



SKILLS GAP IN THE AEROSPACE SECTOR

**Causes, definitions,
analysis, and responses**

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WIA-EUROPE WORKING GROUPS & WHITE PAPERS

Looking into the future, in Europe seven million job openings are forecast for the entire STEM field by 2025 as well as an exponential growth for the aerospace industry in the decades to come. Despite the abundant career opportunities, the aerospace sector is currently facing a significant occupation shortage, which calls for a comprehensive set of actions on the part of the different actors involved.

As a strategic sector, to safeguard future economic and social well-being, our industry needs to invest in their human resources at all career levels: from expanding the potential talent pool and attracting new early career talent to retaining the existing workforce and increasing the number of highly skilled women in the C-Suite, not just as a diversity initiative, but as a strategic priority to improve business performance.

Since its foundation in 2009, Women in Aerospace Europe (WIA-Europe) has been committed to tackling these challenges by fostering inclusive representation for women across the European aerospace sector, giving visibility to outstanding women, motivating girls to get interested in science, and communicating the key role that space plays in our daily lives.

For more than a decade now we have been organising events, trainings, grants and awards, bringing together individuals and organisations from across our industry to network and share experiences through our local groups. WIA-Europe has gained high-level support from its corporate members and a growing individual membership base fully devoted to spreading such values as equality and inclusion, with no distinction of race, religion, gender, background or culture.

Adding to our range of initiatives, we have launched the WIA-Europe Working Groups, consisting of individual members and representatives of corporate members and partners, in order to work on key topics related to the objectives of our association and to give recommendations on effective actions, which are published as White Paper series available to all WIA-Europe members.

Focussing on some of the most acute questions, WIA-Europe has established the first three WIA-E Working Groups: “Skills Gap in the Aerospace Sector”, “Increasing the Number of Women in C-Suite Roles” and “STEM Education in Europe”. The Working Groups have evaluated the current landscape and collected insights and strategies, based on the review of existing reports and research studies. This research was supplemented by personal experiences and recommendations of WIA-Europe members at all career levels, which have been recorded through surveys and personal interviews.

Following the publication of the first White Papers we will review the recommendations and together with the Working Group assess their implementation within the current scope of WIA-Europe activities.

We would like to acknowledge the excellent work done by the members of each Working Group, and say a very big thank you to all the members of our network who have contributed their with time and expertise by participating in surveys and interviews.

Thanks to your contribution, we are able to share tools to progress on these acute challenges.

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ABBREVIATIONS

ASSETs	Alliance for Strategic Skills addressing Emerging Technologies in Defence
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
CV	Curriculum Vitae
ESA	European Space Agency
EU	European Union
HEI	Higher Education Institution
HR	Human Resources
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
IPR	Intellectual Property Rights
IT	Information Technology
MOOC	Massive Open Online Courses
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PR/PE	Public relations/Public Engagement and Education
R&D	Research and Development
SME	Small and Medium-sized Enterprises
SSPI	Space & Satellite Professionals International
STEM	Alliance for Strategic Skills addressing Emerging Technologies in Defence
UKSA	United Kingdom Space Agency

1 INTRODUCTION

The aerospace sector is flourishing with new technologies, ambitious endeavours, and high expectations from stakeholders. However, the sector, like other high-tech sectors needs to overcome key challenges, one of the most critical is widely described as the 'skills gap'.

Skills gap by definition refers to the fundamental mismatch between the skills required for a job and the skills that the workforce offers, crucially meaning that employers have difficulty recruiting the workforce they need to thrive. The intention of this paper is to investigate what type of, if any, skills gaps the various organisations and countries experience. Hereafter we interpret the findings and link to existing information, aiming to extend the current knowledge of skills issues within the European aerospace sector.

As the aerospace industry strives for consistent, high standard performance, organisations are seeking skilled talent in niche fields. This drives a competitive recruitment process, which can be, and increasingly is, long and daunting for applicants. Decreasing the pool of applicants with stringent role requirements, in order to hopefully select the best people with all the 'right' attributes (skill, background, network), increases the risk of finding no suitable applicant and seriously impacts the diversity of the workforce. This increases the risk that knowledge and expertise is lost as people retire or leave the organisation. In addition, with the fast pace of the aerospace sector, the expected right skills can and do change over time. This then highlights two challenges: one for academia to provide the necessary education/courses for students, and second for mid-career workers who are unable to find training in these areas.

While some university courses are too generic, others may be too specific. For both cases, they may not satisfy industry's needs. There are concerns that academia and industry do not interact efficiently to provide adequate support to students and that industry is not sufficiently aware of the courses that exist, the modules included in them or programmes for specific fields which were previously assumed to not be directly linked to the needs of the aerospace community. Additionally, perceptions differ of the responsibility for training: to what degree are universities, colleges, and other Higher Education Institutes (HEI) responsible, what should be under the purview of 'on-the-job', or job-specific training, internships and apprenticeships by industry, and individually driven personal and career development. Further, there are various national and international associations, from professional and regulatory associations to voluntary committees, working parties and associations, and public, governmental and Non-Governmental Organisations (NGO) offering training and personal development opportunities.

Societal or organisational challenges such as recruiting organisations failing to provide feedback to applicants, not recruiting transparently or offering open opportunities, or not providing training to their employees, have in turn led to less engaged applicants or employees with less commitment, who are more ready to change organisations or sector. Although aerospace organisations might acknowledge the benefits of diversity and inclusion, this is not yet treated as a high priority. However, this has a direct impact on other priorities such as how an organisation can diversify its activities, be resilient and ensure differentiation from its competitors.

Skills issues across the aerospace sector are driven by a range of causes, and demand different definitions, analysis, and responses.

- 1. Rapid change:** An expanding and rapidly diversifying sector demands an increasing number of relevantly skilled employees. An obvious example is the divergent needs of the more traditional aircraft sector, compared to space sector and the newer, more commercially driven 'Space 4.0'.
- 2. Uneven maturity:** Across Europe, there are large differences in the state and maturity of the aerospace sector as a whole, and specialisations within. This is reflected in the capabilities and skills of people, and level of integration between industrial, public and educational sectors.
- 3. Need for up-skilling:** Rapidly changing technology, for example digitalisation and the use of computational and Artificial Intelligence (AI), means that the existing workforce may not have the skills necessary for the future, leading to a need for up-skilling, re-skilling or replacement. This is particularly important for mid-career professionals with 'in demand' skills, possibly recruited from parallel or related sectors, who may need specific domain knowledge.
- 4. Retirement wave:** Within the next 10 years, it is predicted that a high percentage of the expert workforce will retire. For example, the European Space Agency identifies that, between 2020 and 2030, 44% of the workforce will retire [1]. Without robust succession planning ESA (and others) will be unable to fulfil mission objectives, and this must include the transfer of knowledge and expertise from retiring, or outgoing workers and incoming or existing junior personnel.

WIA-Europe is seeking to evaluate the extent to which skill gaps exist, their circumstances, the nature of the skills that are in short supply and to develop a strategy which will support the sustainability of the European aerospace sector.

2 WHERE ARE WE TODAY?

The Working Group has considered previous studies and reports on skills gaps in the aerospace sector, with a focus on Europe. While the aerospace sector was the broad remit, the study has considered evidence from space, aviation, and defence, where aerospace related skills were discussed. These reports have emphasised several differences between the sectors within aerospace, European countries and highlight some interesting open issues.

The aerospace industry in Europe recruits highly skilled people from across the globe. About 75% of the workforce has at least one university degree which is much higher than other industries. The representation of women in the workforce is low but it correlates to the lower proportion of girls who opt to continue their STEM education in schools and universities. To keep up with the technological advancements required in the coming decades, and to maintain the growth of the sector, the industry needs not only to retain its existing workforce and attract new early career talent, but it also needs to ensure that the potential talent pool continues to grow and bridge the looming workforce skills deficit.

The European Company Survey 2013 showed that around 40% of firms in the EU are experiencing difficulties in hiring candidates with the right skills. Some of the aerospace recruitment difficulties can be summed up as follows:

- University courses offered do not quite keep up with the technological advances that the aerospace industry demands.
- Industry relies heavily on referral-based recruitment and prefers hiring experienced and familiar candidates. This not only reduces the total skilled labour pool but also takes the focus away from training efforts.
- Industry can lose talent because of competition with other higher paying sectors like financial services, information technology, artificial intelligence, data analytics, machine learning and robotics.

Humanity's pursuit of the exploration of outer space is expanding dramatically so the aerospace sector needs to keep up with technological advances and in parallel cope with the human resource aspect. To tackle the problem of skills gap, close cooperation between industry and higher education institutions is necessary so that employable and

suitably skilled graduates are produced to fill the challenging and demanding vacancies of the aerospace domain. A similar cooperation is also required between industry and further education or technical colleges to satisfy an increasing demand for vocational or technical training specific to the sector's needs. Industry working with training organisations and specialists could also increase support and focus on post recruitment intensive training instead of demanding high and strict entry requirements. Cross training suitably skilled candidates from other industries is also something that could help reduce these gaps and is being developed in some countries.

2.1 SUMMARY OF LANDSCAPE

Issues around workforce skilling compromise the completion of tasks, or in some cases, even the quality of results. Consequently, mitigating such a gap will bolster the competitiveness of Europe. Some of the published reports that were reviewed advised adopting a systematic approach. The European Commission has published the *Pact for Skills*, a shared engagement model for skills development across Europe [2]. Aerospace companies and organisations held a round table in the framework of the *Pact for Skills* and participants agreed that the actions should focus on the necessity to fill existing skill gaps and to mitigate them in the future. Skills forecasting, easy-to-access online training, knowledge transfer from large companies to Small and Medium Enterprises (SME) and suppliers, internal company training centres, apprenticeships, Masters and PhD programs were some potential actions discussed. Other suggestions included embedding researchers within industry to analyse and suggest solutions to particular problems, a qualification framework with related enhanced talent development and mobility and including life-long learning. A key takeaway from the round table was to highlight that the suggestions are well aligned with political ambitions for a greener, digital, autonomous, and resilient Europe. There is increasing awareness that effective skill development and utilisation is a vital prerequisite to ensure Europe's ability to scale up innovation and withstand increasing global competition.

Similar recommendations are given by the *Circular Job Initiative* [3], where up-skilling is seen as essential and where governments, industry, education and training providers, and civil society and social partners are called on to prioritise collaboration and the development of a culture of lifelong learning.

2.2 COUNTRY-SPECIFIC INFORMATION

Denmark

In Denmark, information on skills gaps within the aerospace sector appears rare or very low. Several organisations have started to analyse trends for a wide range of sectors. According to these studies, most Danish companies appear to be experiencing an acute skills gap. Larger and expanding companies report a slightly wider gap as they have more role/skills to fill in comparison to small companies. The greatest shortages relate to science and engineering, followed by IT, IT-related, and skilled production workers. This effect is primarily reported by companies engaged in international activities, due to global recruitment of people working in specific fields of expertise. The manufacturing industry also reports a shortage of qualified employees to a higher degree than other industries. Most successful companies are using a variety of methods to address their skills deficits [4].

France

The French aerospace sector has reported an increased need for staff qualified to Masters and Bachelors of Engineering standard from 2022. Other than specific aerospace competence, areas like telecom, energy, materials and cybersecurity will also need to be recruited into aerospace. Special challenges are seen around energy, sustainability and environmental issues [5]. From the French point of view, the space sector is seeing an increased number of players, with competition particularly in launcher construction but also in the development and launch of satellites [6]. In addition to these, the French aerospace sector identified that there are a wide range of specialist jobs and missions which are at risk due to skills gaps in the overall workforce, an inability to attract skilled talent and the growing risk from the approaching retirement of many skilled employees who have not been able to transfer their knowledge to younger colleagues. They also identify that with the increasing uptake of new technologies and innovation, employees' expertise needs to be refreshed or adaptable to market needs. Although, these roles are mainly in technical areas, management and leadership skills such as those for workforce, project and lean management also need to be adapted to improve the organisations' performance. Organisations need to consider role profiles which are more collaborative, multi-disciplinary, agile, and flexible [7].

Germany

Data shows that the shortage of skilled professionals is a major concern in Germany and one in five businesses feel that a skills gap exists. There are some regional differences highlighted, with East German organisations grappling with this problem more compared to their West German counterparts. Small and medium sized enterprises consider this a much bigger issue when compared to larger enterprises as their recruitment is limited to local labour markets [8]. The Federal Labour Agency (Bundesagentur für Arbeit) and the federal and state governments acknowledge this issue and have placed a strong emphasis on skills development at an early stage. German organisations offer various early career options like apprenticeships, internships, Master Thesis, Working Student etc. where students enrolled at a university can get exposure to the industry in parallel to their studies and achieve a smooth education-to-work transition. Germany has a national dual vocational educational system, where students split their time between the vocational school and a company, giving them immediate opportunity to practice their newly acquired skills. The students get a mix of theoretical and practical skills, and the hiring companies save recruitment and training costs. Similar systems exist in Austria, Denmark, Luxembourg, Switzerland and the UK [9], and the system is intended to be used as a model to reduce youth unemployment within Europe [10]. The space industry also gives a lot of importance to training and skill development and the German Aerospace Centre (DLR) offers exciting opportunities in terms of graduate programs, continuing professional development and vocational training.

Italy

In Italy, in line with EU *Pact for skills* [2], the main players of the aerospace sector are supporting up-skilling and re-skilling initiatives for people employed in aerospace companies. Priority has been given to initiatives focused on attracting talent and to developing new skills. The aerospace agenda set by the Italian Space Agency (ASI) promotes the development of services and applications for the space economy and the Italian aerospace sector is implementing the actions required by the national strategic plan. The development of necessary skills is supported by ASI, which supports universities, research institutes/centres and doctoral schools, in defining training courses in the space sector and promotes the assignment of scholarships and research grants (both post-graduate, doctoral and post-doctoral). In addition, based on special agreements with universities, ASI promotes research doctorate courses, in collaboration with industry. Aligned with the aerospace strategy, the development of skills is focused on disciplines related to the needs of the space economy, such as space

exploration, space missions design and applications, space optical design and remote sensing, aerospace medicine, satellites and orbiting platforms, launchers and re-entry vehicles, mathematical and physical methods for space sciences. In addition, the major Italian companies have highlighted the need to proceed in a coordinated manner to bridge the gap in terms of digital knowledge necessary for the aerospace sector. Finally, the post Covid recovery and resilience plan has committed a significant amount of resource to developing skills in those sectors with a focus on AI, robotics and IoT [11] [12].

Luxembourg

The aerospace sector in Luxembourg focuses on accelerating the collaboration and coordination opportunities between private and public entities. The technology and knowledge transfer opportunities are numerous, and mostly carried out through exchanges of people through mobility and partnership. Luxembourg hosts several European institutions and has a high proportion of researchers from other countries, this ensures that it is highly internationalised in traditional manufacturing industries as well as service industries. A significant amount of the private research carried out in Luxembourg is led by companies based in international markets. Thus, the companies based in Luxembourg benefit from the university resources and skilled talent from surrounding countries, which is an advantage for contracted research and the engineering hiring process, an asset ensuring that research is less prone to skill gaps. Nevertheless, some companies have reported difficulties recruiting candidates with IT, technical and language skills as well as the behaviours and motivation to fit their needs. By comparison to more technology-focused jobs, the average age is higher in the aerospace sector with often a more experienced workforce. Many organisations are now looking to invest in digitalised operations and services, which are business critical and a potential business risk in order to respond to market needs. Some organisations have a smaller labour pool to draw from because they are constrained by citizenship and security clearance barriers. Other larger organisations, which are often managing multiple activities, have a much more fragmented workforce. Additionally, for many organisations, the skills gap gets wider when they project their requirements forward over the next two to four years, with misaligned talent and business strategies [13].

Romania

As for other high-tech sectors, the aerospace sector in Romania appears to have acute skills gaps and shortages. This is reported to be due to a mismatch and misalignment between the different sector needs and educational provision. It is common for there to be a mismatch between the level of education required for an occupation or role and the actual level of education for the worker in that occupation. Among the several

factors that contribute to skills gaps, emigration patterns, low participation in lifelong learning such as continued vocational or technical training, strong resistance to change in the educational system, and underfinancing are important drivers [14].

Serbia

Like many other countries, Serbian organisations also report facing skills gaps. To bridge this, Serbia's institutions and organisations are collaborating and looking to ensure that vocational and higher education institutions themselves also possess the skilled people required to train for the skills demanded by the labour market. This is done while supporting private-sector development and the transition towards a sustainable, green economy [15].

Switzerland

Switzerland's aerospace sector also reports that it is impacted by skill gaps. To mitigate these issues, Swiss organisations are mainly focusing on talent availability, supply chain quality, and production or operations cost. With digitalisation and new working approaches, the organisations' current strategies are to hire new permanent and temporary staff who already possess relevant skills, to automate work tasks where possible, and to retrain existing employees. Organisations are conscious that re-skilling and up-skilling, with a mindset of agile learning will have an important impact on their leadership. However, this will only be efficient with the help of policymakers, regulators and educators [16].

United Kingdom

The UK Space Agency's *Space Sector Skills Survey* [17] points to the difficulties space sector companies are facing to find candidates with the right skills and experience, while also highlighting the growing necessity to recruit in order to satisfy the predicted growth of the sector. The report identifies the struggle to provide specialist and niche training owing to the wide range of skills needed in the industry. There is also an emphasis placed on the difficulties companies face as mobile mid-career employees move towards other employers with better opportunities, pay or benefits, leading to issues over retention. Further, it reports a disconnect between the skills taught in university to students and those required by employers which suggests a need for post-employment training. A similar trend is reported by SSPI [18], where they show a strong exodus of early career employees (about 67%) over the initial period of 1–5 years and how it detrimentally affects companies who are having to rely only on

experienced staff to fill the gaps for their skills. A 2009 UK study emphasises the relationship between the skills required for the satellite industry workforce, and advancements and developments in Higher Education [19] degree courses and collaboration with industry and professional bodies. This collaboration or partnership continues to be important as evidenced in the 2021 UK report. Education and training in STEM subjects throughout the education pipeline, allied with information about careers are key factors that support growth in the space sector. The 2009 report notes the importance of sharing the knowledge of employers' requirements and where a lack of skills is identified with universities and professional development course providers. The UK's All Party Parliamentary Group on Diversity and Inclusion in STEM points out the lack of dependable data, while mentioning that the data that does exist and is shared, shows that the STEM sector is less diverse than the broader workforce, that there is acknowledgement of the problem but no agreement on solutions, that barriers are set early in education and continue into organisations, that Covid-19 has made the situation worse and that there is a need for multi-faceted governmental actions [20].

Finally, it should be noted that some countries with less aerospace footprint or tradition conduct very little or no research about skills compared to more active players such as the United Kingdom, France or Germany.

2.3. GENERAL OPEN ISSUES

The skills gap in aerospace, as in other related technology sectors, is tied into many other issues, such as equality and diversity, and different generational paradigms. This section looks at open issues that directly and indirectly impact, and are impacted by, the skills gap.

Level of education

The aerospace sector is partially driven by R&D, with often a high degree of subject matter expertise listed for specialist technical roles. This is particularly highlighted in the space sector as the base level of education can be higher than average. Within STEM generally, the number of graduates from all degree programmes has been steadily increasing over the past several decades. The Pegasus network, a consortium of 28 leading European universities offering specialised degrees in aerospace, list 3000 graduates annually for undergraduate aerospace degrees, and 6600 MSc graduates in aerospace [17]. In addition to under- and post-graduate taught degrees, research degrees have also seen a very sharp rise over the past 20 years [21]. In 2014, Germany

and the UK produced the most PhD graduates per year in Europe, 52000 across all disciplines, and behind only the US on a global basis. Compared to 1998, the UK had tripled the number of doctorates awarded, while Germany increased by 17%. Looking closer at PhD graduates, 40% of new doctorates awarded in the OECD area are in STEM (excluding medical and health sciences). Doctoral programmes are particularly oriented towards sciences and engineering in France (59%) Canada (55%) and China (55%).

Most graduates follow a relatively linear path from education into industry, with little iteration between. Within the EU, 87% of graduates with Bachelor's and Masters degrees are under 30 years old, while 65% of PhD graduates are under 30.

Continuous professional development (CPD) is an open issue that is receiving more attention in an attempt to address specific skills gaps, especially during the work career. HEIs are offering options: credit-bearing courses that can be taken as part of degree programme leading to Post-Graduate Certificates, Diplomas or stand-alone Masters (e.g., MSc), non-credit bearing courses (often short courses, on the order of days/weeks, tailored to a very specialised topic, e.g., CPD, MOOC (massive online open courses). Online course and open universities are popular options, and offer courses tailored to be worked through part-time.

Other agencies, companies and associations also offer training, for example in aerospace both the AIAA and IEEE offer advanced, tailored courses designed for those already in the workplace to up-skill and the US Teaching Science and Technology Inc also provide online and in-person training in aerospace topics (some delivered by European organisations). Online websites such as FutureLearn, or edX in the US offer MOOCs which aim to address sideways transitions between sub-sectors. For example, for a data scientist to learn application specific domain knowledge about satellite data and Earth Observation applications.

Open issues still exist about flexible degree and training programmes, and how these can integrate within HEIs and the traditional full-time degree and course structures. Accreditation, governmental support and funding, and national/international recognition of training provided by other organisations are also open issues.

Cross and multi-disciplinarity

Skills gaps also exist for roles that require expertise in several often-diverse fields. Managers of technical departments or programmes must have a high level of technical

knowledge and experience, often across several specialist topics, as well as management and leadership skills. With issues currently facing the sector in recruitment and retention, HR positions may require a level of understanding of technical fields to be able to better find and target hiring campaigns. Communications, public and social media relations also require a diverse skill set, the ability to translate technical and scientific advances for public consumption, and use this to raise awareness, support and investment. These also come into play for existing cross-domain jobs, such as copyright and IPR law, programme administrators, governmental advisors, etc. How to effectively and efficiently train for these, and to raise awareness of the wide range of (more non-traditional) job options within the aerospace sector are open issues. A lack of awareness of these non-traditional roles could also contribute to recruitment.

Transfer of expert knowledge

Irregular hiring patterns driven by large missions requiring particular specialisms at different times can contribute to knowledge transfer issues when these hires are no longer required, and if their knowledge has not been passed on to younger workers. Expertise developed through experience is recognised as a critical deficit.

High rates of mobility between companies, countries and sectors have been noted. Investment in job-specific training by the employer is not always compatible with specialists who are highly mobile and often in high demand. There is also a tension between countries who have a very well established, and highly ranked education system, but fewer jobs, e.g., Italy and Spain, compared to countries who may be newer to the space sector but can offer better post-graduate employment.

There is increasing discussion around the refresh and upskilling of returning staff following career gaps. These issues have become even more relevant following the economic impact of Covid, and lockdown.

3 METHODOLOGY

The Working Group has evaluated the current landscape, reviewing reports and studies carried out within Europe and internationally by public and private bodies, supplemented by the experience and expertise of its members, and carried out a preliminary investigation to validate these results with an online survey of selected companies backed up by an interview. The survey was sent to companies who are corporate members of WIA-Europe and to contacts in the Working Group network.

- The objective was to use data and discussions from published literature, combined with the survey to gather insights and opinions of current aerospace skills gaps.
- The choice was made to use a mixed method data collection, for both qualitative and quantitative data analysis.
- This perspective provides information about current skills issues across the European aerospace sector in 2021 and highlights potential and predicted issues in the near-medium term.

For the data collection, an anonymised survey was distributed, using a mix of open and multiple-choice questions. Open questions have been used to encourage respondents to give their opinions freely, permitting qualitative analysis, while quantitative data has been collected from the multi-choice questions.

4 SURVEY RESULTS AND DISCUSSION

Fourteen responses were received from eleven organisations. 71% of the responses were contributed by people working in management and 29% by Human Resources personnel. The survey was created and distributed using the Google survey tool. A summary of the survey has been used to shape the results. The responses were varied as the participants represented different clusters within the aerospace sector, but it helped us to capture broader aspects of the industry. It has been recognised that the small number of responses imposes a limitation on the study. The restricted timeframe for the survey and the analysis may also have influenced the number of replies and amount of data. This work was also performed during the 2020-2021 pandemic which has led to a significant slowdown of some parts of the aerospace sector, and may have had an impact on the answers. The survey was completed by companies of all sizes, from SME to Primes. The challenges, strengths and business models of the respondents was equally diverse.

Out of the 11 organisations, 42% do not report problems while promoting or hiring. Within the survey, this dichotomy correlates to the size of the company with other potential factors including geographical location, company culture and policy. When asked about skills gap, 84% agree that a skills gap does exist.

More than half (58%) of employers report an imbalance between employee capabilities and organisational needs and it is important to ensure that the nature of the imbalance is identified. Simplistically, organisations need to train their workforce or to increase the number of employees for the job so as to meet the productivity cycle between employee capabilities and organisational needs and it is important to ensure that the nature of the imbalance is identified. Simplistically, organisations need to train their workforce or to increase the number of employees for the job so as to meet the productivity cycle.

Currently organisations across the European aerospace sector report a deficit of technicians, managers and engineers. There are also rapidly increasing demands for skills in artificial intelligence, machine learning, data science and IT. The survey also emphasised the lack of leadership, communication and entrepreneurial qualities. In order to ensure sector sustainability, an ongoing understanding of the current landscape coupled with a strategic understanding of future direction will be imperative. Without this evidence base it will be difficult to ensure a suitably skilled workforce at any time, and increased recognition of the importance of transferable skills to both organisations and individuals. Explanations can be found in published material from several European countries [4-6][13-18].

In the coming decade communication, digital skills, flexibility, and adaptability will become increasingly valued alongside technical competencies, as has been noted by the French Observatoire de la Metallurgie [7]. Hard technical skills can be learnt, and all respondents to the survey agreed the importance of providing technical training irrespective of where you stand in the career ladder. In parallel, approximately 63% of companies encourage their personnel to undertake assessments or participate in personal or professional development schemes. Hence, several respondents suggested that organisations should always be flexible and open-minded when reviewing CVs and evaluating candidates.

One of the new space companies interviewed thinks it is essential to establish the capabilities of all employees and to identify any gaps they may have so that the organisation can provide training to support their employee's development. In their own words, "it is a way to enhance promotion and thus, talent retention". It was also

found that new graduates are not equipped to match the skill requirements currently seen across the industry. The training received at universities tends to be much more theoretical rather than practical and “real-life” oriented. It was therefore recommended that universities should engage more with industry and update their curricula to meet professional life requirements. This also highlights the benefits that vocational routes through apprenticeships into the workplace can offer to both employer and employee.

While the working culture in Europe focuses highly on theoretical concepts, countries like the USA and increasingly the UK are more open to Agile (trial and error) development methods. Although there are noticeable economic differences, a varied approach does make a significant impact, such as the German vocational education and training program [9].

Issues around mid-career hiring had scattered reports. Principally, experienced talent may or may not find it difficult progressing on the career ladder as progression is subject mainly to individual capabilities and business needs.

The ongoing pandemic situation hasn't necessarily changed anything, but it has emphasised the value of soft skills and adaptability to smart working. Good communication skills and attitude are now being appreciated more than ever.

4.1 CONCLUSION

This section has presented the results of a survey of European aerospace organisations. The survey has shown that 39% of the respondents face a skills gap issue, both for classical skills such as management, technology, IT and engineering, and for emerging skills like AI, data science and machine learning. It is also noted that communication, flexibility and adaptability will increase in value in the future. There was no evidence that skills gaps could be related to any protected characteristics, or whether there was any contribution through conscious or unconscious bias.

New graduates are seen as easy to recruit but not quite matching the skill set needed by industry, while 53% and 21% of the respondents confirm that they see a need to recruit outside their organisation and outside the aerospace sector respectively for mid-career talent.

To summarise, the mismatch between university courses and industry needs weighed heavily with recruiters who find it difficult to identify particular talent and distinguish between candidates. To integrate with industry, the ability to adapt and learn quickly

actively supports an individual's opportunity to progress in their career. Each assignment/project requires different approaches thus it is imperative to be open minded and collaborative. For a better bonded, productive workforce, it is advisable that changes in policy comes as result of collaboration or partnership between industry, academia and government. Therefore, effective forecasting in terms of skills and budget would connect the needs of today to the demands of tomorrow.

The Covid-19 pandemic has not had a large influence on skills requirements, as per our survey responses, other than to demonstrate the need for resilience and adaptability.

5 RECOMMENDATIONS

5.1 GENERAL RECOMMENDATIONS FOR STAKEHOLDERS

It is important to identify actions that organisations across the sector can implement to mitigate for the consequences of skills deficits, and notably to highlight those activities which have been proved of benefit elsewhere. Different actions will be recommended for implementation at different points in the career profile: commencing at departure from the school system, at university or college and continuing within organisations in the sector. The set of recommendations proposed were developed after analysing the available literature, already implemented actions and responses received from the survey. These are some of the general recommendations:

The importance of dual educational systems

This kind of system, which incorporates vocational training, is widely implemented in Germany. Vocational training consists of a cooperation between employers and vocational schools (e.g., universities or technical colleges), which enables trainee employees to spend part of the week participating in off-the-job learning and part of the time working at an employing organisation. This kind of training lasts between one to five years. The German approach to the dual system [9] has proved to be key to the skill development of employees across the sector, helping organisations in the recruitment of personnel and ensuring a well-prepared and supported workforce in the early stages of their careers. Dual training can also be beneficial for employees in the search of a job as they will receive market-relevant training that can positively improve their chances in the labour market which is evolving rapidly [10] [22].

Skills forecasting

It is increasingly important to forecast skills and capability requirements in order to anticipate the key skills that will be needed in the next 5 ... to 10 years. By performing skills forecasting or 'fore sighting', it will be easier for organisations to define training matrices for individual employees in each step of their professional development. The benefits of performing skills forecasting are enormous: Analysing skills gaps, by using for instance data science techniques can help develop new education and training courses. For each of the educational levels a framework could be defined for how to conduct the skills development and education activities supporting skills identified in the forecasting. This type of activity is already being implemented, for example by ASSETs+ [23].

Up-skilling and re-skilling programs

Up-skilling and re-skilling programs should be implemented in organisations not only for young graduates but also for mid-career employees and returners. According to the Pact for Skills [2] the sector will try to incorporate these actions to up-skill and re-skill around 30% of the current EU workforce in the next 5 years. This will help to support emerging and essential roles. This correlates with the proposed Circular Job Initiative [3]. A strong investment in training and upskilling of the workforce can also help unlock hidden skills in existing employees and encourage cross-training between candidates adding value across the business. Training sessions are a good chance to bridge the gap between the employee's background and potential. Upskilling and reskilling programs have also proved to increase the engagement and motivation of the workforce in the company, encouraging those on career breaks to return, and reducing the risk of talent loss.

Talent development and cross sector engagement

The authors also recommend proper support for talent development and cross sector engagement to describe and promote partnership programs. This is a very important action to boost attraction into the industry and to encourage retention. By keeping the talent, skills are also retained and will evolve with employees. Having a solid and talented workforce will ensure adaptability as new, demanding, skills are required. As the Pact for Skills claims: "The aerospace industry will need 300,000 people in the next ten years to join the industry." [2]

Rewarding and promoting learning and development capability

It is essential that the sector implements and promotes a culture which rewards continuous learning and competency development. Having employees who are able and open to learning new skills will be a very valuable asset that should not be neglected. A culture of continuous learning can be activated and increased by facilitating the opportunities available to employees for training: including training programs, practical courses, or workshops, giving access to different kinds of training content through online, blended or face to face learning and enabling the training of trainers. The promotion of a continuous skills development culture should also be encouraged through salary appraisals, promotions, or other types of rewards.

Increasing cooperation between universities and other organisations

Cooperation between university teaching, industry and government employers must be increased. This way, courses will be more focused on the needs of the sector and new graduates will gain competencies, which will be in demand by the sector in future years. The development of such relationships will be fundamental for both the learning and employing community, reducing training costs and time in the future. There are also benefits to be gained by employers providing opportunities for continued study alongside the job, which support training programs for companies in order to develop the skills of all employees. These part-time opportunities could include undergraduate and postgraduate degrees or diplomas to enable progression to more senior positions. [39]

Increasing recruitment diversity

There is abundant evidence that recruiting a diverse workforce increases innovation and reduces 'group think'[24][40] It provides benefits for performance, innovation and productivity in teams and across organisations. In addition, these teams are able to contribute with broader skills and experiences, which usually will contribute to bridging skills gaps in companies. Broader skillsets in teams accompanied by investments in training, can reduce the impact of talent shortages in businesses by discovering talents that standard hiring practices might not uncover [24][25]. Targeting mid-career persons with transferable skills from other sectors is one way to achieve more diversity in recruitment.

5.2 WIA-EUROPE ACTIONS

WIA-Europe aims to “become the preferred professional association in Europe for women and men who wants to work and develop professionally in the space sector, to promote space programs and to support the young generation to come and to contribute in shaping the future.” [26] As a result, we believe that WIA-Europe should contribute to addressing the gap through the following actions:

Mentoring program

Supporting and coaching young members to grow and develop their careers. The purpose of mentoring is to connect individuals with different levels of expertise and knowledge in the aerospace sector, in order to help those who need guidance and to promote personal and professional growth (e.g., Mentors can provide information of in-demand skills of which mentees may not be aware.). Mentoring can also be useful for mid-career recruits from other sectors to quickly gain aerospace specific expertise. WIA-Europe recognises the mentoring program offered by Madrid’s WIA-Europe Local Group which could be emulated by other local groups or by local groups connecting to and supporting relevant similar initiatives in their countries.

Networking to engage and interact with diverse roles and skills

Networking offers a crucial opportunity to connect companies demanding certain skills and candidates who possess them. Networking could also provide links between companies and educational organisations for those who are willing to give seminars, speeches or supplement courses.

Guidance and support on how to accelerate the transfer of knowledge and learning

Develop a simple generic capability framework, that would be applicable to most organisations and that highlights the competencies expected at different levels. Analyse and share methods to facilitate knowledge sharing between employees. In addition, facilitate skills information to individual members and guide them through the training processes to acquire those, in order to increase their chances in the recruitment processes.

Sponsor training, courses, webinars, competitions

By identifying the needs of industry, different courses and activities can be promoted or commissioned in order to help companies and individuals to acquire new competencies. In addition, sponsoring activities that enable collaboration and competition could contribute to the development of soft, management and leadership skills and encourage networking between academia, government and industry, employers and employees.

Support in analysing skills gap issues

Publishing information like this can provide evidence to support organisations interested in providing the training required across the sector. It may also help companies in their skills forecasting. “WIA-E Skills Gap” working group carry out regular evaluations of European studies in this area and will share and promote best practices identified.

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ANNEX: SURVEY QUESTIONS

SKILLS GAP IN THE AEROSPACE SECTOR

Note : Skills gap is a fundamental mismatch between the skills that employers rely upon in their employees, and the skills that job seekers possess.

* Required

1) Organisation name *

2) What position do you occupy in your company? *

- Engineering/Science
- Management
- Human Resources
- Other

3) Does your organisation or you, find any difficulties to hire or promote individuals related to the gap of skills necessary for different positions? *

- Yes
- No
- I am not sure

4) How do you scale the relevancy of the skills gap? *

	1	2	3	4	5	
Least important	<input type="radio"/>	Most important				

5) Why do you think is the "Skills gap" a relevant topic?

6) Do you think skills gap is biased? Please choose from the option below: *

- None, Skills gap is not biased
- Gender
- Culture
- Age
- Disability
- Sexual orientation
- Other _____

7) From the "role skills" listed below, please check the ones you think that are currently missing in the aerospace sector: *

- Technicians
- Research
- Management
- Engineering
- Other _____

8) From the "profile skills" listed below, please check the ones you think that are currently missing in the aerospace sector: *

- Artificial Intelligence
- Data Science
- Machine Learning
- Mathematical Modelling
- IT Skills
- Other _____

9) From the "capacity skills" listed below, please check the ones you think that are currently missing in the aerospace sector: *

- Entrepreneurship
- Leadership
- Communication
- Teamwork
- Other _____

10) Do you think recent graduates are equipped with relevant skills to start working in the Aerospace Industry? *

- Yes
- No
- I am not sure

11) For mid-career positions, do you see a need to recruit from outside of your organisation/sector? *

- No
- Yes, outside of my organisation
- Yes, outside of space sector

12) In your opinion, what skills do you consider that will be needed in the future? *

13) Is your company executing actions to bridge the gap? Please choose the ones that apply: *

- None
- Training
- Assessment
- Professional/Personnel improvement schemes
- Other _____

14) How has the Covid-19 pandemic changed the skills needed in the aerospace industry? *

15) Would you like to be contacted by us to get further information on this topic ? *

- Yes
- No