ASSESSING THE EDUCATIONAL GAPS IN AERONAUTICS AND AIR TRANSPORT

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SEVENTH FRAMEWORK PROGRAMME

FINAL REPORT

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Consortium Composition and Beneficiaries

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Executive Summary

The overarching objective of EDUCAIR project was to improve the match between needs in human resources, and the educational and training offer of engineers and researchers within the Europe Union Aviation Sector for the horizon of 2020. Such objective results from an assumption that a misalignment or gap between the Competences (& Skill) required by the Industry and those provided by the Educational Institutions and Students could exist. A second objective of the project was to identify the key attractiveness and repulsion factors for studying and working in the Aviation Sector. A third objective was to forecast the amount of jobs in the EU Aviation Sector for the year 2020. This will provide relevant information on the short term needs of graduated students. A final objective was to review and characterise the current educational offer on Aviation (and related fields) within the space of the European Union.

The analysis to the Attractiveness and Repulsion Factors for studying and working in the Aviation Sector was based on a wide scale online survey to students, employees and graduated students in Aviation domain but working elsewhere. Three key attraction factors emerged from the analysis of the results: Fascination of Aviation sectors, Challenging carrier and development path, Employment and working benefits. Looking now into the repulsion factors, the employees focussed around three main repulsion factors: cumbersome regulatory and legal framework, heavy theoretical with unperceived connection with real practice, reduced amount of practical working hours. Whereas the students identified the following ones: above-average difficulty and lengthy of the programme, excessive theoretical contexts, insufficient emphasis on practice.

In 2010, the direct employment by Aviation within the European Union is estimated to be about 1.7 million jobs, while the indirect effect includes 2 million jobs, the induced effect 0.9 million jobs and the catalytic effect due to tourism 3.2 million jobs. The evolution of employment numbers until 2020 was predicted on a disaggregated basis for airlines, airports, the (civil) aeronautics sector and ANSPs based on previous year's evolutions in relation with different independent variables such as GDP, FTK etc. As basis the share of engineering jobs in aeronautics was estimated to be between 30% and 35%, at airport operators between 15% and 25% and in airlines between 5% and 10%. The amount of direct engineering related jobs in 2010 was around [103,200; 120,400] in civil Aeronautics, around [20,500; 34,100] in Airports, and around [21,200; 42,400] in Airlines. The number of jobs in Aviation is calculated to evolve, in 2020, to about [121,000; 141,200] jobs in Aeronautics, around [34,200; 57,000] jobs in Airports, and [26,667; 53,300] in Airlines. The number of jobs for Air Traffic Control Officers is

estimated to grow from between 13,236 and 13,857 in 2010 to between 16,839 and 17,628 in 2020.

Looking now into the asseement of the Skill gaps, a total of seven skills were considered in the analysis: Problem Solving, Analytical Background, Technical Background, Theoretical Background, Oral and Written Communication, Leadership and Ability to work in a multidisciplinary team. The overall results reveal that Skill 1 – Problem Solving was consistently ranked higher than the other Skills. Conversely, Skill 4 – Theoretical Background is consistently ranked lower than the other Skills. The relative positioning of Skill 4 – Theoretical Background was somewhat unexpected, since we were expecting that a strong theoretical background would be perceived as relevant. The results show a mixed behaviour concerning the relative positioning of the remaining Skills, with no apparent pattern emerging among the different group of respondents. In addition to the analysis of the relative valuation, an analysis to the absolution valuation of Skills also offers interesting insights. Foremost, there is a wide recognition about the relevancy of all Skills in a professional carrier in Aviation sector.

A total of 88 competences were analysed in EDUCAIR project, divided in 19 aggregated competences along 4 domains (Airlines, Airport, ANSPs and Manufacturers). The Gaps of Competences were assessed between four pair of agents: Companies, Employees, Students and Educational Institutions.

Looking now into the Employees – Students Competence Gap Assessment, the results show a wide Gap in all educational backgrounds and domains. Yet, the situation is likely of no major concern, since the gap results from an overvaluation of students vis-à-vis employees. The Companies – Employees Gap Assessment reveals visible gaps in all domains of activity for a considerable number of Competences (around half of them). The majority of the Gaps are however minor and only a fraction are significant. The situation is of concerns as the Gaps invariantly result from an overvaluation of the companies versus the employees. The educational Institutions – Students Gap Assessment reveal Gaps in the majority of the cases. The Gaps invariantly result from the students' high valuation and the relatively frequency of teaching competences. The Gaps must be analysed having in mind the discussion already undertaken in the Employees – Students Gap. Students have highly valuated every single Gap, which may indicate that students still lack knowledge on the actual importance of each gap (and, in doubt, ranked them all very high). Therefore, the Gaps between Educational Institutions and Students do not appear worrisome. Finally, the Educational Institutions – Companies Gap Assessment reveal Gaps in all domains (Airlines, Aiports, ANSPs and Manufactures) and all Educational Programs (Engineering and Non-Engineering), although with less intensity than with Students.

Gaps emerging from high relevancy and low frequency of teaching are worrisome, since they may evidence cases of misalignment between Educational Institutions' curricula and Companies' needs, which in turn may lead students to graduate with an incomplete set of competences. Corrective actions include increasing the information exchange between Companies and Educational Institutions aiming to reduce the natural asymmetry. This can be done by the development of info days, seminars or participation in students' works. Another corrective action is to increase the flexibility of the Educational offer.

The research works of EDUCAIR project revealed a relevant flaw in the European Civil Aviation Sector: the absence of accurate and reliable data sources concerning Education and Employment. Considering Employment, the available statistics are scarce, incomplete and only available at aggregate level. The situation concerning Education is somewhat better but still far from satisfactory. Such situations prevent the development of robust statistical about the state and development of the EU Aviation Sector. Based on the above, we recommend the establishment of an European Observatory for Education and Employment in Civil Aviation.

Objectives and Background

The European Air Transport System is a vital element to European mobility and a significant contributor to European wealth. The resulting benefit is spread across all Member States, with an estimate of 2.6% GDP and 3 million jobs directly linked to air transport. Tourism and business travel have led to a strong development in airport capacities at a worldwide level, supporting millions of jobs in both developed and developing countries. Additionally, air transport sector has arguably been a major catalyst of Globalisation and one of the main pillars of nowadays economies and societies. The world economy is now increasingly dependent on air travel, also with a growing share of freight, in terms of value, conveyed by air. Not surprisingly, air traffic enjoys a continuous growth ever since the advent of civil Aviation, both in terms of passengers and of freight carried. Looking back, since 1945 world passenger traffic grew at an average annual rate of 12%; from 1960 a 9% annual growth is reported, with freight growing at a rate of 11% per annum and mail at 7%. As the industry grew and matured, a decrease in growth rates is observed; nevertheless a growth of 5% per annum was registered in the period 1985-95. The first historical decline occurred in 1991 due to the Gulf War, followed by a slow recovery in the following years, as a result of the economic recession. The current economic turmoil is negatively impacting the growth of the air transport he recent contraction, but

available forecasts say that the effect is only temporary. Indeed, air traffic is expected to grow in the future, leading to a doubling in traffic every 12 years (TRKC, 2010).

The European air transport sector has however been a victim of its own success. The notable growth has resulted in a gridlock of the air transport system, with negative consequences in the respective performance or growth of the agents. In fact, the sector faces nowadays considerable challenges to its growth. Section 2 discusses in detail the major challenges currently impacting the European Union Aviation sector. In face of such challenges we may conclude that the European air transport system is at a crossroad with a need of fitting an ever-growing traffic volume into a fixed-capacity infrastructure and under an increasingly complex web of constrains. At this moment, there are no simple answers for tackling these challenges. However, we may assert with confidence that none of the above mentioned challenges can be faced without adequate human resources.

The future developments in the Aviation sectors will be fundamentally linked to the education and formation of the human resources. Indeed, it is widely recognised that the long term competitive advantage of the European air transport system can only be sustained through the continuous qualification of our human resources.

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 naturally conclude that prospective employees have to master the current (and ideally future) competences, so that they could aspire to become competent professionals. Since prospective employees are firstly students, this entails educational institutions and other education institutions to permanently update the courses and the curricula. In face of the constant changes, there is a 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 emerging competence gaps that may eventually affect the competitiveness and efficiency of the European Aviation sectors. These problems had already been identified by the European Commission, which has been deploying a series of efforts (such as: funding research, directives and regulation, or incentives and dissemination) to foster the education of students and qualification of employees aiming precisely to bridge this competence gap.

In parallel, the European Union is undergoing a profound restructuring of its higher education system. Over the last decade, the so-called Bologna Process has been progressively

implemented, aiming to establish a common higher education degree structure in the European Higher Education Area. The notion of higher education embraces three types of programmes:

- Educational institution programmes;
- Professional programmes;
- Vocational programmes.

So far, the main focus of attention in the Bologna process was the educational institution programme. Firstly, countries have a clear academic structure made of educational institutions, which eased the harmonisation process. Secondly, the understanding of professional and vocational is not the same in the various countries and, in some, the distinction between professional and educational institution programme is blurred. As a consequence, the first years of the Bologna process were dedicated to the educational institution programmes and, only recently, the other programmes were brought under into the process. The Bologna process is comprised by a series of high level meetings of the Education Ministers. The Bologna process was based on two main pillars, being: the European Credit Transfer and Accumulation System (ECTS) and the Diploma Supplement (DS). The European Credit is the basic unit for measuring the competences transmitted to the students. The ECTS is a mechanism whereby degrees are established and recognised between countries. The DS is a standardised template containing a description of the nature, level, context, content and status of the studies completed by the individual noted on the original diploma. The goal of the DS is to increase transparency of education acquired for the purposes of securing employment and facilitating academic recognition for further studies.

Also central to the Bologna process was the commitment of countries to establish a three cycle degree in higher education, being: bachelor, master and doctorate. Typically, first cycle qualifications comprise 180-240 ECTS credits while second cycle qualifications comprise 60-120 ECTS credit. No harmonisation has yet been achieved for the third cycle.

The overarching objective of EDUCAIR project was to improve the match between needs in human resources, and the educational and training offer of engineers and researchers within the Europe Union Aviation Sector for the horizon of 2020. Such objective results from an assumption that a misalignment or gap between the Competences (& Skill) required by the Industry the assumption and those provided by the Educational Institutions and Students could exist. Also, if such Gap was left unattended, it could result in underperformance of employees, with the negative consequences for the EU's Aviation Sector.

EDUCAIR project included other important objectives. A second objective of the project was to identify the key attractiveness and repulsion factors for studying and working in the Aviation Sector. These factors could be pivotal to understand how to attract more students into educational programmes in Aviation and consequently more graduates into the Aviation Industry. A third objective was to forecast the amount of jobs in the EU Aviation Sector for the year 2020. This will provide relevant information on the short term needs of graduated students. A final objective was to review and characterise the current educational offer on Aviation (and related fields) within the space of the European Union. Indeed, information on this topic is relative scarce and disperse among different institutions.

To explore the sources and extend of the competence gap, an assessment framework was 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. The competence gaps were identified between four types of agents: Educational Institutions, Students, Companies and Employees. Four gaps were established, as follows:

- 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 educational institutions 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 educational institutions have (i.e. is the educational institutions' research and teaching activities of relevance for the companies?)

Main S & T results/foregrounds

Attractiveness and Repulsion Factors for Working and Studying in Aviation

The analysis to the Attractiveness and Repulsion Factors for studying and working in the Aviation Sector was based on a wide scale online survey to students, employees and graduated students in Aviation domain but working elsewhere.

Concerning the attraction factors, we could identify an overlap between employees and students' perceptions. Although varying the description among respondents, three key attraction factors emerged from the analysis of the results, as follows:

- *Attractiveness Factor 1: Fascination of Aviation sectors* – both employees and students referred often and often that a fundamental reason for ever entering an aviation or aeronautics graduation was the enthusiasm or fascination for this industry, in particular, on airships or spaceships;
- *Attractiveness Factor 2: Challenging carrier and development path* – employees' referred (and students' mentioned a strong belief) that the ever-changing and always-challenging nature of a job in Aviation was a key factor for pursuing a carrier in this sector.
- *Attractiveness Factor 3: Employment and working benefits* – the above-average conditions and benefits, coupled with high competence requirements and responsibilities was also mentioned as a positive factor.

Interestingly both employees and students agreed on the attraction factors. This denotes that the attraction factors have not been changing over time.

Looking now into the repulsion factors, the employees' answers focussed around three main repulsion factors as follows:

E1. *cumbersome regulatory and legal framework*,
E2. *heavy theoretical with unperceived connection with real practice*,
E3. *reduced amount of practical working hours*.

Whereas the students' answers allowed the identification of the following ones:

S1. *above-average difficulty and lengthy of the programme*,
S2. *excessive theoretical contexts*,
S3. *insufficient emphasis on practice*.

There is a perception in the EU about a steady decline in the level of attractiveness of Aviation industry over the last years. A total of seven factors and trends were already identified as lying at the root of this problem. Although EUCAIR's surveys cannot provide evidence to support the existence of these trends, they can be used to infer about their relevancy and validity. From the surveys we can infer the following conclusions for each trend.

Assessment of the Trends on the Attractiveness of Aviation for Working and Studying

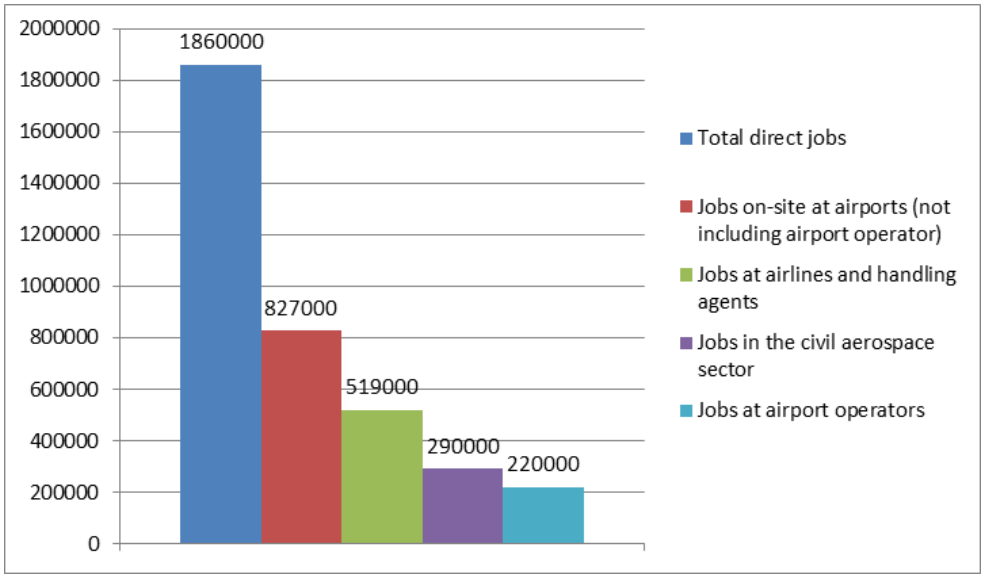
Trends	Impact on the Attractiveness	Discussion
Progressive loss of interest in scientific or technical carriers	High	Both employees and students referred that the technological nature of aviation and aeronautics was a relevant factor in their decision making process (Attractiveness factor 1 and 2);
Progressive loss of prestige of the Air Transport and Aeronautic Sectors	High	Attractiveness Factor 1 provides strong evidence towards the relevancy of this factor;
Progressive reduction of students' interest for mathematics, physics and other sciences	Some	It is indirectly supported by the surveys in the sense that some students referred that a reason to choose Aviation education was the emphasis in mathematics and analytical reasoning
Technical carrier is inferior to management carrier	None	It is not supported by the surveys, as any employee mentioned a feeling of inferior by having a more technical job.
Educational paradigm has changed favouring the teaching of soft-skills in detriment of hard-skills	Low	Surveys do not provide definitive answer, but many students complain about the too heavy lectures on mathematics, physics and other analytical disciplines (repulsion factor E2). This repulsion factor may denote that the teaching of these disciplines has not been softened.
Reduction of systems engineering-related courses	-	The surveys cannot conclude anything towards this factor.

Job Availability

One of the aims of this project was to assess the number of jobs in Aviation today and in the time horizon of 2020. In 2010, the direct employment by Aviation within the European Union is estimated to be about 1.7 million jobs, while the indirect effect includes 2 million jobs, the induced effect 0.9 million jobs and the catalytic effect due to tourism 3.2 million jobs (Air Transport Action Group, 2012b).

The evolution of employment numbers until 2020 was predicted on a disaggregated basis for airlines, airports, the (civil) aeronautics sector and ANSPs based on previous year's evolutions in relation with different independent variables such as GDP, FTK etc. As basis the share of engineering jobs in aeronautics was estimated to be between 30% and 35%, at airport operators between 15% and 25% and in airlines between 5% and 10%. The amount of direct engineering related jobs in 2010 was around [103,200; 120,400] in civil Aeronautics, around [20,500; 34,100] in Airports, and around [21,200; 42,400] in Airlines. The number of jobs in Aviation is calculated to evolve, in 2020, to about [121,000; 141,200] jobs in Aeronautics, around [34,200; 57,000] jobs in Airports, and [26,667; 53,300] in Airlines. The number of jobs for Air Traffic Control Officers is estimated to grow from between 13,236 and 13,857 in 2010 to between 16,839 and 17,628 in 2020.

Jobs supported by Aviation in Europe, 2010



Job Availability of EU Aviation Industry

Year	Airport Domain		Airline Domain		Aeronautics Domain		ANSP Domain	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
2010	20 464	34 107	21 229	42 458	103 208	120 409	13 236	13 857
2013	23 389	38 981	23 138	46 227	108 582	126 679	13 554	14 190
2017	28 926	48 210	25 093	50 186	115 263	134 473	15 343	16 063
2020	34 227	57 046	26 667	53 333	121 071	141 249	16 839	17 628

Review of Aviation Educational Offer

Educational tools and techniques also evolve remarkably: educational programs nowadays provide a more international focus. Furthermore, traditional chalk and talk teaching was (and will be) gradually replaced by active learning and learning through practice. Also the individual perspective was transformed into team work to acquire the wanted skills. In air transport education an international focus is desirable and possible, as was shown by studies by Torenbeek (2000) and Atici & Atik (2011). Furthermore, in air transport education new educational techniques are applied. One of the many examples is that ICAO focuses on competence based training, putting the focus on performing rather than just knowledge, or the use of blended training.

One major part of work performed within the EDUCAIR project relates to the identification and review of the existing educational offer (supply-side) in terms of relevant educational programmes in Aviation at EU27. As far as the 1st and 2nd cycle programmes are concerned, the review was focused on academic degree programmes in Aviation, as well as Lifelong Learning (LLL) and professional or corporate programs (Continuing Professional Development - CPD). Overall, the identified educational offering for the 1st and 2nd cycle of Aviation programmes contains (presented in detail within WP4/D4.8 Deliverable): i) 251 educational programmes offered by more than 100 Educational institutions / Educational Institutes at 22 European countries and ii) 193 LLL/CPD programmes offered by more than 25 educational institutes, key industry actors, international associations or educational institution-industry alliances.

Selected cases of the identified programmes were thereafter reviewed in more depth mainly with view to their key characteristics, structure, and course offering. A dominant observation stemming from the analysis of the reviewed 1st and 2nd cycle Aviation programmes is that engineering education varies considerably with the different educational systems. The engineering profession itself and particularly the “Engineer” interpretation differs across the various European countries and worldwide. Some harmonization of the educational studies across Europe has been achieved with the Bologna 3-5-8 scheme. Although there is substantial progress made towards the Bologna Declaration aims and many Educational institutions have adapted their programme structures to the proposed new scheme, the harmonization process has still some way to go in terms of harmonization and standardization of the educational offering. The next important steps towards harmonization and standardization are mainly related to the types of degrees offered, the duration of studies, as well as the course credits, structure and content, while simultaneously leaving some room for diversity of student profiles and flexibility to the students to build a customized / specialized portfolio of competences.

Despite some differences between countries, educational systems or programmes, there are some similarities or common features among engineering programmes in Aviation. These are mainly related to the temporal structure of studies and the main course categories offered in respective years of studies. Based on the review of engineering programmes of the 1st and 2nd cycle, it was clearly concluded that fundamental sciences and general engineering courses represent by far the dominant category in 1st cycle engineering and integrated Master's engineering programmes (MEng). Specialized aerospace/aeronautical engineering courses are similarly weighted in all cycles of engineering programmes. It is, however, important to underline the fact that airport, airline, and ATM/ATC-related courses are hardly available in engineering programmes but represent almost half of the educational offering of 2nd cycle EU Management Aviation programmes. This observation reveals the strong complementarity between relevant engineering and management programmes in Aviation. Finally, an interesting finding of the review was that although professional accreditation / licensing (directly awarded to students) is common, academic accreditation awarded on the basis of a certain academic programme is sparsely offered. Therefore, there seems to be a need for a European-wide academic accreditation system that should build on recent initiatives (e.g., PEGASUS Partnership) and pursue synergies with other accreditation bodies / associations (e.g., ENAEE/EUR-ACE, ENQA) towards the establishment of an accreditation system for Aerospace Engineering education in Europe.

Regarding the education and formation for researchers (3rd Bologna Cycle), the aim was mainly twofold: (1) to identify the current offer (supply) of educational programmes (3rd Bologna Cycle) in Aviation; and (2) to perform a review of the educational curricula of those programmes according to a well-designed template in order to compile the important information of the Ph.D. Programs.

Educational institutions fully recognise that they have the responsibility to offer doctoral candidates more than core research disciplinary skills based on individual training by doing research. Kivinen et al. (1999) emphasized that in industry and commerce, unlike in academia, a doctoral thesis is not seen as evidence of employability. Educational institutions 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.

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.

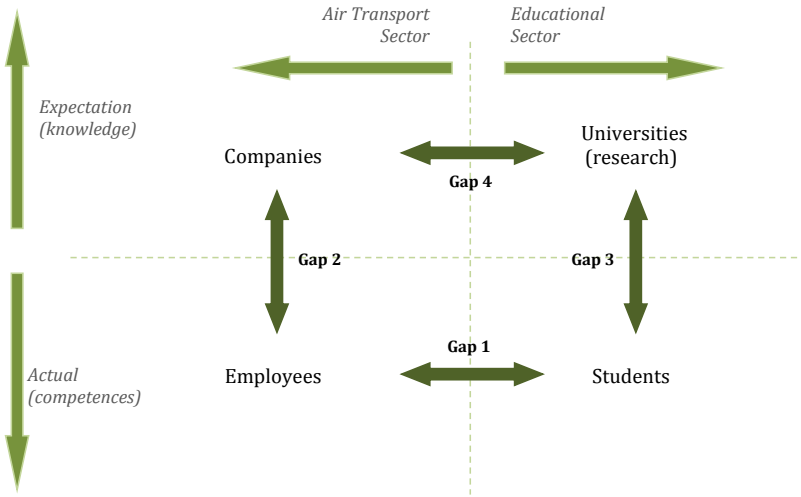
Thus, the third cycle in the Bologna Process became apparent as there was a need to promote closer links between the EHEA and the ERA in a Europe of Knowledge, and of the importance of research as an integral part of higher education across Europe. Therefore, Ministers considered it necessary to go beyond 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.

Skills and Competence Gaps

The following figure presents the framework used to assess the Skills & Competences Gap in the Aviation Sector.

The Four Gap Framework



This framework 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 educational institutions 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 educational institutions have (i.e. is the educational institutions' research and teaching activities of relevance for the companies?)

In theoretical terms, gaps may reveal different perceptions of relevancy, which in turn may eventually lead to some distress among agents. The point is that agents tend to naturally focus their efforts in mastering the most relevant Skills or Competences. If two agents have different perceptions about the relevancy of Skills and Competences, they will naturally concentrate their efforts in different Skills and Competences. Consequently, each one may perceive that the other is not concentrating on the fundamentals, or each one may perceive that the other is not proficient on the most relevant Skill or Competence, which may then result in some sort of stress or underperformance.

A total of seven skills were considered in the analysis, being:

1. Problem Solving
2. Analytical Background
3. Technical Background
4. Theoretical Background
5. Oral and Written Communication
6. Leadership
7. Ability to work in a multidisciplinary team

The overall results reveal that *Skill 1 – Problem Solving* was consistently ranked higher than the other Skills. Conversely, *Skill 4 – Theoretical Background* is consistently ranked lower than the other Skills. The relative positioning of *Skill 4 – Theoretical Background* was somewhat unexpected, since we were expecting that a strong theoretical background would be perceived as relevant. The results show a mixed behaviour concerning the relative positioning of the remaining Skills, with no apparent pattern emerging among the different group of respondents.

In addition to the analysis of the relative valuation, an analysis to the absolution valuation of Skills also offers interesting insights. Foremost, there is a wide recognition about the relevancy of all Skills in a professional carrier in Aviation sector. The results show that Skills were valuated above 2.5 and often above 3.5 (in a scale of 1 to 4), in the vast majority of the cases. Also, the results denote a consistency and similitude of perspectives among groups of respondents since there is a visible alignment in the valuation of the Skills.

- Employees – Students Skill gap Assessment:

  Skill Gaps requiring corrective actions were not found. Minor gaps in the Aerospace and Aeronautics, Civil and Other Engineering Programmes were indeed identified, but without significance.

- Companies – Employees Skill Gap Assessment:

  Multiple minor gaps without significance in all domains, concerning Skill 3, Skill 4, Skill 6 and Skill 7, were found. Skill 6 on the other hand exhibited a relevant Gap that could require corrective actions, although the relative amount of answers does not allow reaching solid conclusions. As such, we recommend conducting further analysis.

- Educational Institutions – Students Skill Gap Assessment

  Gaps were found in the Aeronautics and Aerospace, Mechanical and Other Engineering Programmes, in Skill 2, Skill 3, Skill 6 and Skill 7. Among the Skills generating Gaps, *Skill 7 - Ability to work in a multidisciplinary team* is the only one appearing in all situations.

- Companies – Educational Institutions Skill Gap Assessment

  Gaps were found in all domains in Skill 2, Skill 3, Skill 4, Skill 6 and Skill 7. A distinction between Engineering and Non-Engineering Educational Institutions was made. In overall terms, Non Engineering Educational Institutions tend to exhibit more and more significant Skill Gaps, which can be explained by a lower knowledge about the reality and needs of the aviation sector. Also, *Skill 4 – Theoretical Background* exhibits a Gap in all domains and always with a overvaluation by the educational institutions.

  Concerning the engineering education institutions, *Skill 7 - Ability to work in a multidisciplinary team* exhibits a significant gap in all domains with the exception of ANSPs. All Gaps result from an undervaluation by the Educational Institutions. Such results may evidence a situation in which educational institutions do not perceive the relevancy of the skill in the same way as companies. More studies are required, but if proved correct, graduate students with not enough skills may be leaving our Educational Institutions.

Corrective measures depend on the location and significance of the Skill Gap. The results reveals multiple gaps, but although the vast majority exhibits minor relevancy. Considering that deviations between agents' perceptions is natural and results from different perceptions and roles, we consider not having need for any special corrective measures. In any case, we could identify three skills that may require further studies and eventually tailored actions, being:

- Skill 4 – Theoretical Background, in Companies – Educational Institutions interactions;
- Skill 6 – Leadership, in Companies – Employees interactions;
- Skill 7 – Ability to work in multidisciplinary teams, in Educational Institutions – Students and Companies – Educational Institutions interactions.

The Gap in Skill 4 results from a high valuation by educational institutions compared with the companies. This can be interpreted as a more academic, and thus theoretical, perspective by the former group versus a more practical perspective of the latter group. Obviously, we cannot state that excess of theoretical knowledge is negative, indeed, theoretical knowledge is one of the best ways, although not the only one, to develop problem solving skill which everyone agrees is essential. In worst case, graduate students simply do not make use of the skill. What could be relevant is to understand the reasons leading companies and employees' to have a low perception about these Skills. This could provide insights on actions to improve and to better explain these agents the relevancy of a good theoretical background.

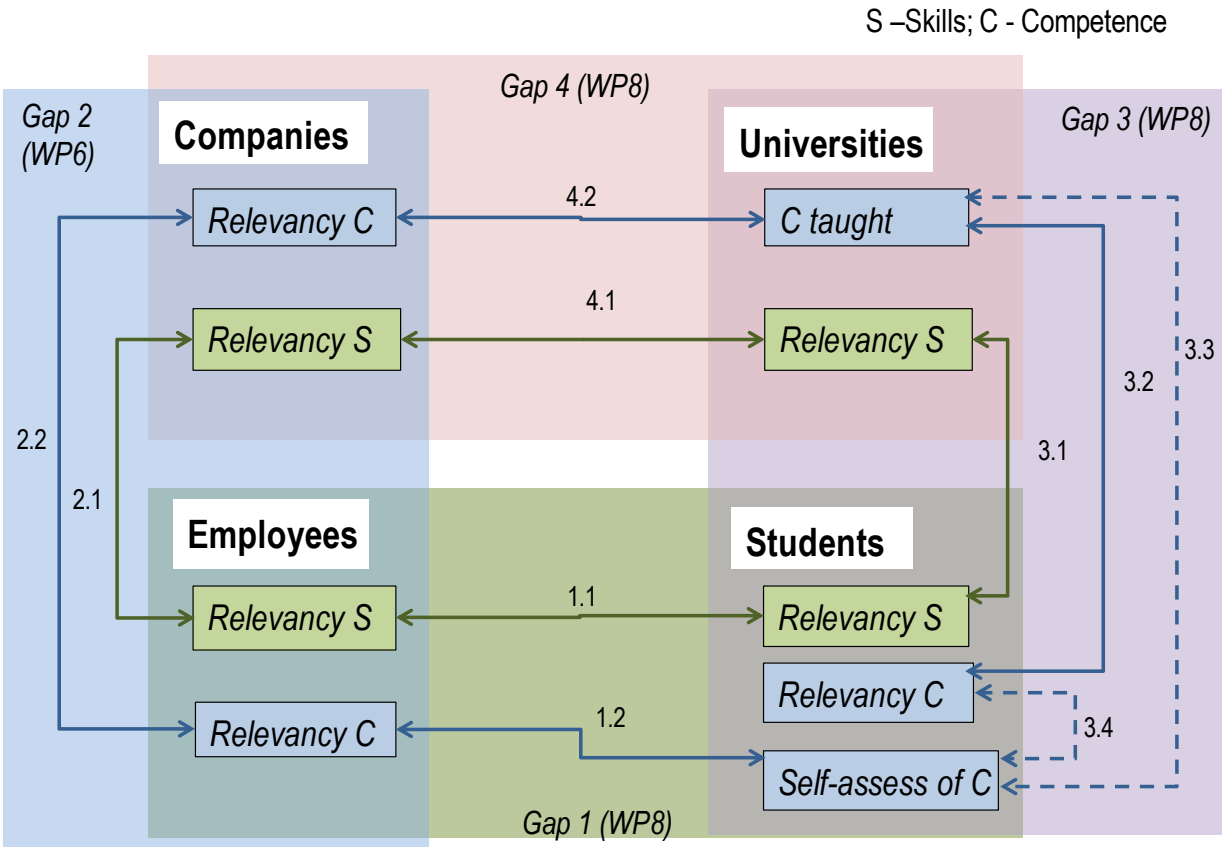
The Gap concerning Skill 7, the situation is worrisome since we repeatedly identified situations in which companies overvalue above educational institutions and, to great extent, students. The results are consistent across domains and may evidence that educational institutions may not be giving enough attention in the development of these skills by the students, which can eventually lead to underperformance. This results requires further investigation and, if proved accurate, intervention mainly by incentivising educational institutions to have propaedeutic disciplines on this matter and promoting working groups.

A total of 88 competences were analysed in EDUCAIR project, divided in 19 aggregated competences along 4 domains (Airlines, Airport, ANSPs and Manufacturers). Likewise the Skills Gaps, the Competences Gap assessment followed the rational laid down in the following figure. It was done on a pair basis between Companies, Employees, Students and Educational Institutions. The students were asked to value the relevancy of the competences (perceived relevancy) and asked to rank their level of proficiency on every competence, so additional

analysis were undertaken. It is important to emphasise that the amount of answers greatly vary among domains and agents, which conditioned the nature of the analyses. Indeed, the analyses were defined in function of the available data. Although not being optimal, this option increases the reliability and accuracy of the results.

In theoretical terms, a competence gap or misalignment results from a difference in the agents' perceptions on the relevancy of a given competence for performing a given task. Gaps may occur from asymmetric information between agents, in which one agent may feel some need earlier than other just because it has privileged access to some information. Other situation that may generate Gaps results from agents' different positioning in the value chain. That is, each agent has its own strategies, objectives, limitations and background experience. Therefore, we may expect differences of perception towards a given competence (for example: students may prefer practical experience in detriment of theoretical one, while educational institutions may prefer the opposite. While the second source of gaps does not require corrective measures, the former source does require.

Surveys' connection in the Gap Assessment Framework



In overall terms, the results to the Educational Institutions reveal two important features. Foremost, all competences are taught which means that European Educational Institutions are able to provide every required competence. Secondly, results show a wide dispersion about the frequency of teaching of the competences, albeit some patterns are recognisable. In our sample, the competences related with the domain of Airlines, Airports and ANSP are always taught is less than half of the Educational Institutions. The same does not happen with the Manufacturer related competences, in which a significant part (around half) is taught in more than half of the sample.

Looking now into each Competence gap, we have:

- Employees – Students Competence Gap Assessment

  The results show a wide Gap in all educational backgrounds and domains. Yet, the situation is likely of no major concern, since the gap results from an overvaluation of students vis-à-vis employees. Employees have already a good understanding about the relevancy of the competences, whereas students are still acquiring them and do not have yet time to grasp their actual relevancy. Even so, if required, corrective actions should increase the contact of Students with Companies, preferably in the Company's premises, if not, by bringing the Companies into the Education Institution (Open Days or Fairs).

- Companies – Employees Gap Assessment

  Gaps are visible in all domains of activity for a considerable number of Competences (around half of them). The majority of the Gaps are however minor and only a fraction are significant. The situation is of concerns as the Gaps invariantly result from an overvaluation of the companies versus the employees. It may evidence a lack of knowledge by the Employees about their Company's real needs. As a consequence, the Company may be feeling needs for some given Competences that Employees are not aware of and, consequently, may be not mastering. In this case, we recommend conducting further analysis to the Gap and, if proved accurate them corrective measures should be implemented. Naturally, the measures will depend on the actual dimension of the Gap in each company, but it may include improvements in the internal communication (e.g.: strategic and management objectives, new projects or new challenges) and promotion of long life educational courses.

- Educational Institutions – Students Gap Assessment

The results reveal Gaps in the majority of the cases. The Gaps invariantly result from the students' high valuation and the relatively frequency of teaching competences, leading to a Gap. The Gaps must be analysed having in mind the discussion already undertaken in the Employees – Students Gap. Students have highly valuated every single competence, which may indicate that students still lack knowledge on the actual importance of each gap (and, in doubt, ranked them all very high). Therefore, the Gaps between Educational Institutions and Students do not appear worrisome. In any case, corrective actions can be deployed. Indeed, the corrective action already proposed to the Employees – Student Gap can also provide help in this situation. An increased contact with Companies will lead to a more mature valuation. Other corrective actions may include improved explanations and demonstration of the validity and relevancy of the curricula, so that students could understand it and therefore adjust their expectations (like for example: a 1st-year/2nd-year series of seminars on the topic: Introduction to Aerospace Engineering).

- Educational Institutions – Companies Gap Assessment

  The results reveal Gaps in all domains (Airlines, Aiports, ANSPs and Manufactures) and all Educational Programs (Engineering and Non-Engineering), although with less intensity than with Students. Gaps emerging from high relevancy and low frequency of teaching are worrisome, since they may evidence cases of misalignment between Educational Institutions' curricula and Companies' needs, which in turn may lead students to graduate with an incomplete set of competences.

  Corrective actions include increasing the information exchange between Companies and Educational Institutions aiming to reduce the natural asymmetry. This can be done by the development of info days, seminars or participation in students' works. Another corrective action is to increase the flexibility of the Educational offer. Many of the competences analysed can easily be provided through short to medium-term courses. These courses can be held in parallel with existent disciplines (of the main stream programs) to external students (as lifelong learning programs) or given as extra credits. These type of courses have typically less restrictions in terms of accreditation and preparation, therefore they can be given almost on an ad-hoc basis and tailored to the Companies' actual requirements.

Based on this assessment, the following Recommendations are proposed:

1. Strengthening Companies and Educational Institutions interactions:
   - ✓ Fiscal benefits to support research;
   - ✓ Support mobility between industry and academia of employees and researchers (expand People Programme – Marie Currie and similar)
2. Improve the visibility and readability of Aviation-related courses:
   - ✓ Further support and incentives to internships or on on-job working
   - ✓ Explaining and promoting the understanding of Curricula
3. Support and incentivise Life Long Learning (recycling and updating competences)
   - ✓ Supporting Companies with their human resources' formation;
4. Incentivise Educational Institutions to offer tailored Short to Medium term Courses: Credits Awarding (reinforce Bologna Systems)

The research works of EDUCAIR project revealed a relevant flaw in the European Civil Aviation Sector: the absence of accurate and reliable data sources concerning Education and Employment. Indeed, a key problem felt during the execution of the works was the difficulty in gathering the required information. Such difficulties brought problems in the analysis to the job availability, review of educational offer and execution of the surveys.

Considering Employment, the available statistics are scarce, incomplete and only available at aggregate level. The situation concerning Education is somewhat better but still far from satisfactory. Data about students and/or graduates of engineering programmes in Aviation are not available at central EU level, while these are only sparsely available (and in some cases for engineering graduates as a whole) at national statistical agencies. Such situations prevent the development of robust statistical about the state and development of the EU Aviation Sector.

Based on the above, we recommend the establishment of an European Observatory for Education and Employment in Civil Aviation. The Observatory would be responsible for collecting standardised data about relevant Educational offer and Employment figures of the Aviation sector at EU level. The Observatory would enable the development of robust and valuable statistical analysis about the state of development of EU Aviation Sector.

Potential Impact

A number of impacts are expected in the fulfilment of EDUCAIR objectives, of which we highlight the following ones:

• To increase the visibility of the European educational offer in the air transport and aeronautics sectors;

• To improve the relevance of the European educational offer and research in these sectors.

• To improve the relevance of the European applied research in these sectors.

• To disseminate new courses and curricula for students and researchers.

• To contribute to the employability of students and to the productivity of current employees.

By placing research information where it is most needed EDUCAIR will help bridging the educational needs and offers in the air transport and aeronautics sectors in Europe:

• Between employers and employees;

• Between industry and academia;

• Between industry and educational institutions;

• Between students and the professional market.

Main Dissemination Activities

1. Intensive dissemination of the project objectives/outcomes and the online survey through personal, targeted communication with faculty members.

2. Email communication of the project activities and the online survey.

3. Telephone interviews and communication through social media (i.e., LinkedIn) of the Company and Employee surveys.

4. Establishment of communication liaisons with the U.S. National Center of Excellence for Aviation Operations Research (NEXTOR II) Universities and inclusion in the review of current offering (WP4) of relevant programmes offered by 4 Core Members of NEXTOR II (i.e., Massachusetts Institute of Technology, University of Maryland, Georgia Institute of Technology, and Purdue University).

5. Dissemination of the project activities in Transportation Research Board (TRB) 92nd Annual Meeting (January 13-17, 2013), Committee on Airport Terminals and Ground Access (AV050).

6. Preparation of a joint, co-authored scientific publication summarizing the key findings and recommendations of the project.

7. Final Seminar of EDUCAIR Project during the 2013 Paris Air Show

8. Project website: http:www.educair.eu

9. Publication on the Journal of Higher Education, with the paper: “Mitigating the competences gaps to improve the person-job fit in the aviation industries”

10. Dissemination through regular newsletter

Exploitation of Results

The multiple and valuable results of EDUCAIR project are now being intensively exploited by all EDUCAIR partners. Besides the material produced in each deliverable, the Competence Gaps offer rich and valuable information for enhancing the curricula and interactions with Industry. The various deliverables contain relevant information. The exploitation of EDUCAIR project is being done along 5 dimensions being: i) support to the production of scientific papers (for journals and conferences) and other documents, ii) support to the production of master and doctoral thesis, iii) support to the preparation of courses, iv) support to the development of other research projects, v) support in the preparation of advising documents for Educational Institutions’ curricula updating and development.