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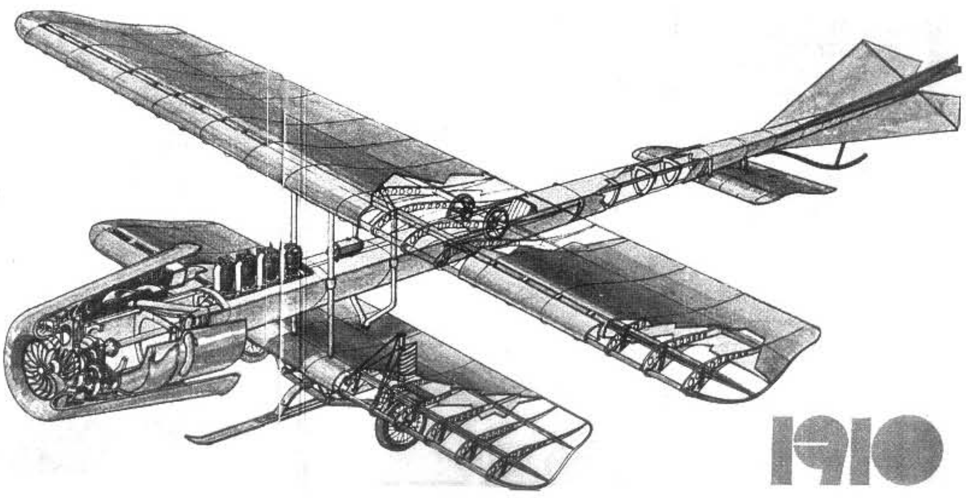

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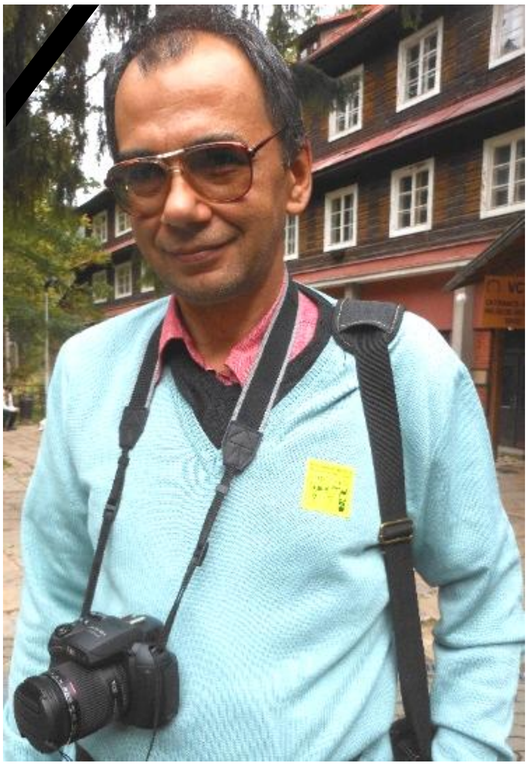

Cristian George CONSTANTINESCU

Magicianul din E-39

"So spoke the wizard in his mountain home"

O știm cu toții: pe domnul profesor Cristian Constantinescu nimeni nu poate pretinde că l-ar fi cunoscut prea puțin ca să conteze – și nici nu cunosc pe nimeni care să și-l amintească cu ranchiună. Mai degrabă rămâneai cu senzația, chiar de la primele conversații, că magul din balada *The Wizard* a trupei Uriah Heep există, *working undercover* – și nimic nu venea, nici mai apoi, să contrazică această primă impresie. Pentru că domnul profesor era în mod evident un om cu gesturi magice: gesturi aparent simple, dar care ne-au făcut, cred, tuturor (colegi sau studenți deopotrivă) viața mai frumoasă, mai fericită, mai bogată... sau, alteori, suportabilă.

Au fost momente când domnul Constantinescu mi-a răspuns înainte să întreb, m-a ajutat când nici nu mă gândeam că aș putea să i-o cer, m-a îndrumat spre explorări ale propriului potențial pe care altfel nu aș fi avut niciodată curajul să le închipui. Și totul pornea în modul cel mai firesc în pauza dintre cursuri, dintr-o discuție aparent oarecare, de la micile revederi sau răscruci cotidiene. Adevărat, se mai întâmpla, din când în când, să avem, unul sau altul dintre noi, privilegiul de a primi o invitație (întotdeauna informală) în sala E-39. Și toată lumea știa că aceasta era, fără excepție, o invitație la explorare: ne așteptau acolo, de obicei, cele mai ingenioase *gadgeturi* – pe care nu am înțeles niciodată exact din ce joben le extrăgea cu atâta naturalețe și nici în ce fel reușea să le mânuiască cu o dexteritate de *n+1* ori mai tinerească decât a mea. De altfel, laboratorul unde își petrecea orele de muncă – ore pe care nu se ferea să le extindă la nevoie, ca și cum spațiu-timpul ar fi fost vreo jucărioară nesemnificativă (dar poate că și era) – funcționa ca un soi de peșteră fermecată, în interiorul căreia ori de câte ori călcam, ca într-o altă lume, îmi venea să rostesc pe ascuns un „Sesam, deschide-te!".

Pentru că știam că trecând pragul, aveam să mărturisesc din nou vreun mecanism extraordinar – electronic sau al lumii, diferența nu era oricum notabilă între una și cealaltă, fiindcă la domnul profesor totul funcționa ca un continuum vrăjit, între fumul de țigară prin ploaie și butonul Kashtanului fermecat din sala de clasă, între priza din perete și Pink Floyd, între tableta grafică cu formule alambicate scrise de mână pe ecran și studenții plecați acasă, la sute de kilometri distanță (depărtările se anulau aici și ele, brusc, ca prin vrajă), în fine – între toate acestea și viață, cu toată intensitatea ei (uneori) ireală. Așadar, cum spuneam: magie.

Și culmea, domnului Constantinescu nu-i trebuia mult: puțină conversație aparent oarecare, și rezolvările sau inspirația veneau să dizolve pe loc orice anxietate măruntă a zilei. Gestul magic se petrecea întotdeauna *l'air de rien*, aproape neobservabil și fără preț: nimic nu ți se cerea vreodată în schimb – în afară, poate, de promisiunea de a deveni tu însuți mai bun, mai inteligent, mai profesionist, mai fericit. Căci omul și profesorul Cristian Constantinescu au fost mereu, în modul cel mai autentic, unul și același lucru: o raritate, unul dintre aceia dintre noi care au înțeles că nu poți să fii una fără cealaltă. Că adevărata forță pe care o deținem este libertatea de spirit. Dar și că pentru a fi cu adevărat liberi, trebuie să știm, să cunoaștem, să îndrăznim, să ne dedicăm fără rest lucrurilor în care credem – fiindcă (nu-i așa?) nicio baghetă magică, oricât de fantastică, nu poate face minuni în mâna unui scamator.

Acum, domnul Constantinescu s-a înălțat, cu toată acea demnitate supraomenească pe care numai curăția și nefalsificarea de sine o pot conferi unui om în fața marii probe finale. Îi voi prețui amintirea cât voi trăi. Iar apoi, îndrăznesc să sper că ne vom revedea la supremul concert, acolo unde muzica nu se dă mai încet niciodată. Până atunci, însă, nu cred că ne putem onora mai frumos prietenul, colegul, profesorul, decât încercând să… menținem ritmul. „*We cannot just write off his final scene.*” We have to „*take heed of the dream*”.

Ramona Hărșan

The Wizard of E-39

"So spoke the wizard in his mountain home"

We all know it for a fact: no one can claim that they knew Professor Cristian Constantinescu too briefly for it to matter – and again, I can't pretend to know anyone who may remember him with resentment. The feeling one rather had, right from the first conversations, was that the magician in Uriah Heep's ballad *The Wizard* actually existed, working undercover – and nothing ever came, not even later, to controvert this first impression. Because the professor was obviously a man of magical gestures: seemingly simple, they had the power to make, I dare say, all of our lives (colleagues' and students' alike) happier, richer, more beautiful... or, at other times, bearable.

There have been times when Mr. Constantinescu answered my questions before I had even asked them, helped me out when I couldn't even dream to turn to him, or guided me through explorations of my own potential I would have never had the courage to imagine otherwise. And everything would always start in the most natural way, during the break, from an apparently ordinary discussion, at small reunions or daily crossroads. True enough, he would sometimes grant one or the other of us the privilege of an invitation (which he always made sure was informal) to room E-39. It was where he had most of his classes and everyone knew that these invitations were, without exception, all challenges to explore, for the most ingenious gadgets were usually waiting for us there to try them out – to tell the truth, I never really understood from which hat he would pull them out so casually, nor in what way he would manage to handle them with a youthful dexterity *n+1* times better than mine. In fact, the laboratory where he spent his working hours – hours he seemed to be capable of extending, if need be, just as if space-time was an insignificant toy (and perhaps it really was little more) – functioned as a kind of an enchanted cave, inside which whenever I would step, as in another world, I wouldn't be able to help but secretly utter a silent "Open, Sesame!". Because I was aware that by crossing that threshold, I would consent to bear witness again to the hidden workings of some extraordinary mechanism – or of the world itself, the difference was not readily noticeable anyway between one and the other, for the professor was able to make all that work together, like a magic continuum, linking together the cigarette smoke in the rain and the button of the enchanted Kashtan magnetophone he kept on a shelf in his classroom, the wall socket and the music of Pink Floyd, the graphics tablet with twisted, handwritten formulas showing on its screen and the students who had been sent home, miles away (distances suddenly shrank there, too, as if by magic) – between all this and life, in the end, with all its (sometimes) unreal intensity. As I said: a kind of magic.

And on top of that, Mr. Constantinescu didn't need much to work it out: a little seemingly ordinary conversation, and the solutions or inspiration came to dissolve any small anxieties of the day, on the spot. The magic gesture was always performed *l'air de rien*, it went almost unnoticed and was always costless: nothing was ever asked of one in return – except, perhaps, for the promise of becoming a better professional, a better person, a smarter, happier self. This is, in fact, because the person and the professor Cristian Constantinescu have always been, and in the most authentic of ways, inseparable: he was a rarity, one of those rather few of us who understood that one cannot be the latter without the former. That the only real strength we possess is our freedom of spirit. But also, that in order to be truly free, we must know, learn, dare, dedicate ourselves without compromise to the things we believe in – because (isn't that so?) no magic wand, no matter how fantastic, can work wonders in the hands of a trickster.

Now, professor Constantinescu has stepped into a better world, with all that surreal dignity that can only originate in the absence of malice and self-falsification, intact in front of the final, the greatest test of all. I will cherish his memory for as long as I live. And then, I dare hope that we will see each other again at that great gig in the sky where the music is never turned down. But by then, I suppose the best way to honour our dear friend, colleague, and professor might just be to try and… follow the music. “We cannot just write off his final scene”. We have to “take heed of the dream”.

Ramona Hărșan

C O N T E N T S

WIND SHEAR ASSOCIATED WITH MEDITERRANEAN CYCLONES ACTIVITY AND THE IMPACT ON FLIGHT SAFETY DURING WINTER OPERATIONS AT HENRI COANDA OTOPENI AND AUREL VLAICU BANEASA AIRPORTS

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Abstract: *The regulated airspace in which aircraft flights take place is part of the Earth's atmosphere. At the same time, the same airspace is the seat of meteorological process and phenomena that have no borders and whose activity is not regulated, but whose evolution in time and behavior is governed by their own laws.*

This study presents, in a descriptive manner, low level dangerous weather conditions associated with wind shear also called the invisible killer. The phenomenon can occur locally, extremely rarely (3-4 times per year) during winter operations, mainly in January, under the activity of Mediterranean cyclones and its uniqueness consists in duration and intensity. To highlight the impact on flight safety in winter operations, especially in the current context of global warming, the reference and analysis periods applicable to this study are indissolubly reduced to days and minutes. When we talk about flight safety, the immediate application of corrective actions by pilots, the reference period is indissolubly reduced to seconds, those seconds that can make the difference between life and death.

Keywords: *Wind shear, Mediterranean cyclones, flight safety, runway, winter operations*

Acronyms and symbols

LLWS	*Low-level wind shear*	*ASOS*	*Automated Surface Observing Systems*
METAR	*Meteorological aerodrome reports*	*NOAA*	*National Oceanic and Atmospheric Administration*
WMO	*World Meteorological Organization*	*RVR*	*Runway Visual Range*
LLJ	*Low level jet*	*QNH*	*Air pressure measured at the airport meteorological station and reduced to Mean Sea Level from International Standard Atmosphere*

1. INTRODUCTION

The significance of wind shear to aviation lies in its effect on aircraft performance and hence its potentially adverse effects on flight safety. The response of aircraft to wind shear is extremely complex and depends on many factors including the type of aircraft, the phase of flight, the scale on which the wind shear operates relative to the size of the aircraft and intensity and duration of wind shear encountered [1].

Although it may be present at all levels in the atmosphere, the occurrence of wind shear in the lowest 500 m is of particular importance to aircraft landing and taking off.

During the initial climb-out and approach phases, aircraft fly at low heights and near critically low airspeeds, therefore being especially exposed to the most adverse effect of wind shear: sharp variations of lift force [5].

Low-level wind shear at the airports or in their vicinity has been cited in a number of aircraft accidents/incidents and is considered by the aviation community be one of the major technical problems facing aviation [1, 5].

This study can be a useful guide for pilots applicable in exceptionally wind shear situation, a briefing about winter operations under Mediterranean cyclones activity at Henri Coanda Otopeni and Aurel Vlaicu Baneasa Airports, a briefing based on analysis of real meteorological situations reported in METAR in the last 10 years. This study aims to be a briefing for the immediate recognition and awareness of the associated hazards that may occur locally when aircraft experience shear conditions on the runway and/or during the take-off and landing procedure.

2. MATERIALS AND METODS

The meteorological situations analyzed are based on the information in database from archive of automated airports weather observations available on the website of The Iowa Environmental Mesonet (IEM), network Romania ASOS, [12].

The Automated Surface Observing Systems (ASOS) serves as the nation's primary surface weather observing network. ASOS is designed to support weather forecast activities and aviation operations and, at the same time, support the needs of the meteorological, hydrological, and climatological research communities [17].

The primary concern of the aviation community is safety, and weather conditions can threaten that safety. A basic strength of ASOS is that critical aviation weather parameters are measured where they are needed most: airport runway touchdown zone(s) [17]. Taking into account this consideration, the Romania ASOS data archive was chosen as the main data source for the analysis of this meteorological phenomenon.

For a more accurate interpretation in scientific purpose of the meteorological data from archives available on the website mentioned above, was used simultaneously the database, graphs and charts from the archives available on https://weatherspark.com (the archive that is based on records obtained from NOAA's Integrated Surface Hourly data set), [13, 19 and 21].

The comparative analysis of the meteorological situations at the two airports from the last 10 years, from January 1, 2011 to December 31, 2020, highlights the fact that, in the context of global warming, there are significant differences between the theoretical aspects known about the low level wind shear phenomenon and the real manifestation of the phenomenon not negligible when talking about flight safety.

3. RESULTS AND DISCUSSIONS

Processing data from meteorological observations over a period of several years (e.g., 10 years) is essential for understanding the climate system to which both airports belong. The climatological particularities give only an overview in terms of the appearance, duration and evolution of the weather in general.

The meteorological conditions specific to each season (winter and summer) play an essential role in terms of scheduling flights. In each season, the weather factor is predominantly favorable for the aeronautical activities according to the schedule. Sudden changes in the weather are what disrupt air traffic at an airport.

Even reported and/or forecasted these sudden changes of the weather in the last 10 years by the way of manifestation at the airport sometimes surprised pilots with great flight experience.

We are not referring here to the effect on attitude of the aircraft and the variation of the flight parameters, but of the way in which these meteorological phenomena manifested themselves at the airport and at low levels, at their duration and intensity, aspects that are not properly known increase the chances that the flight safety is endangered.

In order to identify the effects of global warming on local shear and flight safety, meteorological data recorded and coded in METAR messages issued by the two airport weather stations in the last 10 years were processed, a period that WMO characterized as *the warmest decade on record, the warmest six years since 2015* [17] (FIG. 1).

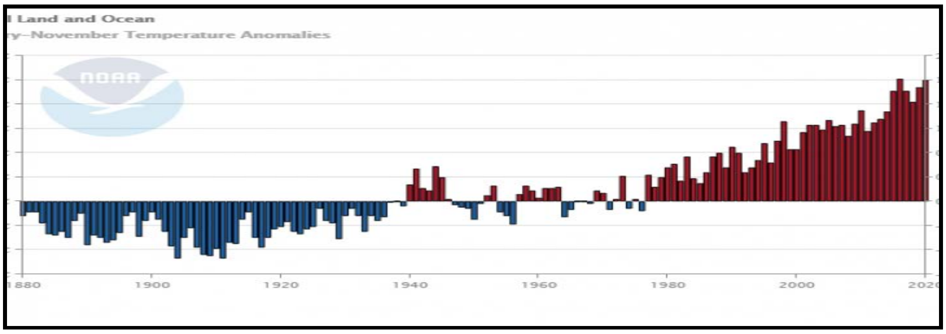


FIG. 1. Temperature anomalies 1880 - 2020

In order to present completely and in detail the unfavorable changes in the evolution of the weather for short periods of time (days, hours, and minutes) and to highlight the shearing reported in the period 24 – 26 January, 2014.

3.1. Comparison of the average weather at Henri Coanda International Airport (LROP) and Bucharest Baneasa Aurel VlaicuI International Airport (LRBS) (1 jan 2011 – 31 dec 2020)

The graphics included in this section (FIG. 2 – FIG. 9) depicts the typical weather for Henri Coanda International Airport and Bucharest Baneasa Aurel Vlaicu International Airport, based on a statistical analysis of historical hourly weather reports and model reconstructions from January 1, 2011 to December 31, 2020. From climatic point of view, the two airports are located in mid-latitudes where the climate is temperate continental with a transitional character.

As reference Influence of meteorological phenomena on worldwide aircraft accidents, 1967–2010 the weather is characterized by low-pressure systems and large-scale synoptic fronts [7]. The climatic and meteorological differences between the two airports are given first of all by the particularities of the active surface (Baneasa is included in the urban perimeter; Otopeni is in the plain and less by the elevation difference (17ft) between them.

Located in the central part of the Romanian Plain, on the background of the general circulation of air masses, specific to the middle latitudes, the interference of the western and eastern atmospheric circulation is noticeable, an effect that is reflected primarily in the direction of runways (080^0-260^0 Otopeni Airport, 070^0-250^0 Baneasa Airport). The meteorological phenomena that accompany wind shear and that have a significant role in reducing visibility below the limits of operation at the airport appear in winter on the predominant wind directions (FIG. 2).

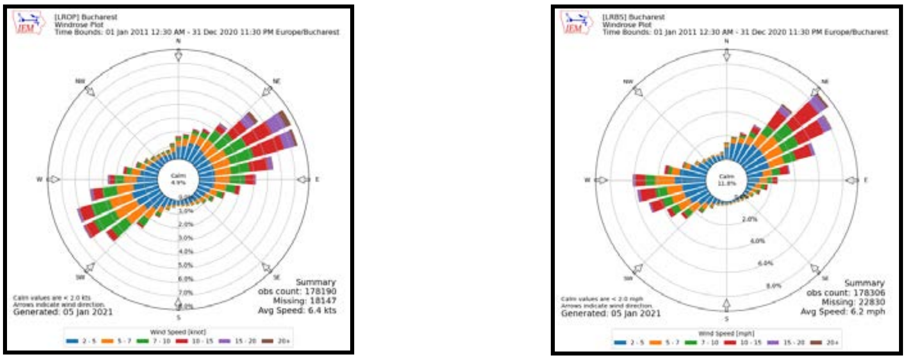


FIG. 2. Wind roses, left Otopeni airport-LROP, right Băneasa airport-LRBS

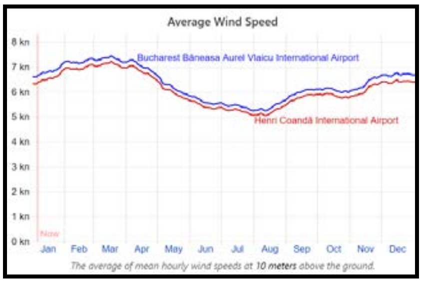


FIG. 3. Average Wind Speed

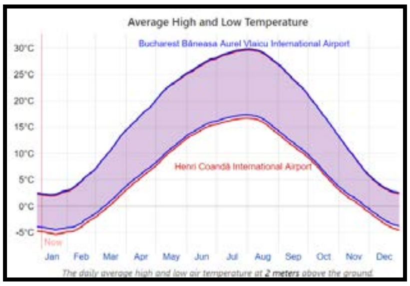


FIG. 4. Average Temperature High and Low

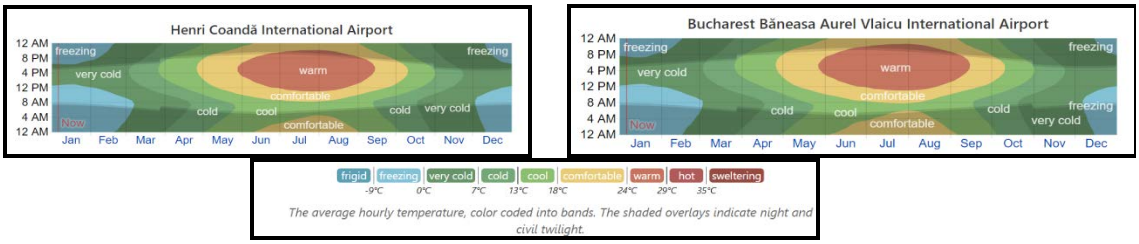


FIG. 5. Average HourlyTemperature

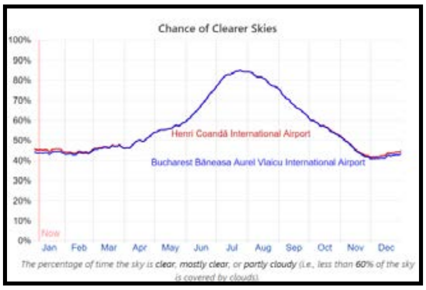


FIG. 6. Chance of Sky Clear

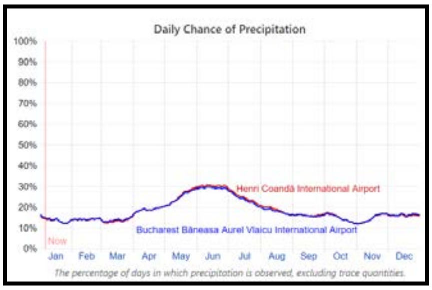


FIG. 7. Daily Chance of Precipitation

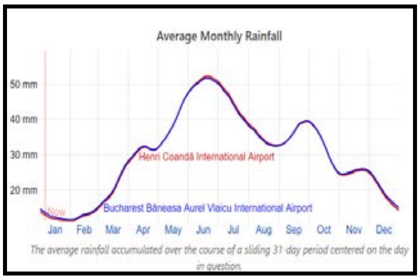


FIG. 8. Average Montly Rainfall

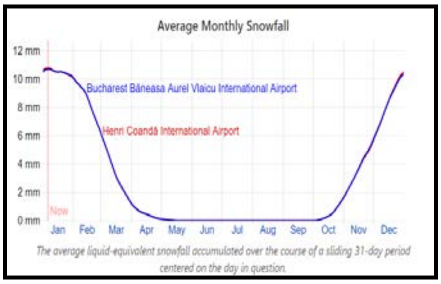


FIG. 9. Average Montly Snowfall

During winter operations the analyzed shear situations associated with low visibility are mainly due to freezing drizzle, moderate snow, fog, usually freezing fog and exceptionally with freezing rain. Specific to both airports is wind shear accompanied by moderate snow. These associated phenomena are due to the prevalence of large-scale synoptic fronts. They not only reduce the values of horizontal visibility, vertical visibility and RVR below the operating limits but also have the greatest contribution to the runway contamination, to the decrease of the friction coefficient and the decrease of the braking action. The lowest values of horizontal visibility and visibility along the runway occur when shearing is accompanied by moderate snow and blowing snow associated with fog:

LROP 251130Z 05030G40KT 0050 R08R/0175N R26L/0150N R08L/0375V0550N R26R/0175N SN BLSN BKN005 OVC021 M07/M07 Q1009 WS ALL RWY 58450294 08450294 NOSIG

Through their action, the Mediterranean cyclones that cross in the cold season (October - March) these two airports have the greatest negative impact on flight safety both on the ground and on takeoff and landing operations.

3.2 Impact of wind shear as extreme weather phenomena on flight safety during winter operations

Wind shear is a change in wind speed and/or direction over a short distance, which results in a tearing or shearing action. If the change occurs gradually (slowly) the effect would be negligible but when the change occurs within a few seconds, the flight crew would have to make rapid, positive inputs to maintain control of the aircraft.

Although wind shear can occur at any altitude, it is particularly hazardous when it happens over a short period of time and within 2,000 feet of the ground, during takeoff or landing. During takeoff phase, the aircraft operates only slightly above stall speed, and a major change in wind velocity can lead to a loss of lift. If the loss is great enough that power response is inadequate, it results in a steep descent [5, 16] .

The altitude at which the encounter occurs, pilot reaction time, and airplane response capability determine if the descent can be altered in time to prevent an accident [16]. To reduce the risk of LLWS affecting operations at LROP by increasing its probability of detection, ROMATSA (the Romanian national Air Navigation Services provider) is currently deploying a wind monitoring and wind shear detection system based on the use of a scanning Doppler Lidar system and of a Doppler Sodar system[4].

The time dependency of significant low-level wind shear can best be illustrated through example. In this study was analyzed the *reported wind shear (on all runways)* produced during the Mediteranean cyclons activities, between 24 - 26 January 2014.

In order to demonstrate the negative impact that low level wind shear and awareness of risks on flight safety, more arguments were introduced: meteorological messages, meteorological maps, atmospheric soundings and low level wind shear maps.

Following the average monthly situations of the atmospheric pressure distribution over Europe, it is found that these cyclones form in October and disappear at the end of March. During this period above the Mediterranean Sea, by advection of the polar air on Central and Western Europe, a permanent front is formed, front which separates the polar air from the north from the tropical air from the south.

Behind these cyclones, in their western sector, cold and dense air penetrations from the Siberian or Greenlandic Anticyclone take place, which causes wind intensifications, low ceilings, sudden and pronounced decreases in air temperature and sometimes violent snowstorm (blowing snow).

The wind shear associated with the Mediterranean cyclones activity at the two airports is generated by the existence of large horizontal baric gradients that determine the intensification of the wind speed and the appearance of gusts (FIG. 10 - 21 and Annex 1).

Practically, during winter operations when the wind shear is associated with advection of warm air, the weather conditions at both airports can have a negative impact on flight safety.

From the processing of the data included in the METAR messages issued by the meteorological stations of the airport, it results that in the last 10 years, at Otopeni airport (LROP) the shear phenomenon has a frequency 4 times higher than in Băneasa airport (Table 1).

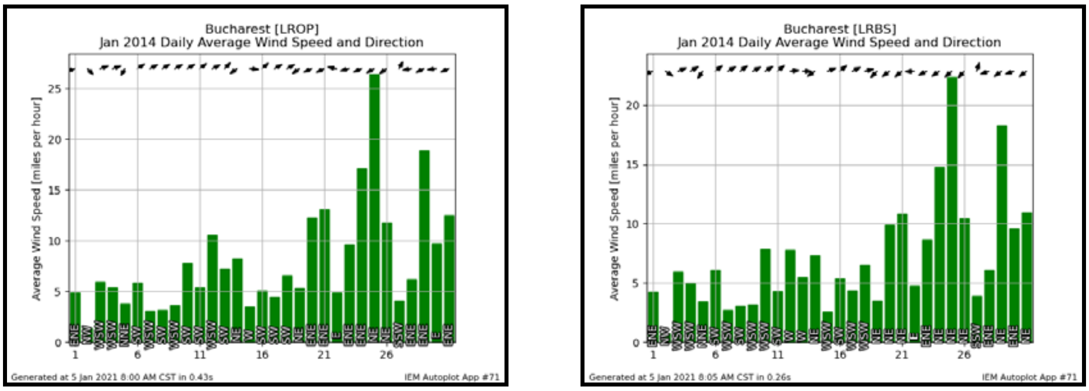


FIG. 10 Average Wind Speed and Direction – January 2014

Table 1. Reported wind shear on all runways

Airport	*The start of period (from) 2011-01-01 00:00Z*	*The end of period 2020-12-31 23:30Z(till)*	*Total number of METAR messages issued during analyzed period*	*WS reported in METAR*	*% from total number of METAR messages*
LRBS	2011-01-01 00:00Z	2020-12-31 23:30Z	178.259	445	0,25%
LROP	2011-01-01 00:00Z	2020-12-31 23:30Z	178.143	1803	1,01%

Practically, in the context of global warming, during the winter, the local particularities of the manifestation of the wind shear associated with the Mediterranean cyclones prove once again that nature works according to its own laws. Although the horizontal distance is very small, only 9 km, due to the duration, intensity and meteorological phenomena of significant weather associated, the wind shear manifests itself differently at the two airports.

In order to describe as completely possible the influence on the flight safety during winter operations using the method of comparative analysis the meteorological situation was analyzed following three sequences:

• before the occurrence of the phenomenon of shearing at the airport (before)

• during the manifestation of the shear phenomenon at the airport (during)

• after the phenomenon no longer appears reported in METAR (after).

The three meteorological sequences are analyzed through the prism of the following aviation weather information: wind, visibility and RVR (Runway Visual Range), weather phenomena, cloud coverage/vertical visibility, temperature, QNH and runway state code (SNOWTAM).

Table 2. The start of the reported wind shear in METAR and SNOWTAM (Runway State Code)

A/P	**Date/Time of issued**	**Wind**	**Meteorological (horizontal) visibility**	**Present weather**	**Sky cond. (100s ft)**	**OAT/DP**	**QNH**	**Supplementary information Reported wind shear**
LROP	241800Z	06020KT	2500	-FZDZ BR	SCT004 OVC005	M05/M06	Q1018	
	241830Z	05019KT	4000	-FZDZ BR	FEW004 OVC005	M05/M06	Q1017	**WS ALL RWY**
LRBS	251900Z	05021G31KT	5000	-SN BLSN	FEW011 SCT014 OVC021	M07/M09	Q1012	
	251930Z	05019KT	7000	-SN BLSN	SCT012 SCT016 OVC021	M07/M09	Q1012	**WS ALL RWY**

SNOWTAM	**A/P**	**Date/Time of issued**	**SNOWTAM**
	LROP	241800Z	58750094 08750094
		241830Z	**58750094 08750094**
	LRBS	251900Z	07490293
		251930Z	**07490293**

Table 3. The end of the reported wind shear in METAR and SNOWTAM (Runway State Code)

A/P	**Date/ Time of issued**	**Wind**	**Met. (horizont.) visibility**	**RVR**	**Present weather**	**Sky cond. (100s ft)**	**OAT/DP**	**QNH**	Supplem. Inform. **Reported wind shear**
LROP	**260600Z**	05010KT	0800	R08R/P2000 R26L/1700N R08L/1600N R26R/1900U	SN DRSN FG	SCT004 BKN005 OVC034	M06/M07	Q1012	**WS ALL RWY**
	260630Z	05011KT	0800	R08R/P2000 R26L/1300D R08L/1400D R26R/1500D	SN DRSN FG	BKN005 OVC043	M06/M06	Q1012	
LRBS	**261900Z**	0000KT	0600	R07/1900VP2000U R25/1300U	SN FZFG	FEW004 OVC015	M06/M07	Q1011	**WS ALL RWY**
	261930Z	00000KT	0800	R07/2000U R25/1300D	-SN FZFG	OVC015	M06/M07	Q1011	

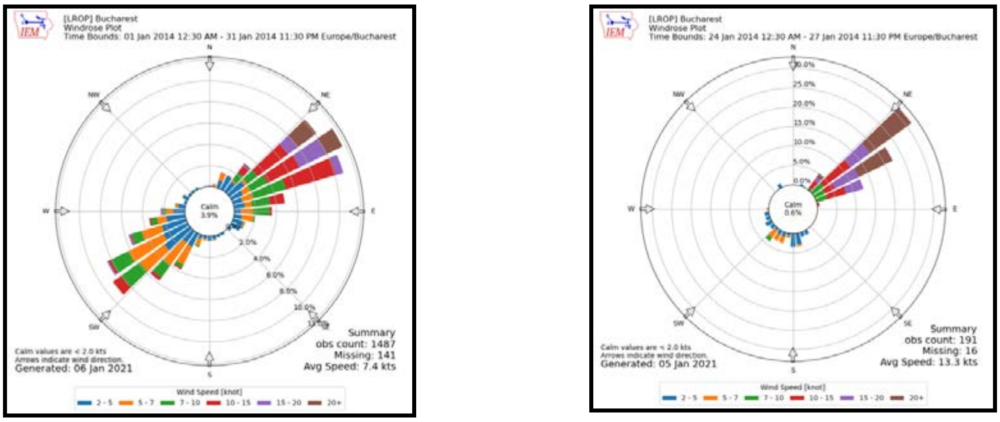
SNOWTAM	**A/P**	**Date/Time**	**SNOWTAM**
	LROP	**260600Z**	**58450394 08450394**
	LRBS	**261900Z**	**07490293**

This graphically presentation (local time) illustrates the historical weather reports recorded by the weather stations at Otopeni and Baneasa Airport, in January 2014, with special 24 - 27 January 2014.

Table 4. The start and the end of the reported wind shear Period (from-till)

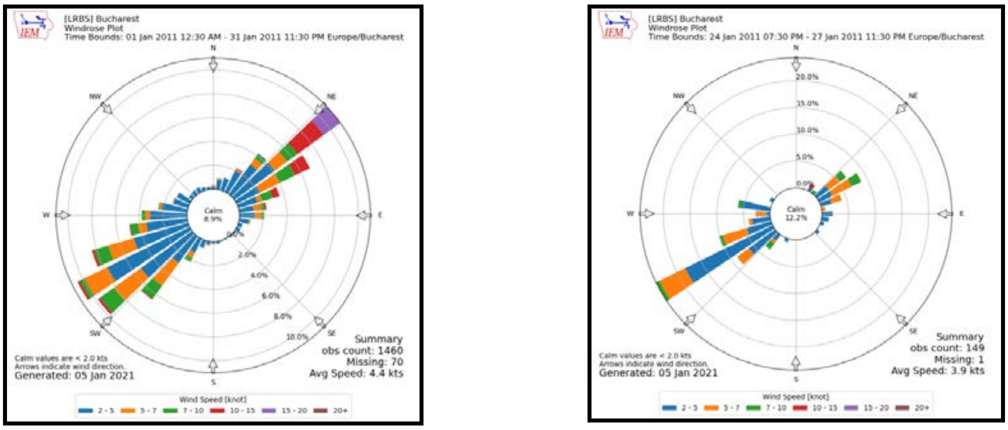
A/P	**Date/Time – START FROM(FM)**	**Date/Time – FINISH TILL(TL)**	**PERIOD**
LROP	241830Z	260600Z	36 hours
LRBS	251930Z	261900Z	24 hours

It can be seen from the graphs (FIG. 10 - 12) that when installed of wind shear at the airport is marked by the backing rotation of the wind direction, typical behavior of cyclonic air masses, sudden increases in wind speed, with values almost double compared with the previous period (FIG. 13).



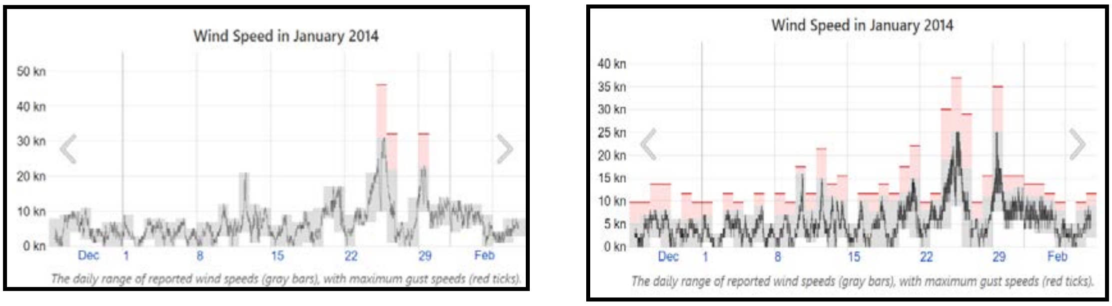
1 – 31 Jan 2014 24 – 27 Jan 2014

FIG. 11. Wind roses - Henri Coandă Otopeni Airport (LROP)



1 – 31 Jan 2014 24 – 27 Jan 2014

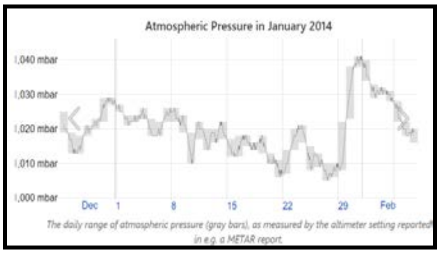
FIG. 12. Wind roses - Aurel Vlaicu Baneasa Airport (LRBS)



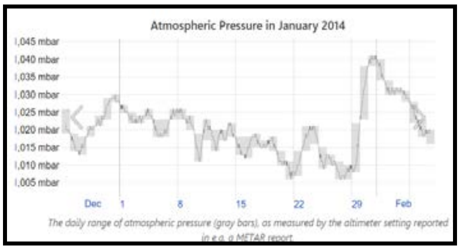
LROP LRBS

FIG. 13. The daily range of reported winds speeds (grey bars), with maximum gust speeds (red ticks)

Sudden decreases in air pressure are shown in FIG. 14. The air pressure decreases in the first 24 hours with 13 mb, from 1021mb (January, 24 -12:00PM) to 1008mb (January, 25 – 03:00PM). Normally pressure variation for mid-latitude is 3mb on 24 hours. The outside air temperature (FIG. 15 - 16) decrease before as wind shear to appear at the airport and after remain constantly (-6^0C - 7^0C) through period when wind shear is reported.

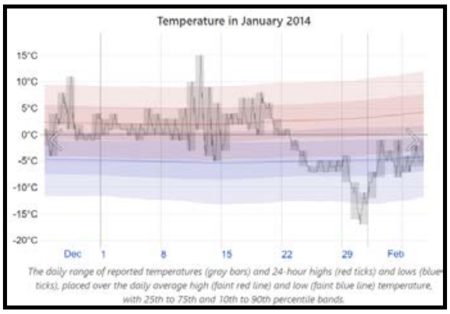


LROP

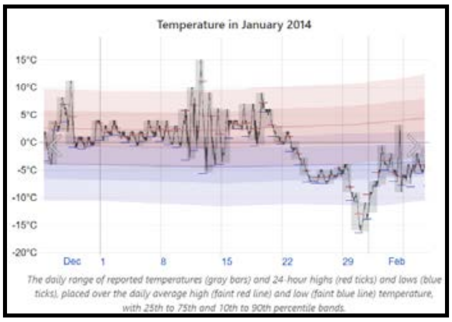


LRBS

FIG. 14. The daily range of atmospheric pressure (grey bars), as measured by altimeter setting reported

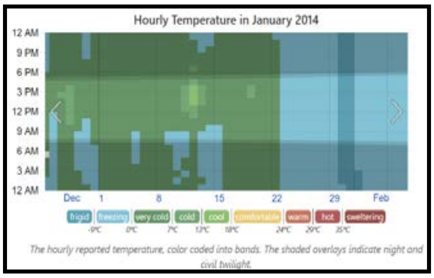


LROP

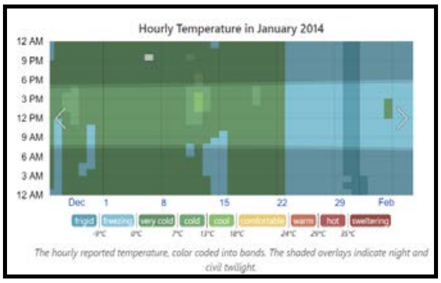


LRBS

FIG. 15. Average Temperature (gray) and average 24-hours highs (red line) and lows (blue line)



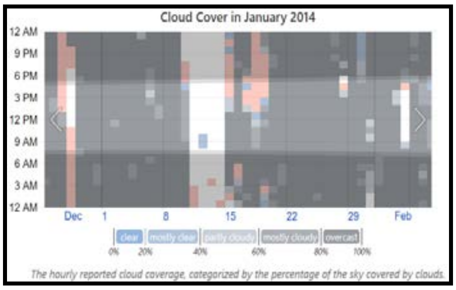
LROP



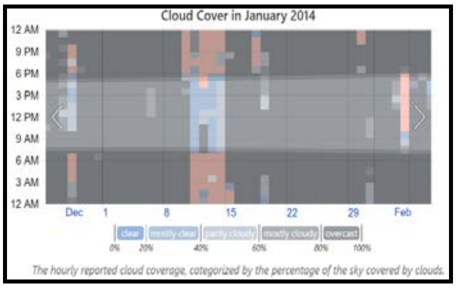
LRBS

FIG. 16. The hourly reported temperature color into bands

During period when wind shear is reported to the airport, cloud coverage (FIG. 17, FIG. 18) increase from broken to overcast, and the height of cloud base decrease significantly from above 600 m during day to below 200 m during night.

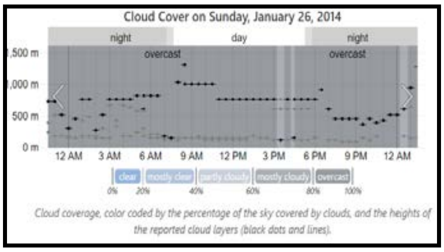


LROP

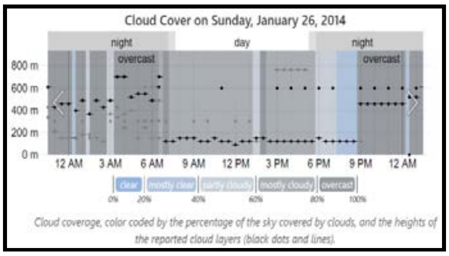


LRBS

FIG. 17. The hourly reported cloud coverage, categorized by percentage of the sky covered by clouds



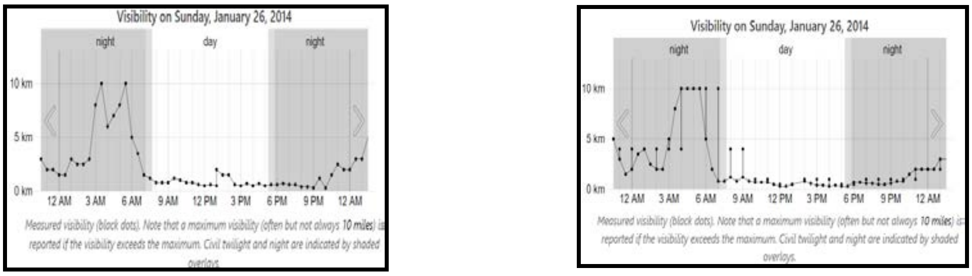
LROP



LRBS

FIG. 18. Cloud coverage, color coded by the percentage of the sky covered by clouds

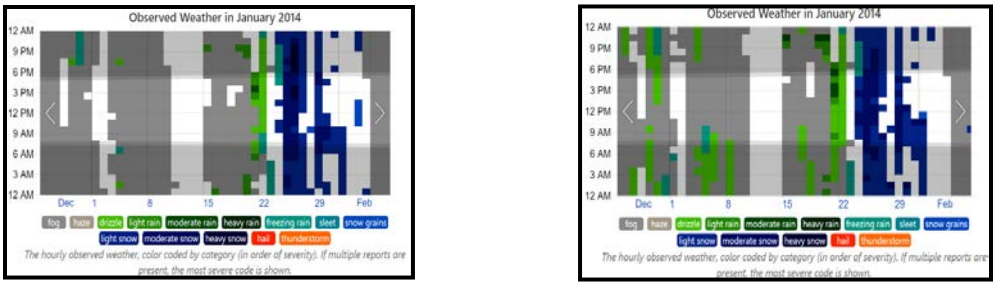
Before reporting wind shear, visibly decreases suddenly, next remains low or improves slightly while maintaining wind shear and, after the phenomenon ceases, visibility begins to increase slowly (FIG. 19). At Bucharest Henri Coanda (OTP) international airport, Low Visibility Procedures are applied when visibility is less than 600 m (2,000 feet) or the ceiling is below 60 m (200 feet) [6].



LROP LRBS

FIG. 19. Measured visibility

At both airports, before of the wind shear reported, the meteorological phenomena (FIG. 20) have low intensity (sleet, freezing rain, snow), during the intensity becomes moderate, intensity that is maintained in the next 24 hours. Fog appears a few hours before the shearing stops.



LROP LRBS

FIG. 20. The hourly observed weather, color coded by category(in order to severity)

All maps display included in FIG. 21 shown the forecast low level wind shear in the 0-.6 mi (above ground) layer during period January,24 08:00PM (06:00Z) - January,26 05:00PM (15:00Z). Wind shear is calculated by taking the wind vector at the surface and subtracting it from the wind vector 0.6 miles (1500 ft) above the surface [13]. The higher shear value (magnitude of 50-60 kt) appear above Bucharest at 11:00 AM (09:00Z) January,25.

Wind gusts appear on the ground reported in METAR messages when in this air layer the magnitude of the wind shear exceeds 30-35 kt and ceases when the magnitude drops below 15 kt. At Otopeni Airport maximum wind speed reported during gust of was 46 kt on January,25 at 1700Z (06030G46KT) and to Baneasa Airport was 35 kt (05021G35KT reported approximately 3 hours later (252030Z).

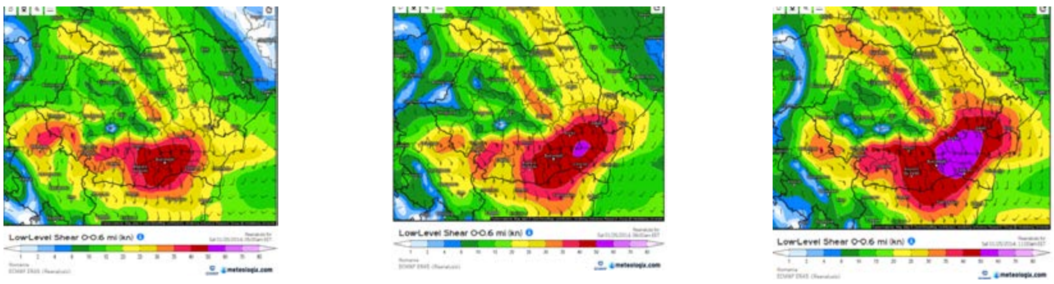


FIG. 21. Low level wind shear January,24 08:00PM (06:00Z) - January,26 05:00PM (15:00Z) 2014

CONCLUSIONS

Practically, in the context of global warming, during the winter, the local particularities of wind shear (the duration, intensity meteorological phenomena of significant weather associated) prove once again that nature works according to its own laws. During winter operations, the most dangerous conditions for flight safety are when the wind shear appears after sunset, ceases before sunrise, reason for which this case was selected. The wind shear which forms in these meteorological conditions (thermal inversion with low level jet above) has the average duration of maintain at the Otopeni Airport 36 hours, comparably with Baneasa Airport where is of 24 hours (Table 4). As reference M. Balmez, F. Georgescu[2, 3], the mechanism that leads to the low-level jet formation (type I) is the baroclinicity induced by the development of a Mediterranean cyclone.

Warm-frontal wind shear may persist 6 hours or more ahead of the front, in cold air mass, because of the fronts shallow slope and slow movement [16]. Strong winds aloft, associated with the warm front (advection of warm air mass at ground level), may cause a rapid change in wind direction and speed where the warm air overrides the cold, dense air near the surface. During the winter, on the background of an accentuated radiative cooling and of the anticyclonic conditions if in the radiosonde profile a thermal inversion appears (Annex A) with thickness of 100 and 500 meters above ground level, 24 hours later a current jet appears with speeds of 50-55 kt, identified at an altitude of about 1000 meters. When the speed of the jet stream from the altitude drops below 40 kt, about 6 hours later than the time when the thermal inversion reaches the maximum vertical extension, the shear phenomenon is reported at the airport.

The most important changes in wind speed at the airport are maintained as long as the thermal inversion is associated with low level jet when the average wind speed exceeds 30 kt, and in gusts it can reach 46 kt (25 January 1700 UTC 46KT). There are mainly fluctuations in wind speed and less in direction. Sometimes these large fluctuations in wind speed are suddenly reduced and calm settles at the airport. When low-level jet (LLJ) it stops at ground level wind speed decreases.

As a rule for both airports, whenever a radiation inversion occurs above the airport and is accompanied by a low level jet at the top, shear is reported on all runways, usually first at Otopeni and few hours laters to Baneasa. When an aircraft departing from the airport ascends and enters the low-level jet, it experiences increasing headwind and lift.

As it departs the jet, however, the headwind and lift decrease and require timely and appropriate corrective action by the pilot. It is vital that such conditions should be quickly recognised if they are encountered, and that pilot response should be immediate and correct. Through a detailed analysis of the meteorological conditions associated with wind shear produced by Mediterranean cyclones during winter operations, *this study is the lesson that wind shear itself offers us for learning through its own manifestation and evolution:*

- *The lesson learned from reported wind shear on all runways (WS ALL RWY) at both airports, when pilots receive information by meteorologists.*
- *The lesson learned from the atmosphere, from real weather situations when, in the context of global warming, the pilot can suspect and report wind shear on all runways and during take-off.*

A decision taken correctly another time, in the same meteorological conditions, in the current context of global warming, when the manifestation of the phenomenon can surprise by intensity and duration, the risk of an incident, respectively aviation accident can increase significantly.

In conclusion, precisely so that pilots are not surprised by the real manifestation of this phenomenon in global warming, this analysis has primarily a preventive role, thus avoiding the application of corrective actions even with a delay of few seconds. Let's not forget: these seconds can make the difference between life and death.

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THE USE OF UNMANNED AERIAL VEHICLES FOR MONITORING PURPOSES IN CIVILIAN APPLICATIONS

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Abstract: *This paper aims to present some of the applications that are currently using Unmanned Aerial Vehicles (UAVs) for monitoring activities in the civilian sector. The domains of use that are detailed in the article were chosen specifically because UAVs have a significant contribution to the increase of their productivity. Each of them is presented in order to highlight the high complexity of the monitoring activities involved, the disadvantages of the methods that are currently in use, as well as the benefits of using UAVs for these tasks. Furthermore, the methods that are most commonly used and have achieved the best results in the researches conducted in the field are mentioned and reviewed.*

Keywords: *unmanned aerial vehicle, monitoring in civilian applications, crop monitoring, wildlife monitoring, infrastructure inspections*

1. INTRODUCTION

An unmanned aerial vehicle (UAV) is a type of aircraft that does not have a human pilot on board [1]. Due to the recent innovations in this domain and the large number of applications, UAVs may be seen as a modern invention, yet their origins are back in the First World War, when the first pilotless aircrafts were developed. The very first radio-controlled pilotless drone was the British Aerial Target, followed after a short period of time by the Kettering Bug, an American aerial torpedo [2, 3]. In the period between the wars, there was a continuous development of the UAVs, with new models being developed and tested for military purposes. Nowadays, the applications of UAVs are various, ranging from aerial photography and filming to goods delivery, and search and rescue missions.

There are two types of drones: remotely piloted aircrafts (RPAs) that need to be remotely controlled by a human pilot, and autonomous drones that are controlled with the help of embedded software algorithms, without the intervention of a human operator. UAVs are a type of device that can be easily controlled by the use of a smartphone, are often equipped with cameras, different types of sensors specific to the application requirements, Global Positioning System (GPS) and communication systems. All of these are characteristics that make drones suitable to use in dangerous environments, time-consuming or repetitive monitoring tasks, or applications that require huge amount of data acquisition, being more reliable and efficient than a human being.

It appears to be a significant progress in the development of UAVs, with even more new capabilities and functions being implemented into these devices in the last period of time. The increase of the onboard processing power, battery life, and the improvement of flight control algorithms, together with the reduced size and weight of the new models, are extending the range of UAVs applications, making them suitable not only for military use.

In the following, several applications of UAVs in agriculture, wildlife monitoring, and infrastructure inspections will be discussed in order to indicate the advantages of using UAVs for activities that were previously done by humans.

2. AGRICULTURE

The agricultural system is one of highly importance for the economy of a country. Since early times, people have lived from the result of their efforts and hard work to cultivate large areas of land in order to provide food for their family and livestock. The output of the cultivated land, along with the animal-source foods, were also used in commercial scope, representing an important source of money at that time. Even if the purpose of the agricultural activities remains the same in our times, the techniques used in order to achieve the desired yields have changed, while the amount of the invested work, money, and time is majorly increasing. Due to the latest technological advances, most of the tasks involved by the agricultural activities can be automated, therefore reducing the efforts made by the farmers, and the negative effects of the climate change and environment conditions on the agricultural output. The recent booming of UAVs, that have become an easy-to-use and affordable device by the general population, makes them an efficient method of field monitoring. UAVs have played a major role in the evolution of a concept named precision agriculture, which aims to develop a system in which decisions can be remotely taken by humans, based on the information resulted from land monitoring performed by drones [4, 5]. Consequently, the most meaningful applications of UAVs in the agricultural industry, that result from field surveillance, include crop health monitoring and soil conditions monitoring.

In order to determine if plants are healthy, or they have been affected by diseases or pests, fields must be carefully examined by farmers. They are searching for changes in the color and shape of the leaves, which indicate that actions must be taken to save the plant. If the process of field monitoring is performed by human operators, it is time consuming and prone to error. Therefore, a commonly used method of crop health assessment uses remote sensing. Aerial images provided by satellites, or UAVs equipped with sensors, such as multispectral or hyperspectral cameras [6, 7, 8], are further analyzed by algorithms to provide useful information to the farmers. However, plant monitoring using satellite images has a series of disadvantages, being highly dependent of the environment conditions, such as cloud cover and available amount of light. Also, accessing satellite images is expensive, and the gathered images have low resolution and quality. The need for higher resolution spatial and temporal data, that can be easily achieved using UAVs, has contributed to the spreading of drones in plant health monitoring. Some of the most frequently used and efficient image analysis techniques are using machine learning algorithms [7, 9, 10], or computation of the Normalized Difference Vegetation Index (NDVI). While the use of artificial intelligence algorithms is still under research and needs some improvements to become a reliable method of plant health assessment, systems based on NDVI are already commercially available [11, 12], being able to detect crop degradation from early stages, when changes are not visible to the human eye, or to spot weeds. Furthermore, the information obtained using this type of system is useful to determine the optimal quantity of herbicides, pesticides, fertilizers, or water that needs to be provided to specific areas of the crop field. NDVI indicates the health of the plant based on the reflection of the infrared light. The cellular structure of a healthy leaf reflects a lot of near-infrared light. The level of the reflected near-infrared light decreases if the plant is dehydrated or affected by diseases, while the amount of reflected visible light remains the same.

Based on this fact, plants can be differentiated from other surfaces, and diseases, pest infection, or dehydration can be detected [13]. Figure 1 illustrates an example of a NDVI map of a crop field.

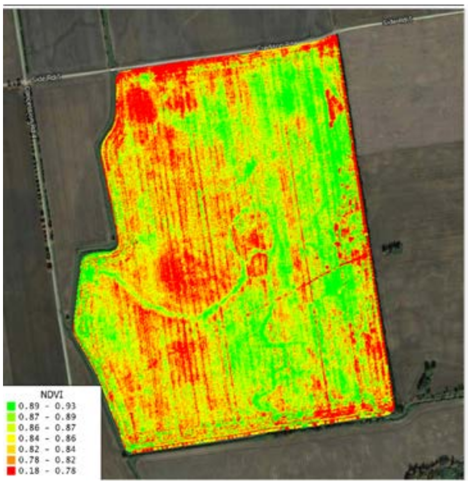

FIG. 1. Example of crop field mapping based on NDVI [14]

UAVs can also be equipped with other types of sensors, such as laser scanners, thermal sensors, or red-green-blue (RGB) cameras for enhanced field information [15, 16, 17, 18]. However, the data provided by those needs more processing operations and is not as useful in plants health assessment as the one provided by multispectral images. Moreover, satellite and UAV data fusion has been explored in [19], proving that increased performance can result from combining the high-resolution data provided by UAVs with information over large areas of land from satellite images.

UAVs equipped with the above-mentioned sensors can also be used to monitor field conditions. After data analysis or correlation of the data provided by sensors, information about soil moisture or irregularities in the field is obtained. This is useful for irrigation planning, with the aim to avoid water wasting or overwatered plants. Some of the researches that have been made in this direction are detailed in [20, 21, 22].

3. WILDLIFE MONITORING

The importance of wildlife monitoring comes from the need of endangered species conservation and, subsequently, the conservation of the ecosystem in which they are living, as well as the desire to know the impact of human actions or climate changes on certain species. Approaches of this problem that are using UAVs have appeared as a better solution than the already existing methods. Those are far too expensive and time consuming because some of the species that need to be monitored live in remote, rough or hard to reach areas, such as polar regions, desert or oceans, and helicopters or boats are required to reach them. Also, the use of UAVs to monitor the wild animals eliminates the process of implanting or attaching them monitoring devices for data collection, which is an invasive technique that affects the animal. In the field of wildlife monitoring, drones have applications in areas like assessing the health of the animals, counting and precisely locating them, or collect useful data for research purposes.

The methods that are currently used for wildlife monitoring generally depend on the size of the habitat and the density of animals in order to achieve the best results.

UAVs represent a reliable, noninvasive and safe method to collect samples from wild animals with the aim of monitoring the health of the animals. In this direction, several papers focus on collecting samples from whale species [23, 24].

Furthermore, a research that proves that UAVs can be used even in virological studies is [25], in which a drone was used to collect whale blow samples, thereby identifying six novel virus species. Figure 2 shows the process of collecting whale blow samples using an UAV.

FIG. 2. UAV collecting a sample of whale blow [23]

The information gathered about the size and the habits of wild animals is also the subject of a lot of biological studies. Drones equipped with cameras can be used to provide data for researchers, in order to make estimations on the body size or the condition of the animals [26], or to gather information about the behavior of the animals under certain conditions [27]. Another method that is commonly used for wildlife monitoring is called footprint identification technique [28]. It is able to identify individuals based on their footprints, using artificial intelligence and a database with footprints of other animals from that species. The efficiency of this technique was demonstrated in [29, 30].

In the same way as plant health monitoring, wildlife population surveys are also driven by remote sensing techniques, aided by image analysis. At the moment, a homogenous background is necessary for the automated image analysis algorithms to obtain results that are comparable to the human counting of the specimens. Most of the experiments on counting animals through the use of drones are conducted in homogeneous landscapes and focus on large bodied species of animals [31] or birds [32], proving that even more accurate results are achieved using automated counting of the animals, compared to the method that uses people to count animals [32, 33]. The recent developments in artificial intelligence have significantly contributed to the improvement of drone-based wildlife surveys, machine learning algorithm being used to detect the animals [34, 35]. In the same way, drones can be used for livestock counting, that represents a more challenging task because of the diversity of the landscape in which domestic animals are living [36]. It has been demonstrated that thermal and infra-red cameras need to be used to achieve better results in the case of heterogenous landscape [37, 38].

4. INFRASTRUCTURE INSPECTIONS

Infrastructure inspections are a mandatory task that guarantees the functionality and the integrity of a system, as well as the safety of the workers and environment protection.

Some of these activities involve dangerous working conditions for the inspector, such as climbing in harsh weather conditions, working near highly flammable gasses or in toxic environment. Furthermore, in some industries, plant shutdowns are required to be able to analyze parts of the infrastructure that are inaccessible during operation.

The shutdown time involves revenue losses for the company, that can be avoided using drones for inspection. Also, by eliminating the need of shutdown planning, inspections can be conducted more frequently, resulting in increased safety of the equipment. As a result of the difficulties involved by the traditional methods of inspection, drones are becoming a very popular alternative in the domain of infrastructure monitoring. Most of the inspections carried out in this field are performed by UAVs equipped with cameras that collect data about the equipment. The information gathered by drones is then visually reviewed by specialized people or by artificial intelligence algorithms, with the scope of discovering the areas that need intervention. In the following lines, some of the uses of UAVs for infrastructure monitoring are detailed.

Oil and gas pipelines need to be frequently analyzed to discover potential signs of corrosion or leakage that might lead to an environmental disaster. The substances that result from oil and gas extraction lead to pollution of the environment in the extraction area, that has irreversible consequences for the plants, wildlife, and the human population that lives in the region. As a consequence, pipelines are often placed in remote, uninhabited areas, spreading over vast regions, which makes them very difficult to inspect. Most of the methods used to detect a potential leak using UAVs are based on laser detectors, that measure the absorption of the transmitted beam in order to detect the presence of methane [39, 40, 41]. Figure 3 shows the diagram of the methane detection system implemented in [41]. It sends an infrared laser beam to a surface, concentrates the reflected beam onto a photodetector, and converts the received laser power to an electronic signal that is processed in order to determine the presence of methane.

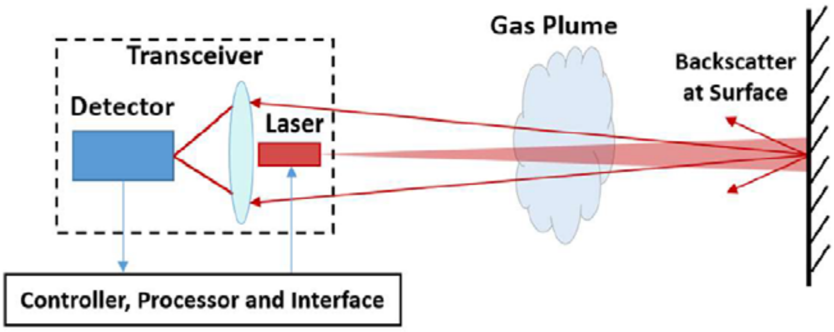

FIG. 3. The operation of the Remote Methane Leak Detector used in [41]

Regarding the oil and gas industry, the storage tanks are another element that requires periodic inspections. Wall-sticking drones, that are able to inspect containers and collect data using onboard sensors [42], prove the capability of using UAVs in the oil and gas industry not only in combination with visual inspection methods.

Mandatory regular inspections of the power lines are currently performed by humans that climb the poles of the distribution lines or by helicopters, and involve a huge risk due to the high-voltage of the transmission lines.

The use of drones equipped with cameras, that are able to record or transmit visual information, reduces the time and the risks of human inspections, as well as the increased cost of inspections performed by helicopters. Besides daylight cameras, sensors that acquire thermal information, as in [43, 44], are a commonly seen payload of the drones in order to detect hot spots that reveal damages on the cables and insulators, resulting in areas with increased temperature [45].

An industry that is in continuous expansion is represented by the renewable energy. The use of wind farms to produce electricity is safe for the environment, reducing the pollution, and uses as source of energy a free and widely available resource of the nature. Wind parks are often placed in regions that are hard to reach and very extended, and the task of monitoring wind turbines is challenging because of their increased height.

The blades of wind turbines are the most affected element, being permanently exposed to high loads and to weather conditions. Photos taken from the ground, inspectors moving using service platforms, or going down on a rope are the methods that are currently used to inspect the blades of wind turbines. Those are able to detect only visible damages at the surface of the blade. Thereby, drones are a tool that can be very helpful in order to assess the condition of wind turbines. The most addressed subject in the researches that have been made in wind turbines monitoring is assessing the condition of the blades. They are able to automatically identify structural damages on the surface of the blades using convolutional neural networks [46, 47], or to detect internal damages using crawling robots that perform ultrasonic inspections and drones equipped with infrared cameras and LiDAR to precisely locate the damages [48].

Another type of renewable energy that requires permanent inspections of the infrastructure in order to avoid losses in the output power of the plant is the solar energy. The most common defects of the photovoltaic modules are detectable by visual inspections and include delamination, corrosion, cracks or snail trails, that lead to a decrease in the energy produced by the panels. An example of a snail trail detected by image processing algorithms is shown in Fig. 4.

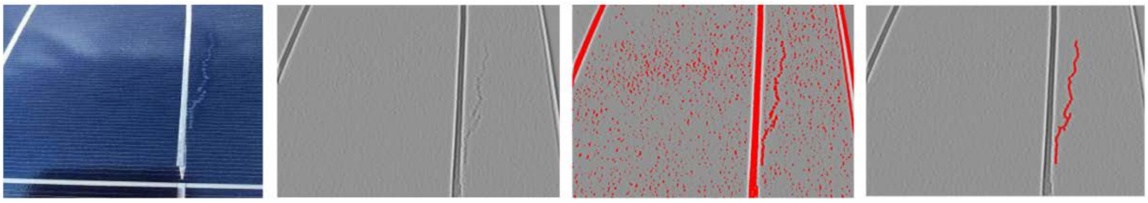

FIG. 4. Detection of snail trails using image processing algorithms [50]

Another commonly used method to detect defects and failures of the photovoltaic modules is called thermography. It uses thermal infrared sensors to observe the temperature regions from the surface of the cell that indicate electrical failures, hot spots or micro-cracks [49]. Researches that have been made using UAVs for the inspection of the photovoltaic systems focus on the automatic detection of the defects through visual inspections using high-resolution cameras and image processing algorithms [50], or in combination with thermography [51, 52].

CONCLUSIONS

There are many activities and industries that require either permanent inspections of the assets in order to achieve the expected output, or the monitoring of remote life and activity to collect useful data for research purposes. This process is often manually performed by humans that are put in dangerous working conditions and is significantly time-consuming and inefficient, while the existing alternatives are very expensive. The continuous improvements of the technology used for drones, that made them more stable, easy to control, lightweight and increased their flight time, makes them an inexpensive and more efficient tool that is able to handle this task.

Furthermore, the possibility to carry different onboard sensors or cameras, and to embed image processing or machine learning algorithms provides more quantitative and qualitative information on the inspected elements. These, together with the recent developments that have been made in the field of artificial intelligence, which is able to eliminate the use of human operators for image analysis, are promising the development of a completely automated, stable and efficient solution for monitoring in the immediate future.

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ELECTRIC GENERATOR POWERED BY A GYROSCOPIC SYSTEM - A THEORETICAL APPROACH

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Abstract: *The development of our society now depends on electrical energy and the demand for electrical power increases yearly. Due to the vast amount of carbon dioxide released in the atmosphere by conventional power plants and the negative influence on the climate, new ways of producing electricity must be developed. A gyroscope consists of a spinning flywheel of mass m mounted in a suspension frame that allows the flywheel's axle to point in any direction. In this analysis, one end of the axle is supported by a pylon situated at a distance R from the center of mass of the spinning flywheel. In order to generate electrical energy at this low speed, the same approach should be used as in wind power electrical generators. In this case, the wind and propeller are substituted by a gyroscopic system and gravitational attraction. Based on the conservation of angular momentum, the gravitational attraction can be used to create a precession strong enough to provide the energy and torque necessary to activate an electric generator similar to those in wind power generators. Instead of recovering the energy from this kinetic energy, we can use the precession rotation created by gravitational attraction to create the necessary kinetic energy.*

Keywords: *flywheel, gyroscope, kinetic energy storage, precession*

1. INTRODUCTION

Nowadays the development of our society depends on electrical energy and the demand of electrical energy increases year by year. Due to the vast amount of carbon dioxide released in the atmosphere by conventional power plants and the negative influence on the climate, new ways of producing electricity must be developed. The renewable energy sources based mostly on wind power, solar power and hydroelectricity rely on climate and weather to work effectively [1].

For this reason, these renewable energy sources may exhibit large fluctuations in power output. In order to become reliable as primary sources of energy, energy storage is a crucial factor. Electrical Energy Storage (EES) refers to a process of converting electrical energy into a form that can be stored for converting back to electrical energy when needed [2].

These technologies open the way to producing, storing and consuming electrical energy locally. One direct result is the increased mobility based on electric energy. Along the years, several solutions for EES were developed. Because electricity is not easy to be directly stored, it can be stored in other forms and converted back to electricity when needed. EES technologies can be classified according to the form of storage into the following:

Chemical Energy Storage: *Electrochemical energy storage*: conventional batteries (lead-acid, nickel metal hydride, lithium ion), flow-cell batteries (zinc bromine and vanadium redox). *Chemical energy storage*: fuel cells, molten-carbonate fuel cells and metal-air batteries. *Thermochemical energy storage*: solar hydrogen, solar metal, solar ammonia dissociation–recombination and solar methane dissociation–recombination.

Thermal Energy Storage: *Low temperature energy storage*: aquifers cold energy storage, cryogenic energy storage. *High temperature energy storage*: steam or hot water accumulators, graphite, hot rocks and concrete.

Electrical Energy Storage: *Electrostatic energy storage*: capacitors and supercapacitors. *Magnetic/current energy storage*: superconducting magnetic energy storage.

Mechanical Energy Storage: *Kinetic energy storage*: flywheels. *Potential energy storage*: Pumped hydro storage, compressed air energy storage. [1,3]

2. MECHANICAL ENERGY STORAGE

A flywheel is a mechanical storage device which converts electrical energy to mechanical energy. The electrical energy is stored in the form of rotational kinetic energy based on the rotating mass principle. A spinning cylinder or disc is used to store rotational kinetic energy and when is needed this energy is used to regenerate electrical energy. The amount of rotational kinetic energy stored is calculated with following equation,

$$E_k = \frac{1}{2} I\omega^2 \tag{1}$$

Where I is the moment of inertia and ω is the angular velocity. The moment of inertia is a function of its shape and mass, given by equation,

$$dI = dmr^2 \tag{2}$$

$$I = \int x^2 dm_x \tag{3}$$

Where x is distance from the rotational axis to the differential mass dm_x.

According with equation 1 the most efficient way to increase the amount of stored energy is by increasing rotational speed ω.

If we double the flywheel’s speed, the amount of stored energy increases by four times. Because a flywheel speeds up as it stores energy and slows down when it is discharging, to deliver the accumulated energy, results the useful energy depend on minimum and maximum of angular velocity according with the following equation [4-6],

$$E_k = \frac{1}{2} I(\omega_{max}^2 - \omega_{min}^2) \tag{4}$$

For a solid cylinder or disc-type rotating mass, the moment of inertia is given by:

$$I = \frac{1}{2} mr^2 \tag{5}$$

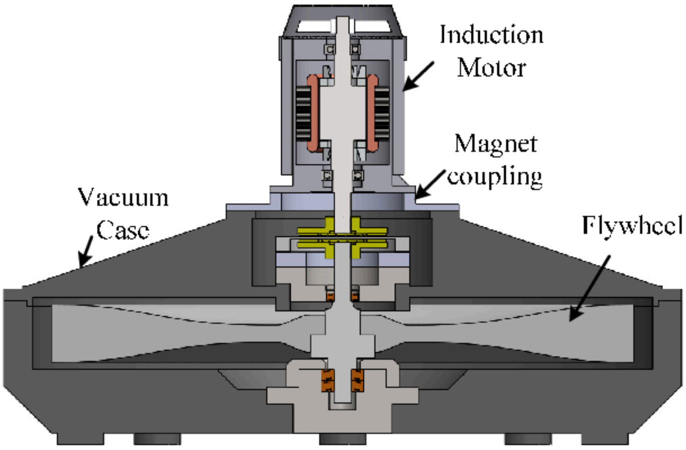

FIG. 1 Flywheel [7]

The amount of energy which can be stored in a flywheel is limited by the maximum speed at the rotor can operate because of the strength of material. In order to operate in a safety zone, the stress experienced by the rotor must remain below the strength of the rotor material. Nowadays the flywheels are used for frequency regulation, trackside energy recovery, electromagnetic aircraft launch, uninterruptible power supplies, motorsport and spacecraft.

All these applications prove the fact the flywheel can easily convert electric energy into rotational kinetic energy, store kinetic energy for long period of time without significant losses and release this energy as electrical energy when is needed. In all presented applications the time of releasing energy is relatively short between 1s to 1 hour with an efficiency between 85-95%. In this paper I am looking for a way to increase the discharging time and to keep the other advantages.

On the other hands the mechanical energy storage based on potential energy like pumped hydro has a discharge time between 6-24 hours and efficiency between 65-85%.

~~A~~ pumped hydro power energy storage consists of two water reservoirs located on different altitudes. The electricity is used to pump water from the lower altitude reservoir to the higher altitude reservoir. The electrical energy is converted into potential energy stored, and converted by a hydroelectric turbine back into electrical energy.

The quantity of stored energy depends on the volume of water in the upper reservoir and the differential height of between the two reservoirs. In this paper I am looking for a way to harvest the gravitational attraction in a more efficient way. This goal can be achieved if we combine the kinetic energy storage with gravitational attraction to obtain a new system based on gyroscope theory and torque-induced regular precession.

3. GYROSCOPE THEORY

A gyroscope consists of a spinning flywheel of mass *m* mounted in a suspension frame that allows the flywheel's axle to point in any direction. One end of the axle is supported on a pylon in point O at distance *R* from the center of mass G of the spinning flywheel.

The flywheel is spinning around Ox axis with a spin angular velocity ω_{gyr}. When the gyroscope is released the center of mass rotates around a vertical axis Oy with a precession angular velocity ω_{pr}.

This movement occur when the magnitude of the precession angular velocity is much less than the magnitude of spin angular velocity, $\omega_{pr} << \omega_{gyr}$. This assumption is collectively called the gyroscopic approximation [8,9].

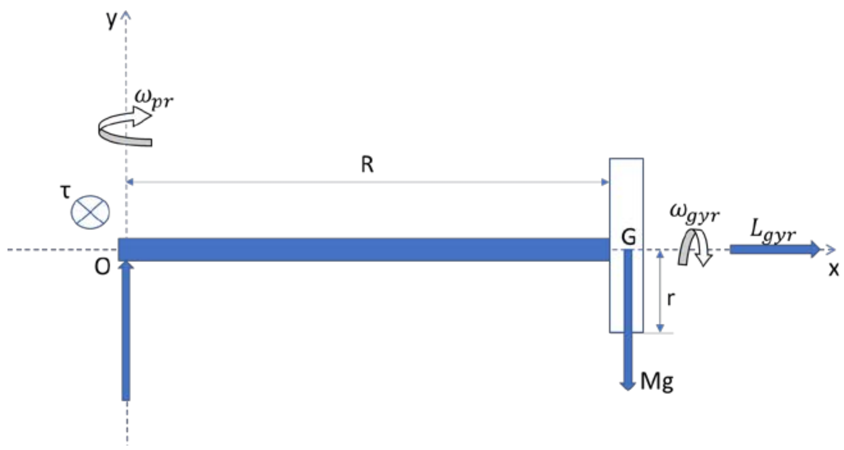

FIG.2 Gyroscope torque-induced regular precession

$$\omega_{pr} = \frac{\tau_{gyr}}{L_{gyr}} = \frac{MgR}{I_{gyr}\,\omega_{gyr}} \tag{6}$$

Where:

- M is the mass of precession equal with total mass which create the torque τ_{gyr}, $M=m+m_{aditional}$.
- m is the mass of flywheel.
- $m_{aditional}$ is used to increase the torque in order to obtain a desired precession angular velocity. For the spinning flywheel is used a disc-type rotating mass of radius r.
- L_{gyr} is angular momentum of flywheel.

Equation 6 can be written:

$$\omega_{pr} = \frac{MgR}{I_{gyr}\,\omega_{gyr}} = \frac{MgR}{\frac{1}{2}mr^2\omega_{gyr}} = \frac{2g}{\omega_{gyr}}\frac{M}{m}\frac{R}{r^2} \tag{7}$$

For my further analyses I assume all frictional forces acting on point O are friction forces from precession and all frictional forces acting on point G are friction forces from flywheel.

The kinetic energy of precession can be calculated with following equation:

$$E_{kpr} = \frac{1}{2}I_{pr}\,\omega_{pr}^2 = \frac{1}{2}MR^2\omega_{pr}^2 = \frac{2g^2}{\omega_{gyr}^2}m\frac{M^3}{m^3}\frac{R^4}{r^4} \tag{8}$$

a) Let investigate the case when the values of friction forces is zero.

The system will maintain the flywheel speed and precession movement as long as the gravitational attraction exists. From (7) result the product between precession angular velocity ω_{pr} and spin angular velocity ω_{gyr} is constant.

$$\omega_{pr}\,\omega_{gyr} = \frac{2MgR}{mr^2} \tag{9}$$

Also, the product between kinetic energy of precession E_{kpr} and kinetic energy of flywheel E_{kfly} is constant.

$$E_{kfly}\,E_{kpr} = R^4\frac{M^3g^2}{4mr^2} \tag{10}$$

In order to analyze some characteristics of a gyroscope I will use pictures from well know demonstrations with gyroscope available on YouTube. I used this unconventional approach to offer the possibility to verify more rapidly my affirmations.

First, the precession rotation of a gyroscope creates centrifugal forces acting in the same way like in other rotation.

FIG.3 Centrifugal forces during precession

In one of his demonstration Professor Eric Laithwaite hang a gyroscope using a rope [10]. In the left side of fig. 3 picture inside the arrow is the position of rope without gyroscope. In the right side of picture, the rope with gyroscope create an angle relative with initial position. In presented video we can observe the gyroscope start from vertical position and without external forces create an angle with vertical. This angle is created by centrifugal forces created during precession rotation.

b) Let investigate the case when the friction forces of precession are zero and the friction forces of flywheel are non-zero.

Due to the friction the flywheel spin ω_{gyr} value decrease. According with (7) the precession angular velocity value should increase and the value of kinetic energy of precession should increase. The angle between precession axe Oy and flywheel rotation axe Ox should remain the same.

Because the kinetic energy of flywheel was decreased due to friction the kinetic energy of precession cannot increase because no energy was added to the system.

In order to maintain the same value of kinetic energy of precession the angle α should be created as in the fig. 4. This angle can be clockwise as in fig. 4 or counterclockwise, above Ox axe. The kinetic energy of precession around point O before flywheel loses spin can be calculated with (8).

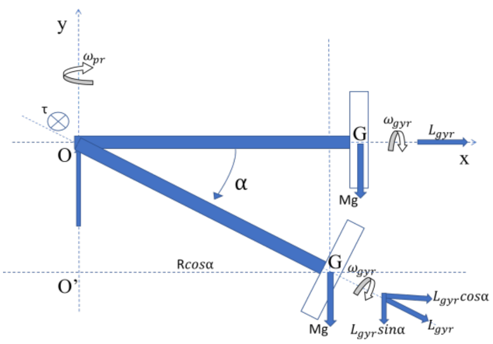

FIG.4 The angle α

The kinetic energy of precession around point O’ after flywheel loses spin is:

$$E_{kpr\,1} = \frac{1}{2} I_{pr}\, \omega_{pr\,1}^2 = \frac{1}{2} M R^2 cos^2 \alpha \omega_{pr\,1}^2 \quad (11)$$

Because the value of kinetic energy of precession must be the same $E_{kpr} = E_{kpr\,1}$, result:

$$cos\alpha = \frac{\omega_{pr}}{\omega_{pr\,1}} \quad (12)$$

The precession angular velocity ω_{pr1} around point O’ should be calculated with:

$$\omega_{pr\,1} = \frac{MgRcos\alpha}{L_{gyr}\, cos\alpha} = \frac{MgR}{\frac{1}{2} m r^2 \omega_{gyr\,1}} = \frac{2g}{\omega_{gyr\,1}} \frac{M}{m} \frac{R}{r^2} \quad (13)$$

The precession angular velocity does not depend by angle α. In this case (10) become:

$$E_{kfly}\, E_{kpr} = R^4 \frac{M^3 g^2}{m r^2} cos^4 \alpha \quad (14)$$

These theoretical results are proved by the following experiments.

In other demonstration the gyroscope has an upward movement during prece ssion [11]. In the left side of picture from fig. 5 the gyroscope start precession from an angle α between rotation axe of flywheel and horizontal axe. This angle increase in time as is showed in the right side of picture. During precession, a force appear to push the gyroscope to vertical position.

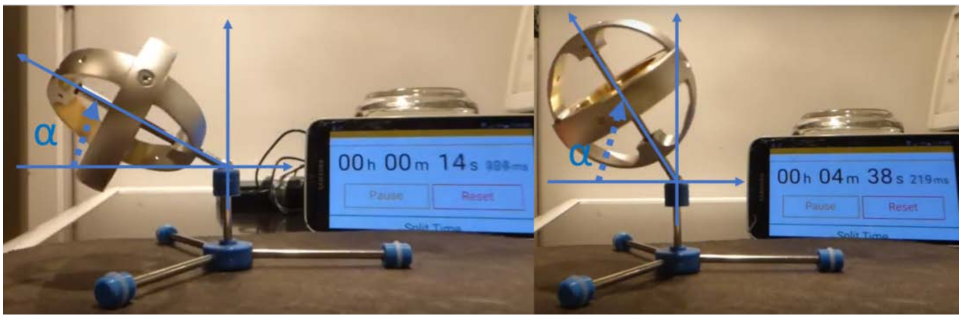

FIG.5 Upward movement during precession

In the following demonstration the gyroscope has a downward movement during precession [12]. In the left side of picture from fig. 6 rotation axe of flywheel is almost horizontal. In the right side of picture, the rotation axe of flywheel creates an angle with horizontal. During precession, a force should push the gyroscope down and is not the weight of gyroscope. In fact, in both demonstrations the system just conserves the energy and decreases the angle between axe of rotation of gyroscope and vertical axe. Let call this angle α. When the $\alpha = 90^0$ results cosα=0 and the precession angular velocity $\omega_{pr} = 0$ (no precession).

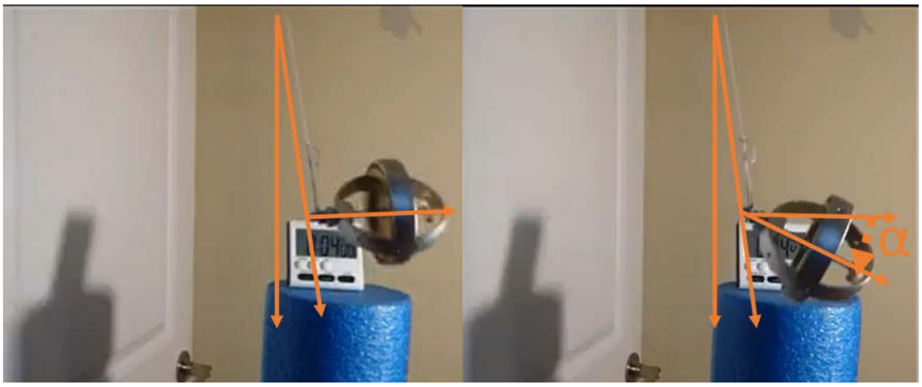

FIG.6 Downward movement during precession

Let assume the flywheel spin is maintained constant and the precession angular velocity is increased with external energy. The kinetic energy of precession adjust his value by changing the angle α.

In fig. 7 is presented this behavior of gyroscope [10]. This time in the right side of the picture the rotation axe of flywheel create an angle with horizontal axe. In the left side of the picture an external energy is added by Professor Eric Laithwaite. As a result, the angle between the rotation axe of flywheel and horizontal axe increase from below horizontal axe to above horizontal axe.

FIG.7 Precession with external energy

From these three experiments we can observe the gyroscopic system conserve the entire energy by changing the value of angle α. Results, if the kinetic energy of precession is decreased the system will conserve the entire energy by changing the value of angle α.

In a Table 1 I give some values to gyroscope in order to match the values of gyroscope from fig. 7 based only with visual approximation to find the ratio between different parameters.

Table 1. Gyroscope parameters

Parameter	Symbol	Value	SI unit
Mass of flywheel	m	10	kg
Mass of precession	M	10	kg
Flywheel radius	r	0.2	m
Precession radius	R	1	m
Flywheel angular velocity	ω_{gyr}	500	rad/s

Based on these parameters and (6) the precession angular velocity is ω_{pr}=0.98 rad/s. The result obey the gyroscopic approximation 0.98<<500. The kinetic energy of precession is E_{kpr}=4.8 J. If we compare this value with the value of the kinetic energy of flywheel E_{kfly}=25,000 J we obtain a ratio of E_{kfly}/E_{kpr}=5,199.55. This low value of kinetic energy of precession can easily create a false impression of non-existence of kinetic energy of precession. Despite the fact the dimensions of our gyroscope are not the same as in this experiment the value of kinetic energy of precession is incredibly low. For this reason, compared with the mass of flywheel 10 kg which is hard to rise with one hand, it is quite easy to increase the precession angular velocity and to rise the flywheel when is spinning using only two fingers.

c) Let investigate the case when the friction forces of precession are non-zero and the friction forces of flywheel are zero or the spin of flywheel is kept constant.

The friction forces create a lose energy which decrease the value of kinetic energy of precession. Let assume the friction forces are dumping forces and the kinetic energy of precession decrease because of these forces. If we reduce the friction forces close to zero, we can use this energy to rotate the shaft of an electric generator as utile energy.

In order to conserve the energy, the system will increase the angle α. If the value of utile energy is to high the angle α increase up to 90 degrease and the precession disappear and E_{kpr}=0. For our application I decided the angle α will increase up to 60 degrease only. The equation 14 becomes:

$$E_{kfly}\,(E_{kpr} - E_{util}) = R^4 \frac{M^3 g^2}{m r^2} cos^4\alpha \qquad (15)$$

$$E_{util} = 180.346 \left(\frac{M}{m}\right)^3 \left(\frac{R}{r}\right)^4 \frac{m}{\omega_{fly}^2} \qquad (16)$$

4. ELECTRIC GENERATOR POWERED BY A GYROSCOPIC SYSTEM – DIMENSIONAL ANALYSES

Based on the same assumption used in a flywheel it is possible to recover the kinetic energy of precession back to electrical energy. Because of gyroscopic approximation, the precession angular velocity has a low magnitude. For this analysis we consider ω_{gyr}/ω_{pr}=2500.

In order to generate electrical energy at this low speed we should use the same approach as in wind power electric generator [13]. In this case the wind and propeller are substituted by gyroscopic system and gravitational attraction.

The precession speed can be increased by a gearbox up to a speed requested by electrical generator to work. In this way we can store the electrical energy in mechanical energy as kinetic energy of gyroscope flywheel and to harvest the gravitational attraction to produce electrical energy. This system can work as long as gyroscopic approximation is maintained.

Because the angular momentum is conserved, the spin of flywheel decrease only because of friction forces, so we only need a small amount of energy to keep the gyroscopic flywheel rotate at certain angular velocity.

Basically, this system transforms gravitational attraction into electrical energy. In this section we will calculate the dimensions of a gyroscopic system able to power an electric generator with the parameters presented in Table 2:

Table 2. Electric generator parameters

Parameter	Symbol	Value	SI unit
Power	P_{gen}	20000	W
Efficiency	η_{gen}	0.95	-
Speed	n_{gen}	250	RPM
Torque	τ_{gen}	800	Nm

This generator is mechanically connected with a gearbox. The parameters of the gearbox are presented in Table 3:

Table 3. Gearbox parameters

Parameter	Symbol	Value	SI unit
Output Power	P_{out}	21,052.63	W
Input Power	P_{in}	23,391.81	W
Efficiency	η	0.9	-
Output Speed	n_{out}	256	RPM
Input Speed	n_{in}	16	RPM
Output Torque	τ_{out}	800	Nm
Input Torque	τ_{in}	14,222.22	Nm

The required energy from gyroscopic system is:

$$E_{kin} = P_{in} t = 23{,}391.81 \cdot 1 = 23{,}391.81\, J \tag{17}$$

In order to maintain the precession rotation, the value of α is limited to 60^0. The value of utile energy should be the same as in (17).

I solved (16) based on the gyroscopic approximation ω_{gyr}/ω_{pr}=2500 for the following values: r=0.4 m; R=3 m and M=20*m. From (16) results the value of m=100 kg.

With (7) I calculated the spin angular velocity of flywheel ω_{gyr}=4,279.65 rad/s; n_{gyr}=40,870.63 RPM and angular velocity of precession ω_{pr}=1.72 rad/s; n_{pr}=16.42 RPM.

The kinetic energy created by precession is:

$$E_{kpr} = \frac{1}{2} M R^2 \omega_{pr}^2 = 26{,}586.9\, J \tag{18}$$

From this we use the kinetic energy applied at the input of the gearbox E_{util}=23,678.236 J. As a result, the angle α increases from 0 to 60 degrees.

The value of torque produced by precession can be calculated with (19). The value is 14,497.84 Nm higher than required value 14,222.22 Nm:

$$\tau_{pr} = \frac{P_{util}}{\omega_{pr}} \tag{19}$$

The flywheel under gravitational attraction creates precession rotation as long as gyroscopic approximations are maintained. The kinetic energy and torque is strong enough to power a gearbox which increase the rotation up to the value required by electric generator.

The electric generator produces electricity as long as precession exists. Because the value of angular momentum of flywheel does not change because of precession the rotation will be maintained as long as frictions forces are compensate or canceled. A part of the electric energy produced can be used to maintain the value of spin angular velocity ω_{gyr}.

The system do not create electric energy from nothing but harvest the gravitational attraction in a much efficient way than actual potential energy storage systems. The main advantage of this system is the ability to produce a certain amount of electric energy without a limit of time.

CONCLUSIONS

Based on the conservation of angular momentum we can use the gravitational attraction to create precession rotation strong enough to provide the energy and torque necessary to activate an electric generator similar like in wind power generator.

The electric energy stored as kinetic energy in gyroscopic flywheel is E_{kfly}=146,523,000 J. and the ratio between E_{kfly}/E_{kpr}=5,511.098.

Instead to recover the energy from flywheel kinetic energy we can use the precession created by gravitational attraction to create necessary kinetic energy. The system is working as long as gyroscopic approximation is maintained and this time can be exceptionally long.

In this paper I didn't analyzed if this solution is efficient from an economic point of view, my intention was to prove if it possible to use a gyroscopic system to produce electrical energy and what are the dimensions of a gyroscopic system able to produce a certain amount of electrical energy. The optimization of dimensions of gyroscopic system based on desired output will be the subject of my future work.

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AERODYNAMIC ANALYSIS OF THE CLARK YH AIRFOIL

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Abstract: *The analysis of the performance of aerodynamic airfoils leads to optimized approaches regarding the pre-design of fixed and rotating lifting surfaces, with implications on the global characteristics and performances of aircraft. The 2D aerodynamics of the airfoils provides indications on the aeromechanical behavior of the selected geometric elements, which may come as constructive solutions depending on the typology of the missions and the initial requirements of the project.*

The article provides a scrutiny of and certain educational perspectives on the Clark YH profile analysis, using freeware tools (Javafoil, Profiles and XFLR5).

Keywords: *Clark YH, aerodynamic analysis, Javafoil, Profili, XFLR5.*

Acronims and symbols

AoA	*Angle of attack*	*CNC*	*Computer numerical control*
XFLR	*Xfoil low Reynolds*	*LLT*	*Lifting line theory*
Cm	*Pitch coefficient*	C_d	*Drag coefficient*
C_p	*Pressure coefficient*	C_l	*Lift coefficient*
C_l / C_d	*Gliding ratio*		

1. INTRODUCTION

1.1 The geometry of the aerodynamic airfoil

The aerodynamic airfoil is characterized by the following geometric elements (figure 1.1): airfoil chord (c), maximum arrow of the profile skeleton (f_{max}), position of the maximum arrow, defined by the distance from the leading edge (a_f), maximum airfoil thickness (e_{max}), the position of the maximum thickness, defined by the distance from the leading edge (a_e), the radius of curvature of the leading edge (r), the angle at the leading edge, τ. [1, 2].

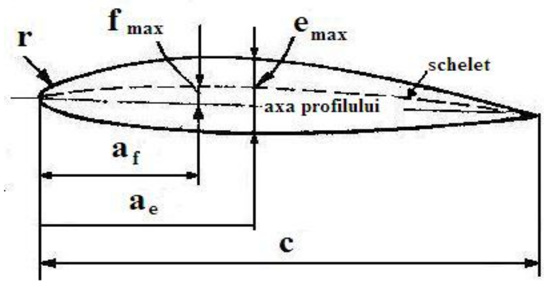


FIG.1.1 Airfoil geometric elements

Airfoil classification

It can be after *the curvature* (figure 1.2): symmetrical airfoils, asymmetrical airfoils (plane-convex, biconvex, concave-convex, double-curvature); according to *the shape* of the skeleton and the flight board: Zhukovsky, Carafoli, von Misses, Karmann-Trefftz; by *speed range* (subsonic, supesonic).

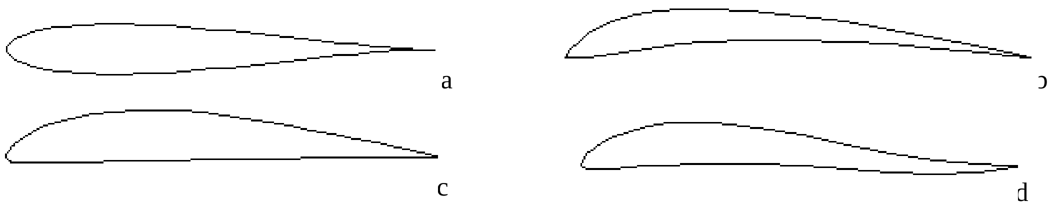


FIG. 1.2 Airfoil types (a.biconvex-simetric, b.concave-convex, c.plane-convex, double curvature)

The airfoils can also be classified according to *the elaboration method*, they can be: *theoretical airfoils*, obtained by conforming transformations, or by inversion of some curves (basic theoretical airfoils, Jukovski airfoils, Jukovski-Betz airfoils, Karman-Trefftz airfoils, Betz-Keune airfoils, Carafoli airfoils); *empirical airfoils*, obtained by free tracing or choosing accordingly equations for skeleton shape and thickness distribution (EC airfoils, EQ airfoils, ECH airfoils, EQH airfoils, NACA-NASA airfoils, Gottingen airfoils, TAGHI airfoils, ONERA airfoils, Clark Y airfoils, RAF airfoils, RAE airfoils, *profiles obtained with inverse methods*, starting from the imposed pressure distributions (supercritical airfoils, superlifting airfoils, airfoils for low speeds).

1.2 Criteria for choosing airfoils

Choosing the class of wing and tail airfoils, correctly establishing the airfoils that will generate the aerodynamic surfaces of the aircraft are complex problems, the correct solution of which depends directly on the level of performance and flight qualities of the designed aircraft. [3]

The value of the C_{lmax} coefficient of the wing without flaps is of interest in establishing the maneuverability of aircraft with acrobatic characteristics. It is important to consider the lifting component at incidences close to that corresponding to the maximum lifting capacity.

Another important parameter is the value of the C_{dmin} coefficient. The maximum flight speed, the maximum flight distance, the fuel consumption over a given distance, etc. depend on this value.

The zero lifting moment coefficient, C_{m0}, intervenes in the degree of stress of the wing structure and in the equilibrium conditions around the pitch axis, affecting the horizontal tail lift at equilibrium and in the corresponding turning tail range. For these reasons it is preferable to have a airfoils whose coefficient C_{m0} is zero or as small as possible.

The requirements presented are contradictory and cannot be equally satisfied by the same type of airfoils, because of this they will be preferentially satisfied depending on the category of the aircraft.

2. OBJECT OF THE ANALYSIS AND SOFTWARE INFORMATION

2.1 The Clark YH airfoil

The airfoil for aerodynamic analysis (figure 1.3) is derived from Clark Y, has the characteristics shown in Table 1.1 and is often used in the construction of flying wings due to stability characteristics (due to reflex flight board) but also low speed aircraft in classic aerodynamic configuration.

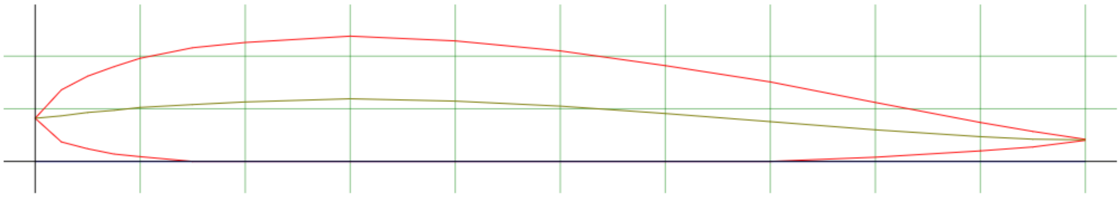


FIG. 1.3 Clark YH airfoil, [4, 16].

Table 1.1 Clark YH airfoil characteristics

Characteristics	Values	Characteristics	Values
Max. thickness	11,9 % la 30% x/c	Max. AoA	9^0
AoA at C_{d0}	-2.0	AoA at $(C_l/C_d)_{max}$	4.5^0
Max. arrow	5.95% at 30% x/c	$C_{l\ max}$	1.11
$(C_l/C_d)_{max}$	32.834	C_l at $(C_l/C_d)_{max}$	0.683

The types of aircraft using the ClarkYH profile are shown in Figure 1.4.

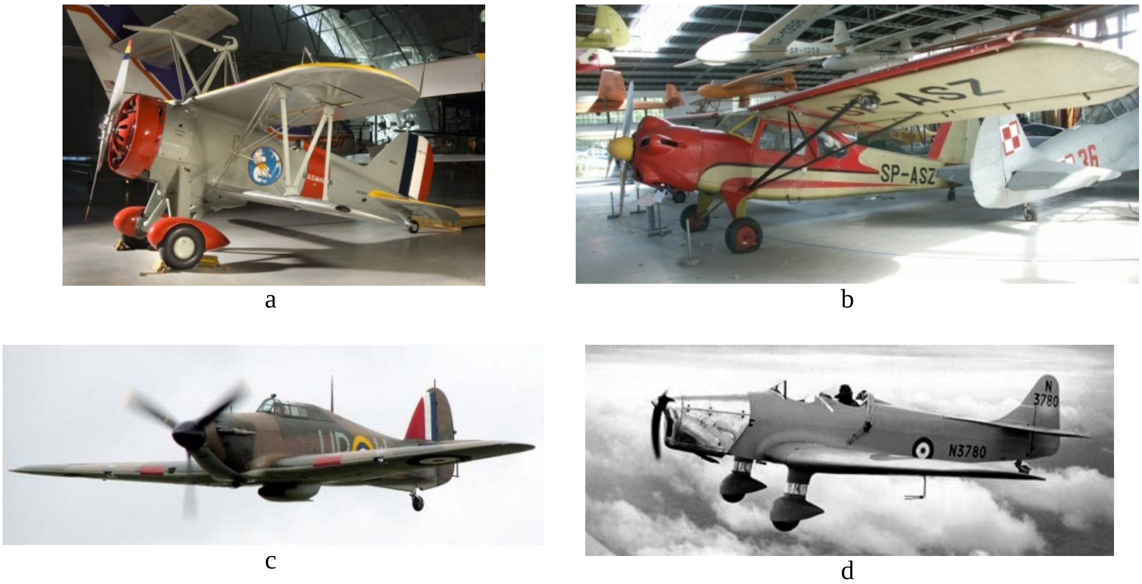


FIG. 1.4 Aircrafts using the Clark YH airfoil, a.Curtiss F9C-2 Sparrow-Hawk (1932) [5], b. YAK 12 (1947) [6], c. Hawker Hurricane (1937) [7], d. Miles M14 Magister (1939), [8].

2.2 SOFTWARE USED FOR THE AERODYMANIC ANALYSIS

2.2.1 Javafoil

JavaFoil is a relatively simple software, which uses several traditional methods for aerodynamic analysis, the most important being the analysis of the potential flow and the analysis of the boundary layer (figure 2.1). The analysis of the potential flow is based on the panel method (linear distribution of variable vorticity). Taking a set of profile coordinates, it calculates the local flow rate (no viscosity) along the airfoil surface for any angle of attack, [9, 10].

The analysis of the boundary layer is applied on the upper and lower surfaces of the airfoil, starting from the stagnation point. It solves a set of differential equations to find the different parameters of the boundary layer (integral method).

The equations and criteria for transition and separation are based on the procedures described by Eppler [11, 12, 16].

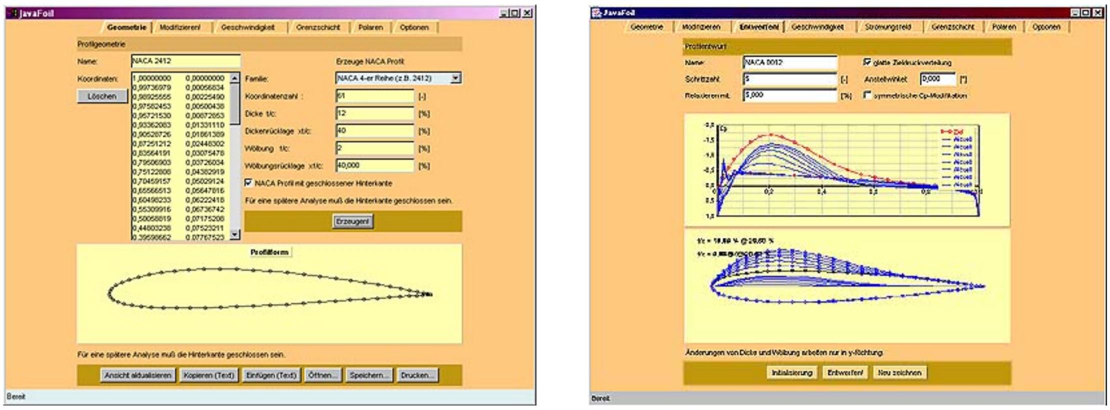


FIG. 2.1 Graphical user interface - Javafoil

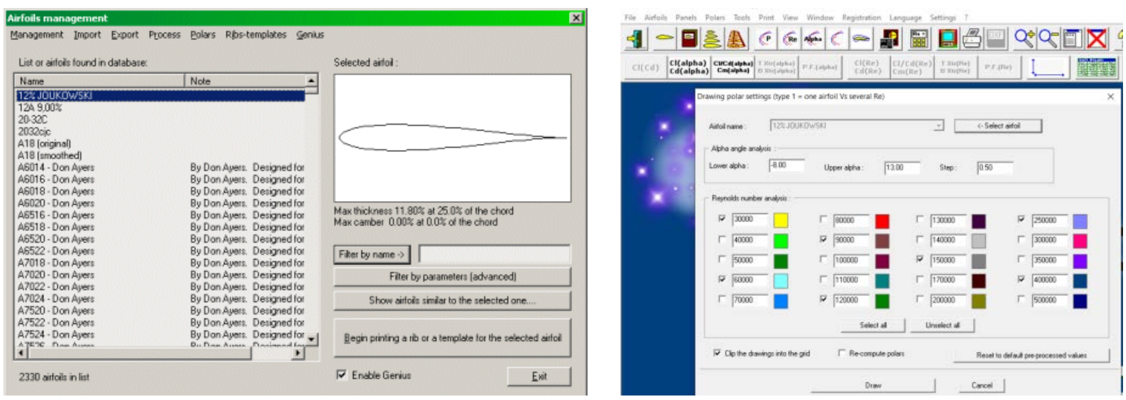
Javafoil also contains specific tools for geometric parameterization depending on the thickness, arrow and curvature of the airfoils. 2D geometries can be generated or imported from external databases.

Both step analyzes (potential flow and boundary layer analysis) are applied for an angle of attack (AoA) interval, which gives a complete polar of the airfoil for a Reynolds number. The calculations are performed by your own computer code (not by Eppler or XFOIL). Only the boundary layer module was based directly on the method found in the initial version of the Eppler program.

JavaFoil is a relatively simple software with limitations. Because JavaFoil does not model laminar flow separation bubbles and turbulent flow separation, the results will be incorrect if large flow separation areas are present. Mass separation, as in the stall mode, is modeled to some extent by empirical corrections, so that the maximum lift can be predicted approximately for ”*conventional*” airfoils. If you analyze an air airfoil beyond this regime, the results will be quite inaccurate.

2.2.2 Profili

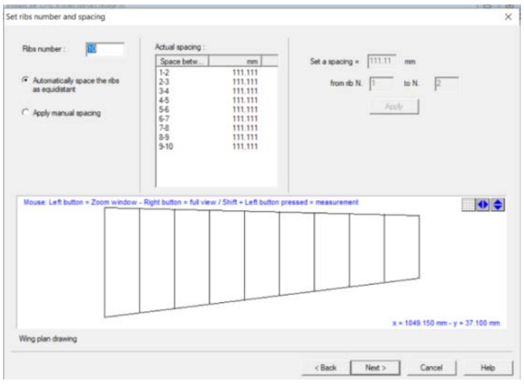
Profili software has a database of over 2,200 aerodynamic profiles with precomputed aerodynamic characteristics, which minimizes the time in performing aerodynamic comparisons (figure 2.2). The user can modify the geometry of the airfoil both by modifying the global characteristics (thickness, curvature) and the local characteristics by applying a flap of curvature, [13].



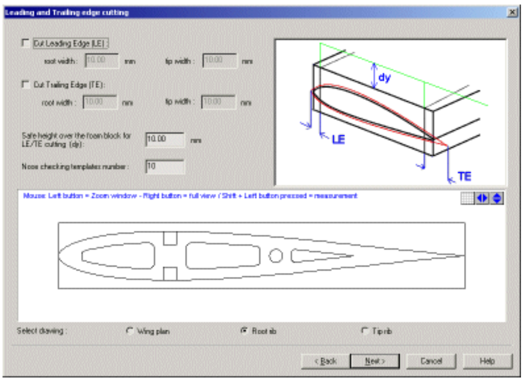
a. airfoil database   b.parameter (AoA și Re) for polars

FIG. 2.2 GUI Profili – airfoil aerodynamic analysis

The software tool has a series of functions of geometric parameterization and aerodynamic analysis grouped on a series of modules, as follows: airfoil geometry management (import/export of airfoils from / to external databases); airfoil geometry processing; polar generation regarding aerodynamic coefficients (C_l, C_d, C_m, C_p); geometric definitions (ribs. wings) for plotting and CNC making and routing (foam panels), see figure 2.3. Profili software contains facilities for exporting geometries in various formats (* .dxf, * plt, * pro, * .dat, * .cor) and polarities (* .html).



a.ribs wing panel



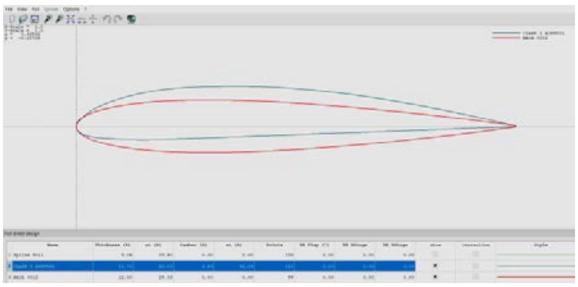
b.rib wing definition

FIG. 2.3 GUI Profili software– wing geometry

2.2.3 XFLR5

XFLR5 is compatible with Windows operating systems using Microsoft MFC libraries, and use in Linux, MAC and Unix requires an emulator.

It is an aerodynamic analysis software tool based on a code valid only for non-propelled models (gliders), for which it provides reasonable results. Therefore, the approach to geometries similar to real aircraft is limited, regardless of the influence of propellers, [14]. XFLR5 is based on five basic modules: two modules for geometric parameterization of initiation and comparison of airfoil (B-Splines); the mode with reverse design routines (mixed-QDES and total-MDES) of the airfoil; direct airfoil analysis module (OPER); how to analyze the wings, fuselage and glider, (Fig. 2.4).



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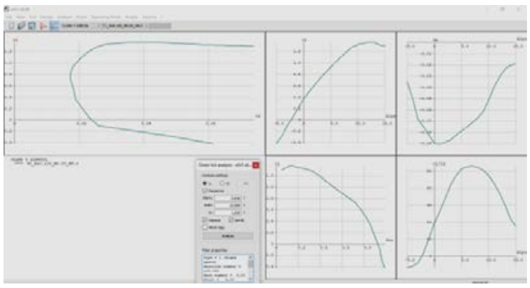

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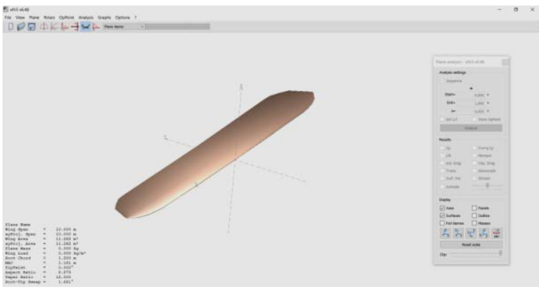


c

FIG. 2.4 XFLR5 modules, a. geometrical module - airfoil, b.direct analysis module - airfoil, c. geometrical module -wing

The numerical analysis methods underlying the software code are: lifting line theory (LLT); vortex lattice method (VLM) and panel method. [15]

3. AERODYNAMIC ANALYSIS

3.1 Conditions for the analysis

The aerodynamic analyses are based on the theoretical characteristics of the Clark YH airfoil in table 1.1, and the analysis conditions used by the three software tools (Javafoil, Profiles, XFLR5) are recorded in table 3.1.

Table 3.1.Conditions of analysis

Conditions	Value	Conditions	Value
Angle of attack (AoA)	$- 5^0 \div 13^0$	Speed	10÷30 m/s
Nr. Reynolds	$2x10^5$ / $4x10^5$ / $6x10^5$	Density	1,22 kg/m^3
Iterations	100	Viscosity	$1,5x10^{-5}m^2/s$

3.2 Numerical results and interpretations

We present the graphical aspects of the numerical results depending on the software tool, according to the analysis matrix in table 3.2.

Table 3.2.Cases of analysis

Polars / graphs	Javafoil	Profili	XFLR5
C_l vs C_d			
C_l vs AoA			
C_d vs AoA	-		
C_m vs AoA			
C_l/C_d vs AoA	-		

3.2.1 Javafoil

The results of the analyses with Javafoil software are highlighted in figures 3.1 ÷ 3.3.

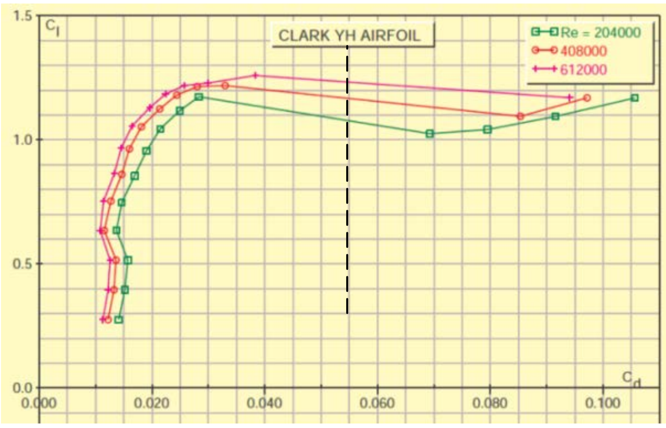


FIG. 3.1 Polarels C_l-C_d - Javafoil

Figure 3.1. shows comparative variations of C_l vs C_d coefficient for the three Reynolds numbers, the lift coefficient (C_l) decreases with the decrease of the Reynolds number at a fixed C_d value, and with the increase no. Reynolds AoA maximum increases, (fig. 3.2) while the value C_m is quasi-constant and reveals a self-stable behavior of the airfoil (fig.3.3).

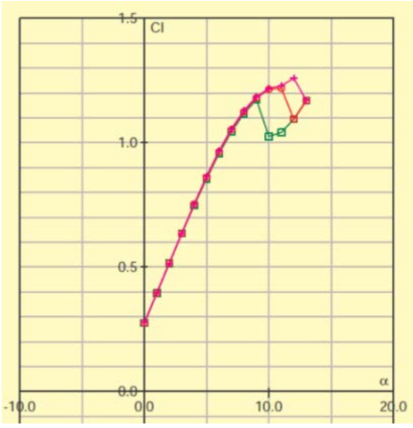


FIG. 3.2 Polar C_l-AoA - Javafoil

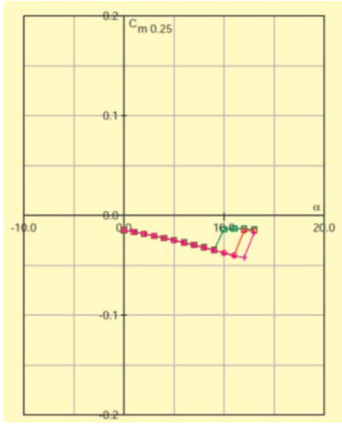


FIG. 3.3 Polar C_m-AoA - Javafoil

3.2.2.Profili

Figures 3.4 ÷ 3.6 provide the most relevant characteristic polars of the analyzed airfoil (without flap junction).

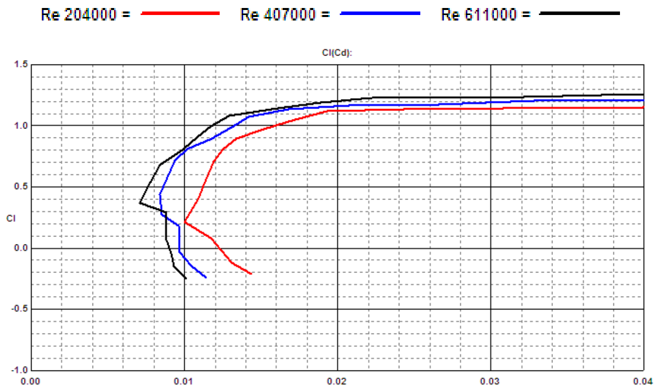
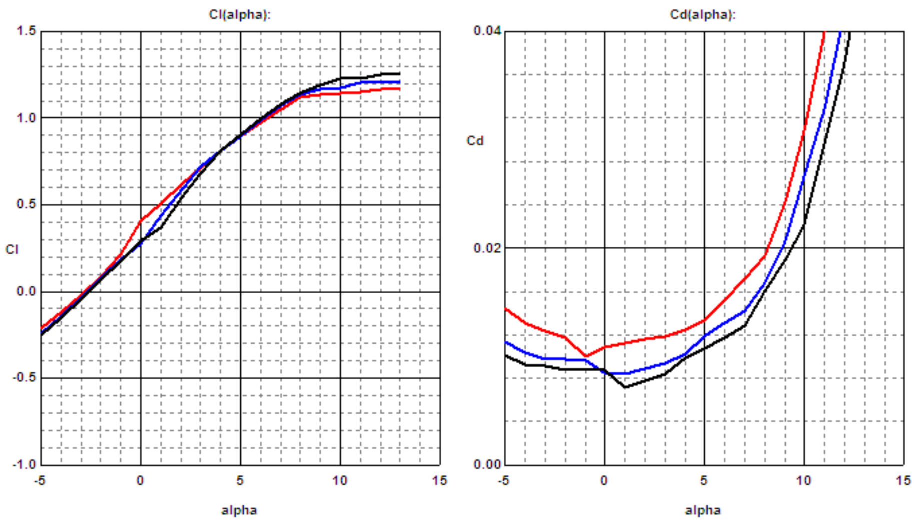


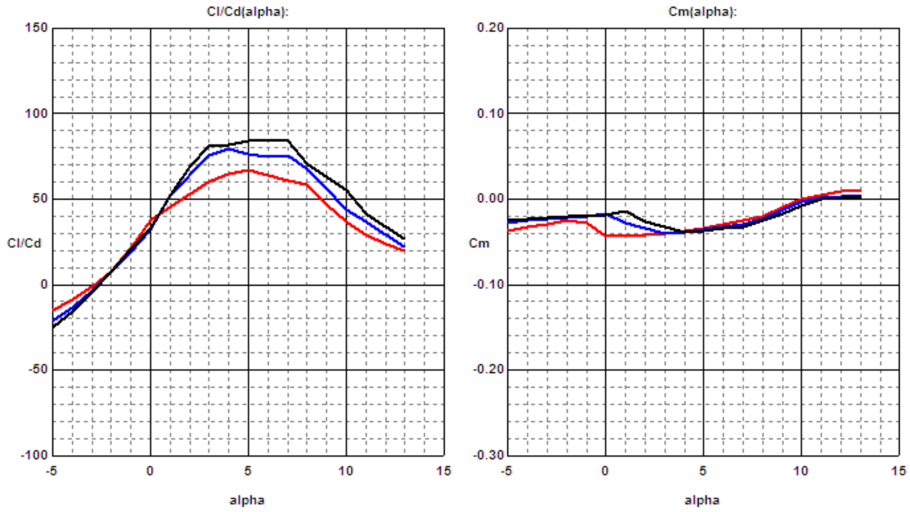
FIG. 3.4 Polar C_l-C_d - Profili



a b

FIG. 3.5 Polars a.C_l-AoA, b.C_d-AoA - Profili

Figure 3.5a shows identical polar corresponding to the three flight speeds, the lift coefficient has a maximum value (1.25) at an incidence of 13^0, and the drag coefficient has a significant linear increase starting with an incidence of 7^0.



a b

FIG. 3.6 Polar C_l/C_d-AoA (a), C_m-AoA - Profili

Figure 3.6a shows a maximum gliding ratio (C_l/C_d -AoA) at the incidence of 7^0 to 30 m/s, 4^0 to 20 m/s and 5^0 to 10 m/s, while the pitch coefficient (C_m) it has almost zero value (-0,0001) at the incidence of 10^0, and after 11^0 positive values are observed (0.005). Maximum negative values (-0.0414) of the pitch coefficient are recorded at the incidence of 2^0 for the speed of 10 m/s.

3.2.3 XFLR5 analysis

Figures 3.7 ÷ 3.9 provide the characteristic polars, the most relevant of the analyzed airfoil (without flap).

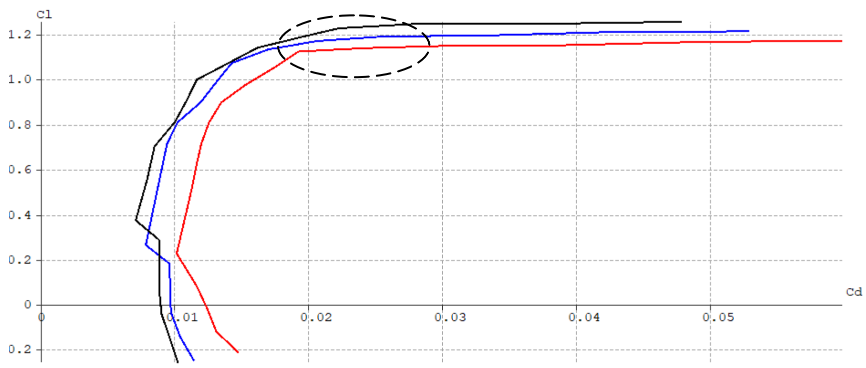


FIG. 3.7 Polar C_l-C_d – XFLR5

Variations of the C_d value are observed for C_l=1.15 ÷ 1.2 (figure 3.7) and for AoA> 5^o (figure 3.8b), while the lifting behavior is similar over the whole incidence range (AoA), figure 3.8a.

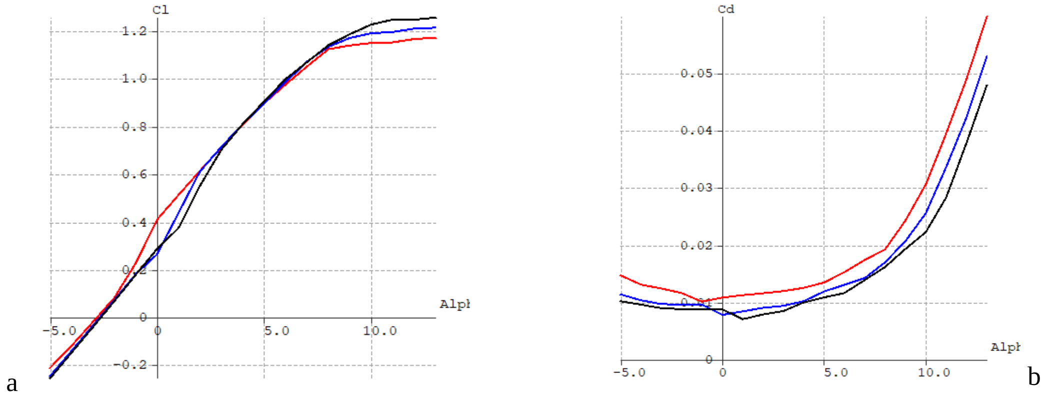


FIG. 3.8 Polars a.C_l-AoA, b.C_d-AoA – XFLR5

According to figure 3.9a the maximum gliding ratio corresponds to AoA = 5^o, and C_m reveals a self-stable behavior for the three Reynolds numbers (according to the sign convention).

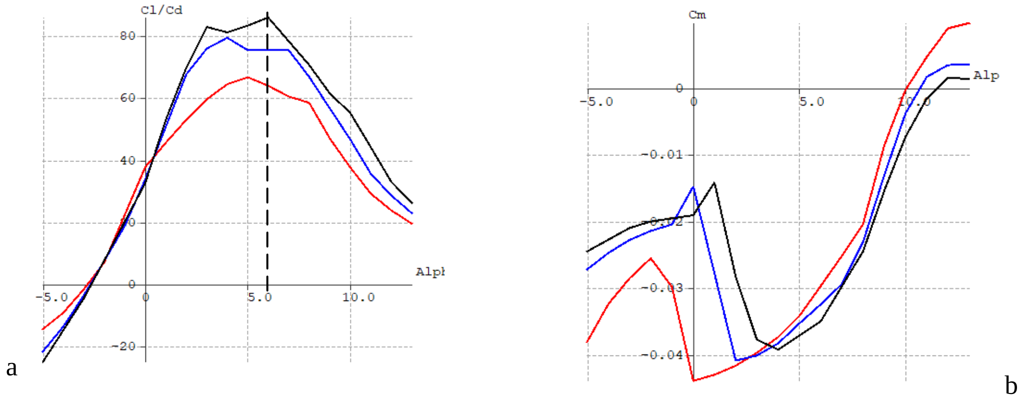
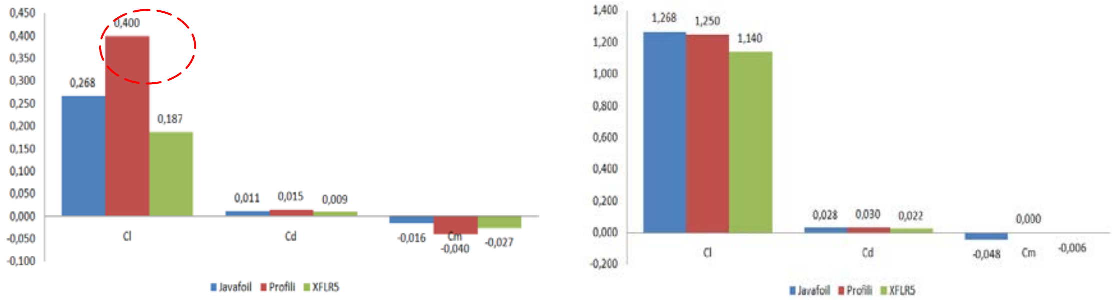


FIG. 3.9 Polars C_l/C_d-AoA (a), C_m-AoA - Profili

For a complete image and a verification of the numerical analyzes we proceeded to a comparative stage of the values generated by the three software tools, for no. Re = 204,000, according to figure 3.10.



AoA=0^o AoA=10^o

FIG. 3.9 Comparative values of coefficients C_l, C_d și C_m

We observe differences of the numerical values for the coefficient C_l due to the calculation errors of the Profili software for the zero angle of attack (see also figure 3.8a). For the other values we observe irrelevant differences of the calculated coefficients.

CONCLUSIONS

Aerodynamic analysis tools based on open source numerical codes can be used in the online or offline environment with a series of geometric options (number of points, setting flap) that provide the user with a complete analysis matrix similar to real cases.

The three selected aerodynamic analysis software provide educational and pre-design approaches to 2D geometries generating relevant qualitative results but limited quantitative results. The use of freeware based on different numerical codes provides a complete picture of the aerodynamic behavior for aerodynamic profiles.

Last but not least, the approach of aerodynamic analysis with the help of a series of software tools offers the opportunity to evaluate the source codes underlying the concept of numerical simulations, giving users the opportunity to seek improvements.

ACKNOWLEDGMENTS

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CONSIDERATIONS REGARDING THE RELIABILITY ASSESSMENT OF THE ROLLER BEARING PROVIDING MOVEMENT IN THE DIRECTION OF ANTI-AIRCRAFT GUNS

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Abstract: *This paper analyzes a method of evaluating the reliability of the rolling bearing in anti-aircraft guns. In evaluating its reliability, the factors that depend on the operating conditions of the anti-aircraft gun are taken into account, as well as the factors of design, technology, materials and assembly.*

Keywords: reliability, failure rate, anti-aircraft gun, rolling bearing

1. INTRODUCTION

The reliability of a technical system must be considered as a quantity with the resulting distributions, given that external stresses, dimensions, material properties and operating conditions have a specific variability.

Currently, due to insufficient data to define the distributions for each type of damage, the calculation of rolling bearings is performed separately for wear at variable contact stresses and for wear in environments with abrasive particles.

In the case of the deterioration phenomenon due to the contact demands of the constructive elements, the durability of the rolling bearings is determined taking into account the statistical character of the initiation and development of the defect, and for establishing the abrasive wear the calculations are deterministic.

2. DETERMINATION OF RELIABILITY IN THE ROLLER BEARING OF ROTATING GUN MOUNTING

At the bottom of the steering platform at the base of the anti-aircraft guns, a rolling bearing is mounted, which ensures the rotation of the moving part of the anti-aircraft gun in the desired direction. The rolling bearing also has the role of taking over the reactions that appear horizontally and vertically, both in static position, but especially under the conditions in which shots are fired (FIG.1).

In order to determine the reliability, or to highlight the specific failures, in this paper we are going to use the FMEA method - Failure Modes and Effects Analysis. By applying this method, there result the causes and effects of the defect, thus offering us the possibility to diminish or even eliminate them.

In order to evaluate the reliability of the rolling bearing, the following hypotheses are considered:

− the statistical model used in the characterization of each type of failure is of exponential type;

− the evaluation of the forecast reliability of the analyzed rolling bearing is determined for the operation period, when the failure rate is constant;

− interdependencies, combinations and overlaps of effects that may occur for different ways of damage are neglected.

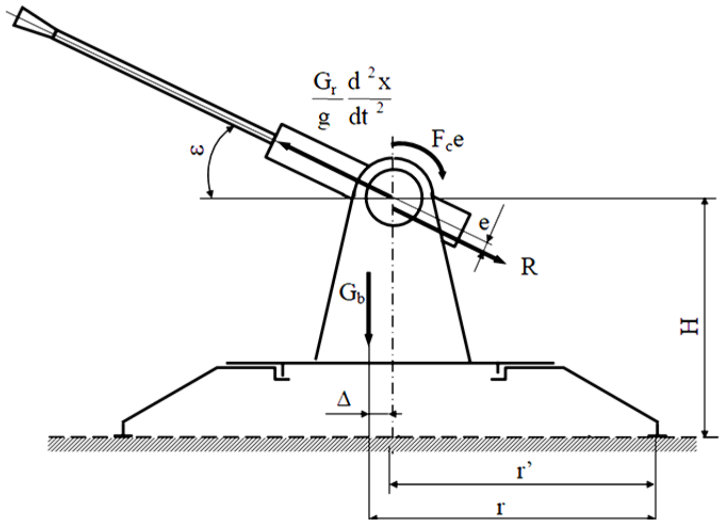

FIG. 1. The forces and the moments that appear during the operation of the anti-aircraft gun

Taking into account the possibilities of failure of the rolling bearing, its reliability, considered as a system, is given by the relation [2]:

$$R_{tot}(t) = R_1(t)\cdot\ldots\cdot R_n(t) = \prod_{i=1}^{n} R_i(t) \tag{1}$$

Based on the simplified hypotheses presented above, the reliability of the rolling bearing can be expressed as follows [1]:

$$R_c(t) = e^{-\lambda_c \cdot t} = e^{-\sum_{i=1}^{m}\lambda_{ci}\cdot t} \tag{2}$$

where:

λ_C – is the effective value of the failure rate;

λ_{ci} - represents the value of the failure rate for each type of damage.

To evaluate the reliability of the rolling bearing it is necessary to establish the values λ_{ci}, $i = 1,\ldots, m$. This can be done either through a database containing quantitative information obtained as a result of operating similar products, under conditions similar to the analyzed rolling bearing, or on the basis of appropriate recommendations and regulations.

In the case of the damage phenomenon caused by variable contact stresses, the modeling of the rolling bearing durability is achieved by using the Weibull distribution. For the regular values of the shape parameter of this distribution *(β)* the reliability function of the rolling bearing R_{OC} relation (2), we can express [4]:

$$R_{OC}(L) = e^{\ln(0,9)\left(\frac{L}{L_{10}}\right)^{1,1}} \tag{3}$$

and the function of the failure rate is [4]:

$$z_{OC}(L) = -\frac{\ln(0,9)\cdot 1,1}{L_{10}}\left(\frac{L}{L_{10}}\right)^{0,1} \tag{4}$$

Relation (4) indicates a slightly increasing function for the failure rate. In general, in determining the reliability of rolling bearings, the Weibull distribution function with the shape parameter $\beta = 1,1$ can be approximated by the exponential distribution, for $\beta = 1$.

In this case, it results:

$$R_{OC}(L) = e^{\ln(0,9)\frac{L}{L_{10}}} = e^{-\lambda_{OC}\cdot L} \tag{5}$$

and:

$$z_{OC}(L) = -\frac{\ln(0,9)}{L_{10}} = \lambda_{OC} \tag{6}$$

In relations (3) … (6), L_{10} is noted the nominal durability of the analyzed rolling bearing. This quantity is calculated using the relations based on the value of the basic dynamic load *(C)* and the equivalent load *(P)*. The latter is assessed on the basis of radial and axial forces (F_r and F_a) which act upon the rolling bearing during the operation of the anti-aircraft gun.

The loading forces acting upon the rolling bearing during the firing of the anti-aircraft gun are, in most cases, variable. Figure 2 [5], shows the calculation scheme of these reactions (internal forces), depending on the load of the analyzed technical system.

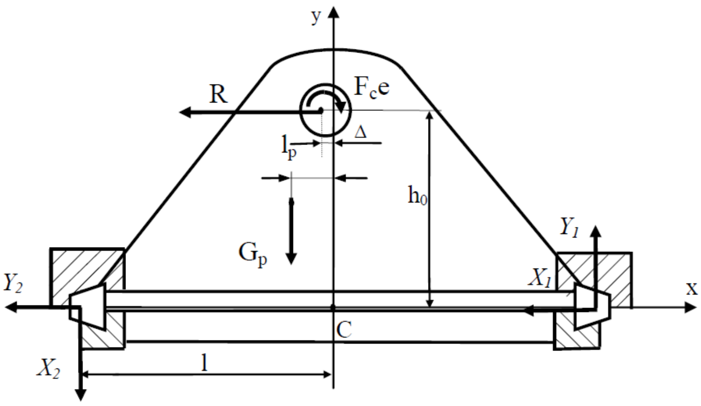

FIG. 2. The reactions (internal forces) that appear in the rolling bearing

The following notations were used in the scheme:

- R - the result and force of the calculation resistances on the recoil mass;
- G_p - weight of the pivoting part;
- $F_c \cdot e$ - the moment of dynamic action;
- X_1, Y_1, X_2, Y_2 - the reactions that occur in the rolling bearing;
- l_p - the pivoting weight arm G_p in relation to the axis of the rolling bearing;
- h_0 - the force arm R, in relation to the point of intersection of the reaction with the axis of the rolling bearing;
- l - the radius of disposition of the rolling bodies of the bearing;
- x_n - the eccentricity between the axis of symmetry of the rolling bearing and the axis of the cradle bearings.

The reactions occurring in the rolling bearing, during the firing of anti-aircraft guns, for the angle of inclination in height of the barrel of the cannon $\varphi = 0$, result from the following equilibrium equations:

$$\begin{cases} \sum_{i=1}^{n} F_x = -X_1 - X_2 - 2R = 0 \\ \sum_{i=1}^{n} F_y = Y_1 - Y_2 - G_p = 0 \\ \sum_{i=1}^{n} M_c = 2F_c e - 2Rh_0 - G_p l_p - (Y_1 + X_2)l = 0 \end{cases} \quad (7)$$

In this case, the horizontal reactions have the value equal to zero, and the vertical reactions are determined by the relations:

$$\begin{cases} Y_1 = \dfrac{2F_c e - 2Rh_0 + G_p(l - l_p)}{2l} \\ Y_2 = \dfrac{2F_c e - 2Rh_0 - G_p(l + l_p)}{2l} \end{cases} \quad (7')$$

If the firing forces are not taken into account, the reactions that occur in the rolling bearing are:

$$\begin{cases} \sum_{i=1}^{n} F_x^{'} = -X_1^{'} - X_2^{'} = 0 \\ \sum_{i=1}^{n} F_y^{'} = Y_1^{'} - Y_2^{'} - G_p = 0 \\ \sum_{i=1}^{n} M_c = -G_p l_p - (Y_1 + Y_2)l = 0 \end{cases} \quad (8)$$

From system (8) there result the vertical and horizontal components of the reactions:

$$\begin{cases} Y_1^{'} = \dfrac{G_p(l - l_p)}{2l} \\ Y_2^{'} = H_1 - G_p \end{cases} \quad (8')$$

$$\begin{cases} R_1^{'} = X_1^{'} \\ R_2^{'} = X_2^{'} \end{cases} \quad (8'')$$

If anti-aircraft gunfire is fired, the resulting reactions in the rolling bearing are:

$$\begin{cases} \sum_{i=1}^{n} F_x = -X_1^{''} - X_2^{''} - R = 0 \\ \sum_{i=1}^{n} F_y = Y_1^{''} - Y_2^{''} - G_p = 0 \\ \sum_{i=1}^{n} M_c = 2F_c e - 2Rh_0 - G_p l_p - (Y_1^{''} + Y_2^{''})l = 0 \end{cases} \quad (9)$$

The vertical reactions in this case are determined by the relations:

$$\begin{cases} Y_1^{"} = \dfrac{F_c e - R h_0 + G_p (l + l_p)}{2l} \\ Y_2^{"} = \dfrac{F_c e - R h_0 - G_p (l + l_p)}{2l} \end{cases} \quad (9')$$

The resulting forces are determined by the relations:

$$\begin{aligned} R_1^{"} &= \sqrt{X_1^{"2} + Y_1^{"2}} \\ R_2^{"} &= \sqrt{X_2^{"2} + Y_2^{"2}} \end{aligned} \quad (10)$$

The effect of internal and external forces on the rolling bearing will be the same as that of an average equivalent dynamic load [7]:

$$P_m = \left[\frac{1}{N_0} \int_0^{N_0} \left[X \cdot V \cdot F_r(N_0) + \lambda \cdot F_a(N_0) \right]^P dN \right]^{\frac{1}{P}} \quad (11)$$

The calculation performed by relation (11) is laborious and a simplified calculation is preferred, which consists of multiplying the equivalent dynamic load given by relation (12), with experimentally determined coefficients, depending on the actual operating conditions of the rolling bearing [3]:

$$P = f_p \left(X \cdot V \cdot F_r + Y \cdot F_a \right) \quad (12)$$

where:

f_p- represents the correction factor of the equivalent dynamic load and has the form, [3]:

$$f_p = f_z \cdot f_d \cdot f_v \cdot f_s \cdot f_t^{-1} \quad (13)$$

In relation (13), the five factors used represent [6]:

f_z - additional factor that depends on the precision of the teeth; it applies to roller bearing assemblies used for gears transmissions. The precision of the inner cylindrical gear being normal, with the division and shape error of 0,02 - 0.05mm, there results $f_z = 1,1 – 1,3$;

f_d - regime factor depending on the type of machine of which the mounting with rolling bearings is part. For the studied case, $f_d = 2,0 – 3,5$;

f_v - additional factor, it applies only in case of belt or chain drive; in this case the value of the coefficient $f_v = 1$;

f_s - shock factor; for the studied case, $f_s = 1,8 – 2,3$;

f_t - temperature factor. The regime temperature being lower than 100^0C, the coefficient has the value $f_t = 1$.

The operating, environmental and precision conditions affect the reliability of the rolling bearings, so that the effective value of the failure rate is obtained by means of the relation:

$$\lambda_C = K_{OC} \cdot \lambda_{OC} \tag{14}$$

In equation (14), K_{OC} represents a correction coefficient depending on the field of use of the rolling bearing. For rolling bearings used in military anti-aircraft artillery, the values of this coefficient are $K_{OC}=120\text{-}150$ [6].

In addition to the way of quantifying the influence of actual operating and environmental conditions on the reliability of the rolling bearing, the values of the failure rate, specific to the other damage mechanisms, can also be used. In this case, a preliminary analysis is required to highlight the ways of failure that may occur as a result of the concrete conditions in which the analyzed rolling bearing operates. The effective value of the failure rate is determined by the relation:

$$\lambda_C = \lambda_{OC} + \sum_{i=1}^{m-1} \lambda_{ci} \tag{15}$$

based on the individual values of the failure rate λ_{ci}, corresponding to the other forms of damage.

During the firing of anti-aircraft guns, the reliability of the rolling bearing is to some extent influenced by accidental damage. The reliability of the rolling bearing (R) will be equal to multiplying the reliability caused by the cumulative degradations (R_c) by the reliability caused by the accidental defects (R_{AC}):

$$R(t) = R_{AC}(t) \cdot R_C(t) = e^{-\left(\lambda_{AC} + \lambda_{OC} + \sum_{i=1}^{m-1} \lambda_{ci}\right) \cdot t} = e^{-(\lambda_{AC} + K_{OP} \cdot \lambda_{OP}) \cdot t} \tag{16}$$

3. CONCLUSIONS

Taking into account the functional parameters specific to the military technology, with reference to anti-aircraft guns, a great importance must be given in terms of the reliability of the component constructive elements.

Thus obtained values of the reliability of rolling bearing that ensures the movement in the direction of the anti-aircraft guns, as well as of the other constructive elements component of them, are the basis for the elaboration of the necessary documentation for an optimal preventive maintenance.

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REFERENCES RELATED TO THE DEFINITION OF THE STATUTE OF AERONAUTICAL STAFF IN THE PIONEERING PERIOD OF THE ROMANIAN MILITARY AERONAUTICS

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Abstract: *The establishment of the Military Aviation 110 years ago, a historical event with reference to the audacious flight made by the engineer Aurel Vlaicu, on the Cotroceni land, with the Vlaicu airplane no. 1 on June the 17th, 1910, the founding of the first Civil Pilot Schools and, later on, of the first Military Flight Training School, specialized aeronautical institutions that will initiate the training of military pilots, represents the starting point that will generate major debates in the leadership and political factors of the Armed Forces, regarding the theoretical and practical methods for the development of this new reality at the beginning of the twentieth century, the selection of the human resource excellently trained and motivated to carry out fearlessly and courageously dangerous activities in the field of air weapons, but also the taking of some measures to regulate the status, the obligations and rights of the aeronautical personnel, aspects that will find their solution by developing innovative legal instruments, adapted to the requirements of the times, which will decisively influence modern developments in the fundamental area of Air Law.*

Keywords: Aeronautics, air weapon, aviation, air balloon, air mission, air observer, pilot, flight.

1. INTRODUCTION

110 years have passed since the first air jump executed in Romania from a plane designed, built and flown by a son of the Romanian people, who came from Transylvania to the Old Kingdom to fulfill his dream. A relatively modest jubilee passed in today's unfavorable conditions almost unnoticed, but fundamentally marked by important achievements, which some of the world's leading countries never had.

Among the first three great pilots of Europe, the Romanian Traian Vuia was the first to fly in Paris in 1906, followed by Ader and Santos-Dumont. In 1908, the legendary Henry Farman made the first flight of 1 km in closed circuit, and in the same year, our famous Vlaicu tested his wooden glider, which, a year later, would lift him in the air while dragged for takeoff by three horses in the whiplashes of his friends [1].

On June the 4th 1917, at 18.00, in the presence of important military and civilian personalities and a generous public, on the third attempt, after a 40 m roll, the Vlaicu airplane no. 1 took off, performing the first 50 m of flight at a height of 3-4 m. It was the anniversary of the Romanian Military Aviation because the plane had been built at the Army Arsenal, with the support of the Ministry of War, Vlaicu himself being remunerated for his achievement [2].

In 1911, the small country from the Danube and the Carpathians already had two pilot schools, a national workshop in Chitila for the building of airplanes, the first patented military pilots and had used airplanes in military maneuvers of the Army.

But the emergence and further development of aviation also meant the solution of three basic problems: the design of the flying machine, its construction and, fundamentally, its testing and operation in flight. The third problem at the beginning of aviation was the most difficult. And for its successful passage, there was need for "fanatics" who, with the sacrifice of their lives, made possible the victory of the belief that flight was possible and achievable. From this perspective, it can be stated that Romanians have contributed perhaps more than others through thought, energy, determination and sacrifice for mastering the air.

Born at the same time with the World Aviation, in times of great trials and changes in international life, aviation in our country immediately needed specialized institutions, capable of training brave pilots, with love of flight, even at the cost of blood sacrifice, able to exploit the new technology. And for the realization of these aims the enlightened minds and the doctrinaires of the times understood that new regulations were needed to substantiate the complex processes of selection, recruitment, development and, especially, to motivate the staff able to fulfill these national aims.

2. FIRST REGULATIONS RELATED TO THE STATUS OF AERONAUTICAL STAFF

Under the patronage of a fruitful development in the first years after its establishment, the Romanian Aeronautical Program, especially in the field of aircraft endowment, continues positively, especially in the direction of training aeronautical personnel. By High Royal Decree, on April the 1st, 1912, for the training of military pilots, the Military Pilot School was established in Cotroceni under the leadership of Major Ion Macri [3]. The National Air League, established at the initiative of Prince George Valentin Bibescu in order to equip the Army with airplanes, was established in Băneasa, in the same year, as the second piloting school [3].

In order to standardize the instruction in the piloting schools and the optimal development of the educational process, the Ministry of War elaborated the *Norms for the theoretical and practical courses for the students of the Aviation School and the Regulation of the Aviation School*. These first regulations represent the initial foundation for substantiating the process of recruitment and selection of student pilots, respectively "*unmarried*", "*... recruited from among the officers of all weapons, from non-commissioned officers, platoon leaders, corporals or soldiers, from volunteers employed at the Park of aviation...*", „*...having to be well graded by all hierarchical leaders, healthy and not older than 30 years* [4].

The training course lasted six months, during which time one learnt *"... taking aerial photos and shooting with bombs in the firing range ..."*. Besides the specialized disciplines, the Military Aviation School taught mathematics, chemistry, physics, general mechanics, geography of the country, disciplines that provided future aviators with a good general and specialized training.

As these criteria did not prove to be sufficient, and aviation had to frame this dangerous weapon with elements of certain moral and professional value, in order to solve a complex problem from an organizational, technical and legal perspective, at the initiative of the first patented pilots, the Ministry of War proposed the adoption of legislation for the organization and operation of the air weapon. Realizing the need to adopt this revolutionary act, at the proposal of the Government, the Romanian Parliament adopted, with entry into force on April the 1st, 1913, **the Law on the organization of military aeronautics**, sanctioned by the sovereign of Romania, King Carol Ist by **High Royal Decree no. 3199 of 18th/30th of April 1913** [5]**.** The adoption of this law actually regulated the organization and operation of a new weapon in the Romanian Army, the Aeronautical Weapon**.**

The law provided the technical-organizational and aviation training structure in the form of the *Military Aeronautics Service* that had in Bucharest, according to art. 5, a *Central Park, with staff, school, technology and all necessary equipment*.

It was intended for *"... the study, procurement, construction and use of air navigation equipment, which could be used in the army"* and was responsible for *"everything related to the administration and mobilization of units for this service, as well as for staff training"*. The Military Aeronautics consisted of two sections: the "*Aviation Section"* which dealt with aviation issues and the *"Aerostation Section"* which dealt with the military aerostation [5].

From an organizational point of view, the Military Aeronautics Service is subordinated to the General Inspectorate of Engineering, which has thus become also of *"the Military Aeronautics"*.

Besides the organization of the new weapon, the Law on the Organization of Military Aeronautics is, in its infancy, the first statute of aeronautical personnel by the fact that it contained provisions on the aircrew conditions, the criteria for admission and graduation of flight schools and established for the first time bonuses for flying hours. Officers were admitted to schools according to the chronology of the applications, having to meet specific conditions *"well marked by all hierarchical heads in all respects, to be healthy, resilient, certified by a doctor ...., a statement that the officer is coming unconditionally and should not be older than 35 years"* [5].

The same criteria were maintained for the lower ranks, specifying that they had to be unmarried and under the age of 30. The teaching staff was recruited from the best pilot-officers, recommended for this purpose by their own commanders. Candidates who did not prove flight skills and did not progress in operating the aircraft in the first two months were excluded from aviation schools and returned to the troops from which they came.

The law also provided the qualification conditions for military pilots. To obtain the license, the pilot students had to pass a series of highly complex tests during the six months spent in school regarding the execution of the flight at certain flight ceilings, maneuverability exercises and landing at the landmarks established by the commission.

The text of the law did not leave out one of the burning problems of aviation, the maintenance of technology, implementing rules for technical specialists, mechanics and their assistants, as well as their responsibility for the proper functioning of aircraft.

According to Article 38, there was initially approached the provision of weather data for flight activities, endowment with specific technology, devices for measuring wind power and altitude, chronometer for determining speed, compasses, cameras, a station for studying the weather, projectors for aircraft and three cars for transporting students, materials and appliances [5].

Constituting itself in a true statute, the law provided the establishment of the *"Permanent Air Force Corps"* [5], which included **pilots** (airplanes and balloons) and **mechanics** (airplanes and balloons), each category holding military licenses depending on their own specialty. After graduation and obtaining the specialized licenses, sergeants, platoon leaders, corporals and soldiers on term were promoted to the next rank.

It is interesting to note that the law in art. 11, par. 10, established the *obligation for permanent pilots to fly at least 120 days a year*, otherwise being *sent to their bodies*, an objective set even today for operational pilots, but always difficult to achieve.

The specific bonuses were granted to staff in the Permanent Aircraft Corps according to the category of personnel and the level of qualification achieved as navigating or instructing personnel.

According to Article 11, additional insurance has been introduced for the retirement of aeronautical staff due to flight events, and seniority exemptions assimilated to internships in the campaign have also been established [5].

3. REGULATIONS MADE DURING NEUTRALITY AND PARTICIPATION IN WAR

The outbreak of the First World War, the evolution of the international situation determined by this event determined the responsible structures to identify, by involving the command of the school and the aviation park from Cotroceni, measures for aviation development, based on the conclusions that resulted from its participation in of the Second Balkan War in the summer of 1913.

The settlement of aeronautics as a combat weapon was validated by the adoption of the **Regulation of the Military Aeronautics Law**, at the beginning of 1914, a document drafted by Romanian pilots with the involvement of the General Inspector of Engineering and Aeronautics, General Mihail Boteanu.

Essential action guideline for all commanders, pilot-instructors, teachers and other specialists in military aeronautics, the regulation established the organization of military aviation schools, the origin and conditions that instructors and teachers had to meet, admission to aviation schools organized by private initiative, flight equipment for students and pilots, recruitment and selection of candidates, admission conditions, school schedule, air navigation personnel licensing. The tasks of the private piloting schools for the training of Military Air Navigation Personnel were established, the graduation quality criteria harmonized with those imposed by the Ministry of War, rules for their inclusion in the aeronautical system during the crisis and war, being provided that, when mobilizing, personnel and equipment were made available to the Army. In this sense, the role of the Central Aeronautics Park was to coordinate and supervise the training of pilots in these schools, flight scheduling and all other aeronautical activities.

The developments of World War II led to the settlement of aviation as a weapon of war, and our Foreign Military Attaches submitted numerous reports on the missions and aeronautical activities carried out by the belligerent aircraft, especially German and French. Based on such signals, General Mihail Boteanu, as Head of the General Inspectorate of Engineering and Aeronautics, with the participation of Air Force Captain Andrei Popovici, Lieutenants Stefan Protopopescu and Gheorghe Negrescu drafted the **Instructions on the use of airplanes**, which are based on the necessary measures to train Romanian aeronauts in the perspective of entering the war.

Completed with the **Service Rules for the use of airplanes in the campaign**, the adopted regulation system ensured the substantiation of the Organizational Model of Aeronautics in the situation of mobilization for the campaign, the role of educational institutions for training and staffing aeronautical structures planned to be established at war.

Thus, according to the adopted ministerial decisions, it was decided to organize a course on several series, for the training of air observers necessary to recruit combat squadrons, first by the participation of personnel especially from artillery, and later, given the complex conditions of the battlefield, staff officers, graduates of the Superior School of War, under the coordination of the Romanian Aviation Corps [6].

During the school of observers, the student observers benefited from specific rights of the air navigation staff: flight allowance, equivalence of time spent in school with that of the campaign for pension rights, insurance in case of incurable disability arising during and due to service and rights to a pension similar to those acquired during the war, survivor's pension in the event of an accident followed by death [6].

Teachers and training pilots, mechanics and craftsmen, paid from the "affected aviation fund" [6] also benefited from additional rights consisting of daily allowances for teaching and flight activities, as well as for the maintenance of the planes. At the end of the course, the participants obtained the certificate of observer-aerial officer and a badge specially dedicated for this category of aeronautical personnel.

After Romania's entry into the war, the General Staff adopted **Temporary instructions for the use of aircraft during the war** [7], new regulations, adapted to new realities, regarding the new missions to be performed, the organizational structures of aviation (squadrons and groups of squadrons), arrangement of airfields, protection by disguise and air defense of targets against enemy air attacks.

Through successive measures, there has been passed to training of other categories of specialized aeronautical personnel for ongoing air missions as well. Thus, by Ministerial Decision no. 207 of 17/30th of May 1916, within the Aviation Training and Advanced Training School in Pipera, the courses were opened for *"... bombers and snipers necessary for military aviation, recruited from the lower ranks, with a complete primary course and I want to serve the Air Force as a navigating personnel..."*[8]. In order to become snipers and bombers, the candidates had to be in excellent health and in very good physical condition, to be very good snipers and the motivation to employ the Air Force as navigating personnel.

The reorganization of the Aeronautics in the autumn of 1916 and the winter of 1917, the ever-pressing needs to staff with specialized personnel in order to participate in the planned campaign in the summer of 1917 implied the ongoing of training specialized aeronautic personnel, pilots, air observers from planes and balloons in the schools located behind the front and, at the same time, the formation of a new category demanded by the realities of the combat devices, the photographer operator [8].

The organizational frames adopted by the Romanian command, the activities carried out for the training of the specialized personnel of the Military Aeronautics, the instruction and performances of the aircraft at the level of the most advanced belligerent aviation ensured the success of the Romanian people and its army in the battles of Marasti, Marasesti and Oituz and, later on, for the liberation of the national territory and the defense of Greater Romania achieved following the plebiscite acts in Chisinau, Cernauti and Alba Iulia.

4. CONCLUSIONS

The beginning of the Military Aviation in our country was marked by important steps for the embryonic development of domestic aviation law related to the Statute of Aeronautical Personnel. The process was amplified by the need to train and develop new categories of aeronautical personnel, required by the dynamics and complexity of the missions that took place in the airspace of the belligerents during the Second Balkan War and the First World War.

The results commensurate the efforts made by the first Romanian aviators and the great personalities of the nation who understood the role and importance of the new weapon for Romania's National Defense.

These achievements will be the starting point for the progress that will take place in the interwar period, and later on, simultaneously with the overall evolution of aviation in all its forms and of International Regulatory Bodies.

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PRESENCE, AUTHENTICITY AND COURAGE IN THE DEVELOPMENT OF LEADERSHIP

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Abstract: *The main issue that is raised is that of the essential behaviours that directly affect a leader's impact on other people. Being present, authentic and courageous is a means of training charisma, a way of developing leadership and a criterion that must be taken into consideration during the efficient process of recruitment and selection of the authentic leaders.*

Keywords: *leader / leadership / charisma / awareness / mindfulness / authenticity / courage*

1. THE ROLE OF MINDFULNESS IN THE DEVELOPMENT OF LEADERSHIP

Being mindful translates into being a charismatic leader that does everything in his/her power to talk without any inhibition to a group of strangers, while smiling warmly to each and every person and maintaining eye contact.

It is very important to develop one's way of concentrating in such moments when, in order to be vigilant, one uses all senses, thus being fully present through sharp hearing, smell and the awareness of their own personal energy. Being mindful is what enables a human being to go beyond the limitations of humanity, to be relaxed enough to contemplate on the things that surround him/her, to notice their surprising features, to become acutely aware of the environment, the hidden tensions, the expectations and what people think, by observing certain details about their character, feelings, moods and anxieties and by being curious to find out new ideas, without judging them immediately and being careful not to hurt other people's feelings.

Most people do not possess the ability to be mindful because they are too submerged in this world, too busy in the urban space and because they lack any bond with nature or themselves. Some people also lose their mindfulness when they go through a period of sorrow or pain, but, in most cases, they lose it when they allow their natural energies to be weakened by certain factors, such as:

-A discouraging environment;

-Anti-leaders;

-Boring work;

-Conflicts between their own values and those of the organisation.

Hereinunder are some ways in which mindfulness can be improved:

- reconnecting with the world

It involves an activity that induces pleasure by making one feel comfortable in their skin, completely alive and vigilant, and that helps them become more centred to the extent to which they are able to forget about the tense state they are in, they no longer feel upset and they manage to pull themselves away from the daily turmoil. Such activities include:

- listening to a concert;
- taking a walk alone;
- spending time in the nature with your loved ones;
- singing in a choir;
- getting fully involved in activities such as cooking, painting, dancing, reading, etc.).

- the rules of mindfulness

The aim of these rules is to create a deep connection with the people one addresses and the first one is to be fully present. The rules that must be complied with are the following:

- stop (don’t speak hastily, use pauses to give yourself enough time to recompose mentally and emotionally);
- breathe (breath in softly, without raising your chest or shoulders, hold your breath and count to five; by repeating this action several times, you will slow down your heartbeat, reduce the level of adrenaline and anxiety, therefore you will diminish the state of nervousness);
- look around (maintain eye contact with a few people in the audience in order to observe the receptiveness of the group you are addressing);
- listen (sounds are an indication that the audience is restless, while silence and stillness indicate that the audience is ready to listen to you);
- feel (intuition is very helpful in determining what is happening around you and not only there; by giving full reign to all your senses, you will manage to observe the subtle signs that might help you communicate better).

-using two types of energy

The two types of energy that a human being possesses are:

1. vigilance in focusing one’s attention on the outside world;
2. self-awareness and compliance with one’s personal values.

- revitalisation

Personal magnetism and the lively presence of leaders is all about using one’s energy to the full extent, which is subsequently transferred to the audience through:

- the liveliness of the gestures and the sharpness of the mind;
- a positive attitude towards life in general and towards one’s peers;
- smile;
- laughter as an expression of optimism;
- wide-open and lively eyes;
- a straight, but relaxed posture.

- increasing self-awareness

Most people tend to hide their self, which turns them into unauthentic and therefore, uncharismatic individuals. It is only true leaders that are intent on exploiting their self. The ways of improving self-awareness and, implicitly, leadership are:

- Listening to one’s own intuition in the absence of tangible evidence:
- predicting, i.e. anticipating an event;
- The subsequent understanding of what caused a process;
- Gut feeling, i.e. the initial and likely answer to a problem;
- Knowledge manifested through the certainty that one knows:

- o When is the best time to intervene;
- o What is the meaning of an event;
- o What is the best way to reach a solution;

- ▪ Forming bonds with people who are an inspiration.

2. THE ROLE OF AUTHENTICITY IN THE DEVELOPMENT OF LEADERSHIP

We live in a world that values dissimulation, which is the opposite of authenticity. Globalisation, the technology that changes our lifestyle, the coordinators of the election campaigns, advertising, virtual products and services, online communication, even online lovers represent only a few examples of things that conspire to undermine what can be considered real or sustainable in human relationships [Andrew Leigh, Charisma, 2010]. There is no formula, nor should there be one for how to be authentic. When an individual is authentic, he/she interacts in a simple manner, he/she acts like him/herself, not like anyone else and there is no rule on how to do this. We are who we are. Each and every one of us is born authentic. A baby never tries to be someone other.

From childhood to adolescence and then maturity, our spontaneity gradually diminished, until we end up wondering who we truly are. As adults, we make a distorted impression on other people, because of our inability to remove the social mask for fear that the people around us will see us for who we truly are. The internal signs of the social mask are an indication that the individual's feelings are completely different from what he/she says and that he/she disconnects from what is important to him/her, thus preventing the real self from surfacing, hiding his/her thoughts and feelings and strongly censuring all that he/she communicates. The external signs of the social mask give a warning that the individual bases his/her actions on what is convenient or easily acceptable to others, without that being actually right, acceptable or good for him/herself.

The signs of the social mask are:

o Friendship with people who have something you want or that could prove useful in the future;

o Preoccupation with getting as many business cards and phone numbers as possible from influential people that could help you professionally;

o Manipulating the people around you in order to gain what you want;

o Allowing other people to manipulate you;

o Focusing on gaining the approval of people, regardless of your feelings towards them;

o Being lied to;

o Feeling alone, disrespected and unengaged in relationships;

o Feeling inadequate, bored, underestimated and unappreciated at work;

o Being uninterested in personal development or even in small progress to this respect;

o Giving up being yourself in your spare time or no longer feeling good in the company of your old friends;

o Not believing in your own values or not complying with them in your actions;

o Paying free compliments that are obviously insincere to the people around you, thus making them feel uncomfortable.

Authenticity comes with charisma and it proves to be extremely important in leadership, which can be defined as the spontaneity manifested by individuals through their ability to express themselves, while remaining perfectly aware of the influence they have on the people around them [Andrew Leigh, 2010].

Basically, it's an act of double focus: firstly, it requires self-awareness and, secondly, it takes receptiveness with regard to the effect one has on the audience, both leading to a long-lasting impression and relationship. But apart from simply improving communication, building a team or promoting a product, authenticity brings a great benefit in that it enables the individual to identify the goals and values that guide people and even organisations.

The reputation of authenticity must be managed carefully. Authentic people are uninhibited, which sometimes makes them feel entitled to lose control by manifesting anger, restlessness or dissatisfaction, regardless of how this affects other people.

Being authentic is a process that is easy to manage by confronting reality in order to answer the following questions:

- Who am I?
- What is important to me?
- What do I really want?

Any discrepancy between the way one sees oneself and the way other people perceive them will diminish their authenticity and, implicitly, their charisma. Thus, authenticity is the result of:

- Manifesting psychological congruence (believe what you say and saying what you believe);
- Being trustworthy, which is proven by the fact that people around you rely on you for support, because you are punctual and you keep your promises;
- Assuming responsibility for your personal development, with a view to reaching your maximum potential;
- Keeping your internal reality and your external image in agreement.

3. THE ROLE OF COURAGE IN THE DEVELOPMENT OF LEADERSHIP

Courage does not necessarily refer to assuming drastic risks; it can simply refer to having the guts to use one's body in order to impose oneself and to benefit from natural hand, face and body expressiveness.

Assuming calculated risks translates into having the courage to be different, fighting one's fears when everything goes wrong and finding ways of making the benefits exceed the costs when there's even the slightest chance that the worst case scenario is about to happen.

Courage represents the ability to emotionally adapt in order to be able to deal with unfavourable situations (after assuming physical, inclusive risks), by experimenting with and exploiting the area of risk [Andrew Leigh, Charisma, 2010]. There are courageous people who feel good when performing dangerous activities, such as mountain climbing or rafting, but who tend to avoid the social risks related to expressing their opinions and who, for this reason, avoid speaking in public. Being introverted or extroverted can influence one's ability to assume such social risks. Extroverts recharge with energy when they have the opportunity to be sociable and positive and to communicate with others, while introverts find it unpleasant to assume the risks related to opening up to their peers, feeling drained of energy in situations such as:

- Asking people questions that animate them, without making them feel threatened, by challenging them in a friendly manner and avoiding to bring out their mistakes;
- Having a personal point of view that generates an entirely new approach that starts with expressing your opinion according to your training and experience, by relating to your personal values, the existing strategy/rulebook, the way that other people's social opinions make you feel or even something that is completely unrelated;

- Expressing your point of view, sometimes even without being solicited, without being dogmatic, without trying to impose your opinions or giving unsolicited advice;
- Defending your beliefs and opinions before your opponents, by asserting your right to an opinion or to certain values and by asking people around to treat them with the same respect that you treats the opponents' views, without wanting to dismantle them;
- Accepting alternative opinions without becoming defensive, by applying the acceptance technique instead of discrediting different views, which involves trying to build up from a different opinion and relating it to your own beliefs;
- Maximising the use of body language, in accordance with the message you are sending and engaging in a subliminal manner to the opinion that you are communicating by means of:
  - communication gestures that translate directly into words and phrases:
    - the OK sign = thumbs up;
    - the victory sign = two fingers forming the letter V;
    - the greeting sign = waving;

  - support gestures that underline the message that is being communicated:
    - when you are talking about something grand = arms wide open;
    - when you are suggesting an action = firm forward movement of the hands;

  - emotional gestures that imply happiness, surprise, fear, anger, sadness, delight, pensiveness or sorrow, which involve removing the mask and reaching your audience through:
    - facial expressions;
    - gestures;
    - body posture;

  - Relational gestures that encourage human relationships, by making the audience perceive the interlocutor as being warm, attractive, involved, well-intentioned and well-mannered – the lack of said gestures makes the interlocutor seem neutral, cold, rude, unfriendly and even repulsive. Such gestures include:
    - nodding to encourage the interlocutor to speak;
    - opening your mouth to show that you want to say something;
    - waving your open hand to encourage the interlocutor to continue speaking;

  - Gestures related to personal needs are involuntary and they indicate the individual's actual mood:
    - Flipping your hair = preoccupation for your appearance;
    - Rubbing your nose = embarrassment;
    - Interrupting eye contact by looking away to the left/right = insecurity;
    - Clenching your fists = aggressiveness and attempt to intimidate;
    - Lack of facial expression = lack of honesty;
    - Shrugging = indifference, unhappiness;
    - Raising only one shoulder = lie;
    - Doodling on a piece of paper = boredom.

4. CONCLUSION: LEADER COMPETENCY MODEL

The leaders' actions are determined by the environment and by their subordinates, but it is also true that "the leaders' inner theatre" is built according to the "scenario" that their essential needs have written in their past; therefore, their skills are the result of the leadership style they have applied [Kets de Vries, Leadership arta și măiestria de a conduce, 2001].

In conclusion, the leaders' style is the consequence of the interactions between the multitude of forces that are intertwined in the leaders' personal policy regarding their essential needs and the skills that they have acquired in time.

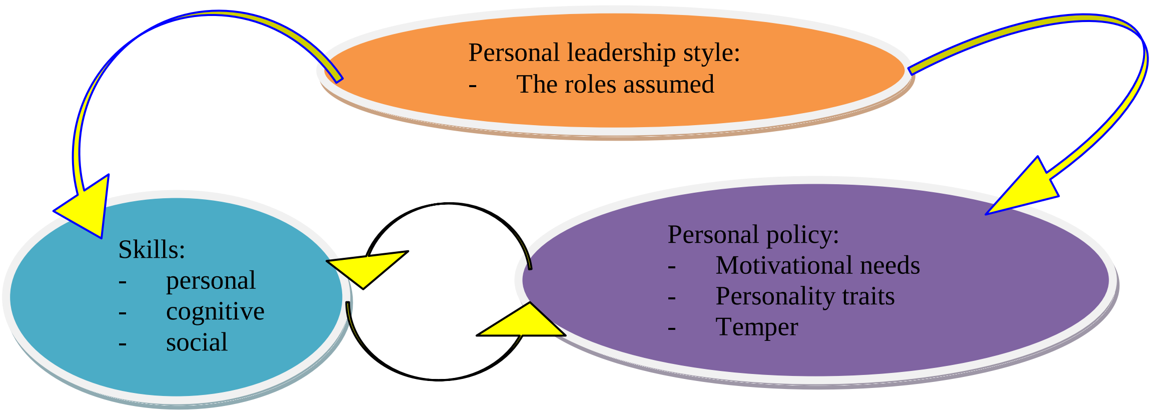

FIG. 1 Dimensions of the leadership style

In any given situation, there is a set of skills that contributes to leadership efficiency and, for leaders, the challenge is to develop their repertoire of skills that are appropriate for most cases. The personality traits that constitute the basis for many of these skills are the individual's authenticity and integrity. According to the leadership model created by Manfred Kets de Vries [Kets de Vries, Leadership arta și măiestria de a conduce, 2001], we shall envision a matrix of leadership skills based on two dimensions:

- Intelligence (this dimension shall translate into the level of professional qualification – high/ average/ low/ lacking personal qualification – and the actual competence in the field of qualification);
- Dynamism (this dimension can only be translated through the rate of reaction that results from the courage to remain authentic, by choosing integrity in relation to one's personal values).

		THE LEADER'S INTELLIGENCE	
		LOW	HIGH
THE LEADER'S DYNAMISM	LOW	Enforcers that rank at the base of the hierarchy I	Management at the middle of the hierarchy III
	HIGH	They fulfil the obligations, but comply with the values of the organisation to a small extent only Charisma effect II	Upper management at the top of the hierarchy Charisma effect IV

-The 4th quadrant refers to people with a high level of intelligence, i.e. those employees who have a high level of qualification and actual competence, who have the courage to remain authentic and upstanding in what concerns their personal values, which are in fact shared by the organisation, who treat their subordinates, colleagues and superiors fairly on a daily basis, wherever they may be. Therefore, it is recommended for such leaders to be part of the organisation's upper management, because they are charismatic, capable of making decisions in uncertain conditions and capable of becoming a source of inspiration and an example of professionalism and morality.

-The 3rd quadrant refers to people with a high level of intelligence, i.e. those employees who have a high level of qualification and actual competence, but who do not have the courage to remain authentic and upstanding in what concerns their personal values; however, they comply with the values of the organisation when interacting with the others, regardless of whether they are superiors, co-workers or subordinates. Therefore, even though they lack charisma, it is still recommended to have such leaders in the field of staff management, because they are capable of making decisions in risky situations that involve diligence, concentration and hard work for the collection, processing / analysis / argumentation and provision of the information required by the upper management.

-The 2nd quadrant refers to people with a low level of intelligence, i.e. those employees who are either unskilled or have a low / average level of qualification, thus showing a lack of actual competence in the profession they practice, but who have the courage to remain authentic and upstanding in what concerns their personal values, which, unfortunately, are contrary to the values of the organisation, thus becoming a danger for the institution, particularly because they possess charisma and can create proselytes and launch a sort of crusade against the organisation, by trying to impose their own values that are opposite to the fundamental vision of the upper management. Therefore, it is recommended to terminate the employment agreement of such people.

-The 1st quadrant refers to people with a low level of intelligence, i.e. those employees who are either unskilled or have a low/ average level of qualification, thus showing a lack of actual competence in the profession they practice, who do not have the courage to remain authentic and upstanding in what concerns their personal values; however, they comply with the values of the organisation when interacting with the others, regardless of whether they are superiors, colleagues or subordinates. Moreover, they are very disciplined and honest in carrying out their professional activity, always wanting to improve; therefore, they are recommended for performance jobs that require a low or average level of qualification.

The recruitment and selection of leaders for management positions should only be carried out with people that fall perfectly under the 4th quadrant (for upper management) and under the 3rd quadrant (for the middle management).

The authentic leaders referred to in the 4th quadrant possess skills that can be classified through a process of stratification (figure no. 2). The needs, defence mechanism, motivations and personality traits are positioned in the centre, followed by their values, attitudes and self-image and finally, their skills and knowledge [Kets de Vries, Leadership arta și măiestria de a conduce, 2001]. The leaders' behaviour and actions are in fact the result of the interaction of the values that support skill development:

Personal skills (courage, integrity, authenticity, efficiency);

- Social skills (empathy, influence, discernment);
- Cognitive skills (conceptual thinking, strategic thinking, verbal / rational / emotional intelligence, creativity, the capacity to synthesise and analyse).

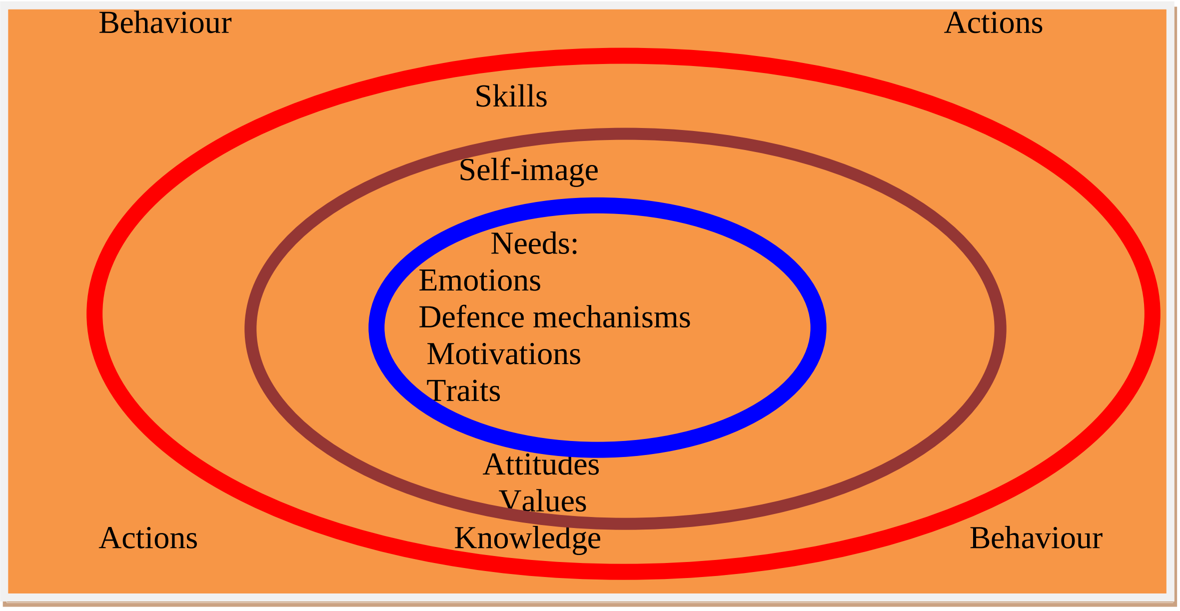

FIG. 2 Circle of skills

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