

AERONAUTICAL AND SPACE TRAINING IN EUROPE

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Last year we celebrated the centenary of the oldest higher education establishment for aeronautics and space engineering in the world, Supaero. Since 1909, with the escalation of aeronautics and space activities, a host of degree courses have been set up. I would like to give an overview of the main courses currently available in Europe and examine the main trends for coming years.

List of specialised aeronautics and space engineering courses

1. French courses:

Three establishments are clearly specialised in these areas:

In the first place, **ISAE Institut supérieur de l'aéronautique et de l'espace (Higher Institute for aerospace engineering education and research)** Formed from the merger of two major engineering establishments, Supaero and Ensica, ISAE was officially created on 1st October 2007. It offers two engineering degree courses: Supaero engineer, with admission via the Mines-Ponts competitive examination; Ensica engineer via Polytechnique joint competitive entrance examination, as well as a comprehensive range of specialised training courses for and through research: two national masters diplomas, twenty or so masters specialised in aerospace technologies, engineering and management of major projects, and nine research masters. ISAE is also accredited to deliver doctorates under its own seal and participates in six doctoral schools in the Toulouse region. The Institute is a founder member of the University of Toulouse Pole for Research and Higher Education (PRES) and enjoys a special partnership with French aerospace research institute Onera.

Then, in France, the following institutions:

ENAC Ecole nationale de l'aviation civile (French Civil Aviation University): also based in Toulouse and placed under the aegis of the French transport ministry and civil aviation authority, it trains pilots, air traffic controllers, technicians and engineers for future work in aerospace companies and in the public sector of civil aviation. It offers seven different degree courses including that of ENAC engineer (IENAC); admission is via the Polytechnique joint competitive entrance examination.

Future ENAC engineers can choose between three specialities. They can specialise in:

- electronic systems, with outlets in the avionics industry as system engineers managing large projects;
- in computer science and air traffic: this course leads to posts in companies involved in use of airspace, aircraft, satellites and more generally in the computer sciences sector;
- in aeronautics techniques: these graduate engineers are attractive both to airlines and aeronautics manufacturers.

In terms of outlets, 30% of IENAC engineers find their first post in a sector other than aeronautics, most often in computer sciences.

ENSMA Ecole nationale supérieure de mécanique et d'aérotechnique (National College of Mechanical and Aeronautical Engineering) Based in Poitiers, it trains engineers in particular for work in design offices and research centres in the fields of aeronautics and space. The ENSMA laboratories work in partnership with the main public and private research organisations. Admission is via the Polytechnique joint competitive entrance examination or on academic record for first or second year. During their course, pupils must carry out three obligatory work placements: a one-month practical work placement, an engineering work placement of three or four months and a final four to five month placement in a company or research organisation in France or abroad. ENSMA also offers various research masters.

These three major aeronautics “grandes écoles” make up the **GEA Groupement des écoles aéronautiques et spatiales (Group of French Aeronautics and Space Technology schools)**. The goal of this GEA is to promote the universities on an international level and to endorse training courses on a national level.

Graduates from the main engineering degree courses are divided up approximately as follows:

- ISAE: About 300 per year spread between Supaero (180 p.a.) and Ensica (120 p.a.)
- ENAC (only civil aviation engineers): 120 p.a.
- ENSMA: 130 p.a.

Alongside these three mainstays of aerospace training in France, three other aeronautical engineering colleges should be mentioned:

ESTACA Ecole supérieure des techniques aéronautiques et de construction automobile (University for aeronautical techniques and automobile manufacturing): situated at Levallois-Perret and in the region of Mans, ESTACA is a private higher education establishment which trains engineers in the four transport sectors: aeronautics, space, automobile and guided transport (high speed trains, tramway...). ESTACA's intake is made up of science and technology baccalaureate graduates and, in parallel admission, students from preparatory classes and universities. The course is spread over five years including preparatory classes. It introduces future engineers to the technologies and methods currently used in industry and prepares them for all sectors of transport activities. It offers a choice of transport specialities: aeronautics, space, automobile or guided transports.

L'IPSA Institut Polytechnique des Sciences Avancées (Aeronautical and Space Engineering Graduate School)

IPSA, based in the Paris area and currently being set up in Toulouse, aims to train aeronautics and space systems engineers and managers capable of assuming all posts in a company (research and development, production, operational systems exploitation...) or another profession in high tech fields connected to aeronautics and space.

L'Ecole de l'Air (French Air force academy):

The Ecole de l'Air, within the French air force officers' schools group, provides high level multidisciplinary and transverse training oriented towards the aeronautics and space fields. The course comprises four parts: military and sports training, human and cultural training, scientific training, specialist training (flying officers, aeronautical systems officer). The Air force academy enjoys a wide network of exchanges with the main foreign air force academies, including many in Europe. Approximately 80 pupils per year are admitted by means of a competitive exam similar to that of preparatory classes, equivalent to the Polytechnique joint competitive entrance examination. The degree obtained is recognised by the CTI (National commission

on engineering degrees). One might note that while all student officers are trained to assume posts of responsibility within the Air Force, a significant number of them go on to pursue a civilian career. The Air force academy is therefore obliged to integrate such perspectives into its offer of scientific training by moving closer to the business world.

Other generalist establishments offer an aeronautics option. These include:

Ecole Centrale, Paris

Ecole Centrale, Lyon

EPF Graduate School of Engineering

ENST Ecole Nationale Supérieure des Télécommunications (Graduate Engineering School for Information & Communication Technologies)

ENSAE Ecole Nationale Supérieure d'Arts et Métiers (Graduate School of Economics, Statistics and Finance)

French universities offer masters in aeronautics (for example the master in aeronautics design at the University of Paul Sabatier) and doctorates in aeronautics and space fields but no engineering degrees.

2. European graduate courses

There are many training courses in aeronautics and space in Europe. Studies in specialised university departments or mechanical engineering departments can lead to bachelors or masters degrees or doctorates.

- In Germany, these include:
 - o The **Technische Universität of Munich (TUM)** whose faculty of mechanics contains an Institute for aeronautics and space (ILR) with chairs of propulsion, flight dynamics and space technologies
 - o The **Technische Universität of Berlin** which has an Aeronautics and space institute (ILR)
 - o the **University of Stuttgart** which has a faculty for aeronautics, space and geodesics, itself subdivided into several specialised institutes;
 - o The **RWTH of Aix la Chapelle (Aachen)** which also has an aeronautics and space institute within its faculty of mechanics
 - o The **Technische Universität of Brunswick (Braunschweig)**, the **Technische Universität of Dresden**, the **Technische Universität of Darmstadt**.

There are also, at a lower educational level, the **FH of Aix la Chapelle** and the **Hochschule of Bremen**. The TUM and the RWTH have been recognised as universities of excellence by the German federal government.

- **In the United Kingdom**, specialised degree courses in aeronautics and space have been centralised within the *AAU (Association of Aerospace Universities)*. Several disciplines can be studied: aeronautical engineering, aeronautical and space construction, aeronautical and space systems, aviation management, aircraft safety, maintenance, navigability, materials technology... Most of these subjects are taught in the following universities:
 - o **Cranfield** which offers the widest range of disciplines and is well equipped with research and simulation resources (>200 graduates per year) This university is highly specialised in one year masters and does not offer any bachelor's training. It attracts many foreign students (>50%).
 - o the **University of Bristol** which is the best of the "Russell Group" universities (equivalent to the Grandes Ecoles in France), offering degree courses and research in aeronautics and space. It is associated in particular with Airbus UK.

- **University College London** which offers bachelor and master degrees in aeronautics, air transport, air traffic management and space systems. It is particularly linked to Thales UK and Astrium.
 - **Imperial College of London** and **Loughborough University**, which offer bachelor and master degree courses in aerospace. They are linked in particular with BAe Systems.
 - Of the other universities, those of **Bath, Nottingham, Sheffield, Surrey, Manchester, Southampton and Glasgow** offer at least one good quality training course of 4 to 5 years (combination of bachelor and masters) in aeronautics or space.
- In **Italy**, several universities offer degree courses in the areas of aeronautics and space;
 - The **Politecnico of Milan** which provides the greatest number of graduates (>150)
 - The **Politecnico of Turin**
 - **The University of Pisa** (~70 graduates)
 - **The University of Padua**
 - **The University of Rome “La Sapienza”**
 - **The University of Naples Federico II**
 - **The University of Bologna**
 - In **Spain**, there are also a number of aeronautical and space degree courses:
 - **The Universidad Politecnica de Madrid**, with the ETSIA and EUTTA schools (about 150 graduates/year), is the most important one
 - **The Universitat Politecnica de Catalunya** in Barcelona with its ETSEIAT school in Terrassa and ETSEIAT in Barcelona
 - **The Universidad de Sevilla** with ESI
 - **The Universidad de Leon** with ESTIHA
 - In **Sweden**, three universities are particularly specialised in aeronautics and space:
 - The **KTH** Royal institute of technology of Stockholm (40 graduates/year)
 - **The University of Mälardalen**
 - **The University of Linköping**
 - In the **Czech Republic**:
 - **The Czech Technical University CTU in Prague** is one of the oldest in the country. The Aerospace Engineering department of the Faculty of mechanical engineering produces dozens of engineers each year. Specialisations in aeronautics and turbojets exist on a masters level.
 - **The Technical University of Brno (BUT)** has an institute for aeronautical and space engineering within the mechanical engineering faculty. This faculty trains approximately 800 engineers a year. Since 1993, students have been able to obtain a master’s degree in air transport.
 - In the **Netherlands**, the **Delft TU** is a reference for aeronautics and space (>100 graduates per year).
 - In **Switzerland**, the **Ecole Polytechnique Fédérale of Lausanne** and the **Ecole Polytechnique Fédérale of Zürich** both provide aerospace training. The former's research programme is widely respected.

- In **Norway**, the **Norges Universitet Trondheim** (NTNU) trains a small number of aeronautics engineers (between 10 and 20 per year).
- Lastly, the following universities also provide degree courses in aerospace: **The Universities of Patras in Greece, of Limerick in Ireland, of Warsaw in Poland, of Lisbon (IST) in Portugal, of Liège, Louvain and Brussels in Belgium.**

This long list clearly shows a very rich, varied choice of degree courses in Europe. Each year, several thousand engineers graduate from different levels of aeronautics and space degrees. All do not stay in the area and many use their talents in other sectors of the economy. The technical and managerial complexity of aeronautical and space systems leads to degree courses which are valued in many highly technical areas.

Factors of evolution

The dawn of this new century is characterised by a move towards globalisation, in which aeronautics and space are playing a major role. Currently only two major powers are capable of offering a comprehensive palette of aerospace products: the United States and Europe. Despite its great weakness following the Second World War, the latter succeeded in developing its skill base and pulling itself up to the top rung in a whole range of products. Behind these two, other competitors are now preparing to make their entry shortly. Chinese ambitions in the area of aeronautics and space are particularly obvious, but neither is India concealing its desire to become a major player. Russia is rediscovering its ambition and would like to return to its old position.

Canadian aerospace policies, within the North American environment, and the more independent policies of Brazil, are also very clear.

In this context of globalisation, the only players are the major economic entities. In our case, this means Europe. Neither the United Kingdom nor Germany nor France, on their own, can be significant actors in the world market. Our flagship products are all European: Airbus, Ariane, telecommunications satellites, tactical and cruise missiles, civil and military helicopters, business jets.

Europe brings together prime contractors, designers and manufacturers of all these high tech products. This pooling of talents happens at all levels. On the industrial level, obviously, with the setting up of EADS and its many European subsidiaries – Airbus, Eurocopter, Astrium – but also Thales which brought together Thomson and Racal (United Kingdom) and acquired an Italian branch with its subsidiary Thales Alenia Space. MBDA, joint subsidiary of EADS, BAE Systems and Finmeccanica, concentrates the industry of tactical missiles. The development of military transport aircraft A400M is entrusted to Airbus with a turbojet manufactured by the European consortium Europrop International. On a level of public prime contractors, ESA is the main developer of space products. The operational implementation of its programmes is carried out by Eumetsat for meteorology or Eutelsat for telecommunications. In the armaments sector, OCCAR (Organisation for joint armament cooperation), a European organisation of as yet modest size, was set up recently and puts in orders relating to the A400M. In terms of air traffic control, the role of Eurocontrol has grown considerably in the course of the past decade. Lastly the European authority for certification of aircraft is the Europe Aviation Safety Agency (EASA). European integration in the aerospace domain is therefore moving forward and undoubtedly set to continue. It goes without saying that aerospace training courses cannot ignore this movement, on the contrary, they must actively embrace it. Schools and universities in this area have taken note of this and actions have already been initiated. It is essential to carry on in this direction and European cooperation in the area of education is, undoubtedly, a priority which must, on the one hand, boost the quality of our future engineers and technicians and their capability to lead joint

programmes and, on the other, enhance Europe's role in the world by offering internationally acclaimed training courses.

Let us have a look at what has already been achieved, and work currently in progress. For some time past, the Pegasus network has been active. More recently the ECATA group was set up, which we would like to see further reinforced.

PEGASUS:

Set up in 1999 at the instigation of the French member schools of the GEA (ENAC, ENSICA, ENSMA and SUPAERO), the PEGASUS network (**Partnership of a European Group of Aeronautics and Space universities**) is made up of the best European Grandes Écoles and universities providing courses in aerospace. It does not include all the institutions listed previously, but does assemble the main aeronautics schools with similar sizes and levels and is responsible for most student exchanges.

Currently the PEGASUS network comprises 23 members from 9 countries of the European Union and Norway:

- France: ISAE, ENAC, ENSMA
- Spain: ETSIA (Universidad Politecnica de Madrid), Seville
- Italy: Politecnico di Milano, Politecnico di Torino, Università degli Studi di Pisa, Università di Napoli, Università di Roma
- Sweden: Kungliga Tekniska Högskolan of Stockholm
- Germany: Technische Universität Braunschweig, Technische Universität München, Universität Stuttgart, RWTH Aachen, Technische Universität Berlin, Technische Universität Dresden
- United Kingdom: Cranfield University, University of Glasgow, University of Bristol
- Netherlands: Technische Universiteit Delft
- Portugal: IST Lisboa
- Czech Republic: CTU Prague

Candidates to such a network have to respect a set of criteria. Partner institutions certify for example that:

- the recruitment process for admission, based on an assessment of the scientific capacities of the student, is sufficiently selective to guarantee the high level of their graduate engineers
- each establishment proposes a engineering degree syllabus that meets with the highest European standards
- these engineering programmes include a solid general and scientific basis, relevant for aeronautics and space engineering, and an in-depth specialisation in at least one of the areas of aeronautics or space.

PEGASUS partners produce around 2000 aeronautics and space engineering graduates per year. It is difficult however to make a simple comparison of these different training courses since no collective data is available and national systems remain highly specific. A very comprehensive brochure has been published by the network and is available on the website www.PEGASUS-europe.org

ECATA (European Consortium for Advanced Training in Aerospace)

The ECATA consortium was formed in 1991, before Pegasus, on the initiative of European industrials. It aims to develop training programmes adapted to the needs of companies in the aerospace sector and thus reinforce the competitiveness of European industries. It comprises seven universities (ISAE, Cranfield, TU Munich, DIAP Pisa, ETSIA Madrid, KTH Stockholm, TU Delft) and eight aerospace industrials (EADS, Airbus, Safran, Alenia, Aermacchi, Dassault Aviation, BAE Systems, SAAB). The different university members signed a consortium agreement which acts as statutes in which one of its members, ISAE, manages the consortium in the name of the other partners and accommodates the headquarters in its premises.

Consultation between the academic and industrial partners has given rise to the elaboration of a joint programme carried out each year in two member universities, which leads to a European degree signed by all academic members. This ABI (**Aerospace Business Integration**) course, with its cultural management and systemic approach component, is one response to the needs of European industrial players for a solid skill base in the area of complex multinational programme management. It comes under the heading of continuous engineering training.

Since it was set up, the ABI programme has trained approximately 15/20 European auditors per year. Former pupils – about 300 for the moment working in 25 companies and research centres – have formed a very active association ECALAS. One should also point out that ECATA has carried out studies on behalf of the European Commission and proposes tailored international training courses, European symposia and research projects within the European FPRTD (Framework Programme for Research and Technological Development). For more information please consult www.ecata.org.

ECATA's perimeter of action is wide and covers all partnership actions in such a way as to promote European competitiveness. In 2005, for instance, it encouraged the setting up of a more in-depth training course spread over two years: EUMAS, the **European Master in Aeronautics and Space Technology**. This new, ambitious programme attracted students from the whole world into our European universities (Cranfield, Pisa, Madrid, TU Munich and ISAE).

The master is organised by two universities on a rotating basis with each new intake. Pisa and Supaero hosted the first session for 2005-2007. Then Munich and Madrid took charge of the 2006-2008 session. Rotations are continuing with Pisa and Madrid for 2007-2009, Cranfield and ISAE for 2008-2010 and Cranfield and Munich for 2009-2011.

25 students are admitted each year and have the choice of an aeronautics option and a space option. A rigorous selection process operates for admission. ISAE and Cranfield, for instance, received 365 applications for the 2008-2010 session. www.eumas.org

European Aerospace Institute

The dynamic initiated twenty years ago in the framework of the ECATA network is now optimised to go beyond the ABI concept and classic student exchanges and set up a more integrated European aerospace training course.

The approach instigated by ECATA members and Prague university is the following: in each university, a certain proportion of degree students, **15% to 20%**, constitutes a European class. These students constitute the **European Aerospace Institute (EASI)**. They receive top quality joint scientific and technical training. The courses are spread over five semesters in at least two to three establishments, and include an industrial or research project. By means of projects led by international teams, exchanges of lecturers, courses in the language and culture of their partner(s), the students obtain a joint degree and thus are better prepared to join a transnational European company.

This European aeronautics and space class aims to enter the future **European Technology Institute (ETI)**. This organisation has the triple goal of higher education, research and innovation. Its objective is to improve European competitiveness in terms of innovation by bringing together the relevant players (scientists, universities, businesses). ETI is to be organised

around a restrained central management structure, the governing board, and a network of **Knowledge and Innovation Communities (KICs)**. The **European Aerospace Institute**, associated with European companies and research organisations involved in aerospace, clearly possesses the characteristics to constitute the **Aerospace Knowledge and Innovation Community for the European Union**. The founding texts of such a KIC can be rapidly drawn up.

The ambition is to constitute the first EASI intake in the coming academic year. The wager is not yet won because many factors are weighing heavily on education and other areas at present and there is also the question of successfully funding the extra costs inherent to this Europeanisation, but the will to go forward does exist. This new training course will be proof that further education centres in Europe are keen to meet the needs of the sector's research centres and industry which themselves constitute clear examples of successful Europeanisation. Armed with a greater awareness of European cultures, the new generations will thus be more eager to defend Europe in the face of globalisation than their own nation against another within the old Europe. This is the challenge at the heart of the **European Aerospace Institute (EASI)**.