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## **Summary of the ACARE Human Research Group Workshop on**

### **Education and Training of Engineers and Researchers in Aeronautics for Europe**

#### ***"Developing the Aeronautics Engineering Skills of Tomorrow"***

**Brussels, 25<sup>th</sup> February 2010**

#### **Introduction**

The boundary conditions mainly in respect of technologies, economy and environment are changing for the European aviation sector; education and training of aeronautical engineers and researchers have to be adapted to the requirement of the aeronautics sector including industry, research, operators and public authorities. The workshop aimed to review the situation in Europe concerning the education of future academics and engineers and to identify needs for actions and inputs for the envisaged new Vision for Aeronautics and a related update of the Strategic Research Agenda of the Advisory Council for Aeronautics Research in Europe (ACARE).

The ACARE Human Resource Group (AHRG) organised the event in collaboration with the European Commission, the EASN Association, the Aerospace University Association PEGASUS, the ACARE Member States Group, and the European Aeronautics ERA-Net AirTN.

More than 70 participants were present from 18 countries (incl. Croatia, Serbia, Switzerland and Ukraine) representing a wide range of stakeholders: 24 came from universities, 6 from major industries, 11 from SME and consulting companies, 14 from research centres, 3 from Government agencies, 10 from the Commission and a few 'others'.

After a number of substantial presentations addressing the main aspects, all participants took part in a lively discussion. The workshop provided useful signals for follow-on activities, at ACARE HRG level, but also for the Aeronautics Workprogramme 2011 of FP7, which will list a support action on this issue.

You will find hereafter the main findings of the workshop, followed by notes about all individual presentations and summarising statements of the final discussion concluded by the Chairman of the ACARE Human Resource Group.

## Summary of the main findings

The workshop was a successful event with substantial presentations and discussions; a wide variety of stakeholders from industry, universities and research organisations could confront their viewpoints and convey the following messages.

**Aeronautics industry is no longer viewed by young people as a prestige industry**, other sectors are more attractive e.g. banking, IT. Nevertheless, there are practical initiatives to attract the young generation to aeronautics engineering: education-oriented private-public partnerships successfully set up school exercises, laboratory visits, competitions and science festival, which involved and entertained thousands of students and their families!

**What type of profile is required by industry today?** They look for a solid technical background, a certain passion for the area, mobility, languages; ideal candidates have experienced multicultural teamwork and problem solving in practical case studies; they understand the specific constraints of industry: budget, time, standardised design practices.

**In general, there is not a big shortage of engineer graduates**, but there is a shortage of professionals, who have real practical experience, especially in some specific disciplines that are newer in Aeronautics: software, electronics, human aspects...

**The SMEs' role is changing** in the supply chain: they are asked to innovate more, they also need high level graduates. SMEs are very attractive for graduates, they offer a direct contact with the customer and a global view on the contract obligations – a kind of experience the bigger companies are looking for.

**Universities have experienced a dip in the number of students** in engineering, following statements in the late 1990's that industry did not need so many; this demonstrates that the needs must be assessed carefully, and well in advance to be able to adapt curricula.

**Lack of experience is a real problem**; universities need platforms where students can gain real hands-on experience e.g. A-planes; could Clean Sky have an educational component? Universities need more European fundamental research projects funded, these give a longer term perspective and are of great benefit to universities and students.

**European and national Initiatives strive to define education quality standards.** Such a quality system would increase students' confidence and enhance their mobility across Europe. But the way to official accreditations may be long, and in the mean time, voluntary systems and universities reputation will bridge the gap. The EU also promotes the researchers mobility - international and inter-sectoral - through its extensive Marie-Curie programme.

**According to Research organisations, educators should adapt their curricula**, covering no longer just aircraft design and flight physics, but should extend it to a total air transport system, including many other disciplines such as ATM, regulations, MRO, supply chain... Platforms, like PEGASUS, connect universities with research centres and industry to better define and cross-breed curricula.

**Women should be encouraged to come into aeronautics**, at present there is a real imbalance.

**ACARE will take all these issues forward** for discussion at plenary level. Also in 2011 work programme, there will be a support action, and ACARE HRG will submit a proposal aiming to better specify the quantitative and qualitative needs and then propose actions.

## Opening session

*Chairman : Liam Breslin, Head of Aeronautics in DG Research – Transport*

### **Welcome by Liam Breslin**

Liam Breslin welcomed all participants to the workshop and thanked the organisers.

He presented the agenda of the day and the reasons for the workshop.

Education and skills of engineers are equally as important as technologies; therefore ACARE has education as part of its agenda. This workshop is very timely in preceding the revision of the Vision 2020 by the ACARE stakeholders this year, as well as the mid term review of FP7.

### **Introduction by Prof. Joachim Szodruch, Co-Chairman of ACARE**

ACARE defines the Strategic Research Agenda, but there is no strategy without young people.

What is the profile of people we need? Do we have a problem? What is the problem?

What are the AHRG actions? What have been obstacles in the past?

### **Keynote address by Dr. Andras Siegler, Director of Transport in DG Research**

Europe still lags behind USA and Japan in terms of budget allocated to Research and Development. However it is not only a question of money, but also about motivating the young people to technical and scientific careers, where the fascinating Aeronautics and space hi-tech areas are in competition with IT and banking sectors.

Universities have an important double role of education and upstream research. There may be a need for adapted curricula, taking into account multi-disciplinary and international aspects.

In the 7<sup>th</sup> Framework Programme, the 'Marie-Curie' programme aims to stimulate the international dimension of education, and projects like RESTARTS are dedicated to attract the students towards Aeronautics.

ACARE have to tackle the essential question about appropriate education for engineers. In view of mid term review of FP7 and the revision of the Vision 2020 by the ACARE stakeholders this year, this workshop comes at the right moment to signal the needs for initiatives for ensuring the future human resources for Aeronautics.

### **Workshop introduction by Prof. Spiros Pantelakis, Chairman of ACARE-HRG**

Spiros Pantelakis summarized the present situation. There are enough excellent education institutes to provide engineers and scientists in quantity and quality, but there is room for improvement and synergies. Existing mechanisms like PEGASUS, EASN, ACARE-HRG are promoting coordination.

The terms of reference define the missions of the ACARE-HRG: notably to provide qualified workforce for the Aerospace industry, and improve the perception of Aeronautics careers.

The objectives of the workshop are to discuss the HRG objectives, identify further actions and give motivation to the group.

## Session 1: Industry view on the qualifications of future engineers

*Chairman: Fred Abbink, ret. NLR*

### **1. Industrial requirements to future aerospace engineers**

***Yves Favenec, VP Research and Technology, Eurocopter***

Aeronautics is no longer considered as a frontrunner industry; science graduates are no longer in demand by engineering sector only, but also by financial sector.

Eurocopter is looking for engineers with: a solid technical background, a specialty studied in detail, geographical and professional mobility, patience (typ. 5-8 years in a function), foreign languages, management skills, taste for challenge, passion...

There is a need to restore a sufficient status for the senior technical experts, often rated below managers.

The problem of resources lies not so much in traditional aeronautics areas, but rather in new fields like electronics, software, human aspects, where there is a need for experienced people, and competition is fierce with other sectors.

### **2. Aerospace engineers between innovative ideas and industrial constraints**

***Dr. Norbert Arndt, Director Engineering, Rolls-Royce Deutschland***

The need for innovation is both environmental and customer driven. Aircraft engines are progressing towards ACARE targets thanks to continued innovation at system and subsystem level, e.g., 3D aerodynamic modelling, leading to better flow understanding, and improved component efficiencies whilst reducing the need for rig tests.

To foster innovation Rolls-Royce has established an international network of 27 University Technology Centres, ensuring long-term, funded collaboration with academic partners.

The engineer working in industry is facing constraints, e.g., programme and budget timescales, and a continued focus on recurring and non-recurring cost. The focus on non-recurring cost for example drives standardization of engineering processes and design practices. The engineering community must therefore drive both innovation and standardization.

The personal qualities Rolls-Royce expects in new staff are innovation, knowledge, accountability, understanding/focus and ambition. R-R offers education, training, delegated authority, experience and challenge. Three career paths are possible: Fellow for world class specialists, Chief Engineer to manage large engineering programs and Functional Leaders for tools and method development as well as people management.

## Session 2: Ensuring the educational quality of future aerospace engineers

*Chairman: Dietrich Knoerzer, DG Research – Aeronautics*

### **1. Standards and Guidelines for Quality Assurance in the European Higher Education Area**

***Ms. Fiona Crozier, Vice-President of the Board, European Association for Quality Assurance in Higher Education (ENQA) and QAA UK***

The ESGs are "Standards and Guidelines for Quality Assurance in the European Higher Education Area". They were approved by the EU ministers at the 2005 Bergen meeting as part of the Bologna Process.

The ESGs aim to develop a quality culture in the High Education Institutes (HEI) and to inform the students and employers about the HE processes and outcomes.

Thanks to this transnational evaluation process, the ESG contribute to the mobility of students and to the set up of double degrees.

## **2. How to attract the young generation for aerospace engineering**

***Prof. Carsten Holze, Univ. of Applied Sciences Bremen and DGLR (presented by D. Knoerzer)***

Integrated, education-oriented, private-public partnerships offer practical solutions to attract the young generation to aerospace engineering!

First, the societies (CEAS/DGLR), schools, universities and education authorities setup the basic educational concept. Second, teachers and professors design educational material and organise practical exercises for the students. Third, the theory is consolidated by visiting companies. Fourth, students take part in regional competitions. Fifth, a final competition and a Science festival are opened to families and friends.

This concept was successfully implemented e.g. the "International Paper-plane contest Hamburg" with 5000 students in classes, 28 regional competitions and 600 students at the science festival and final competition in Lufthansa Base, Hamburg.

## **3. How to assure the educational quality for aerospace engineers**

***Prof. Jan van Ingen, emeritus TU Delft***

Prof. Jan van Ingen presented recommendations based on two earlier EC-ACARE studies on education and accreditation (2006 and 2007), here are some of them:

- As it may still take a long time to reach a European educational accreditation system that would have a legal status, it is recommended to implement a voluntary accreditation system for aeronautical education recognising the diversity of the national education systems. Some stakeholders think reputation is an alternative to accreditation.
- Life-long learning should be improved, both technical and management.
- The studies on academic education should be extended to technical / vocational schools.
- The image of a career in the air transport sector should be improved.
- A (permanent) platform should be created where university representatives should meet at regular intervals to exchange views on the requested developments of the curricula at universities.
- Student Team experience should be promoted (ECATA junior), as well as the exchange of students (EUROALIA)
- It is envisaged that university education will be highly individualised. In continental Europe, this could lead to a system of "dossier diplomas", showing the type of courses and activities followed. However, such a "dossier" approach may not be compatible with the UK-system of "chartered engineers".

Finally, as an example of concrete action to promote Aeronautics, the CANSAT competition organised by TU Delft was presented. 46 teams competed to design and realize a satellite the size of a beer can; they were launched from a balloon, and the winners will be rocket-launched.

### **Session 3: University Education for Aerospace Engineers in Europe**

*Chairman: Prof. Krzysztof Kurzydowski, Warsaw University of Technology*

#### **1. The Marie Curie Programme responding to Europe's needs for training, mobility and career development**

***Georges Bingen, Head RTD-T.2 Marie Curie Actions – Fellowships, European Commission.***

The 'People' programme, better known as "Marie-Curie Actions" accounts for a substantial part (10%, or €4.7billion) of the global FP7 budget.

Its objective is to strengthen the European human potential in R&D by stimulating young people to enter R&D careers and stay in Europe.

It is open to all scientific domains and all stages from PhD to experienced researchers. It fosters transnational and inter-sectoral (industry-academia) mobility. Its budget covers (in general) salaries, mobility and family costs and contribution to research costs. The targeted applicants include individuals but also industry, research institutions and public bodies.

The impact of the actions is monitored via questionnaires at the end of the fellowship – the feedback is globally very positive.

#### **2. Ten Years PEGASUS – "Partnership of a European Group of Aerospace Universities" - Goals & Achievements for Aerospace Engineering Education**

***Presented by Prof. Franco Bernelli, Politecnico di Milano, replacing Prof. Pascal Bauer, ENSMA Poitiers and Chairman of PEGASUS,***

The key factors for an improved efficiency of engineering education are illustrated by the ENSMA example: a solid scientific background, a strong research environment, industrial partners, national networking and international networking.

Founded in 1998 with 23 members in 9 EU countries, the PEGASUS group accounts for approximately 2500 graduates per year in aerospace engineering.

Its main objectives are to:

- define quality standards for Aerospace education
- improve educational process and curricula to serve the needs of the aerospace industry,
- attract foreign students
- crossbreed curricula and engineering profiles generated by student mobility,
- connect universities with laboratories, industry for internships,
- be a recognised channel at EU level

Over the last 10 years, PEGASUS produced the PEGASUS labels (Certificate and Awards), organised yearly PEGASUS-AIAA conferences, issued a comparative analysis ('Catalogue') of the EU curricula in aerospace, and contributed to new "crossed" aerospace profiles and crossbreeding of curricula in parallel with the implementation of the Sorbonne – Bologna 3+2 scheme.



### **3. Adapting the changing requirements to the education of aerospace engineers**

***Prof. Rolf Henke, RWTH Aachen***

The major change is not on the technical side, the topics of the 70's are still the basis for the present education, but the lack of experience is the cause of many projects problems. Universities need working platforms for students to gain hands-on experience, e.g. prototype planes. What about CleanSky, could it later include an educational segment?

Soft skills are important, but we should not overdo them; motivation is key, we have to restore the "twinkle in the eyes".

Universities need more basic research funding within the Framework Programme, namely in pioneering topics for long term open research.

The needs for engineers should be carefully specified and quantified. In the 1990's it was claimed that we did not need anymore engineers in Germany. Due to the lag, this led to an undesirable dip in the number of graduates the following years.

### **4. ECATA – European Initiative for Advanced Training in Aerospace**

***Prof. Bénédicte Escudier, ISAE Toulouse and ECATA Management Group***

ECATA is the European Consortium for Advanced Training in Aerospace, consisting of 7 universities and 8 industrial companies in 7 European countries.

The purpose of ECATA is to identify the needs of the Aerospace industry, and to develop dedicated training programmes and continuous education.

ECATA organises the EUMAS (EUropean Master in Aeronautics and Space), a 4-months course programme split in several sessions over one year and in 5 countries. The programme is designed by professionals for professionals with several years of experience. It consists of case studies, lectures, visits and Multinational Team Projects (MTP) to develop the ability to work in team in multinational and multicultural projects.

So far, ECATA accounts for 350 Alumni from 8 countries, 30 course customers (companies, research centres) and 700 professionals involved in the programmes. Its benefits for the industry are to provide a course adapted to its HR needs, and networking across universities, research centres and industry.

## **Session 4: Meeting the Future Requirements in Aeronautics**

*Chairman: Michel de Glinasty, ONERA*

### **1. Qualification criteria for future engineers in aerospace industry**

***Joachim Sauer, Vice President Human Resources, Airbus Operations GmbH***

Airbus identifies 14 overall "Airbus Key Competencies" (AKC); the technical specialities are described by 12 "Engineering Key Competencies" (EKC), covering structures, systems, power plants, tests...

The Airbus qualification criteria include: understanding engineering fundamentals, design and manufacturing processes, with a multidisciplinary perspective; management, teamwork and communication skills; flexibility, international mobility and language skills.

Airbus offers two career paths: the Aircraft Architect and the Expert. The Aircraft Architect has management, behaviour and multidisciplinary technical skills. The Expert has knowledge, experience, autonomy, with innovative and multidisciplinary spirit.

The reality is that the diversity of cultures leads to misunderstandings and chaos, if it is not organised; multi-cultural education and language teaching are necessary. There is also a need for more practical experience, calling for more case studies.

There is not so much a lack in quantity of engineers, but rather in term of quality: high level experienced specialists are sometimes very difficult to find.

## **2. Researchers of tomorrow – qualifications and knowledge profile**

### ***Fred Abbink, former Director General, NLR***

The US perspective on future aircraft design given by J. McMasters (2005) features an increased demand for engineers up the value chain : from "methods/design" to "integration" up to "requirements" specification phase.

Boeing's desired attributes for an engineer include: foundational (scientific, computing) technical skills, engineering (design, system, integration), professional (communication, teamwork) and business (planning...) skills.

A required set of qualifications for MSc were agreed at the Dublin "Joint Quality Initiative Meeting" in 2004: knowledge, understanding, problem solving, communication and continuous learning skills.

The TU-Delft Aerospace disciplines are evolving. Beyond the traditional disciplines (Aerodynamics, Materials, Flight mechanics, Aero-elastics, Engines), the future engineer profile also includes ATM, Avionics, Human factors, Airworthiness/Regulations, Supply chain management, MRO, Environmental aspects, multinational/multicultural aspects...

After analysis of these new needs, TU-Delft Electrical Engineering faculty has set-up an Avionics specialisation, including subjects as Flight mechanics, Aircraft systems, Avionics and instrumentation.

## **3. The European Co-operation in Vocational Education and Training towards Future Labour Market Needs**

### ***Benoit Desjeux, DG EAC-B.5 Vocational Education & Training, European Commission***

The European Community treaty (art 149, 150) defines the mission of Commission in education and vocational training: the Member States are in charge of the educational systems, and the Commission has a supporting, fostering role.

By 2020, the demand for highly qualified and medium qualified people will increase, while it will decrease at the low qualification level; the education pathways for up-skilling needs to improve.

The EU developed tools to foster a European Area of Vocational Education and Training (VET) and to facilitate pathways between education systems.

The EQF (European Qualification Framework for long life learning) defines 8 levels covering academic and vocational qualifications, based on Learning Outcomes (knowledge, skills and competences) and integrating the Bologna descriptors.

The European Credit System for Vocational Education and Training (ECVET) describes the qualification in terms of units of learning outcome, thereby facilitating the individuals' mobility across countries and between different education training systems. It also enhances the partnership between education institutions and employers and the responsiveness to labour market needs.



## Panel Discussion:

### "University Contributions to the Update of the European Aeronautics Vision"

- **Panel Moderator: Prof. Joachim Szodruch**, Co-Chairman ACARE
- **Fred Abbink**, former Director General, NLR
- **Yves Favennec**, Vice-President Research & Innovation, Eurocopter
- **Michel de Glinasty**, General Scientific Director, ONERA
- **Prof. Krzysztof Kurzydowski**, Warsaw University of Technology
- **Prof. Spiros Pantelakis**, Univ. Patras and Chairman ACARE HRG
- **Joachim Sauer**, Vice President Human Resources, Airbus Operations GmbH
- **Liam Breslin**, Head of RTD-H.3 Aeronautics, European Commission

#### Four major topics were addressed:

- **the image of Aeronautics,**
- **the quantitative labour demand,**
- **the required skills,**
- **the gender balance.**

All generally agree the image of the Aeronautics industry has been tarnished over the last decades, it should be restored; nevertheless, jobs in the SMEs seem to be more attractive as the engineers are dealing with early technology development, and closer to the contract and customer.

Regarding the labour supply, it is not obvious that there is a generalised shortage; however some express the present need for more project engineers, and a future shortage for specialists as the pension schemes allow for early retirement.

According to the industry, the skills to be improved are: languages, project management, teamwork and meeting management; students must also be prepared to corporate work, they should better understand and accept budget, planning and industrialisation constraints.

SMEs' viewpoint is that large industrials subcontract a lot more to smaller enterprises, which innovate, and so need high-level graduates; SMEs also develop the management skills of the engineers, sometimes later hired by large companies.

Universities think the forecast of future needs (2020) is critical, as the curriculum adjustment is a long process. TU Delft tackles the language issue by giving lectures in English.

Regarding the gender balance, women are underrepresented in industry, although their soft skills are highly appreciated. In Research centres, they are sometimes well represented (30%), but maybe more in the administrative tasks. It is broadly agreed that incentives are more desirable than quotas. The EC promote the women in science, namely by a dedicated project; the new Commissioner definitely wants to increase the women representation in science.

## Closing statement

### **Prof. Spiros Pantelakis, Univ. Patras and Chairman ACARE HRG**

It is not obvious that there is a lack in quantity of engineers; this should be quantified by the analysis of supply and demand fluxes.

Regarding the skills, the main problem concerns the new disciplines such as ATM, Avionics, Human factors, Airworthiness/Regulations, Supply chain management, MRO, Environmental aspects, multinational/multicultural aspects...

A European project would help to better specify the quantitative and qualitative needs and then propose actions; the HRG should submit a proposal for a Support Action.