

EDUCATION, PROJECTS AND OTHER AEROSPACE ACTIVITIES ON BRNO UNIVERSITY OF TECHNOLOGY (CZECH REP.)

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OVERVIEW

The paper starts with a short description of aerospace industry in Czech Republic. Core of the paper is focused on the description of aerospace activities of Institute of Aerospace Engineering (Brno University of Technology). This description may also serve as an illustration of integration of former eastern European universities in the EU research activities. The paper also presents influence of R & D on education of young aerospace engineers.

Activities covered in the paper include education in several aerospace specializations, involvement in national research (and industrial) projects and European research projects. While activities on the national level are oriented on the needs of Czech aviation industry (traditional producer of General Aviation airplanes), European cooperation includes wide range of solved problems. Participation on research projects as well as on the practical applications has positive impact on the quality of education.

ACRONYMS

ARC – (Czech) Aerospace Research Centre
BUT – Brno University of Technology
IAE – Institute of Aerospace Engineering (Brno University of Technology)
EU – European Union

1. INTRODUCTION (CZECH AEROSPACE INDUSTRY)

In the past, Czechoslovakian aerospace industry produced airplanes in different categories, both for military and civil use. Well known types were especially military training jets (L-29 Delfin, L-39 Albatross) and small transport airplanes (L-410). Famous were also aerobatic airplanes (Zlin Z-50) and small General Aviation airplanes (Zlin Z-26, Z-42, Z-142, etc.).

After political changes in 1989 and subsequent division of Czechoslovakia into Czech and Slovak Republics, (1993), aerospace sector in Czech Republic underwent huge reduction in 90's. The number of employees



Fig.1 - L-410 Turbolet, twin engine 19-seats turboprop (produced by Aircraft Industries – former LET Kunovice)



Fig. 2 – Zlin Z-50 aerobatic airplane (produced by Moravan-Airplanes)



Fig. 3 – Aero Vodochody L-159 Army Light Combat Aircraft



Fig. 4 – Aero Vodochody Ae-270

dropped from 30 000 to approximately 7 000 and some of big producers bankrupted (as a consequence of loss of traditional markets). In present, Czech aerospace industry has again growing tendency.

Present aircraft production is represented mainly by civil production in General Aviation category. Some of traditional producers were replaced by quickly growing companies focused on the design and production of small airplanes (from ultralight categories to small sport airplanes). Although Czech Republic is still producer of military training jets and light combat airplanes (L-159), the biggest success was achieved in ultralight, light sport aircraft and small sport airplanes (with current annual production around 450 airplanes per year). Examples of such airplanes are: EV-97 Eurostar, Rapid200 and TL-2000 Sting in ultralight and light sport aircraft categories. In small transport airplanes, already certified Aero Ae-270 (single engine 10-seats turboprop) and developed Evektor EV-55 (twin engine 10-seats turboprop) should be mentioned.

Brno University of Technology (BUT) took part in all recent important industrial projects within Czech Republic and also initiated development of several new airplanes, most important being VUT100 Cobra recently developed and certified by Evektor company (single engine 5-seats airplane).

2. AEROSPACE RESEARCH IN CZECH REP.

Aerospace research activities were historically largely focused on the support of the national industry. Since most of Czech aerospace products are in General Aviation category, the research is focused more on this category of airplanes. Major aerospace research centres can be found in Prague and Brno. Fig. 5 shows also key organizations focused on aerospace research in the Czech Republic:

- Aeronautical Research and Test Institute, Prague

- Institute of Aerospace Engineering, Brno University of Technology
- Technical University, Prague

shown on the figure 6. List of workpackages covers all important areas of aircraft design, manufacturing and operation.

BRNO UNIVERSITY OF TECHNOLOGY

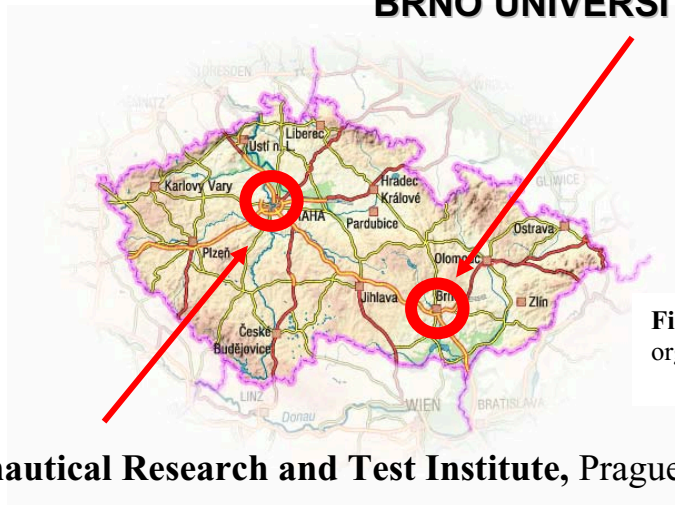


Fig. 5 – Location of key research organizations within Czech Republic

Aeronautical Research and Test Institute, Prague

Czech Technical University, Prague

Department of Automotive, Railway and Aerospace Engineering

Major research organizations are also associated in the **Aerospace Research Centre (ARC)**. National ARC was created in an attempt to unite aerospace research within Czech Republic. It is financially supported by Ministry of Education, Youth and Sports. The project includes all abovementioned key research institutes under the lead of *Brno University of Technology*. Structure of the centre is

ARC is able to support producers during whole design process starting from preliminary analyses and calculations through technological solution for manufacturing plants to structural and flight testing of prototypes and serial airplanes.

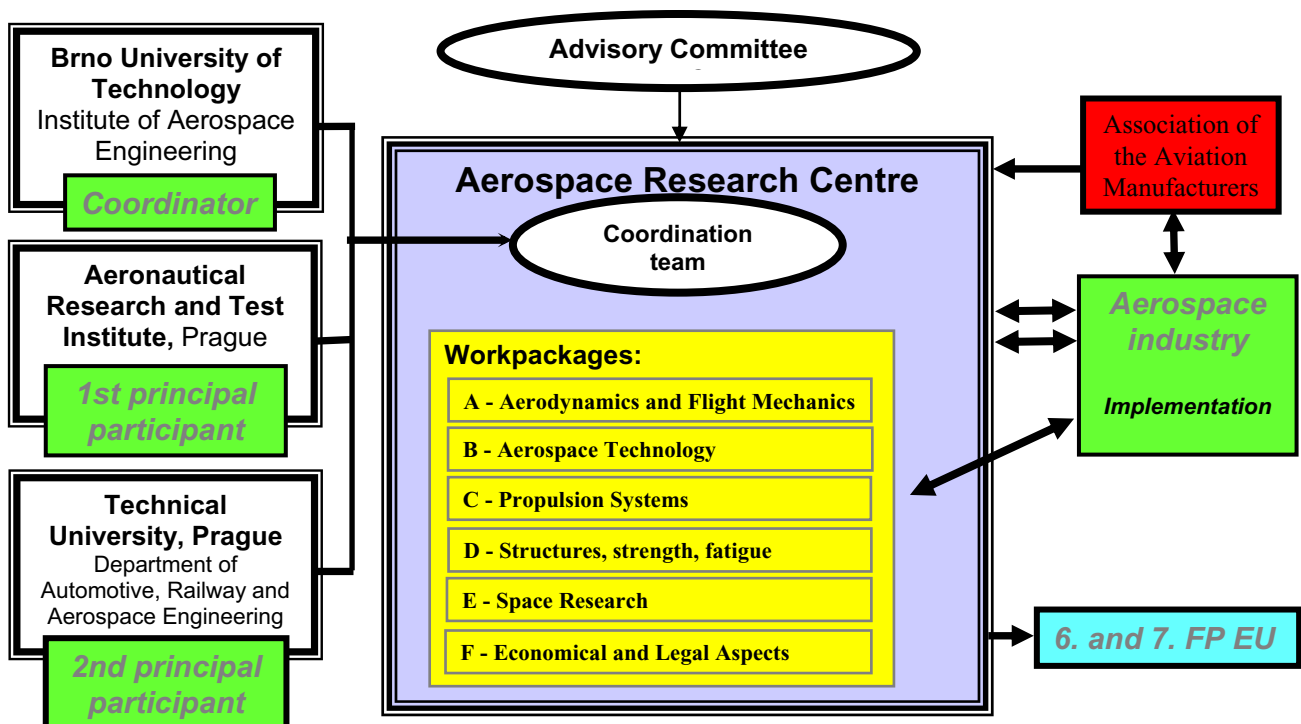


Fig. 6 – Structure of Aerospace Research Centre

3. BRNO UNIVERSITY OF TECHNOLOGY / INSTITUTE OF AEROSPACE ENGINEERING

Institute of Aerospace Engineering is a part of Faculty of Mechanical Engineering, Brno University of Technology. Whole BUT consists of 8 faculties and has approximately 20 000 student. Since 1991, IAE is lead by prof. Ing. Anotnin Pistek, Ph.D. IAE is primarily focused on education of young aerospace engineers and scientists. It provides education in following major areas:

- **Aircraft design** (master study)
- **Aeronautical traffic** (master study)
- **Professional pilot** (bachelor study)

Also Ph.D. students form important part of IAE's research capacity. This means that the recent team involved in the research and development activities is very young.

Education in the Czech Republic took great advantage from joining European Union – in May 2004. IAE is involved in several international activities leading to students exchanges, staff mobility and participation on important events - most important activity being ERASMUS programme. Some of the international activities were available for new member states (including Czech Republic) even before their full membership in European Union. Currently, approx. 10% of students take

airplanes (EV-97 Eurostar, KP-2U/Rapid, TL-96/2000, etc.).

Key successful projects in this area of activities were:

3.1. Development of ultralight airplane KP-2U Sova (Rapid200)

KP-2U was the first industrial project of IAE. Design was led by prof. Pistek. Certification and start of the production was made in cooperation with Kappa 77 company.

KP-2U is a single engine 2-seat all metal ultralight airplane with retractable landing gears. It has a tapered wing with winglets and Fowler flaps (which enables low stall speed - only 55 km/h). The airplane structure utilizes only skin plates with one-dimensional curvature. Such plates are easy to manufacture (without special equipment) and the airplane is offered also as a kit. The main landing gears are never fully retracted which enables emergency landings with landing gears up without significant damage to the airframe. This was already practically proved during operation.

Over 120 airplanes have been produced since beginning of the production. The Aircraft received airworthiness certificate from LAA-ČR (Czech Amateur Aircraft Association) in 1997 and in 1999 it was certified in Germany and USA (by FAA as a kit). The airplane later



KP-2U Sova (Rapid200)

Single engine
All metal structure
2-seats

Engine ROTAX 912UL

Max. cruising speed	200 km/h
Stall speed	55 km/h
MTOW	450 kg
Empty weight	285 kg

Range	880 km
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advantage from foreign exchange stays in different European countries. A number of foreign students also take lessons on IAE (most of them from France and Belgium).

Apart from educational activities, IAE has also tradition in cooperation with Czech aerospace industry. As previously mentioned, IAE was involved in practically all major industrial projects within Czech Republic. This includes small transport airplane Ae-270 (developed and produced by Aero Vodochody), EV-55 (developed by consortium of companies under the lead of EVEKTOR), light military combat aircraft L-159, small sport airplane VUT100 Cobra (developed in joint cooperation of *Brno University of Technology* and EVEKTOR), small transport airplane RAVEN 257 and many ultralight and very light

received airworthiness certificate in Italy, France, Netherlands, Poland, Portugal, Brazil, Ecuador, Canada,... Production still continues in Jihlavan-Airplanes company.

The airplane was also recently selected for an integration of hydrogen fuel cells propulsion system in the frame of ENFICA-FC project. Both IAE and current producer of the airplane – Jihlavan-Airplanes – are consortium partners in this project, coordinated by prof. Giulio Romeo from Politecnico di Torino.

3.2. Development of VUT100 Cobra

VUT100 is a single engine airplane for air traveling, pleasure flying and pilot training (including IFR flights training). It is the first airplane from the whole VUT airplanes family. It was designed in compliance with FAR 23 requirements. It is the lower wing 4 to 5-seater (2+3) with retractable landing gears. The airplane has advanced avionics with “glass cockpit” (presentation of flight data on multifunctional displays) and IFR equipment.

VUT100 project was initiated on October 1st, 2000. IAE made preliminary design of the airplane with a support of Czech Ministry of Industry and Trade. In the frame of the project IAE started cooperation with EVEKTOR Company (located at Kunovice). After the first flight in the autumn 2004, project was overtaken by Evektor. Currently, the airplane is in the certification process.

projects, mainly within 6th Framework Programme. Brief description of some of them follows:

- **CESAR** - Cost Effective Small AiRcraft, supported by EU in 6th FP, first project coordinated by partner from Czech Republic - **Aeronautical Research and Test Institute, Prague** (project has 40 participants from whole Europe). As a first organization from new member states, *Aeronautical Research and Test Institute* (member of ARC) is responsible for coordination of EU project.
- **ENFICA-FC** - Environmentally Friendly Inter City Aircraft Powered by Fuel Cells, supported by EU in 6th FP, coordinator **Politecnico di Torino, Italy**. Within the project, hydrogen fuel cells propulsion will be tested on KP-2U airplane (developed on IAE) and flight validated in 2009.



Photo: EVEKTOR Company



VUT100-120i Cobra

Single engine
All metal structure
5-seats

Engine
Lycoming IO-360-A

Max. cruising speed 280 km/h
Stall speed 95 km/h
MTOW 1330 kg

Range (45' reserve) 2000 km

3.3. Other projects

Involvement in national research is mainly focused on General Aviation area, to support needs of national aerospace industry. Research is supported mainly from Ministry of Industry and Ministry of Education, Youth and Sports. Within IAE major activities belong:

- Aerodynamic analyses (including CFD applications)
- Flight mechanics (including flight measurements)
- Structural analyses (with a focus on non-linear FEM analyses, both static and dynamic / crashworthiness)
- Structural tests (static and fatigue tests performed on Aircraft Testing Lab certified by Czech CAA)
- Material testing (with equipped lab for specimen testing and evaluation)
- Accident databases for investigation purposes
- Safety/Reliability analyses of aircraft systems
- Airport safety analyses

Membership of Czech Republic in the European Union brought also opportunity to participate fully on **European research projects**. BUT (IAE) participates on several EU

- **DATON** – Innovative Fatigue and Damage Tolerance Methods for the Application of New Structural Concept, supported by EU in 6th FP, coordinator **TU Braunschweig**

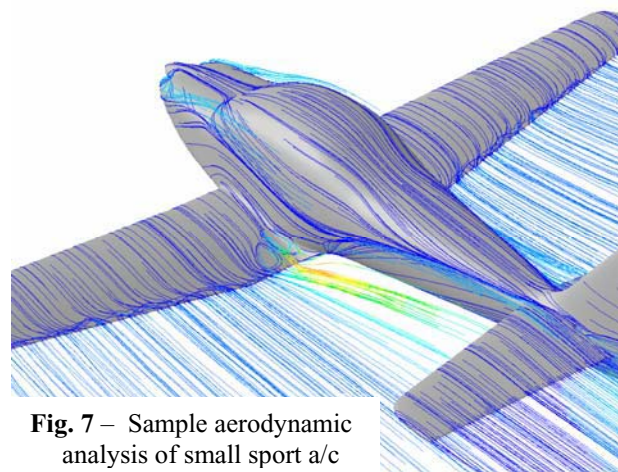


Fig. 7 – Sample aerodynamic analysis of small sport a/c

- **CELPACT** – Cellular Structures for Impact Performance, supported by EU in 6th FP, coordinator **DLR Germany**

4. CONCLUSIONS

Active participation of IAE on domestic industrial projects and also on EU projects results in an improvement of quality of research staff (but also of academic staff) with subsequent positive effect also on education. Description provided in the paper may also serve as an example of university activities in the country that underwent huge transformation of aerospace industry. In this case, integration of Czech Republic into EU has a positive effect on continuance of aerospace research and education of young aerospace engineers.



Fig. 8 – Structural tests on IAE with the participation of students