ASSESSING THE EDUCATIONAL GAPS IN AERONAUTICS AND AIR TRANSPORT

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SEVENTH FRAMEWORK PROGRAMME

DELIVERABLE WP5:

QUANTITATIVE AND QUALITATIVE ASSESSMENT OF EDUCATIONAL SUPPLY FOR RESEARCH (THE 3RD BOLOGNA CYCLE)

Partner Responsible: ULPGC

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Executive Summary

This work package is focused on the education and formation for researchers (3rd Bologna Cycle). As such, the purposes and task structure of this WP closely follows the previous WP. WP5 is aimed to i) to identify the current offer (supply) of educational programmes (3rd Bologna Cycle) in air transport and aeronautics, ii) to perform a review of the educational curricula of those programmes , and iii) to identify the expected portfolio of researchers' competences developed as a result of the educational process. Like WP4, WP5 will also closely interact with WP3 in terms of the overall assessment framework based on competencies' gap assessment, and it will feed the WP7 (i.e., knowledge generated through teaching / courses, students' competencies) for the assessment of Gap 3 and Gap 4, and for the assessment of the attractiveness of air transport and aeronautics industries.

Universities fully recognise that they have the responsibility to offer doctoral candidates more than core research disciplinary skills based on individual training by doing research. From various surveys on career paths of doctoral graduates carried out either at national level or institutional level, it is evident that doctoral graduates often lack skills needed in industry or enterprise. Ahola and Kivinen (1999) emphasized that in industry and commerce, unlike in academia, a doctoral thesis is not seen as evidence of employability. Universities are certainly most aware of this fact and are increasingly introducing courses and modules offering transferable skills training and preparing candidates for careers in various sectors. However the financial crisis that is affecting unevenly to the European countries is posing additional challenges resulting from the consequences of structural change (especially decreases in financing of the higher education and research sectors and the impact of "brain drain").

The culmination of the Bologna process needed a basic line establishing two pillars of the knowledge based society: "European Higher Education Area (EHEA) and European Research Area (ERA)", in order to promote the key role of doctoral programmes and research training in the context of increasing the competitiveness of the European region.

Thus, the third cycle in the Bologna Process became apparent as there was a need to promote closer links between the EHEA and the ERA in a Europe of Knowledge, and of the importance of research as an integral part of higher education across Europe. Therefore, Ministers considered it necessary to go beyond the focus on two main cycles of higher education to include the doctoral level as the third cycle in the Bologna Process. They emphasised the importance of research and research training and the promotion of interdisciplinary in maintaining and improving the quality of higher education and in enhancing the competitiveness of European higher education more generally. Ministers call for increased mobility at the doctoral and postdoctoral levels and encourage the institutions concerned to increase their cooperation in doctoral studies and the training of young researchers.

Research training and research career development - and the need to increase the number of highly qualified graduates and well trained researchers – are also becoming increasingly important in the debate on strengthening Europe's research capacity. The aeronautical and air transport sectors are not an exception regarding this need.

First, we present the results of the questionnaire developed to gain some insight of the doctoral programmes in the field of aerospace, aeronautics and air transport. In order to summarize the main results, we will comment these according to the ten principles obtained in the 'Bologna Seminar' held in Salzburg:

(1) The core component of doctoral training is the advancement of knowledge through original research. At the same time it is recognised that doctoral training must increasingly meet the needs of an employment market that is wider than academia.
    a. This principle is mostly achieved.
(2) Embedding in institutional strategies and policies: universities as institutions need to assume responsibility for ensuring that the doctoral programmes and research training they offer are designed to meet new challenges and include appropriate professional career development opportunities.
    a. This principle is also mostly achieved but here we recommend in a major involvement of the industry in order to develop collaborative doctoral programmes.
(3) The importance of diversity: the rich diversity of doctoral programmes in Europe - including joint doctorates - is a strength which has to be underpinned by quality and sound practice.
    a. Here, we consider that there is enough room to improve. There is a need to start joint programmes. However it is highlighted that there is a real informal cooperation between the different existing programmes in Europe.
(4) Doctoral candidates as early stage researchers: should be recognized as professionals – with commensurate rights - who make a key contribution to the creation of new knowledge.
    a. This principle is basically achieved but there is also a need to have a more common framework within the EU.
(5) The crucial role of supervision and assessment: in respect of individual doctoral candidates, arrangements supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral

candidates, supervisors and the institution (and where appropriate including other partners).

a. This principle is also partly achieved and it is highly recommended to work in a common code of conduct at the European level.

(6) Achieving critical mass: Doctoral programmes should seek to achieve critical mass and should draw on different types of innovative practice being introduced in universities across Europe, bearing in mind that different solutions may be appropriate to different contexts and in particular across larger and smaller European countries. These range from graduate schools in major universities to international, national and regional collaboration between universities.

a. This principle has been partly achieved with the creation of Doctoral Schools in some countries. However in our opinion, it will be advisable to move into the direction of joint programs within the field as a better way to get a critical mass with the main stakeholders of the industry at the European level.

(7) Duration: doctoral programmes should operate within an appropriate time duration (three to four years full-time as a rule).

a. This principle is basically achieved.

(8) The promotion of innovative structures: to meet the challenge of interdisciplinary training and the development of transferable skills.

a. There is no evidence about the performance of this principle, but it is highly advisable to work into the direction of creating joint programmes including several universities and different stakeholders of the industry.

(9) Increasing mobility: Doctoral programmes should seek to offer geographical as well as interdisciplinary and intersectoral mobility and international collaboration within an integrated framework of cooperation between universities and other partners.

a. There is enough room to improve the performance of this principle.

(10) Ensuring appropriate funding: the development of quality doctoral programmes and the successful completion by doctoral candidates requires appropriate and sustainable funding.

a. This principle is mostly achieved.

Secondly, we present the results of the survey of the students. It was necessary to identify the relevant stakeholders as the key sources of information for analysis the various competence gaps – that is, the target of the surveys. Four types of relevant stakeholders were identified, being:

1. companies (human resources),

2. employees,

3. universities (professors and lecturers),

4. graduating and graduated students.

This deliverable shows the results of the surveys administered to students. A consensus was achieved in the Consortium, seeing that it was advisable to statistically exploit the databases separately for students and universities. The results for universities can be consulted in the deliverable 4.8. All the questionnaires can be found in the deliverable D3.7 (Educair, 2012) and in the project website: http://www.educair.eu/

The target audience of the survey administered to the students were the PhD-students, the master students and the undergraduate students of universities and colleges with PhD programs, master programs and undergraduate programs in air transport/aeronautics. The survey aims to collect quantitative and qualitative information on the demand for graduates at the three different Bologna Cycles as a basic input to analyse the gaps that exist in the air transport and aeronautics industry regarding the existing relations between students-employees (Gap 1) and between universities-students (Gap 3). This survey holds three parts. The first part contains general questions to get a view on the background of the respondent. The second part is divided into several sections: questions about the educational background and career path (A), about the competences needed in the sector (B) and about the cooperation between the industry and the educational institutes (C). In the last part of this survey, respondents had the opportunity to make any comments or remarks they might have. The survey takes about ten minutes to be completed.

Another important issue in terms of confidentiality, it is that respondents were guaranteed that information gathered was for internal use only after statistical exploitation and that under any circumstances personal information like email address or relevant information will not be shared with any third parties. Thus, all the answers to this survey are private and confidential and will only be used within EDUCAIR project, and no nominal data will be kept in the database whether this is shared with third parties for scientific purposes.

Using the basic information provided by the tasks 5.1 and 5.2., we gather information about potential respondents for the implemented phase of the surveys. This information was also completed by the list of contacts of the different partners involved in this project: IST, AUEB, UA, ULPGC and TUD. All the partners also provide contacts for the companies and research centres that were identified by IST. Our intention was to have a balanced sample covering different criteria, such as, covering the main universities involved in the field under analysis and some geographical location coverage in Europe. On the basis of the Questionnaires developed by WP3 for the subsequent WPs, IST as the coordinator for the project decides that ULPGC was in charge for the data analysis of the students' survey within the task 5.3. within WP5, as it was difficult to split the information of the universities and students according to the different cycles commented in the Bologna Process.

The data analysis of the students' survey is going to be presented in five different parts: (1) personal information, attraction and repulsion factors; (2) competences, academic degree evaluation, personal career assessment and career planning consultants; (3) areas of interest for working, additional interest in education, companies for working and activities of the curricula; (4) previous labor experience, relevant qualifications for getting a job and skills; and (5) competences by subsectors and internship awareness. We finally obtained 215 valid responses that represent the three cycles of the Bologna Process (32 (15%) of the 1st Cycle engineering students; 58 (27%) master students; and 125 (58%) of Ph.D. students) .

Regarding the nationality of the respondents, we obtain that the best represented countries were Portugal (33%), Italy (15%), Sweden (12%) and Germany (11%). Focusing now on the age of respondents, we see that most of the respondents belong to the same cohort of students in their 20s (67%). We have minority groups of respondents who are younger than 20 years old (7%) and older than 50 years old (6 %) and whose age in in the range of 40-50 (5%). Finally, 15 per cent of the sample are in the 30s. Looking at the gender distribution, it can be seen that males are still predominant in the sample (82%). The low percentage of females in the sample and subsequently in the survey participation is not atypical. For many years, the average percentage of students in this field has always been very low.

Regarding the attraction factors for choosing the courses or field of study. It can be seen that 95 respondents (44%) answer this question for a total of 112 attraction factors grouped in 9 classes. In order of importance, it is remarkable that the passion for the field (31%), good employment perspectives (24%) and the provision of high-technical skill (16%) are with difference the most cited attraction factors.

In any case, the responses given can be certainly used as an important input in order to develop a strategic plan about "How to Attract the Young Generation for Aerospace Engineering". It is evident that there still exists a sort of overall fascination of Aeronautics and Aerospace Engineering. A sustainable future for humankind is going to be only possible if we are able to attract talented people to be the workforce of the innovation needed to handle all the challenges posed in our planet now and in the future. Innovation is the lifeblood of the engineering profession, and consequently it seems plausible to think that engineers will need to play a major role in ensuring this future.

Regarding the repulsive factors, the most cited factors, after tabulating the raw data, are the difficulty of the courses (49%), the lack of direct application or involvement in the real world (12%) and other aspects related to the exercise of the profession which difficult the employability of the respondents (15%), such as for example like the need of obtaining different professional licenses. Other interesting issues that appear is the gender gap and the concentration of the job in a limited number of countries.

As a consequence of the current financial crisis, the engineering job market is experiencing the same weakness as other sectors and it is becoming to be less healthy than some previous years ago. Then, the key question remains to be unsolved to what extent is worth for a 14 to 18 year old to follow a secondary school study path of mathematics, physics and chemistry to ultimately find themselves doing a longer bachelor degree that needs necessarily complemented by additional studies in a master, to finally end working in a job that has long hours and hard work, and getting paid the same if not less than someone who has done a less demanding qualification?

It can be seen that in order of importance, the following competences are the most valued: Knowledge transfer and outreach activities (3.27), Communication skills (3.37), Team working (3.37), Research skills and techniques (3.38) and Personal effectiveness (3.49). However, when we look at the self-assessment, we obtain the following results: Team working (3.04), Communication skills (2.88), Personal effectiveness (2.85), Ethics and research governance (2.84) and Research skills and techniques (2.81).

Finally if we subtract from the importance the value of self-assessment, we obtain a measure of internal gap according to the evaluation of each of the respondents. In this case, it can be seen that the most pronounced gap is obtained for the following competences: Personal effectiveness (-0.63), Research skills and techniques (-0.57), Knowledge transfer and outreach activities (-0.54), Communication skills (-0.48) and Career management (-0.45).

Following the discussion of the career development students were asked to respond about the main areas of interest for career development. It can be seen that most of the respondents answered that they are interested in developing a career as an employee in air transport related company (61%). There is only a scarce 11 per cent who wants to develop their career outside the air transport sector, 15 per cent wants to become a researcher, 3 per cent wants to continue studying further and 10 per cent does not still decide it.

Regarding the companies for working, most of the respondents have decided to work in air transport related companies. It is evident that due to the degree of specialization of their field of studies, many of them manifest a desire to work for manufacturers, motors, propulsion and other high-tech companies related to the supply chain of air transport.

Regarding the activities carried out during the curricula, students have less interest in improving communication skills (22 %), they have already acquired experienced outside their immediate area of field (39 %), and they maintain an interest for the future for most of the activities: Acquiring experience outside your immediate area (49 %) , Developing management experience or expertise (65 %), Developing a broader experience of research functions (62 %) and Improving communication skills (58 %).

Regarding the relevancy of qualifications and skills for getting a job, it can be seen hat with respect to qualifications, the possession of a university degree (3.45) is even more valued than the degree in air transport and aeronautics (3.21). Behind these two issues, the previous working experience is also highly valued (3.10).

Regarding the awareness of internships programs, a great percentage of the respondents (63 %) are aware of this type of activity. However, at the same time they do not consider that it is enough, so it is necessary that in the last years of the programs where the core of the advanced Aerospace Engineering topics are usually presented, or the industrial collaborative doctoral programs can be developed in order to increase the presence of the students in the industry to have a first taste and experience of company life as an engineer.

An internal assessment of the core competences was made for different sectors, mainly airports, airlines, manufacturers and ANSP. The 23 core competences for airports were analysed, obtaining that most valued are: security concerning passengers (3.55), design of airside infrastructure (3.47) and handling of vehicles (3.47). The selection of core competences were made adequately as in all the cases the average importance value was higher than 3. It is really surprising that in all the cases the self-assessment was lower and students consider that only in one competence (emission control) they pass the assessment with an average value of 2.

Regarding airlines, the competences were classified in 11 classes. The most valued are: safety management (3.69), planning and coordination of operations (3.47) and maintenance and reparation of airframe (3.45). The self-assessment is even worse than for the case of airports, as the students consider that they do not have any competence with an average figure higher than 2.

The 15 core competences for Air Navigation Service Providers were analysed, obtaining that most valued are: supervision & planning approach operations (3.61), Provision of terminal radar approach control (3.59) and aircraft landing & taking-off control (3.56). In all the cases, the relative importance of the competence obtains average figures higher than 3.28. Nevertheless, the self-assessment is really poor as the competence of management of air traffic capacity and efficiency presents the highest score with an average value of 1.68.

Regarding manufacturers, the competences were classified in 36 classes. The most valued are: test engineering (3.69), stress and structures analysis (3.65) and quality engineering (3.63). This sector presents the better results of all regarding the self-assessment as in this case there are 19 core competences in which students claim that they possess the respective competence in certain degree (average figure higher than 2). The competences with the highest values of self-assessment are: flight physics (2.58), structural & general engineering (2.47), materials and processes (2.35), fluid mechanics and acoustics (2.3) and stress and structures analysis (2.3)

The role of Air Transport has never been more important to society, and it is vital that aviation is prepared to meet the challenges of a changing world. With changing demographics and increased urbanisation, society towards 2050 will need more long-range transport to connect markets and people. Passenger travel will increase with growth in business and social-related mobility (dependent on the population being able to afford air travel).

This continuing growth in demand will bring increased challenges for dealing with mass transportation and congestion of infrastructure. Transport will increasingly become a place for work, commerce, leisure, and meeting others. Some travel needs may disappear because of teleconferencing and virtual access to knowledge, but Information and Communication Technology development will add to the opportunities for interaction and ultimately contribute to transport demand. Global forecasts show a potential demand for some 25,000 new passenger and freight aircraft between 2008 and 2028 representing an order book value of Euro 3 trillion. This will be driven by the need for more fuel efficient and eco-efficient vehicles to handle additional capacity as well as for the replacement of older generation aircraft. Important changes in infrastructure and operations will also be needed.

Air Transport will have to find innovative ways to meet the future needs of society for mobility. This “new version” of aviation must be competitive and complementary with other transport modes. Europe, with its unique infrastructure, is able to develop advanced multimodal transport solutions including an appropriate role for aviation in order to provide safe, affordable and sustainable transportation.

Thus, universities need to impulse a sort of working together across the whole community of industry, research establishments, governments, regulatory authorities, and the European Commission. This collaborative framework needs to be maintained to help develop an even more successful future Aeronautics and Air Transport System in Europe.

People recognise aerospace as one of the major drivers of the high-skill levels in society and the significant spill-over/spin-off benefits that this gives to other products and services outside aeronautics. Aerospace provides a rich source of academic problem areas and challenges as well as a good exploitation route for scientific ideas and advances in universities.

The world-class standing of a few aerospace companies (Airbus, Rolls-Royce, Thales, Safran, etc.) is something in which people take pride, giving positive economic benefits in their countries, a healthy balance of payments surplus, and skilled employment.

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1 Introduction

Deliverable 3.3 of WP3 - *Setting the assessment framework for education and training*, explores the roots of the eventual divergence between the demand of and the supply of competences and set the scene for the works undertaken in WP4, WP5 and WP6. Deliverable 3.3 also identified the core competences in air transport and aeronautics. These competences are the focal points along which the gaps may emerge. Finally, it proposed a first draft version of the surveys to collect the required information from the sector. The surveys are the primary source of information for assessing the competence gaps.

The assessment of the competences was done in three separate WPs, namely: WP4, WP5 and WP6. They were developed in parallel. Each one studied different relevant stakeholders and perspectives, as follows:

- WP4 – Universities (1st and 2nd Level of Bologna) and Graduating Students;
- WP5 – Universities and Research Centres (3rd Level of Bologna) and Graduated Students and Post-Doctoral Researchers
- WP6 – Companies and Employees.

Together they offer a complete view of the air transport and aeronautics sectors. Accordingly, each deliverable only reports the findings of the respective WPs, therefore it provides a segmented description of the sectors. In order to obtain the full picture the reader is required to read the three deliverables. WP5 is focused on the education and formation for researchers (3rd Bologna Cycle). As such, the purposes and task structure of this WP closely follows the previous WPs, but WP5 is aimed to i) to identify the current offer (supply) of educational programmes (3rd Bologna Cycle) in air transport and aeronautics, ii) to perform a review of the educational curricula of those programmes , and iii) to identify the expected portfolio of researchers' competences developed as a result of the educational process. Like WP4, WP5 will also closely interact with WP3 in terms of the overall assessment framework based on competencies' gap assessment, and it will feed the WP7 (i.e., knowledge generated through teaching / courses, students' competencies) for the assessment of Gap 3 and Gap 4, and for the assessment of the attractiveness of air transport and aeronautics industries.

WP5 was divided into three tasks and different activities (Table 1), as follows:

- *Task 5.1: Development of List of Academic Programmes, List of LLL Programmes and Review Templates*
    - Identification of the current Ph.D. Programs at the geographical scale of the EU27

- Owing to budgetary and time constrains, a full list of Ph.D. programs of some important countries like the USA, Canada, Brazil and Australia was not considered.
- This task used different sources to have a detailed list of the most important programs in the EU27.
- At the same time a list of LLL programs was analysed from online survey methods through the proper web sites of each of the universities under analysis. From this analysis it became clear that one of the institutions to be contacted is the European Consortium for Advanced Training in Aerospace (ECATA). The ECATA Consortium is composed of leading Aerospace Teaching Institutes in association with the European Aerospace Industry and it aims at identifying the high level training needs of the Aerospace Industry and jointly developing appropriate training programmes. Academic know-how, experience and knowledge of the profession are combined to organize a range of courses fitted to the needs.
- Regarding the development of the template to include the basic information about the Ph.D. Programmes for subsequent phases, it can be said that it was successfully developed in acrobat and that the template aims to get information about the organization of the programs and a sample of potential interviews for Ph.D. supervisors and Ph.D. doctoral students who have defended in the last five years.

Task 5.1 was led by ULPGC.

- *Task 5.2: Development of Survey Questionnaires*
  - Finalization of (Online) Survey Instruments.
  - List of Ph.D. supervisors to be surveyed.
  - List of Ph.D. doctoral candidates to be surveyed.
  - Identification of Contact sources / Details for the survey.
  - Implementation / Running of the survey.

  Task 5.2 is led by ULPGC with contribution from AUEB-RC/TRANSLOG, IST, TUD and UA on the implementation of Task 5.2 survey.

- *Task 5.3: Data Analysis and Final Synthesis*
  - After the finalization of (Online) Survey Instruments the data analysis and final synthesis will be developed by ULPGC and the contribution of the rest of the partners.

Task 5.3 is led by ULPGC with contribution from AUEB-RC/TRANSLOG, IST, TUD and UA.

Table 1. WP5 - Activities and responsibilities

Tasks	Activity	Responsible partner
T5.0	Preparation of D5.9 Interim Report (Workplan and Methodology)	ULPGC
T5.1	Development of List of Academic Programmes	ULPGC
T5.1	Development of List of LLL Programmes	ULPGC with contribution from all WP4 partners
T5.1	Development of Review Templates	ULPGC
T5.2	Development of Survey Questionnaires	ULPGC in cooperation with WP3 Leader (UA)
T5.2	Development of List of Department Heads & Academic Staff (incl. contact details)	IST and ULPGC with contribution from AUEB-RC and UA
T5.1/5.2	Implementation of Review / Survey	All WP5 partners
T5.1/5.2	Documentation of Review / Survey Results (incl. submission of completed review templates and survey questionnaires)	ULPGC with contribution from all WP4 partners
T5.3	Data Analysis & Final Synthesis	ULPGC with contribution from all WP4 partners
T5.3	Preparation and Submission of D5.9 Deliverable	ULPGC with contribution from IST

This report is structured in 6 sections, each one dedicated to a specific topic and task of EDUCAIR in general and WP5 in particular, as follows:

- **Section 1**, the present one, introduces the reader to the contents of the report and provides a description about the WP5 including: objectives, scope, tasks and rationale.
- **Section 2** provides an overview about the objectives, scope and rationale of EDUCAIR project, frames WP5 within EDUCAIR project (that is, clarifies the relationships with the remaining WPs);
- **Section 3** describes the important elements of the educations offer regarding the third cycle of the Bologna Process, that is the Doctoral Programs in aerospace, air transport and aeronautics;
- **Section 4** describes the structure of the surveys conducted in EDUCAIR, in general, and in WP5, in particular, and presents the results.

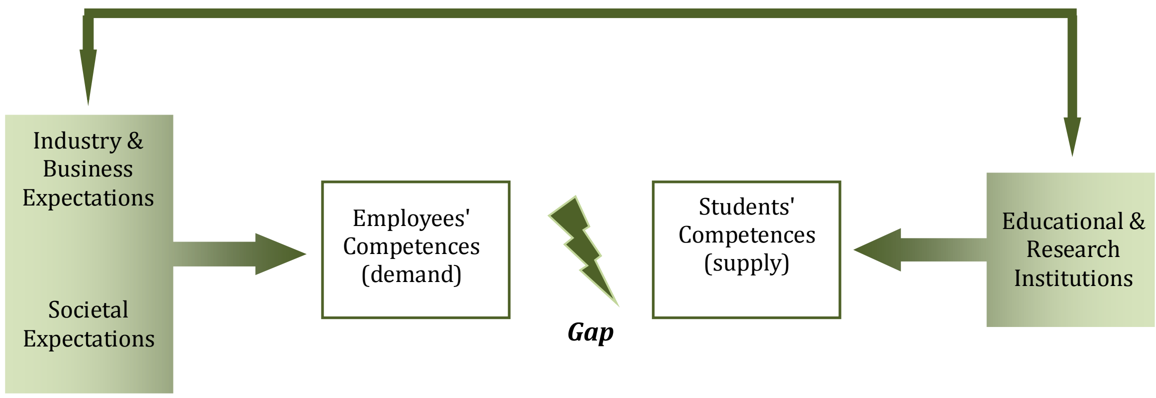
- **Section 5**, the final section, concludes the report.

2 EDUCAIR Project

2.1 Objectives

The recent dynamics and evolutions have indisputably brought changes in the demand of professional competences for working in air transport- and aeronautics-related professions. Arguably, the very nature of the professional competences has evolved in parallel with the progressive modification in economies, societies and, ultimately, in the air transport systems. As such, we are led to conclude that prospective employees have to master the current (and ideally future) competences if they aspire becoming competent professionals. Since prospective employees are firstly students, then this entails that universities and other education institutions have to permanently update the courses and the curricula.

In face of the constant changes, there is a real risk of mismatch between the prospective employees' competences and the market's actual requirements. And if such mismatch is not addressed, there is the danger of creating a significant competence gap that will inevitably affect the competitiveness and efficiency of the European air transport and aeronautics sectors (Figure 1).



Source: EDUCAIR(212)

Figure 1 - Potential competence gap

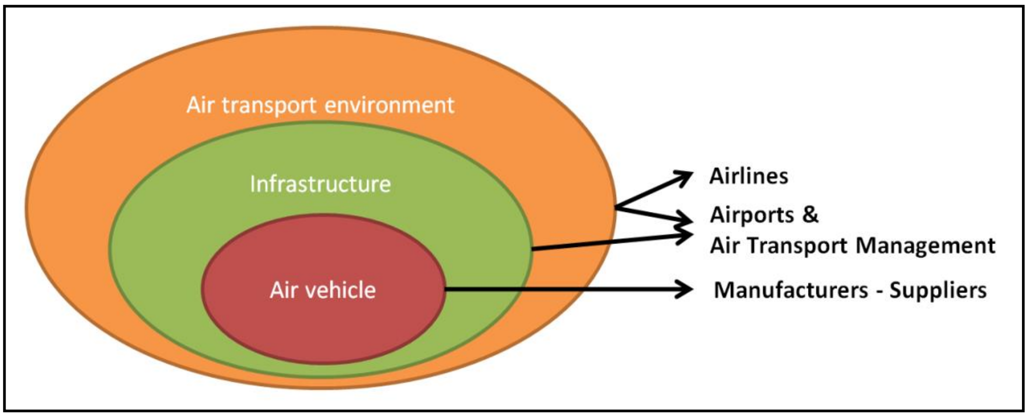
EDUCAIR project aims to improve the match between needs in human resources and the educational and training offer of skills across the Europe Union. EDUCAIR will identify the air transport and aeronautics needs in terms of staff training and education in the horizon of 2020, in order to recommend improvement in the current educational offers.

2.2 Scope

2.2.1 Demand Side

The demand side refers to the labour market that recruits the graduated students in air transport and aeronautics. Owing to time and budget restrictions, EDUCAIR's scope was limited to the key sectors of the market. These sectors correspond to the large majority of the demand, basic demand and the derived demand for educated staff. Foremost, EDUCAIR will only focus on the civil aviation labour market, and restrict the geographical coverage to EU27.

EDUCAIR's demand side scope is illustrated in Figure 2. EDUCAIR focuses on four sectors, being: manufacturers and suppliers of air vehicles, airports, airlines and companies that deal with air transport management. It is also important to add that air vehicles comprise aircraft as well as helicopters, but the latter goes beyond the scope of the project.



Source: EDUCAIR (2012)

Figure 2 - Demand side of the aviation market which will be studied by the EDUCAIR project

At the lowest level, there is the air vehicle. Design and construction of the air vehicle on the one hand and the maintenance of the air vehicle on the other hand can be distinguished. A large fraction of airline costs and activities are related to Maintenance, Repair and Overhaul (MRO). Some airlines do MRO themselves, other use MRO suppliers or rely on the OEM (Original Equipment Manufacturers). Often, there is a combination of all three.

However, as the aeronautics and air transport sector is more than only the aircraft, we have to broaden the view and, in first instance, also look at the necessary infrastructure and infrastructure management, as well as infostructure, that is needed by the sector, such as airport landside and airside infrastructure management and air traffic control navigation and communication air infrastructure. General air transport management cannot be ignored in this analysis. Air transport management influences the aviation environment, the aircraft specific domains and the infrastructure and makes sure that the different domains and layers work well together.

The third layer comprises the air transport environment. This environment contains aircraft operations and training, the airport operations, air traffic management and the air transport companies (airlines). It is important to add here, that, next to the air traffic management, there is also the management of the aircraft design, development, testing, certification, production and new versions along the entire life cycle. Managing an aircraft development and production programme is far more complex than managing an airline or airport and should not be omitted or ignored. For example, is it generally known that developing a new airliner costs around ten billion euros; the production of a thousand is worth 100-250 billion euros and life-cycle costs are much higher (Airliner, 2012, several articles). Development takes five to six years, production may span ten to twenty years in different versions and lifetime can be over 40 years. The process involves hundreds of suppliers at four or five levels. Therefore, the technical managers are often senior engineers after some years of experience and aircraft and equipment producers also employ economists, personnel managers etc.

2.2.2 Supply Side

The supply side refers to the higher-education and long life learning institutions that provide formation in air transport and aeronautics. In EDUCAIR the universe of European Union institutions was narrowed down to the universities offering engineering education programmes on the 1st and 2nd level of Bologna. For the education on the 3rd level of Bologna (i.e. PhD programs) and the post doc research, also other educational areas are analysed, for example management/business economics, law, economics/public policy. In addition, lifelong learning programmes (vocational or professional or corporate training) which are more focused on tactical learning, on acquiring specific skills for immediate use are also includes. In particular, those leading up to obtaining a license in the air transport sector, such as Pilot, Air Traffic Controller, Aircraft Maintenance Mechanic, Aeronautical Station Operator or Flight Operations Officer). Table summarizes the various supply entities that will be covered by the EDUCAIR project.

2.3 Rationale

To explore the sources and extend of the competence gap, the assessment framework presented in Figure 3 will be used. The framework is based on two core concepts, being: *competence and knowledge*. Competence may be understood as the ability to retrieve the *right* skill from our mental *warehouse* of skills to solve some problem. The more adequate our skill is to solving the problem, the higher our competence will be. Knowledge, on the other hand, may be understood as the information, understanding and skills of someone on some domain. A person's competence depends on the ability to pin-point in her body of knowledge the adequate skill to do something. Naturally, if there is no knowledge or the skill is not correctly identified, then the person's competence is affected.

Table 2: Overview of levels and types of education concerning Air Transport and Aeronautics

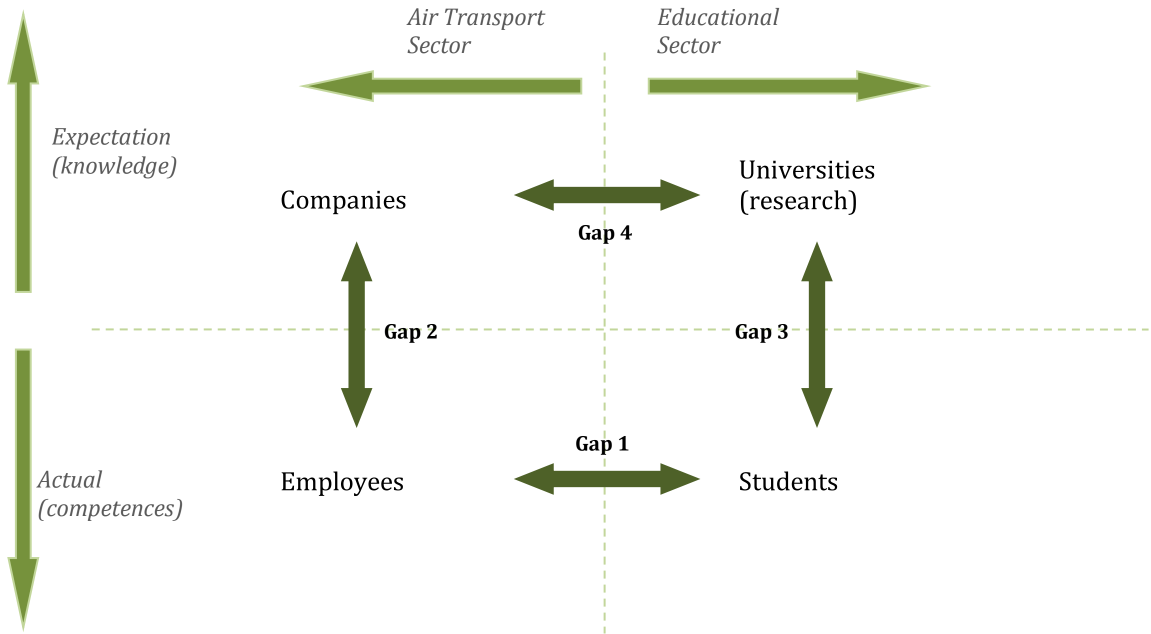
	Level of education	**Type of education**
Academic: University	1st and 2nd cycle of Bologna	Engineering
	3rd cycle of Bologna	• Engineering • Management/ Business Economics • Law • Economics/ Public Policy
	Research (post-doc)	• Engineering • Management/ Business Economics • Law • Economics/ Public Policy
Non-academic: Lifelong learning	Vocational programmes (licenses)	License programmes mentioned above
	Professional programmes	Engineering

Source: EDUCAIR(2012)

Looking again to Figure 1 and using this assessment framework, we may identify the four gaps and better understand the positioning and origin of the Competence Gap (Gap). Figure 4 identifies the four gaps. Using the concepts of competence and knowledge, and analysing from two perspectives – industry (demand) and educational institutions (supply) – the assessment framework presented in Figure 3 identifies four gaps, being:

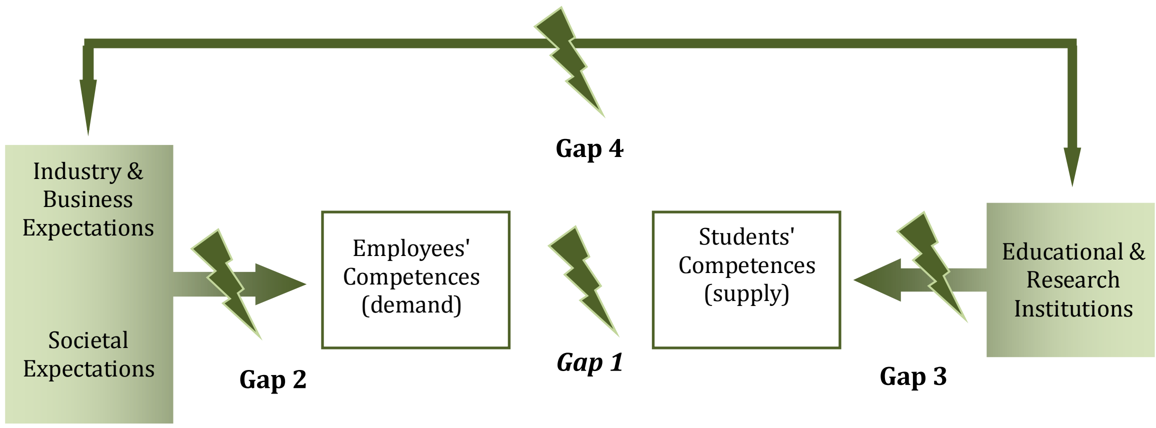
- **Gap 1** - Competence Gap - Gap between the competences that the employees need and the actual competences of the students (i.e. to what extend are the student's competences actually useful in their working daily activities?);
- **Gap 2** - Gap between the knowledge that the companies need and the actual competences of the employees (i.e. to what extend do the employees' competences actually fit in their companies' competences requirements?)
- **Gap** 3 - Gap between the knowledge the universities generate and the actual competences of the students (i.e. is the knowledge generated in the research transferred in the courses?)

- **Gap 4** - Gap between the knowledge the companies need and the knowledge the universities have (i.e. is the universities' research and teaching activities of relevance for the companies?)



Source: EDUCAIR (2012)

Figure 3 - The four gaps framework



Source: EDUCAIR (2012)

Figure 4 - Competence Gaps

A detailed description on the various competence gaps can be found in Deliverable 3 of EDUCAIR project (EDUCAIR, 2012).

Figure 5 presents EDUCAIR's overall methodological approach to assess the four competence gaps. The methodological approach is divided into three stages, being:

1. **Conceptual development** of the competence gap framework and **Identification of the key competence** – already done in WP3;
2. **Collection of information** (relevant stakeholder's views and perspective) on the current state of those competences - done in WP4 , WP5 and WP6
3. **Competence Gap assessment** - cross comparison between the *demand* side and the *supply* side for those competences – done in WP6 and WP7, and to be done in WP8.

The first stage corresponded to the identification of the key competences in the various relevant stakeholders (that is, companies, employees, universities and students) that led to the conceptual development of the Four Gaps Framework. This part was developed and completed in WP3 (See Deliverable 3 (EDUCAIR, 2012). The design of the survey included the elaboration of four questionnaires that were structured to allow assessing the competences gap (more information about the survey can be found below in Section 5 and in the Deliverables 4 and 5). To complement and validate the surveys a set of interviews, meetings and other desktop research was conducted. Upon completion of this second stage, the surveys were disseminated and the interviews and meetings were conducted. Finally, the information from the surveys and other sources were compiled and compared. The assessment of the competence gaps was done through the analysis and cross comparison between the *demand* and the *supply* side on each gap.

The present deliverable describes the results of the tasks conducted under WP5. This work package is focused on the education and formation for researchers (3rd Bologna Cycle). As such, the purposes and task structure of this WP closely follows the previous WPs. WP5 is aimed to i) to identify the current offer (supply) of educational programmes (3rd Bologna Cycle) in air transport and aeronautics, ii) to perform a review of the educational curricula of those programmes , and iii) to identify the expected portfolio of researchers' competences developed as a result of the educational process. Like WP4, WP5 will also closely interact with WP3 in terms of the overall assessment framework based on competencies' gap assessment, and it will feed the WP7 (i.e., knowledge generated through teaching / courses, students' competencies) for the assessment of Gap 3 and Gap 4, and for the assessment of the attractiveness of air transport and aeronautics industries. The scope of the deliverable (and WP5) corresponds to the green shadow in Figure 5.

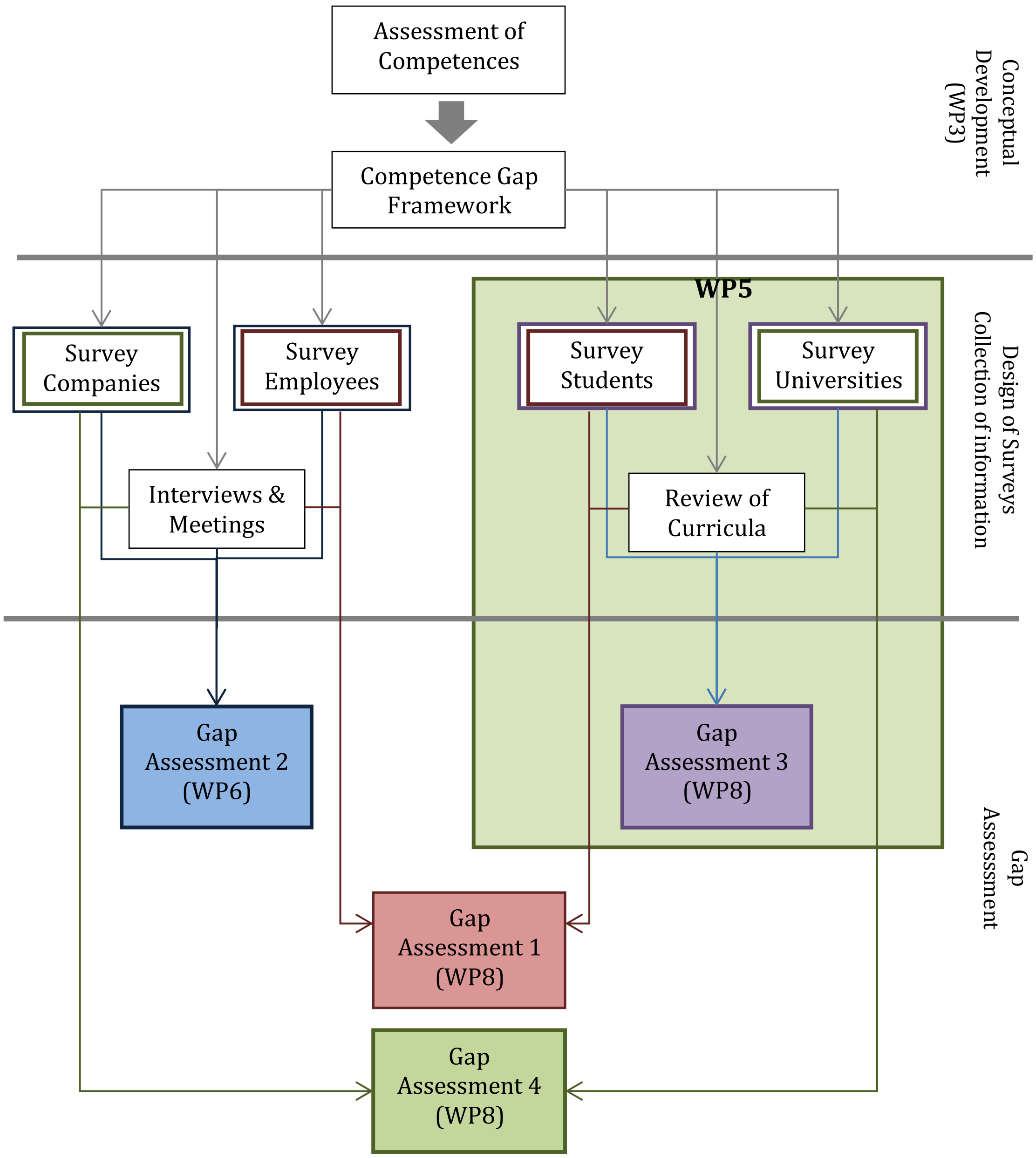


Figure 5 – EDUCAIR rationale for assessing the competence gaps

3 Educational Offer

3.1 Introduction

Universities fully recognise that they have the responsibility to offer doctoral candidates more than core research disciplinary skills based on individual training by doing research. From various surveys on career paths of doctoral graduates carried out either at national level or institutional level, it is evident that doctoral graduates often lack skills needed in industry or enterprise. Ahola and Kivinen (1999) emphasized that in industry and commerce, unlike in academia, a doctoral thesis is not seen as evidence of employability. Universities are certainly most aware of this fact and are increasingly introducing courses and modules offering transferable skills training and preparing candidates for careers in various sectors. However the financial crisis that is affecting unevenly to the European countries is posing additional challenges resulting from the consequences of structural change (especially decreases in financing of the higher education and research sectors and the impact of "brain drain").

The air transportation industry has increased its share of overall passenger transport and cargo traffic over the last decades. Numerous studies have shown that air transportation makes a significant contribution to a country's economic and social development and represents an important engine of economic growth for nations. Daley (2009) summarizes the economic benefits of aviation, finding that it allows companies to expand and penetrate other markets, it contributes to corporate specialization by generating scale economies and stimulating direct foreign investment, and there are also social benefits in terms of workforce mobility, leisure travel and cultural exchanges, amongst others.

The deregulation of airspace has meant that low-cost carriers (LCC) have expanded since 1977 with the deregulation of US air freight, followed by passenger airlines in 1978. Alamdari and Morrell (1997) and Button et al. (2007) reported similar changes in Europe since the mid-1990s. Governments and internationals organizations that regulate the industry are increasingly concerned about different issues, such as the impact of LCC on the competitiveness of other aspects of the airline industry, the prominent role that processes of airport privatization will play in the future.

Gineis et al. (2012) examine the extent of interest in the air transportation sector using the systematic literature review (SLR) approach[1] taking into account the number of citations of each of the paper under analysis. However, their approach is not complete as they were only concerned with the management, policy, and economic aspects of the field, not covering part of the more scientific literature that relates to such things as aerodynamics, meteorology, and applied physics which are also important in the context of our project.

Tranfield et al. (2003), Thorpe et al. (2005) and Moustaghfir (2008) have established the criteria for applying SLR to the field of business management and administration. First, a series of

[1] The SLR method originated in the 1990s was initially used in the field of medicine, although more recently it has also been adopted in physical sciences such as systems engineering, and in social sciences such as marketing, tourism, and strategic innovation. It differs from heavily statistics methods such a meta analysis that seek to find common parameter values across studies or moderator variables that can explain differences in the values found.

keywords[2] related to the topics included in the analysis need to be identified and a search criterion for articles needs to be established. Secondly, the databases in which to search for articles need to be selected, for example Scopus or Social Science Citation Index. Once the documents have been identified and selected, the final information according to the impact of the analysis needs to be stored. SLR is useful “for practitioners and managers” because it “helps to develop a reliable knowledge base by accumulating knowledge from a range of studies” (Tranfield et al., 2003).

3.2 Review of Current Educational Offer and Curricula (3rd Cycle Bologna) in Air Transport and Aeronautics

PhD Programmes are gaining increasing importance in the context of the Bologna Process[3] since the Berlin Communiqué (2003) which included doctoral programmes as the ‘third cycle’ following the bachelor and master levels. At the same time, doctoral programmes also form one of the crucial phases of new researchers’ careers and are important drivers in the creation of a Europe of knowledge. The Ministers, after the meeting in Berlin in September 2003, declared that more researchers need to be trained than ever before if the ambitious objectives concerning enhanced research capacity, innovation and economic growth are to be met.

Ministers added an Action Line to the Bologna process entitled “European Higher Education Area and European Research Area – two pillars of the knowledge based society” that underlines the key role of doctoral programmes and research training in this context.

Ministers were conscious of the need to promote closer links between these two pillars: EHEA and the ERA in a Europe of Knowledge and of the importance of research as an integral part of higher education across Europe. For this reason, they consider it necessary to go beyond the present focus on two main cycles of higher education to include the doctoral level as the third cycle in the Bologna Process. They emphasise the importance of research, research training and the promotion of interdisciplinary in maintaining and improving the quality of higher education and in enhancing the competitiveness of European higher education more generally. Ministers call for increased mobility at the doctoral and postdoctoral levels and encourage the institutions concerned to increase their cooperation in doctoral studies and the training of young researchers.

[2] Gineis et al. (2012) included in their analysis, air transport, air transportation, aircraft, aviation, airport, airline, airplane, air traffic, air travel, and aerospace, as the keywords. These keywords needed to appear in the title of the article, in the abstract, or in the keyword list.

[3] On 19 June 1999, one year after the Sorbonne Declaration, Ministers responsible for higher education from 29 European countries signed the Bologna Declaration. They agreed on important joint objectives for the development of a coherent and cohesive European Higher Education Area by 2010.

Strengthening Europe's research capacity is a paramount objective that will be based on research training and research career development. Thus, it is more necessary than ever before to increase the number of highly qualified graduates and well trained researchers as a tool to achieve the best of European potential.

The European University Association (EUA) launched in 2004 a Socrates funded Doctoral Programmes Project to analyse key issues related to structure and organisation, financing, quality and innovative practice in doctoral programmes. 49 Universities from 25 countries were involved in this project showing the commitment of the universities and their desire to contribute directly to the wider policy debate on this important issue.

Governments and universities are both aware of the importance of PhD Programmes and that, universities across Europe need to play an important role in the development of such vision. After the Bologna Seminar (2005) held in Salzburg, a set of recommendations were made identifying the key challenges and main actions to be taken in order to develop doctoral programmes.

From the discussions in Salzburg a consensus emerged on a set of ten basic principles as follows:

1. The core component of doctoral training is the advancement of knowledge through original research. At the same time it is recognised that doctoral training must increasingly meet the needs of an employment market that is wider than academia.
2. Embedding in institutional strategies and policies: universities as institutions need to assume responsibility for ensuring that the doctoral programmes and research training they offer are designed to meet new challenges and include appropriate professional career development opportunities.
3. The importance of diversity: the rich diversity of doctoral programmes in Europe - including joint doctorates - is a strength which has to be underpinned by quality and sound practice.
4. Doctoral candidates as early stage researchers: should be recognized as professionals – with commensurate rights - who make a key contribution to the creation of new knowledge.
5. The crucial role of supervision and assessment: in respect of individual doctoral candidates, arrangements for supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution (and where appropriate including other partners).
6. Achieving critical mass: Doctoral programmes should seek to achieve critical mass and should draw on different types of innovative practice being introduced in universities across Europe, bearing in mind that different solutions may be appropriate to different contexts and in particular across larger and smaller European countries. These range from graduate schools in major universities to international, national and regional collaboration between universities.
7. Duration: doctoral programmes should operate within an appropriate time duration (three to four years full-time as a rule).

8. The promotion of innovative structures to meet the challenge of interdisciplinary training and the development of transferable skills
9. Increasing mobility: Doctoral programmes should seek to offer geographical as well as interdisciplinary and inter-sector mobility and international collaboration within an integrated framework of cooperation between universities and other partners.
10. Ensuring appropriate funding: the development of quality doctoral programmes and the successful completion by doctoral candidates requires appropriate and sustainable funding.

Since the celebration of this seminar, Ministers take note of different Progress Reports commissioned by the Follow-up Group on the development of the Bologna Process and by the European University Association (EUA), as well as of the results of national seminars, which were organised as part of the Higher Education Systems Work Programmes by several member States. Ministers further note the National Reports, which are evidence of the considerable progress being made in the application of the principles of the Bologna Process. Finally, the European Commission and the Council of Europe have developed different actions to support the implementation of the Process.

One of the more relevant issues which is of common agreement among the Member States is that efforts shall be undertaken in order to secure closer links overall between the higher education and research systems in their respective countries. The emerging European Higher Education Area will benefit from synergies with the European Research Area, thus strengthening the basis of the Europe of Knowledge. The aim is to preserve Europe's cultural richness and linguistic diversity, based on its heritage of diversified traditions, and to foster its potential of innovation and social and economic development through enhanced co-operation among European Higher Education Institutions.

It is also of special relevance, the interest shown by other regions of the world in the development of the European Higher Education Area. In particular, there are different collaboration patterns, like for example the Follow-up Committee of the European Union, Latin America and Caribbean (EULAC) Common Space for Higher Education.

Various initiatives have been undertaken to move towards more comparability and compatibility, to make higher education systems more transparent and to enhance the quality of European higher education at institutional and national levels. It has been greatly recommended the initiatives for promoting the co-operation and commitment of all partners - Higher Education Institutions, students and other stakeholders - to this effect.

3.2.1 Quality Assurance

One of the elements with more importance of all within the Bologna Process for establishing the European Higher Education Area, that has been stressed in order to intensify the efforts at institutional, national and European level, is the development of effective quality assurance systems. To give the Process further momentum, Member States commit themselves to promote these systems. It is necessary to step up effective use of these quality assurance systems based on two cycles and to improve the recognition system of degrees and periods of studies.

The quality of higher education is paramount of the setting up of a European Higher Education Area. Thus, Member States commit themselves to supporting further development of quality assurance at institutional, national and European level. They stress the need to develop mutually shared criteria and methodologies on quality assurance.

Therefore, it was agreed that by 2005 national quality assurance systems should include:

A definition of the responsibilities of the bodies and institutions involved; Evaluation of programmes or institutions, including internal assessment, external review, participation of students and the publication of results; A system of accreditation, certification or comparable procedures; International participation, co-operation and networking.

The importance of consolidating the progress made, and of improving understanding and acceptance of the new qualifications through reinforcing dialogue within institutions and between institutions and employers was also underlined. Thus, Ministers encourage the member States to elaborate a framework of comparable and compatible qualifications for their higher education systems, which should seek to describe qualifications in terms of workload, level, learning outcomes, competencies and profile.

Within such frameworks, degrees should have different defined outcomes. First and second cycle degrees should have different orientations and various profiles in order to accommodate a diversity of individual, academic and labour market needs. First cycle degrees should give access, in the sense of the Lisbon Recognition Convention, to second cycle programmes. Second cycle degrees should give access to doctoral studies.

3.2.2 Promotion of mobility. Establishment of a system of credits

Mobility of students and academic and administrative staff is the basis for establishing a European Higher Education Area. Ministers emphasise its importance for academic and cultural as well as political, social and economic spheres. Mobility figures are constantly increasing thanks to the substantial support of the European Union programmes, and there is a common vision to undertake the necessary steps to improve the mobility figures in the future. It is necessary to make every effort to remove all obstacles to mobility within the European Higher Education Area. With a view to promoting student mobility, Ministers will take the necessary steps to enable the portability of national loans and grants.

The important role played by the European Credit Transfer System (ECTS) in facilitating student mobility and international curriculum development has been highlighted in different forums. They note that ECTS is increasingly becoming a generalised basis for the national credit systems. They encourage further progress with the goal that the ECTS becomes not only a transfer but also an accumulation system, to be applied consistently as it develops within the emerging European Higher Education Area.

Ministers agree that the attractiveness and openness of the European higher education should be reinforced. They confirm their readiness to further develop scholarship programmes for students from third countries. Ministers declare that transnational exchanges in higher education should be governed on the basis of academic quality and academic values, and agree to work in all appropriate forums to that end. In all appropriate circumstances such forums should include the social and economic partners. They encourage the co-operation with regions in other parts of the world by opening Bologna seminars and conferences to representatives of these regions.

3.2.3 Evolution of the literature on air transportation in social sciences

Turning specifically to the literature on air transport, Gineis et al. (2012) showed that the number of social science publications in the field has increased; in 2001 there were about 70, this rose to over 100 in 2006 and surpassed 110 in 2008 and 2009. Considering the distribution of these across, they found large differences, with 521 documents in the Journal of Air Transport Management that deals exclusively with air transportation and then is a huge gap compared the next-placed journal, Transportation Research E, with 111 papers, and an even bigger gap with the third-placed journal, Transport Science, with 75 articles. The Journal of Air Transport Management publishes around 49.2% of the articles on air transportation, followed by the Transportation Research series, which includes Parts A, B, D, E and F and accounts for 21.3% of the articles published. Transport Science, Journal of Transport Geography, Journal of Transport Economics and Policy, International Journal of Transport Economics, and Transport Policy together account for 23.9% of salient articles, and the remaining journals only 5.6%.

The authors found eleven sub-areas of air transportation[4]:

[4] These isolated categories were chosen on the basis that the smallest category should account for at least of 2% of the articles.

1. Airports; including articles on airport taxes and infrastructures or different case studies on them.
2. Alliances; including articles on the agreements established between different airlines.
3. Costs; referring to everything related to air transportation costs, including studies on direct operating costs and indirect costs, cost accounting, and capital costs.
4. Environment; this category covers issues such as CO2 and fuel emissions, and acoustic pollution.
5. Finances; articles on the capital structures of airlines, their profitability, productivity, efficiency and development.
6. Management; including articles on various subjects, such as air transport management, the services provided, air traffic, airline crews, industrial policies, maintenance, programs, engineering, and flight scheduling.
7. Models; referring to models and indexes, algorithms and mathematical formulae for calculating variables related to air transportation.
8. Network; everything related to air routes and airspace.
9. Passengers; including articles on issues relating to passenger demand, prices, and airline tickets.
10. Regulation; including articles on the deregulation of the sector, privatizations and transport reforms.
11. Safety; articles concerning passenger health and safety, travel- related diseases and air accidents.

3.2.4 Doctoral Programmes in the EU

EUA (2005) published a report, entitled "Doctoral Programmes for the European Knowledge Society", with the aim to provide EUA members and other stakeholders in higher education and research with a broad view of the current landscape of doctoral programmes in Europe[5]. EUA received the support and mandate from the European Commission's Socrates Programme to investigate the doctoral programmes in the EU. There were forty-eight Higher Education Institutions from twenty-two countries and several individual academics who participated in the project.

Doctoral studies are in a process of change in Europe reflecting the need to adapt research training to meet the challenges of the global labour market, technological advances, new profiles and demands of doctoral candidates, and not least, the policy objectives of European governments. To achieve the ambitious Lisbon objectives, Europe both seeks and needs to increase the number of researchers and research related careers, and doctoral training programmes can be seen as a cornerstone in reaching such a goal.

[5] EUA set itself two main objectives for the development of the project. First, to identify essential conditions for successful doctoral programmes in Europe; and second to promote and encourage cooperation in the development of doctoral programmes at the European level.

3.2.5 Structure and Organisation of Doctoral Programmes

Doctoral programmes represent a crucial part of university education and research. Traditionally, they used to be considered mainly as a gateway to future academic careers. With the rapid increase in the number of doctoral candidates in recent years and major changes in the global labour market, universities face a challenge to reform doctoral programmes in order to adapt to new conditions. The ambitious Lisbon objectives to build Europe as an advanced knowledge-based society, and to increase its competitiveness, have to be reflected in changes in the European higher education and research sectors if these objectives are to be met.

Doctoral training is quite different from the first and second cycles of higher education in that its premise lies in the production of new knowledge through original research. It is certainly clear though that doctoral training in Europe is experiencing a necessary period of reflection and change, and that innovations and reforms are underway at both different levels and paces in university institutions.

The organisation of doctoral programmes shows a large diversity not only across different countries in Europe, but also across universities within the same country and across faculties within the same university. In some countries, regulations for doctoral programmes are set up at the national level and universities follow such legal requirements. In other countries, university autonomy is much greater and the organisation of doctoral programmes is entirely under the university's responsibility.

Diversity of research and educational traditions and variety of approaches towards organisation of doctoral programmes, on the one hand, can be seen as a European strength. However, universities often do not have common institutional strategies, rules and regulations towards doctoral programmes, and organisation is left to the responsibility of faculties or departments. This can cause fragmentation of doctoral training and inhibit the creation and support of an adequate research environment. Having a common framework, clearly defined in the guidelines, codes and regulations at the highest institutional level that provide detailed rules on recruitment, supervision, exams, evaluation and defence of the thesis would seem to be a highly beneficial and innovative approach for universities in Europe. Administrative management of doctoral programmes at the university (not faculty) level and open access to common regulations on university websites play an important role in the organisation of doctoral programmes and enhances transparency of the whole process.

The structure of doctoral training can be characterised as two approaches that commonly co-exist with each other in individual countries throughout Europe.

1. An individual study programme based on an informal to formal working alliance between a supervisor and a doctoral candidate (an apprenticeship model, sometimes described in a less complimentary way as a "master-slave" relationship) with no structured coursework phase;

2. A structured programme organised within research groups or research/graduate/doctoral schools with two phases: a taught phase (mandatory and voluntary courses or modules) and a research phase.

However, there is an increasing tendency in many European countries towards structured programmes with doctoral candidates grouped in research/graduate/ doctoral schools. These entities, however, cannot be described as conforming to only one organisational model. They are run either at institutional level as mono-disciplinary or multi- disciplinary graduate schools, or through closely- connected departments, research groups, and other research milieus. In some countries graduate schools are developed under the national umbrella of the Ministry of Education (e.g., Finland or France) or in close cooperation with research institutes and funding organisations (such as the Max Planck Institute or Deutsche Forschungsgemeinschaft in Germany). They help to incorporate doctoral candidates into research teams, projects, excellence centres and clusters of centres. When organised at institutional level, they provide a research environment with a common set of rules and codes of practice for all candidates, which also helps to create similar quality requirements. Research/ graduate/doctoral schools offer structured discipline-specific and generic training in transferable skills and can be open to interdisciplinary approaches and programmes. An additional positive aspect of research/graduate/doctoral schools is the social environment which they provide for doctoral candidates who create a common feeling that they form part of a community of doctoral candidates with similar needs and interests.

3.2.5.1 Training in Core and Transferable Skills

Universities are most aware of the fact that in order to prepare young researchers for different positions both within and outside academia, and to meet the increasingly multiple skill demands of the global labour market, they need to offer a wide choice of courses and modules as a part of structured doctoral programmes. Various forms of training through lectures, seminars, colloquia or summer schools aim to provide: scientific training in core research skills (research methodology and techniques; research management; analysis and diffusion; problem solving; scientific writing and publishing; academic writing in English; awareness of scientific ethics and intellectual property rights; etc.); training in transferable (generic) personal and professional skills and competences (writing and communication skills; networking and team-working; material/human resources and financial management; leadership skills; time management; career management including job-seeking techniques; etc.).

Scientific training in core research skills is usually mandatory, but often offered as a free choice from a range of modules or courses. Training in transferable professional and personal skills and competences is offered more on a voluntary basis, but also as a free choice from different lectures, courses or workshops that are designed to fit the individual needs of doctoral candidates. Training in transferable skills is often organised in the form of short-term blocks of lectures and seminars, or summer schools.

In relation to doctoral training through structured programmes, there was a lack a consensus on the issue of the utility of ECTS (European Credit Transfer System) as the opinions of participating scholars and universities differed. In general, ECTS was considered as a useful tool when used in the structured phase of the programme (courses) and for international mobility modules, but not in the research thesis phase for measuring research progress.

In some European countries teaching is obligatory for doctoral candidates as a part of training in communication and didactical skills (e.g., Hungary, Slovakia, Czech Republic, the Netherlands, etc.). It is important, however, to define an appropriate time limit for teaching duties, and not to use doctoral candidates as a source of cheap labour, a negative tendency which should be avoided.

However, the trend in the new doctoral programmes in the EU is to develop a procedure of producing a Personal Development Plan (PDP) for each individual doctoral candidate. The PDP helps the candidates to recognise and to articulate skills and competences which they acquire throughout the course of completing their studies. The PDP specifies the training schedule in terms of both scientific and generic skills based on crucial needs of each candidate. The document has to reflect all the competences and skills that the doctoral candidates have achieved in the first year of the programme. This practice has started in many European universities under differing titles and formats.

3.2.5.2 Research Groups, Clusters and Networks

Research environment plays an important role in the doctoral candidate's professional and personal development but also in the institutional development of universities. In an increasingly competitive national, European and global framework, it is crucial for universities to focus on achieving a critical mass of doctoral candidates, and on building strong research environments in order to enhance research excellence and international collaboration.

To achieve critical mass of doctoral candidates, new innovative structures of doctoral programmes such as doctoral/graduate/research schools need to be developed. In small countries and universities where an adequate critical mass of doctoral candidates cannot be easily achieved, other models may be developed. High quality research work and training can be acquired through the involvement of active research groups, research clusters and networks. These can be defined in the broadest sense from interdisciplinary to inter- institutional and international groupings. In some countries (e.g., Nordic countries) clustering of doctoral candidates from several regions or even from neighbouring countries has proved to be a good practice in creating critical mass and an active research environment which stimulates research collaboration at regional, national and international level.

Doctoral candidates as young professionals should always be included as partners and co-researchers in research projects and research groups. It is important to develop protocols within such groups providing a description of the contribution of each member including the doctoral candidates. By integrating doctoral candidates into research groups or clusters in this way they become an integral part of the research community, which can enhance their motivation and performance. In this sense, doctoral training aims to provide training by research, not only for research. This approach gives doctoral candidates an extended competence in the specialised research field as well as transferable skills such as solving complex problems, quickly extracting and analysing knowledge, networking, team-working, communication, time and project management, risk and failure management, etc., and hence widens their career perspectives.

3.2.5.3 Duration and funding

A standard timeframe for completion of a doctoral degree was judged to be three to four years in case of full-time studies. A three-year period is generally considered too short and if such a time duration was envisaged in the third cycle of the Bologna Process, big concerns exist related to the maintenance of quality standards. In order to assure high scientific integrity and quality of doctoral training and a higher completion rate, universities would ideally prefer four years full-time and fully-funded doctoral programmes. In any event, it was essential that sufficient time is allocated for the actual thesis work (recommended time is two and a half years).

The duration of doctoral studies is inevitably closely connected with funding. Throughout Europe fellowships and scholarships grants tend to have a three-year limit on funding. As the average completion time of doctoral studies is four years, most candidates have to solve their financial situation by finding a job (often as teaching assistants) at the time when they should fully concentrate on the completion of the thesis.

3.2.5.4 Recruitment, funding and status in Doctoral Programmes

Practices of recruitment vary across universities and countries. There are several methods for the recruitment of doctoral candidates, mostly based on a competition: Entrance examinations and/or an interview; Master degree and good study results (with no entrance exam or interview); Application and a publication (journal article or conference paper); CV plus defence of the research project proposal.

More universities are requiring also a good command of a foreign language from doctoral candidates, most often English as a precondition for mobility and international collaboration requirements in the doctoral programme.

Selection of candidates should be transparent, fair and consistent with well defined institutional guidelines and codes of practice. Selection is usually undertaken by a research/doctoral Committee/Board or by a supervisor or a group of supervisors. Candidates either present their own research proposal or it is identified in consultation with the supervisor(s). The selection of the candidate is based on the candidate's abilities, interest, enthusiasm, the relevance and innovative nature of the research project, and also on adequate funding arrangements. A clear match between the candidate's research project and research experience of the supervisor is crucial.

The recruitment process is completed by preparing and signing a contract between the candidate, the supervisor and the institution in which rights and duties of all parties are clearly defined, and the criteria for assessment and monitoring identified. This practice, used at some universities, provides a sound basis for finding solutions to any problems that may arise during the doctoral studies.

The profile of a doctoral candidate has been changing rapidly in recent years. In the past, a doctoral candidate was, in most cases, a person with a deep interest in research and a future career in academic research and teaching. This is not true anymore, although society still tends to maintain the stereotype of people with doctoral degrees as scholars living in their isolated world of academia. There are still, of course, students who strongly want to pursue their career in academia, but there are a growing number of students who pursue doctoral training for professional knowledge and skill development as preparation to enter other sectors of society: industry, government and administration, medical and health provision, legal and financial services, etc. There are also many students who decide to take up doctoral training for personal development reasons.

The status of the doctoral candidate differs from country to country. The doctoral phase can be seen as the first part of a professional career; doctoral candidates are young professionals – early stage researchers – who are trained through undertaking research and who make considerable contributions to the creation of new knowledge, methods and products. Their status is very closely linked to funding opportunities, country regulations and educational traditions.

Several types of funding arrangements are in practice: grants, scholarships and fellowships (national, regional, EU, public or private, industrial); salaries; self-financing (often in the case of part-time candidates).

Depending on what kind of funding is provided, candidates have the status of a student or the status of an employee - early stage researcher (or a combination of both). Funding usually covers tuition fees connected with education and living costs. Covering full social security costs is still not the case in many countries and hence doctoral candidates are not entitled to pension rights, unemployment benefits or maternity leave. Assuring a greater diversification of financial resources and their management poses a major challenge for universities that offer doctoral programmes and want to achieve a critical mass of doctoral candidates.

3.2.5.5 Supervision, Monitoring and Assessment

Supervision is critically important for the quality of experience and training of doctoral candidates. Supervisory practices are embedded in national cultures and institutional traditions (e.g., hierarchical patterns of the academic profession). The supervisor's role, his/her title and its meaning differs from country to country (e.g., mentor, tutor, promoter, guide, instructor, coordinator, etc.) as do the duties of a supervisor (from irregular contacts when needed, to professional assistance on a regular basis).

Qualification requirements, responsibilities and duties of a supervisor should be clearly defined in institutional regulations at each university and each supervisor should be aware of them. Supervisors' qualifications should include extensive knowledge and research experience in the broad subject area/field of the doctoral candidates' chosen work, and current involvement in research groups and projects preferably with a European and/or international dimension. In most European countries, only academics with a doctorate and a senior tenured position (full Professor or Associate Professor) can be selected as a supervisor.

To increase the awareness of supervisors' responsibilities, some universities produce handbooks, guidelines and codes for supervisors. This approach has become a common and well-developed practice particularly at UK universities. Supervisors are usually responsible og being fully aware of the skills necessary to facilitate the intellectual and personal development of the candidate, his/her training needs and career development perspectives. Regarding this issue, assessments of supervisors usually form a part of the doctoral candidate's regular progress plan/report.

On the issue of the number of doctoral candidates per supervisor, a common average is from four to six candidates but there tends to be no specified maximum limit. In many universities, doctoral supervision forms part of a "workload model" for academic staff which ensures that supervisors allocate enough time for each doctoral candidate.

Universities have clear procedures for monitoring and assessing doctoral candidates, but they differ from one institution to another, according to the content of the doctoral programme and to the academic culture and practices. Usually, monitoring and reviewing of the work plan and timelines for each candidate is carried out every six or twelve months by a supervisor and reported to a doctoral/research committee (or an equivalent academic body) in a progress report.

Good practices used at several universities are: Regular meetings between the candidate and the supervisor, with records being kept by both parties; Regular review stages, which include some assessment independent from the supervisor (e.g., review panels); Feedback from the candidate on the doctoral programme, training and supervision in forms of assessment and evaluation. However, this requirement may be sometimes difficult to achieve due to the nature of the supervisory relationship.

3.2.5.6 Requirements for the Doctoral Thesis and the Defence

The doctoral thesis is a core element of the doctorate and a proof of independent research performance and competence of the doctoral candidate. The main quality requirement for any thesis is that it should produce a new insight or knowledge – an innovation in the field, a new scientific method or an application of a known method to a new field. The thesis should present an original piece of research work and place it in the context of the theoretical knowledge and the literature in the field. The thesis (or at least a part of it) should be publishable in a peer reviewed scientific journal or as a peer reviewed book. However, the time lag between submission and publication in many journals is a major obstacle to achieve this goal.

At many universities, the defence of the thesis presumes the publication of partial results of the candidate's research. The required number of articles in peer reviewed journals varies from one to five. Prior to submission of the thesis, doctoral candidates in many countries have to pass examinations in the discipline and sometimes in a foreign language, and/or a final comprehensive doctoral examination. This is often done at the end of the coursework phase of the studies.

Many universities require a declaration signed by the doctoral candidate that the work (thesis) is based on one's own original research. In the case of a doctoral candidate's active participation in research groups, universities need to ensure clear rules on co-authorship in order to protect the intellectual property of the doctoral candidate as well as that of other members of the research group.

The defence of the thesis is usually public and the information about it is publicly announced prior to the event (minimum ten days before the event). This practice is common in most European countries, except for the UK where the defence of the thesis is private and it is usually organised as an oral examination (a viva) with one internal and one external examiner.

The thesis is reviewed by two to three reviewers who submit written reviews. The thesis defence committee is composed of internal and external professors and experts in the field including the reviewers. The presence of the supervisor in the defence committee is required in some countries and challenged or forbidden in others. It is suggested that at least one member of the committee comes from abroad to ensure an assessment at an international level. Such a practice, although it poses additional financial costs, could contribute to improving quality standards of the doctorate across European countries.

The defence itself consists of the candidate's presentation of main points of his/her research work and thesis, followed by an open discussion between the defence committee and the candidate. The decision is made by the committee in a secret ballot and announced to the audience. There are differences between countries in grading the thesis defence. In some countries (e.g., the Netherlands), it is impossible to fail a public defence. In most countries the candidate can fail but should be entitled to follow a complaint procedure if he/she disagrees with the decision of the defence committee.

3.2.5.7 Last remarks. Tracking, Mobility and European Doctorate

Follow-up and tracking of PhD graduates and their further careers is a challenge for most universities. In order to evaluate the value and efficiency of innovation and reform in doctoral programmes and to provide evidence of the ways in which doctoral candidates use their acquired skills, it will be crucial to track doctoral candidates' subsequent careers. This seems to be an area where more work needs to be done.

Successful mobility is based on close and well-organised international and inter-institutional cooperation. Existing mobility programmes for doctoral candidates take various forms: the European Commission Marie Curie programmes; joint doctoral programmes between university institutions; co- tutelle arrangements; international collaboration amongst research groups; or simply individual research periods abroad. However, mobility is not always recognised and supported as an "added value" and as a part of career development. In some cases, supervisors are not in favour of mobility of their doctoral candidates, for example, where reintegration after a mobility period can be problematic.

The idea of a European Doctorate (European PhD or Doctor Europaeus/Europaea) originated from an informal initiative in 1991 of the former Confederation of European Union Rectors'

Conferences concerning requirements for the awarding of a "Doctor Europaeus". The proposed requirements included: The PhD thesis defence will be accorded if at least two professors from two higher education institutions of two European countries, other than the one where the thesis is defended, have given their review of the manuscript; At least one member of the jury should come from a higher education institution in another European country, other than the one where the thesis is defended; A part of the defence must take place in one of the official languages, other than the one(s) of the country where the thesis is defended; The thesis must partly have been prepared as a result of a research period of at least one trimester spent in another European country.

There are pros and cons of the European Doctorate that need to be further considered. On the one hand, the European Doctorate could be seen as a powerful tool for making the Lisbon objectives more visible and for making the doctoral degree more attractive for young people as a symbol of European research collaboration. On the other hand, it can be questioned what "added-value" a European Doctorate brings to a research doctorate awarded at the university level.

3.3 Air Transport and Aeronautics Doctoral Programmes

It is evident that for the air transport and aeronautics sector characterized by an increased competitive environment there exists a growing awareness of the importance for Europe of increasing its research potential which is mainly interlinked with the third Bologna cycle that are offered at the universities which are the main providers of doctoral programmes in the EU. Thus, the universities are responsible for providing the unique environment in which young researchers are trained by and through research. In the present adverse financial circumstances, this role has to be reinforced in order to prepare the next generation to compete in the global world.

This section provides the results obtained by the questionnaire developed by ULPGC for compiling information for the development of task 5.2. Throughout the web sites of different universities and other vital information obtained from different networks as PEGASUS, EASN, ASD, ECATA and EREA

The PEGASUS network of European aerospace universities was founded in 1998 in Toulouse. The idea of PEGASUS originated from a growing awareness within academia that the European aerospace industry was on the track of a strong concentration with no equivalent in any other industrial sector. PEGASUS was first conceived as a restricted network of the main aerospace universities of the main aerospace countries and their partners, so the initial founding members group was deliberately limited to 20 universities from 8 European countries. In a second phase, PEGASUS has begun to open its membership to more aerospace universities. PEGASUS was born as an initiative of academia to accompany research and industry in their move towards more synergy and effective co-operation.

The European Aeronautics Science Network has as its main long-term goal to built up an open, unique European platform in order to structure, support and upgrade the research activities of the European Aeronautics Universities, as well as to facilitate them to respond to their key role within the European Aeronautical research Community in incubating new knowledge and breakthrough technologies. Any individual with interest in Aeronautics and Aeronautics related research may become a member of EASN. In addition, entities such as Research Establishments, SMEs, Industries and Universities are welcome to join the EASN. EASN is a network involving more than 100 university institutes and research groups dealing mainly with research, possibly in co-operation with other stakeholders.

The AeroSpace and Defence Industries Association of Europe, ASD, represents the aeronautics, space, defence and security industries in Europe in all matters of common interest with the objective of promoting and supporting the competitive development of the sector. ASD pursues joint industry actions which require to be dealt with on a European level or which concern issues of an agreed transnational nature, and generates common industry positions. ASD has 28 member associations in 20 countries across Europe. In 2011 over 2000 aeronautics, space and defence companies in these countries employed more than 730.000 people and generated a turnover of almost €171.5 billion. The essence of the Association is to provide a single platform for the development of joint positions for the industries it represents. Adept at spreading the word regarding new policies and possible legislative development, ASD raises awareness and promotes the values and positions of its members to all EU institutions.

The Institute/Industry ECATA Consortium (European Consortium for Advanced Training in Aerospace), composed of seven leading Aerospace Institutes and the major Aerospace Manufacturers, is widely recognised as one of the leaders in these fields. With a tradition of innovation since its creation in 1988, ECATA has developed a range of courses designed by professionals for professionals. In particular it is quite relevant the annual "Aerospace Business Integration" course which has been attended by engineers and scientists from more than 30 European companies, research centres and government agencies in Europe. ECATA aims at identifying the high level training needs of the Aerospace Industry and jointly developing appropriate training programmes. Academic know-how, experience and knowledge of the profession are combined to organize a range of courses fitted to the needs.

EREA, the association of European Research Establishments in Aeronautics, is a non-profit organisation which gathers Europe's eleven most outstanding research centres active in the field of aeronautics and air transport. These organisations gathered in EREA with the goals to: promote and represent joint interests; intensify the co-operation in the field of civil, military and space-related aeronautics research; improve and intensify the co-operation with third parties in the field of aeronautics, and to facilitate an integrated management of joint activities, thereby contributing to Europe's role as a global player in aeronautics.

Table 3. Universities with Ph.D. Programs in Air Transport and Aeronautics

Member states of the EU (year of entry)	University	Partner
Austria (1995)	University of Applied Sciences Wiener Neustadt	TUD
	Graz University of Technology	TUD?
Belgium (1952)	University of Liège	UA?
	University of Leuven	UA?
Bulgaria (2007)	School of Engineering	IST?
	Vasil Levski National Military University	IST?
	Technical Unoiversity of Sofia	IST
Cyprus (2004)		NA
Czech Republic (2004)	Czech Technical University in Prague	TUD
	Brno University of Technology (Czech Republic)	TUD
Denmark (1973)		NA
Estonia (2004)		NA
Finland (1995)	University of Jyvaskyla (Finland)	NA
France (1952)	Ecole National de l' Aviation Civile (France)	ULPGC
	Institut Supérieur de l'Aéronautique et de l'Espace (France)	ULPGC

Member states of the EU (year of entry)	University	Partner
	University of Toulouse (France)	ULPGC
Germany (1952)	RWTH Aachen University (Germany)	AUEB
	Technical University of Munich (Germany)	TUD
	Technical University of Berlin (Germany)	TUD
	Technical University of Braunschweig (Germany)	AUEB
Greece (1981)	Aerospace Engineering University in Patras, Greece	AUEB
Hungary (2004)		NA
Ireland (1973)	Aerospace Engineering University in Limerick, Ireland	ULPGC
Italy (1952)	Polytechnic University of Milan (Italy)	IST
	University of Padova (Italy)	AUEB
	University of Pisa (Italy)	IST
Latvia (2004)		NA
Lithuania (2004)		NA
Luxembourg (1952)		NA
Malta (2004)		NA
Netherlands (1952)	Delft University of Technology	TUD
	Inholland University of Applied Sciences	TUD?
Poland (2004)	Rzeszów University of Technology (Poland)	ULPGC

Member states of the EU (year of entry)	University	Partner
	Warsaw University of Technology (Poland)	ULPGC
	University of Technology Poznan (Poland)	NA
Portugal (1986)	Instituto Superior Técnico (Portugal)	IST
	Universidade Da Beira Interior (Covilha)	IST
Romania (2007)	Politehnica University of Bucharest	IST
	Technical Military Academy of Bucharest	IST
Slovakia (2004)		NA
Slovenia (2004)	University of Ljubljana	IST
Spain (1986)	Polytechnic University of Madrid (Spain)	ULPGC
	Carlos III University of Madrid	ULPGC
	Polytechnic University of Valencia	ULPGC
	Universidad de Sevilla	ULPGC
	Universidad de León	ULPGC
	Universidad Politécnica de Catalunya	ULPGC
Sweden (1995)	KTH Royal Institute of Technology (Sweden)	UA
United Kingdom (1973)	Cranfield University (UK)	ULPGC
	Imperial College (UK)	IST
	Loughborough University (UK)	IST
	University of Barh	IST

Member states of the EU (year of entry)	University	Partner
	University of Herfordshire	ULPGC
	University of Bristol	IST
	University of Glasgow	IST
	Loughborough University (UK)	IST
	University of Westminster (UK)	IST?
	City University London (UK)	IST
	Brunel University (UK)	IST
Source: Own elaboration		

Table 3 shows the list of the universities of the EU27 to be surveyed and the responsible partner to complete the task 5.2. The questionnaire can be consulted in the annex. As it can be seen, the questionnaire was divided in different parts that resemble the sections discussed above. Our intention was to dispose of certain information that allows us to evaluate the Ph.D. Programs of the EU27.

In the first part of the questionnaire, basic information of the responsible staff is asked such as, the name of the program, Director, email, Secretary, email. Then we ask whether the program consists of some teaching modules. If we obtain a positive answer we ask about the number of modules, names and if possible list of competencies acquired.

The second part of the questionnaire was dedicated to gather information about the structure of the programme, whether the program was developed and controlled by one department, interdepartmental, Doctoral School, a European Joint Programme or under other circumstance. We also obtain information about if research groups are involved; the grade of collaboration and cooperation with the industry; the length of the programme in years; and finally the fee in euros.

A third part is devoted to obtain the following information: (1) the recruitment Criteria or how the candidates are selected (Master, CV, Personal Statement, Ph.D. proposal and Other); (2) the Funding Scheme (Percentage of students with grants or fellowships); (3) Status of Doctoral Candidates with grants (Student, Employee, Researcher and other).

In the final part of the questionnaire we ask the respondents about: (1) the process for monitoring and assessment; whether the students need to fill some forms that need to be validated by the supervisor or the university provides some on-line students Logs and websites;

(2) the implication for supervision; in this item we obtain if there exists some other qualification requirements beyond being a Ph.D.; whether the duties are clearly stated in a code; and if there exists some workload (hours) for the duties of the supervisors; (3) a list of supervisors in the last five years which is quite important for the next step of the surveys of universities; (4) the requirements for the Doctoral Thesis; whether there is a need to have a number of ISI Papers published, a number of papers published, an external Commission or a supervisor; (5) requirements for the Defense, whether there exists some rule about the configuration of the number of the members Committee; if there exists a public or private session; if the mark is obtained by unanimous judgment or emitted in a private ballot; and if the candidate can fail in the act of the defense; (6) the system to track the Ph.D. Graduates; the number of Ph.D. Graduates in the last 5 years with a list of dissertations and contact email if possible; (7) the efficient ratio calculated as "# PhD Graduates / # PhD Candidates in the five-years cohort".

First of all we really need to acknowledge the efforts made by our partners and the respondents who have shown a maximum disposal to cooperate with this task. Unfortunately from the list of 25 potential respondents for the survey, we finally got 13 valid surveys. In most of the cases, the partner involved contact the head of the programs directly by phone. In particular we would like to acknowledge the following institutions and respondents for their generosity in the time dedicated to this activity.

- UNIVERSITY: RWTH Aachen University
- NAME OF THE PROGRAM: Faculty of Mechanical Engineering Doctoral Studies
- DIRECTOR: Professor Robert Schmitt, Dean of the Faculty of Mechanical Engineering
- SECRETARY: Ms. Monika Dahmen-Göbbels, Mr. Philip Miessner

- UNIVERSITY: Technical University of Braunschweig, Department of Mechanical Engineering
- NAME OF THE PROGRAM: PhD Program of the Department of Mechanical Engineering
- DIRECTOR: Professor Arno Kwade (Department Dean)
- SECRETARY: Ms. Stefanie Werner

- UNIVERSITY: University of Patras, Department of Mechanical Engineering and Aeronautics
- NAME OF THE PROGRAM: Ph.D. Program in Mechanical Engineering and Aeronautics
- DIRECTOR: Professor Spiros Pantelakis (Head of Department)
- SECRETARY: Mr. Andreas Vasilakis

- UNIVERSITY: KU Leuven

- NAME OF THE PROGRAM: Ph.D. in Engineering (Mechanical Engineering or Materials Engineering)
- DIRECTOR: Dirk Vandepitte

- UNIVERSITY: Technical University of Madrid (UPM)
- NAME OF THE PROGRAM: Doctorado en Ingeniería Aeroespacial
- DIRECTOR: J. Peláez
- SECRETARY: M. Guijarro

- UNIVERSITY: Technical University of Catalunya (UPC)
- NAME OF THE PROGRAM: Ciencia y Tecnolología Aeroespacial
- DIRECTOR: Eduard Bertran
- SECRETARY: Antonio Gálvez

- UNIVERSITY: Polytechnic University of Milano
- NAME OF THE PROGRAM: Aerospace Engineering
- DIRECTOR: Sergio Ricci
- SECRETARY: Laura Lupano

- UNIVERSITY: University of Pisa
- NAME OF THE PROGRAM: Aerospace Engineering
- DIRECTOR: Prof. Luigi Lazzeri
- SECRETARY: Dr.ssa Sara Andrenucci

- UNIVERSITY: University of Beira Interior (Covilhã, Portugal)
- NAME OF THE PROGRAM: Aeronautical Engineering
- DIRECTOR: Prof. Jorge Manuel Martins Barata

- UNIVERSITY: University of Bristol
- NAME OF THE PROGRAM: Aerospace Engineering
- DIRECTOR: Professor Christian Allen

- UNIVERSITY: University of Glasgow
- NAME OF THE PROGRAM: Aerospace Engineering
- DIRECTOR: Dr. Douglas G. Thomson

- UNIVERSITY: Instituto Superior Técnico
- NAME OF THE PROGRAM: Aerospace Engineering
- DIRECTOR: Prof. Doutor Luís Manuel Braga da Costa Campos
- SECRETARY: Prof. Fernando José Parracho Lau

- UNIVERSITY: Imperial College (UK)
- NAME OF THE PROGRAM: Aeromechanics of Micro Air Vehicles
- DIRECTOR: Dr Rafael Palacios

It is evident that the respondents are highly biased by the contacts that partners have in the respective universities. Unfortunately some key players at the European level as Cranfield University and Technical University of Delft did not respond to our questionnaire. However, we think that our results can be considered a valid sample as more that the fifty percent of Ph.D. graduates in the Pegasus networks belong to the universities of our sample. Other significant contributors to education and training, such as industry training programs, e.g. ECATA professional courses will be analyzed in another section. Due to the deadlines and scarce resources a better analysis has not been possible in which we could analyze why some potential respondents were not finally available to cooperate with this investigation.

Nevertheless, it is interesting to remark some common features that doctoral programs present as in the last decades, air transport, aeronautics and aerospace has been characterized as one of the most research-intensive industrial sectors in developed countries. In some cases the activities for R+D achieve percentages near the 30% of the overall revenues - a much higher percentage than in any other high-tech sectors. Consequently, the need of the evaluation of the Doctoral Programs in the EU27 is even more needed than in the past, because talented young engineers and scientists have become an indisputable competitive advantage for the companies which contract them. The competition for the most brilliant doctoral students is part of a race at a global scale, with aerospace companies trying to attract the best, high-potential employees not only from their home universities but from everywhere. This competition has become even more acute at a time when the motivation for long, hard scientific studies is decreasing among the young people in developed countries.

The data collected will be presented following the same structure of the questionnaire and having in mind that we will use Exploratory Data Analysis (EDA) as a pragmatic approach for the analysis of the data, in which tables and graphical analysis will be used as principal instruments of analysis. EDA is more than an approach and a set of techniques, it can be considered as an attitude or a philosophy about how a data analysis should be carried out. Sometimes EDA and statistical graphics are used indistinctly for being rooted in the graphical analysis. However, EDA embraces more a philosophy than a mere set of techniques; the importance gains some terrain to the techniques regarding how we dissect a data set; what we look for; how we look; and how we interpret. It is true that EDA heavily uses the collection of techniques that we call "statistical graphics", but it is not identical to statistical graphics per se[6].

3.3.1 First part of the questionnaire. Teaching modules

Figure 6 shows that 62 percent of the doctoral programs under analysis have some teaching modules. However, in-depth analysis of the surveys show that the figure has to considered with caution, as in most of the European countries teaching modules are not anymore mandatory for doctoral programs, as these are largely based on previous specific master courses. It is for the students whose provenance is not any master course in aeronautics, aerospace or air transport for whom these modules are compulsory and the doctoral commission designs some individual teaching activities for each candidate.

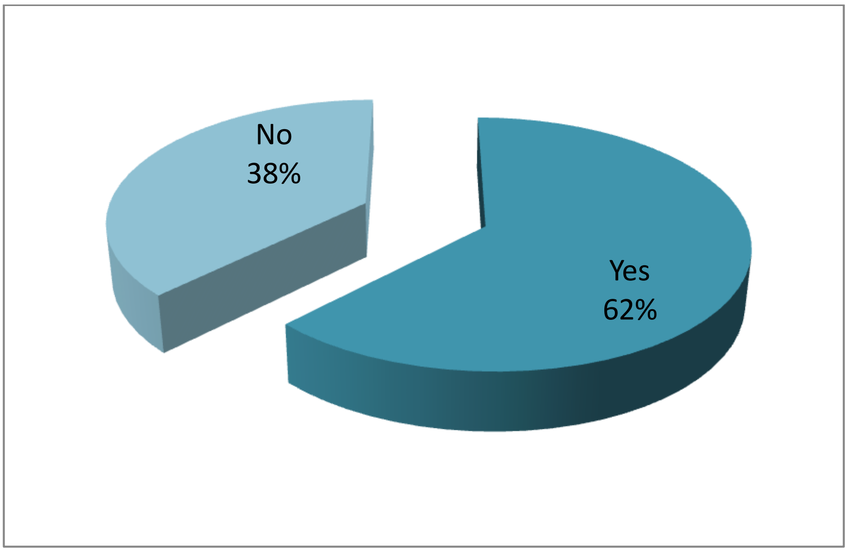


Figure 6. Teaching modules

This routine allows other candidates to concentrate their time in pure activities of research, the ultimate goal for the existence of doctoral programs. In any case, teaching activities are usually grounded in some master programs of the university in which teaching is usually based on some modules which can be taken in one or two weeks periods; thus candidates dispose of the rest of the time largely free of structured teaching for more independent learning, reflection and research. Normally, candidates need to submit a thesis proposal in order to be accepted in the program.

[6] For a better understanding, the reader is referred to Tukey (1977)

Table 4 shows the list of the teaching modules of the doctoral programs of the universities, but it is necessary to keep in mind what we said above about the mandatory character of these modules only for some candidates who have not studied any master in the related field: air transport, aeronautics or aerospace. In essence, these compulsory teaching modules courses are an additional requirement only for students without a prior, relevant engineering degree. In addition, there are very specific teaching modules which are only relevant to some special fields or departments within the Ph.D. program, e.g., aeronautics and astronautics.

Depending on the candidate, the Commission of the Ph.D. Program can assign up to 8 courses in extreme and rare occasions. This specific and individual program is normally agreed between the candidate, supervisor and the Commission.

The list of teaching modules, as said, are usually based in some master and graduate courses of the department which offered the Ph.D. program and they are usually split according to the following categories: core subjects, relevant discipline subjects and other subjects.

Table 4. List of teaching modules of Doctoral Programs

Core Subjects
Engineering Mathematics III
Engineering Mathematics IV
Thermodynamics
Engineering Mechanics II
Design and Calculation of Complex Machine Parts
Control Systems I
Basics of Product Development and Design
Required Courses
Aircraft Design 1, 2
Flight Mechanics 1
Flight Measurement
Engineering Theories of Lightweight Construction
Mechanical Behavior of Materials
Space Technology 1
Control Engineering Fundamentals 1
Wing Aerodynamics
Electives
Adaptive Systems 1, 2
Aerodynamics of the engine components 1, 2
Aeroelasticity 1, 2
General Numerical Methods
Analytical Methods in Materials Science
Bionic Computational Methods 1, 2
Computer-Aided Optimization of Static and Dynamic Systems
Damage Tolerance and Structural Reliability
The Human Machine Interface in Airplane Cockpit
Introduction to Measurement
Introduction to Numerical Methods in Aerodynamics

Introduction to Satellite Aerodynamics Development and Project Management 1, 2 Composites Finite Element Methods 1, 2 Flight Guidance Systems Flight Mechanics 2, 3 Flight Control 1 Fundamentals of Aeroacoustics Fundamentals of Air Traffic Control Fundamentals of Continuum Mechanics Fundamentals of Product Development and Construction Configuration Aerodynamics Construction of Aircraft Structures Corrosion of Materials Lightweight and High Temperature Materials Aviation and Space Medicine Management of Software Development Projects Mathematical Methods in Engineering Mechanical Behavior of Materials Measurement Methods in Fluid Mechanics Meteorology Methods of Aeroacoustics Microtechnology New concepts in Air Traffic Management Numerical Simulation of Technical Systems Numerical Analysis in Aerodynamics Product Modeling and Simulation Profile Aerodynamics Space Technology 2, 3, 4, 5 Satellite Navigation Turbomachinery 1, 2, 3 Flow Measuring Technology Technical Reliability Thermodynamics of Mixtures Turbulence and Transition Experimental Techniques in Satellite Aerodynamics
Source: Own elaboration

3.3.2 Second part of the questionnaire. Structure, industry participation, fees and length

It can be seen in Figure 7 that regarding the structure of the program, 38 percent of the doctoral programs are developed under the umbrella of the doctoral school and 62 percent are under the control of individual departments.

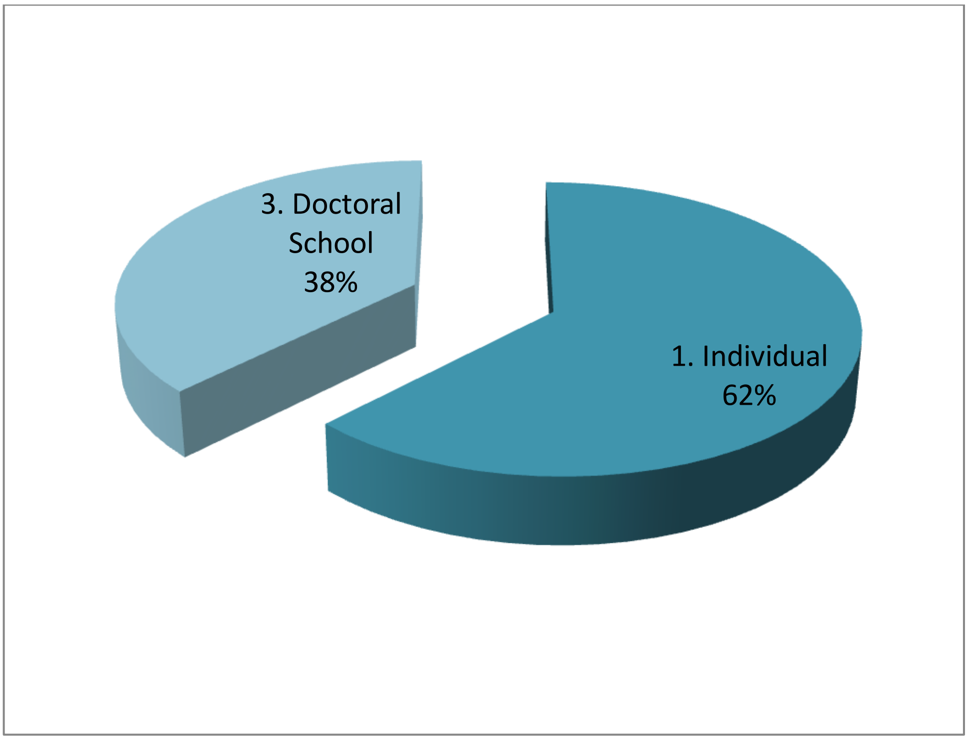


Figure 7. Structure of the programme

We have already explained that there is an increasing tendency in many European countries towards structured programmes with doctoral candidates grouped in research/graduate/ doctoral schools. However we have found certainly difficult to explain that there are no conjoint programs at European level in spite of the existence of strong links between some academics who have met in different European projects or consortiums.

In all the programs under analysis (100 percent), it has been observed that they are run under the umbrella of closely connected research groups. These research groups act as catalyzers helping to incorporate doctoral candidates into research teams, projects and excellence centers. They also provide a research environment that guides the candidates in their research career. The involvement of research groups provides also an additional positive aspect of the doctoral programs which is the creation of the feeling of belonging to a particular community of doctoral candidates with similar needs and interests.

Figure 8 shows that the industry is involved in the 87 percent of the programs. In such dynamic and competitive context as the observed in the aeronautical sector, the development and characteristics of collaborative doctoral programmes established between universities and industry can be considered vital for the strength and positioning of the European aerospace industry. It is time to trigger the process at a governmental, university or industrial level. In the subsequent sections and other WPs, we will examine the perspectives, expectations and experiences of the partners from university and industry and, not least, the doctoral candidates themselves. The importance of these collaborative programmes is evident because more than 50 percent of doctorate holders in Europe are moving into careers beyond the academic sector. In this respect, there is a need to foster the Ph.D. dissertations from the industry itself. There many positive features that can be highlighted in such cooperation, in particular we can cite the transferable skill components developed and the wider employment horizons opened.

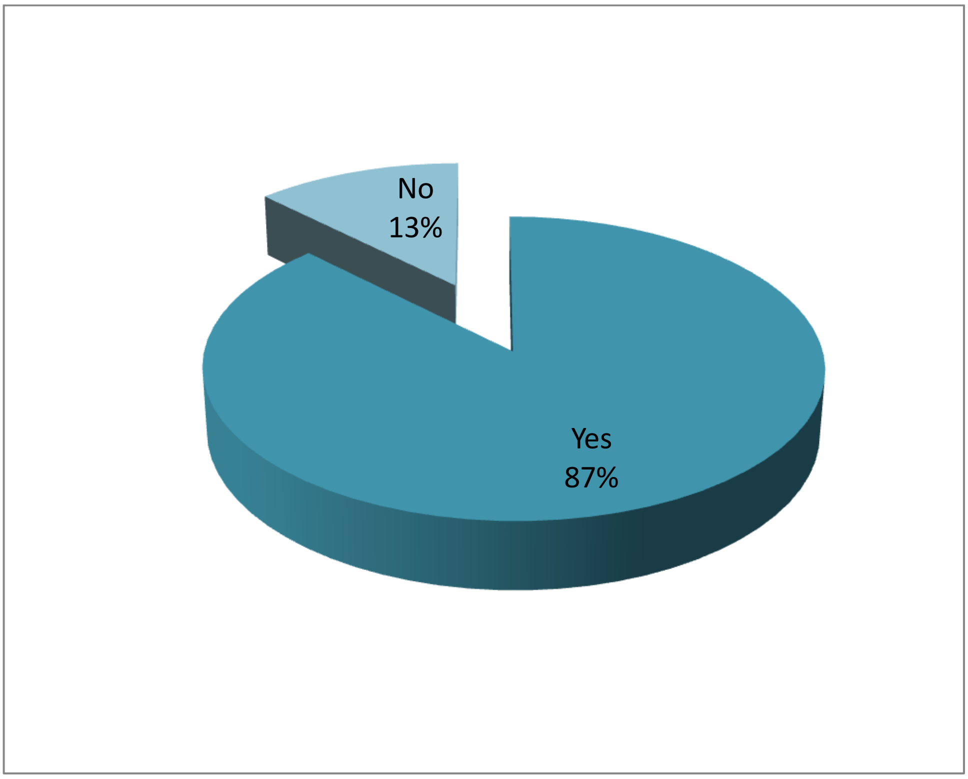


Figure 8. Participation of the industry

Borrell-Damian (2009) expressed the idea that the involvement of the industry in the doctoral programmes can be seen as a working model of the “knowledge triangle” whereby education, research and innovation are brought together in a common framework of high skills and knowledge development by university and industry partners. In its recent “Prague Declaration 2009”, EUA identified “10 Success Factors for European Universities in the Next Decade” – one of these being universities’ abilities in developing partnerships to help strengthen their missions in teaching, research and innovation activities.

In summary, the involvement of the industry in the doctoral education is of a great importance in Europe given the increased focus on innovation through R&D in order to advance towards a more “knowledge- based” economy and the reality that a majority of doctorate graduates are destined for careers outside academia in both research and non- research positions. Universities can and must provide unique environments where high academic standards and a vast range of disciplines meet and flourish, where R&D and oriented business Ph.D. dissertations could achieve its maximum potential.

Regarding the fees in euros, we observe that in most of the cases the Ph.D. programs is highly subsidized as most of the programs only charge a symbolic fee for less than 500 hundred euros for administrative issues and medical insurance. However there are also two outliers of 6000 and 19500 euros, respectively. It is evident that finding a global pattern of the funding for doctoral education in the doctoral programs under analysis is complex. As with other higher education institutions and cycles, funding generally comes from broad panoply of different sources. For doctoral education sources include state and regional governments (mainly through funding of public higher education institutions and systems and also through research grants to individual professors and occasionally to academic institutions and several different kinds of loan programs), tuition and fees paid by students –this cover the smallest proportion of the total budget, university endowments, philanthropic foundations and businesses of various kinds. The mix of funding can vary very much depending on the program, therefore generalization is difficult.

Needs for creative funding schemes are evident during this period of economic crisis as we are assisting to a decreasing public funding for public universities and higher education systems, there is a tendency of important public disinvestment in higher education that can affect the future and viability of some Ph.D. programs and the professional careers of some doctoral candidates. This is affecting particularly to the countries that are experiencing important problems in the euro zone, as Portugal, Italy, Ireland, Greece and Spain.

In any case, it can be said that the top doctoral institutions in Europe receive the bulk of research funding from the states, firms, foundations and other corporate research funding as the European projects. Thus, they are typically able to provide funding packages for many, and in some cases, virtually all of their doctoral students. Al large proportion of students has research internships and work directly on research projects with professors and industry associates. Less prestigious universities have fewer financial resources. More of their students pay for their studies, and a larger proportion serve as teaching assistants instead of research assistants conforming a vicious cycle difficult to escape from[7].

[7] As previously explained, in some countries there still exists the obligation for doctoral candidates as a part of training in communication and didactical skills (e.g., Hungary, Slovakia, Czech Republic, the Netherlands, etc.), to spend some hours as teaching assistants. It is important, however, to define an appropriate time limit for teaching duties, and not to use doctoral candidates as a source of cheap labour. This is a mala praxis which produces very negative results and for this reason should be avoided. In some countries doctoral candidates are allowed or encouraged to work as teaching assistants for a salary, which is often used as a source of income in the final phase of the doctoral program when the scholarship grant has ended.

Regarding the length of the doctoral programs it has been observed that the majority of the programs last 4 years with some exceptions for some programs that can last 5 or 6 years. In any case this issue depends very much on the type of the doctoral candidate, i.e., full-time vs. part-time. The seventh basic principle agreed from the discussions in Salzburg of a set of ten basic principles was that the duration for doctoral programmes should be in accordance of an appropriate time (three to four years full-time as a rule). Thus, it can be concluded that all the programs under analysis satisfied this requirement.

3.3.3 Third part of the questionnaire. Recruitment, grants and status

Regarding the university's policy admission to doctoral programs, it can be seen that the most common requirement asked to the candidates is the master (see Figure 9). Nevertheless, it can be seen that there are other additional requirements that doctoral candidates have to fulfil in order to be admitted in the doctoral programmes, as CV, personal statement, research proposal and others. These additional requirements vary by university and go as follows: (1) Recommendation letter(s), acceptance of supervision by a Faculty Member, specific grade requirements posed by supervising faculty, requirements for international students (e.g., relevance of degree, Master equivalent degree and University); (2) Application Form, acceptance of supervision by a Faculty Member, requirements for international students (e.g., relevance of degree, Master equivalent degree and University), selection of Ph.D. topic (without a detailed Ph.D. proposal); (3) Relevance of previous degree(s), acceptance and recommendation letter from prospective Ph.D. Supervisor, other recommendation letters, previous research experience (e.g., publications), current employment, duration of undergraduate studies, Grade Point Average (G.P.A.); and (4) Two recommendation letters and a certificate of English level. There are additional requirements for those programs which show a higher involvement with the industry, on top of them, additional company interviews and/or follow company standard human education can be cited.

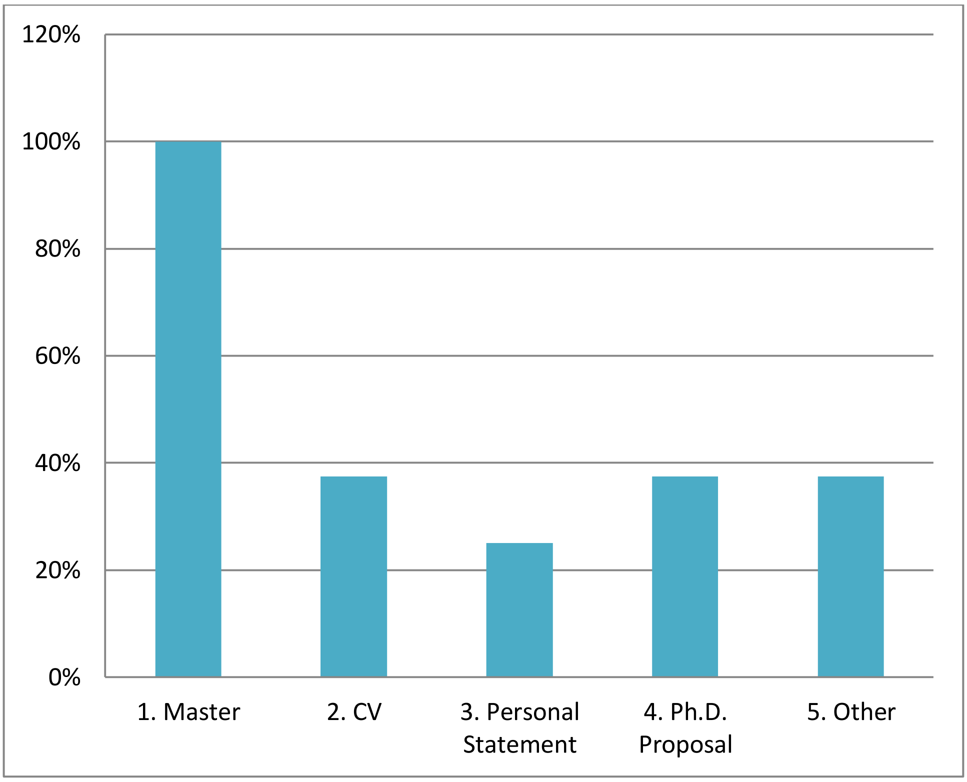


Figure 9. Entrance requirements to doctoral programs

After the Bologna process reform, in the European Union, the basic academic requirement is the master. Only for some adequate candidates there exists some exception and Bachelor can be sufficient if the candidate got his-her degree before the Bologna process. In these cases, the CV of the candidate has to show enough evidence of the fulfilment of 300 ECTS. This is also valid for international students not subject to the common European regulation.

In the cases where the candidate develops a case study within the industry as the Ph.D. dissertation, then the candidate may have a legal status of an employee of the company. For this reason, candidates also followed the standard internal human resources procedures for recruitment.

The analysis of the grants within the programs is not conclusive due to the lack of data. We could only obtain information for 6 universities. However, the analysis of the figures shows that the percentage of candidates with some type of grant varies from 65 to 95 per cent. Figure 10 analyses the legal status of the doctoral candidates. It can be seen that the majority of doctoral candidates are also considered students. It is necessary to have in mind that in some cases the candidates are considered to have a multiple legal status depending on the condition and year of their career. It is obvious that funding and legal status of the doctoral candidate are closely related. In doctoral programmes with a high involvement of the industry, a status of employee or research fellow can be granted to the candidate according to the policy in place, and in some cases the firms can normally pay a high proportion of the salary of the doctoral candidate. In other occasions, it is not uncommon that the candidate is self-employed or employed by a department or academic institution and that he/she does only have a status as a doctoral candidate (at the stage of undertaking a doctoral project their aims may simply be to enhance their employability prospects and/or satisfy their intellectual interests).

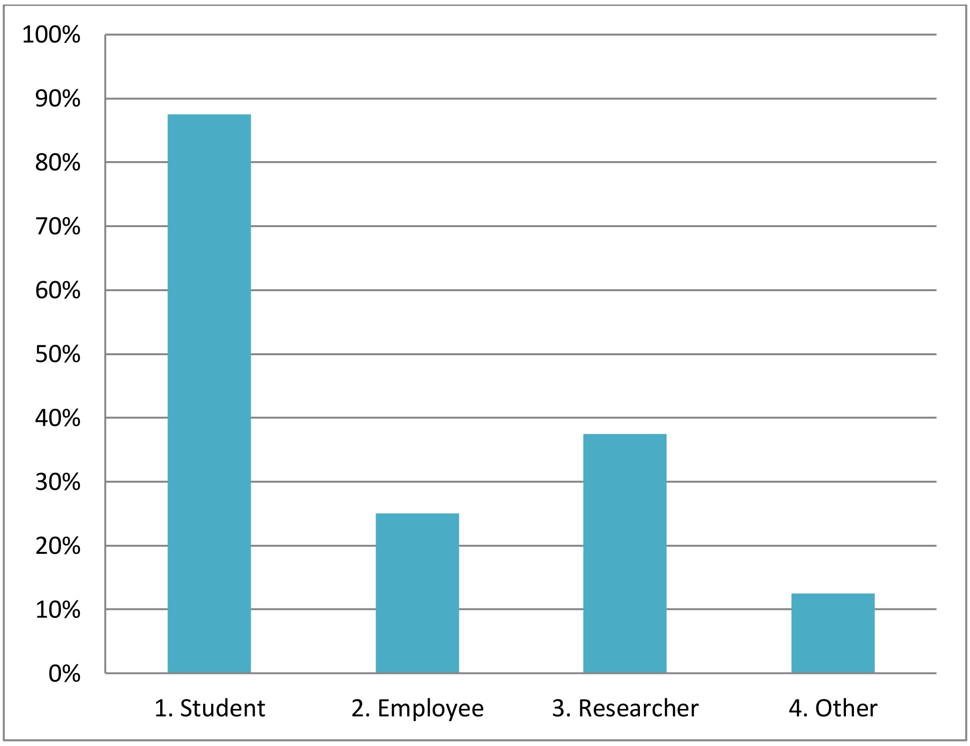


Figure 10. Legal status of the doctoral candidates

A doctoral candidate should always seek to have a legal cover that would establish a set of rights and duties, cover health issues arising from working in the doctoral project and protect the authorship of his/her research outcomes. Legal status can be grouped in four general types: fellowship/student of the university; employee from a public research funding body, employee from the university (teaching or professor assistantship, researcher), employee from the industry or self-employed in department university centres or the industry; researcher in some university institute or department; and other legal status that depend on the national labour policy.

Throughout Europe fellowships and scholarships grants tended to have a three-year limit on funding. However, this tendency was changing in the recent years in some countries as the average completion time of doctoral studies is four years. Thus, there was a try to accommodate the financial situation of most of the doctoral candidates avoiding the need of finding a new job to solve their financial situation (often as teaching assistants) at the time when they should fully concentrate on the completion of the dissertation. The problem of accommodating the duration for the Ph.D. and the grants obtained was already posed by many countries in different fields, so there exists a proactive policy to control this gap existing period.

In summary, there are different schemes for funding the programs from direct involvement of specific firms as companies paying full salaries of researchers. The basic condition for such policies is that the dissertations should benefit the companies. Internships are also very appreciated by firms and candidates and sometimes are an intrinsic part of the program. Duration of internships can range from 2 weeks to several months. The firms can pay the salary receiving part of it from the government. Definitively, there are different formulas and for the years to come it is interesting to note that more solutions should be perpetrated in order to attract good talented people as the future aerospace doctor-engineers.

3.3.4 Fourth part of the questionnaire. Monitoring, assessment, supervision and defence.

The era of the "knowledge-based economy" has brought into focus the dynamics of the interaction between universities as basic promoters of knowledge production and the economy and society as users and adaptors of this knowledge into new products and services. Universities play worldwide an increasing pivotal role in strengthening the economic competitiveness of the regions they serve, based on the knowledge, skills and transferability these institutions generate. One outcome of the current political and policy debate on this central challenge of competitiveness in a knowledge-based economy has been to place a greater emphasis on the main responsibilities that universities have as suppliers of trained researchers capable of anticipating and meeting the demand in competitive sectors such aerospace, aeronautical and air transport.

In this section, we analyse important issues regarding the monitoring and assessment process, the supervision and the act of the defence. Monitoring and assessment processes have always been paramount and critical since the results obtained in the first project of the Bologna Process Salzburg Conference (February 2005), in which ten basic principles were established. The subsequent reforms and guidelines for the future development of doctoral education which were built according to the recommendations adopted by the Conference of European Ministers for Higher Education held in Bergen, Norway, in May 2005 also highlighted these issues as very important for developing these high-quality doctoral programmes. Regarding the rights and duties of each party – universities, supervisors, doctoral candidates and external partners if exist, it is clear that supervision of the doctoral candidates, monitoring of the progress of research, reporting periods and deliverables for assessment, evaluation of placement conditions and analysis of dedication in terms of different activities carried out during the yearly or semester periods are basic ingredient to evaluate the progress of the doctoral candidates.

In Figure 11 it can be seen that in most of the cases there are particular forms that need to be filled up by the candidates and validated by the supervisors. In other cases, it is common to see a quite decentralized process that depends strongly on the requirements / procedures followed by the respective supervisor.

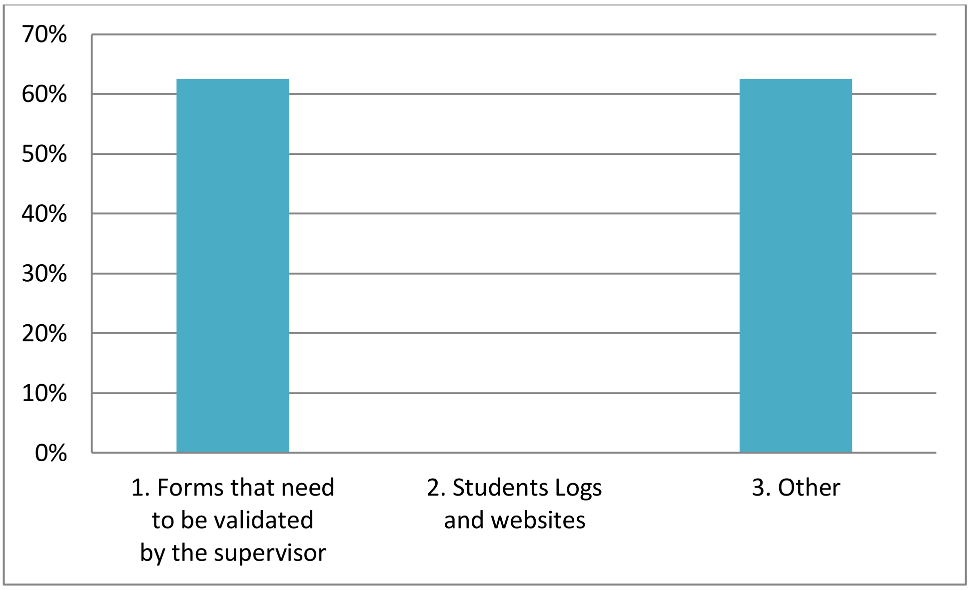


Figure 11. Monitoring and assessment procedures

We obtain that in none of the cases a decentralized process of students logs and websites exist. In these cases not only the supervisor is responsible for the monitoring process of the doctoral candidates but also a Commission for the doctoral programme is responsible for it. We also obtain that in some cases the doctoral candidate is supervised by both the academic and firm counterpart. Thus, supervision of the university is independent from the supervision in company. In any case, we would like to highlight here that it is advisable to install a monitoring system in place which can be considered more participative in order to receive regular feedbacks, going further than the simple academic supervisor who is responsible for all the process of monitoring. In having this type of supervision, a more decentralized system that can be accessed for more members than simply the supervisors, the arrangements, the assessment and the feedbacks can be better than that for a normal procedure. Progress reviews can be undertaken each every semester or annually with the members of the commission and supervisors involved. These reviews are helpful not only for monitoring, but to identifying training needs and future work.

Figure 12 shows the requirements and the existing implications for being a supervisor. As we have seen above, the role of supervisors is quite important in the phase of monitoring and assessment of the progress of the doctoral candidate. It can be seen that in the majority of the universities there exists a tight policy regarding who can be a supervisor in a programme, as it is not only possible to have a Ph.D. degree. In most of the cases there exists some additional evidence that shows the adequacy of the constituent for being a supervisor as, for example, a good research record measured by the number of projects, patents and published papers.

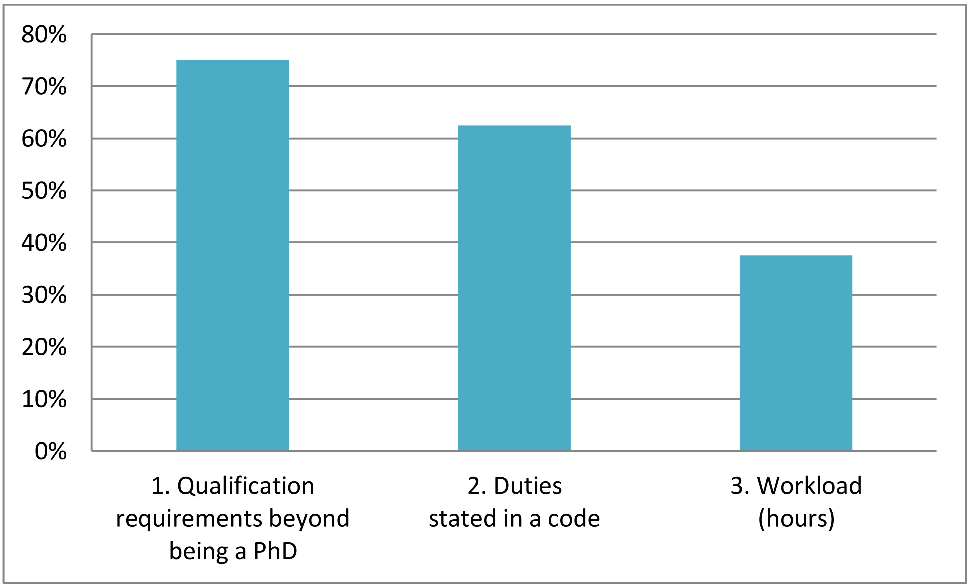


Figure 12. Implications for supervisors

It can also be seen that the duties of the supervisors are explicitly written in a code of conduct and that there is also a number of hours that supervisors need to dedicate to this important activity.

The need for universities in having a large proportion of academics with doctorates has generated an interest in the nature and quality of PhD training (Conrad et al., 1992). Most of the interest centres on the management of the process, content and length of the program (Anderson et al., 1997; O'Kane 1997). However, McPhail and Erwee (2000) propose that the development of a professional relationship between a supervisor and doctoral candidate, based on key relationship variables such as trust and commitment, is an essential component in the successful completion of a doctoral program.

Wilson (1995, p. 340) proposes the following stages in the model of the dyadic relationship development process between the doctoral candidate and supervisor: partner search and selection; defining purpose; setting relationship boundaries; creating relationship value; and relationship maintenance. Wilson (1995) expressed the idea that clarifying the breadth of purpose of the relationship as well as the scope of the Ph.D. is critical at the different stages.

Failing to do this may result in insufficient detail to make decisions about the relationship. The ideal outcomes at this stage involve setting mutual goals and objectives, the emergence of social bonding, and the development of the trust relationship. If these outcomes are not achieved, it leads to a fragile relationship, since both parties have limited commitment and can terminate the relationship at this stage.

It is well known that the doctoral thesis is a core element of any doctoral programme and a proof of independent research performance and competence of the doctoral candidate. Figure 13 shows the requirements for the doctoral thesis. It can be seen that there is still an important bond between the doctoral candidate and the supervisor, as in most of the cases the thesis is not ready to be defended until the supervisor emits a positive evaluation.

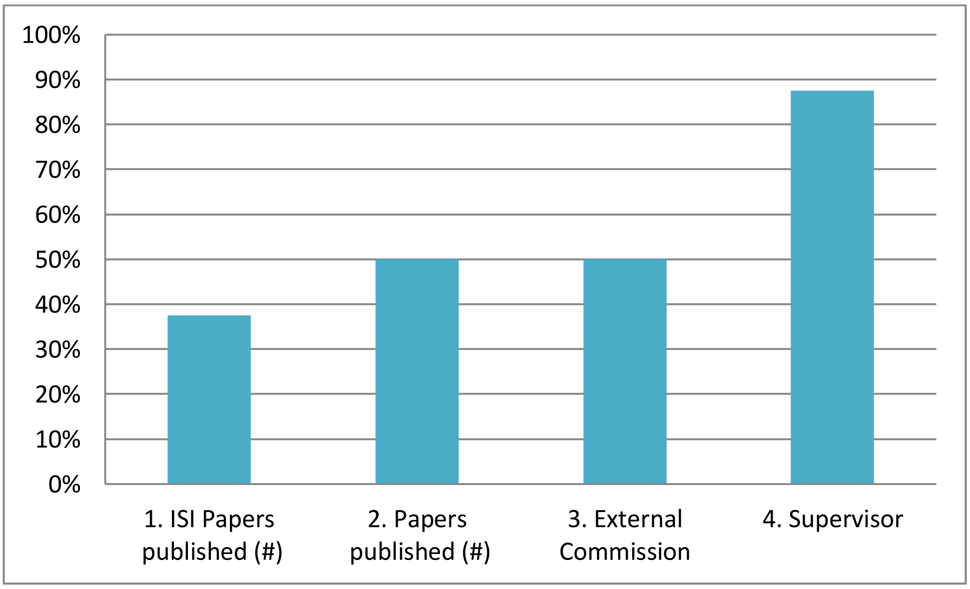


Figure 13. Requirements for the Doctoral Thesis

In recent years, and due to the quality assurance programmes established in the EU it is becoming very popular to add additional requirements in terms of publications for the admission of defence. Of course, the main quality requirement for any thesis is that it should produce a new insight or knowledge – an innovation in the field, a new scientific method or an application of a known method to a new field. The thesis should present an original piece of research work and place it in the context of the theoretical knowledge and the literature in the field. The thesis (or at least a part of it) should be publishable in a peer reviewed scientific journal or as a peer reviewed book.

It can be seen that some universities, the defence of the thesis requires the publication of partial results of the candidate's research. The required number of articles in peer reviewed journals can vary from one to five depending on the type of the thesis. In other cases, prior to submission of the thesis, doctoral candidates have to pass an external examination in the discipline and sometimes in a foreign language if the European Doctorate is pursued. These practices are really positive, however, the time lag between submission and publication in many journals is a major obstacle to achieve this goal. Another important issue to be resolved is the theme of authorship. Many universities require a declaration signed by the doctoral candidate that the work (thesis) is based on one's own original research. This is particularly an issue in the case of a doctoral candidate's active participation in research groups, universities need to ensure clear rules on co-authorship in order to protect the intellectual property of the doctoral candidate as well as that of other members of the research group.

Figure 14 shows that, in most of the cases, the act of the defence of the thesis is usually public and the information about it is publicly announced prior to the event (minimum ten days before the event). This practice is common in most of the programmes under analysis except in some cases where the defence of the thesis is private and it is usually organised as an oral examination (a viva) with one internal and one external examiner.

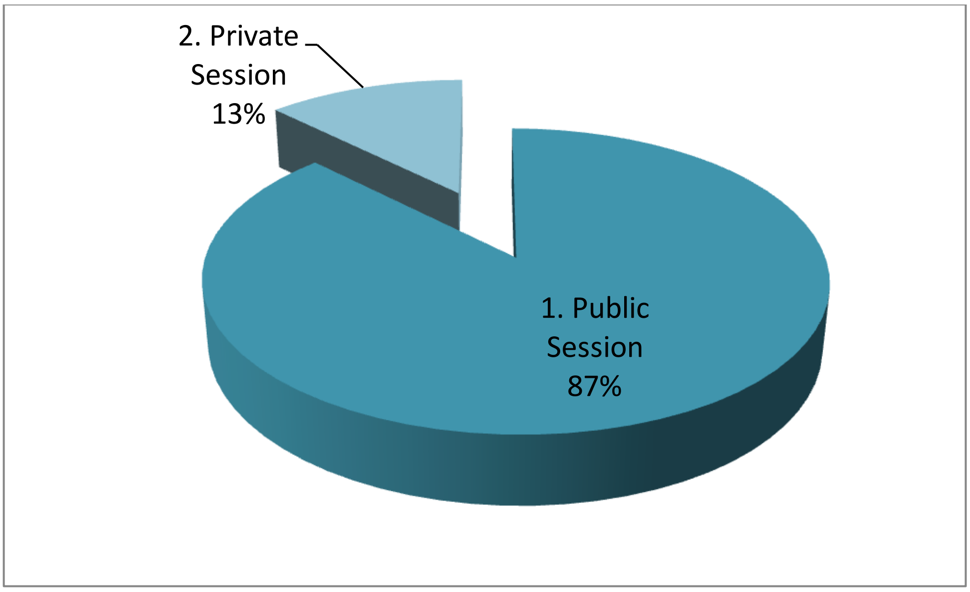


Figure 14. The act of the defence

The thesis is usually firstly reviewed before the defence by two to three reviewers who submit written reviews. The thesis defence committee is composed of internal and external professors and experts in the field including the reviewers. The presence of the supervisor in the defence committee is usually forbidden and in some programmes there is at least one member of the committee who comes from abroad to ensure an assessment at an international level. Such a practice, although it poses additional financial costs, contributes to improving quality standards of the doctoral programmes across the EU.

The defence itself consists of the candidate's presentation of main points of his/her research work and thesis, followed by an open discussion between the defence committee and the candidate. The decision can be made by the committee in a secret ballot and announced to the audience. It can be seen that in the 37 per cent of the programmes under analysis, the decision is made in a private ballot (Figure 15).

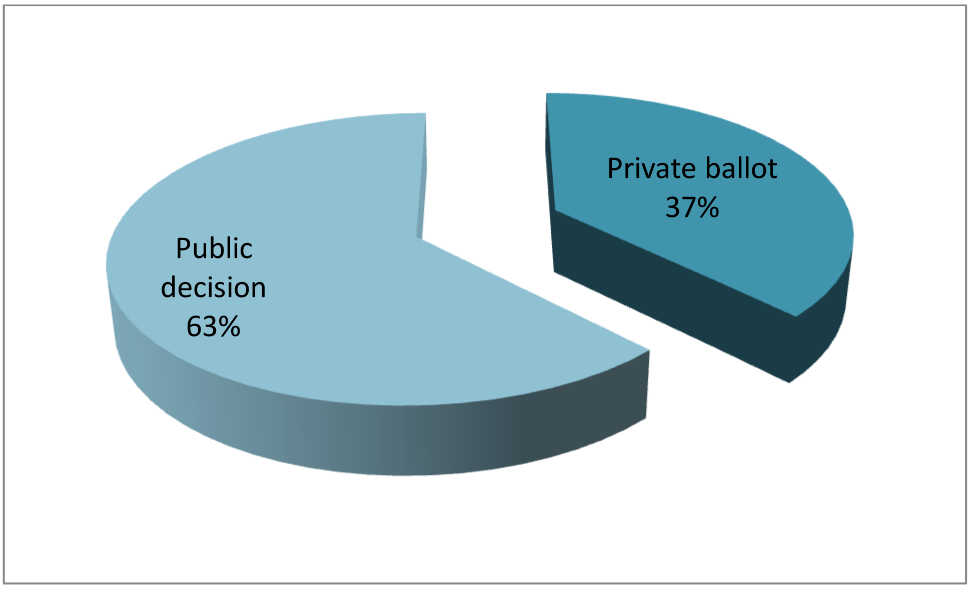


Figure 15. The committee's decision

There are differences between programmes in grading the thesis defence. In most of the programmes, it is possible to fail a public defence, but the candidate who fails is usually entitled to follow a complaint procedure if he/she disagrees with the decision of the defence committee. However, this event is not common as in order to ensure a high quality thesis, each doctoral candidate must receive an authorisation from their thesis supervisor and/or from the doctoral commission before the defence. It is evident that to a certain extent, once the thesis is authorised, the supervisor and the doctoral programme are also responsible and judged for the quality of the thesis, so a failure is not usually seen in the act of the defence.

Figure 16 shows that in most of the cases, the doctoral candidate can fail in the act of the defence. The 87 per cent of the doctoral programmes analysed allow the candidate to fail the defence.

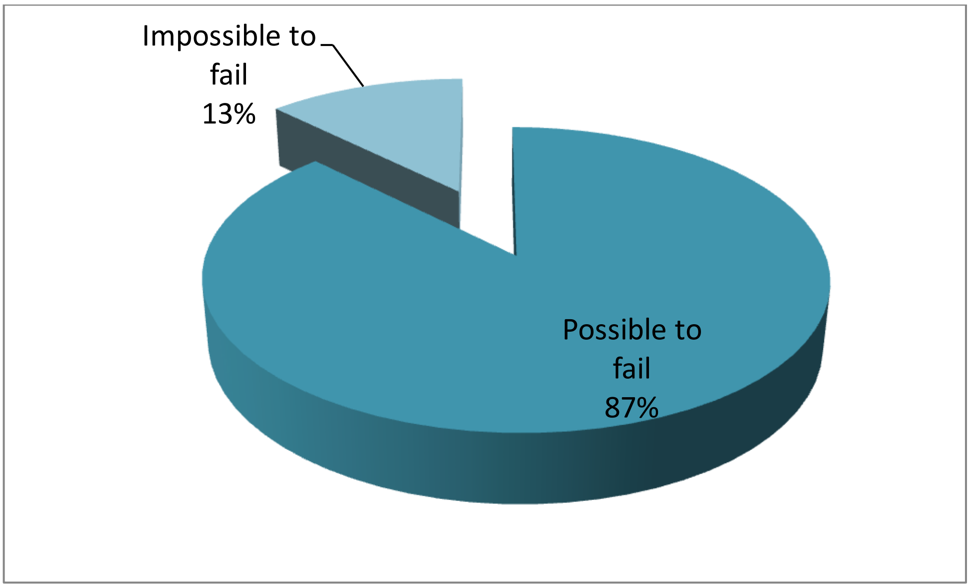


Figure 16. Possible outcomes of the act of defence

Another issue to analyse is how the grade is obtained. Regarding this issue, there are also some differences observed in the analysis of the programmes. Normally the grade is quite simple as in most of the cases a simple `pass' or `satisfactory' grade is obtained. In other cases this is usually complemented by `the cum laude' mark, which is usually referred as a satisfactory mark with an honour. It is not easy to establish a common framework for this grading system, but the grade of `cum laude' can be reserved for exceptional thesis, the best 15 per cent. In these cases, the grades can only awarded at the end of a cycle, but even in these cases a simple comparison of the final thesis with the defence is not possible. For these reasons, sometimes this type of award is given at the end of a period as an extraordinary merit in which the number of published papers in scientific journals with impact is a more objective criterion that can be used.

Even in the case of particular grades is important also to observe when this mark can only be achieved by unanimous judgement or not. It can be seen in Figure 17, that for the half of the programmes, the decision has to be taken unanimously. Sometimes, the unanimous judgement creates critical issues in doctoral programs and sort of a storm, where doctoral candidates can be trapped in the middle of external artificial quarrels between different members of departments. For this reason, it is much simple to recur to majority rules that avoid this type of misbehaviour. The importance of writing exemplary thesis, of the highest possible quality, can be better judged for the adequate number of publications in refereed journals that have been published. There is also a need to have previous written reports before the act of the defence lauded by the internal and external examiners of his thesis committee. Even in the most favourable cases, it is true that sometimes the doctoral candidate fails in giving a brilliant exposition of motives of the thesis and even in the act of the defence he/she is not particular good, arguing the potential questions raised by the members of the committee. There exists an excessive pressure that is difficult to handle by some doctoral candidates. It is usually one of the most important days in the life of a doctoral candidate, and some of them can collapse suffering from severe, disabling exam anxiety that appears to have significantly impeded the doctoral candidate's ability to perform to their real potential in this particular date.

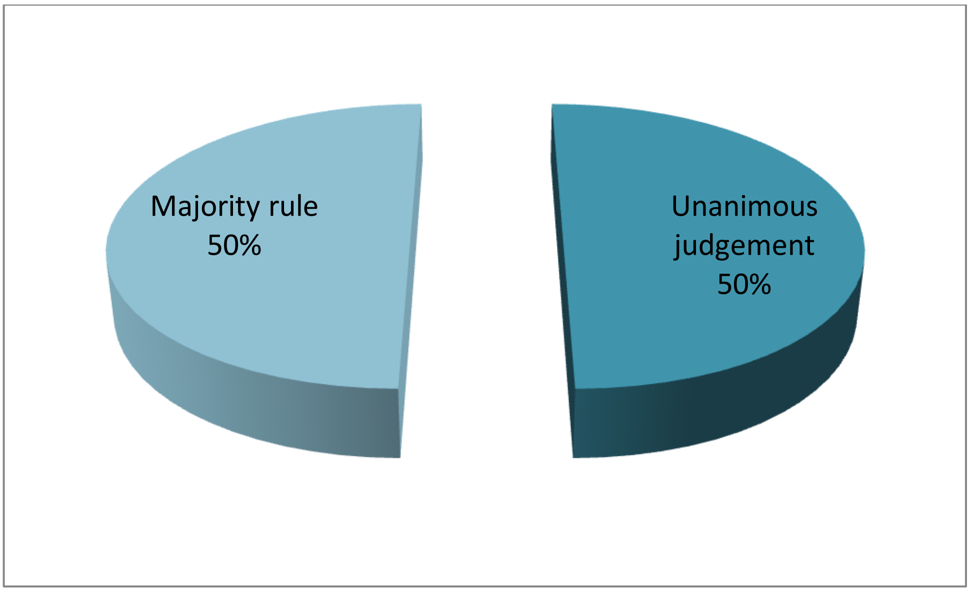


Figure 17. Grading rule in Ph.D. Programmes

3.4 Life-Long Learning Programmes

One of the characteristics of the European Union is its cultural diversity across the nations that constituted it. Consequently, mainly for historical and cultural reasons, there are many different Higher Education Systems being universities the most important institutions of this level. In the case of the curricula for engineering, in special for aerospace and aeronautics, the program structure can also vary depending on the importance of the national aerospace industry and Professional Organizations and Societies that can exert some kind of influence in the contents of the program. For this reason, a good understanding of the available offer is quite difficult for non-specialists, and even more difficult for people who are outside of the educational system.

However, the development and recent trends in the Higher Education System, through the Erasmus Exchange Programs and the Bologna Process have helped not for the uniformity of the programs but for the coexistence of this diversity. It is now even more possible than in the past, that some universities, forming part of a network like PEGASUS, develop some joint degree (graduate, master or Ph.D. program), or even some specialized professional courses known as life-long learning programs (LLPs).

In this section, we will present the case of the LLP of ECATA. This course is the consequence of the competition in the worldwide aerospace market which has become more and more fierce. Thus, there exists a need to constantly improve European competitiveness and this need is more vital today than ever before.

European Industry for its nature in both the commercial and military sectors is irreversibly involved in multinational programmes. Independently of the program, within the rapid business moments of these days, European companies have a necessity to function together as a single unit, overcoming cultural differences. The rapid current reshaping of the world-wide aerospace companies and research centers then leads to make a good positioning and to sustain a competitive advantage in the global market place.

Many challenges must be overcome when working jointly to build the best and most advanced product on the market in time and at the lowest cost. In particular, the complex nature of business integration with evolving technologies imposes a need for appropriate skills in the management of multinational technical programmes. Behavioral flexibility, overcoming cultural differences, team building, team process, understanding, rapid and effective decision making process, quick reactivity, customer focus, strategic thinking, networking use, must all be mastered for success in this new global environment.

ECATA has built for young high-potential engineers, scientists and researchers a top ranking international training programme and a unique learning methodology specifically designed to meet the high standards of these new qualification requirements.

The ECATA course is designed by professionals for professionals and is taught by experienced experts in Aerospace and professionals world-wide recognized. The ABI Course has been selected as pilot project of the European Union Programme for continuing professional education (LLP).

The course provides the know-how and training necessary to prepare those likely to play a key role in aerospace programmes of the future. The dynamic ECALAS association (ECATA Course Alumni Association) constitutes an effective European network that is useful for current and future European Aerospace challenges in the world.

The framework of the course is split in such a way delegates can attend the course without perturbing their job. There are lectures in 4 weeks (114 hours) developed normally in KTH (Sweden) with three different blocks of lectures: (1) International Aerospace Management; (2) Integrated Product Development; and (3) Multinational Project Management.

After these theoretical sessions, there are short courses developed in ETSIA (Spain) where two different modules are developed: (1) Team building and personal development seminars and tutoring (60 hours); and (2) Workshops, Simulation Games, Technical Visits and Cultural Events (50 hours). In a multinational working environment, these two modules make that delegates develop skills in: international aerospace awareness, multicultural working environment, multinational aerospace project, management, cross disciplinarily, integrated product development, concurrent engineering and networking.

Then the delegates have to develop the multinational team project which is the course corner stone. In this final practical module, the delegates need to act as consultants for customers all along the sessions. Teams get assistance, tutoring and coaching with experts, facilitators and seminar trainers. Thus, delegates develop skills in: Team Working and Project Management in a multinational environment, Strategic thinking in a global and fast moving environment, Running of a virtual team customer focus.

In summary, a range of innovative LLPs are emerging to respond to the changing demands of a fast- evolving labor market. Employability is the quintessential of these programmes, as well as individual and societal needs for lifelong education and training, have acted as a catalyst to the development of new programmes, more university - industrial collaboration based doctorates and increased European and international cooperation, often leading to joint or European doctorate, will also diverse the creation of new LLPs. Diversity of these programmes will reflect the increasingly diversity of the European Higher Education landscape in which higher education institutions have the autonomy to develop their own missions and profiles and thus their own priorities in terms of programmes and research.

3.5 Conclusions

The culmination of the Bologna process needed a basic line establishing two pillars of the knowledge based society: "European Higher Education Area (EHEA) and European Research Area (ERA)", in order to promote the key role of doctoral programmes and research training in the context of increasing the competitiveness of the European region.

Thus, the third cycle in the Bologna Process became apparent as there was a need to promote closer links between the EHEA and the ERA in a Europe of Knowledge, and of the importance of research as an integral part of higher education across Europe. Therefore, Ministers considered it necessary to go beyond the focus on two main cycles of higher education to include the doctoral level as the third cycle in the Bologna Process. They emphasised the importance of research and research training and the promotion of interdisciplinary in maintaining and improving the quality of higher education and in enhancing the competitiveness of European higher education more generally. Ministers call for increased mobility at the doctoral and postdoctoral levels and encourage the institutions concerned to increase their cooperation in doctoral studies and the training of young researchers.

Research training and research career development - and the need to increase the number of highly qualified graduates and well trained researchers – are also becoming increasingly important in the debate on strengthening Europe's research capacity.

From the discussions in Salzburg a consensus emerged on a set of ten basic principles, so a summary of the doctoral programmes analysed is being undertaken following the structure of these principles:

(1) The core component of doctoral training is the advancement of knowledge through original research. At the same time it is recognised that doctoral training must increasingly meet the needs of an employment market that is wider than academia.
    a. This principle is mostly achieved.
(2) Embedding in institutional strategies and policies: universities as institutions need to assume responsibility for ensuring that the doctoral programmes and research training they offer are designed to meet new challenges and include appropriate professional career development opportunities.
    a. This principle is also mostly achieved but here we recommend in a major involvement of the industry in order to develop collaborative doctoral programmes.
(3) The importance of diversity: the rich diversity of doctoral programmes in Europe - including joint doctorates - is a strength which has to be underpinned by quality and sound practice.
    a. Here, we consider that there is enough room to improve. There is a need to start joint programmes. However it is highlighted that there is a real informal cooperation between the different existing programmes in Europe.
(4) Doctoral candidates as early stage researchers: should be recognized as professionals – with commensurate rights - who make a key contribution to the creation of new knowledge.
    a. This principle is basically achieved but there is also a need to have a more common framework within the EU.
(5) The crucial role of supervision and assessment: in respect of individual doctoral candidates, arrangements supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution (and where appropriate including other partners).

   a. This principle is also partly achieved and it is highly recommended to work in a common code of conduct at the European level.

(6) Achieving critical mass: Doctoral programmes should seek to achieve critical mass and should draw on different types of innovative practice being introduced in universities across Europe, bearing in mind that different solutions may be appropriate to different contexts and in particular across larger and smaller European countries. These range from graduate schools in major universities to international, national and regional collaboration between universities.

   a. This principle has been partly achieved with the creation of Doctoral Schools in some countries. However in our opinion, it will be advisable to move into the direction of joint programs within the field as a better way to get a critical mass with the main stakeholders of the industry at the European level.

(7) Duration: doctoral programmes should operate within an appropriate time duration (three to four years full-time as a rule).

   a. This principle is basically achieved.

(8) The promotion of innovative structures: to meet the challenge of interdisciplinary training and the development of transferable skills.

   a. There is no evidence about the performance of this principle, but it is highly advisable to work into the direction of creating joint programmes including several universities and different stakeholders of the industry.

(9) Increasing mobility: Doctoral programmes should seek to offer geographical as well as interdisciplinary and intersectoral mobility and international collaboration within an integrated framework of cooperation between universities and other partners.

   a. There is enough room to improve the performance of this principle.

(10) Ensuring appropriate funding: the development of quality doctoral programmes and the successful completion by doctoral candidates requires appropriate and sustainable funding.

   a. This principle is mostly achieved.

4 Surveys (Rationale)

4.1 Introduction

The surveys (Step 2 of EDUCAIR's methodological approach, see Figure 5 in Section 2.3) provided the bulk of the information for the assessment of the competence gaps. The interviews, meeting and other, although relevant, served mainly for calibration purposes.

The adaptation of the Four Gaps Framework (Figure 3) to the scope of the EDUCAIR project led to the identification of the *relevant stakeholders* as the key sources of information for analysis the various competence gaps – that is, the target of the surveys. Table 5 gives an overview of the relevant stakeholders (the upper panel shows the scope, while the lower level shows the stakeholders). Four types of relevant stakeholders were identified, being:

1. companies (human resources),
2. employees,

Table 5: Overview of target group of survey

INDUSTRY (demand side)	EDUCATION (supply side)
• Airlines • Airports • Companies involved in air traffic management (such as air traffic control organisations) • Aircraft manufacturers and suppliers	• Universities and colleges with engineering programmes involving air transport/aeronautics • Universities and colleges with research and PhD programmes in air transport/aeronautics • Vocational and Professional training institutes
Relevant Stakeholders: 1. Managers of new employees and people recruiting new employees (human resources) 2. New employees (max. 5 years' experience) 3. The employees/professionals (with more than 5 years' experience	Relevant Stakeholders: 1. Heads of departments, professors or lecturers related to air transport/aeronautics 2. Graduating students only 3. Graduated students (pursuing a doctorate) 4. Graduated students that are not working in air transport or aeronautics 5. Researchers (post-doctoral fellows)

Source: EDUCAIR(2012)

3. universities (professors and lecturers),
4. graduating and graduated students.

A tailored survey was designed and launched for each stakeholder, in a total of four surveys. Figure 18 shows what was gauged in the survey and how this was linked to the specific relevant stakeholders. This is aligned with the assessment framework (Figure 3). The link between Table 5 and Figure 18 is shown by use of colors.

For practical matters, each stakeholder received one survey. Looking at Figure 18, we may conclude that each stakeholder is the focal point for two gaps; therefore, each survey contained questions from two gaps. Bearing in mind that the competences and the gaps were assessed in different Work Packages (WP4, WP5, WP6 and WP8)(Figure 5), then the design of the surveys entailed a strong articulation and coordinating among WPs.

The following diagram (Figure 18) presents the rationale underlying the design of the surveys. Within bracket, we present the number of the question. All surveys contain questions aimed to assess the respective gaps of each stakeholder. With the exception of the survey targeting universities, a split of the questions between each gap was possible. In what concerns the universities, the questions were used to assess both gaps. All surveys started and ended, in a similar fashion, with the basic characterisation of the respondent and a request about their interest in receiving further news and updates. It is important to note that the surveys also provided information for the assessment of the attraction and repulsion factors of air transport and aeronautics, in the WP7.

This deliverable shows the results of the surveys administered to universities and doctoral students. All the questionnaires can be found in the deliverable D3.7 (Educair, 2012) and in the project website: http://www.educair.eu/

The target audience of the survey administered to universities were heads of departments or full professors of universities and colleges with engineering programs involving air transport/aeronautics and/or research and PhD programs in air transport/aeronautics. Furthermore, also vocational and professional training institutions are addressed. The survey aims to collect quantitative and qualitative information on the demand for graduates in the air transport and aeronautics industry and input on educational topics and industry-education relationships. This survey holds three parts. The first part contains general questions to get a view on the background of the respondent. The second part is divided into several sections: questions about (graduating) students (A), about the current educational offer of your university (B), about the competences needed in the sector (C) and about the cooperation between the industry and the educational institutions (D). In the last part of this survey, respondents could leave any comments or remarks they might have. It was estimated that the survey takes 30 minutes to be completed.

The target audience of the survey administered to the students were the PhD-students of universities and colleges with PhD programs in air transport/aeronautics. The survey aims to collect quantitative and qualitative information on the demand for graduates in the air transport and aeronautics industry and input on educational topics and industry-education relationships. This survey holds three parts. The first part contains general questions to get a view on the background of the respondent. The second part is divided into several sections: questions about the educational background and career path (A), about the competences needed in the sector (B) and about the cooperation between the industry and the educational institutes (C). In the last part of this survey, respondents could any comments or remarks they might have. The survey takes about ten minutes to be completed.

Another important issue in terms of confidentiality, it is that respondents were guaranteed that information gathered was for internal use only after statistical exploitation and that under any circumstances personal information like email address or relevant information will not be shared with any third parties. Thus, all the answers to this survey are private and confidential and will only be used within EDUCAIR project, and no nominal data will be kept in the database whether this is shared with third parties for scientific purposes.

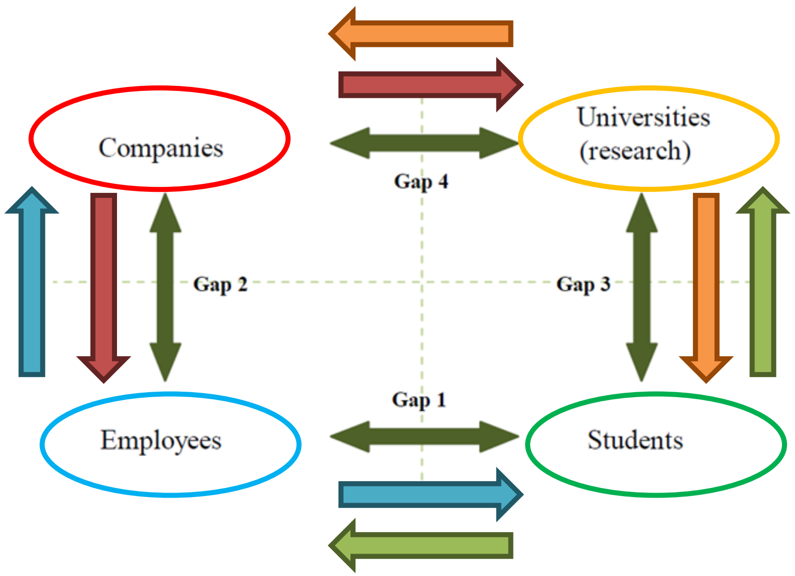
Legend:
----= industry survey addressed to managers of new employees and people recruiting new employees
----= industry survey addressed to employees

In the survey to the companies (industry survey - 1), we want to find out whether the industry is satisfied with the number of courses that are offered (quantitative) as well as their quality concerning the competences that are taught (qualitative)

In the survey to the educational institutions (education survey - 1), we want to find out whether the universities believe that they live up to the expectations of the companies, regarding the courses taught.

Legend:
----= education survey addressed to heads of departments or full professors
----= education survey addressed to students

In the survey to the companies (industry survey - 1), we want to find out which competences the employees <u>need to</u> have in the eyes of the companies and whether the existing employees, incl. "new" and "old" employees have them or not



In the survey to the educational institutions (education survey - 1) we want to find out which competences the students <u>should</u> acquire through their education.

In the survey to the employees (industry survey 2-3), we want to find out what career paths the employees have and which competences they have or have acquired for the job.

In the survey to the students (education survey - 2) we want to find out which competences the students <u>actually</u> acquired through their education and whether they are satisfied with them.

In the survey to the employees (industry survey - 2-3), we want to find out which competences the employees <u>actually</u> had when starting their work and whether the employees were satisfied with them.

In the survey to the students (education survey - 2), we try to find out which competences students <u>think</u> they have that are needed for their career.

Source: EDCUAIR (2012)

Authors: Martín, Román
Partner Responsible: ULPGC
Dissemination Level: Confidential

Figure 18 - Overview of different surveys in line with the educational gaps

Companies

Characterisation of the Company (Q6-Q45)
Evaluation of educational offer (Q126-Q225)
Cooperation with educational institutes (Q265-Q270)
Identification of the relevant competences (Q226-Q264)

Relevant criteria when hiring graduates (Q46 – Q70)
Characterisation of employees (Q71– Q110)
Trainee program /how do they attract best resources (Q111-Q125)

Gap 4

Universities

Characterisation of the educational offer and universe of students (Q6-Q11)
Employability of the courses (Q12-Q16)
Identification of the relevant qualifications in recruitment (Q17-Q20)
Identification of the educational competences taught (Q41-Q78)
Cooperation with industry (Q79-Q84)
Quantitative evaluation of the educational offer (Q30-Q40)

Gap 2

Gap 3

Employees

Attractiveness and repulsion factors of the job (Q53-Q54)
Self-evaluation of the relevant qualifications and skills (Q48-Q51)
Career planning (Q52)
Application process (Q236-Q238)

Educational background and employment career (Q11-Q45)
Attractiveness and repulsion factors in educational offer (Q46-Q47)
Evaluation of educational offer (Q91-Q190)
Identification of the relevant competences for the job (Q191-Q229)
Lifelong Learning (Q230-Q235)
Cooperation between industry and educational institutes (Q239-Q243)

Gap 1

Students

Attractiveness and repulsion factors in the educational offer (Q12-Q13)
Self-evaluation of the relevant competences (Q15-Q16)
Additional formation (Q20-Q23)

Characterisation of the educational background general and in air transport (Q8-Q11 + Q14)
Career planning (Q17-Q19)
Previous work experience (Q24-Q26)
Assessment of the relevant qualifications to get a job (Q27-Q30)
Assessment of the relevant competences for employment (Q31-Q68)
Cooperation with industry (Q69-Q70)

Figure 19 – Structure of the surveys and list of questions to assess the competence gaps

4.2 Dissemination Efforts and Description of the Collected Surveys

Using the basic information provided by the tasks 5.1 and 5.2., we gather information about potential respondents for the implemented phase of the surveys. This information was also completed by the list of contacts of the different partners involved in this project: IST, AUEB, UA, ULPGC and TUD. All the partners also provide contacts for the companies and research centres that were identified by IST. Our intention was to have a balanced sample covering different criteria, such as, covering the main universities involved in the field under analysis and some geographical location coverage in Europe. On the basis of the Questionnaires developed by WP3 for the subsequent WPs, IST as the coordinator for the project decides that ULPGC was in charge for the data analysis of the students' survey within the task 5.3. within WP5, as it was difficult to split the information of the universities and students according to the different cycles commented in the Bologna Process. Thus, this section will be devoted to analyse the students' survey.

The questionnaire contains multiple questions to collect students' views and experiences on different issues, such as: (1) a first part devoted to get personal information, attraction and repulsion factors; (2) a second part to analyse competences, academic degree evaluation, personal career assessment and career planning consultancy; (3) a third part gathers information about the areas of interest for working, whether respondents have additional interest to study further, potential companies for working and activities of their curricula; (4) a fourth part to analyse previous labour experience, relevant qualifications for getting a job and skills; (5) and finally a fifth part to analyse the competences for different sectors and the internship awareness.

The survey questionnaire was administered by web-site through a personal distribution made by all the partners involved in the project. The Internet is increasingly used for online surveys and Web-based research. It is out of the scope of this WP to evaluate the possible bias obtained by this procedure in comparison with mail-based surveys, but it was previous recognized that the lack of resources and time preclude us from such type of comparisons that could be an object of future research activity within other research project.

However, we need to highlight that these surveys can be subject to a certain degree of bias. In particular, bias can result from 1) the non-representative nature for the formation of the sample as this has been based in previous respondents and particular databases of the partners and 2) the self-selection of participants (volunteer effect). As in many other online surveys we have a very low response rate (this effect is even larger if the number of visitors is used as denominator). Thus, considerable debate ensues about the validity of online surveys. Editors and peer reviewers of journals are frequently faced with the question of whether to accept for publication studies reporting results from Web surveys. This is not a simple question and often it "just depends", it depends on the reasons for the survey in the first place, its execution, and the conclusions. Conclusions drawn from a convenience sample are limited and need to be qualified in the discussion section of a paper. On the other hand, it is certainly risky to routinely express sort of negative feelings against reports based on web surveys, even surveys with very small response rates, which are normal events of electronic surveys. In this case, a positive and decisive approach is used to show that the conclusions drawn from our web survey are valid and useful for readers. Web surveys may be of some use in generating hypotheses which need to be confirmed in a more controlled environment; or they may be used to pilot test a questionnaire or to conduct a Web-based experiment. Lack of time and resources do not permit to carry out these but these are something that can be done in future research. In this section, statistical methods such as propensity scores are going to be used to present results instead of techniques of exploratory analysis.

Every biased sample is an unbiased sample of another target population, and it is sometimes just a question of defining for which subset of a population the conclusions drawn are assumed to be valid. For example, it can be thought that the polling results of our web site are certainly highly biased and not representative for the entire EU students' population in the field of aerospace and aeronautics engineering and air transport. But it is legitimate to assume that they are "representative" for some subset of this representative group who choose to participate in the online survey.

This illustrates the critical importance of carefully describing how and in what context the survey was done, and how the sample, which chose to reply, is constituted and might differ from a representative population-based sample. For example, it is very important to describe the content and nature of the Web site where the survey was posted in order to get an idea of the people who filled in the questionnaire (i.e., to characterize the population of respondents). It is also important to describe in sufficient detail exactly how the questionnaire was administered. For example, was it mandatory that every visitor who wanted to enter the Web site fill it in, or were any other incentives offered? It is well known that a mandatory survey is likely to reduce a volunteer bias.

In our case, it has been already explained that the sample was mainly selected by the already known list of contacts of the information gathered in the first phase of the templates administered in the previous task 5.2., and also by a list of contacts based on the information provided by the heads and directors of the programs subject to analysis.

In online surveys, there is no single response rate. Rather, there are multiple potential methods for calculating a response rate, depending on what are chosen as the numerator and denominator. As there is no standard methodology, we do not calculate such metric.

A common concern for online surveys is that a single user fills in the same questionnaire multiple times. Some users like to go back to the survey and experiment with the results of their modified entries. Multiple methods are available to prevent this or at least to minimize the chance of this happening. In our case this has been prevented by the use of the IP address.

In order to have a valid answered online survey, we have also stated whether the completion or internal consistency of certain items have been enforced using Javascript (i.e., displaying an alert before the questionnaire can be submitted). An ex-post analysis have also been implemented in order to check the validity of the questionnaire, e.g., if a questionnaire does not present a number of sectorial competences answered then this questionnaire was dropped from the analysis. With this technique the sample was reduced to a total of 215 valid responses.

4.3 Survey Data Analysis

It is difficult to obtain an accurate figure of the number of graduates in each of the Bologna cycles at the EU level. However, we can take from Pegasus Working Group 2 (2009) that there are more than 2500 aeronautical engineers graduate from the member institutions of PEGASUS[8] each year. In the same document, it is possible to see that there were 2700 master students and almost 300 Ph.D. doctorates for the period 2006-2008 (Table 6), and that the following universities were the most productive during that period regarding the third cycle of the Bologna process: ISAE Toulouse (35), ENSMA Poitiers (27), TU Braunschweig (36) and Cranfield (38). It can also be seen that these universities are also the most important if we take into consideration the second cycle of the Bologna Process.

There is a relevant issue that is important to have in mind which is that not all aerospace engineers work directly into the aerospace industry after completion of their studies. According to Pegasus Working Group 2 (2009), about 50% of the PEGASUS engineering graduates go into other sectors such as automotive and mechanical industries, information technology companies,

[8] PEGASUS was formed from an initiative taken by the main French Grandes Ecoles involved in aerospace engineering. The general objective of PEGASUS is to optimise the services that its member institutions offer in the best interests of Europe both in terms of continuing to attract the best students and also to offer highly relevant educational and research programmes.

consulting firms, etc. Surely, the percentage varies considerably according to regional employment opportunities.

On the other hand, the aerospace industry does not limit its recruitment of engineers to the sole source of PEGASUS. Other universities and engineering schools also provide the industry with talented people, but in much less numbers than PEGASUS. Overall, under today's conditions the graduates output of the PEGASUS partners appears to be adequate to the needs of the aerospace industry.

Thanks to the permanent communication of interests with the European aerospace industry, the PEGASUS group is on top of the evolving needs of the aerospace industry. And, thus, is able to consider these needs in the adaptation of the study programmes.

Table 6. Yearly average number (2006-2008) of graduated students for Master and Ph.D. Programmes. Pegasus Members

UNIVERSITY / SCHOOL	Master students 2nd cycle Bologna	Ph.D. students 3rd cycle Bologna
ENAC Toulouse (F)	225	5
ISAE Toulouse (F)	396	35
ENSMA Poitiers (F)	152	27
CTU Prague (CZ)	59	6
RWTH Aachen (2004) (D)	42	13
TU Berlin (2004) (D)	58	14
TU Braunschweig (D)	194	36
TU Dresden (2004) (D)	36	5
U. Stuttgart (2004) (D)	125	22
TU Munich (D)	320	20
Politecnico di Milano (I)	153	9
U. Pisa (I)	76	6
U.Napoli (I)	120	10
U.Roma (I)	140	5
Politecnico di Torino (I)	142	5

UNIVERSITY / SCHOOL	Master students 2nd cycle Bologna	Ph.D. students 3rd cycle Bologna
TU Delft (NL)	173	17
ETSIA Madrid (E)	40	6
IST Lisboa (P)	55	3
KTH Stockholm (S)	38	3
U. Bristol (UK)	n.a.	10
Cranfield U. (2004) (UK)	153	38
U. Glasgow (2004)	60	3
TOTAL	2758	298

The data analysis of the students' survey is going to be presented in five different parts: (1) personal information, attraction and repulsion factors; (2) competences, academic degree evaluation, personal career assessment and career planning consultants; (3) areas of interest for working, additional interest in education, companies for working and activities of the curricula; (4) previous labor experience, relevant qualifications for getting a job and skills; and (5) competences by subsectors and internship awareness. We finally obtained 215 valid responses that represent the three cycles of the Bologna Process (84 (39%) of the 1st Cycle engineering students; 90 (42%) master students; and 41 (19%) of Ph.D. students). Unfortunately the sample is not large enough to present the results for each group separately. Next sections are devoted to present the data analysis for each of the parts of the online survey instrument employed in Educair.

4.3.1 First Part. Personal information, attraction and repulsion factors

Regarding the nationality of the respondents, it can be seen in Figure 20, that in decreasing order of participation the countries more well represented are: Portugal (33%), Italy (15%), Sweden (12%) and Germany (11%). As explained above this online sample is clearly biased in favor of the nationality of the coordinator of the project. We certainly regret that this sample could not be more representative of the students at the universities of France, the UK and the Netherlands. With more time and resources, this sample should be corrected in order to balance the sample with more students of these important countries in this specific sector. We have tried for more than three months to gain a better representativeness but at the end this has not been possible.

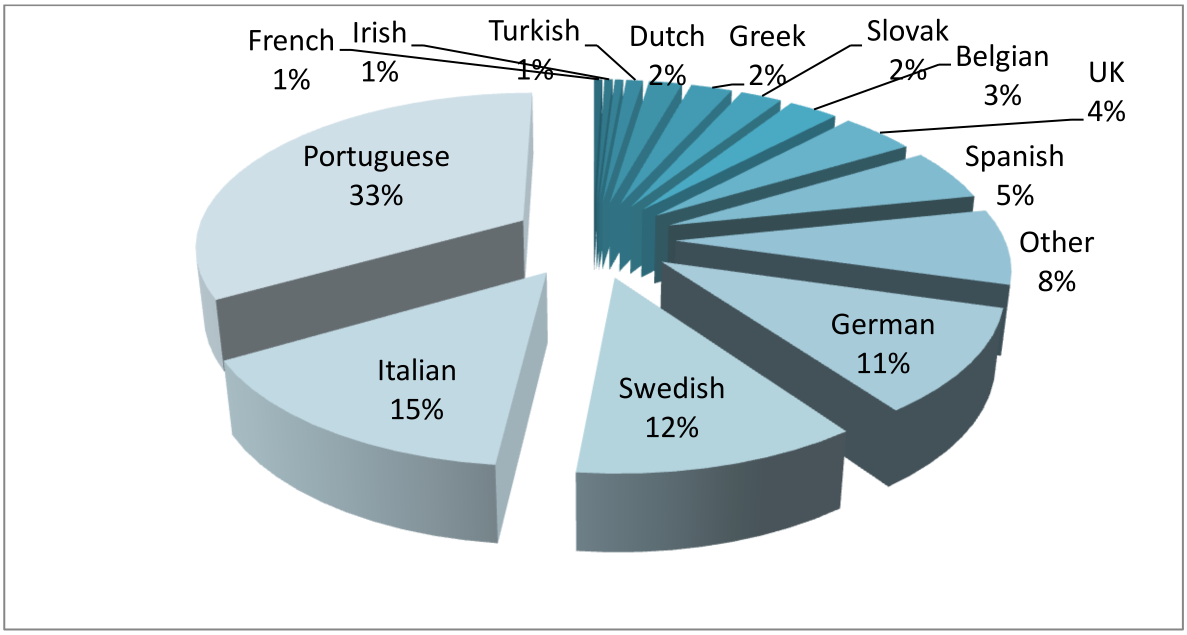


Figure 20. Nationality

Focusing now on the age of respondents, Figure 21 shows that most of the respondents belong to the same cohort of students in their 20s (67%). We have minority groups of respondents who are younger than 20 years old (7%) and older than 50 years old (6 %) and whose age in in the range of 40-50 (5%). Finally, 15 per cent of the sample are in the 30s.

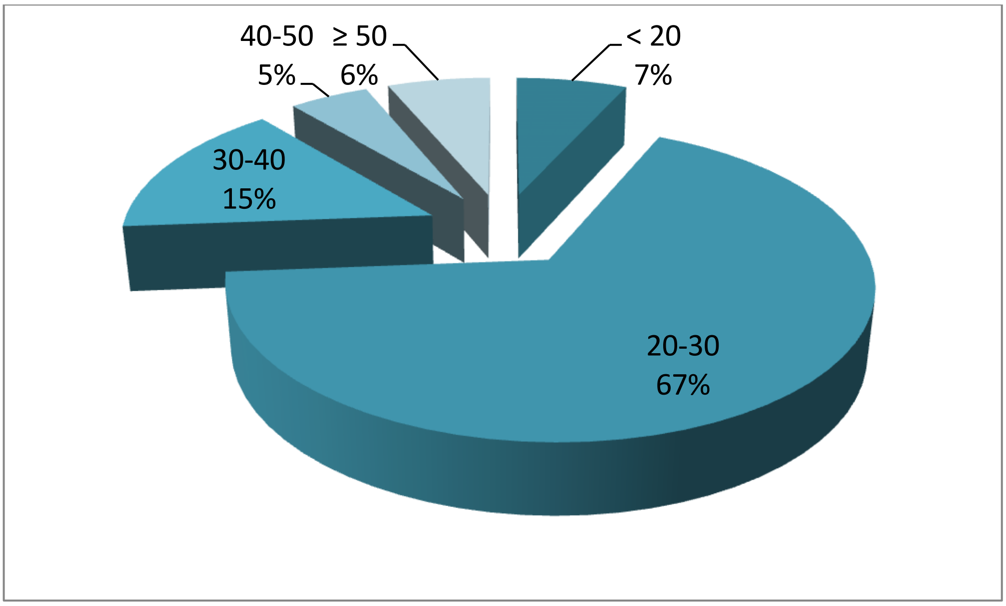


Figure 21. Age

It is well known that English is a vehicular language in the sector of aeronautics, aerospace and air transport. However, our sample for obvious reasons is only represented by a ten per cent of English native speakers (Figure 22).

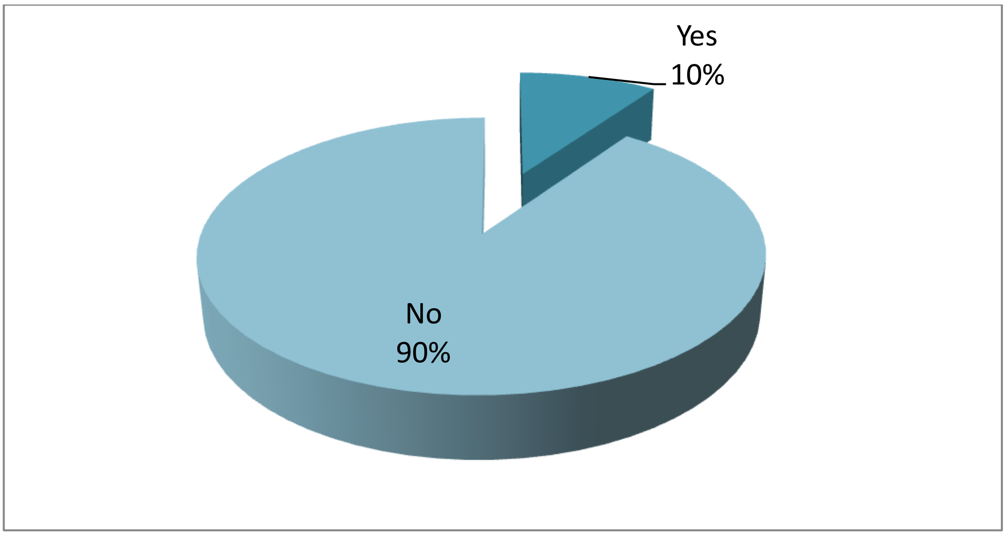


Figure 22. English as a first language

To end the description of the personal information, Figure 23 shows the gender distribution. It can be seen that males are still predominant in the sample (82%). The low percentage of females in the sample and subsequently in the survey participation is not atypical. For many years, the average percentage of students in this field has always been very low. In spite of an increasing number of females in this and other related fields, the real potential is still lagged behind and a further diversity regarding the gender will be a reality in the years to come. This will mean that occupation, roles, and career trajectories that were once restricted to one single group (e.g.,. chief engineers positions were filled almost exclusively by white males) will be in the future open to many.

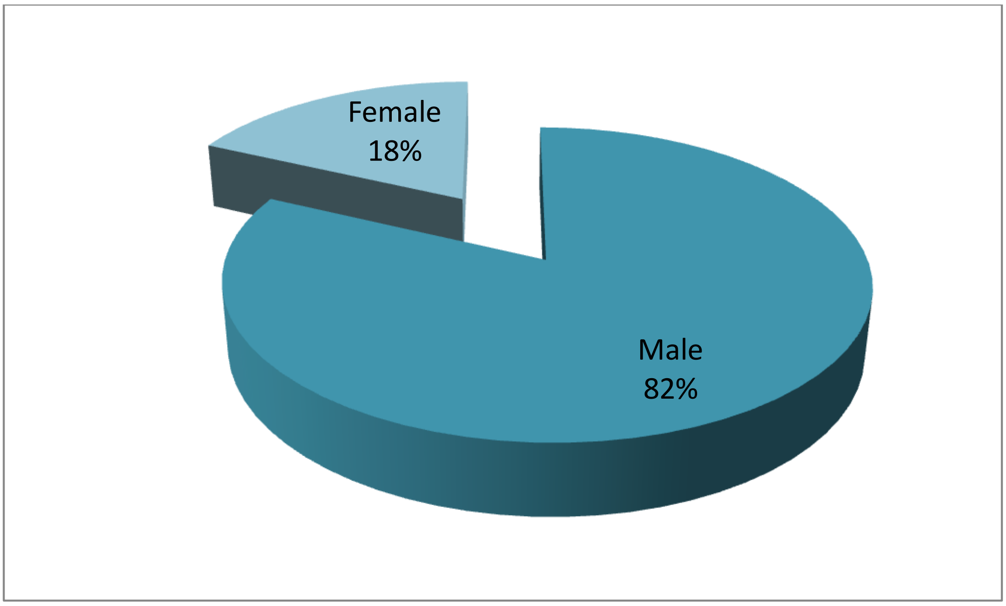


Figure 23. Gender

Regarding the attractive factors of the course and field of study, it can be seen in Table 27, that in many responses it is clearly perceived a passion for aviation, good perspectives of employability, high salaries, engineering is still seen as a very special field in terms of technical issues, aircraft manufacturing, etc., other issues that are more closely linked with the university offering the course, like quality of the courses, skills of the lecturers, etc.

The presentation of the results for an open-ended question is always a challenge. In this case, we have preferred to tabulate the raw results for this open-ended question according to a list of 9 different classes. However, interested readers can consult the raw data of the spontaneous response made by the students in the annex (Table 27).

The presentation of results of open-ended questions gained its momentum with the appearance of online and email surveys. Bachmann et al. (1996) found that length of answers to open-ended questions was higher with the E-mail version than with printed questionnaires. It is evident that entering answers on a keyboard may be easier for some people than writing by hand, it seems plausible that response to open-ended questions may be more complete. For this reason, it became important to develop a method that can be relied on to provide consistent results. Schaefer and Dillman (1998) found even more conclusive results analyzing responses to open-ended questions where more important differences between E-mail and paper mail surveys were observed. Four of the questions obtaining significantly higher completion rates by E-mail were open-ended. The last question on the survey, which asked for additional comments achieved a 12 percent higher completion rate on the E-mail version ($p = .004$). Further, the E-mail version achieved much longer responses to open-ended questions than the paper version. On average, open-ended responses on the E-mail version contained 40 words, while open-ended responses on the paper version contained only 10 words. A similar exercise could be done with our data and our results could be compared with those of Schaefer and Dillman.

Table 7. Attractive factors to choose courses or field of study

Factor	Code	Frequency	Perc.
Passion for aerospace	1	35	31%
Dynamic innovation in the sector	2	10	9%
Good employment perspectives	3	27	24%
Good provision of technical skills	4	18	16%
Educational excellence	5	7	6%
Networking with the industry	6	5	4%
Internship possibilities	7	4	4%

Globalization, International atmosphere	8	3	3%
Other: residence, fees	9	3	3%

Table 7 shows the tabulation of the open-ended question regarding the attraction factors for choosing the courses or field of study. It can be seen that 95 respondents (44%) answer this question for a total of 112 attraction factors grouped in 9 classes. In order of importance, it is remarkable that the passion for the field (31%), good employment perspectives (24%) and the provision of high-technical skill (16%) are with difference the most cited attraction factors.

In any case, the responses given above can be certainly used as an important input in order to develop a strategic plan about "How to Attract the Young Generation for Aerospace Engineering". It is evident that there still exists a sort of overall fascination of Aeronautics and Aerospace Engineering. A sustainable future for humankind is going to be only possible if we are able to attract talented people to be the workforce of the innovation needed to handle all the challenges posed in our planet now and in the future. Innovation is the lifeblood of the engineering profession, and consequently it seems plausible to think that engineers will need to play a major role in ensuring this future.

A recent report focusing on one particular challenge, climate change which is particularly linked with the field under analysis, prepared by the Institution of Mechanical Engineers in the UK suggested the pivotal role to be played by engineers stating "the engineering profession is an important stakeholder in enabling the world to adapt to climate change and engineers themselves need to be provided with the opportunities to respond to the challenges" (ImecE, 2009) .

In order to meet this requirement, there must be a supply of engineering talent that can turn its collective mind to the work required. For this reason, it is become evident that we need to embark young people in the study of engineering as a way to start their professional careers. However, the situation is becoming difficult as data suggests that engineering is not a preferred subject of study for the current generation of students. A December 2008 report prepared for the European Commission found that when asked if they would consider studying engineering in order to get a job, 71% of young EU citizens answered no (Gallup, 2008). The interest in science and technology across the EU27 countries is variable, in some cases only just reaching 50%. The challenge for governments, policy makers and engineering educators is how they can change perceptions such that a career in engineering is seen as both worthwhile and rewarding.

Regarding the repulsive factors, Table 8 shows that the most cited factors, after tabulating the raw data, are the difficulty of the courses (49%), the lack of direct application or involvement in the real world (12%) and other aspects related to the exercise of the profession which difficult the employability of the respondents (15%), such as for example like the need of obtaining different professional licenses. Other interesting issues that appear is the gender gap and the concentration of the job in a limited number of countries.

In this case we obtain that 76 respondents (35%) answer this question for a total of 78 repulsion factors grouped in 6 classes. Again, interested readers in all the raw data of the spontaneous response made by the students are referred to the annex (Table 28).

Table 8. Repulsive factors to choose courses or field of study

Factor	Code	Frequency	Perc.
Lack of employability	1	12	15%
Lack of innovation	2	3	4%
Lack of applicability	3	9	12%
Difficult topics, maths, physics	4	38	49%
Poor educational level	6	4	5%
Other	5	12	15%

Regarding the professional licenses that our respondents have, the results show that the interaction between this field of study and the professional licenses is not very important: 10 respondents are pilots, 3 are air traffic controllers and other 3 are aircraft maintenance mechanics.

As a consequence of the current financial crisis, the engineering job market is experiencing the same weakness as other sectors and it is becoming to be less healthy than some previous years ago. Then, the key question remains to be unsolved to what extent is worth for a 14 to 18 year old to follow a secondary school study path of mathematics, physics and chemistry to ultimately find themselves doing a longer bachelor degree that needs necessarily complemented by additional studies in a master, to finally end working in a job that has long hours and hard work, and getting paid the same if not less than someone who has done a less demanding qualification? This lack of interest is translated also into a shortage of skilled labor which can mean national infrastructure work needing to be outsourced to international suppliers. So, another question appears in the horizon, are these big corporations going to be very big in order to exert monopoly power even to national states, as they are really vulnerable relying on outsourcing global players to address engineering demands. This vicious circle does clearly exists and is even being aggravated at a time when the economy is weak and jobs are being lost.

Engineering education is traditionally costly and requires government and industry funding to assist it and ensure its quality. Establishing the cost associated with training an engineer would be both an interesting and valuable in order to evaluate what society can gain from this engineering education as well as the likely global impact of the engineer's work.

4.3.2 Second Part. Competences, academic degree evaluation, personal career assessment and career planning consultants

The aerospace and aeronautics engineering involves several disciplines and it has an evident global orientation. For this reason, the educational programs should also provide a global or international focus. One of the first steps in the process of developing a global curricula is then to understand what subjects and topics are important, what methodologies can be used, and what tools are needed to achieve the desired outcomes. Parkinson et al. (2009) sustained that students with global competence should be equipped with a wide set of abilities. The most important abilities include:

- appreciation to other cultures;
- proficiency in working in or in directing a team of ethnic and cultural diversity;
- ability to communicate across cultures;
- effective dealing with ethical issues arising from cultural or national differences; and
- engineering practice in a global context, whether through an international internship, a service-learning opportunity, a virtual global engineering project or some other form of experience.

To prepare the students with these abilities, emphasis should be placed on three areas of education:

- foreign culture appreciation and understanding;
- communicating in foreign language; and
- real-world practice in a global context.

Based on Parkinson, an individual program that only focuses on one of these aspects, such as on campus foreign language training class, is insufficient. A complete program should combine all three aspects. If this is impossible, a program system constituting different levels of activities should be established, and the activities should involve training or education that can compensate for missing elements.

To succeed within a global engineering environment, it is more important than in the past that graduates possess some additional skills and competences which can be declared as "global", beyond the classical technical engineering competences. This has to be done in terms of complementing and not substituting them, because these are needed in our global world that is even more interconnected and interdependent than ever before.

In the online survey, the respondents were asked to indicate if a set of competences are important for their appraisal and if they possess those competences. As the reader can see there are some competences that can be classified as "global".

Table 9. Importance of competences for appraisal and self-assessment

Competence	**Average Importance**	**Average Self-Assessment**
Research skills and techniques	3.38	2.81
Ethics and research governance	2.87	2.84
Personal effectiveness	3.49	2.85
Communication skills	3.37	2.89
Team working	3.37	3.04
Career management	2.87	2.42
Knowledge transfer and outreach activities	3.27	2.73
Teaching	2.50	2.50
Leadership management	2.94	2.66
Importance for appraisal? 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant | NA. Not applicable Self-assessment. Possessed by me? 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

Each respondent was requested to rank from one to four the importance of individual competences under a set of nine pre-established competences. A four point mark is chosen when the competence is considered highly relevant to their appraisal. On the other extreme, 1 point is chosen when the competence is considered not relevant at all. Other feature of the online survey is that the respondent was asked to give a self-assessment for each competence in other likert scale of 4 divisions (from 1. I do not possess to 4. I have more than required). The average figures for the importance and the self-assessment are shown in Table 9.

It can be seen that in order of importance, the following competences are the most valued: Knowledge transfer and outreach activities (3.27), Communication skills (3.37), Team working (3.37), Research skills and techniques (3.38) and Personal effectiveness (3.49). However, when we look at the self-assessment, we obtain the following results: Team working (3.04), Communication skills (2.88), Personal effectiveness (2.85), Ethics and research governance (2.84) and Research skills and techniques (2.81).

Finally if we subtract from the importance the value of self-assessment, we obtain a measure of internal gap according to the evaluation of each of the respondents. In this case, it can be seen that the most pronounced gap is obtained for the following competences: Personal effectiveness (-0.63), Research skills and techniques (-0.57), Knowledge transfer and outreach activities (-0.54), Communication skills (-0.48) and Career management (-0.45).

We would like to highlight here that the average respondent thinks that the gap is negative for all the competences except teaching which is the less valued competence in importance and the gap value is zero.

Regarding the academic degree evaluation, respondents were asked to compare in relation to other people whether they think that their academic degree will provide or provided a higher salary and other statements. The question needs to be answered on a base of their agreement on a 4-point agreement Likert scale as shown in the last row: 1. Strongly disagree | 2. Disagree | 3. Agree | 4. Strongly agree.

Table 10 shows the results and it can be seen that in order of agreement, the following statements are the most valued: Opportunities to participate in international projects and consortiums (3.5), Better conditions of employment (3.33), Opportunities to participate in decision-making processes (3.28), Opportunities for promotion (3.25) and Opportunities to attend conferences and external meetings (3.24).

Table 10. Academic degree evaluation

Statement	**Average Importance**
Higher salary	3.13
Opportunities for promotion	3.25
Opportunities to participate in decision-making processes	3.28
Visibility on website and staff directories	2.14
Better conditions of employment	3.34

Statement	Average Importance
Access to training and development	3.22
Opportunities to attend conferences and external meetings	3.24
Opportunities to participate in international projects and consortiums	3.50
In comparison with other people who do not have your academic degree, do you agree that your studies will provide/have provided… 1. Strongly disagree | 2. Disagree | 3. Agree | 4. Strongly agree	

Regarding the personal career assessment, respondents were asked whether they agree or not with a set of statements. The question needs to be answered on a base of their agreement on a 4-point agreement Likert scale as shown in the last row: 1. Strongly disagree | 2. Disagree | 3. Agree | 4. Strongly agree.

Table 10 shows the results and it can be seen that independently of the statement, all the respondents seem mostly to agree with all of them. These results are very important as work engagement is an important indicator of occupational well-being for both employees and organizations.

Table 11. Personal career assessment

Statement	Average Importance
You are encouraged to engage in personal and career development?	3.88
You are reflected on your development needs?	3.86
You have a clear career development plan?	3.38
You maintain a record of your professional development?	3.57
To what extent do you agree that… 1. Strongly disagree | 2. Disagree | 3. Agree | 4. Strongly agree	

Bakker and Schaufeli (2008) have noted the need for positive organizational behavior (POB) research, defined as "the study and application of positively oriented human resource strengths and psychological capacities that can be measured, developed, and effectively managed for performance improvement in today's workplace. Work engagement is defined as a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption (Schaufeli et al., 2002). Vigor is characterized by high levels of energy and mental resilience while working. Dedication refers to being strongly involved in one's work and experiencing a sense of significance, enthusiasm, and challenge. Absorption is characterized by being fully concentrated and happily engrossed in one's work, whereby time passes quickly and one has difficulties with detaching oneself from work (Schaufeli and Bakker, 2004). In short, engaged employees have high levels of energy and are enthusiastic about their work. Moreover, they are often fully immersed in their work so that time flies (May et al., 2004). Bakker and Demerouti (2008) put work engagement on the research agenda by showing that engagement is predicted by typical job resources, is related to personal resources and leads to higher job performance. Thus, work engagement is an important indicator of occupational well-being for both employees and organizations. Human resource managers can do several things to facilitate work engagement among their employees. Important starting point for any active policy is the measurement of engagement and its drivers among all employees.

Table 12 shows the relative importance of the parties consulted for the long-term career planning. The results show that in order of importance, the most consulted parties are as follows: Colleagues (100%), Partner/family/friends (100%), Mentor (67%) and Career advisors (36%).

Table 12. Long-term career planning consultants

Consultant	Avg. Percentage Relative terms
Career advisors	36%
Staff developer	10%
Human resources specialist	19%
Principal investigator (PI)/line manager	26%
Your appraiser (if they are not your PI/line manager)	10%
Mentor	67%
Colleagues	100%
Professional body/learned society	17%
Funding organization	6%
Recruitment agency	10%

Consultant	Avg. Percentage Relative terms
Online social networks	16%
Partner/family/friends	100%

Organizational structures, cultures and processes are essential inputs for career systems. Career is a major life constituency – it evolves around work, and work provides sense of purpose, challenge, self-fulfillment, and, of course, income. Moreover, work is a source of identity, creativity, life challenge, as well as status and access to social networking. Overall, one can see career as a life journey. Building on the metaphor of life journey, people can take the beaten path, or opt to navigate their own way in the open plains.

Baruch (2004) analyzed the new emerging nature of career paths, as being multidirectional, dynamic and fluid. This will be contrasted with the traditional view of careers, which is more linear, static and rigid. He concluded by offering different ways and an intriguing model, i.e. the academic career model, as a possible alternative for traditional career perspectives. Contemporary works put under focus the changing meaning of careers. Scholars point out a shift from the long-term-based career relationships, into transactional, short-term-based ones that evolved between individuals and their employing organizations (Baruch, 2003). In the past, people expected to serve their organization for their entire working life. Even if this was not the actual case, this was the desirable development. Now people expect the organization to serve them, and the time span for the relationship to last could be easily reduced to very few years.

Some scholars have proposed to have the academic career model as a role model for future careers? They argue very seriously according to the following premises. The academic career system has unique features, which, in the past, have made it significantly different from the traditional career model. The academic career model used to be just different, more of an exclusive and unique model. Now, with the changing nature of careers, organizations in both business and not-for-profit sectors explore alternative career models which they may adopt. Can the academic career model operate as a leading prototype, an indicator of direction and changes in the career systems in other sectors? The major features of the academic career model are: flat structure (but quite rigid), professionally based. Individually leads where lateral and even downwards movement are accepted (e.g., when a Dean returns to serve as a Professor, conducting research and teaching, it is not considered "demotion"). Upwards mobility is limited, even not desired (becoming a Dean might take scholars off the research route). Cross organizational moves (but not cross functional) have become the norm of career moves (i.e. scholars in biology can move around universities, but will not move within the university to a different section, say to sociology). Sabbaticals are part of the career. Perhaps more fundamental, the academic career model builds on networking within and across organizations.

4.3.3 Third Part. Areas of interest for working, additional interest in education, companies for working and activities of the curricula

Following the discussion of the career development students were asked to respond about the main areas of interest for career development. Figure 24 shows that most of the respondents answered that they are interested in developing a career as an employee in air transport related company (61%). There is only a scarce 11 per cent who wants to develop their career outside the air transport sector, 15 per cent wants to become a researcher, 3 per cent wants to continue studying further and 10 per cent does not still decide it.

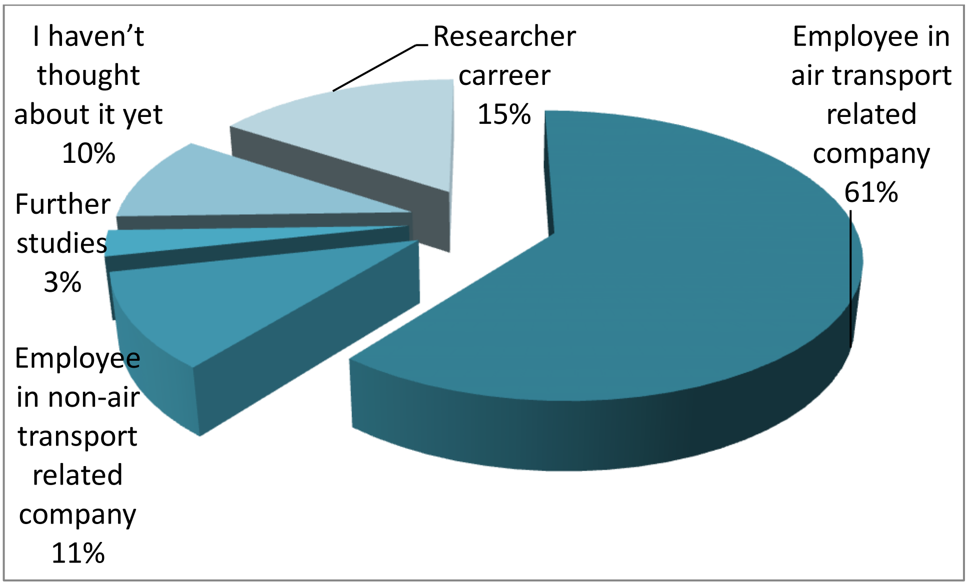


Figure 24. Areas of career development

It is evident that most of the respondents are keen to develop their career in air transport related companies. At the start of the new millennium, the Group of Personalities expressed a vision for European aviation evolution for the 2020 horizon. This vision led to the formation of ACARE to define and review the content of the Strategic Research Agenda (SRA).

The SRA themes and goals have had a leading influence on aeronautical research and are paving the way for the significant improvements in sustainable, reliable, affordable and passenger-friendly aviation that will reduce the environmental impact of air travel across the world.

However, since 2000, the perception and requirements of air transport have changed significantly.

In recognition of these important changes, ACARE has for the last years reflected on their implications and emergent challenges for aeronautics and air transport on a revised horizon. A great deal is at stake: aeronautics and air transport should be considered as a strategic economic and social domain to ensure the future of European integration, independence, prosperity, and competitiveness in the global economy. Far-sighted research and development programmes are essential for the development of new ideas and to drive investment and innovation in support of an environmentally sound Air Transport System in the longer term.

The European Air Transport sector is vigorous and will need the best talented engineers for the future in order to maintain its privileged status in the world. It is made up of civil Aeronautics and Air Transport that generates a turnover in excess of Euro 94 billion and represents a pinnacle of manufacturing which employs almost half a million highly skilled people directly and spinning-out technology to other sectors. About 2.6 million indirect jobs can be attributed to air transport related activities and a contribution of around Euro 240 billion to gross domestic product. The Aeronautics and the Air Transport sector is a key strategic economic domain for Europe.

A European Vision for Aeronautics and Air Transport in 2020 was launched by Commissioner Busquin in 2000. This established a vision to meet the needs of society, while maintaining European global leadership in aeronautics. This vision led to the formation of ACARE (the Advisory Council for Aeronautics Research in Europe) to define a Strategic Research Agenda (SRA) and make the vision a reality. The SRA provides strategic goals and Research & Technology (R&T) roadmaps for proposed solutions to achieve the objectives outlined in Vision 2020.

The SRA goals have had a clear influence on current aeronautical research. There is strong evidence of a vigorous programme of Aeronautics and Air Transport research, which is already delivering important initiatives and benefits for the aviation industry, including: EU collaborative research in Aeronautics and Air Transport (EC's Framework Programme research), the Clean Sky Joint Technology Initiative, the SESAR Joint Undertaking, national programmes in many Member States and research establishment as well as private company programmes.

In the report of the High Level Group on Aviation Research "Flightpath 2050 Europe's Vision for Aviation" EC(2011), highly ambitious goals can be read according to two parallel objectives: maintaining global leadership and serving society's needs. Regarding the global leadership it is necessary to: (1) provide the best products and associated services in aeronautics and air transport; (2) ensure the competitiveness of European industry, supported by a strong research network and balanced regulatory framework, in the face of fierce competition from both established and emerging rivals; (3) Maximize the aviation sector's economic contribution and creating value; (4) attract the best people and talents. To serve society's needs there is a need to create market conditions that guarantee an affordable, sustainable, reliable and seamless connectivity for passengers and freight with sufficient capacity. Thus, there are good opportunities to be involved in this high-tech sector in the near future within the EU.

Table 13 shows the raw data of the question about the interest in taking any additional programs/courses to gain extra competences. It can be seen that for the affirmative response, there is a clear distinction between those courses in specific aeronautics themes as Advanced Polymer Chemistry, Aeronautics and propulsion or Air Accident Investigation, from those more general in complementary competences like Economics or Management, and finally skills related with languages.

Table 13. Additional interest in further education

Yes.
Advanced polymer chemistry
Aeronautics and propulsion.
Air Accident Investigation
Air controller and flight license
Air traffic controller
AMPAP
ATC controller licence, Commercial Pilot Licence (CPL)
Athens Programme
Aviation Maintenance Management
CATIA, English course, audit courses, safety courses
Computer Science and Programming
Economics
Exchange program
Flight Training / Pilot License
German course

I would like to do a Post Doctoral course.
I'd like to do ERASMUS in another country of Europe, but I'd like even more to do an internship in some aerospace related enterprise
Information Technology
International internship
Internships in air transport sector to understand airports operations
Language
Language courses
Language courses
Language courses
Language skills(third language)
language(French, Chinese)
Languages Courses (Chinese, French)
languages formation
Leadership course, economy course, (politics, social science course)
Management
Management
Master Degree, EASA Part 66 License
Master in economy
MBA
MBA programme.
Nanotechnology
Online Education; Research-Enterprise collaboration
Operations Research

Other languages, Operation research, or, Management courses.
Personal pilot license
Post Doc stay
Presentation style, Business English
Programmer Certification for software development
Soft-Skills, maybe economical knowledge
Some international internships
Specific program about air traffic education
Statistics, scenarios prediction and data analysis
Technical maintenance
The ones needed to do an excellent work in my future job.
Thinking about a helicopter pilot licence
No
A PhD should be sufficient
After a 5 years of studies i want to work in the area
Any competence needed at this point can be acquired on the fly
At first finish my doctor degree.
Further courses don´t interest me
I am working on my PhD
I don't have time or money to do it
I don't know yet. I think there aren't any at the moment
I have to learn by myself
I haven´t thought about it yet
I haven’t thought about it yet.
I need to finish my Ph.D. thesis
I prefer on the job experience

I value most experiences on companies than courses
I'm hoping to become an air-traffic controller.
Maybe not academic courses but of some other kind.
No because the next competences I need more are from experience and on site not more courses
No interest or need at the moment
No need up to now
Not now!
Not right now, because I will take this exam and see what I can do with it. If I decide to study more in 3 years, it's a matter then.
The competences necessary in the job are provided by small, special trainings.
The programme is already full with courses and there is no time to study extra courses.
Time restrictions

Regarding the respondents with negative answers, it can be seen that some of them manifested that it is time to put into practice the previous knowledge acquired. Other answers are also related to the same concept as they want to enjoy some internship and others for lack of time and money.

Regarding the companies for working, Table 14 shows that most of the respondents have decided to work in air transport related companies. It is evident that due to the degree of specialization of their field of studies, many of them manifest a desire to work for manufacturers, motors, propulsion and other high-tech companies related to the supply chain of air transport.

Table 14. Companies you would like to work for

Air transport, manufacturer, airline industry, aerospace industry, fuselage industry, propulsion industry.
A company in aerospace sector.
A company which provides ATC.

A global air traffic company, which is (hopefully) under development.
Academia
Aero or automotive
Aeronautical
Aerospace company, preferably about space applications
Agusta-westland. eurocopter
Air carriers
Airbus Boeing Rolls-Royce
Airbus ESA Lufthansa Technik Airport
Aircraft Manufacturer, ranging from General Aviation to Air Transport
Airline or Air Navigation Service Provider or Aviation Consultancy
Airline or airport
Airline, airports.
Airliners and MRO
Airport, airline..
An airline or at an airport
An international organisation which has excellent opportunities for solving difficult problems
Automotive company
Automotive, Impact Analysis, Safety, Civil
Boeing/ Thales/ Astrium
Commercial company or institutional organisation/program
Consulting (research)
Definitely an Airliner and/or University
Design and development of new aircraft for atmosphere or space
EASA Part 21J Design Organisation (for General Aviation)
Either European Space Agency, or some aerospace consultancy

company, or something like SpaceX, but I'm also hoping to create my own company, further in the future, in order to do aerospace related business my own way.
Family enterprise
I would like to work in air transport company - TACV
ICAO; ACI World, IATA
Jet engine development company
Luxury/sports cars

The European Air Transport sector must continuously innovate to remain globally competitive against strong competition from North America as well as emerging economies. The shift of economic power to the East implies new markets for the European industry, but at the same time new competitors will emerge from Brazil, Russia, India, and China. Some of these states view aviation as a strategic sector, which implies strong governmental support for the respective companies. For Europe, a strong aviation sector is vital to compete effectively on a global scale. Managing the evolution of the supply chain of the future will be a key element in Europe's success.

For the industry as a whole, a concentration on core competencies and high value-added activities will be key success factors. There is an additional urgent need for a new commitment to global cooperation (e.g. with the USA and with emerging new competitors) to help European industry address the technological challenges. Developing a strategy for clear "win-win situations" will help aviation better serve the needs of society.

Table 15 shows the answers about the way students have in mind to contact the firms they want to work for. It can be seen that most of the answers can be grouped in the following categories: internet or web sites, fairs, networking or internships.

Table 15. Instruments to contact the firms of interest to work for.

A variety of methods, from conferences to being introduced to key people.
At a job fair at my university
At the fairs, job offers at the university

By Email
By internet
By virtue of being in the field as a pilot.
Communication
Conference, internet.
Conferences and direct contact via email
During these year in university and reading journals.
Exhibitions
Friends and Professors
Friends, professors, conferences, ...
From colleagues and teacher that have been contacting them
From my education.
From my studies
from publications, through colleagues or through work
Household name
I don't exactly know any because my course doesn't have a very strong integration with real world technology companies, only with research institutions
I have used many of them on my travels. And there have been some people lecturing us in the school.
I know them... can't say how you learn about car manufacturers ;)
I study here during my Master
I work there.
Internet, media
International meeting or publication...
Internet
Internet

internet
Internet
internet
Internet and University industry divulgation/career workshops.
Internet, contacts
Internship / Final year thesis, Internet, Career fair, Aviation fair
Internship during studies.
Internship, then full-time employment at ICAO (aside of my PhD: doing both at the same time). Work relations with ACI and IATA
Internships and cooperation
It's from my country.
Job fair
Media, internet
Most of them by searching on the internet
Networking
Networking
No specific company at the moment.
Online research; forum and presentations at the university
Own research
Personal experience since six years as a commercial pilot.
Presentation days of companies, company fairs, internet, a conference
Presentations, internet
Publicity, research, conferences
Reputation, publication, international visibility
Research
Researching online

Sending my CV
Search the internet
Study visits
Television, internet
Television, Newspaper, Internet
They are well-known since many years back
Through application for my studies
Through internet and lectures
Through my own network
Through my studies
Through PhD conferences
Through presentations in the IST campus.
Through Think Research
University and social websites
Use of their services.
Usually by web
Via the internet
Web
Website
Websites
Work during PhD

Ninety nine per cent of the work force are employed and work for someone else, a firm or a NPO. Around only one per cent runs their own business. This leaves a majority of us who needs to find an employer, then how does this match occur?

As in every situation where two parties must come together to accomplish their objectives. the employer and potential employee should meet each other's needs. The big challenge for employees is to learn what the real needs of the employers are, both in the areas of hard and soft skills. Employers, on the other hand. would like to know the real drivers of the people they are considering. "Real driver" refers to what motivates potential employees. If employers know that a job can meet employees' needs, the chances are high that these employees will stay at their jobs for a long time and contribute more to the organization. Different aspects of engineering motivate different individuals. For some, it means working on the latest development in the field; for others, it’s doing failure analysis, and for still others, it's communication and technical presentations.

Employers generally look for technical competencies and an ability to fit into the organization, They check these two main aspects through various means: going through the resume, conducting an interview, and doing reference checks. The right education and work experience might attract employers' attention to initiate a meeting, but it is the actual interview that will allow employers to discover the overall suitability of candidates. Viewed from another angle, employers look for a “can do" attitude., a willingness to learn and adapt quickly, and to work with others, among other qualities.

The majority of engineers find jobs through networking. Other means include searching the Internet, company websites, newspaper advertisements, resource centres, etc. Some people find jobs through phone calls. Engineers seeking jobs come from various backgrounds and experience levels. Normally, people first look at job advertisements in newspapers. But not all jobs are advertised. There are many hidden jobs. When people cannot find jobs advertised in the paper or on the Internet that match their requirements, they start asking around (networking). Networking is the main method used to find jobs. Apart from networking and Internet job postings, some may take up volunteer jobs or internships in their field and then find permanent positions.

Regarding the activities carried out during the curricula, Figure 25 shows that students have less interest in improving communication skills (22 %), they have already acquired experienced outside their immediate area of field (39 %), and they maintain an interest for the future for most of the activities: Acquiring experience outside your immediate area (49 %) , Developing management experience or expertise (65 %), Developing a broader experience of research functions (62 %) and Improving communication skills (58 %).

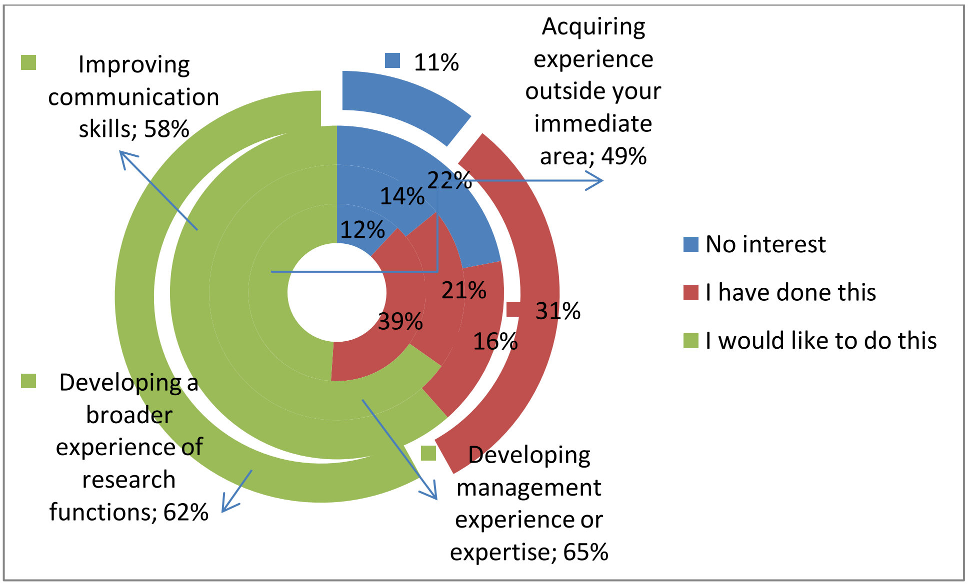


Figure 25. Activities of the curricula

Nguyen (1998) defined engineering as a broad field that embraces knowledge and training in business/management, science, mathematics, social science and (computer) technology. In order for engineers to function effectively in such a multidisciplinary environment, engineering education must have the capacity to instil its graduates with skills and attributes from these diverse areas among other that can be more technical and specific to engineering: Social Science (Communication skills, Social skills, Presentation skills and Interpersonal skills); Business/Management (Leadership skills, Business management skills, Team-working skills and Accounting skills).

She concluded that the ideal engineer must possess sound knowledge of fundamental engineering principles and laws, and must be able to apply the knowledge and convert theory into practice. The engineer must be skilful and practical in the chosen field. The research also indicates that there is growing demand for engineers to understand the impact of their work on the environment and to be able to find environmental solutions to minimise or prevent damage to the environment.

The ideal engineer must be able to keep control of the quality of the product, which requires familiarity with auditing and checking procedures, and must understand the common language of engineers and have a broad understanding of economic and political structures and the relationships between different countries.

The desirable skills and attributes for engineers include the ability to communicate effectively, both verbally and in writing, to peers, the employer, client and the community; engineers should also be bilingual.

4.3.4 Fourth Part. Previous labor experience, relevant qualifications for getting a job and skills.

In Figure 26, it can be seen that most of the students (73 %) does not have previous experience in work. For this reason it is very important to develop at each level of the Bologna Process, real activities that are fruit of adequate internships.

Normally it is through adequate internships programs when junior engineers first encounter with real world far apart from sophisticated mathematics, physics and other disciplines problems solving. Having been interested in the discipline for a number of years, students with a sort of passion for the field or "`always knew I wanted to be an aeronautical engineer", it is the time where this attitude needs to be consolidated and solidified during periods of being an apprenticeship, working a number of hours a week as an intern among real engineers. In these circumstances, it is easier to be ready to the next step of finding a job and sometimes they can even finally work for the company where they have developed the internship program. It is like a baptism for the new graduates, they usually enjoy the experience and the atmosphere of working in solving real problems.

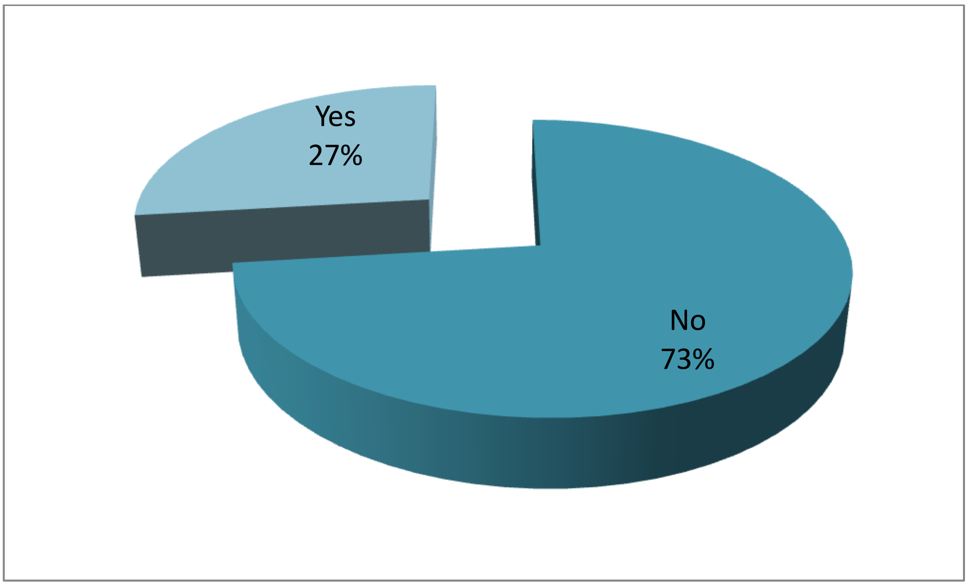


Figure 26. Previous work experience

Regarding the relevancy of qualifications and skills for getting a job, it can be seen in Table 16 that with respect to qualifications, the possession of a university degree (3.45) is even more valued than the degree in air transport and aeronautics (3.21). Behind these two issues, the previous working experience is also highly valued (3.10).

Looking at the skill, it can be noted that technical skills are the most valued. However, two transversal skills like Oral and written communications (3.26) and Ability to work in multidisciplinary teams (3.66) are also very important.

Table 16. Importance of qualifications and skills for getting a job

Qualifications	**Average**
University degree	3.45
University degree in air transport/ aeronautics	3.21
Previous working experience	2.92
Previous working experience related to air transport/ aeronautics	3.10
Other	2.82
Skills	**Average**
Problem solving	3.71
Analytical background	3.30
Technical background	3.48
Theoretical background	3.03
Oral and written communications	3.26
Leadership	3.13
Ability to work in multidisciplinary teams	3.66
Other	2.78

Warnick (2010) found similar results analyzing the importance competences when companies hire mechanical engineers. He showed that GPA and work experience are usually considered by many organizations as part of standard selection criteria when hiring. He used a classification of 4 competences that are usually standard for measuring general technical proficiency in engineers and other general and 8 global and transversal competences.

He found that competences considered important or very important according to a mode analysis included all of the standard engineering technical competences, pertinent applicable work experience, and four of the global competences: an ability to exhibit a global mindset, an ability to appreciate and understand different cultures, an ability to communicate cross-culturally, and an ability to work in international teams. The remaining global competences: a high GPA; an ability to demonstrate world and local knowledge; an ability to speak more than one language including English; an ability to understand international business, law, and technical elements; and an ability to live and work in a transnational engineering environment were considered only moderately important (3) by the survey respondents. None of the competences were considered less than moderately important when making hiring decisions for new engineers.

These results indicated that not only are standard engineering technical competences important, but global competence is an important consideration when making hiring decisions for mechanical engineers who will work immediately or eventually in a global environment. In particular the ability to exhibit a global mindset, an ability to appreciate and understand different cultures, an ability to communicate cross culturally, and an ability to work in international teams are important competences for engineers to develop.

Regarding the list of other competences that were considered important for the respondents, we would like to highlight the following in the group of qualifications: a track record of publications in the field and participation in projects; and these in the group of skills: resilience, management and social skills. (Table 17)

Table 17. Other qualifications and skills

Other Qualifications
Type of personality (being a person whom is ready to learn and work, not afraid of challenges, and capable of maintain a good relation with the others.
A track record of publications in the field.
Acquaintances
Connections
English language
Passion for the aeronautics sector
Projects/research outside the studies plan, related to the aerospace area.
Recommendations
Social skills and personal values are as many important as the described ones.
Specific certifications and processes awards
Other Skills

Resilience.
If you want to work in a organisation or program which is dealing not only with technical problems, but also with political and social ones like EDUCAIR or for example UN organisations do (related to the space sector) you need to have social and political skills
Management.
Sense of Moral/Ethical Responsibility, Stress resistance capabilities/personality, Competitiveness.

Again, we obtain similar results to those obtained by Warnick (2010). He also invited respondents to list any additional competencies their company considered when hiring new mechanical engineers to work in a global environment. Of the 149 respondents that rated competencies considered when hiring mechanical engineers, 51 (34.2%) provided additional qualitative responses. He found that from the categorized qualitative responses of survey respondents, there were only two of the additional competencies (communication and people skills and ability to travel) which were significantly different than the competencies identified in the pre-defined list of competences. The data indicated that an ability to communicate effectively was an important consideration when hiring mechanical engineers to work in a global environment; nearly 30% of respondents considered it important. In addition, the ability and willingness to travel was an important consideration for some with nearly 8% indicating that it was an important consideration when hiring new engineers.

4.3.5 Fifth Part. Competences by subsectors and internship awareness.

This section will present the results of the importance of competences and the self-assessment for a set of competences that are adapted for each sector in which we also made a research in the industry. Each respondent was requested to rank from one to four the importance of individual competences under a pre-defined set of competences. A four point mark is chosen when the competence is considered highly relevant in their opinion for the sector under analysis. On the other extreme, 1 point is chosen when the competence is considered not relevant at all. Other feature of the online survey is that the respondent was asked to give a self-assessment for each competence in other likert scale of 4 divisions (from 1. I do not possess to 4. I have more than required). The average figures for the importance and the self-assessment for the sectors: AIRLINE-COCKPIT CREW and AIRLINE – TECHNICS & ENGINEERING are shown inTable 18.

It can be seen that in order of importance, the following competences are the most valued for the sector AIRLINE-COCKPIT CREW: Planning of the flight (3.28), Understanding air law & operational procedures (3.28) and General and radio navigation & communication (3.27). However, when we look at the self-assessment, we obtain the following results: Understanding air law & operational procedures (1.92), On board instrument control (1.9) and Management of technical aspects (1.89). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Planning of the flight (-1.52) and General and radio navigation & communication (-1.44).

Looking at the competences for the sector AIRLINE – TECHNICS & ENGINEERING, It can be seen that in order of importance, the following competences are the most valued: Maintenance and reparation of airframe (3.45), Maintenance and reparation of power plant (3.36) and Reparation of on board instruments (3.34). However, when we look at the self-assessment, we obtain the following results: Maintenance and reparation of airframe (1.66), Maintenance and reparation of power plant (1.61) and Maintenance and repair of auxiliary systems (1.56). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Reparation of on board instruments (-1.88), Maintenance and reparation of navigation and radio communications equipment (-1.80) and Maintenance and reparation of airframe (-1.79).

Table 18. Importance and Self-Assessment of Competences.
AIRLINE-COCKPIT CREW. AIRLINE – TECHNICS & ENGINEERING

AIRLINE – COCKPIT CREW		
Competence	**Average Importance**	**Average Self-Assessment**
Planning of the flight	3.28	1.76
On board instrument control	3.20	1.90
General and radio navigation & communication	3.27	1.83
Understanding air law & operational procedures	3.28	1.92
Management of technical aspects	3.25	1.89
AIRLINE – TECHNICS & ENGINEERING		
Maintenance and reparation of airframe	3.45	1.66
Maintenance and reparation of power plant	3.36	1.61
Reparation of on board instruments	3.34	1.46
Maintenance and reparation of navigation and radio	3.28	1.48

communications equipment		
Maintenance and repair of auxiliary systems	3.23	1.56
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

The average figures for the importance and the self-assessment for the sector AIRLINE – PLANNING, CONTROL & ICT are shown in Table 19.

It can be seen that in order of importance, the following competences are the most valued for the sector AIRLINE – PLANNING, CONTROL & ICT: Safety management (3.69), Planning and coordination of operations (3.47) and Coordination of maintenance (3.36). However, when we look at the self-assessment, we obtain the following results: Safety management (1.92), Planning and coordination of operations (1.73) and Coordination of maintenance (1.65). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Ramp planning (-1.85), Safety management (-1.77), Planning and coordination of operations (-1.74) and Flight dispatching (-1.74).

Table 19. Importance and Self-Assessment of Competences.
AIRLINE – PLANNING, CONTROL & ICT

AIRLINE – PLANNING, CONTROL & ICT		
Competence	**Average Importance**	**Average Self-Assessment**
Coordination of maintenance	3.36	1.65
Planning and coordination of operations	3.47	1.73
Safety management	3.69	1.92
Flight dispatching	3.34	1.60
Determination and provision of meteorological circumstances	3.17	1.54
Ramp planning	3.35	1.50
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

The average figures for the importance and the self-assessment for the sectors AIRPORT INFRASTRUCTURE, BUILDING & CONSTRUCTION AND PLANNING. AIRPORT OPERATIONS – HANDLING are shown in Table 20

It can be seen that in order of importance, the following competences are the most valued for the sectors AIRPORT INFRASTRUCTURE, BUILDING & CONSTRUCTION AND PLANNING: Design of airside infrastructure (3.47), Design of landside access (3.30) and Master planning (3.30). However, when we look at the self-assessment, we obtain the following results: Design of airside infrastructure (1.80), Design of building and terminal (1.70) and Design of landside access (1.67). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Building & construction of airside infrastructure (-1.85), Building & construction of building and terminal (-1.82) and Building & construction of landside access (-1.82).

It becomes apparent that aerospace engineers made a bad self-assessment in competences that are more related to the ones that are achieved by the civil engineers.

Regarding the competences and the self-assessment for the sector AIRPORT OPERATIONS – HANDLING, it can be seen that all the competences are considered really relevant and that in all the cases, the respondent think that they do not possess enough capacity in all the handling operations.

Table 20. Importance and Self-Assessment of Competences.
AIRPORT INFRASTRUCTURE, BUILDING & CONSTRUCTION AND PLANNING.
AIRPORT OPERATIONS – HANDLING

Competence	Average Importance	Average Self-Assessment
AIRPORT INFRASTRUCTURE		
Design of airside infrastructure	3.47	1.8
Design of building and terminal	3.22	1.7
Design of landside access	3.3	1.67
AIRPORT INFRASTRUCTURE – BUILDING & CONSTRUCTION		
Building & construction of airside infrastructure	3.27	1.42
Building & construction of building and terminal	3.18	1.36
Building & construction of landside access	3.18	1.36
AIRPORT INFRASTRUCTURE – PLANNING		
Master planning	3.3	1.56

Land use planning	3.27	1.52
AIRPORT OPERATIONS – HANDLING		
Handling of passengers	3.37	1.77
Handling of freight	3.25	1.58
Handling of air vehicles	3.47	1.74
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

Table 21 shows the results of the importance and the self-assessment for the sectors AIRPORT OPERATIONS – EMERGENCY, MAINTENANCE AND ENVIRONMENTAL. It can be seen that in order of importance, the following competences are the most valued for the sectors: Airside maintenance (3.46), Emission control (3.41) and Rescue and firefighting (3.36). However, when we look at the self-assessment, we obtain the following results: Emission control (2.OO), Noise control (1.8O) and Rescue and firefighting (1.64). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Airside maintenance (-1.88), Wildlife control (-1.86), Terminal maintenance (-1.76) and Rescue and firefighting (-1.72).

Table 21. Importance and Self-Assessment of Competences.
AIRPORT OPERATIONS – EMERGENCY, MAINTENANCE AND ENVIRONMENTAL

Competence	Average Importance	Average Self-Assessment
AIRPORT OPERATIONS – EMERGENCY		
Rescue and fire fighting	3.36	1.64
Obstacles removal	3.22	1.58
AIRPORT OPERATIONS – MAINTENANCE		
Airside maintenance	3.46	1.58
Terminal maintenance	3.31	1.55
AIRPORT OPERATIONS – ENVIRONMENTAL		
Noise control	2.83	1.8
Emission control	3.41	2
Waste maintenance	3.27	1.58

Wildlife control	3.27	1.41
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

The average figures for the importance and the self-assessment for the sectors AIRPORT OPERATIONS – SECURITY. ATM – AREA CONTROL are shown in Table 22

It can be seen that in order of importance, the following competences are the most valued for the sector AIRPORT OPERATIONS – SECURITY: Security concerning passengers (3.55), Prevention of intrusion / unauthorized access (3.44) and Security concerning employees (3.41). However, when we look at the self-assessment, we obtain the following results: Security concerning passengers (1.83), Security concerning cargo (1.57), Prevention of intrusion / unauthorized access (1.55) and Security concerning employees (1.55). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Prevention of intrusion / unauthorized access (-1.89), Security concerning employees (-1.86) and Security concerning cargo (-1.73).

It becomes apparent that aerospace engineers made a bad self-assessment in competences that are more related to the ones that are achieved by other type of curricula.

Regarding the competences and the self-assessment for the sector ATM – AREA CONTROL , it can be seen that all the competences are considered really relevant and that in all the cases, the respondent think that they do not possess enough capacity in all these type of competences.

Table 22. Importance and Self-Assessment of Competences.
AIRPORT OPERATIONS – SECURITY. ATM – AREA CONTROL

Competence	Average Importance	Average Self-Assessment
AIRPORT OPERATIONS – SECURITY		
Security concerning passengers	3.55	1.83
Security concerning cargo	3.3	1.57
Security concerning employees	3.41	1.55
Prevention of intrusion / unauthorized access	3.44	1.55
ATM – AREA CONTROL		
Supervision of Area Control Centre operations	3.38	1.5
En route aircraft control	3.43	1.54

Planning & coordination en route air traffic	3.45	1.54
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

Table 23 shows the results of the importance and the self-assessment for the sectors ATC – APPROACH, TOWER AND OTHER OPERATIONS. ATM. It can be seen that in order of importance, the following competences are the most valued for the sectors of ATC: Supervision & planning approach operations (3.61), Provision of terminal radar approach control (3.59) and Aircraft landing & taking-off control (3.56). However, when we look at the self-assessment, we obtain the following results: . Aircraft landing & taking-off control (1.61), Provision of flight information to VFR traffic (1.58) and Planning and coordination of network capacity (1.58). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Supervision & planning approach operations (-2.09), Provision of terminal radar approach control (-2.03), Aircraft landing & taking-off control (-1.95), Supervision of tower operations (-1.89) and On the ground aircraft movements control (-1.89).

Table 23. Importance and Self-Assessment of Competences.
ATC – APPROACH, TOWER AND OTHER OPERATIONS. ATM

Competence	Average Importance	Average Self-Assessment
ATC – APPROACH		
Supervision & planning approach operations	3.61	1.52
Provision of terminal radar approach control	3.59	1.56
ATC – TOWER		
Supervision of tower operations	3.41	1.52
On the ground aircraft movements control	3.41	1.52
Aircraft landing & taking-off control	3.56	1.61
ATC – OTHER ATC OPERATIONS		
Provision of flight information to VFR traffic	3.33	1.58
Planning and coordination of network capacity	3.28	1.58
ATM		
Design, development and evaluation of ATC procedures	3.34	1.5
Design, development and sustainment of ATC systems,	3.34	1.61

product and tools		
Management of safety of ATC operations	3.38	1.61
Management of air traffic capacity and efficiency	3.45	1.68
Management of interaction of operational controllers with operational environment	3.35	1.51
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

It can be seen that in order of importance, the following competences are the most valued for the sectors of ATM: Management of air traffic capacity and efficiency (3.45), Management of safety of ATC operations (3.38) and Management of interaction of operational controllers with operational environment (3.35). However, when we look at the self-assessment, we obtain the following results: Management of air traffic capacity and efficiency (1.68), Management of safety of ATC operations (1.61) and Design, development and sustainment of ATC systems, product and tools (1.61). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Management of interaction of operational controllers with operational environment (-1.84), Design, development and evaluation of ATC procedures (-1.84), Management of air traffic capacity and efficiency (-1.77) and Management of safety of ATC operations (-1.77).

The average figures for the importance and the self-assessment for the sector MANUFACTURERS / SUPPLIERS – RESEARCH & TECHNOLOGY are shown in Table 24.

It can be seen that in order of importance, the following competences are the most valued for the sector MANUFACTURERS / SUPPLIERS – RESEARCH & TECHNOLOGY: Test engineering (3.69), Quality engineering (3.63), Propulsion and power plant (3.59), Structural design (3.56) and Failure assessment and recognition (3.54). However, when we look at the self-assessment, we obtain the following results: Fluid mechanics and acoustics (2.30), Propulsion and power plant (2.27), Structural design (2.25), Avionics, electronic and electrical systems & EMC (2.10) and Software design & IT (1.97). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Quality engineering (-1.96), Production rigs (-1.75), Test engineering (-1.74), Customer service (-1.71) and Services solutions (-1.68)

It becomes apparent that aerospace engineers made a better self-assessment in competences of this sector that the other sector shown above. In any case, there are still many internal gaps that need to be further analyzed.

Table 24. Importance and Self-Assessment of Competences.
MANUFACTURERS / SUPPLIERS – RESEARCH & TECHNOLOGY

Competence	Average Importance	Average Self-Assessment
MANUFACTURERS / SUPPLIERS – RESEARCH & TECHNOLOGY		
Failure assessment and recognition	3.54	1.86
Avionics, electronic and electrical systems & EMC	3.50	2.10
Customer service	3.22	1.51
Fluid mechanics and acoustics	3.40	2.30
Propulsion and power plant	3.59	2.27
RAMS, human factors & operability	3.50	1.92
Software design & IT	3.40	1.97
Structural design	3.56	2.25
Test engineering	3.69	1.95
Services solutions	3.37	1.69
Quality engineering	3.63	1.67
Production rigs	3.27	1.52
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

Table 25Table 23 shows the results of the importance and the self-assessment for the sectors MANUFACTURERS / SUPPLIERS – OPERATIONS. It can be seen that in order of importance, the following competences are the most valued for this sector: Maintenance (3.57), Risk management (3.55) and Composites manufacturing and assembly (3.54). However, when we look at the self-assessment, we obtain the following results: Components and aircraft architecture (2.17), Manufacturing engineering (2.14) and Maintenance (2.03). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: Risk management (-1.74), Airline operations appreciation (-1.60), Maintenance (-1.54) and Composites manufacturing and assembly (-1.54).

Table 25. Importance and Self-Assessment of Competences.
MANUFACTURERS / SUPPLIERS – OPERATIONS

Competence	Average Importance	Average Self-Assessment

MANUFACTURERS / SUPPLIERS – OPERATIONS		
Airline operations appreciation	3.30	1.70
Components and aircraft architecture	3.50	2.17
Manufacturing engineering	3.46	2.14
Maintenance	3.57	2.03
RAMS, human factors & operability	3.36	1.85
Governance	3.17	1.68
Risk management	3.55	1.81
Composites manufacturing and assembly	3.54	2.00
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

The average figures for the importance and the self-assessment for the sector MANUFACTURERS / SUPPLIERS – ENGINEERING are shown in Table 26

It can be seen that in order of importance, the following competences are the most valued for this sector: Stress and structures analysis (3.65), Materials and processes (3.59), Structural & general engineering (3.55), Flight physics (3.55) and Composites design and stress (3.55). However, when we look at the self-assessment, we obtain the following results: Flight physics (2.58), Structural & general engineering (2.47), Materials and processes (2.35), Stress and structures analysis (2.30) and Composites design and stress (2.23). If we look at the internal gap we see that the more pronounced gaps are obtained for the following competences: . Electrical design/integration (-1.61), Supply management (-1.53), Systems engineering and architecture (-1.46), Configuration management (-1.45) and Architecture, integration and in-service support (-1.44).

It becomes apparent that aerospace engineers made a better self-assessment in these competences. It can be seen that in all the cases cited above the self-assessment is always higher than two.

Table 26. Importance and Self-Assessment of Competences.
MANUFACTURERS / SUPPLIERS – ENGINEERING

Competence	Average Importance	Average Self-Assessment
MANUFACTURERS / SUPPLIERS – ENGINEERING		

Competence	Average Importance	Average Self-Assessment
MANUFACTURERS / SUPPLIERS – ENGINEERING		
Aircraft operability and design maturity integration	3.4	2.07
Design	3.34	2.14
Failure assessment and recognition	3.45	2.05
Stress and structures analysis	3.65	2.30
Materials and processes	3.59	2.35
Systems engineering and architecture	3.53	2.07
Airworthiness and certification	3.51	2.12
Architecture, integration and in-service support	3.28	1.84
Systems & electronics engineering	3.53	2.1
Structural & general engineering	3.55	2.47
Flight physics	3.55	2.58
Configuration management	3.36	1.91
Importance 1. Not relevant | 2. Minor relevancy | 3. Relevant | 4. Highly relevant Self Assessment 1. I did not possess it | 2. I lacked some bit | 3. I possessed it | 4. I had more than required		

Regarding the awareness of internships programs, Figure 27 shows that in a great percentage the respondents (63 %) are aware of this type of activity. However, in Figure 28, it can be seen that at the same time they do not consider that it is enough, so it is necessary that in the last years of the programs where the core of the advanced Aerospace Engineering topics are usually presented, or the industrial collaborative doctoral programs can be developed in order to increase the presence of the students in the industry to have a first taste and experience of company life as an engineer.

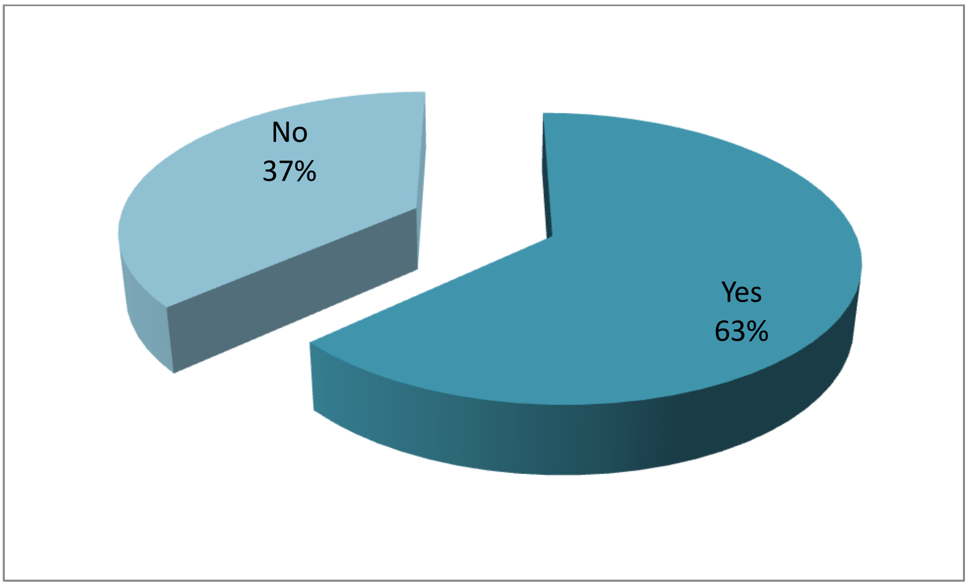


Figure 27. Awareness of internships programs

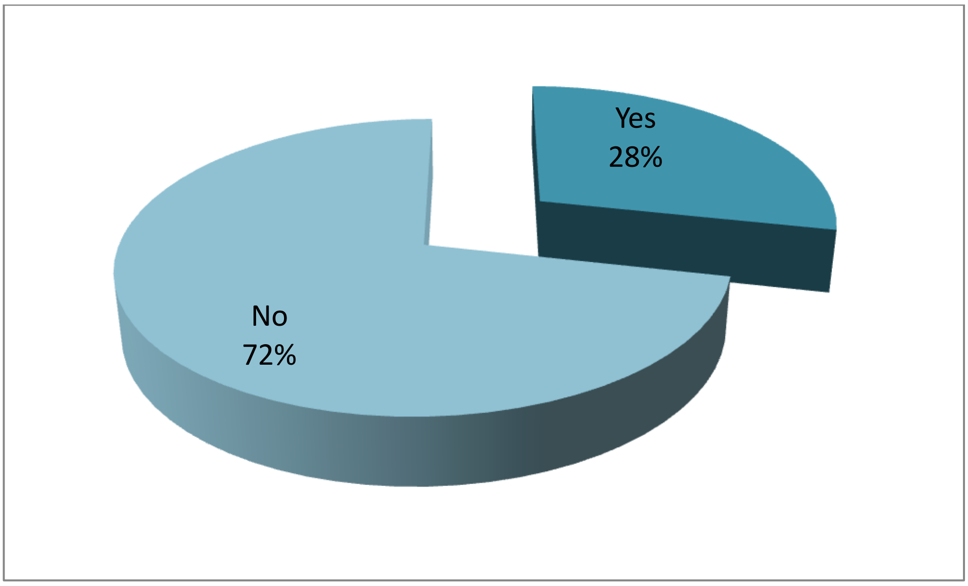


Figure 28. Do you think it is enough?

5 Conclusions

We first analyse the Ph.D. programs of 25 universities checking the web sites of their institution. In some cases, basic information of the teaching modules and other aspects could be gathered and annotated in the template prepared to extract the information of these programs. Then all of our partners were involved in order to complete the available basic information, acknowledging the efforts made by our partners as most of the respondents were reluctant to cooperate, we could only get 13 valid surveys that were not totally complete. In most of the cases, the partner involved contact the head of the programs directly by phone. From the discussions in Salzburg a consensus emerged on a set of ten basic principles, so a summary of the doctoral programmes analysed was undertaken following the structure of these principles:

(1) The core component of doctoral training is the advancement of knowledge through original research. At the same time it is recognised that doctoral training must increasingly meet the needs of an employment market that is wider than academia.
   a. This principle is mostly achieved.

(2) Embedding in institutional strategies and policies: universities as institutions need to assume responsibility for ensuring that the doctoral programmes and research training they offer are designed to meet new challenges and include appropriate professional career development opportunities.
   a. This principle is also mostly achieved but here we recommend in a major involvement of the industry in order to develop collaborative doctoral programmes.

(3) The importance of diversity: the rich diversity of doctoral programmes in Europe - including joint doctorates - is a strength which has to be underpinned by quality and sound practice.
   a. Here, we consider that there is enough room to improve. There is a need to start joint programmes. However it is highlighted that there is a real informal cooperation between the different existing programmes in Europe.

(4) Doctoral candidates as early stage researchers: should be recognized as professionals – with commensurate rights - who make a key contribution to the creation of new knowledge.
   a. This principle is basically achieved but there is also a need to have a more common framework within the EU.

(5) The crucial role of supervision and assessment: in respect of individual doctoral candidates, arrangements supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution (and where appropriate including other partners).
   a. This principle is also partly achieved and it is highly recommended to work in a common code of conduct at the European level.

(6) Achieving critical mass: Doctoral programmes should seek to achieve critical mass and should draw on different types of innovative practice being introduced in universities across Europe, bearing in mind that different solutions may be appropriate to different contexts and in particular across larger and smaller European countries. These range

from graduate schools in major universities to international, national and regional collaboration between universities.

   a. This principle has been partly achieved with the creation of Doctoral Schools in some countries. However in our opinion, it will be advisable to move into the direction of joint programs within the field as a better way to get a critical mass with the main stakeholders of the industry at the European level.

(7) Duration: doctoral programmes should operate within an appropriate time duration (three to four years full-time as a rule).

   a. This principle is basically achieved.

(8) The promotion of innovative structures: to meet the challenge of interdisciplinary training and the development of transferable skills.

   a. There is no evidence about the performance of this principle, but it is highly advisable to work into the direction of creating joint programmes including several universities and different stakeholders of the industry.

(9) Increasing mobility: Doctoral programmes should seek to offer geographical as well as interdisciplinary and intersectoral mobility and international collaboration within an integrated framework of cooperation between universities and other partners.

   a. There is enough room to improve the performance of this principle.

(10) Ensuring appropriate funding: the development of quality doctoral programmes and the successful completion by doctoral candidates requires appropriate and sustainable funding.

   a. This principle is mostly achieved.

Regarding the data analysis of the students' survey, we be presented the results of the statistical analysis in five different parts: (1) personal information, attraction and repulsion factors; (2) competences, academic degree evaluation, personal career assessment and career planning consultants; (3) areas of interest for working, additional interest in education, companies for working and activities of the curricula; (4) previous labor experience, relevant qualifications for getting a job and skills; and (5) competences by subsectors and internship awareness. We finally obtained 215 valid responses that represent the three cycles of the Bologna Process (32 (15%) of the 1st Cycle engineering students; 58 (27%) master students; and 125 (58%) of Ph.D. students).

One of the main characteristics of the personal information is that regarding the gender distribution, it can be seen that males are still predominant in the sample (82%). The low percentage of females in the sample and subsequently in the survey participation is not atypical. For many years, the average percentage of students in this field has always been very low. In spite of an increasing number of females in this and other related fields, the real potential is still lagged behind and a further diversity regarding the gender will be a reality in the years to come. The tabulation of the open-ended question regarding the attraction factors for choosing the courses or field of study, showed that 95 respondents (44%) answer this question for a total of 112 attraction factors grouped in 9 classes. In order of importance, it is remarkable that the passion for the field (31%), good employment perspectives (24%) and the provision of high-technical skill (16%) are with difference the most cited attraction factors.

Regarding the repulsive factors, we showed that the most cited factors, after tabulating the raw data, are the difficulty of the courses (49%), the lack of direct application or involvement in the real world (12%) and other aspects related to the exercise of the profession which difficult the employability of the respondents (15%), such as for example like the need of obtaining different professional licenses. Other interesting issues that appear is the gender gap and the concentration of the job in a limited number of countries.

It can be seen that in order of importance, the following competences are the most valued: Knowledge transfer and outreach activities (3.27), Communication skills (3.37), Team working (3.37), Research skills and techniques (3.38) and Personal effectiveness (3.49). However, when we look at the self-assessment, we obtain the following results: Team working (3.04), Communication skills (2.88), Personal effectiveness (2.85), Ethics and research governance (2.84) and Research skills and techniques (2.81).

We also showed that the results for the relative importance of the parties consulted for the long-term career planning were as follows: Colleagues (100%), Partner/family/friends (100%), Mentor (67%) and Career advisors (36%).

Regarding the companies for working, respondents showed an inclination to air transport related companies. It is evident that due to the degree of specialization of their field of studies, many of them manifested a desire to work for manufacturers, motors, propulsion and other high-tech companies related to the supply chain of air transport.

Regarding the relevancy of qualifications and skills for getting a job, we showed that the possession of a university degree (3.45) was even more valued than the degree in air transport and aeronautics (3.21). Behind these two issues, the previous working experience is also highly valued (3.10).

Regarding the list of other competences that were considered important for the respondents, we would like to highlight the following in the group of qualifications: a track record of publications in the field and participation in projects; and these in the group of skills: resilience, management and social skills.

Regarding the awareness of internships programs, a great percentage of the respondents (63 %) are aware of this type of activity. However, at the same time they do not consider that it is enough, so it is necessary that in the last years of the programs where the core of the advanced Aerospace Engineering topics are usually presented, or the industrial collaborative doctoral programs can be developed in order to increase the presence of the students in the industry to have a first taste and experience of company life as an engineer.

An internal assessment of the core competences was made for different sectors. However, for the sake of exposition we presented the results here in four basic groups: airports, airlines, manufacturers and ANSP. The 23 core competences for airports were analysed, obtaining that most valued are: security concerning passengers (3.55), design of airside infrastructure (3.47) and handling of vehicles (3.47). The selection of core competences were made adequately as in all the cases the average importance value was higher than 3. It is really surprising that in all the cases the self-assessment was lower and students consider that only in one competence (emission control) they pass the assessment with an average value of 2.

Regarding airlines, the competences were classified in 11 classes. The most valued are: safety management (3.69), planning and coordination of operations (3.47) and maintenance and reparation of airframe (3.45). The self-assessment is even worse than for the case of airports, as the students consider that they do not have any competence with an average figure higher than 2.

The 15 core competences for Air Navigation Service Providers were analysed, obtaining that most valued are: supervision & planning approach operations (3.61), Provision of terminal radar approach control (3.59) and aircraft landing & taking-off control (3.56). In all the cases, the relative importance of the competence obtains average figures higher than 3.28. Nevertheless, the self-assessment is really poor as the competence of management of air traffic capacity and efficiency presents the highest score with an average value of 1.68.

Regarding manufacturers, the competences were classified in 36 classes. The most valued are: test engineering (3.69), stress and structures analysis (3.65) and quality engineering (3.63). This sector presents the better results of all regarding the self-assessment as in this case there are 19 core competences in which students claim that they possess the respective competence in certain degree (average figure higher than 2). The competences with the highest values of self-assessment are: flight physics (2.58), structural & general engineering (2.47), materials and processes (2.35), fluid mechanics and acoustics (2.3) and stress and structures analysis (2.3)

The role of Air Transport has never been more important to society, and it is vital that aviation is prepared to meet the challenges of a changing world. With changing demographics and increased urbanisation, society towards 2050 will need more long-range transport to connect markets and people. Passenger travel will increase with growth in business and social-related mobility (dependent on the population being able to afford air travel).

This continuing growth in demand will bring increased challenges for dealing with mass transportation and congestion of infrastructure. Transport will increasingly become a place for work, commerce, leisure, and meeting others. Some travel needs may disappear because of teleconferencing and virtual access to knowledge, but Information and Communication Technology development will add to the opportunities for interaction and ultimately contribute to transport demand. Global forecasts show a potential demand for some 25,000 new passenger and freight aircraft between 2008 and 2028 representing an order book value of Euro 3 trillion. This will be driven by the need for more fuel efficient and eco-efficient vehicles to handle additional capacity as well as for the replacement of older generation aircraft. Important changes in infrastructure and operations will also be needed.

Air Transport will have to find innovative ways to meet the future needs of society for mobility. This "new version" of aviation must be competitive and complementary with other transport modes. Europe, with its unique infrastructure, is able to develop advanced multimodal transport solutions including an appropriate role for aviation in order to provide safe, affordable and sustainable transportation.

Thus, universities need to impulse a sort of working together across the whole community of industry, research establishments, governments, regulatory authorities, and the European Commission. This collaborative framework needs to be maintained to help develop an even more successful future Aeronautics and Air Transport System in Europe.

People recognise aerospace as one of the major drivers of the high-skill levels in society and the significant spill-over/spin-off benefits that this gives to other products and services outside aeronautics. Aerospace provides a rich source of academic problem areas and challenges as well as a good exploitation route for scientific ideas and advances in universities.

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7 Annex

EDUCAIR
Assessing the EDUCational Gaps in Aeronautics and AIR Transport

EDUCAIR Ph.D. PROGRAMS QUESTIONNAIRE

UNIVERSITY: ____________________

NAME OF THE PROGRAM: ____________________

DIRECTOR: ____________________ E-MAIL: ____________________

SECRETARY: ____________________ E-MAIL: ____________________

HAS THE PROGRAM BEEN TEACHING MODULES? YES ☐ NO ☐

IF YES, HOW MANY MODULES? :

TOTAL ECTS:

NAME OF THE MODULES

EXTRACT THE MAIN COMPETENCIES OF THE PROGRAM IF POSSIBLE:

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STRUCTURE OF THE PROGRAM:

- ☐ Individual or interdepartmental
- ☐ Doctoral school
- ☐ European joint program
- ☐ Other. Specify: ____________________

ARE RESEARCH GROUPS INVOLVED? YES ☐ NO ☐

IS THE INDUSTRY INVOLVED? YES ☐ NO ☐

LENGTH OF THE PROGRAM IN YEARS: ______ YEARS

RECRUITMENT CRITERIA:

- ☐ Master
- ☐ CV
- ☐ Personal statement
- ☐ Ph.D. Proposal
- ☐ Other. Specify: ____________________

FEE IN EUROS: ______

FUNDING:

PERCENTAGE OF STUDENTS WITH GRANTS OR FELLOWSHIPS:

STATUS OF DOCTORAL CANDIDATES WITH GRANTS:

- ☐ Student
- ☐ Employee
- ☐ Researcher
- ☐ Other. Specify: ____________________

MONITORING AND ASSESMENT PROCEDURES:

- ☐ Forms that need to be validated by the supervisor
- ☐ Student logs and websites
- ☐ Other. Specify: ____________________

IMPLICATIONS FOR SUPERVISORS:

- ☐ Qualifications requirements beyond being a Ph.D.
- ☐ Duties stated in a code
- ☐ Workload (hours)

REQUIREMENTS FOR THE DOCTORAL THESIS:

- ☐ ISI published papers
- ☐ Published papers
- ☐ External commission
- ☐ Supervisor approval

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REQUIREMENTS FOR THE DEFENSE: PUBLIC SESSION ☐ PRIVATE SESSION ☐

IS THE MARK OBTAINED BY UNANIMOUS JUDGEMENT? YES ☐ NO ☐

IS THE MARK EMITTED IN A PRIVATE BALLOT? YES ☐ NO ☐

CAN THE CANDIDATE FAIL THE DEFENSE? YES ☐ NO ☐

DO YOU TRACK THE PH.D. GRADUATES? YES ☐ NO ☐

NUMBER OF PH.D. GRADUATES IN THE LAST FIVE YEARS: ______ GRADUATES

EFFICIENT RATIO (NUMBER PH.D. GRADUTES/NUMBER PH.D. CANDIDATES IN THE COHORT): ______ %

NAME AND E-MAIL OF SUPERVISORS IN THE LAST 5 YEARS:

NAME	E-MAIL

NAME AND E-MAIL OF THE PHD STUDENTS OF THE LAST 5 YEARS AND TITLE OF THEIR DISSERTATION:

NAME	E-MAIL	TITLE

Table 27. Raw data for the attractive factors to choose courses or field of study

Airports are not just transport terminals. They have become complex facilities that need to satisfy both transportation needs of the passengers, other activities related to business or pleasure and at the same time be efficient in order not to impede the ´´flow´´ of movements in the great air and airport network, find new ways to become more efficient in terms of its own operations (check-in, security, aircraft activities), of the environment, of the peripheral land development.
A good career
Ability to learn about a demanding sector and broad technical skills
Activity Led Learning
Aerofoil
Aeroplanes
Aerospace technology.
Air traffic management, how to handle the air traffic in the future with a touch of logistics.
Aircraft, engineering, employment rate
Aircrafts
Airport development investigation, mainly in the operational and efficiency determination of the airport system.
Attractive prospects for employment after graduation, dynamic field of study, technology.
Attractiveness of career in aviation
Because the future is based on it !
Becoming an engineer   Get a good job
Being space related, and people saying it's one of the best university course in the country
Broad knowledge of government policies and regulation in the field
Broad scope on physics
Career

Challenging and modern
Close relations to aviation industry.
Combination of theory and practical work
Complexity Good chances of having a high salary
Course: Aerospace Systems Lots of different fields to get in contact with.
Curiosity and fascination of aeronautical and astrophysical phenomena
Depth of research (completing my PhD this year)
Employ
Employability
Employment Challenge and difficult
Employment, Physics, ...
Exciting and interesting field of study
Fascination of aircraft and aerospace topics
For me it's like the space, and the excellence of the course between others...
For study a properties of materials on aerospace application
Global
Global Impact
Good support (book, slides, resources on internet, ...) highly skilled professor with industrial experience large team project as part of the evaluation high number of exercise sessions
Hard problems regarding real-time safety-critical nature
High-Tech
Hi-tech engineering, good salary, feeling challenged by working close to the edge what's possible
I chose the course of aeronautics because it is a course in development in my country and it is a course with goods future perspectives for work.
I really appreciate the flexibility offered in the residential requirement.

I was always attracted by ait transport industry
In first place, I like everything related with space, technology and innovation. Since I was 16 years old that I wanted to choose this course. Besides being an almost new course, is sure a "future-facing" one.
Industry interaction
Immediate applicability to my Ph.D. objectives
Interest in the topic, right skills set to be developed
Interest of the topics Job opportunities in aerospace Opportunities of working in international environment
interest, importance of aviation,
Interest, Salary, International Aspect.
Interesting field. Many real complex problems. Still many improvement possibilities. Employability.
Interesting subject and business. Diversity, we study both air transport and common logistics.
interesting subjects
It is an incipient area
It's a fascinating subject, where I can surpass myself
It's a growing field with a lot of potential.
It's a very demanding course with a high variety of subjects which provides you a good theoretical background.
Level of funding, tax breaks, chance to do taught units at university
Maintenance for example.
My major is air traffic logistics, which I consider a very exciting type of logistics. Air traffic is fast but still limited in freight space. There are so many factors to puzzle together, which I find challenging and fun!
New technologies
Personal interest

Planes. job availability
Practical, specific
Provide sufficient qualifications recognized for the profession of aeronautics engineer, which is characterized by conducting research, design, study, design, manufacturing, construction, production, inspection, quality control and management in the aeronautics sector.
Research works Job availability
Some airlines provide very cheap tickets and their business models make them very competitive to other transport modes.
Sounds cool
Space related research Hands-on experience
State of the art technology
Technical knowledge, Team working and Education in aerospace field
That it is specified on air traffic management instead of other logistics.
The air transport world amuses me
The almost absolute guarantee of having a job after graduating
The determinant factor for choosing my course are the following: I knew I could work with a supervisory team skilled people in human machine interaction, risk and safety management. So the expertise of the supervisory team was a major factor to enrol on my university. Note I knew they have this expertise as I worked with them before commencing my Ph.D.
The development of a more efficient and secure air transportation
The dynamics of the industry and air for efficiency
The fact that Aeronautical and Space Engineering is the most demanding course in Engineering, and unemployment rates are nearly zero.
The fact that you can become an air-traffic controller.
The field of work I am probably going to work in seems to be very interesting. Many engineering work areas are combined. The thought of building something for a space crafts or a satellites is very attractive,

The innovation
The major factor for choosing this course was the hereditary 'taste' in my family for airplanes. The other factors are the need for global knowledge transfer and global communication, the social prestige, and the complexity of course itself.
The possibility of working on cutting-edge technologies
The prospect of contributing to avoid accidents.
The importance of security and safety in aeronautics transport and developing new technologies
This course will eventually lead to getting employed within the ATC-sector of northern Europe.
To work with something that can motivates going further every day.
Topics are not common
Versatility and adaptability to various situations in the aeronautical domain.
Vocation, job opportunities
Wide targeted area, allows one to have multiple choices in the work domain, depending on the specific needs of that time.
Work Area, Technologies, Flight
Work in a pioneering field.
Working within Aviation

Table 28. Raw data for the repulsive factors to choose courses or field of study

Compared to other fields it provides limited chances to find a job at this sector. Also, the chances are geographically restricted depending on both the development of the field and the regulations of each country.
Compared to other sectors again, it is very difficult to bring innovations since there are some major institutions that form the regulations and standards which should afterwards be followed by all the airports and the airlines.
A lot of knowledge is very interesting but the chance is big that you will never use it in your carrier.
Aptitude
Being so difficult and having so few chairs about space
Big Chance of having to work oversees. Little time left for the personal/private life.
Challenging and demanding courses, discourage from rate of failure of certain exams
Companies think we are too specialized in our field. Much theory.
Difficult, lots of Math
Difficulty
Difficulty
Difficulty in accessing the necessary facts about Air Traffic Management systems/protocols/services - especially the technical specifications
Difficulty. The need to concentrate in studying.
Difficulty
Due to the many different fields it is not possible to analyse systems down to deep physical level.
Endogamy
Extensive theoretical component
From theory to application is a long way, because there is a lot theory to learn first
Great need of commitment towards the course.
Great responsibility resulting from the profession

Hard exams, high percentage of mathematical subjects
Heavy and long study period
Heavy Math
high level of mathematics/natural sciences
High requirement level, long average time of finalization
Highly ambitious
Highly quantitative
I think that mathematic is a difficult subject for more students.
If you are not interested in air traffic management, there is no good place to be at.
It is a lot of work to finish the study path. In the beginning it seems to be a long path until you can work for a space sector company for example.
It is a new education, not very developed and people don't know about it. To little contact with real business organizations.
It requires a good mathematical knowledge.
It is very difficult to obtain actual data, and it is very expensive due to the lack of project funding.
Job Opportunities for Immigrants
Lack investment for development and investigation
Lack of funding to support researchers (to attend a conference)
Lack of jobs and financial security
level of funding, unsure if a Ph.D. would help career prospects
Low contact with industry
Maybe hard to find a job after education, maybe some aren't ready to move to another country if there are problems finding a job... Job logistics related issues.
Much work, complicated,
Not "air transport' enough focused
Not enough focus on the practical side

Not enough women in engineering
Not updated support bad professor - low pedagogic skills, no industrial experience
One cannot achieve the superior engineering licence, until one has at least 2 years of experience after graduation.
PhD is generally hard work and emotionally very demanding.
Poor supervisory skills exhibited by both academic and the research centre sponsoring my Ph.D.
Proneness to immigration.
Referencing
Requirements
Specialized degree means less possibilities compared to a general mechanical engineering degree
Stressful, not much free time
That this course also educates flight controllers. Which often leads to neglect of the logistics of air traffic.
That you have no guarantees for becoming an air-traffic controller.
The absence on really innovation
The amount of work during the 5 years.
The course are more theoretical than practical
The course itself has a high emphasis on theory and low emphasis on practice with the current industry technology
The difficulty of the subjects
The difficulty, the stress, the responsibility involved in critical areas (safety and security), the high demand of previous knowledge based on mathematics and physics, as well as the very high grades demanded just to be admitted.
The difficulty, is a very demanding course.
The lack of application for my Ph.D. program
The large number of licenses, necessary for the execution of various activities.

The length of the education
Time to devote to the study
Title consideration outside university
To have some parts that is more to memorize than to work.
Too many studies on regulations and standard procedures
Too much theory and less practice complex maths and physics High level of hard and complex work (study and projects...) during all semester
Too much theory not enough practice
Too narrowly focussed
Very difficult (lots of different subjects, and many of them are tough)
Very extend course, and also a bit difficult
Very interdisciplinary
Very poor relation with the industry, poor organization of some subjects and lack of a more practical approach.
We have to study a lot about logistics too and if you don't like it you should not study this

INTRODUCTION

This survey is conducted by the consortium of the EDUCAIR project, a European 7th Framework Programme. The objective of project is to improve the match between needs in human resources in the European air transport and aeronautics sector and the educational and training offer. More information about the EDUCAIR project can be found on the project website: www.educair.eu

The target audience of this survey are **students of universities and colleges with programs in air transport/aeronautics.** The survey aims to **collect quantitative and qualitative information on the demand for graduates in the air transport and aeronautics industry and input on educational topics and industry-education relationships.**

This survey is structured into three parts. The first part contains general questions to get a view on the background of the respondent. The second part is divided into two sections:

(A) questions about the educational background and career path,

(B) the cooperation between the industry and the educational institutes.

In the last part of this survey, you can provide any comments or remarks you may have.

The survey takes 10-15 minutes to complete.

Information gathered is for internal use only, and will not be shared with any third parties. All your answers to this survey are private and confidential and will only be used within EDUCAIR. The information provided will be used for statistical purpose only and no nominal data will be kept in the database.

Respondents are identified for the single purpose of clarification of answers.

PART 3: OTHER COMMENTS

Please provide below any other comments that you might have.

Please indicate whether you are interested in receiving the results of this survey.

- Yes
- No

If yes, please state your contact details / email.

Thank you for your participation!

Please click at the button 'Done' to finish the survey.

For more information about the EDUCAIR project, please visit our website at www.educair.eu