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Industry 4.0 and Soft Skills Framework Report



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SOFT SKILLS 4.0 FOR THE AEROSPACE INDUSTRY



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SOFT SKILLS 4.0 FOR THE AEROSPACE INDUSTRY



Executive summary

A new revolution is underway in the industrial world supported by equipment connectivity, technology and data. It will have an impact on each and every company department, changing completely the layout where they develop their activities. Industry 4.0 will result in an optimization of the industrial processes, reducing, therefore, costs and busting productivity gains.

The availability and costs of technology are making this transformation possible. This change will be rapid and disruptive, changing the rules of the game in a short period of time. Those who cannot adapt themselves to these fast changes are set to fail in this future context. Workers in every hierarchical level, including entrepreneurs, need to develop broader relational and technical skills to participate in the development of the entire company. The human aspect is the greatest challenge of this transformation.

The aerospace industry is a very sensitive sector to this revolution. It is needed to assure that companies that operates inside this wide market adapt their workers to the upcoming changes that come with the 4.0 revolution.

The Sky4.0 project aims to this very issue, focusing on one of its major problems: education and training of the aerospace industry workers; more precisely, education and training on soft skills. The SKY 4.0 will develop tools to establish the necessary soft skills, thus, adapt the aerospace industry workers to the new industrial revolution through their education.

This will be done through the following pillars:

- 1. Aiming the developing of soft skills to key groups inside the Aerospace sector:
 - a. Companies and their workers
 - b. Trainers and VET providers
 - c. Secondary education students and technical colleges.
 - d. Human resources teams and team managers
- **2.** Applying the knowledge acquired in the first pillar to develop training resources to be applied inside companies.
- **3.** Taking the data from the first two steps to improve training materials on soft skills for technical courses students, VET and aerospace companies' workers.

This document belongs to the first pillar of the SKY4.0 project, it stablishes a set of soft skills, and contrasts it with companies from the aeronautical sector. Thus, once the set of soft skills is stablished and verified, the development of training materials can begin.

The gathering of information for this document has been conducted through three main methods. Firstly, a desk research was conducted. Documentation and similar projects were gathered in order to stablish a base for the development of this study.





Secondly, an online survey was sent to workers from aerospace companies from the European Union. This survey aims to collect information on their knowledge about Industry4.0 and their companies' implication on soft skills education. They were also asked about their opinion on the SKY4.0's skill set, so to contrast it with workers that can be affected by the changes that Industry4.0 may bear.

At the same time, partners from the SKY4.0 consortium held several meetings with representatives from aeronautical companies, in order to gather information about their perspectives on Industry4.0 in their respective companies.

Companies' opinions showed, mainly, the importance of the SKY4.0 project and the need of start rising awareness on these matters inside companies in the aerospace industry. They recognize the importance of Soft skills education, as well as the need of investing on it. The information gathered reveal that, even though soft skills training is not fully implemented yet, it is something that aeronautical industry workers see as something necessary.



SOFT SKILLS 4.0 FOR THE AEROSPACE INDUSTRY



1 Introduction

1.1 Industry 4.0

The term Industry 4.0 is used to describe an emerging fourth industrial revolution. After the mechanization of production through the emergence of steam and hydroelectric power (Industry 1.0), the electrification, and with-it Taylorism (assembly line production, Industry 2.0), soon followed. These developments were then succeeded by the arrival of automated mass production through electronics and numerical control (Industry 3.0). The fourth phase, Industry 4.0, is defined by digital, intelligent, networked and largely self-managing production achieved through the union of production techniques, information technologies (IT) and the Internet.

The basis for Industry 4.0 is formed by networked, real-time capable and self-optimizing production systems. These systems shift the lines between the areas of production, services and consumption inside companies; as well as between labor, consumption and services on an individual level. The networking of things and services support the interaction and communication and join the physical and digital systems into a cohesive, seamless and flexible value-added network.

The impact of the development of the technologies in this context has many dimensions, not only affecting the way things are produced or factories works. These technologies are central to securing business locations and social welfare from a European perspective. At a company level, it will affect their technological innovations, standards, interfaces and new safety requirements that will be developed in order to adapt themselves to the upcoming changes.

At a societal level, the labor market and (vocational) education are directly affected, which could lead to associated social impacts; either positives (new job positions and opportunities) or negatives (unemployment) for those that do not adapt. Moreover, the way new professionals and current ones are trained should change, in order to assure that they can cope with this new environment.

These new educational needs are one of the key aspects inside the industrial development. For accomplishing the adaptation or change into a new set of technologies, it is important that everybody involved within the process is familiarized with them, as vertically and horizontally as possible, inside any company that wants to overcome the challenges of Industry 4.0. In order to accomplish this, it is required that the new set of skills that are needed to acclimate to the upcoming industrial context are established.

Some research on these new skills have been conducted, such as (Lamb, Doecke, & Maire, 2017) or (Aichholzer, Weber, Rhomberg, Gudowsky, & Saurwein, 2015), where they establish a collection of new skills that are needed to be taught in order to adapt





to the new Industry. This project belongs to this family, seeking to overcome the educational requirements of the new industry.

1.2 Revolution inside Aerospace Industry

The complexity and exigence of the aerospace industry make it a perfect target for the Industry 4.0 technologies. The digitalization and interconnection of the means involved in manufacture and production makes a fastest, safest and cheapest way of production possible.

Companies are taking the chance to tighten global supply chains, drawing suppliers into the network and using new technologies to link them through a wide range of dataprocessing based technologies. Products based upon data and data-analytics are used to explore new business models inside the industry than can improve revenues and ways of production.

The framework for the digital transformation of the aerospace industry stretches from cloud computing and mobile technology; to the use of augmented reality, big data analytics, smart sensors, location detection technologies and advanced human/machine interface. All of them, technologies based upon the principles of the Industry 4.0 revolution.

The nature of these new technologies will place higher demands on all members of the workforce in terms of managing complexity, abstraction thinking and problem-solving. Employees will have to act more independently and possess better communication skills and ways of organizing their own work. The soft skills, those related to the human character and interpersonal relationships, will have a more prominent role inside the aeronautical production chain.

Soft skills, such as initiative, critical thinking or intellectual curiosity, will require from an adequate training and supervision that will ensure that every part involved in the production chain know how to use and apply those soft skills. Thus, new personal competences and qualifications will be needed.

In order to solve this educational problem, new training modules focused on soft skills and social competencies will be required. The lack of these preparation may lead to fatal human errors and financial losses that can be avoidable.

1.3 SKY 4.0

It is, inside this context of new job positions and social and emotional skills, where this project comes along. SKY 4.0 aims to develop curriculum, training activities and materials for three specific target groups:

• <u>Current Industry 4.0 Aeronautical companies and their Industry 4.0 workers</u>: Sky 4.0 training activities target the needs of white collar and blue-collar workers.



The project will design a joint soft skill training program to address the needs of both target groups.

- <u>Future Industry 4.0 workers, or young students of secondary and technical</u> <u>schools, that could become future workers in aeronautical industry 4.0</u> <u>companies.</u> The project aims to increase the employability of these group by promoting the acquisition of skills and competences that students might need in their future employment at Industry 4.0 companies.
- <u>Human resource and team managers in aeronautical companies.</u> Those who manage teams or have human resources responsibilities, who may have more difficulties to face the new challenges of this new industrial revolution and are able to share and promote new procedures among other workers.

All the new CVs and training materials produced under SKY 4.0 will introduce and promote work-based learning. Curricula and training materials will be based on practical projects and Text and Workbooks that will contain "real life" workplace situations. These materials are aimed to develop the required soft skills for the Industry 4.0 challenge, namely Character-Building Skills, Social competence, and Personal Development skills.

In order to develop these materials as thorough as possible, direct contact with the target groups will be needed to collect data on their work environments and the degree of implementation of measures or projects related to Industry 4.0. This document presents a literature review of the documents, papers and projects consulted related to soft skills on Industry 4.0 on aerospace companies. Then, it shows the interviews and survey results and, lastly, an analysis of the results will be conducted.





2 Literature review

The concept of Industry 4.0 is not new, but it is young, as well as the studies that treat its impact on the Aerospace Industry. Another matter that is not exclusive from the SKY 4.0 project is the urge to set the corresponding soft skills, and its corresponding (World Economic Forum, 2018) educational materials, in order to adapt workers and futures employees to the new framework of the aerospace industry. Other projects from outside the European Union have achieved similar objectives that those set for SKY 4.0.

This section relates to other previous works with the objective of setting this project in its own context, thus clarify the need of its outputs and objectives.

The term Industry 4.0 was born in Germany and Austria, (Aichholzer, Weber, Rhomberg, Gudowsky, & Saurwein, 2015), as a way of explaining the new changes that the manufactures of these heavily industrialized countries are going through. This term gathers the changes achieved through digitalization, new production techniques and interconnectivity.

These changes will create a new high-quality job market and vastly improve their quality; however, these also can lead to a lose-lose situation: technological change accompanied by talent shortages can generate mass unemployment and growing inequality. As a solution, (World Economic Forum, 2018) proposes that business take an active role in supporting their existing workforces through *"reskilling and upskilling"*.

The aerospace industry is a sector very sensitive to the changes that Industry 4.0 brings along, (Peaford, 2018), therefore, there are many airlines and companies related to this sector that are starting to invest in developing and applying Industry 4.0 technologies. These changes, according to (Peaford, 2018), are going to affect these companies' revenues and the ways they interact with each other and their customers.

In particular, looking at the technologies that come along with Industry 4.0, (Baronio, Uberti, Speranza, & Filippi, 2017), there are several that can make a real difference on how things are done in the Aerospace industry. According to (Bonneau & Copigneaux, 2017), the internet of things (IoT); that is to say, the interconnection of not only people but also the tools that are used during the manufacture procedure, will affect the operations agility, the innovation and range of products, the client service and the revenue model of the company.

Other technologies that can be applied to the aerospace industry, as mentioned in (Franco Barbosa & Vidal Aroca, 2017) or (Baronio, Uberti, Speranza, & Filippi, 2017), are:

- Robotics
- Digital manufacturing
- Augmented Reality (AR)
- Additive manufacturing (AM)



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- Radio frequency identification (RFID)
- Composite materials
- Simulation
- System Integration
- Cybersecurity
- Cloud computing
- Big Data

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All these new developments, as mentioned in (Bonneau & Copigneaux, 2017), will have a direct impact in many aspects of aerospace industry.

In Table 1, all the references related to Industry 4.0 and Aerospace industry are gathered:

| INDU A | STRY 4.0 EROSPACE | A N D |
|---|--|--|
| Reference | Title | Outcome |
| (Aichholzer, Weber, Rhomberg, Gudowsky, & Saurwein, 2015) | "Industry 4.0: Foresight & Technology Assessment on the social dimension of the next industrial revolution" | Oversight of the impact of Industry 4.0 in the Austrian and UE industry |
| (Bonneau & Copigneaux, 2017) | "Industry 4.0 in Aeronautics: IoT applications" | Impact of some of the new Industry 4.0 technologies in the aerospace industry |
| (Franco Barbosa & Vidal Aroca, 2017) | "Advances of Industry 4.0 Concepts on Aircraft Construction: An Overview of Trends" | applications of Industry 4.0 concepts within the aerospace manufacturing processes. |
| (Peaford, 2018) | "This revolution has real byte" | Importance and application of Industry 4.0 technologies to the upcoming future of aviation |
| (Baronio, Uberti, Speranza, & Filippi, 2017) | "How will change the future engineers' skills in the Industry 4.0 framework?" | Definition and technologies that apply in Industry 4.0. Results of a survey conducted to state how skills affect the implantation and development of Industry 4.0 |
| (World Economic Forum, 2018) | "The future of jobs report" | Skills training as way of coping with the |

Table 1 References for Industry 4.0 and Aerospace Industry



technological changes that can change the job market

SKY 4.0 is a project which aims to develop educational material that ensures that the engineers and future engineers of the aerospace industry know and are able to use properly the soft skills needed in the upcoming future. In order to define these skills, it is needed that a classification and definition of the skills and capabilities of the members of the industry is done.

Skills can be divided into two categories; hard and soft skills. A definition of both can be found in (Baronio, Uberti, Speranza, & Filippi, 2017):

- Hard skills: specific and teachable scientific technical abilities that can be defined and measured.
- Soft skills: combination of interpersonal skills, personality characteristics and emotional intelligence.

Due to the characteristics of soft skills, intangible and hard to measure, they have been the object of many studies directed to define and classify them. Thus, teaching material could have been produced. An example of this kind of effort is the definition of the skills for the 21st century: (Lamb, Doecke, & Maire, 2017), (Binkley, Erstad, Raizen, Ripley, & Rumble, 2010).

These works aim to define the soft skills needed to overcome the future changes of the Australian industry (and other countries that contribute to the research). They predict that the technologies related to Industry 4.0 will be a reality in a short-term future, there it is necessary that the educational system of this country is prepared to teach its students the appropriate soft skills. This education should prepare them on how to *"become engaged thinkers, resilient and resourceful learners, creative problem solvers and active members of their communities."* (Lamb, Doecke, & Maire, 2017). So, their proposal goes beyond the Industry framework and takes into account more social aspects besides the technical ones.

Another work on soft skills for Industry 4.0 is (Aulbur, Arvind, & Bigghe, 2016), where they develop a basis series of soft skills to adapt the BRICS countries to the upcoming Industry 4.0.

Focused on education for Aerospace Industry, two different works can be highlighted. First, (Lappas & Kyriakos, 2016), based upon the skills for the 21st century mentioned before, this work define a more critical skill set for the aerospace industry that *"can be translated to the higher education environment through an effective redesign of the existing teaching and learning philosophy"*.

Lastly, (Aéro Montréal, 2018), as well as SKY 4.0, aims to create a *"Industry 4.0 Skill Sets for Aerospace to equip educational institutions (professional, technical and academic) to*



modify and adapt their training programs for future company needs", (Aéro Montréal, 2018). SKY 4.0 goes far beyond; because after setting these critical soft skills, it will develop teaching materials that can be used to ensure that those skills are put into practice.

Table 2 gathers all the works mentioned before and describes the contribution of each one of them:

S 0 F T SKILLS Reference Title Outcome Impact of new way of industrialization in (Aulbur, Arvind, & "Skill Development for BRICS a skill set to Bigghe, 2016) Industry 4.0" overcome the challenge Skill set for aerospace future; definition and "Industry 4.0 skill sets for (Aéro Montréal, 2018) their level of aerospace" importance for every work position future skills to the "Anticipating the Need for university classroom (Lappas & Kyriakos, New Skills for the Future for the aerospace and Aerospace and Aviation 2016) aviation industry Professionals" personnel Proposes a model for (Binkley, Erstad, "Assessment and Teaching assessing 21st century Raizen, Ripley, & of 21st Century Skills" skills, that is to say, soft Rumble, 2010) skills for industry 4.0 Set of soft skills to "Key Skills for the 21st prepare future (Lamb, Doecke, & Century: an evidence-based students to the Maire, 2017) review" Industry 4.0 in Australia Definition and technologies that apply "How will change the future in Industry 4.0. Results (Baronio, Uberti, engineers' skills of a survey conducted Speranza, & Filippi, in the Industry 4.0 to state how skills 2017) framework?" affect the implantation and development of Industry 4.0

Table 2 References on soft skills

On Table 3 more documents regarding soft skills are gathered:



Table 3 More information on Soft Skills

SOFT SKILLS

| Reference | Title | Outcome | |
|-----------------------------------|---|--|--|
| (Kwiatkowski, 2018) | "Kompetencje przyszłości" | The text concerns the issue of competences, with particular emphasis on competences that will be necessary in social and economic environment in the coming years. | |
| (Borowiec- Gabryś M., 2018) | "Przedsiębiorczość jako kompetencja przyszłości" | The text deals with the challenges for the future in the area of developing key competences that determine the need employees with new competences. The relations between entrepreneurship and socio-economic development prove that and entrepreneurial person plays an important role. The place of entrepreneurship in the Polish education system is described. | |
| (E, 2018) | "Międzynarodowe projekty edukacyjne drogą do rozwoju kompetencji kluczowych" | Participation in international educational projects creates favorable conditions for the development of entrepreneurial, socially oriented, civic and democratic attitudes, as well as interpersonal competences. | |
| (Gracel J., 2017) | "Kluczowe kompetencje menedżera w dobie czwartej rewolucji przemysłowej" | The text develops issues related to competences and distinguishes features for competent managers. The concept of the fourth industrial revolution, Industry 4.0, has been precisely described and outlined what their implementation looks like in Poland and worldwide. Special focus was put on emphasizing the role and importance of educated staff and managers in the era of the fourth industrial revolution, who should be distinguished by their characteristic competences and abilities, as well as substantive preparation for work in a specific environment. An important and innovative element of the study is the separation of requirements for managers in the context of Industry 4.0. | |
| (Cotet G.B., 2017) | "Assessment procedure for the soft skills requested by Industry 4.0" | The premise behind this article is the need to adapt the human resources performance to the requests of the industry 4.0; being supported by an organizational culture. It is concluded that there is no clear procedure for the assessment of the constellation of skills and personal qualities – soft skills requested by industry 4.0. These capabilities should complete professional, technical (hard) skills. The procedure should provide a map for the constellation of capabilities necessary to adapt and perform in specific industry 4.0 activities. The core of the complex various skills required was identified. | |
| (Kamiński W., 2017) | "Kompetencje miękkie w pracy inżyniera" | The role of soft skills in engineers' work. | |
| (A., 2018) | "Co ma wspólnego Inżynier 4.0 z człowiekiem renesansu?" | Analysis of the competences that a modern engineer should have. | |



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| (Astor, Harvard Business review Polska, s.f.) | "Towards 4.0 industry, Practical guidance" | Practical guide to technical, organizational and technical changes coming with the industry 4.0 revolution |
| (Hartmann) | "Needs Analysis for "Industry 4.0" Based on Roadmaps for Smart Systems" | In the context of fourth industrial revolution, based on distributed Smart Systems, integrated in the Internet of Things, a methodology for skills needs analysis was presented; embedded in an approach encompassing (technological) foresight and development of educational frameworks, all within the context of R&D program management. |
| (World Skills Russia) | "Skills for Industry 4.0, World skills Russia" | The report shows transformation of the economy towards Industry 4.0. The key elements are cyber-physical Systems, internet of things, internet of services, smart factory, key Industry 4.0 elements, cloud computing and big data. |



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3 Interviews analysis

3.1 Objective, procedure and sample

The aim of this project is to generate curricula and training modules for companies, so that they can accomplish their preparation for the upcoming industrial context. These materials are intended to be specific for aeronautical companies, so it is important to get to know their implication with the Industry 4.0 progress, their needs and their views on this specific issue.

In order to get to know what the main preferences of the aeronautical companies are, the members of the SKY 4.0 consortium have conducted interviews with companies from the aeronautical sector. During these interviews, representatives from these companies explained their concerns and opinions about the implementation of the Industry 4.0 in their companies and how the training on soft skills may have an impact on the upcoming context. Table 4 summarizes participation on the interview on SKY4.0 countries:

| SKY4.0 member | Country | Number of interviews | Number of participants |
|-----------------|----------|-------------------------|---------------------------|
| Aviation Valley | Poland | 5 | 85 |
| QSR | Portugal | 2 | 6 |
| IMH | Spain | 13 | 16 |
| UPM | Spain | 1 | 3 |
| HUKD | Turkey | 1 | 1 |

Table 4 Participation on the interview

To standardize the answers that were collected, each partner used a template to collect and summarize the answers so to simplify the process of analysis. Each template contains the following information (it can be consulted on ANNEX 2: Interview template):

- Company name
- Date
- Aim of the meeting
- Feedback
- Conclusions
- Participants



In the following sections a qualitative analysis of the answers gathered by the SKY4.0 consortium in their meetings is presented.

3.2 Qualitative analysis

3.2.1 Acquaintance with I4.0 concept and soft skills training

Most companies showed their awareness of the importance of the soft skills education and training. They commented that the engineer of the future will have to have these in order to cope with the future needs of the aerospace industry needs.

SMEs showed, however, in some cases, a lack of knowledge on this concept, admitting that it was mostly new to them. They also admitted that this new concept fills a gap that they couldn't name but that they could feel it was there.

3.2.2 Examples of implantation of similar projects

Most companies accepted to have their own dissemination plans of similar concepts related to soft skills training inside their companies. They also admitted that they have been trying to raise awareness on the importance of this dissemination plans and programs.

3.2.3 Utility of the SKY4.0 project

A comment on the utility of this project commented the lack of similar projects as SKY 4.0, highlighting, thus, the importance of the aims of the SKY 4.0 consortium. Others admitted that, due to their companies' activities, education of their workforce was very important, so it was formation on soft skills; in order to retain talent, thus augmenting the abilities of their workforce.

3.2.4 Difficulties of implementation of the SKY4.0

results

The main difficulties about SKY4.0 results implementation was expressed by SMEs. They usually have a small workforce that is dedicated entirely to production, so it is complex for them to arrange courses or training programs or curricula.

On the other hand, having expressed their awareness of the importance of the project, some of them indicated that they will try to have into account these soft skills during the hiring process.

3.2.5 Support of the SKY4.0 project

The general opinion about Sky4.0 project was very positive, and support came from every interviewee. Everyone that was asked about the set of soft skills that SKY4.0 is elaborating agreed with it. A good number of them also agreed on the necessity of having an active approach on Industry4.0 implementation.



About participating actively in the project, the creation of Human Capital Aviation Valley Forum, as a platform to support SKY4.0 in Aviation Valley, was achieved. Following the same idea, each company agreed to participate in the survey that is commented in the following sections.

3.2.6 Implementation needs

To this topic, companies mentioned the need from local and national authorities to implement the SKY4.0 training models and curricula.

At a company level, they mentioned the need of analyzing industrial development solutions in order to adapt the SKY4.0 to their respective needs and challenges.



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4 SKY 4.0 survey analysis

4.1 Procedure and sample

The data used in this report was collected through an on-line survey. This survey was sent to members of the aeronautical community in several European countries inside and outside the SKY4.0 consortium. The criteria for selecting the sample was that they needed to work for companies that belong to the aeronautical sector. Even though there were no criteria on companies' size or their revenue, participants were asked to identify those aspects, if they knew them. Companies' names were optional, so not to interfere with any privacy policy.

The sample of this study consist of 67 aeronautical workers (17 more than the minimum requested) from the consortium countries (Spain, Poland, Turkey and Portugal) and from countries outside it (France, Netherlands, Italy) as well. The difference observed in the number of participants from each country is not related to the precedence itself but from the desire of each person to participate on the survey. All the companies are related with the aviation sector, although in different activities: ANSP, ATM consultancy, academic education, manufacturers, airlines, among others. There are also participants that work with or alongside educational institutions related to aeronautical science.

In Graph 1 and Graph 2, can be seen the approximate number of employees and the companies' annual turnover given by the participants:



Number of employees:

67 respuestas

Graph 1 Number of employees

SOFT SKILLS 4.0 FOR THE AEROSPACE INDUSTRY



Company's annual turnover

62 respuestas

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Graph 2 Companies' annual turnover

Participants were also asked to describe their role in their company. Results show that a vast majority are in charge of work teams (as seen in Graph 3) or have managerial positions in their companies:



Are you in charge of a work team?

Graph 3 Percentage of participants in charge of a work team

There are also participants that works inside educational institutions, working as lecturers, professors or researchers. They are a minority, but their participation is valuable because it widens the spectrum within the aeronautical sector: from the educational institution to the private company.



4.2 Measures

The survey was tailored for the main purpose of the study; also keeping in mind the natural constraints of collecting data among organizations, the questions were adapted to make them understandable for a wide public. The survey script can be founded in ANNEX 1: Survey Script.

4.2.1 Companies characterization

The participants' organizations are characterized through the indicators: Business Activity; Number of employees and Annual Financial Turnover

4.2.2 Industry 4.0

After the characterization of each company, they were asked several questions about Industry 4.0 general concept. These questions are intended to measure the knowledge of the participant about I4.0, how deeply implemented is inside his or her company and what kind of technologies show this implementation.

Besides short-answer questions, a scale from 1 to 5 (where one is the least and five is the most value for the answer of the question) was used to grade several aspects, such as degree of implementation or compromise with the I40.

4.2.3 Skills

In this section, participants were questioned about hard skills and soft skills. Thus, get to know the knowledge of the participant on this issue and the companies' compromise with training.

As soft skills are the main issue of the SKY4.0 project, participants were asked to grade each soft skill using the indicators in Table 5 for each level of the hierarchy inside a company. Therefore, expand or eliminate a given list of soft skills that are necessary to help aeronautical companies overcome the challenge of I4.0

| Level | Description |
|-------|--|
| А | The individual is a recognized expert. |
| В | The individual uses the skill. He/she has a good level of autonomy but needs guidelines. |
| С | The individual understands the importance of the skill. He/she is aware and uses some of it. |

Table 5 Indicators



4.3 Results

Results obtained from the survey about Industry 4.0 and soft skills in the Aerospace Industry.

4.3.1 Familiarity with the concept of Industry 4.0

Most part of the interviewees are familiarized or know about the concept of Industry 4.0 as seen in Graph 4:



Graph 4 Familiarity with I4.0

When asked for a description, a vast majority of the affirmative answers associate I4.0 with the technologies that this concept will bring along, such as automatization, robotics, IoT, artificial intelligence and so on. Only one respondent gave an answer similar to the academic one.

4.3.2 Strategy on I4.0 implementation

When asked if their companies have a strategy on I4.0 implementation, results were tie (Graph 5):



Does your company have any strategy on Industry 4.0 implementation?

67 respuestas

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Graph 5 I4.0 Implementation Strategy

If they had answered negatively, they were questioned if they thought there will be any in the upcoming future. Most answers are vague and do not specify if they think about it as a real chance.

For a positive answer, they were asked about its implementation status (

Graph 6), being mainly low. They were also asked about its deadline, being this one nonexistent for most of the answers.



Graph 6 Implementation status

Another strategy of implementation is the propaganda used by the company to promote I4.0 concept and the courses they may already offer to familiarize their



workers with these new changes in the industry. The results to these two questions can be seen in Graph 7:



Are there any courses or propaganda about I4.0 inside your company?

Graph 7 Courses or propaganda

If the answer was affirmative, they were asked about the kind of propaganda and the impact of it. Only 20 people answered to this question and their responses can be shorted out in the following categories:

- Easy access to information about 14.0
- Courses, seminars, workshops, etc. (either voluntary or mandatory)
- As a result of an ongoing project inside the company.

4.3.3 Involvement on I4.0 implementation

In Graph 8 can be seen the management involvement with the I4.0 implementation in their respective companies:





Graph 8 Management involvement in 14.0 implementation

On the other hand, in Graph 9 can be appreciated the involvement of each participant's working peers and, if they are in charge of a working team, the engagement of his or hers employees on this particular matter.



Graph 9 Employees or working peers' involvement on 14.0 implementation

4.3.4 I4.0 technologies

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The last question about I4.0 is about the technologies that come with the concept. A list of technologies was presented to the participants and they were asked to choose the most important ones (they were able to choose as many as they considered). The percentages shown in the graphics tell how many participants have chosen a technology per total number of answers. Results can be seen in Graph 10





Graph 10 I4.0 technologies

Among the technologies classified as Other (Graph 10), participants have listed, mainly, technologies related to machine learning or artificial intelligence. The list of technologies shown in Graph 10 was obtained from (Baronio, Uberti, Speranza, & Filippi, 2017)

4.3.5 Hard skills

Before participants were asked about soft skills, several questions about hard skills, those related to experience and practice to conduct a determine task, were made; in order to assess the importance in formation in more common issues companies have, for example, formation on the use of a specific piece of software.

When asked about the existence of formation curricula about hard skills, answers where tie (Graph 11)



Is there any study or program about the development of hard skills inside your company? 67 respuestas





For those answering negatively, they were asked if they find important the need of lunching any (Graph 12)



If there is none, do you think it is necessary to launch any?

Graph 12 Necessity of a Hard skills formation CV

When asked to describe particular activities, the answers were really varied but can be summarize in these categories:

- Technical courses related to their fields inside aeronautical industry.
- External courses.
- University or technical school courses.

4.3.6 Actual soft skills education inside each company

Before they were asked about the set of soft skills that is the main goal of the SKY 4.0 project, they were questioned about the implementation of soft skill training inside their companies (Graph 13)

Is there any study or program about the development of soft skills inside your company?



Graph 13 Soft skills courses



For the negative answers they were asked about the necessity of lunching some (Graph 14):



If there is none, do you think it is necessary to launch any? ³⁴ respuestas

Graph 14 Necessity of lunching soft skills training programs

After this, they were asked about the courses that their companies may have (35% of participants), in case there are some. The objectives of the courses can be sorted out in the following categories:

- Communication skills
- Learning methods
- Team working methods
- Management methods
- Problem solving methods
- Emotional intelligence education

For those whose company have soft skills training programs, they were asked about the importance of this investment (Graph 15)

sky40



Graph 15 Importance of investment on soft skills training

On the other hand, for those that did not have any program on soft skills training, they were asked about the need of implanting any, therefore making an investment on soft skills training programs (Graph 16).

If there is not any kind of investment, do you consider that there should be some?

40 respuestas

У



Graph 16 Need of investment on soft skills training

When asked about the reason of their answer, all of them referred to the importance of education as a way of following the market trend and keep up with the challenges that Industry 4.0 adaptation may bear.



4.3.7 Set of soft skills

At last, participants were asked to give their opinion about a set of soft skills previously made that are considered important for the adaptation of aeronautical companies to Industry 4.0. These soft skills are:

- Initiative
- Change adaptability
- Critical thinking
- Analytical thinking
- Intellectual curiosity
- Cognitive flexibility
- Effective communication in digital environment

For each one of them, participants were asked the grade of expertise (A, expert; B, basic; C, beginner) for every stage of the vertical company organization:

- Assembler, Fitter, Machinist and mechanic
- Technician and methods Agent
- Engineer
- Supervisor
- Leader and Entrepreneur

This distribution is based on the one that appears on (Aéro Montréal, 2018). After that, they were asked about the implication of the development of such skills in their companies and why that may be important. These last two questions were optional. In the following sub sections, a definition of each soft skill is given, followed by the answers of those two optional questions and a graph showing the results.

4.3.7.1 Initiative

It is the willingness to act, create opportunities and improve results without the need for an external requirement that pushes them to do so, to act proactively and to think about what needs to be done in the future. Participants answered that when trained it improves proactiveness, openness, and assertiveness. They valuated this skill because of its contribution to development and innovation, growth and the build of company culture.



Initiative



it is highly valuated among engineers, supervisors and high ranks. It stands out how valuated it is among technicians, reaching the same level that this skill has among leaders and entrepreneurs. The difference is that these last ones should have and expert level against a basic level for technicians.

4.3.7.2 Change adaptability

It is the ability to adapt and get used to changes, modifying if necessary, their own behavior to achieve certain objectives when difficulties arise, new information or changes in the environment, which are from the outside environment, the organization itself, the client's or the requirements of the work itself. This skill can bring flexibility, good assessment of implications and low resistance to the upcoming changes. The importance, upon participants, of this skill lays on the need of keeping competitiveness and up to date with the aerospace industry needs.



Change Adaptability



The expertise level is required at the higher ranks. Lower ranks are recommended to have a basic level of this soft skill.

4.3.7.3 Critical thinking

The ability to interpret, analyze, evaluate, make inferences, explain and clarify meanings. It is based on logical reasoning, the ability to work with concepts, the



awareness of perspectives and own and other points of view, and systemic thinking. A progressive development of knowledge about one's own thinking and effective thinking strategies is necessary. Participants think that it can contribute to improve understanding of situations and processes, avoid failure and it is important for finding out the weak points of the industrial process



Critical Thinking



As happened before, higher ranks are advised to have and expert level at this skill. Technicians and machinists are recommended to have a basic level on this matter. A fair number recommend only a beginner level for machinist, almost as much as those mentioned before.

4.3.7.4 Analytical thinking

It is the ability to understand a situation, disaggregating it into small parts or identifying its implications step by step. It includes the ability to systematically organize the parts of a problem or situation, make comparisons between different elements or aspects and establish rational priorities. it also includes the understanding of temporal sequences and the cause-effect relationships of actions. They survey results say that it can help to coordinate and plan tasks and thus, by understanding a process, the trainee can gain more independence and responsibilities. It is important to optimize solutions and keep high the expertise levels within the employees.



Analytical Thinking

Graph 20 Analytical thinking

SOFT SKILLS 4.0 FOR THE AEROSPACE INDUSTRY



It stands out the expertise level recommended for engineers, above any other group. It is also important how technicians are recommended by more participants to be the next, following engineers, on level of expertise in this matter, even though it is at a basic level.

4.3.7.5 Intellectual curiosity

It is the inquisitiveness and the constant curiosity to know and learn more about things, facts or people. It involves looking for information, new concepts, new ways of doing and always going beyond routine questions or what is required by the position. It implies always going one step ahead. It may involve questioning the current ways of doing or simply the desire to move forward learning and deepening, always in order to get extra value to the tasks of the position. This skill has more value for research and development and innovation. Participants also say that helps auto pedagogy, retains know-how and contributes enormously to finding new concepts



Intellectual Curiosity

Graph 21 Intellectual Curiosity

It stands out how engineers are the ones with the highest level of expertise recommended in this matter.

4.3.7.6 Cognitive flexibility

It is the ability to modify personal behavior to achieve certain objectives when difficulties arise, new data or changes in the environment. Versatility is associated with behavior to adapt to different contexts, situations, means and personnel in a fast and adequate way. Flexibility is more associated with cognitive versatility, the ability to change convictions and ways of interpreting reality, it is also closely linked to the capacity for critical review. Participants implied that this soft skill helps to walk in someone else's shoes, adapting communication methods to each situation. They pointed put the importance of being trained on this skill on a managerial level.



Cognitive Flexibility





For this one, the trend is similar than the last ones, higher ranks are recommended to have a higher lever of expertise than low or middle ranks.

4.3.7.7 Effective communication in digital environment

Participants point out the importance of building a digital mindset that helps horizontal communication, adaptation to changes and team working efficiency. The importance of this one was highlighted on the basis that, due to the variety of partners in the aerospace industry, a digital mindset helps and simplifies means of communication and understanding.



Effective communication in digital environment

Graph 23 Effective communication in digital environment

For this one all ranks are requested a high level of expertise: A for engineers, supervisors and leaders, and B for machinist and technicians. These shows how valuable this soft skill is for participants.

4.3.7.8 Comments on the SKY 4.0 soft skill set

The following questions were if they would remove any of the ones listed above and which ones, acceptance of the SKY 4.0 soft skill set was high. (Graph 24 and Graph 25).



Be noted that both Graph 25 and Graph 26, the percentages shown refers to the number of times that and option have been chosen per the number of total answers per each question. Graph 25 shows results for an optional question that only was answered by six people, whereas as the question in Graph 26 was mandatory.

67 respuestas



Would you remove any of the ones listed above?

Graph 24 Acceptance of SKY 4.0 soft skills list



Graph 25 Soft skills that participants would remove

Another question was about the importance of being able to transmit each soft skill between peers inside every aeronautical company. They were presented with the soft skills listed above and had to choose which ones they thought were more important to be able to transmit among them inside their own companies. (Graph 26)



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Graph 26 Transmittance of soft skills among peers

4.4 Additional soft skills

The last objective of the survey was to enlarge the list of soft skills that SKY4.0 project is generating. That is the reason why participants were asked to add anymore soft skill of their choice.

Their main picks were:

- Resilience to pressure
- Emotional intelligence
- Time management





5 Discussion

All the new CVs and training materials produced as a result of SKY4.0 investigations will introduce and promote work-based learning. Curricula and training materials will be based on practical projects and Text and Workbooks will contain "real life" workplace situations. These materials are aimed to develop the required soft skills for the Industry 4.0 challenge, namely Character-Building Skills, Social competence, and Personal Development skills.

Some projects or studies, like (Lappas & Kyriakos, 2016) or (Aéro Montréal, 2018), also highlights the importance of the objectives of the SKY4.0 project: creating a set of key soft skills and then elaborating teaching and training materials as a way of overcoming the upcoming changes in the aeronautical sector (World Economic Forum, 2018).

Most part of the literature checked for conducting this investigation agreed on the importance of soft skills training in order to overcome the challenges of the new industrial framework.

Secondly, companies' opinions showed, mainly, the importance of the SKY4.0 project and the need of start rising awareness on these matters inside companies in the aerospace industry.

Mostly SMEs declared that they were not familiarize with the soft skills and industry 4.0 concept. Due to their number of workers and the need of dedicating all of them to production, training programs inside their companies seem to them rather difficult. However, they pointed out the importance of soft skills and suggested that they will take them into account during the hiring process.

Another important point highlighted during the interviews was that, in order to apply the results of the SKY4.0 project successfully, some institutional support will be needed, either at a local or at a national level.

The range of companies that participated was varied. Half of them had over 250 employees. And most part of participants have managerial positions or oversee work teams.

Even though almost 80% participants were familiarized with the Industry 4.0 concept, only 50.7% of the answers revealed that their companies have strategies on their implementation with low levels of implantation statuses. Propaganda or courses only appeared in 39.7% of the answers. Involvement of companies' members on its implantation was rather low too These results reveal that I4.0 concept is at an early stage in most companies or is not seen as a reality yet.





Half of the companies have courses on soft skills or hard skills training, so it is not something fully spread among them. However, most participants agreed on the importance of implementing some, in case there is none.

Most of them agreed on the importance of investing on soft skills education and that if no investment was made, a majority agrees on the need and importance of making some. These results reveal that, even though soft skills training is not fully implemented yet, it is something that aeronautical industry workers see as something necessary.

About the answers related to the set of soft skills, the higher levels of expertise are required for higher ranks (engineers, supervisors and leaders), meanwhile the least level were given to the lower ranks (machinists and technicians). These levels are A or B, respectively, little to none were those recommended to have a C level among all ranks.

There are two skills related to problem solving capacities which engineers were the ones that were recommended the higher levels of expertise, (analytical thinking and intellectual curiosity). Managers and leaders had a similar trend over each skill, they were recommended to have a relatively high level of expertise (A) for each one of them.

The ability of being able to transmit soft skills to workers or partners was positively valuated, which proves the importance of education.

The list of relevant skills and competencies introduced by SKY4.0 in this report is exhaustive, and it might be difficult for any single future professional to cover all of them. However, the most important skill that all future professionals need is the ability to apply one's own knowhow in various contexts of collaboration to create synergies and add value to the task at hand. What is needed from future professionals is readiness for continuous learning in new settings and from other people with diverse background and experiences.





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ANNEX 1: Survey Script

PROJECT OBJECTIVES

The overall objective of the project is to create a "Industry 4.0 skill set for Aerospace" to equip educational institutions (professional, technical and academic) to modify and adapt their training programs for future company needs. Thus, this project intends to promote a better alignment between training and jobs in aerospace industry. In charge of this project, there are several companies and schools from several countries: Portugal, Poland, Turkey, Spain and the support of the European Union through the Erasmus + program, that support education and formation. The SKY 4.0 project aims to develop the tools to establish the necessary soft skills, thus, adapt the aerospace industry workers to the new industrial revolution through their education.

This will be done through the following pillars:

- 1. Aiming the developing of soft skills to key groups inside the Aerospace sector:
 - a. Companies and their workers
 - b. Trainers and VET providers
 - c. Secondary education students and technical colleges.
 - d. Human resources teams and team managers
- 2. Applying the knowledge acquired in the first pillar to develop training resources to be applied inside companies.
- 3. Taking the data from the first two steps to improve training materials on soft skills for technical courses students, VET and aerospace companies' workers.

In order to collect data on your company's and your own knowledge about INDUSTRY 4.0, we are requesting your cooperation in this project by filling in the present SURVEY. THANK YOU!





1. Company Characterization

- 1. Company's name:
- 2. Business activity:
- 3. Number of employees:



- 4. Company's annual turnover: Please, indicate the company's annual financial turnover.
- ≤ 2€ Millions
 ≤ 10€ Millions
 ≤ 50€ Millions
 ≥ 50€ Millions
- 5. What is your role inside your company? Are you in charge of a work team?

2. INDUSTRY 4.0 (I4.0)

1. Are you familiar with the concept of INDUSTRY 4.0?

| Yes |
|-----|
| No |

- 1.1. If you have answered yes, can you describe briefly what you know about it?
- 2. Does your company have any strategy on Industry 4.0 implementation?



- 2.1. If so, how would you describe its implementation status? (from 1 to 5, where 5 means fully implanted and 1, that it is still an ongoing project)
- 2.2. If there is any ongoing project about I4.0 implementation, which is the approximate deadline?
- 2.3. How is management involved in the I4.0 Implementation? (from 1 to 5, where 5 means fully compromised and 1, not involved)



- 2.4. How are your employees (or working peers) involved in the I4.0 implementation? (from 1 to 5, where 5 means fully compromised and 1, not involved)
- 2.5. Are there any courses or propaganda about I4.0 inside your company? (YES or NO). If so, what kind? Do you think it is useful? Please, explain briefly.
- 2.6. Please choose from the following list the I4.0 technologies that you think will impact more in you company (mark as many as you consider appropriate):
- Autonomous Robots
 Simulation
 System Integration
 Internet of things
 Cybersecurity
 Cloud computing
 Additive manufacturing
 Augmented Reality
 Big Data
- 3. If your company does NOT have a 14.0 implementation plan, in your own opinion, do you think there will be some kind of development towards this changes any time soon? Why?

3. SKILLS

1. Is there any study or program about the development of hard skills inside your company?

| Yes |
|-----|
| No |

- 1.1. What kind of activities, courses, etc. are currently going on inside your company related to hard skills training?
- 1.2. If there is none, do you think it is necessary to launch any?
- 2. Is there any study or program about the development of soft skills inside your company?

| Yes |
|-----|
| No |
| |

- 3.1. What kind of activities, courses, etc. are currently going on inside your company related to soft skills training?
- 3.2. If there is none, do you think it is necessary to launch any?



- 4. How important do you consider the economic investment that your company make on soft skills training? (from 1 to 5, where 5 means essential and 1, not necessary)
 - 4.1. If there is not any kind of investment, do you consider that there should be some? (YES or NO) Why?
- 5. Now you are going to be presented with a list of soft skills related to different roles inside a company. You will have to level each one using the following scale:

| Levels | Descriptions |
|--------|--|
| А | The individual is a recognized expert. |
| В | The individual uses the skill. He/she has a good level of autonomy but needs guidelines. |
| С | The individual understands the importance of the skill. He/she is aware and uses some of it. |

| Skills | Assembler, Fitter, Machinist and Mechanic | Technician and Methods Agent | Engineer | Supervisor | Leader and Entrepreneur |
|---|--|------------------------------------|----------|------------|----------------------------|
| Initiative | | | | | |
| Change adaptability | | | | | |
| Critical thinking | | | | | |
| Analytical thinking | | | | | |
| Intellectual curiosity | | | | | |
| Cognitive flexibility | | | | | |
| Effective communication in digital environment | | | | | |

- 5.1. Would you add any new soft skill?
- 5.2. Would you remove any of the ones listed above?
- 5.3. Upon you, what kind of attitude each soft skill implies in your workers or working peers towards their day-by-bay work?
- 5.4. Why do you think each one of these skills are important or should be present inside your working environment?
- 5.5. Being able to transmit the necessary skills to your workers or peers is as important for the development of your company as training yourself; which ones from the listed above, do you think, should you be able to transmit? Please choose.



GLOSSARY OF TERMS

This section is intended to help the interviewer answer most of the possible questions that the interviewee may have, related to the terms and expressions that are gathered in this document.

- Industry 4.0: also known as the fourth industrial revolution is based on the use of Cyber-Physical Systems. The focus of Industry 4.0 is to create smart products, procedures and processes using smart factories which are capable of managing complexity, less prone to disruption and able to manufacture goods more efficiently. In the smart factory, human beings, machines and resources communicate with each other as in a social network. Smart products embed the details of how they were manufactured and how they are intended to be used as they actively support the manufacturing process. Industry 4.0 should be implemented in an interdisciplinary context and in close cooperation with the other key areas, and using different technologies drivers, formerly known as the nine pillars of the technological advancement: Autonomous robots, simulation, system integration, internet of things, cyber security, cloud computing, additive manufacturing, augmented reality and big data.
- Internet of things: the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.
- Additive manufacturing: manufacturing method based on building objects adding layer after layer following a 3D model data. It's opposite to the current material-subtracting methods.
- Soft skills: combination of interpersonal skills, personality characteristics and emotional intelligence needed to success in an activity. Difficult to measure or teach.
- Hard skills: job-specific skills and knowledge you need to perform job.
- Initiative: It is the willingness to act, create opportunities and improve results without the need for an external requirement that pushes them to do so, to act proactively and to think not only about what needs to be done in the future.
- Change adaptability: It is the ability to adapt and get used to changes, modifying if necessary, their own behavior to achieve certain objectives when difficulties arise, new information or changes in the environment, which are from the outside environment, the organization itself, the client's or the requirements of the work itself.
- Critical thinking: the ability to interpret, analyze, evaluate, make inferences, explain and clarify meanings. It is based on logical reasoning, the ability to work with concepts, the awareness of perspectives and own and other points of view, and systemic thinking. A progressive development of knowledge about one's own thinking and effective thinking strategies is necessary.
- Analytical thinking: It is the ability to understand a situation, disaggregating it into small parts or identifying its implications step by step. It includes the ability to systematically organize the parts of a problem or situation, make



comparisons between different elements or aspects and establish rational priorities. it also includes the understanding of temporal sequences and the cause-effect relationships of actions.

- Intellectual Curiosity: It is the inquisitiveness and the constant curiosity to know and learn more about things, facts or people. It involves looking for information, new concepts, new ways of doing and always going beyond routine questions or what is required by the position. It implies always going one step ahead. It may involve questioning the current ways of doing or simply the desire to move forward learning and deepening, always in order to get extra value to the tasks of the position.
- Cognitive flexibility: It is the ability to modify personal behavior to achieve certain objectives when difficulties arise, new data or changes in the environment. Versatility is associated with behavior to adapt to different contexts, situations, means and personnel in a fast and adequate way. Flexibility is more associated with cognitive versatility, the ability to change convictions and ways of interpreting reality, it is also closely linked to the capacity for critical review.



SOFT SKILLS 4.0 FOR THE AEROSPACE INDUSTRY



ANNEX 2: Interview template

Meeting with (Company name)

Date:

Aim of the meeting:

Purpose of the meeting.

Feedback

• Context on the realization of the meeting

Conclusions

• Conclusions obtained from the interview

Participants:

(number of participants on the interview) 1.



SOFT SKILLS 4.0 FOR THE AEROSPACE INDUSTRY