Educational Plan

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Short abstract: Future Sky Safety is a Joint Research Programme (JRP) on Safety, initiated by EREA, the association of European Research Establishments in Aeronautics. The Programme contains two streams of activities: 1) coordination of the safety research programmes of the EREA institutes and 2) collaborative research projects on European safety priorities.

This deliverable is produced by the Project P2 “Dissemination, exploitation and communication” of Future Sky Safety. The main objective is to provide recommendations for educational activities in the field of aeronautics, with a focus on aviation safety.

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Acronyms

Acronym	Definition
AAT	Air Transport and Aeronautics
ACARE	Advisory Council for Aviation Research in Europe
ANSPs	Air Navigation Service Providers
ASD	AeroSpace and Defence industries association of Europe
CA	Consortium Agreement
CPD	Continuing Professional Development
CSA	Coordination and Support Action
EASA	European Aviation Safety Agency
EASp	European Aviation Safety Plan
EREA	European Research Establishment Association
EU	European Union
FSS	Future Sky Safety
H2020	Horizon 2020
ICAO	International Civil Aviation Organisation
IATA	International Air Transportation Association
IMG	Industry Management Group
JU	Joint Undertaking
PP	Project Plan
R&TD	Research and Technology development
R&D	Reaserch and Development
SME	Small and Medium Enterprise
SRIA	Strategic Research and Innovation Agenda
3D	Three Dimensional

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EXECUTIVE SUMMARY

Problem Area

One of the ambitions of Future Sky Safety is to promote knowledge creation to different target audiences through scientific and technical studies, where academia plays a significant role. Furthermore, in order to improve aviation safety, it is expected to be beneficial – and maybe even needed – if professional careers and properly trained professionals incorporate a common safety culture within the air transport domain.

Additionally, hence pre-career individuals tend to embrace social sciences' related occupation rather than engineering and 'hard science' related careers, Future Sky Safety aims to contribute to raise the interest in aeronautics and aviation safety, and promote careers in aviation safety in order to help reversing this trend.

Measures are needed to introduce aviation safety related careers to students while showing them interesting and relevant aspects of aviation safety jobs both in research and in industry. The ACARE SRIA and Flightpath 2050 safety challenges show that the current and future technological challenges with respect to aviation safety are wide, and engineering solutions are often the innovation basis could drive the whole aviation sector. Aviation safety R&D and technology innovation and pioneering importance have to be stressed so that skillful and trained resources would be motivated to resume embracing careers in aviation safety.

In doing so, it would be beneficial to build on the results of the European Commission (EC) education CSAs in aviation (e.g. FlyHigher, PromoAir, AIRVET). However, none of these activities specifically addressed aviation safety, and there is a need for an exploitation activity dedicated to education of aviation safety. This would promote scientific and technical studies and careers in aviation safety research, and support the setting and requiring of skills and educational training paths in aviation safety and help reach ACARE SRIA safety goals.

The work is to produce an educational plan for aviation safety related studies, taking into account long term safety research needs as provided by e.g. ACARE SRIA and Flightpath 2050 and research performed in FSS.

This task identifies a set of educational activities capable of promoting scientific and technical studies and careers within the aviation safety area. Simultaneously, it aims to support just culture within air transport domain, fostering trans-sectorial exchange of know-how and experiences with other safety critical domains.

This educational plan may be used by organizations providing education in the field of aeronautics, and in particular in aviation safety. The plan could be useful for e.g. colleges and universities, involved in higher education and research in aviation safety. It supports teachers and/or researchers in the development of courses and learning material in view of the safety challenges and research needs in the coming years. As such, it supports universities and other higher educations in exploiting FSS results for educational purposes.

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INTRODUCTION

1.1. The Programme

FUTURE SKY SAFETY is an EU-funded transport research programme in the field of European aviation safety, with an estimated initial budget of about € 30 million, which brings together 32 European partners to develop new tools and new approaches to aeronautics safety, initially over a four-year period starting in January 2015. The first phase of the Programme research focuses on four main topics:

- Building ultra-resilient vehicles and improving the cabin safety
- Reducing risk of accidents
- Improving processes and technologies to achieve near-total control over the safety risks
- Improving safety performance under unexpected circumstance

The Programme will also help to coordinate the research and innovation agendas of several countries and institutions, as well as to create synergies with other EU initiatives in the field (e.g. SESAR, Clean Sky 2). Future Sky Safety is set up with expected seven years duration, divided into two phases of which the first one of 4 years has been formally approved. The Programme has started on the 1st of January 2015.

FUTURE SKY SAFETY contributes to the EC Work Programme Topic MG.1.4-2014 Coordinated research and innovation actions targeting the highest levels of safety for European aviation in Call/Area Mobility for Growth – Aviation of Horizon 2020 Societal Challenge Smart, Green and Integrated Transport. FUTURE SKY SAFETY addresses the Safety challenges of the ACARE Strategic Research and Innovation Agenda (SRIA).

1.2. Project context

Dissemination, exploitation and communication of knowledge are a key ingredient for any successful research project. Future Sky Safety Project P2 is specifically dedicated to Dissemination, Exploitation and Communication; its goals are to:

- Develop a dissemination plan and communication strategies;
- Disseminate safety research findings to relevant target audience;
- Develop a plan for exploitation of results;
- Develop a knowledge and data management policy and approach;
- Assess dissemination activities.

Project P2 ensures that all aspects of dissemination are efficiently and effectively managed over the entire duration of the project, aiming at communicating in a consistent and distinctive way, while engaging and involving different categories of audiences.

In this context, an educational plan is to be developed, supporting universities and other higher educations in exploiting the results of the Programme for educational purposes.

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1.3. Objectives

The main goals to be achieved through the FSS Educational Plan are:

- To identify a set of educational activities to enhance studies and careers within the aviation safety area;
- To foster a common safety culture within the air transport and aeronautics domain, learning and sharing with other safety-critical industries.

1.4. Approach

The specific exploitation activity dedicated to education will be undertaken, as follows:

- Promote scientific and technical studies and careers in safety research, allowing the sharing of a common safety culture within the air transport domain and also fostering trans-sectorial exchange of knowhow and experiences with other safety critical domain. Opportunities to provide aviation safety knowledge, expertise and results to local students in secondary and higher education are identified.
- Selection of learning subjects relevant for schools curricula. An educational plan related to the project by setting/requiring new skills and educational training in aviation safety will be defined.
- Build on the recently completed educational CSAs (e.g. FlyHigher, PromoAir, AIRVET) in aeronautics, and complement those activities by focusing now on education needed to support aviation safety.

The Educational Plan will focus on illustrating the FSS major contributions for:

- Raising interest in the aviation safety domain: disseminate basic knowledge in aviation safety, and support understanding of the high level scientific and technical open issues in aviation safety research;
- Fostering scientific and technical aviation safety studies: provide recommendations for development of e-learning modules in the field of aviation safety. This could be based on problem solving and serious games, in which students are engaged in real or simplified problems coming from the FSS Programme;
- Promoting careers in aviation safety: prepare young people to meet recruitment demands for highly skilled professionals in the aviation safety domain, whose job market could reach higher demand rates for specialized skills in the future.

The basis for definition of the Educational Plan, with different educational and training particular measures, will be the ACARE SRIA and Flightpath 2050 safety challenges and the safety research performed in FSS.

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The FSS Educational Plan includes the following steps:

- Identify specific educational and training activities in aviation safety;
- Identify the range of professionals and properly trained users or stakeholders potentially impacted by the educational and training activities in aviation safety;
- Foster the dissemination measures to raise the interest in aviation safety, and support a better understanding of the aviation safety domain's high level scientific and technical open issues;
- Identify measures contributing to increase students interest for careers in aviation safety;
- Provide recommendations for monitoring resulting training and educational benefits as well as trained and skilled resources for the aviation safety sector.

The Programme deliverables are analysed in order to pinpoint the training and educational subjects, and related educational potential for the field of aviation safety within the air transport and aeronautics sector. The analysis of the Technical Projects (P3, P4, P5,. P6, P7) has to be performed along Programme life cycle.

1.5. Structure of the document

This document is structured around three main topics.

The first one is dedicated to the Educational Plan strategy description with focus on the approach to each educational goal.

The second topic includes an identification of gaps in terms of education needs in aeronautics.

The third topic includes an analysis, around the three educational goals, on each one of the five Technical Projects' objectives and highlights on the identification of the projects' related educational measures and potential educational effects, based on information provided by some academic partners.

Considering the key role played by academic partners on educational mission, the potential contribution of the academic partners in FSS is described, with a focus on the educational activities capable of promoting scientific and technical studies and careers within the aviation safety area.

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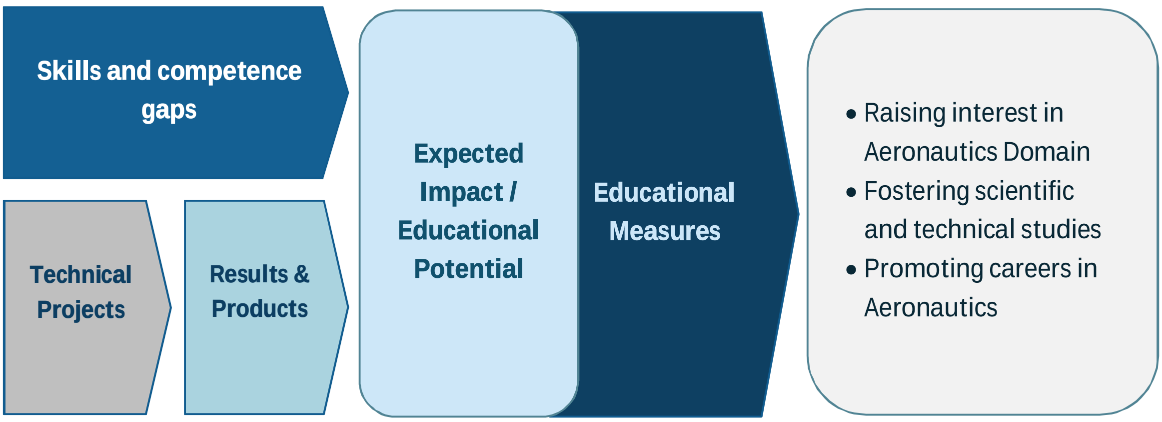
2 EDUCATIONAL PLAN STRATEGY

The Educational Plan contents intend to answer the skills and competence gaps identified in professionals in the aviation safety area. From the results of FSS technical projects, new educational measures may be defined in order to cover the gaps identified. Thus, whenever these results become available, current and future actions may be gathered and condensed in groups according to the potential demonstration effects.

For that purpose, a list of educational and training measures, envisaged to be undertaken after FSS, should be drafted. Educational and training potential, or expected effect, will be spotted along with further actions to enhance the resulting impact aligned with the envisaged educational objectives.

Figure 1 – Educational Plan Strategy



2.1. Approach

The Educational Plan will firstly seek to identify potential educational activities related to the FSS Technical Projects. This information is complemented with results from queries put forward to academy and industry partners, leading to identification of a set of educational measures contributing to educational objectives.

Secondly, the educational measures will be organised around the Educational Goals and expected impacts (as mentioned in Table 1) considered as guide lines for the success of FSS in supporting the creation of a common safety culture within the total air transport domain. Furthermore, the Educational Plan will identify measures that foster the exchange of know-how and experiences with other safety critical domains.

Table 1 - FSS Goals for educational effect demonstration

Goals	Educational effect
Goal 1	Raising interest in the Aviation Safety Domain
Goal 2	Fostering scientific and technical studies in Aviation Safety
Goal 3	Promoting careers in Aviation Safety Domain

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3 THE FUTURE OF AVIATION SAFETY

The Flightpath 2050 vision addresses two parallel objectives: firstly to serve society's needs for safe, more efficient and environmentally friendly air transport; and secondly, to maintain global leadership for Europe in this sector with a competitive supply chain including large companies and small and medium size enterprises. The vision identifies goals to reach these objectives and recommends addressing the following key challenges:

Challenge 1: Meeting market and societal needs

Challenge 2: Maintaining and extending industrial leadership

Challenge 3: Protecting the environment and the energy supply

Challenge 4: Ensuring safety and security

Challenge 5: Prioritising research, testing capabilities and education.

In response to the recommendations of Flightpath 2050, ACARE stakeholders have come together to develop the **Strategic Research and Innovation Agenda (SRIA)**. The aim of the SRIA is to provide a research and innovation roadmap to reach the goals highlighted for each Challenge in Flightpath 2050. The roadmap highlights the priorities for aeronautical and air transport research and innovation, and the related public policy issues to be addressed to support these priorities. The roadmap addresses three timescales: short-term – to 2020; medium-term – to 2035; and longterm – to 2050.

The scope of the SRIA comprises all the aspects of aviation necessary to achieve the goals of Flightpath 2050. It addresses:

- The science, engineering, manufacturing and in service support of civil air vehicles and aviation products.
- The development and operational management of the air transport system, as part of an overall transport system.
- The impact of aviation on the environment, including the emissions, and noise generated by air vehicle operations as well as the impact of the product lifecycle, including manufacturing, operation, maintenance, recycling and disposal.

In the scope of this study, two main challenges are relevant: Challenge 4 (Ensuring safety and security) and Challenge 5 (Prioritising research, testing capabilities and education).

In terms of aviation safety, the SRIA identifies the following main enablers that contribute to the achievement of goals related to this Challenge:

- Societal expectations: identifies the enablers and capabilities that are needed for aviation to meet the needs of society in terms of safety and security, both from the perspective of the customer of aviation services and that of the citizen subjected to the impact of aviation.

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- Air vehicle operations and traffic management: addresses the enablers and capabilities that are needed to provide safe and secure operations, managing the diversity of air vehicles and aerial applications while transiting airspace and on the ground.
- Design, manufacturing and certification: focuses on new approaches to the conception, building and certification and approvals of system components aiming to ensure that safety and security requirements are built in from the outset and reducing time-to-market of new products and services. These enablers take into account the growing influence of software as well as the high levels of automation and integration in the ATS of the future.
- Human factors: addresses the research and innovation needs to support and optimise the human roles across the ATS. These enablers consider the ever-increasing volume information available as well as the shifting demarcation of authority and responsibility between the human and the machine.

These enablers are in-line with the main priorities and research domains of the FSS Programme.

The SRIA also proposes a set of enablers related with Challenge 5, which are identified around the following topics:

- Optimisation of the research and innovation lifecycle: generates the results needed by industry as well as by a prospering society, with European aviation research considering the complete system, including full life cycle management.
- R&D infrastructure: is an elementary pillar of high-technology research and needs to be of highest quality and efficiency, reaching from wind tunnels via iron and copper birds up to experimental aircraft, all organized in a network for the best usability for all stakeholders.
- Education and workforce: delivers the quality, the skills and the motivation to be able to meet the challenges of the future. This requires a harmonised and balanced approach covering the entire scope from attracting talents over primary and secondary education to apprenticeship, academia and lifelong professional development.

Concerning the current Educational Plan a special focus is made on the last topic, making the link between the SRIA recommendations on this subject and the expected outputs and potential impact of the several FSS technical projects.

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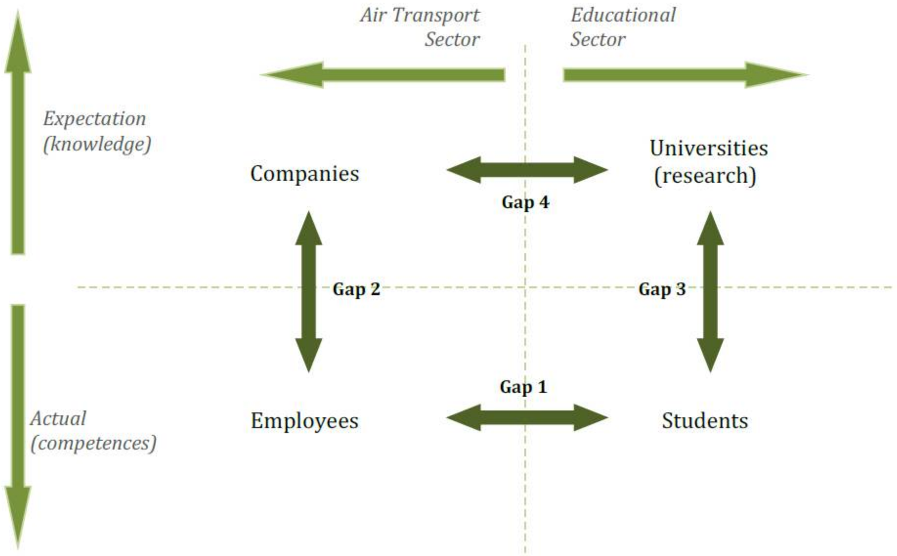
4 SKILLS AND COMPETENCE GAP

Within the framework of the FP 7 European Project AirTN NextGen a "Workshop on Education and Training Needs for Aviation" was organized on 23 September 2015 in Brussels, aiming to identify Air Transport Industry needs in the field of specialised education, bringing together academia and industry experts.

In line with the European Vision for Aviation "Flightpath 2050" the quality and availability of educated and skilled workforce is crucial for aviation competiveness. Education and training must be linked with the needs of air transport industry, research and aviation authorities. The aim of the Workshop was to identify educational and training courses and stakeholders and exchange views on the problems.

One of the presentations made was about the EDUCAIR project. This project aimed 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. Within this project an important assessment of the skills and competences gap was performed. The following figure presents the framework used to assess the Skills & Competences Gap in the Aviation Sector.

Figure 2 – 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?)

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- 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?)

Although the following analysis is made considering the whole aviation sector, the results presented are also applicable to aviation safety issues, since these are inherently included in all aviation aspects.

4.1. Skills Gaps

Within the Educair project 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 revealed 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 results show a mixed behaviour concerning the relative positioning of the remaining Skills, with no apparent pattern emerging among the different group of respondents. Foremost, there is a wide recognition about the relevancy of all Skills in a professional career 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.

- 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.

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- 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 an 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.

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, it cannot be stated 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.

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. These results require further investigation and, if proved accurate, intervention mainly by incentivising educational institutions to have propaedeutic disciplines on this matter and promote working groups.

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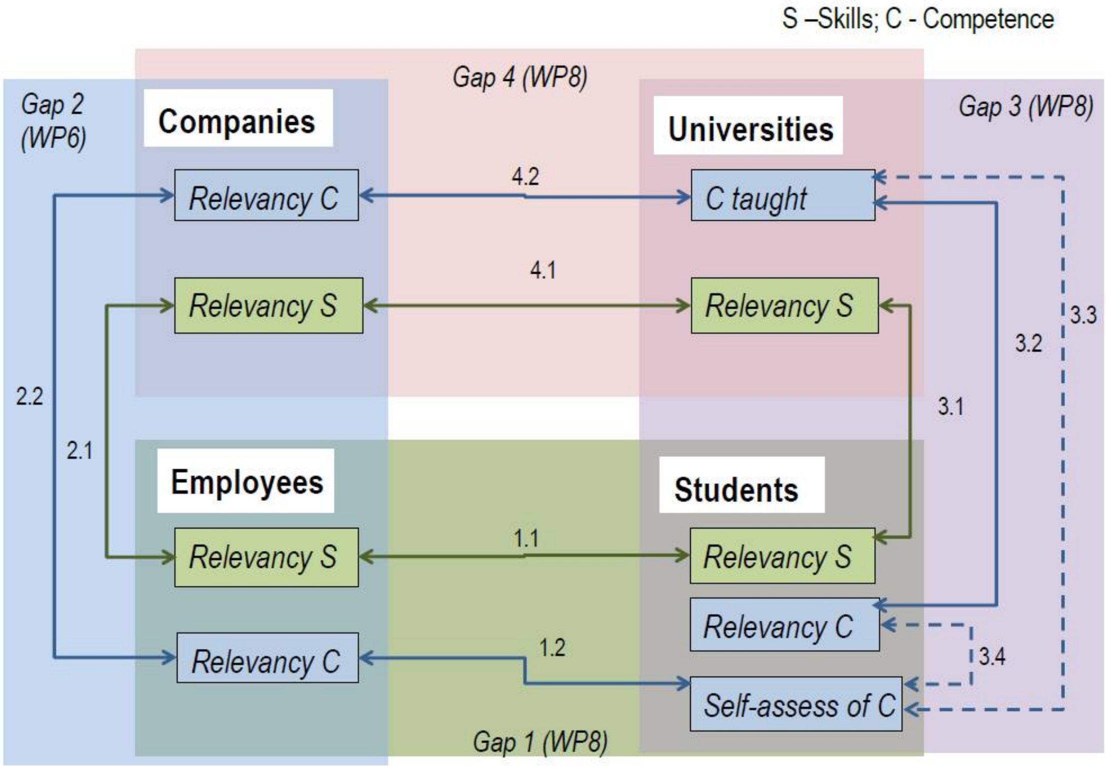
4.2. Competences Gaps

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.

Figure 3 – Surveys' connection in the Gap Assessment Framework



It was done on a pair basis between Companies, Employees, Students and Educational Institutions. 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 this project's 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 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

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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. Corrective 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 Gap, which may indicate that students still lack knowledge on the actual importance of each gap (and, in doubt, ranked them all very high). 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.

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5 LABOUR ATTRACTIVENESS OF THE AERONAUTICAL SECTOR

Aviation sectors have been suffering from this growing problem and progressively industries are reporting the difficulty in attracting sufficiently skilled employees. The main identified problems related with this issue are summarised here:

- Problem 1: Progressive loss of interest in scientific or technical careers

Traditionally, scientific and technical careers ranked among the most reputed and socially relevant ones. However, along the years, they have progressively been replaced by others more fashionable (and better paid). Among these, the following can be included: financing and banking, management and entrepreneurship, marketing or public relationships, etc.

Rewards (promotions, salaries, societal relevancy, etc.) in the scientific and technical careers appear (if any at all) after a long time of dedication and investment; whereas in the new fashionable careers, it is believed to appear almost immediately and with lower investments. Consequently, when making the trade-offs between careers, the rewards of a scientific or technical career may be considered not worth the required investment.

- Problem 2: Progressive loss of prestige of the Air Transport and Aeronautic Sectors

Air Transport and Aeronautics, in the broadest sense, have always captured the interest of people, in general, and youth, in particular. The opportunity to work with a flying machine or in a related sector was often the main driver to apply for a job in this area. However, such glamour has somewhat faded over time. Endogenous and exogenous reasons may be identified. The popularisation of air transport contributed to the reduction of the mystique. Also, many other industries have been much more pro-active in attracting youth, like for example: car makers. This reason is linked with the previous problem and it is related with a change in society's view on the technical related jobs (and inherently, in the aviation sectors).

- Problem 3: Progressive reduction of students' interest for mathematics, physics and other sciences

A change in students' perception about educational needs in mathematics, physics and other sciences is underway over the last decades. Nowadays, students no longer look to these disciplines with awe and eagerness to learn. Indeed, they label them as unattractive, difficult, boring and with low connection to reality. Also, they do not see them as necessary requisite to get a good job in the future. Instead, they are favouring other disciplines, often related with the development of soft-skills. These disciplines are often advertised as fundamental for getting the job.

No longer, the promising students are those with better grades in mathematics, physics, chemistry and other science; but, in areas related with management, entrepreneurship, marketing, etc.

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- Problem 4: Technical carrier is inferior to management carrier

Although promotions and progression do occur in both technical and management tracks, in many companies, the top positions (and, consequently, the higher salaries, benefits and recognition) are restricted to those in the management career. There is therefore a major incentive for employees and applicants to move towards this track.

- Problem 5: Educational paradigm has changed favouring the teaching of soft-skills in detriment of hard-skills

The spread of globalisation has led to the emergence of new business and educational paradigms, largely based on the concepts of networking and chains, and (multidisciplinary) teams. In parallel, we witnessed in many prominent management schools the emergence of novel educational paradigms, often largely based in the development of soft-skills (precisely to educate students working in the Globalised world and teams). Progressively, this trend was adopted by other schools and educational institutions. Although the relevancy of soft-skills cannot be challenged, the problem occurs when the teaching of hard-skills is reduced to a point that students lack the competencies to work in scientific or technical areas. This trend also occurred to more or less degree in engineering schools leading to a progressive reduction of knowledge on central areas for Aviation. The direct consequence was the reduction of interest of students in these industries.

- Problem 6: Reduction of systems engineering-related courses

The development of industry and labour market has favoured the specialisation of employees. In paralleled many engineering-related courses were structured in silos with low (if any) interaction among them. This has created a breath of knowledgeable engineers in a given area, but with little understanding outside their area. If this is positive in certain business sectors, the same does not occur in aviation, in which employees are required to have a systems' view and knowledge of the entire productive process. This may be leading specialised applicants to look elsewhere. Some companies are more rapid, active and offer better starting salaries than aviation: e.g. Goldman Sachs, Ernst & Young. They seek aviation students for their technical ability that they cannot find in others (economist, ….)

The impact of each of the abovementioned problem in the level of attractiveness varies in nature and reach. The Progressive loss of interest in scientific or technical careers (Problem 1) has an earlier influence in the job choice process and, thus, in the level of attractiveness. The point is that if students do not even think in getting a scientific degree they will hardly become acquainted with jobs in the domain of Aviation (Step 1) or will immediately discarded them (Step 2). The Progressive loss of prestige of the Air Transport and Aeronautic Sectors (Problem 2) is another problem with the same level of impact. If Aviation sectors fail to get known to students and applicants, they will simply not search for jobs (Step 1). AT&T sectors need to adopt a pro-active positioning in order to stand above the crowd and flag themselves out. The progressive reduction of students' interest for mathematics, physics and other sciences (Problem 3) has a similar effect, since may lead them to divert to other domains and necessarily exclude them from searching (Step 1) and working (Step 2) in Aviation sectors.

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By the same token, the fact of a Technical carrier is inferior to management career (Problem 4) may divert students from pursuing educational (Step 1) and later on a career (Step 2) in Aviation afraid of being relegated to inferior job positions.

The fact of Educational paradigm has changed favouring the teaching of soft-skills in detriment of hard-skills (Problem 6) and the Reduction of systems engineering-related courses (Problem 7) may lead applicants to not process Aviation jobs offers (Step 2) afraid of not having enough competences, or simply discarded them upon reading the actual requirements (Step 3).

The above analysis was performed considering the whole aviation sector and of course the same conclusions are applicable to specific labour attractiveness of aviation safety employment positions.

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6 CURRENT EDUCATION AND CURRICULA IN AVIATION

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: 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.

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7 AVIATION SAFETY RESEARCH

OPTICS is a Coordination and Support Action (CSA) funded by the European Commission that aims to provide oversight of progress in Research and Innovation (R&I) targeting aviation safety improvement in relation to the Flightpath 2050 goals. OPTICS aims to provide this oversight by implementing a sustainable process that supports stakeholders with strategic recommendations and a comprehensive overview of the aviation safety research landscape. OPTICS implements methodologies to perform the assessment of progress both from a technological perspective and from the societal and economic perspective. The assessments result in the provision of an annual report that identifies main performers, gaps and obstacles in the research landscape, and that formulates strategic recommendations, corrective actions and suggested priorities.

This first OPTICS yearly deliverable has provided an overview of the state-of-the-art of aviation safety research. This initial picture includes maturing innovations with a strong potential to improve aviation safety value, and also projects of lower maturity that nevertheless tackle key strategic safety issues. On the other hand, for many capabilities no associated projects were identified. Some capabilities have numerous projects that collectively do not address the full scope of the capability. Projects that address the full scope of a capability are scarce.

Observed potential gaps in research are related to addressing specific environmental hazards, domains and operations other than commercial aircraft operations, a number of global aspects (e.g., global CNS coverage and integration of safety data through all stakeholders), and passenger management. In Human Factors, a game-changing priority is to foster an industrial and organisational culture that values Human Factors, while other priorities are the human performance envelope, automation, and the integration of Human Factors into design engineering practices.

A number of bottlenecks were identified in the adoption of research results. These specifically concern data issues (sharing of data and data protection), legal and organisational issues surrounding changing stakeholder responsibilities (e.g., automation), realising radical innovative ideas, and certification issues (regarding e.g, automation and mitigation of environmental hazards).

The safety-related part of the SRIA provided a good structure for potential educational activities. Its points of improvement include the large scope of some capabilities, clarification of the enabler clusters, and the use of R&I needs below the level of capabilities. Furthermore, three potential supplements were identified: training and selection for the pilot and controller of the future, security impacts on safety, and a common Human Factors education system. These potential supplements, together with gaps in aviation safety research, should be considered in the definition of the educational measures in the field of aviation safety.

8 FSS TECHNICAL PROJECTS OUTPUT AND EDUCATIONAL POTENTIAL

Hereafter, the Educational potential and related effects are arranged around the three mentioned goals and considering the enablers identified around Challenge 5 of the SRIA, as described in section 3.

8.1. Raising interest in the Aviation Safety Domain

The raising interest in the aeronautics domain is an important issue given the current trend in youngsters adopting social sciences careers rather than those based on STEM (Science, Technology, Engineering and Math). Additionally, all those careers that support the aeronautical industry and AAT domain are expected to demand a growing number of human resources with training and back ground so that the industry could be sustained. New aircraft programmes, airliners' market demanding more and more aircraft for the world development, aerospace industry constant innovation requirements, air traffic safety and congestion challenges, among other needs will require future a growing number of trained and qualified human resources.

If the number of technical and science students keeps diminishing, it could be a severe issue for the sustainability of the industry. Thus, the educational goal "Raising interest in the Aeronautics domain" aims to disseminate basic knowledge and support better understanding of the Aeronautics and Air Transport (AAT) domain's high level scientific and technical open issues.

Throughout Europe several initiatives have been deployed towards the increase on the interest in science studies and related professions. This is supported on the one hand by the rising demand for qualified researchers and technicians in several fields, as an essential requirement to assure an adequate level of innovation to support the maintenance of the economic competitiveness.

This problem has been addressed at national and international level and several strategies have been proposed aiming essentially:

- Promote a positive image of science, by:
  - Improving school based science teaching & learning
  - Striving for a better gender balance
- Improve public knowledge of science, by:
  - Raising pupils' interest in science subjects
  - Providing employers with the required skills

Five generic measures are proposed to implement such strategies, and these include:

- Implementing curriculum reforms
- Creating partnerships between schools and companies
- Setting up science centres
- Providing particular guidance to encourage youth (girls) to choose scientific careers
- Developing Continuing Professional Development (CPD) material for teachers

Some gaps have been identified between the measures proposed and strategies aimed. These gaps refer mainly to the fact that very few initiatives deal with career advisors (issue on the profession) are deployed, focusing instead on the education point of view. In fact, if no references are introduced in terms of future

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professional life, the increase in interest in aeronautics will only be partly achieved. The Flyhigher project mentioned a series of events organized by several partnership initiatives between industry and schools[1].

8.1.1. Potential actions

Actions towards the raising of interest in aeronautics shall be directed mainly to secondary school students and considering the average technical knowledge of these students, the content of any action to be taken shall be made in general aeronautical terms but introducing some safety concepts, although superficially only. These actions to be carried out should be either at the universities or R&D centers facilities or at the schools. These actions may have the following configurations:

- Visits to R&TD aviation safety facilities
- Visits to aviation safety industrial facilities
- Lecture on specific subjects at schools
- Internships at R&D institutions and universities under scope of challenges/games on specific technologies.

8.2. Fostering scientific and technical studies

One of the educational objectives aims at “Fostering scientific and technical studies” through, e.g., developing e-learning modules based on problem solving and serious games, in which students will be engaged in real, even if simplified, problems coming from the Programme.

E-learning will present outstanding scientific and technical challenges, understandable and manageable for students, motivating them to proceed in deeper scientific and technical studies leading to an increase of the Aviation safety knowledge base.

8.2.1. Potential actions

To foster scientific and technical studies in aviation safety, and considering all the previous analysis work that was carried out concerning the educational offer on the aeronautical sector, the following potential actions to use the knowledge developed in each project are proposed:

- At BSc and MSc

  At this level of education the main objective should be the incorporation of the developed knowledge on existing BSc and MSc programs. In order to accomplish this objective, a list of universities should be invited for the FSS final event in order to present the main achievements in each FSS project. This could be used by educational organizations for updating aeronautical and safety related educational plans.

  Note: In order to enable a broad dissemination this final event should also be possible to be attended on-line, its presentations made available on the FSS website and mails should be sent to universities inviting them referring the importance of their attendance.

[1] Flyhigher project Deliverable 1.1: Aeronautical sector report on future skills needs, Jun3 2013 (accessed at http://www.flyhigher.eu/).

- At Postgraduate level

At postgraduate level the main objective should be the creation of specific and dedicated courses on the subjects developed throughout FSS. These courses may have different configurations and duration, from a standard in class room course, to an online course or a MOOC (Massive Open On-line Course)..

Contacts with specific universities may help to put in place such postgraduate courses.

- At PhD level

At PhD level the main objective should be the creation of PhD programs or the definition of PhD thesis themes for future researches on subjects related with the several FSS projects. At the FSS final conference, a research outlook should be presented in a dedicated session, where the participation of universities and research institutions from outside the FSS consortium will be highly recommended.

8.3. Promoting careers in aviation safety

The preference of younger individuals to enter social science related occupation rather than engineering and 'hard science' related careers might put at risk the existence of educated and trained candidates for the various different aeronautics and aviation safety related careers.

An early stage contact between students and aviation safety industry and academia work environment is fundamental to present the challenges and careers in this area. At the same, time support the industry on actual human resources safety training is another gap which should be filled.

FSS may support actions on showing students interesting and relevant aspects of jobs in aviation safety research and industry, and to prepare young people to meet recruitment demands for highly skilled professionals, hoping that this job market will reach higher demand rates for specialized skills in the future. Further actions from FSS may also be the support on the creation of a training offer for current aviation employees, promoting aviation safety careers.

8.3.1. Potential actions

The promotion of careers in aviation safety requires that actions to be taken closer to industry and involving industry, as these shall be the main employers and the main responsible for the creation of jobs in aeronautics. To address the challenge of promoting careers in aviation safety, the following potential actions are proposed:

- Supporting Companies with their human resources' training

Concerning human resources already working in industry it is essential that a continuous or lifelong training program shall be put in place tailored for these professionals. This shall be accomplished through the design and deployment of short courses dedicated to specific technical or management subjects in the scope or aeronautical safety issues**. A small course could be designed and a university – possibly involved in FSS – could make all the efforts towards its promotion and deployment.**

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- Further support and incentives to internships or on on-job training

Both industry and R&D organizations should create a internships program directed towards graduation students or even holidays internships that could work as a first time experience and contact with the aeronautical industry and specifically the aeronautical security issues and impacts on professional life. This internship programs should be presented to the university(ies) in the surrounding of each company or R&D center so that local students can be attracted. Throughout these internships students are given specific and limited assignments that shall put them in contact with real professional life and the responsibility and impact of their job on a specific aeronautical safety issue, assuring that a tutor is supervising the work done closely.

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8.4. Education measures proposal

Considering the content and objectives of FSS, the following educational measures could be identified as potential for future actions:

Project No.	Project objectives	Education measures
P3	• To improve models for analysing aircraft ground control under crosswind and on slippery runways; • To analyse the impact of water/slush covered runways on braking performance for modern tyres and antiskid systems; • To develop algorithms to identify veer-off risk using operational flight data; • To improve prevention or mitigation of runway excursions	• Create contents for lectures on aeronautics or aerospace university degrees • Create contents for pilot courses on take-off, landing and ground operation procedures, directed to pilot schools. • Create on-line courses (MSc or technical training course) on aircraft ground operations, take-off and landing procedures, with a broad audience
P4	To develop a prototype risk observatory to assess and monitor safety risks throughout the Total Aviation System and allow frequent update of the assessment of risks.	• Create contents for lectures on aeronautics or aerospace university degrees. • Create a post-graduate/MOOC course on aviation risk and safety assessment. • Establishment of a research agenda for new R&D projects and PhD and master thesis • Create a training course for aeronautic related companies employees on aviation safety and risk prevention.
P5	To significantly reduce the likelihood of organisational accidents in aviation via implementation of a Safe Performance System (SPS).	• Create a post-graduate/MOOC course on aviation organisations safety/risk prevention practices.

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Project No.	Project objectives	Education measures
		• Establishment of a research agenda for new R&D projects and PhD and master thesis (including psychology and sociology). • Create a training course for aeronautic related company's employees on organizational aviation safety and risk prevention.
P6	• Collecting knowledge and analysing pilot strategies used in the representation of the situation (example of a slow impacting system failure); • Enhancing HMI representation of situation to facilitate the coherence between pilot representation and HMI representation; • Considering the application of advanced automation (e.g. information, control) to optimise the cognitive demands of the pilots. • Validating with State of the Art real time objective measures (e.g. pupilometry)	• Create contents for lectures on aeronautics or aerospace university degrees. • Establishment of a research agenda for new R&D projects and PhD and master thesis (including ergonomics and computer science) • Organize student visits at R&D institutions performing R&D activities in this area
P7	• To improve knowledge about fire behaviour of primary structure materials • To improve material solutions to mitigate fire, smoke and fumes in cabin. • To develop general solutions to improve on-board air quality.	• Create contents for lectures on aeronautics or aerospace university degrees. • Establishment of a research agenda for new R&D projects and PhD and master thesis (including mechanical engineering, materials engineering and chemical engineering) • Organize student visits at R&D institutions performing R&D activities in this area

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8.5. Case Studies

Considering the education measures presented above two case studies are presented, performed by two partners of FSS Programme, which have already put in place measures towards the transfer of aviation safety knowledge to educational actions.

8.5.1. Case study – Total System Risk Assessment – TUM

The goal of P4 is to develop a prototype risk observatory to assess and monitor safety risks throughout the Total Aviation System and allow frequent update of the assessment of risks. Aligned with one of the educational objectives of the FSS Programme, "Promoting careers in aeronautics", TUM and particularly the Institute of Flight System Dynamics have been conducting several educational activities directed to promoting aeronautics knowledge. In particular, TUM offers a set of courses in which students are put in contact with motivating aspects of the AAT domain thus promoting careers in aeronautics. Such actions include:

- ***Safety and Certification of Avionics and Flight Control Systems***, a graduate course worth 5 ECTS that deals particularly with safety assessment of flight control systems. It addresses the certification process of avionics in commercial aviation with focus on safety analysis methods.
- ***Flight Guidance 1***, a graduate course worth 5 ECTS that deals with the technical background of flight instruments and navigations methods as well as aerial surveillance. The aspect of safety is also addressed in every chapter when explaining the principles.
- **Two practical courses *Flight Guidance* and *Fundamentals of Practical Flight*** worth 4 ECTS each that teaches the students the fundamentals of IFR flying and the theoretical part of a pilot license exam. Both of them address safety-relevant contents such as crew coordination, the use of checklists and procedures as well as human factors.
- Students are given the opportunity to work on their **Bachelor's and Master's thesis** dealing with a large variety of topics concerning safety in all areas of research currently being conducted at the Institute of Flight System Dynamics.
- The institute of ergonomics at TUM also has a research group that focuses on human factors and they also work in the aviation domain. Currently they offer a graduate course **Aviation Human Factors** worth 5 ECTS.

Furthermore, TUM is planning several activities containing:

- An additional graduate course **Flight Guidance 2** worth 3 ECTS that addresses the operational aspects when conducting a commercial flight. Part of the lecture will also focus on safety issues that are reflected in regulations, operating manuals and technical specifications.
- An additional graduate course **Flight Safety** worth 3 ECTS that is dedicated to this particular topic. The contents will include Safety Management Systems, Flight Data Monitoring, Accident Investigation and reporting systems.

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8.5.2. Case Study: Resolving the organizational accident – Trinity College Dublin

The goal of P5 is to significantly reduce the likelihood of organisational accidents in aviation via implementation of a Safe Performance System (SPS). The SPS comprises Safety Intelligence at top and middle management organisational layers, Safety Emergence at middle and operational/engineering layers optimised Safety Culture at all layers, and an inter-organisational Agile Response Capability for evolving crisis events.

Contributing to the Educational objective of the FSS "fostering scientific and technical studies", the P5 partner Trinity College Dublin developed the online M.Sc./Postgraduate Diploma Managing Risk and System Change[2] relevant to safety critical industries across the globe. This online course is focused on people already in work, who have responsibility for managing: risk; change; safety; quality; planning; system design. In fact, it brings the next generation of safety, risk and change management to the students, embedding everyday practice with a systemic, proactive and performance focus.

The overall objective of the online M.Sc./Postgraduate Diploma Managing Risk and System Change is to provide a rigorous but practical focus on risk, change and system design in operations, manufacturing and services, with an innovative integrated approach to the role of people in such systems. It provides a core framework that has been tested in collaborative industrial research and practice for managing and developing people, the design and integration of new technologies, the management of risk and the implementation of change.

[2] Reference: https://psychology.tcd.ie/postgraduate/msc-riskandchange/

9 CONCLUSIONS AND RECOMMENDATIONS

9.1. Conclusions

This Educational Plan contains potential educational measures for organizations providing education in the field of aeronautics, and in particular in aviation safety. This could enable the transfer of the generated knowledge into new contents in aviation safety education curricula. The proposed measures result from a sequence of several strategic and scientific studies, such as the Flightpath 2050 and Acare's SRIA and other Coordination and Support Action (CS) projects focused on aviation education and aviation safety.

The actions proposed are organized around three main targets:

- Raising interest in the aviation safety domain;
- Fostering scientific and technical aviation safety studies;
- Promoting careers in aviation safety.

This educational plan supports academic organizations, universities and other higher educations in exploiting the results of the Programme for educational purposes. Under this scope, the potential actions cover all the education levels, from high-school, graduation, post-graduation, including Masters and PhD.

9.2. Recommendations

In order to assure the highest degree of implementation effectiveness of this plan and achieve the highest impact, it is important that this plan and specifically the measures proposed, are further discussed with academic organizations, universities and other higher educations. These should be the main actors in the implementation of the measures proposed. It is recommended to update this educational plan towards the end of the Programme, taking into account the feedback from these anticipated main actors, as well as the end results from the Technical Projects in Future Sky Safety:

- P3 Solutions for runway excursions
- P4 Total system risk assessment
- P5 Resolving the organizational accident
- P6 Human performance envelope
- P7 Mitigating risks of fire, smoke and fumes

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