council in Nice (December 2000) adopted new measures in terms of the ESDP institutional development by integrating masse structures and functions of WEU in the European Union. There were also established the principles underlying the institutionalization of cooperation mechanisms in defence and security with third countries but also with other international bodies like NATO and the UN.

The tragic events of the 11th of September 2001 have also influenced the wording of the EU response to such threats. In this sense the European Council in Seville (June 2002) decided to extend the range of Petersberg tasks in order to include the combating terrorism. At the same time, the EU-NATO relationship has become an institutionalized identity through the adoption of the NATO-EU agreements, in December 2002, in Copenhagen, regarding the EU access to NATO assets and capabilities, other than national ones, to conduct operations under the leadership of the Union. Known as the *„Berlin plus" Agreements*, they provided: guaranteed access of the EU to NATO's planning capabilities, to conduct an operation; the presumption of availability for the EU to NATO's collective capabilities and resources; the identification of the European Command options for DSACEUR during the running of an EU operation with recourse to NATO assets and capabilities.

The conclusion of such arrangements permitted, in March 2003, the launch of the first EU military operation - Concordia (FYROM) and then the post-SFOR operation, Althea, in Bosnia-Herzegovina (December 2004).

The strategy of European security, drawn up by the high representative of ESDP, Javier Solana, the document guidelines the strategy of internal and international security of the European Union. Known under the name of *„A safe Europe in a better world"*, the strategy has been approved, in 12 December 2003, by the European Council in Brussels. Regarded by many specialists as a response to National Security Strategy of the United States in September 2002, the document says, to ensure an European effective security, in a world in which more than covered by the globalization processes, is urgently needed the existence of close cooperation both within Europe and beyond it, because *„no nation is capable of coping with the complex challenges of our days"*. Appearance of challenges is punctual, strategy identifying as major threats to address Europe: terrorism, proliferation of weapons of mass destruction; regional conflicts; waned states; organized crime.

The European Union will act to ensure the safety and actively promoting their own values, by: expanding area of security in the vicinity Europe; strengthening international order; adoption of appropriate responses to the outlined threats. We can say that ESDP has been defined and developed on the fundaments of challenges and threats (as) valued at the early '90. But, from that moment, many concepts in the field of security have changed. After 11 September 2001, major threats addressed to security are no longer defined in Europe after the conflict criteria between states or ethnic groups, but the global insecurity level, where risks are showing much more difficult to define, identifiable, such as those related to international terrorist

organizations, use weapons of mass destruction, etc. They may cause mutations, deviations from the traditional sense of crisis management missions.

Moreover, the draft of EU Constitution is not breading the area missions of "Petersburg" type, the remaining humanitarian missions concentrated in the area aimed at avoiding emergence of regional conflicts. Proposals to add the operations of disarming and military guidance, for conflict prevention and the post-conflict stabilizing seem rather clarifications brought missions of „Petersburg" type, and not an extension of them. Also, plans promoted during the Spanish presidency for the reconfiguration of ESDP have been disputed, repeatedly, both by Great Britain, and the other members, in which opinion the fight against terrorism must continue to remain a NATO responsibility. Thus, counter terrorism has not been added to „Petersburg" type missions, but was drawn up a passage in the Constitution, under which the mission of this type „can contribute to the fight against terrorism".

As is clear from the European security strategy, the Union does not want to use military force against terrorism, as preventive action to end. EU acted more in favor of flexibility, which would allow some small groups of military operations to lead the fight ad hoc and effective. Appearance of flexibility has led to the idea of a structured cooperation between members, according to military capabilities each with their suitability for missions to be fulfilled. Applying this principle, has led to creation groups of struggle (battle groups), operational in 2007 (showing similarities with NATO response force), to serve as stimulus and model for the EU members which are in the process of development of their capabilities.

According to their mandate transmitted through the security strategy, member states have decided, the European Council in June 2004, adopting a new approach as regards the development process of European capabilities in security and defense. From this perspective, the overall objective was adopted by the new EU (Headline Goal 2010 - *HG 2010*) aimed at EU steps focusing on improving quality of defense capabilities, and adaptation to the requirements through security strategy.

In a concrete way, *HG 2010* covers:
- growth of interoperability of the forces EU has available, also the consolidation of dislocation capacities and the support of them;
- broadening spectrum of missions that EU will perform in spirit with the security strategy to include some types new operations such as disarming, assistance to member countries in combating terrorism and reform the security sector;
- develop the capabilities of rapid reaction force (**battle groups**) of the EU, also on the decision-making plateau (Objective that the decision to launch an operation can be taken within 5 days), as well as how to deploy in the theatre (maximum 10 days from adoption of the decision).

ESDP also includes, in accordance with the decision of the European Council meeting in Santa Maria da Feira, the creation by 2008 (the objective having 2010 as horizon), a civilian rapid reaction force made up of some 5,000 police officers, which be able to carry 1,000 of them within 30 days, for crisis management activities in areas such as policing, humanitarian aid, restoration of service of administrative and legal structures, activities search - rescue, monitoring elections, human rights, etc.. Activity institutionalization in the area of prevention of conflicts, consolidating peace and internal stability of states, areas or regions in crisis or at risk of seizures was made by, before the summit in Feira, the Committee for Civilian Aspects of Crisis Management as a fourth permanent body of ESDP. Committee for Civilian Aspects of Crisis Management submits information, recommendations and opinions Political and Security Committee.

3. CONCLUSIONS

In conclusion, we can state that since its creation, in 1999, the ESDP has made important and unexpected progress, establishing itself as an irrefutable reality of the European integration process. The way ahead still remains long and tortuous. Nowadays, the debate on the future development of ESDP involves numerous stakes like: the problem of coherence between civil and military means, the relationship between ESDP

and NATO, the issue of democratic control of the European Parliament, the issue of financing the ESDP, the issue of the EU military capabilities and of the national defense budgets. In reality, these stakes turn back to a substantive issue, this being in fact quite simple, regarding the quality of the European defense integration and of the foreign policy.

Once the ESDP was created, the question of its relationship with NATO has turned to be particularly acute for a number of reasons. Among those are: the clear definition of the European states intervention frame, more exactly under NATO or outside NATO; the rigorous establishing of the value added by ESDP in relation with NATO.

The European Security and Defense Policy seek above all to promote greater complementarily and better coordination between different national defense policies in order to avoid duplication of functions at European level.

The promotion of a restructure of the military budgets of the member states, the rationalization of the existing resources, a better coordination in terms of equipment, a timid opening of the defense markets represent important objectives of the ESDP. In fact, such ambitions are aimed at strengthening military capabilities, today too fragmented, and at encouraging greater investment in defense.

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CONSCIOUSNESS CONSOLIDATION IS CHANCE GROUP LEADERS LEADERSHIP

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Abstract: The imperative of the present is the fact that no science, and the management science makes no exception, can and must ignore the issue of the values. Why so? The reason is the any science free from the moral values no longer serves the values of the humankind. Among these, the most urgent, imminent and vital to solve is the issue of the evil, whether at an individual level or the group level, or even at the level of the organization.

Keywords: management, development, efficiency, responsability.

1. THEORETICAL AND PRACTICAL CHALLENGES OF MANAGEMENT SCIENCE

More clearly than any time, nowadays we understand the fact the major threats posed to our survival no longer come from the outside nature, but from the human inner nature. The question to which an answer must be given without delay is:

"How can we temper the potential evil in the human soul, with the same kind of detachment, discernment and rigour with which we, humans, look at the outer world?"

Whether we are or are not yet willing to admit, this is not about mere theoretical difficulties in the study of the phenomena specific of the management science, which might appear in the context of the scientific managerial practise when we approach such issues as:

1. **The issue related to the construction of the moral judgements** (the imperative need to apply, construct, update and re-apply the ethical codes in organizations);

2. **The frequent and sometimes intentional confusions between opinion and scientific fact** (the need to replace autocracy by authoritarianism);

3. **The mistaken use of the scientific information by Machiavellian or uninformed bosses** (the painful need to use the job specification and the individual performance assessment report in tandem as dynamic instruments);

4. **The issue of the risk of a too great closeness to the organizational evil** (individual/group) **when the bosses get too close to look into the organizational evil.** There is no doubt that by avoiding or, on the contrary, tackling directly such issues as those mentioned hereinabove, these difficulties might make the bosses in an organization become the victims of the present.

Much less is the risk of developing the psychology of the organizational evil as science than that of failing to turn the human evil into a rigorous scientific subject matter.

2. ORGANIZATIONAL EVIL – IMPERATIVE QUESTION OF VALUES

How about those destined to lead nowadays? Are they endangered by their own activity? I believe so.

There is no other way to squander the organizational entropy than that of the individual who plays the role of a healer, as a person willing to fight the battle against the

evil lurking behind the appearance/claim, while wrestling the evil itself.

Greater than the risk of death of physical crippling is, in this context, the risk that the employees of the organisation may get a hurt or corrupted soul. This is the reason why, a person is recommended to promote to a managerial position not only by a Degree in management, but also by a lot of maturity and a real capacity to fight less common things such as **resistance and counter-transfer.** A light-hearted boss will be vulnerable.

But let's not get self-deceived: **the danger exists not only for the people in managing positions in an organization, but also for any employee becoming preoccupied with the topic of the eradication of the organizational evil. There is always the risk of contamination in one way or another. The closer we rub elbows with the evil, the more likely it is for us to become evil ourselves.**

Someone once said that all scientists should start searching for the scientific truth by reading Aldous Huxley's *The Devils of London*, the most comprehensive work on evil contamination, made of a historical analysis of some evil events that took place in a French city in the 18th century. Reduced to the essence, the message of the book is the following:

"The outcomes of constant and intense concentration over the evil are always disastrous." Those who go on a crusade against the evil in the others and who don't start fighting the evil in themselves for the sake of God will never succeed to make a better world, but will leave it as it was, or sometimes even sensibly worse than it was before they had started the crusade.

One must become aware of the danger in the sense that by thinking of the evil first, we, as humans, non-regardless of how high our pretensions are, tend to create opportunities for the evil to become manifest. **No human being can focus on the evil or, al least, the idea of evil, and stay untouched. One must bear in mind the fact that fighting the evil is extremely dangerous for anyone other than God.** He/she will be hunted by his enemy's

cunning, which becomes, in a certain way, a part of him/her.

Bearing these in mind we can understand the danger represented by the misuse of science. **It is not the wrong doing of the scientists, but that of the uninformed individuals who use scientific discoveries for questionable purposes.** The atomic bomb, for instance, was created through the scientists' work, but the responsibility for the decision to build belongs to the politicians, and the launching of the bomb is done by the army. On the other hand, the fact that the general scientific information is often misused by the public doesn't mean that we are in a worse situation than that in question. Why so? Because while the snobs might try to shock at parties by trying to use such terms as "… envy", "fear of castration" or even "narcissism", many of us would admit the reality of our own subconscious, which for some might be the seed of salvation.

Unquestionably, the evolution leap of humankind is related to the liberation of the individual from the mental routine that causes resistance to development, and this can be possible through the dissemination and internalizing of the scientific information in key domains such as psychology and management.

Finally, a refinement of the knowledge of the public in respect of the evolution of the managerial culture and the scientific management in confrontation with the psychology of the evil will serve to minimize the abuse of this psychology. Certain things are already known, beyond all doubt.

One of them is the tendency of the evil one to protect the evil in the others. What do we understand by the projection of the evil? Here the evil has to do with the unnatural death through the murder of the spirit following the transformation of the individual into an obedient automaton, by stripping him of his/her humanity. How can that be possible in a modern organization of our times? **In the simplest possible way: by using the power of the number (in the personal policy of the bosses/subalterns), for the purpose of destroying the others to defend and**

preserve the integrity of the diseased self, (here the evil being considered a disease).

Incapable or just unwilling to face his/her own sin, the evil individual must justify it by accusing the others of their flaws. The more we get to know the psychology of the evil, the more we become capable to track those who cast the stone**. It is characteristic of the evil ones to judge the others as being evil. Incapable of acknowledging their own imperfections, they must justify their flaws by blaming the others and, if necessary, they will destroy the others in the name of correctness.**

This phenomenon is unfortunately quite widely met, starting from the martyrdom of the saints, Christ the Savior's sacrifice, but also the atrocities of the inquisition, the Nazi holocaust, the MYLAI massacre, the events of Romania in 1989, the events in Targu Mures in 1990 etc., so that it becomes obvious that **whenever we judge someone as being evil, we might commit the evil act ourselves.**

3. CONFRONTATION BETWEEN PSYCHOLOGY OF EVIL AND MANAGERIAL CULTURE

The evil is a moral judgment and we may suppose that it could be scientific judgment as well.

Warning! Making the evil a scientific judgment won't remove it from the moral sphere. Science is as dangerous as the moral judgment.

How will we dare mix them? I don't know! But I am certain that it is impossible and, at the same time, deeply wrong to refrain from making moral judgments when we analyse ourselves or, in fact, live our everyday lives. If, as employers, we needed to hire someone, should we take the first person coming or interview a number of candidates and pick one of those?

What sort of mother would I be if I discovered that my daughter was a cheater, a liar or a thief and I didn't criticize her?

What must I tell my subaltern who threatens to kill him/herself when I request him/her to meet the requirements of his/her position?

The question is **whether it is fair or not to associate kindness with excessive sympathy, tolerance and permissiveness.**

Each of us should answer this question for him/herself. I believe we cannot live a decent life by making judgments in general and moral judgments in particular.

Whether we admit it or not, we all make decisions that betray our attitudes layered while living different sorts of personal life experience, many of them having moral implications.

"Don't judge in order no to be judged" is usually told outside the context, by misinterpreting the Saviour's words. In fact He is teaching us that, before judging the others, we must judge ourselves. The potential evil in the moral judgments makes necessary the purification by means of self-analysis and the acknowledgement of one's own mistakes. Christ the Saviour didn't teach us to always avoid the moral judgments, but to get purified before making them.

Any leader must remember the purpose of his/her own decisions, **that of curing.** When the purpose of the individual is only that of strengthening or enhancing self-respect and personal pride, his/her decision is, doubtlessly, mistaken. **Any judgment of the someone's evil must be justifiable by the expression, considered fatalist by some, "Only for the gift of God walk I!"**

The question is:

"Is fatalism fatality only?"

Is the purpose of life for us to prepare to die? Even though we will never discern the entire significance of human life, nor the reason why one is good or evil, what we are left with is the freedom, or more exactly the responsibility to live as correctly as possibly. **This involves making moral judgments necessary to support life, choosing to live in a state of ignorance of a higher or lesser degree.**

Therefore the question is not whether we must or mustn't judge. **We definitely need to do so.** The issue is how and when to judge wisely. Our great spiritual leaders have provided the fundamental teachings. And because we are those who must make moral judgments, it is absolutely necessary for us to

140

refine our wisdom by applying methods, concepts and knowledge, by remembering the fundamental teachings.

Few of us understand the limits of the science of management, and much less those of science in general. The reason thereof might be the fact that we, humans, are much too dependant on the authority, in general. We are used to regarding science as the supreme **truth** and we are wrong, because what we don't understand in fact is that the **truth cannot belong to someone in particular and cannot be possessed**. What is the truth then?

The truth is a purpose that we strive to attain full of hope. To put it otherwise, we must try to judge over the good and the evil ourselves, being made responsible by the free will, which is too important to leave aside for the scientists alone.

Making sure that science stays exact, founded on a democratic culture in which open debate is encouraged is the best measure of protection against the misuse of the concept of evil by scientists or anybody else.

In a paradoxical way the foundation of anything that has ever been built is the very banality of the orders given and executed by the individual, the fact being given that in the last resort however, each and every human act or deed remains the result of an individual choice. Moreover, it has been proven scientifically that human groups tend to behave like the individuals, only to a more primitive and immature level. This is also the cause of entropy in certain organizations.

4. POSSIBLE CAUSES OF CONSCIOUSNESS DILUTION GROUPS MET IN AN ORGANIZATION

The question is:
"Why is the group less than the sum of its components?"
"Why is group behaviour so strikingly immature?"
The science of the organizational behaviour and psychology reveal some of the causes.
- The first and hardest to control cause of group immaturity is **specialization.** The issue of group specialization must be tackled with as much caution as required for a nuclear reactor. How can specialization lead to immaturity in a group? Answer: "**through the fragmentation and dilution of consciousness**", i.e. through the transfer of responsibility to another part of the group. What does the lack of responsibility lead to? Answer: There are two inauspicious consequences of the dilution of the group responsibility: **incorrect action** (materialized in fraud/abuse/ atrocities) and **cover-up** (either due to fear, or due to the refuse to assume the committed evil owing to the fact that is not perceived as a correct or rightful action).
- The second possible cause of a group immaturity is **chronic stress**. In a situation of prolonged stress, an overwhelming majority of a group's individuals have the tendency to either **regress,** behaving in a primitive manner and abandoning their moral principles, or be **psychically paralyzed,** adapting themselves up to the point of numbness, not being able to respond to other people's suffering or their own. It is a scientific and not only religious fact that **stress is a test for goodness**. **The people who are genuinely good are the ones who do not abandon their integrity, maturity and sensitivity in times of stress. Nobility can be defined as the ability of not regressing as a response to degradation, of not becoming insensitive to pain, of tolerating torment and remain unchanged. "The best measure of a person's greatness is the capacity to suffer" (M. Scott Peck).**
- The third cause of a group immaturity is the **leader dependence.** There are relatively few persons with genuine managerial abilities. In fact, most people want to be led by others. Why? I think the reason is laziness. It is unquestionably much easier to be led than to be a ruler/manager/leader because:
   - there is no need to make decisions for others or on behalf of other people;
   - there is no need to make plans;
   - there is no need and you really don't have to exercise your initiative;
   - there is no need to assume the risk of being unpopular, inconvenient;
   - there is no need to prove out one's courage.

In fact, by assuming the role of subjects, the members of the group hand their personal power, their command of themselves, as well as the maturity to decide on their own behalf to their leader. Thus, they consent to depend on the ruler/manager/leader of the group just as a child depends on his/her parents. It is a scientific fact that **as soon as he/she becomes the member of a group, the average individual has the tendency to regress emotionally**. Through the nature of its mission, the army cultivated regressive dependence that naturally appears in the individuals of a group. Therefore, one can rightfully ask, **what should mature, independent thinking mean for the members of a group**, even a military one? A famous experiment conducted by Stanley Milgram gave the answer to this question: **mature independence means to refuse to obey an illegal order.**

- The fourth cause of a group's immaturity resides in **narcissism.** Like everything else in this world, this concept is considered to have a good side and a bad side. In its benign form, narcissism stimulates the **group cohesion,** acting as a corpus spirit. Rulers have always reinforced the group cohesion in times of failure by channelling the member's hatred towards something alien and hostile. The malignant form of narcissism appears in the **construction of the enemy** or in the **hatred towards a scape-goat**. In this case, the responsibility of the group disappears and all that matters is cementing the group through the arousal of hatred towards an external enemy. In the most serious cases, the external enemy coincides with what the group members perceive as different from them and thus every attempt to evolve is brutally stopped. Therefore, the group's deficiencies are overlooked by focusing one's attention on the flaws of a scape-goat or another rival group. The malignant narcissistic behaviour of evil individuals who avoid assuming their guilt or self-analysis, placing the blame and trying to destroy anyone who discloses their deficiencies develops in a natural manner inside groups. The group that fails is likely to behave in the worst manner. Failure hurts their pride and this is the reason for an animal and

rebellious behaviour. In the case of a healthy organism (individual/group), failure is the most efficient way and at the same time a stimulus for self-analysis and criticism, leading to the lessening of pride and cohesion in order to create the premises for change and adaptation, survival and evolution.

On the whole, specialization/chronic stress/dependence/narcissism are part of the causes that have been scientifically proven to dilute the group's consciousness and dissipate the responsibility of its members respectively.

5. CONCLUSIONS ABOUT WHAT SHOULD BE DONE

Besides rational solutions such as:
- transparency in corporate communication;
- eliminate the causes of pathologic communication in organizations;
- organizational redesign activities in accordance with the organization's strategic objectives;
- increasing professionalism of the organization's employees;
- knowing and respecting the lows in force.

The means of correction that can and must be used as a response to the immature / irresponsible actions of groups are known or should be known by the holders of managerial positions in organizations. In practice, these employees must be seen as persons with the capacity of acting in real time within the organization, at the price of risking their own spiritual integrity in a face-to-face combat with the organizational evil, by accepting that:
- evil is opposed to life, nevertheless being a form of life;
- by trying to destroy evil we come to destroy ourselves spiritually, if not physically;
- man's life has its own purpose in the battle between good and evil;
- the hope that good will prevail gives one a reason for living;
- evil can be defeated through goodness;
- evil can be conquered only by love.

The way of love is a dynamic balance of opposite poles, a painful creative tension of uncertainties, a difficult path between extreme actions.

Those of us who are blessed with a ruler's vocation must be tolerant and intolerant, rigid and flexible. An almost godly compassion is needed. It is not easy to embrace ugliness with the sole hope that, in an unknown way, it could turn into beauty. But the myth of the frog that turns into a prince remains. Love works in many ways. And none of them is foreseeable.

A thing that is beautiful up to transparency happens when, through God's grace, someone comes to love one's enemies. It is as though the malignant energy were burnt up, drained, mastered and neutralized by the light. The process could be painful for the carrier of the light, sometimes even fatal. But this does not mean that evil succeeds; on the contrary, it retreats because, like someone said:

"Evil was the one who lifted Christ on the cross… and this is what made us see Him from a distance."

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A BRIEF HISTORY OF ACTION RESEARCH

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Abstract: *This article presents a brief history of the action research, starting with Kurt Lewin's contribution (1946). Right from the start, the action research was conceived as a methodological alternative to the mainstream science, but it is still little used, including in Romania.*

Keywords: *action research, methodology, positivism.*

1. KURT LEWIN'S CONTRIBUTION

The action research began to assert a distinct type of research in the social and human sciences after 1946, following Kurt Lewin's publication of his article: *Action research and minority problems*. The American (of German origin) psycho-sociologist Kurt Lewin is considered the „father" of the action research (especially since he is considered to have created the term, although John Collier used it in the same way a year before Lewin) and the delimitation of the specificity of this type of research is one of his major contributions to the development of psycho-sociology. Also, Jacob Levi Moreno's contribution to structure this type of research is noticed in most works devoted to the history of the action research.

A number of authors (Kock et.al., 1997; Baskerville, 1999 etc.) show that in parallel with Kurt Lewin's work at the University of Michigan,Research Center for Group Dynamics, similar research was developed (independently) at the *Tavistock Institute of Human Relations* in London on disorders being suffering from by the soldiers who fought in the Second World War. Also, James McKernan (1991, 8-9) identifies a number of similar research (Collier, 1945, Lippitt and Radke, 1946) immediately after the period when research was carried out by Lewin or by the Group from Tavistock and links the

emergence of the new type of research to the „Science in education" movement, active in the United States during the period between the XIX and XX centuries, as well as to a series of re-conceptualization of education within the same cultural space, especially those of John Dewey (e.g. description of problem solving). Kurt Lewin's contribution is regarded as fundamental as he is the first author who conducted a systematic methodological reflection on the specificity and way of realization of the action research.

The idea of action research was based in the 40's by Kurt Lewin, in an attempt to connect social theory and practice. Lewin considered at the time that there was neither a relationship between social theory and social action, nor collaboration between scientists and practitioners, who should use the scientific results in their work. While scientists developed the theory without taking into consideration its applicability, practitioners in the social field engaged mostly in actions without being informed, so no one could talk about consistent results in any of the two „worlds": the abstract, the scientists' one, and the real one, of those who build the intervention strategies and work towards the social change. Bringing together these two worlds and the combination of the research with the action would result, in Lewin's conception, in the production of information and solutions that would result in informed

actions, improved behaviors, and strategies of encouraging social change.

Lewin (1951) brought the cycle of action research approach, designed as a series of activities: identification of an initial „idea", fact-finding, planning, action, evaluation, developing a better plan and implementing it, then followed by the resumption of these activities to further understanding of the situation and formulating a theory as close as possible to the actual situation [13].

Besides the article from 1946, Kurt Lewin developed the concept of „action research" in two other articles, which appeared in 1947. Although he developed the first theoretical approach and described for the first time the cycle of action research, Kurt Lewin has failed (due to his premature death, he was only 57 years old) to further articulate his ideas on this type of empirical research.

At sixty years after the publication of the article *Action research and minority problems*, David Bargal [3] and has assumed the task of formulating the principles of the action research, by extracting them from Kurt Lewin's three articles:

1) Action research combines the systematic study - often experimental – of some social problems with the solving efforts. In contrast to the traditional scientific model, where the researcher's main task was that of understanding the problem, in the action research one studies the problem and offers opportunities to intervene to solve it. The implementation of this principle requires a very good knowledge of the theories on the studied social problem, starting from the dictum „There isn't a more practical thing than a good theory" (Lewin, 1943/1951, 169).

2) The action research includes a data collection spiral setting the purpose for action to achieve results and assessment of intervention. Lewin designs the action research as a process of problem solving that takes place in a constantly changing environment. Therefore, in principle, there isn't an end of the intervention as problems to be solved arise permanently. For each process of solving a problem, the following stages are taken: data collection to determine the purpose of the

intervention; the achievement of the goals (through the intervention of the individual groups, organizations or communities) and the evaluation of the completed intervention.

3) The action research requires feedback from all parties involved in achieving it. The feedback can show deviations from the aim of the intervention (alterations in the original plan) and may exhibit discontinuities in the process of the intervention that are thus corrected in real time. This principle emphasizes the active role of all parties involved in the research project, including the customers (who are usually excluded, not having access to the information available to those carrying out the research).

4) The action research implies continuous cooperation between researchers and practitioners. If within the framework of the conventional scientific research model the investigator has exclusive control (being the only one familiar with the research hypothesis, the selection of participants, etc.), within the action-research framework the scientist and the other people who carry out the research are equal partners in making decisions. This cooperation is based on the recognition that the participants should be responsible for making decisions affecting their existence and they need to understand the reasons for the intervention. Because they are the researcher's equal partners in the project of intervention and know the reasons and decisions that were taken up, the participants can maintain their motivation at a high level.

5) The small group plays a central role in making decisions and changing individuals. For Kurt Lewin the small group is the most important vehicle for making decisions democratically, and the change of individuals through it goes through three phases: a) defrosting (reduction of forces that are keeping pressure on the current situation, by presenting a problem or a challenging event, with the aim to determine the organization's members to recognize the need for change and seek new solutions), b) the change itself (changing group members' behavior by developing new behaviors, values and attitudes), c) freezing (through the establishment of new procedures

and systems to support and maintain the change made).

6) The action research takes into account the values, goals and aspirations for the power of the parties involved. Since each person involved in the action research has its own set of priorities and values, the only way to ensure the success of the research is to approach the occurring conflicts in an open way. Again, one can notice the contrast with the classical manner of approaching the research, where only the person carrying out the research has the power to make decisions and resolve conflicts unilaterally.

7) The action research serves to create knowledge, to formulate the principles of intervention and evaluation. Regarding knowledge, it generates both data collected and processed in the same way as other types of research and „actionable knowledge" (important both for the intervention and for improving, in time, the group's, organization's or community's functioning). Also, the group can use the measuring instruments/tools used in the action research long after the intervention, as assessment tools.

8) In the action-research one focuses on recruitment, training, development and support of the change agents – the trainers. Since action research aims to social change, these investments in trainers (the change agents) may be considered essential, since they are the principal means of achieving the wanted social change: "In Lewin's definition, the action research is portrayed as a triangle: the training is the first leg and the other two are research and intervention. In contrast to the usual research, the trainer's role is beyond data collection and management of the evaluation process. The action research trainer needs a thorough understanding of the participants who take part in the intervention and should have the appropriate means to achieve the goals of the research. For this reason, the appropriate trainers' selection is essential, as well as providing them guidance and support during the intervention" [3].

Another way of interpretation of Kurt Lewin's contribution to the substantiation of the action research is the identification of the

essential aspects of the paradigm of this type of research. For W.J. Allen [1] Lewin's fundamental presumption is that effective social change depends on the engagement and understanding of those involved in the process of change. Richard Baskerville [4] identified two such assumptions: a) that reductionism is not effective in addressing complex social systems, b) that action brings their understanding. For Bob Dick [7] the essence of the action research is given by the simultaneous presence of the following characteristics: it serves both research and action, knowledge is produced in a cyclical manner, and the presence of a critical reflexivity component within each cycle of research.

2. CURRENT TRENDS IN ACTION RESEARCH

In relation to the effervescence recorded in the mid-twentieth century, during which several authors can be credited with remarkable contributions to defining the action research, further development of this distinct type of research has been slow [4]. Bob Dick [8] characterizes this trend as being caused by a „strange neglect" of this type of research, especially when this approach succeeds in drawing near the results of the research to the action desired by the practitioners from different social fields. As for us, we systematized the factors that have slowed down the affirmation of the new paradigm (described disparately in the literature) in the form of the following categories:

a) The existence of the ongoing controversy on the interpretation of Kurt Lewin's contribution to the delineation of the action research as a distinct type of research. As the „father" of this paradigm did not finish his work, the detailed interpretations of his contribution (the extraction of principles and basic assumptions) are relatively diverse and numerous. As a result, even the theoretical basis of the new methodological approach seems a shaky one, despite the fact that the American psycho-sociologist was its firm supporter: "His energy devoted to the action

research during the last years of his life and his efforts in establishing the Center for Group Dynamics shows a real passion for the new paradigm. In his memoirs about his father Miriam Lewin (1992) writes: „I think action research was a part of his response to the tragedy caused by the death of his mother (Lewin's mother and his aunt were killed by the Nazis - David Barge). The memory of violent anti-Semitism and discrimination in Germany, delicately expressed in his letter to Köhler (1933/1987), was clearly the impetus for his efforts to ease tension and discrimination to which minorities were subject to in the United States" [3].

b) „Opposition" with positivism. Nereu F. Kock, Robert J. McQueen and John L. Scott (1997) note that, since its beginnings the action research was „evangelized" by its practitioners and intensely criticized by those who defended the positivist approach. Because the practitioners of the new type of research presented it as a methodological alternative designed to overcome the limitations of the positivism, the impression that action research and positivism are guidelines for research that were exclusive was created. The created opposition is unrealistic at present, since positivism is an epistemology that guides the dominant power in science (the mainstream science) and the action research, in relation to positivism, can not be more than one particular way of addressing the research (emerging as the need for intervention to solve a social problem, which is accompanied by a careful theoretical study and the analysis of results).

Starting from this observation, there are attempts to „reconcile", based on the description of the classic studies of action-research (including Kurt Lewin's) in positivist terms as a particular form of the field experiment, conducted with little control of the variables [11]. Moreover, it should not be forgotten that the „father" of the action research remained in history as one of the psycho-sociologist with the most remarkable experimental results and did not make a demarcation between it and positivism.

Several authors suggest that the declared opposition could become a genuine one, by

developing an epistemology based on the paradigm of the action research, which show some real differences from the mainstream science.

c) The way of financing the social and human sciences during the postwar period, based mainly on public funds, encouraging mainly quantitative research, to the detriment of the quality. Action research, as a type of predominantly qualitative research, was one of the „victims" of this funding mechanism [4]. Perhaps this is the reason why a series of statements minimize the action research, classified as „fans' science" or „the poor's science" [10].

d) Social Activism (sometimes of a radical type) adopted by some followers of the action research was appreciated neither by the positivists, nor by the governments (the principal donors of the research programs). Among the best-known examples in this respect there are the approaches made by Paulo Freire and Orlando Fals Borda in South America. Due to the social activism, the action research was seen as a less desirable type of research and was not financed very well.

e) Attempts to „corrupt" the action research (reinterpreting wrongly Kurt Lewin's essential concepts) derived both from those who practice it (giving up generating theories and testing them, trying only to ensure successful interventions) and from those who try to increase the rigor by experimental designs, bringing a deployment of theory to reality, producing research results largely irrelevant [2]. Because of these attempts, a „distortion" of the action research over the way it was originally conceived took place [10].

f) Strong assertion in a limited number of fields of study (such as school development or health care) and its discreet presence in the most areas. The possible causes of this trend are the affirmation of the experiment as the main method in psycho-sociology and the fact that higher education has a certain tendency to conservatism in terms of teaching and learning the research methodology [4].

The action research is less important among the academic concerns, but, in recent

years, it has become more substantial precisely because of the need to create bridges between theory and practice, because of the need to apply research results in social intervention strategies, being adopted by international organizations as part of the social development programs.

Although in many studies one can identify elements of the action research, they do not always bear that name. Sometimes, the emphasis is placed on the idea of participation, sometimes on action, but the final concern is always the resolution of the social problems. Most applications of this approach are found in areas such as the organizational change, the social policies, the social assistance and the information systems [13].

Due to these restraining factors, the action research has not had a spectacular evolution, except in some clearly defined sectors and scientific communities dedicated to practicing this type of research. Despite the fact that it has more than six decades of existence, the action research can still be considered a paradigm emerging globally [5].

In an article which suggested reviewing the literature on the action research, Bob Dick [9] listed a number of areas of psychosocial intervention for which there are the most publications: community development, health, education and applications in different types of organizations.

The author identified a number of trends in the current literature: an increase in the volume of articles that use the action-research methodology, researchers' increased concern for the community and increased attention to practical details that can obtain the participants' participation and involvement.

3. ACTION RESEARCH IN ROMANIA

As regards Romania, the action research was used very rarely, and in a review of the works appeared in 2004 (Lambru and Mărginean) such an approach was noted as „among the first examples of the application of the action research in our country". However, the action research is not a novelty in the Romanian literature: Pantelimon Golu presented Kurt Lewin's contribution, and

Henri H. Stahl described the „centering on *action* as a common platform for all the particular social disciplines".

This timid practice cannot be explained by the absence of the latest local sources of information, because there are many authors who presented the action research in their work on the methodology of research, community development, or psychosocial intervention. In this regard, we will give three definitions of the action research extracted from volumes published in the last decade:

1) „An attempt to associate the social and human sciences to the action which a power can develop in different sectors of public life (political, educational, administrative, economic). It is a new kind of applied research, a new general methodology of the action issues, a praxeology of administration, difficult to dissociated from a pedagogical intervention" [12].

2) „A process of diagnosing problems, planning and implementing actions to reduce or eliminate the disruption, while monitoring the induced social changes" [6].

3) "It is an iterative process, involving a series of activities, including the diagnosis of social problems, social intervention, the analysis of the results of the intervention, the adjustment of the strategy of the social intervention" [13].

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Complex systems: Outlook for a general theory (Spanish: Sistemas complejos. Perspectivas de una teoría general). By Germán A. de la Reza. Published by Anthropos, Barcelona, 2010, 175 pp., ISBN: 978-84-7658-964-9, 12,00 €

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The general conjecture here is that systems theory should and can establish the guidelines for a rigorous study of complexity in social sciences. As German de la Reza states, this means placing it at the intersection of various methods and theories that share postulates and derivations in the form of a meta-science. It also implies –we might add– the recognition of the seriousness of its normative gaps. As this book cannot embrace all the disciplines –their simple enumeration would fill several pages– the author focuses on the concepts and applications in economics and sociology, and on the research methodology.

The first part of *Complex systems* eruditely explains the evolution of systems models and their versatility in adapting themselves to distinct objects of study. Their intellectual trajectories are analyzed from the origins up to the encounter with the most recent postulations of systems theory. Whoever is familiar with the systems literature will detect the inclusion of non-traditional themes, such as the *ars combinatoria* and the law of identity; the recovery of certain issues that have fallen into disuse, such as the law of variety, and others of a more incontrovertible approval, such as the Gödel's incompleteness theorems, and Luhmann's theory of self-reference. This part of the book, the author explains, responds to the need to broaden the field of ideas, techniques and applications of systemic character.

In the second part, De la Reza analyzes the major concepts of systems theory, above all those susceptible to developing new methodological tools. According to its plan, this section seeks to satisfy two important demands for the social sciences researcher: conformity with the latest scientific advances, and the handling of imprecision within the parameters of experimental study. It cannot be ignored that these objectives put the book into a tense relation with the canons of systems theory, although in general they fit in with the traditional subject-matter defended by Bertalanffy, Rapoport, Ashby and Boulding.

The plan of the third part is to "build a coherent response to the crisis of systemic

application to the experimental social sciences". De la Reza first analyzes the basic elements for model-building, including rules and systems controllers. In the next chapter, he examines the application of entropy to economic processes and presents a systemic based model coherent with Georgescu-Roegen expectations: like the illustrious Romanian, he seeks to overcome the cyclical focus of economic theory. In the third chapter, the author studies complex systems from a normative point of view. The project is ambitious and is constructed as a program to renovate systemic applications in the social sciences.

The last three chapters of the book are devoted to various existing methodologies: the problem solving techniques, expert systems, and active research. Their presence in the third part seeks a contextualization, although its connection with various issues studied in the first part gives a circular form to the work.

Some of its recommendations made me both worried and hopeful. Worried because they require large scientific resources at a time of anemic economic recovery; they fill me with hope because their enunciation is clear and precise, leaving me to assume that a large part of the way forward is illuminated. Some recommendations about systemic methodology are really inspiring. I cite just two of them: (a) It is necessary to transform the linkages between macro- and micro-economics in a self-referencing system; (b) in a complex system, optimal equilibria and hierarchical levels are closely interconnected.

Altogether, De la Reza provides us with a clear and concise intellectual product, whose recommendations could have radical implications not just for systems theory, but also for the philosophical approach to the social sciences. There are books that fill spaces in the organization of scientific work, and which are indispensable for the formation of the researcher; this is, undoubtedly, one of them.