CONNECTIONS BETWEEN PROFESSOR ELIE CARAFOLI’S ACTIVITY AND THE DEVELOPMENT OF THE AERONAUTICAL UNIVERSITY EDUCATION FOCUSING THE PROPULSION SYSTEMS FIELD

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Abstract
The intent of this paper is to reveal other features of Professor Elie Carafoli’s complex personality, his devotion and fully commitment to the development of the aeronautical university education; the focus on the propulsion systems field was justified by the rapid succession of the political events on the worldwide stage and the subsequent mission assignment of the aviation as the ultimate weapon. A parallel evolution of the aerospace academic education, within the field of the propulsion systems, with fully details about the courses and professors was presented. The spiritual legacy of the Professor still continues today to drive generations of students to successful careers in aviation: academic education, fabrication, operations, top management.

Introduction: A today’s flash

A tribute paid to the memory of Professor Elie Carafoli by the Faculty of Aerospace Engineering from the “POLITEHNICA” University of Bucharest, was the assignment of its name to the Department of Aerospace Sciences in 1996. At present, the Faculty of Aerospace Engineering has 3 departments and provides high quality university education, with a variety of study opportunities for prospective students:

1. “Elie Carafoli” Department of Aerospace Sciences
2. “Nicolae Tipei” Department of Aeronautical Systems Engineering
3. Department of Descriptive Geometry and Engineering Graphics

There are available the following authorized directions of study:
I. GRADUATE STUDIES in Aerospace Engineering, Level: B. Sc., a full-time 4-years degree/ Major and Programmes:
   1. Aerospace Constructions
   2. Propulsion Systems
   3. Avionics
   4. Engineering and Management in Aeronautics
   5. Air Navigation (all courses taught in English)

II. MASTERS PROGRAMMES:
   II. 1 ADVANCED POST-GRADUATE MASTERS, Level: M. Sc., a full-time 1.5-years degree/ Major:
      1. Aeronautics & Aerospace Structures
      2. Aerospace Propulsion, Noise and Chemically Pollution
      3. Avionics and Aerospace Navigation
      4. Engineering and Management in Aeronautics
   II. 2 INTERDISCIPLINARY MASTERS, Level: M. St., a full-time 2-years degree/ Major:
      1. Software in Aerospace Engineering
      2. Space Technology
      3. Management Science in Aerospace Engineering
      4. Engineering Graphics and Industrial Design

III. Ph. D. PROGRAMME, Level: Ph. D., a full-time 4-years degree/ part-time degree/ Field of study: Engineering Sciences,
       Major: Aerospace Engineering

1. Brief history of the aeronautical university education:

   The university education in the field of Aerospace Engineering celebrates this year its 81st anniversary. Important milestones of this multi-decade period can be highlighted, such as:
   - 1928 – Lectures on Aerodynamics given by Professor Elie Carafoli at the Polytechnic School;
   - 1930 - Foundation of the Department of Aviation, which successively changed its name during operation, as follows:
     - 1931-1942, Department of Aviation
     - 1942-1948, Department of Aero-Techniques and Mechanics, Department of Technology of Aircraft Construction
     - 1948-1953, Department of Aviation
     - 1953-1955, Department of Air Machines
     - 1955-1967, Department of Aeronautical Constructions
-1967-1996, Department of Aircraft and Board Instruments
-1996-up to present, “Elie Carafoli” Department of Aerospace Sciences
-1931, Inauguration of the subsonic wind-tunnel, the largest of the South-Eastern Europe.
-1971, Foundation of the Faculty of Aerospace Constructions with the following majors: Aircraft, Propulsion Systems and Board Instruments; legally based on the Decision of the State’s Ministers Council HCM 1244 released on October 7th 1971.
-1996, Organization of the Faculty of Aerospace Engineering, with the following three accredited majors:
  1). Aerospace Constructions
  2). Propulsion Systems (turbo engines, rockets)
  3). Equipment and Board Instruments
-1996, “Elie Carafoli” Department of Aerospace Sciences
-2003, Organization & development of a new major (4) within the faculty:
  1). Aerospace Constructions
  2). Propulsion Systems (turbo engines, rockets)
  3). Equipment and Board Instruments (Avionics)
  4). Engineering and Aeronautical Management
-2006, Foundation of the “Nicolae Tipei” Department of Aeronautical Systems Engineering
-2009, Organization & development within the faculty of a new major (5) entirely taught in English
  1). Aerospace Constructions
  2). Propulsion Systems (turbo engines, rockets)
  3). Equipment and Board Instruments (Avionics)
  4). Engineering and Aeronautical Management
  5). Air Navigation (teaching in English)

Up to present over 4800 engineers graduated the Faculty of Aerospace Engineering.

2. Archive documentary

The records memories [1-2] bring to the light events <E> and facts <F>, i.e.:
- <E>: in 1931, Professor Ludwig Prandtl visited the „POLITEHNICA” University of Bucharest on the occasion of the subsonic wind-tunnel inauguration, [2].
- <F>: in 1939, the „POLITEHNICA” University of Bucharest (as it is known today) was named King Carol Polytechnic School, [1], being ruled by Professor N. Vasilescu Karpen as Rector.
In 1939, King Carol Polytechnic School had been made of 5 faculties, (see below), with a few number of students enrolled; all the activity was carried on at the POLIZU site, Fig. 1. The academic activity was structured on study semesters. The graduate studies in engineering allowed the obtaining of a full-time 5-years degree, level: M. Sc.

1. Faculty of Constructions
2. Faculty of Mechanics and Electricity, structured in two departments:
   - A) Electromechanics \( \Rightarrow \) Aeronautics (general course taught by Professor Elie Carafoli)
   - B) Aviation and Weaponry \( \Rightarrow \) Aeronautics (general course taught by Professor Elie Carafoli) and Mechanics and Aerodynamics of Aircraft (main course also taught by Professor Elie Carafoli).
3. Faculty of Mines and Metallurgy
4. Faculty of Industrial Chemistry
5. Faculty of Forestry

There had been recorded [1] the following repartition of students to the Faculties:

1) Faculty of Constructions: Sem. (Semester) V-VI (36 students)/Sem. VII-VIII (50 students)
2) Faculty of Mechanics and Electricity:
   - A) Department of Electromechanics: Sem. V-VI (43 students)/ Sem. VII-VIII (35 students)
   - B) Department of Aviation and Weaponry: Sem. V-VI (6 students)/Sem. VII-VIII (8 students)
3) Faculty of Mines and Metallurgy: SEWM. V-VI (7 students)/Sem. VII-VIII (16 students)
4) Faculty of Industrial Chemistry: Sem. VII-VIII (14 students)
5) Faculty of Forestry: Sem. V-VI (21 students)/Sem. VII-VIII (20 students)
The original document [1] also provides details about the courses and the staff:

<table>
<thead>
<tr>
<th>Date of examination</th>
<th>Faculty of Mechanics and Electricity</th>
<th>Department of Aviation and Weaponry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sem. V-VI (6 students)</td>
<td>Sem. VII-VIII (8 students)</td>
</tr>
<tr>
<td>Saturday 10(^{th}) of June</td>
<td>Steam engines (Prof. I. Cantuniari)</td>
<td>Electro-Communications</td>
</tr>
<tr>
<td></td>
<td>Core Ballistics, Blasting Powders and Explosives (Substitute Associate Professor G-ral D. Petrovan)</td>
<td>(Associate Professor I. Constantinescu)</td>
</tr>
<tr>
<td>Monday 12(^{th}) of June</td>
<td>Strength of Materials and Static Graphics (II) (Substitute Prof. I. G. Dumitrescu)</td>
<td>Infrastructure and Commercial Aeronautics (Associate Professor N. Tipei)</td>
</tr>
<tr>
<td></td>
<td>Infrastructure and Commercial Aeronautics (Associate Professor N. Tipei)</td>
<td></td>
</tr>
<tr>
<td>Tuesday 13(^{th}) of June</td>
<td>Aeronautics (Prof. Elie Carafoli)</td>
<td>Ammunitions (Associate Professor G-ral Șt. Dumitrescu)</td>
</tr>
<tr>
<td>Wednesday 14(^{th}) of June</td>
<td>Aviation (Aerostation, aerostats and airship) (Substitute Associate Professor Major I. Linteș)</td>
<td></td>
</tr>
<tr>
<td>Saturday 17(^{th}) of June</td>
<td>Hydraulics (Prof. D. Germani)</td>
<td>Mechanics and Aerodynamics of Aircraft (Prof. Elie Carafoli)</td>
</tr>
<tr>
<td>Monday 19(^{th}) of June</td>
<td>Outer Ballistics (Associate Professor G-ral Gh. Buicliu)</td>
<td>Guns (Associate Professor Major I. Linteș)</td>
</tr>
<tr>
<td>Tuesday 20(^{th}) of June</td>
<td>Use of Electrical Energy (Prof. I. Ștefănescu-Radu)</td>
<td>Hydraulic Machines and Water Power Stations (Subst. Prof. D. Pavel)</td>
</tr>
<tr>
<td>Wednesday 21(^{st}) of June</td>
<td>Technology of Aerospace Materials (Associate Professor Gr. Zamfirescu)</td>
<td>Industrial Hygiene (Associate Professor PhD. Jean Dumitrescu)</td>
</tr>
<tr>
<td>Thursday 22(^{nd}) of June</td>
<td>Machines (automobiles) (Associate Professor I. Nicolini)</td>
<td>Manufacture Organization and Operation (Associate Professor N. Stânescu)</td>
</tr>
<tr>
<td>Friday 23(^{rd}) of June</td>
<td>Chemistry of Raw Materials used in Aviation and Weaponry (Associate Professor Major D. Bardan)</td>
<td></td>
</tr>
<tr>
<td>Saturday 24(^{th}) of June</td>
<td>Aviation (Air Navigation, Board)</td>
<td>Aviation (Air Navigation, Board)</td>
</tr>
<tr>
<td>Monday</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Academic career of Prof. Elie Carafoli (15th of Sept.1901-1983)

- 1928, Substitute Associate Professor for the course of *Aeronautics*, DM 49925/ 1928
- 1929, Temporary Associate Professor / in ordinary for the course of *Aerodynamics and Mechanics of Aircraft* DM 1874/ 1929
- 1931, Temporary Professor in ordinary within the Department of Aviation DM 1845/ 1931
- 1933, Professor in ordinary within the Department of Aviation, DM 1979/ 1933
- 1948, Member in ordinary of the Academy of People’s Republic of Romania
- 1956, Member (of a total of 33 members) of the Superior Commission for Diplomas within the Ministry of Education, HCM 1015/10 MAI 1956
- 1931-1971 , Head of Department.

Courses taught by Professor Elie Carafoli:

1. *Aeronautics* (general course) (1928-1939)
4. *Fluid Mechanics* (1948)
5. *Fluid Mechanics and Aerodynamics* (1951)
An excerpt of Professor Carafoli’s published works

One can access today from the permanent collections of the Library of the “POLITEHNICA” UNIVERSITY OF BUCHAREST an excerpt of Professor Elie Carafoli’s published works:


4. Connections between Professor Elie Carafoli’s activity and the development of the university education in Aerospace Engineering focusing the propulsion systems field

Professor Elie Carafoli was the founder of the Romanian university education in Aerospace Engineering. The foundation of the Faculty of Aerospace Engineering in December 1971, according to HCM 1244/7 Oct 1971, is a direct consequence of his supporting efforts to the establishment of an institutionalized form of university education.

The concern of Professor Carafoli to extending the activity field of the Department was materialized by driving his interest towards the propulsion systems domain (namely jet engines and piston engines).

This choice was justified by the intense activity carried on worldwide (i.e. 1936 in: Germany/ Hans von Ohain and Max Hahn/, Great Britain /Frank Whittle/, former Soviet Union /Ušakov and 1937: Liulka/, France, 1940: USA /NACA/) to develop more powerful propulsion systems, with improved performances, such that to enable the increasing of the flight autonomy. Before and during the World War II (1941-1945), the aviation was meant to strengthen its crucial role in supporting the Defence Industry as an active combat factor.
A synopsis of the political events of the IVth decade allows to point out and to justify the orientation of the theoretical and experimental research and also the aerospace constructions towards the war industry. Within this background, it comes out the continuously increasing interest for the reactive propulsion and particularly to the axial jet engines.

- 1933 ascent of Hitler as the commander of German army which created jobs for the thousands of unemployed, in order to support the weapon industry;
- 1938, Germany annexes Austria and then the Sudet region (Czechoslovakia)
- 1939, Germany attacks Poland at 1 September, when World War II starts as England and France engaged in war against Germany
- 1939-1940, Germany occupies France;
- 1940-1941, The Battle of England;
- 1941, Germany attacks The Soviet Union in June, 22 when the latter engages in war;
- 1941, the Pearl Harbor attack in July, 22 marks the moment when US enters in war;

Because of the major changes occured in the political context of Europe in 1933-2938, Germany started an intense activity for developing the war industry. As an answer, England initiated the preparations for the incoming war. This period was characterized by a tight competition which had as an ultimate goal the supremacy on the battle field, through the endowment of the armies with the best weapons.

Later on, in 1940 the USA entered this competition with the foundation of NACA National Advisory Committee for Aeronautics, in Cleveland, Ohio, where in a short time the US started the research about the design of turbojet engines equipped with air flow compressor. In September 1941, as the arrangements between the governments of Great Britain and US had been done, the W.1X engine built by Frank Whittle, the complete project of W.2X engine as well as the British working team were transported to NACA.

During the period when Prof. Elie Carafoli acted as Head of Department the following objectives were achieved:

1. **Organization of the CURRICULAR AREA**: → purposed to prepare highly skilled future engineers, **new courses and majors** have been introduced and continuously developed.

2. **Development of the HUMAN RESOURCES**: → prestigious professors, highly skilled engineers have been incorporated to the university staff, with employment contract as either full-time officials in ordinary or part-time temporary.

The following information is focused on propulsion systems **PS** field.
CURRICULAR AREA: Courses and conferences, Departments

1942- Departments:
- Aero-techniques and Mechanics of Aircraft (Elie Carfoli)
- Aircraft Technology and Engineering (G.Zamfirescu)
- Guns, Portable Weapons and Ammunitions (vacancy)

1942- Conferences:
- Aviation Engines (vacancy)
- Core Ballistics, Blasting Powders and Explosives (vacancy)

1948- Course:
- Light and Jet Engines (vacancy)

1951-courses:
- Design and Construction of particular Engines for Aircrafts (Alexandru Stratilescu),
- Technology of Materials for Aircraft and Engines (Mihai Popescu)

HUMAN RESOURCES appointments of teaching staff:

- Ioan Linteș, Captain Commander engineer
  - 1930 - Substitute Teaching assistant for the course of Aviation, DM 47603/ 1930
  - 1940-Teaching assistant in ordinary within the Department of Aviation, DM 1714/ 1940
  - 1943-Professor in ordinary, PhD Engineer within the Department of Guns, Portable Weapons and Ammunitions, D 1813/ 1943

- Grigore Zamfirescu
  - 1934, Temporary Associate Professor for the course of Technology of Aviation Engines and Aircraft Engineering
  - 1941, Associate Professor in ordinary for the course of Aircraft Technology and Engineering, DM 3438/ 1941

1942 Asociate Professors in ordinary
- Colonel Dimitrie Bardan, for the course of Chemistry of raw materials used in aviation and weaponry, war gas and means of protection, D 2938/ 1942
- Commander Engineer Nicolae Popp for the course of Aircraft Engines (D 2937/ 1942)
- General Engineer D. Petrovanu for the course of Core Ballistics, Blasting Powders and Explosives (D 3058/ 1948).

1948 Asociate Professors:
- George Rohr, Department of Aircraft Technology and Engineering, D 2938/ 1942
-1956-1971-1990-2000:
  - **Adrian Stâmbuleanu**, 1956 Associate Professor, 1965 Temporary Professor in ordinary, 1971 Professor
  - **Alexandru Statilescu**, 1951 course, 1965 Temporary Professor
  - **Victor Pimsner**, 1965 Temporary Associate Professor in ordinary, 1971 Professor within the Department of Heat Engineering and Thermal Machines
  - **Corneliu Berbente**, 1960 Junior Teaching Assistant, 1970 Assistant Professor, 1976 Associate Professor,
  - **Virgil Stanciu**, 1971 Teaching Assistant within the Department of Steam Boilers and Turbines, 1981 Lecturer within the Department of Aircraft and Board Installations/Avionics, 1990 Associate Professor, 1993 Professor,
  - **Vasile Nicolae Constantinescu**, 1972 Teaching Assistant within the Department of Aircraft and Board Installations/Avionics, 1986 Assistant Professor, 2005 Associate Professor,
  - **Călin Adrian Vasilescu**, 1970 Associate Professor, 1971 Professor within the Department of Internal Combustion Engines,
  - **Sergiu Sidon**, 1972 Teaching assistant within the Department of Aircraft and Board Installations/Avionics, 1986 Lecturer,
  - **Dan Radu Rugescu**, 1976 Lecturer within the Department of Aircraft and Board Installations/Avionics, 2002 Associate Professor,
  - **Silviu Zancu**, 1990 Teaching Assistant, 1993 Lecturer,
  - **Mircea Buruiană**, 1993 Lecturer,
  - **Irina Carmen Andrei**, 1992 Teaching Assistant, 2008 Lecturer,
  - **Marius Brebenel**, 2002 Assistant Professor,
  - **Dan Racoți**, 2004 Lecturer,
  - **Constantin Levențiu**, 2003 Teaching Assistant,
  - **Cornel Dinu**, 2005 Teaching Assistant, 2009 Lecturer
  - **Valentina Lungu**, 2004 Junior Teaching Assistant, 2006 Teaching Assistant
  - **Daniel Crunțeanu**, 2005 Junior Teaching Assistant, 2006 Teaching assistant

**Conclusions**

*The legacy* that Professor Elie Carafoli had left to his disciples and followers, can be briefly described by the words:

- development of highly skilled professionals,
- sharpness & strictness & accurate as defining the working style
- perseverance in carrying on scientific research,
- emulation and team spirit.

The spiritual legacy of the Professor has driven and still continues to drive generations of students to successful careers in national and international aviation, in the field of academic education, fabrication, operations, top management, as the Alumni records can prove.
The research areas, that had been initiated in the field of Aerodynamics and coordinated by Professor Elie Carafoli, have been expanded towards other fields; therefore, at the Faculty of Aerospace Engineering, one can point out the continuity in terms of research and design, as well as the results sharing and dissemination:

- 1974, *Seminar of Aerodynamics*, initiated by then Lecturer and at present Prof. PhD. eng., PhD. mat. Adriana Năstase
- *Workshop of Mechanics*, initiated and conducted for a long time by Acad. Prof. PhD. Eng. Virgiliu Nicolae Constantinescu
- At present, details about the Faculty of Aerospace Engineering can be found on the web sites: [www.aero.pub.ro](http://www.aero.pub.ro), [www.upb.ro](http://www.upb.ro).

Also, the students of the Faculty of Aerospace Engineering can access the MOODLE on-line support course at URL:

- [http://aero08.curs.ncit.pub.ro/](http://aero08.curs.ncit.pub.ro/)

An excerpt of the courses that are currently given at the Faculty of Aerospace Engineering is listed below:

- Heat Engineering and Thermal Machines
- Gas Dynamics and Aerothermochemistry
- Processes and Characteristics of Air-breathing Engines ➢ Processes in Jet Engines
- Computation of Jet Engines Characteristic Maps ➢ Optimization of Jet Engines
- Design and Construction of Jet Engines
- Aviation Piston Engines
- Units and Equipments for Propulsion Systems
- Operation and Maintenance of Propulsion Systems
- Unconventional Propulsion Systems
- Transient Processes in Propulsion Systems
- Gas Dynamics–computational elements
- Tribology
REFERENCES

[1]. SCHEDULE OF GENERAL EXAMINATIONS, SECONDARY CYCLE = Semester V-VI and Semester VII-VIII, Summer Session 10-30 of June 1939, POLITEHNICA KING CAROL II


