CATAPULT
Connected Places

FUTURE AVIATION SKILLS STRATEGY

Engagement Report - Skills needs in Aviation

July 2023

EXECUTIVE SUMMARY

The aviation ecosystem is under considerable pressure to evolve rapidly, in response to the push for net zero and from changing technology, including automation.

Transformative change is needed to reach sustainability targets in aviation. In parallel with these changes other emerging technologies are being adopted by the sector; notably the introduction of unmanned flights and automation of ground operations.

There is often focus on the research and innovation driving these changes and not enough recognition of how this is going to impact the people who work in the industry. These changes have an impact on the skills needed to operate a safe, efficient and sustainable aviation sector.

To avoid negative impacts arising from these trends, we recommend that the Government collaborates with the aviation sector to support up-skilling, re-skilling and attracting of new talent into the aviation space.

The development of new apprenticeships which offer specialist, relevant skills required for the future of aviation is imperative. This requires a coordinated approach across industry which should be convened and facilitated by the Department for Transport (DfT).

The available qualifications are currently limited in scope and are at a low level and therefore do not meet the changing needs of the industry. The apprenticeship frameworks are typically slow to change, and typically change after new systems are in use, which would slow down the necessary transformation.

Speeding this up requires clear targets and close industry engagement, but at the same time, industry is very focused on their day-to-day operational requirements.

Therefore, industry would benefit from the DfT's support in facilitating their engagement and helping them look towards their future needs.

The key trends that will impact skills and capabilities needs identified are:

- the transition to zero emission flight, and the changing use of fuel and fuelling, with the challenges of new safety regulations and ways of working to be embedded
- increased operational automation, and whilst there are highly skilled roles within the sector with specialised training, there are also lower skilled roles where the impact of automation will be felt and where additional higher-level training will be required in the future.

There are initiatives set out by the DfT to build science technology engineering and mathematics (STEM) skills targeting the aviation sector but more action is required. Most notably, there is a gap in provision of apprenticeship standards in aviation. To achieve the skills required we recommend the closing of this gap to be prioritised by the Government. Our recommendations set out in the roadmap above suggest an approach to deliver, including:

- Convening - We recommend that employers in the aviation industry collaborate and plan together to form a coherent and well-planned strategy for developing multiple standards concurrently and avoid overlap or duplication, to ensure logical progression between levels of apprenticeship standards. Since industry is very focused on the day to day operational requirements, it would benefit from the DfT's support in facilitating their engagement and helping them look to their future needs.
- Apprenticeship development - We recommend that activity is instigated to revise the existing aviation apprenticeship standards, so that the time delay in developing new standards has less impact in training the potential future workforce.

Action is imperative. If the skills gaps are not addressed, the aviation sector will not be able to rise to the challenges of the coming decades to continue to position the UK as a global leader in this ecosystem.

Aviation Skills Roadmap

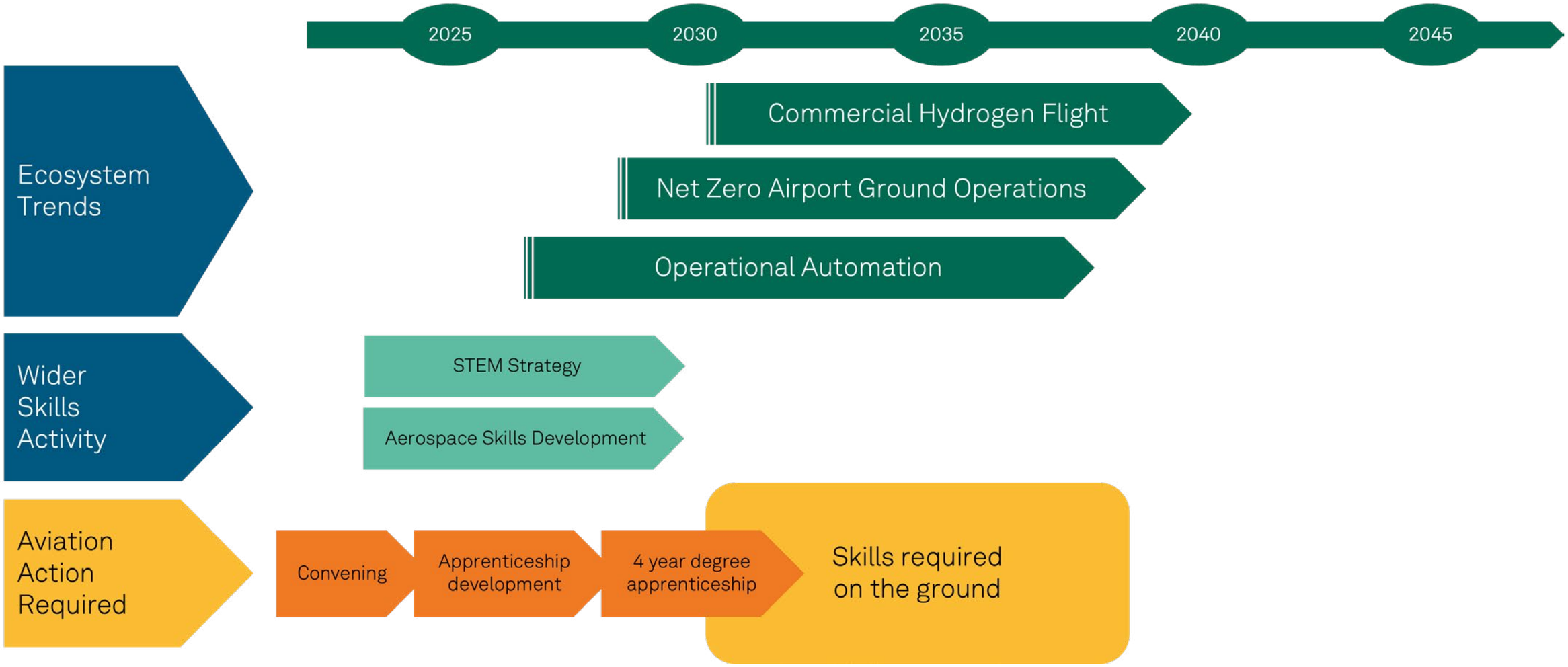


TABLE OF CONTENTS

FUTURE AVIATION SKILLS STRATEGY

INTRODUCTION

The aviation ecosystem is under considerable pressure to evolve rapidly, in response to pressure for net zero and from technologies such as automation. The right skills available at the right time in the right place are needed to make this transition a success.

The Department for Transport (DfT) has recognised that there is a need for an informed and well evidenced skills plan for aviation, which is made even more important by the wider uncertainty about how the sector and its workforce needs will evolve. Industry stakeholder engagement by the Department has also confirmed the need for research and strategy in this area. DfT is keen to ensure the research also explores the current aviation and wider skills landscape – how far back we go in the course of a person's career, education and training in terms of intervention from government and/or others, and how early can a person start developing the requisite skills (for example. educational institutions attracting people into the skills needed) – and how that system might evolve as the sector changes in future.

Drawing upon skills-based assessment techniques developed during the future of transport skills project, Connected Places Catapult will be building a foundation for skills investment based on short, medium and longer-term thinking and stakeholder engagement. This project also supports the development of near to market technologies to support DfT's strategic objectives.

It also supports skills providers to develop new education packages/ products and enabling investment therein, and the implementation of emerging aviation technologies by providing the supporting components of capability which sit around the core function – operations, logistics, support, and maintenance.

This report sets out the results of the engagement activity carried out through the project. This includes:

- The outline and discussion of the current aviation ecosystem, and the current position on skills in aviation
- The future of aviation in the near and longer term, looking maybe 15 years ahead and considering key changes such as decarbonisation and automation
- The potential for the development of skills pathways to support and enable this future aviation ecosystem.

The report consists of:

- A section on the background, which sets out the reasoning behind the project, and the approach to the development of the content of this report
- A section on the current aviation ecosystem, explaining the scope and roles involved and the pathways to skills in this arena
- A section on the future aviation ecosystem, using trends visible today to support our vision of that future space, and using that to support an assessment of the future skills needed and how they may be achieved
- A summary of the key insights and recommendations that will be taken forward into the development of the action plan.

PROJECT SCOPE

The scope of the activity is the aviation industry which specifically excludes aerospace. For the purposes of this report, aviation is everything about flight and air travel except for the design and manufacture of aircraft.

This report is set in the context of previously published research including the Flightpath to the Future Framework and the Jet Zero Consultation which explore current aviation skills and pathways. Therefore, the aims of this project, set out below, are to build on this research, with a focus on the skills needed in the future.

The aims:

Future Aviation Skills Strategy is a 9-month project with the aim of performing a study to gather expert perspectives on the skills requirements of the new aviation system and then identify the steps to realise this ambition.

The purpose of this research is to help Government and Industry understand what skills the aviation workforce is likely to need in future in order to fully realise the benefits of emerging technologies in the field. The project will culminate in a research report addressing the following questions:

1. What kind of skills will the aviation workforce need in this possible future compared to the skills requirements of the present?
2. What factors will need to be in place in order to meet the skills needs that are identified in (1) – for example, what kind of systems of training and accreditation will need to be in place?
3. What actions should the aviation industry and Government take now, and in coming years, to ensure that future skills needs are met?

The scope of this project is to define expected areas of change in the aviation ecosystem and make recommendations for where Government can de-risk failure to adapt through addressing skills shortages.

The objective of this report is to assist Government and industry to understand what skills the aviation workforce is likely to need in the medium and long-term to fully realise the benefits of emerging technologies. This will provide the foundations for the Department for Transport to support the future skills needs of the aviation industry.

FUTURE AVIATION SKILLS STRATEGY

APPROACH

Emerging technologies will change the very nature of aviation. To fully realise the promise of these technologies and the benefits they can bring to the UK economy, a workforce needs to be available with the necessary skills.

This section of the report sets out the context to further explain why a targeted approach to aviation skills is necessary, elaborates on some of the wider changes and timescales, and explains how the material in this report was developed.

CONTEXT

The first generation of modern aviation commenced in 1903 when the Wright Flyer made the first sustained flight by a manned heavier-than-air powered and controlled aircraft on 17 December 1903 in North Carolina (1). Invented and flown by Orville and Wilbur Wright, it marked the beginning of the pioneer era of aviation.

The second generation of flight began in 1940 with the first jet-propelled flight taking place, revolutionising the aviation world from that time on (2). Each of these two phases caused major changes in the aviation industry and the participants within it, and to the world at large.

As we enter the next generation of aviation, one containing artificial intelligence, electric and hydrogen powered flight, autonomous air mobility as well as drone - including beyond visual line of sight (BVLOS) - flight, the aviation industry needs to prepare itself for what this new paradigm of flight will look like moving into the years 2030-2050.

This next generation of aviation will bring changes to operational approaches and business models; it will change how aviation is accessed and used, and its impact on the wider economy. Some of these changes are coming fast, with investment and regulatory incentives being driven by the Net Zero agenda.

With the increasing complexity of both the engineering and operations in this field there is now a split into aerospace and aviation.

We have defined aerospace as those aspects involving the research, development, design and manufacture of aircraft, and that is outside the scope of this study. This study is focused on aviation which, for the scope of this report, is defined as the operation or flights and air travel.

To be supportive of the changes coming to aviation, Government and related industries need to start thinking about the training and resource questions brought about by such changes. For example:

- What skills are required in the new aviation ecosystem?
- What accreditation and training are needed to support the development of the skills this new ecosystem needs?
- What actions do Government and industry agencies need to undertake to support this training and skill build and when does it need to act?

Armed with these questions, the aim of this study is to:

1. Document the scope of the new aviation system to be studied,
2. Conduct a skills requirements analysis to map the current skills landscape, and
3. Develop a skills strategy action plan, using a foresighting methodology, for the development of an aviation skills development programme needed to meet the medium and longer-term needs of the aviation industry.

Upon establishing these, this study will enable Government to facilitate the resources and requirements to support the safe and effective transition to the 3rd generation of aviation.

Following our stakeholder engagement, set out in more detail below, we concluded that an intermediate category of aviation “themed” was needed. This is because some “generic” functions have specific aviation-related knowledge or skills, such as management accountant. However, it was generally agreed that these specific skills or knowledge can be acquired in-post.

We recognise that this is not precise and that how someone describes their job is likely to depend on their personal preferences and ambitions, but we believe it is a suitable structure for discussing the development of the appropriate skills.

We also provided some initial classification of the approach to developing skills to provide a simplified method of discussing the skills pathways, explained in detail in the following chapter of this report.

ECOSYSTEM

Whilst it is not possible to foresee the future, we can determine the trends driving change, identify likely futures and determine actions that enable us to reduce the risks and take advantages of the opportunities. A previous Connected Places Catapult report for the Department for Transport looked holistically at the Future of Transport Skills (FOTS). In the FOTS report, scenarios were developed to help contain future uncertainty. The intent of the DfT to support the aviation industry, as exemplified by this study, rules out some of the FOTS scenarios and therefore this approach has not been adopted by the project. Instead, the approach taken for this project comprised the following steps, set out in more detail below:

- Considering current operations, to understand the current aviation ecosystem
- Based on the trends and changes underway in this environment, building a view of the future aviation ecosystem
- Validating these views with stakeholders through workshops and interviews
- Assessing the changing skills landscape needed to support the envisaged future

To provide a baseline to build from, the current aviation ecosystem was mapped. This built an understanding of the jobs that currently exist in aviation and bound the scope of the roles to be considered.

We did get feedback from our engagement exercise that showed that, depending on the operations and their scale, the allocating of operational demand to individuals or groups of individuals could vary from operation to operation.

For the rest of this discussion we have therefore referred to 'functions' instead of roles.

The changing future of aviation will require new functions, the areas these are likely to emerge in have been indicated in this report, but the terminology is likely to evolve.

Aviation functions were identified by using a two-pronged approach:

- Firstly, analysing functions that are encountered by considering a passenger's journey through an airport, thinking about each interface between the passenger and personnel.
- Secondly, by analysing functions that interact directly with an aircraft, that impact on the aircraft's journey through the airport.

These functions were distinguished as either aviation, aerospace or both. Aerospace has been defined as roles involving the research, development, design and manufacture of aircraft (3), whereas aviation has been defined as roles required to run and operate flights and air travel. Purely aerospace roles were deemed to be out of scope, but any roles that also featured in the aviation space were included in the scope of this project. Aerospace is a wide-ranging industry which has the potential to have a scope that becomes too large for this project, therefore it has been excluded from this work. Additionally, other parties, such as the Aerospace Growth Partnership (AGP) are conducting research in this area (4).

For our initial approach, aviation functions were classified as either aviation "specific" or "generic". "Specific" functions were identified as those where if the person carrying out that function was asked what industry someone worked in, their response would be "aviation". "Generic" functions were identified as functions that are not specific to aviation, finance, for example. Some functions were also categorised as "emerging" or "changing" functions. This allowed a discussion to understand if, and how, these functions are likely to develop and the demand for them to increase.

Following our stakeholder engagement, set out in more detail below, we concluded that an intermediate category of aviation "themed" was needed.

This is because some "generic" functions have specific aviation-related knowledge or skills, such as management accountant. However, it was generally agreed that these specific skills or knowledge can be acquired in-post.

A visualisation of how these functions were categorised is shown in Figure 1 below. Any functions that have a dependency on aviation were classed as in-scope for this project, including some more back office but critical functions, such as aviation specific commercial and planning.

Figure 1: A visualisation showing how the aviation roles were categorised to bound the scope

These functions and their classifications were validated through the stakeholder engagement, as set out below. This also provided us with an improved understanding of the current skills pathways to support development of recommendations for the future.

It was then necessary to consider how the future ecosystem may change. Building on our wider portfolio of projects within Connected Places Catapult, and engaging with other members of the team, we developed a view of the trends impacting the future aviation ecosystem and the aviation roles required to support it. This included considering aspects such as the Zero Emission Flight activities, wider projects around the hydrogen and electric transition, and projects in the future flight and drone arena.

By suggesting potential areas of technological change, we investigated how these roles may change in the future, including building an understanding of how skills suppliers might meet these changing needs.

ENGAGEMENT METHODOLOGY

This report is comprised of findings gathered from desk research and stakeholder engagement. An initial literature review was carried out, including policy documents, recently published materials and other relevant internal projects. Our initial findings and project scope were then validated in one-to-one interviews and workshops.

We held a workshop with stakeholders from the aviation industry followed by a workshop with aviation skills providers. These workshops were complemented by one-to-one interviews with a variety of different organisations in the aviation sector. This engagement was also used to get the aviation sector's thoughts and insights on current and future roles, as well as the skills needs for their areas of specialism.

All the engagement took place in an open and collaborative way with no attribution of input. The following organisations were engaged through workshops and interviews, and we would like to take this opportunity to thank them for their input and support.

NATS	British Airways	Stansted Airport College
Talentview	Easyjet	University of Nottingham
CAA	UKRI	University of Salford
NEBOair	Airport Operators Association	Cranfield University
H2 Network Board	Mott Macdonald	
dnata	University of Exeter	

WORKSHOPS

Two workshops were run, one with members of the aviation sector and the other with the skills supply ecosystem. These workshops were used to validate our present aviation skills landscape and understand implications of the possible future. These workshops were run in a similar way and comprised of three parts.

1. Firstly, participants were invited to explore the diagram of aviation specific functions, highlighting functions that they wanted to discuss further, including any functions that maybe weren't already represented.
2. Participants were then guided around a potential airport of the future. This activity involved discussing emerging technologies applied to the airport apron and airport customer experience. Each technology was discussed with regards to its perceived likelihood, impact on aviation roles and therefore skills. There was also discussion on how we might mitigate future skills gaps through skills supply.
3. Finally, participants were asked to discuss current aviation skills gaps and highlight any potential barriers to entry into aviation careers.

INTERVIEWS

A total of eight targeted interviews were held over the course of the project to build on and cover any gaps within the aviation industry. This also allowed us to get insights for specific roles or technologies, including into current skills needs, future skill needs, any future or emerging roles and any existing or upcoming skills gaps. Where possible, publicly available references have been added to reinforce these stakeholder views.

CURRENT AVIATION ECOSYSTEM

To realise the benefits of emerging technologies in aviation and define our approach to addressing the aviation skills requirements of the future, we need to define what current skill needs are.

CURRENT ECOSYSTEM

The current aviation ecosystem is varied and complex. The same role at different locations may entail different skills, for example, baggage handling at a small, regional airport will operate differently compared to larger, busier airports. The same applies to fuellers at local airfields compared to international airports, or even vertiports in the future.

The same roles that are needed for both Commercial and General Aviation have differing responsibilities and therefore skill requirements. Consequently, in the ecosystem map produced below and utilised in the engagement we refer to functions.

Notably, each have their own unique issues, such as gaps in licensing and technical support.

There are also different categories of certain roles with more specific or different skills requirements, such as maintenance engineers, where the skills needed are dictated by the licences the engineer holds and for the different aircraft they maintain.

This is likely to extend to the future where fuellers and maintenance roles are likely to be linked to specific aircraft fuel types, such as a hydrogen refueller or an electric aircraft maintenance engineer.

This is illustrated in ‘The Ecosystem’ diagram overleaf.

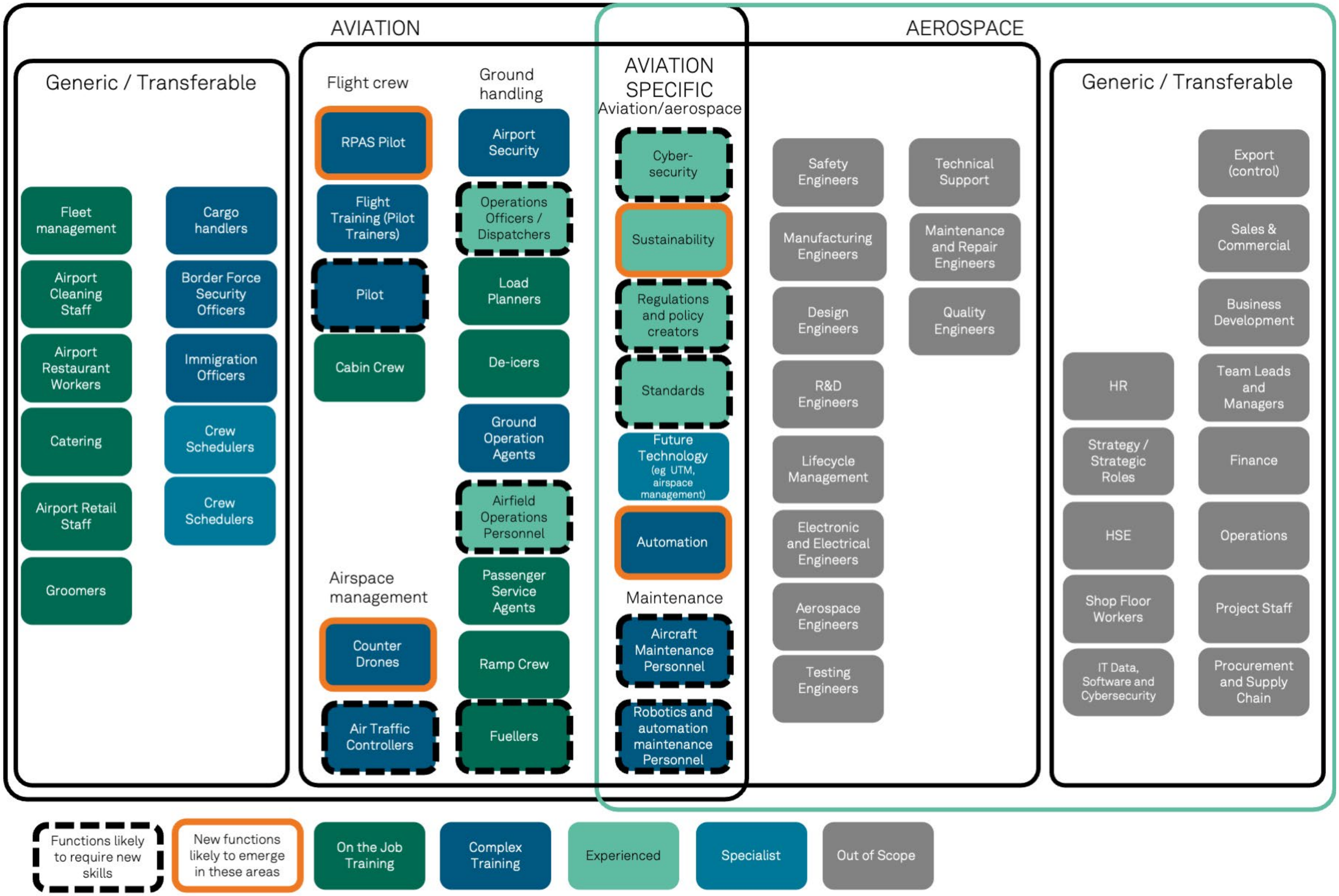
This diagram was the key engagement tool used in all discussions and interviews, it provided a way of defining the scope of the project and a structure for a narrative about change.

It is designed to be a foundation for discussion, therefore the terms used are not definitive but open to change. The assessment of future skills needed in the form of new and modified functions is indicated using orange and dotted black borders respectively.

Terminology will develop as the functions develop, and the diagram should be updated accordingly.

The ecosystem map is colour coded by training requirements of each function. More detail on each training category is given in the Current Skills Pathway section below.

FUTURE AVIATION SKILLS STRATEGY


AVIATION
AEROSPACE
Generic / Transferable
Fleet management
Airport Cleaning Staff
Airport Restaurant Workers
Catering
Airport Retail Staff
Groomers
Cargo handlers
Border Force Security Officers
Immigration Officers
Crew Schedulers
Crew Schedulers
Flight crew
RPAS Pilot
Flight Training (Pilot Trainers)
Pilot
Cabin Crew
Ground handling
Airport Security
Operations Officers / Dispatchers
Load Planners
De-icers
Ground Operation Agents
Airfield Operations Personnel
Passenger Service Agents
Ramp Crew
Fuellers
Airspace management
Counter Drones
Air Traffic Controllers
AVIATION SPECIFIC
Aviation/aerospace
Cyber-security
Sustainability
Regulations and policy creators
Standards
Future Technology (eg UTM, airspace management)
Automation
Maintenance
Aircraft Maintenance Personnel
Robotics and automation maintenance Personnel
Safety Engineers
Technical Support
Manufacturing Engineers
Maintenance and Repair Engineers
Design Engineers
Quality Engineers
R&D Engineers
Lifecycle Management
Electronic and Electrical Engineers
Aerospace Engineers
Testing Engineers
Generic / Transferable
HR
Strategy / Strategic Roles
HSE
Shop Floor Workers
IT Data, Software and Cybersecurity
Export (control)
Sales & Commercial
Business Development
Team Leads and Managers
Finance
Operations
Project Staff
Procurement and Supply Chain
Functions likely to require new skills
New functions likely to emerge in these areas
On the Job Training
Complex Training
Experienced
Specialist
Out of Scope

The table on pages 22 and 23 groups the new and modified functions in the map into core role categories; ground handling, maintenance, flight crew and airspace management. The current and future skills requirements in each of these categories have similarities, which are summarised in the table and discussed further in the report. The scale of change in the functions expected to be affected by future trends is categorised as modified or new; where 'modified' refers to existing functions which are likely to require new skills, and 'new' refers to areas where functions are likely to emerge in the future.

GROUND HANDLING

The findings in this section are based on a one-to-one interview with a ground handling organisation, unless stated otherwise.

Currently, ground handlers require basic English language skills including reading and writing to ensure correct information is captured and understood. However, an ability to speak other languages is being increasingly valued. Basic maths and time reading skills are also vital in ground handling roles. There is now an increasing need for basic IT and digital skills in this role to be able to use technology as part of the role day-to-day.

Some ground handling roles have a similar skills base but require different levels of training, for example cargo crew and ramp crew. These roles also lead to the opportunity to become more specialist with the required training, such as becoming a dangerous goods regulator.

There is currently a need for more dispatchers which usually requires aviation experience. This role tends to be hard to recruit for given its specialist nature. It has been suggested as a good course for college apprenticeships to try to get more people into the role. Dispatchers are required for both passenger and cargo flights, where both require the same extensive training.

MAINTENANCE

There is currently a skills gap in maintenance engineers needed to service and maintain electric aircraft and a likely skills shortage in the future as numbers of electric aircraft grow. Although electric aircraft are not currently in wide-scale use, there are some electric aircraft that are certified to fly in the UK. There is likely to be an increase in the number of electric aircraft operating, which will require the maintenance engineers trained and ready to service these aircraft. There is also a lack of training provision for electric aircraft maintenance staff; currently all training in this area is done abroad which is expensive and a barrier to further staff being trained.

FLIGHT CREW

Currently the Civil Aviation Authority (CAA) has guidance for drone operators to be able to fly (5). This states that a remote pilot must "have the appropriate remote pilot competency, dependent on the operating category" (5). It is understood that the CAA are developing further guidance and regulation on this, and are now consulting on their proposals. The International Civil Aviation Organisation (ICAO) have published some initial standards (6); it is assumed that UK guidance will follow a similar direction.

AIRSPACE MANAGEMENT

The findings in this section are based on a one-to-one interview with an air traffic control organisation, unless stated otherwise. Where possible, publicly available references have been added to reinforce these stakeholder views.

Air traffic controllers currently don't need any A level or equivalent academic qualifications (7). The main skill required is spatial awareness, along with tactical awareness and mental planning. There is a very extensive training programme to become qualified as an air traffic controller. The role is likely to change over time with technology, becoming less siloed as it moves to integrate new users. These potential changes and trends are discussed in subsequent sections.

ROLE CATEGORIES	CHANGING FUNCTIONS	EXPECTED CHANGE	CURRENT SKILLS	FUTURE SKILLS
Ground handling *Refers to roles required to facilitate aircraft departure and arrivals including ground repositioning, ramp services, customer service and marshalling.*	Airfield operation personnel	Modified	• Ground handlers require reading and writing skills to ensure correct information is captured and understood. • There is an increasing need for basic IT and digital skills to be able to use technology as part of the role day-to-day. • Some ground handling roles have a similar skills base but require different levels of training, for example cargo crew and ramp crew. These roles also lead to the opportunity to become more specialist with the required training, such as becoming a dangerous goods regulator. • There is currently a need for more dispatchers which usually requires aviation experience. This role tends to be hard to recruit for given its specialist nature.	• There is likely to be a mix of SAF, hydrogen, battery aircraft and conventional fuel, each supplied to serve a distinct aircraft, route or geography. • Different fuels will have a significant impact on the type of skills required. However, this may not require a change in skills for fuellers themselves, as connecting an aircraft to a fuel source could be a responsibility or skill that doesn't depend on the type of fuel being used. • However, hydrogen fuelling in particular will require licencing or certification and further responsibilities. Ammonia and other hydrogen derivatives are likely to be closer to Sustainable Aviation Fuel (SAF) in terms of skills requirements for refuelling and maintenance.
	Fuellers	Modified		
	Operations officer / dispatcher	Modified		
Maintenance *Refers to roles responsible for routine checks and emergency repair work of aircraft and ground transport to ensure they are safe to operate.*	Aircraft maintenance personnel	Modified	• Maintenance engineers are trained for specific aircraft types and propulsion systems and the skills needed are dictated by the licences the engineer holds and for the different aircraft they maintain. • Training for electric aircraft is currently only available abroad which is expensive and provides a barrier to up-skilling.	• The development of hydrogen and electric flight is leading to distinct aircraft types which in turn is creating distinct skill requirements for aircraft maintenance. These roles are likely to become more highly skilled and diversified to maintain the diversity of aircraft, fuel and communications systems. • Aircraft maintenance training will need to change as a more system-based approach is taken by future aircraft. This will also require more system architects.
	Robotics and automation maintenance personnel	Modified		
Flight crew *Refers to the role(s) responsible for the aircraft's execution of safe flight, navigation and operation and onboard passenger experience.*	Pilot	Modified	• There are some automated systems onboard aircraft today, pilot training ensures that pilots can take direct control of the aircraft if required.	• The number of automated systems onboard aircraft is set to increase. Pilot training will need to adapt as more systems require supervision rather than direct control. There will still be a need for pilots to take direct control if required, so ensuring that this skillset is trained and tested adequately will be important. • New propulsion systems may lead to different licencing requirements and standard operating procedures for pilots.
	RPAS Pilot	New		
Airspace management *Refers to the function of ensuring safe air traffic flow and air defence.*	Air traffic controllers	Modified	• Air traffic controllers can currently enter the workforce via a higher apprenticeship including through the armed forces or a trainee scheme with National Air Traffic Services. The minimum academic requirements for entry to the training are GCSE qualifications or equivalent with some higher apprenticeships requiring A levels or equivalent(7). The main skill required is spatial awareness, along with tactical awareness and mental planning. • There is a very extensive training programme to become qualified as an air traffic controller.	• Air traffic controllers are likely to be needed for at least the next 20-30 years, especially for vocal control of aircraft. Once the technology and systems have developed and matured, the controller is likely to be taken out of the loop and manage by exception. In this case air traffic controllers may require different skills to occupy the time that they are not managing the airspace. • Safety management of electric and conventional aircraft on the ground is going to be increasingly important. Air traffic controllers also need to understand the different needs and priorities of electric aircraft.
	Counter drones	New		
Aerospace /aviation *Refers to functions which sit in the aerospace sector but are specific to aviation. They are likely non-operational desk-based roles looking at improving future functions.*	Cyber security	Modified	• Currently, the skills requirements are similar to other sectors with these functions.	• While these functions already exist in the ecosystem the emphasis is likely to be increased in future. This will lead to up-skilling of the workforce in these areas.
	Regulations and policy creators	Modified		
	Standards	Modified		
	Sustainability	New		
	Automation	New		

CURRENT SKILLS PATHWAYS

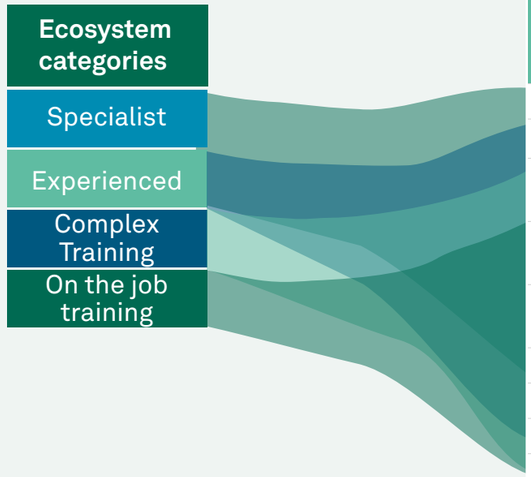
At the outset of the project, we sought to define boundaries regarding which roles are considered to be aviation-specific, as opposed to aerospace, and also as opposed to general business functions in aviation settings (for example, a Financial Controller in an aviation company is employed in finance, not in aviation). The project focused on future roles in civil aviation, and has not considered the military.

The development of the ecosystem broadly classified the current roles in four categories listed below:

On the Job Training (OJT)	No formal qualification or training required to work in the role. Training provided by employer during onboarding
Complex Training	Role requires a licence or assessment Onboarding or pre-role training requires complex training
Experienced	Role requires a degree or equivalent / substantial experience. Role requires specific knowledge or skills but not to a specialist level
Specialist	Role requires a degree and potentially post graduate study. Role requires substantial experience

The four categories set out above and used for the engagement, can be roughly approximated to the framework regulated by OfQual which defines a nine level (including entry level) framework equivalent to levels of education. This is set out in the diagram on the following page:

Category alignment with Regulated Qualifications Framework



Regulated Qualifications Framework Level	Example Qualification
Level 8	PhD
Level 7	Master's Degree
Level 6	Bachelor's Degree, Degree Apprenticeship
Level 5	Foundation Degree, HND, Level 5 Higher Apprenticeship
Level 4	HNC, Level 4 Higher Apprenticeship
Level 3	A Level, T Level
Level 2	GCSE Grades 4 – 9
Level 1	GCSE Grades 1 – 3
Entry Level	

EMERGING DISCUSSION POINTS

Our discussions of current skills pathways to support our assessment of future pathways, generated the following points around provision of training and education in aviation;

- Companies hire graduates and non-graduates to be cross-trained into aviation-specific roles, including ground operations, flight operations and network planning. Investment in on-the-job training programmes should continue to be one of the ways for the aviation sector to grow its own talent.
- Further Education colleges local to airports offer courses relevant to service the current demands of the industry; in these locations, where career opportunities in aviation are more well-known in the general population, it is therefore more likely that young people in these locations consider a potential career in aviation. Communities local to major airports tend to have a good level of provision to meet current local workforce requirements for volume recruitment.
- At a national level, providing more specialist courses in order to meet emerging and future skills needs requiring higher levels of technical skill, there are innovative university courses available. For example, courses in Sustainable Air Transport Operations and Planning offered by the University of Salford, and opportunities resulting from the Digital Aviation Research and Technology Centre (DARTeC), which opened in 2021 at Cranfield University.
- The engagement we carried out suggested that the future skills requirements of the aviation industry will require higher levels of technical skill in the majority of roles, both airside and landside, not just in those jobs which are currently viewed as requiring higher skills and qualifications. This requirement will extend to ground handling operations, in which much of the work is currently manual; in the future, people will need to have an increased level of various technical skills, such as remote diagnostics, in order to work in an increasingly automated function.

CURRENT BARRIERS

During each interview and workshop, the stakeholders participating were asked what they perceived to be the main barriers, if any, to entering and working in the aviation sector.

This section highlights and explores the points raised in these engagements. Where possible, publicly available references have been added to reinforce these stakeholder views.

The World Aviation Festival suggested that aviation is seen as a less desirable industry now with younger, more climate conscious generations more likely to avoid industries they see as polluting (8). However, it is possible that the activities being invested in by the DfT to support the transition to zero emissions flight could be used as a part of a campaign to counter this.

Whereas there are clear pathways to aerospace, the skills pathways to the aviation industry can be seen as being inadequate, particularly with the focus on low level apprenticeships in this sector apparent from a search of the Institute for Apprenticeships and Technical Education (IfATE) website. This does show existing apprenticeships in the sector, but they are very focused on current ways of working and are mostly limited to Level 2 and 3 with only one Level 4 option.

A dynamic approach, focussing on transferable skills, could result in a more resilient supply of skills to the industry.

GRASSROOTS

The aviation industry is seen as a male-dominated industry (8). This perception is supported by statistics, with pre-pandemic records showing that, of job seekers researching roles in aviation, only 21.83% of searches for pilot roles and 20% and 19.81% of mechanic roles were conducted by female prospective applicants. Of these prospective applicants, the conversion rate to the workforce is even lower. Research published by the International Civil Aviation Organization (ICAO) in 2023, states that in Europe 4.2% of pilots, 4.1% of licensed mechanics and technicians and 21.97% of air traffic controllers are women (9, 10). This may also be reflected in education in terms of the number of women studying various related courses, including Engineering (less than 18% of higher apprentices in Engineering and Manufacturing are female, with 7.4% of all engineering apprentices being female (11)), Physics (22% of students starting A Level Physics in 2018 were female (11)) and other STEM courses. More work needs to be done to make aviation and STEM more attractive to women as well as encouraging young people into STEM and this is being tackled across Government (12).

There is an issue around awareness of what the industry does and needs, such as engineers, supply chain, logistics and cyber security. A wider awareness of the aviation industry as a whole and the opportunities involved is needed to get more people into aviation careers.

INDUSTRY ATTRACTION

In the wake of the pandemic, both a perceived lack of job security and an increased awareness of well-publicised industrial relations issues conspire to make aviation a less attractive sector than before. Coupled with an increasing environmental awareness among job-seekers, the sector faces some challenges in making itself appealing to new entrants, especially to those who are at the start of their career. More people are conscious of a work-life balance with a lot of people no longer seeing the aviation industry as suiting their lifestyle. There are opportunities to do a similar skilled job at a similar rate of pay somewhere that's easier to get to, involves more sociable hours and better suits family life. Work needs to be done to make aviation attractive again. There is the opportunity to start in one job and on one path and end up somewhere completely different. Aviation's unique selling point is endless opportunity and lots of areas to explore, but there are often numerous and significant hurdles.

Aviation was considered a secure sector for employment before the pandemic but the potential workforce may no longer perceive it to be so(8). Ways of working and expectations have also changed and it is not clear how these will develop longer term; currently more people want to work from home and not be out beside an aircraft no matter the weather. Hybrid roles may increase for roles where people can work across different airports, such as Hydrogen Specialists for a group of smaller airports.

ACCESS

While some airports are well connected to residential areas, others are not, with public transport links making commuting to an airport an unattractive proposition. Public transport is seen as prioritising air travellers over workers, despite the latter being essential for the industry to operate. Some areas are easier to access than others, for example Crawley was the most furloughed area in the country as Gatwick was such a big source of work for the area (12).

Challenges with access may be exacerbated by public transport links running at times suitable for travellers, but not staff who need to commute early in the morning or late at night. The expansion of the ULEZ was flagged as a concern. While it is only predicted to impact 9% of drivers, this may be disproportionately weighted towards low paid workers reliant on shift travel (13).

SECURITY PASSES

The use of temporary security passes to work in or around the airport apron, while previously widespread, are now exceptional. The acquiring of full security clearance is seen as difficult, but necessary. An added challenge is there are differing requirements across airports in applying for security passes. Work experience often comes with age requirements, which can be off putting to younger people exploring career options.

FUTURE AVIATION ECOSYSTEM

Current and expected future trends are likely to dictate the future of aviation, specifically what roles are needed and therefore what skills are required.

This analysis was largely carried out through engagement with the Connected Places Catapult activity across the ecosystem including in projects to support the decarbonisation of aviation, automation and drones, as well as related projects where the outputs provide indications of what is emerging over the horizon that will impact on the future of aviation. These views of the trends were validated through the engagement with stakeholders as set out in the methodology.

TRENDS

There are emerging and expected trends, both in aviation and in wider industry, that are likely to change the aviation industry.
These trends, and their potential impacts, are explored below.

TECHNOLOGY

The development of technology, specifically the activities supporting automation, Artificial Intelligence (AI) (being addressed by the TAS Hub (14) and digital twins (being addressed by the Digital Twin Hub 15)), will lead to a new focus on data and engineering skills. This will need to be accommodated by engaging prospective aviation students earlier and integrating STEM further into aviation skills.

It is anticipated that any technological skills required for the future aviation ecosystem are likely to classified as aviation "flavoured", with most of the skills required being generic with some application-specific knowledge.

Automation is widely seen as a likely feature of ground vehicles around the apron. Autonomous systems may also enable bespoke user experiences within the airport by 2030. Parallels can be drawn from different industries, particularly the automotive and construction industries, to understand the likely nature of change.

There is likely to be increasing digitisation in aviation, with potential use of technologies such as blockchain, for example with drone operations and verification. In addition to specific technical skills, this is likely to lead to an increase in demand for cybersecurity skills. Quantum and supercomputers could potentially be used to process data faster and act quicker, accelerating these changes.

The use of AI at airports is likely to grow with the development of digital twins and advanced sensors. This may be an enabler of regional airports, allowing them to build their capacity as aviation moves away from few larger airports to many smaller regional ones.

Digitalisation, AI and automation are likely to be used alongside human operations, with a human-in-the-loop and not removing oversight completely, for the foreseeable future. Public acceptance of complete autonomy with no human-in-the-loop will play a significant part in its use.

Putting a timeline on digitalisation and automation is challenging, however, the trends show that the pressures for automation are increasing and the potential for technology to rise to this challenge is becoming more evident. This is a clear target for the UK in the newly published science and technology framework (17).

FUTURE AIRPORTS

Our expectation is that aviation will be a sleeker, more modern and more efficient industry in 2050 with less dependence on a few larger airports and growth in smaller regional ones. To enable this, the UK needs to make itself attractive for people to invest, ship their cargo through or fly their aircraft here. This is likely to be in the form of lower fees for these activities. By attracting more investment, this is likely to grow the economy and workforce of this sector. Otherwise, the UK is at risk of giving up some market share to lower cost competitors.

With airports likely to change to meet the future trends and needs, an emphasis on aspects such as infrastructure, real time analysis and scenario modelling will likely be needed to streamline the airport experience and operation. This may require significant roles involving data, both in terms of volume of roles and their responsibilities.

EVTOLS

It is likely that very little will have to change in terms of air traffic control for piloted Electric Vertical take-off and landing (eVTOLS) to be able to operate in controlled airspace, as they would fit in as another user. As pilots are phased out and the systems do more, there will be a reliance on getting accurate information quickly. Detect and avoid is a potential part of the solution but there is a lot that needs to be done, even before public perception is involved, for this to be a viable solution.

Airfields need to be future-proofed, including making them suitable for drones, remotely piloted aircraft, eVTOLs and other new entrants. In order for these new entrants to operate, there will need to be "vertiports", which provide the infrastructure for eVTOLs and other players in Urban Air Mobility (UAM) to land, recharge, load/unload and take-off (18). Vertiports are coming, but the planning and regulation required for these is unclear. Skills will be required to fill these gaps in planning, regulation and maintenance.

The technology required for these vertiports is likely to be very similar, if not the same as for airports. However, there may be different skill requirements, for example for security workers, depending on how similar or different to airports the set-up becomes. This may be in the form of different forms of security checks, or maybe behaviour monitoring if the role becomes less "hands-on". This may also impact certifications and qualifications. There will also need to be training for everyone involved in the whole vertiport environment, specifically to ensure safety for the people using them.

REMOTELY PILOTED AIRCRAFT SYSTEMS AND AUTONOMOUS FLIGHT

Cargo Remotely Piloted Aircraft Systems (RPAS) flights are currently more likely than passenger-carrying RPAS, but remote piloting for passenger carrying services and larger vehicles will be largely dependent on the nature of aircraft and the emergence of eVTOLs. These skills will only be required once the vehicles themselves are in service. Autonomous flight is unlikely to hit the market before 2050. New aircraft, such as eVTOLs, are likely to be piloted before moving to semi-autonomous operations and then fully autonomous flight. Training and regulation will have to be developed to meet the demand of these aircraft. Autonomous flight also has implications in terms of accountability and liability; if an autonomous flight crashes, who is responsible? These sorts of issues won't be limited to autonomous flight but also ground operations.

AIRSPACE MANAGEMENT

The findings in this section are based on a one-to-one interview with an air traffic control organisation, unless stated otherwise. As stated in the methodology and throughout the report, publicly available references have been added to reinforce these stakeholder views.

Unmanned traffic management has already started changing how air traffic management is handled. In the long term, there is likely to be a lot more automation and digitalisation. There are likely to be a lot more drones and eVTOLs operating. This requires new tools and technologies to be developed, as well as an integration of current airspace and air traffic control.

To this end, the Airspace Modernisation Strategy (19), has set out a roadmap to achieve the end goal of integrated traffic management which will help with planning training. This could be further enhanced by adding implementation timelines to ensure the required changes are made on-time. The management of drones and eVTOLs may be very different to conventional air traffic corridors. They are likely to be much lower altitude and interacting with a lot more airspace users. These corridors need to be created and integrated, the demands of which are being investigated by the Future Flight Challenges (20).

HYDROGEN AND OTHER EMERGING PROPULSION TECHNOLOGIES

The emergence of new fuels, aircraft and systems will likely, in the mid-term at least, create a need for employers to focus on the resilience of their workforce. As the existing fuels, aircraft and systems are phased out, roles and skills will need to be adapted via reskilling and upskilling to cope with the speed of change. New planning and logistics may be needed for hydrogen flight for rapid turnover of passengers, with current refuelling rules playing a big part in this. Dynamic upskilling and regulation will be required to enable airports to accommodate a variety of technologies in the future.

Communication and collaboration with the energy system is needed as energy is required to create hydrogen, and the more hydrogen needed, the greater the strain on the energy system.

Regulation needs to change to be able to take into account new technologies and approaches, including the qualifications of engineers (for example, airworthiness engineers). A review of the regulatory framework would be appropriate to ensure that it can enable the necessary transformational change. Providing more certainty and roadmaps to help industry plan for the future will be valuable.

There will need to be the infrastructure in place to accommodate the technologies and advancements of the future. There needs to be a willingness to trial and test new technologies within the industry. Willingness to learn is a valuable behaviour in the aviation sector.

We have been examining the roadmap for these developments in detail in the Zero Emission Flight Infrastructure (ZEFI) project (21) and example transition dates which highlight the speed of change can be found in the Aviation propulsion technology highlights table below.

Aviation propulsion technology highlights, as set out in ZEFI

	Number of seats	Airframe Type	Propulsion System	EIS Target
ATAG Waypoint 2050	50-100 seater	Retrofitted	Hydrogen Fuel Cell	2030
ZeroAvia	40-80 seater	Retrofitted	Hydrogen Fuel Cell	2027
Cranfield Aerospace	20-50 seater	Clean Sheet	Hydrogen Fuel Cell	2032
	5-100 seater	Clean Sheet	Hydrogen Fuel Cell	2035+
Project Napkin	40-50 seater	Clean Sheet	40 seater - Liquid Hydrogen Fuel Cell 50 seater - Liquid Combustion	2035 (fuel cell) 2040 (gas turbine)
	90 seater	Clean Sheet	Liquid Combustion	2040
GKN-H2GEAR	96 seater	Retrofitted	Hydrogen Fuel Cell	2035
Universal Hydrogen	78 seater	Retrofitted	Hydrogen Fuel Cell with modular hydrogen capsules	2025
H2FLY	30 seater	Retrofitted	Hydrogen Fuel Cell	2025+

GENERIC SKILL REQUIREMENTS

Automated systems are already integrating into the airport experience with remote check-in, baggage drop machines and e-passport gates all reducing the need for human interaction. However, customer service is seen as becoming an increasingly important skill, especially as human interactions will become more limited with the increase in automation. Demographic change will lead to an older population in coming years who are more likely to require assistance (22), alongside an increased focus on inclusivity, requiring a bespoke customer service. Automated systems are still some way from providing this.

An increased focus on 'soft' skills, with the airport experience taking a hospitality-oriented approach was seen as a likely trajectory for this area, with the potential for airport employees to be trained alongside other customer facing industries. Such skills include emotional intelligence, resilience and the ability to relate to people.

There is a crucial need for further upskilling in soft skills such as communication and passenger experience, as these are skills that the advancement of technology is less able to cover.

Building out a good passenger experience also includes rigorous inclusivity to ensure appropriate measures are taken so that no one is excluded. Soft skills training will become more important as more technology is used within aviation, for example if robotic security were to be used, this would be a worse experience than a sociable and friendly security experience.

More digital and engineering skills will be needed for 2050 for both aviation and aerospace. Other industries or countries may be able to bring the automation, digitalisation and other skills needed into aviation.

The aviation sector has a need to become future-proof in diversity of its workforce as well as its skills base. Closer working and collaboration between the aviation industry and education providers is needed to ensure that the right skills and training is being provided, especially when it comes to digital skills. Professional organisations are hugely important in terms of training and ongoing development. These could be leveraged when it comes to up-skilling the aviation workforce.

Training for emerging propulsion technologies, hydrogen and battery electric in particular, will become an increasing gap, specifically for pilots, maintenance and others that will be affected by this technology.

In summary, increasing complexity in roles will push the entry level qualifications and the training requirements for all roles up the qualification levels. This will generate demand for additional training.

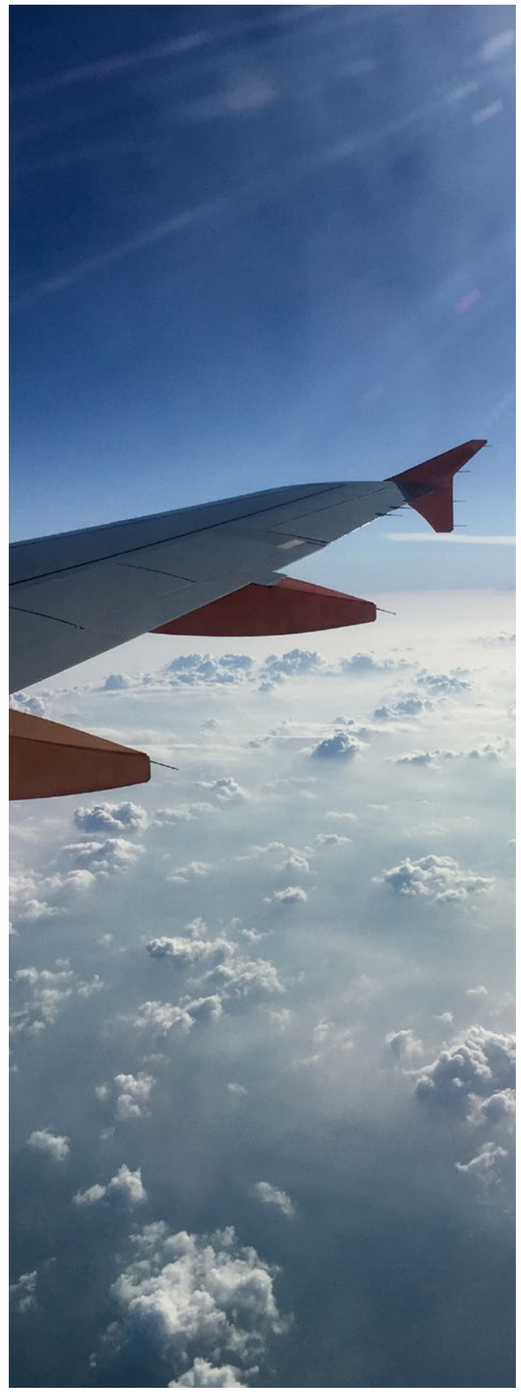
EXPECTED FUTURE AVIATION ECOSYSTEM

Some roles may be replaced in the future, but we are unlikely to see a vast reduction in human workers, especially landside. With the emergence of automated systems, a new focus on customer service, hospitality and inclusion is likely to be necessary to ensure a good customer experience in a competitive field. Robotic and machine-based customer service is seen as being confined to self-service machines and apps, with human customer service unlikely to be replaced any time soon. Passenger service is unlikely to be automated, especially for more high-end airlines, where customers pay for the personal touch.

EMERGING ROLES

Future roles are likely to be more skilled, knowledge-based and-knowledge driven. More environmentally conscious people are coming into the sector and there may be more sustainability roles. There are likely to be fewer people in the low-paid manual labour workforce with more efficiency through technology, the new technology being implemented will require higher skilled people looking after the new technology.

There is likely to be an enhanced dependency on technical engineers and planners which will need to be accommodated by skills suppliers, with greater focus on electro-mechanical systems, data systems, planning and fleet management.



TECHNOLOGY

The increasing pace of automation is likely to increase the skills required by people on the ground, with manual handling-based jobs likely to be replaced. As a result, there is an expected increase in the need for highly skilled people to manage and maintain a network of autonomous systems. It is unclear whether this will be part of a generational change of roles, or whether operators such as baggage handlers could be retrained to work with autonomous systems.

The emergence of autonomous technologies and artificial intelligence will likely open the door to more remote roles. If this occurs, airports may shift away from being local employers to attracting high-level skills that can be used from remote locations. Local colleges will need to adjust teaching to remain competitive.

Airports have come to a stop on several occasions when technology has failed. Consideration needs to be made to the split of technology and human based roles and responsibilities to ensure a failsafe.

More innovation and continuous improvement roles may allow there to be people able to fix technology when it goes wrong, whilst working on other improvements when technology is working as expected. The number of these roles may be higher in the short-term but gradually decreasing over time as technology gets better and more dependable. This may depend on appetite for risk and the rate of technological change.

Integrating AI systems into aviation is likely to reduce the staffing requirement, but these systems will still require human intervention and oversight. Skill requirements for these technologies such as engineering and data skills will likely grow in importance, while those working alongside these systems will need training to both understand the systems and their biases.

DATA

It is highly likely that data science and skills are going to form a significant part of aviation skills in the future. This may be a more generalist skill of data science, or with an aviation knowledge component which helps to get the most information out of the data. Understanding user sentiments, tracking passenger flows and building scenario planning are skills that are being increasingly used and will enable a more seamless and externally integrated airport experience. Technical planning, cybersecurity and digital signal processing will also be essential.

Digital twins, being related to automation and artificial intelligence, will require engineering and especially data skills. If used as a ‘central command centre’ or ‘controlling mind’, there will be a need for quality analysis to deliver the benefits of a digital twin. Digital twinning is more seen as a supporting technology that will increase airport resilience, rather than replacing existing roles.

FUTURE AVIATION SKILLS STRATEGY

SUSTAINABILITY

Sustainability has a variety of implications and there is a need to understand the roles related to the 17 United Nations Sustainable Development Goals. There are likely to be future roles in aviation for ecological management including biodiversity, noise, emissions and decarbonisation, alongside many others. Maintenance and refurbishment of airports themselves, including the materials used, is also important for sustainability.

EVTOLS

The skills required to manage eVTOLs and drones in terms of air traffic management will, at least in the short term, be similar, if not the same, as those needed to manage conventional aircraft: for example, spatial awareness, being able to monitor and manage. The only difference will be the way they operate when they take off and land.

HYDROGEN AND OTHER EMERGING PROPULSION TECHNOLOGIES

The findings in this section are based on a one-to-one interview with a Hydrogen Research and Innovation organisation, unless stated otherwise. Where possible, publicly available references have been added to reinforce these stakeholder views. Whilst this also covers aerospace roles, there is significant overlap with aviation roles.

More aeronautical engineers will be needed for hydrogen flight. Knowledge around non-fuel cell use of hydrogen has increased over the last few years, but other skills and areas of knowledge will be needed in the future, including:

- Material science – materials for storage as well as transport and movement
- Combustion science – how to burn hydrogen efficiently – this has reduced in the UK, where it used to be a world leader
- Storage management– both on the ground and in the air
- Cryogenics engineering
- Health and safety – earthing/ purging, maintenance, explosion proof components, leak detection
- Logistics – more stops may be needed, meaning more planes taking off and landing, even just for re-fuelling
- Explosion safety
- Water management and electrolysis knowledge are also essential if hydrogen is being produced on-site
- Regulation and governance of new fuels

CHANGING ROLES

Whilst some roles are emerging for the Future of Flight, some existing roles are likely to continue, but change significantly in terms of responsibilities and skills.

MAINTENANCE

The development of hydrogen and electric flight is leading to distinct aircraft types which in turn is creating distinct skill requirements for aircraft maintenance. These roles are likely to become more highly skilled and diversified to maintain the diversity of aircraft, fuel and communications systems.

Aircraft maintenance training will need to change as a more system-based approach is taken by future aircraft. This will also require more system architects.

GROUND HANDLING FOR NEW FUELS

A change in the nature of aviation fuel and fuel systems is inevitable (23). There is likely to be a mix of Sustainable Aviation Fuel (SAF), hydrogen, battery aircraft and conventional fuel, each supplied to serve a distinct aircraft, route or geography. Different fuels will have a significant impact on the type of skills required. However, this may not require a change in skills for fuellers themselves, as connecting an aircraft to a fuel source could be a responsibility or skill that doesn't depend on the type of fuel being used. However, hydrogen fuelling in particular will require licencing or certification and further responsibilities. Ammonia and other hydrogen derivatives are likely to be closer to SAF in terms of skills requirements for refuelling and maintenance.

The implementation of hydrogen fuels will also have knock-on effects, with bespoke skills needed for firefighting, planning and storage, amongst others.

A diverse fuel mix is likely to increase the skill requirement of fire personnel, who will be required to deal with a diverse range of aircraft and fuel types, each with their own safety risks and requirements (24). This training requirement will not be restricted to fire crews based within the airport perimeter, but will become an essential training requirement for fire services across the UK and beyond, to equip fire-fighters with specialist knowledge to deal effectively and safely with risks presented by incidents involving specific aircraft fuel types, such as hydrogen-fuelled or fully electric aircraft.

FLIGHT CREW

Pilot training will need to change as a more technology controlled approach is taken by future aircraft, whereby pilots are more likely to monitor and control systems, rather than the aircraft directly. This will also require more system architects. Systems management and situational awareness are skills that are needed for current and future pilots, especially for electric aircraft. There needs to be sufficient understanding of battery management, weather conditions and temperature, as to how that will affect the battery life of the aircraft. Otherwise, the fundamental skills for a pilot are likely to be the same for electric and conventional aircraft. Experienced pilots are estimated to need at least 4-6 hours of additional training on the differences of currently operational electric aircraft.

The number of pilots has decreased in recent years, and passenger numbers are set to increase post COVID-19 pandemic, research indicates that the UK could face a shortage of airline pilots (25).

AIRSPACE MANAGEMENT

The findings in this section are based on a one-to-one interview with an air traffic control organisation, unless stated otherwise. Where possible, publicly available references have been added to reinforce these stakeholder views.

Air traffic control needs to change, as set out by the Airspace Modernisation Strategy (19) and illustrated by the ongoing Future of Flight programme. The current system dates to the 1950s but isn't necessarily suitable or equipped to deal with new market players. In the short term, a segregated air space is probable, but in the longer term, a more intricate and integrated traffic management approach will be needed. To achieve an integrated traffic management system, lots of work needs to be done in terms of the tools needed and the people needed to manage the traffic in an integrated way. Whilst there is a plan for this in the Airspace Modernisation Strategy (19), it is unclear how and when this change will take place, making it difficult to know how to train people.

Air traffic controllers are likely to be needed for at least the next 20-30 years, especially for vocal control of aircraft. Once the technology and systems have developed and matured, the controller is likely to be taken out of the loop and manage by exception.

There is likely to be more systems manipulation for air traffic controllers if pilots are replaced with systems operators. Piloted systems are likely to still be in place by 2030, but up to 2050 is still very open. There may be a reduction in the amount of everyday traffic management that air traffic controllers may need to do, but there will at least be managing by exception still in place for 2050.

Safety management of electric and conventional aircraft on the ground is going to be increasingly important. Air traffic controllers also need to understand the different needs and priorities of electric aircraft.

WHAT SKILLS PATHWAYS ARE NEEDED?

UP-SKILLING THE ECOSYSTEM

From the discussion of trends and changes that are coming, the aviation industry needs to address its future talent requirements to develop a workforce with higher level technical skills for jobs that have traditionally been viewed as volume recruitment roles. These roles, including ground-handling operations, will continue to require on-the-job training, but with increasing automation and anticipated robotisation, in line with many other sectors facing similar challenges, future jobs are likely to require a higher level of digital skills. Over time, the reskilling and upskilling requirements may mean that some of the existing workforce is displaced by more highly qualified and highly-skilled digital workforce. There are difficulties in retaining ground handling staff which requires the sector to continually provide training to new staff and any increased need to provide additional or more complex training to meet new role requirements will add further challenge (26).

To maintain current skills in the workforce and to address skills gaps, it is important both for employers to invest in on-the-job training to upskill their existing workforce, and for the industry to formulate and implement plans to work with both public-sector and private-sector training providers to develop and deliver new short-courses. These may be in the form of modular courses, building towards new qualifications, which will require industry input to develop course content.

In time, some of these training providers are likely to become employers for some people working part-time in the aviation industry, as demand increases for specialist knowledge and skills in teaching, tutoring and lecturing.

UPDATING APPRENTICESHIP STANDARDS

We have found a gap in provision of apprenticeship standards available in England, Wales, Scotland and Northern Ireland.

This assessment was made by Connected Places Catapult after consolidating feedback from interviews and workshops, having taken note of the aviation-specific apprenticeship standards currently offered.

Changes need to be made to aviation apprenticeship standards to ensure they are sufficient to develop the knowledge and skills required for future occupations. These should be pre-emptive of the technology advancements rather than reactive to ensure standards are revised or developed before the skills are needed by the industry. Some of the current aviation apprenticeship standards are versatile enough to enable apprentices to work in different roles. However, as new technologies are introduced and lead to changes in aviation roles, it will be necessary for apprenticeship standards to be reviewed and updated to reflect these developments.

For example, updating apprenticeship standards to reflect the anticipated displacement of conventionally fuelled aircraft by new fuel types such as hydrogen and fully-electric aircraft needs to be considered by both the aviation industry and training organisations as a priority. Similarly there are currently no apprenticeship standards available for RPAS functions.

The leading employers in the aviation industry could engage with the Institute for Apprenticeships and Technical Education to carry out a review of existing apprenticeship standards, to identify where revisions to existing standards and creation of new standards are required to ensure that aviation apprenticeship standards are future-proofed in advance of new technologies being introduced. We would suggest that any new apprenticeship standards that are required should have employer trailblazer groups convened by industry at the earliest opportunity as a way to address future skills requirements; this process is very well-established and provides a format for industry partners to collaborate on skills initiatives.

Whilst the process of setting up apprenticeship trailblazer groups of employers can be time-consuming, and has a long lead time from the formation of the employer group to the first cohorts completing their apprenticeships, the outcome should be rewarding, and it provides an opportunity for the industry to both create and then signpost aviation career opportunities in order to develop the potential workforce in order to meet future demand.

We recommend that activity is commenced to review and revise existing aviation apprenticeship standards, so that the inevitable time delay necessitated by developing new standards has less impact on training the potential future workforce.

This approach would both address the skills gap, by using apprenticeship-levy funding to provide a very cost-effective option to upskill the existing workforce , and also meet the challenge of skills shortages as they emerge, where there is a shortfall or mismatch between known workforce supply and future industry demand.

As a long-established formal process for on-the-job training, the development of new apprenticeship standards will be required, through the industry collaborating to form trailblazer groups. This will require planning and coordination to ensure that, for example, a particular aspect of aviation may have a series of apprenticeship standards, showing a clear pathway for career progression, such as a Technician (Level 2), a Supervisor (Level 4) and a Manager (Level 6).

We recommend that employers in the aviation industry collaborate and plan together to form a coherent and well-planned strategy for developing multiple standards concurrently and avoid overlap or duplication, to ensure logical progression between Levels.

To drive the transitions that are envisaged, we recommend that the DfT could facilitate discussion through the Aviation Industry Skills Board (AISB) to promote collaborative activity to support the development of the aviation sector, defining the new standards that will be required and then starting to map apprenticeship duties at specific apprenticeships levels. This should take place with consideration given to the other apprenticeship standards in any given pathway, ensuring that the set of duties for each standard is distinctive and logically differentiated from apprenticeships in the same career pathway. In England, IfATE provides guidance and ongoing support for the development of apprenticeship standards, and we suggest that the Institute should be engaged at the earliest opportunity, to establish a network of apprenticeship trailblazer groups which will be necessary to develop a far more extensive programme of apprenticeships.

It will require main employers in the aviation sector to collaborate and approach the IfATE to request their input. It is recommended that engagement with IfATE should take place as soon as leading aviation industry employers agree that a review of existing apprenticeship standards and the development of new standards are main priorities, noting that a trailblazer group must “be a group of employers recognised by the Institute and reflective of those who employ people in the occupation” (27).

EXPANDING AVIATION FOOTPRINT

There are many aspects to attracting talent, addressing the anticipated skills shortages, the level of awareness of careers specific to the aviation industry, and increasing the skill-level, particularly in digital technologies in functions already experiencing increasing levels of automation; in turn this will require skills in remote diagnostics enabling some future aviation roles to be located outside the airport perimeter, which in theory could be based anywhere; this trend would expand the potential sphere of influence of airports as employers with a more globalised workforce, where aviation systems in multiple airports could be managed from different locations.

There is an opportunity for the aviation sector to substantially increase its geographical footprint as an employer across the UK, which will require a much wider awareness of aviation roles in parts of the country without a traditional aviation workforce, and for FE colleges to increase provision when stimulated by an increasing level of demand resulting from awareness of career opportunities. This will be a substantial challenge for the industry and will require new relationships with FE colleges in parts of the country currently not offering any specific provision for aviation related roles. If pursued, this will need careful management, as the attraction and hiring of technical trainers and tutors will be difficult due to being paid higher salaries in industry and risks further salary inflation in the training providers if competition is stimulated between FE colleges at a local level. There will need to be investment in the resourcing of cross-training those from the aviation sector into teaching.

ATTRACTING TALENT

In common with many industries facing current and future skills shortages, where there is a shortfall or mismatch between known supply and future forecast demand, the future workforce demands will require a range of meaningful long-term inspiration and attraction strategies, targeting school-age students.

Whilst there is ongoing work to inspire the next generation of aviation professionals by groups such as the Aviation Ambassadors, awareness of STEM requirements and careers is a current gap that needs to be addressed by both private sector and public sector organisations which make up the industry. Promoting emerging opportunities in new and anticipated aviation technologies, including the RPAS industry and associated operations is anticipated to be a long-term requirement.

Within this, there needs to be a greater push for Equality, Diversity and Inclusion in STEM, ensuring that careers interventions are developed and deployed to target under-represented groups alongside proven recruitment strategies. To monitor the effectiveness of such interventions, it may be useful to work with organisations to develop ways to assist with the longitudinal tracking of the benefits of such intervention, such as tracking apprenticeship applications from those who have benefitted from STEM workshops at school, or being able to promote opportunities and therefore recruitment activities to reach a wider section of the working-age population across the country.

TRANSFERRING SKILLS

A common issue raised was the poor transferability of aviation skills between different fuels, aircraft and locations. There is a clear need for employers in the aviation industry to collaborate to dynamically equip aviation workers with appropriate skills as situations and technologies change to enhance resilience.

Data science is different to data analytics and is seen as a gap at the moment, not just in aviation, but across all industries. There is a need for more data scientists in general, but then also attracting them to aviation and giving them the aviation specific skills required. Data scientists understand inherent biases in data, so being able to pull out unbiased insights to influence regulations and change will be hugely valuable to the industry.

It will be vital for the aviation industry to look outside the sector, to other industries, to explore the skills transfer potential between sectors or industries; for example, for more data scientists to be attracted to work in the aviation sector. In order for this challenge to be met, it will be important to identify where real or perceived structural barriers may exist, such as differences in levels of remuneration, benefits and working conditions. It is possible therefore, that meeting the need for data scientists could be achieved through them being employed on a consultancy or short-term contract basis, which is likely to be on a project basis, rather than as aviation-specific data scientists.

EMBRACING NEW TRAINING METHODS

Leveraging remote training through Virtual Reality / Augmented Reality / Mixed Reality could enable training in the future. Digital twins have the potential to be used for training, especially in high-risk environments, such as helicopter search and rescue, fire training and others.

As previously mentioned in the Future Aviation Ecosystem section, an area of training linked to aviation needing careful thought and planning involving multiple stakeholders across the public and private sectors, will be how to upskill and train emergency services, including fire-fighters, to effectively and safely manage the potential scenarios where accidents could occur involving alternative fuels, including hydrogen and electric aircraft.

The use of simulators for operator training is already very well established in the aviation sector for pilot training, and elsewhere within the aviation sector, including for ground-based roles, simulating breakdowns requiring remote diagnostics, maintenance and repair of automated ground operations machinery.

This approach could be developed further to enable more people to gain access to training courses involving simulators, with all of the benefits that simulator training in a very safe environment can bring, such as measuring the efficiency data of operators.

According to a university we engaged with, universities are receiving less funding (27) and therefore are not able to invest in infrastructure and experimental apparatus. This means students are lacking hands-on experimental experience and understanding of physical systems, which can lead to professional institutions being unable to accredit courses.

INSIGHTS

The aviation ecosystem is changing and the skills available to the industry need to change to enable aviation to fulfil its potential. This section summarises the insights and recommendation developed through this research and engagement, and that will be taken forward into the action plan.

SUMMARY OF INSIGHTS

There is currently a need for more dispatchers which usually requires aviation experience. This role tends to be hard to recruit for given its specialist nature. It has been suggested as a good course for college apprenticeships to try to get more people into the role.

There is currently a gap in maintenance engineers needed to service and maintain electric aircraft. There is also a gap in the training provision for electric aircraft maintenance staff; currently all training in this area is done abroad which is expensive and a barrier to further staff being trained.

Pathways to the aviation industry are also seen as being inadequate. A dynamic approach, focussing on transferable skills, could result in a more resilient supply of skills to the industry. A wider awareness of the aviation industry as a whole and the opportunities involved is needed to get more people into aviation careers.

The development of technology, specifically the acceleration of automation, artificial intelligence and digital twins, will lead to a new focus on data and engineering skills. This will need to be accommodated by engaging prospective aviation students earlier and integrating STEM further into aviation skills.

The UK needs to make itself attractive for people to invest, ship their cargo through or fly their aircraft here.

Airfields need to be future-proofed, including making them suitable for drones, remotely piloted aircraft, eVTOLs and other new entrants.

Unmanned traffic management has brought a change in how air traffic management is handled. This requires new tools and technologies to be developed, as well as an integration of current airspace and air traffic control.

A roadmap is needed to achieve the end goal of integrated traffic management which will help with planning training.

A more intricate and integrated traffic management approach will be needed which requires lots of work creating the tools needed and the people needed to manage the traffic in an integrated way.

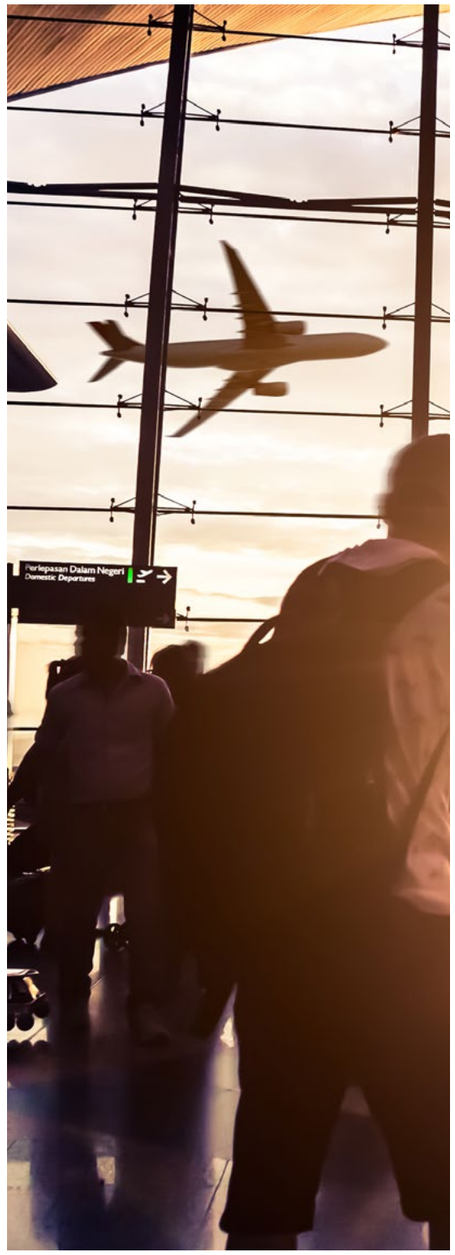
Dynamic upskilling and regulation will be required to enable airports to accommodate a variety of technologies in the future.

Regulation needs to change to be able to take into account new technologies and approaches, including the qualifications of engineers. A review of the regulatory framework to ensure it can enable the necessary transformational change may be appropriate.

There is a crucial need for further upskilling in soft skills such as communication and passenger experience, as these are skills that the advancement of technology is less able to cover.

More digital and engineering skills will be needed for 2050. Other industries or countries may be able to bring the automation, digitalisation and other skills needed into aviation.

Closer working and collaboration between the aviation industry and education providers is needed to ensure that the right skills and training is being provided, especially when it comes to digital skills.



RECOMMENDATIONS

An apprenticeship standard is a description of an occupation. It contains a profile and describes the knowledge, skills and behaviours needed for an apprentice going into that occupation.

We recommend that the aviation apprenticeship standards are reviewed with industry to check for gaps in occupations needed in the current ecosystem. In addition, we recommend that activities are instigated to revise existing and develop new aviation apprenticeship standards so that they meet the needs of the expected change in the sector. There is a role for DfT to convene the relevant stakeholders early to mitigate the risk of a time delay in developing new standards impacting day-to-day operations. We recommend that activity is instigated to revise the existing aviation apprenticeship standards, so that the time delay in developing new standards has less impact in training the potential future workforce.

We recommend that new apprenticeship standards are developed to address the future skills requirements. We recommend that employers in the aviation industry collaborate and plan together to form a coherent and well-planned strategy for developing multiple standards concurrently and avoid overlap or duplication, to ensure logical progression between Levels.

In order to drive the transitions that are envisaged, we recommend that the DfT convenes and facilitates collaboration activity to support the development of the aviation sector, defining the new standards that will be required and then starting to map apprenticeship duties at specific apprenticeships levels.

The table on pages 48 and 49 maps the key challenges for the aviation sector that have been identified in the report to the actions that industry and DfT can take to mitigate the risks arising from them.

"As EUROCAE's Working Group (WG) no. 125 on the Next Generation of Aviation Professionals is gathering momentum, Connected Places Catapult has been instrumental in providing very valuable insight into the subject matter, with its latest report on the future skills needed in aviation, commissioned by the UK's DfT"

DISSEMINATION FEEDBACK

As a part of the dissemination activities of the project, Connected Places Catapult was invited to deliver its outcomes of the findings to the EURO-CAE Working Group WG-125- Next Generation of Aviation Professionals. Next Generation Aviation Professionals (NGAP) Programme is an initiative, which was introduced by ICAO in 2009 to ensure that sufficient qualified and competent aviation professionals would be available to operate, manage, and maintain the future international air transport system. WG-125 was created to support the aviation industry with the expected personnel shortages. Through this WG, EUROCAE aims to engage with members in the aviation industry, universities and students, organisations that work on a similar topic, and act as facilitator in encouraging industry-university collaboration.

Feeback from the Chairman on the working group acted to confirm and consolidate the assumptions that have been raised in this report.

"With two presentations provided to WG125 since January this year, Daniel Cooney and his team have enabled a great opportunity for the group to start debating how to ensure young school-age boys and girls are enticed by what aviation has in stock for them. Likewise, the presentations fostered a discussion on how best to pave the way for sufficient qualified, competent, and motivated aviation professionals to be committed to pursuing an aviation career and operating, managing, and maintaining the future international and revolutionary new air transport system into its next quantum leap."

"The Connected Places Catapult report provides an insight into the trend over the next 30 years, on which existing but also innovative domains in aviatio will be needing certain new skills. In the same manner, the report identifies perceived barriers to aviation careers existing today, as well as the skill gaps detected by aviation stakeholders. The preliminary work done by the WG125 has identified that academia, training, students/apprentices, and the aviation industry worldwide, are grappling with these very questions at present."

"Thanks so much for your great presentation. I reckon it was an excellent way to open the debate. It was very on point regarding the method used to match the skills needed and new jobs already existing (and demanding new work force). And even a useful approach to identify the jobs we might not even know we need."

"There were some great discussions and ideas put across with your presentation. I will see how far we can stretch the group's mandate and include some of the points mentioned"

In addition to this and in support of the reports findings was a recent article by Tech UK titled "Driving The Future Of Transport-Addressing The Skills Gap" that summarises and overlaps a lot of the findings gleaned from our study. The link to this article can be found here;

Driving the future of transport – addressing the skills gap (techuk.org)

AN EMERGING AVIATION CHALLENGE IS...	THE RISKS COULD BE MITIGATED AND OPPORTUNITIES GRASPED THROUGH...	THE ROLE OF INDUSTRY IS TO...	THE ROLE OF DFT IS TO...	IF NOT ADDRESSED, IT COULD LEAD TO...
Aviation is not attracting enough talent	• STEM outreach, more excitement around sector and a focus on diversity and inclusion to get a greater pool of talent at grassroots • Exploit skills transfers from other sectors e.g. data scientists	• Push STEM outreach • Pursue talent from other areas in transferable skills – e.g. data scientists • Adopting a dynamic approach, focussing on transferable skills, could result in a more resilient supply of skills to the industry.	• Continue to promote aviation as well as aerospace as a great sector for jobs and growth, to attract talent further afield from airports • Convene and facilitate collaboration between aviation industry and training providers to ensure that the right skills and training is being provided	Shortage of people in the sector, UK left behind in exploiting transformative trends in aviation.
Aircrafts with new propulsion systems including electric and hydrogen being introduced	• New apprenticeship standards to meet the needs of emerging trends, targeting higher skill levels • Re-skilling maintenance workers to accommodate use of electric and hydrogen vehicles. • Increasing safety training to all staff and wider system actors e.g. firefighters to equip them to deal with new risks	• Update apprenticeship standards to reflect the anticipated displacement of conventionally fuelled aircraft by new fuel types such as hydrogen and fully-electric aircraft • Invest in remote training methods such as augmented reality and simulators to train staff faster and more safely.	• Convene and facilitate collaboration between aviation industry and training providers, accelerating development time to reduce impact on training the potential future workforce	The sector not being equipped with the skills to transition to new propulsion systems. As a result, the UK may fall behind Net Zero targets.
Greater automation of flight and ground operations	• Up-skilling of low-paid manual labour workers in digital and technology areas to avoid job losses • Increasing data and engineering roles	• Offer on the job training programmes in digital skills and IT. • Learn from other sectors also experiencing automation transformation	• Convene and facilitate collaboration between aviation industry and training providers, accelerating development time to reduce impact on training the potential future workforce. • Support digital and IT skills across the population, at schools and general apprenticeships	The UK not being able to make best use of efficiency improvements from greater automation, increasing the cost to the public and UK business of air travel.
Complicated and inefficient airport passenger experience	• A focus on upskilling for soft skills, helping passenger to navigate a more digital experience at airports. • This is especially important in the context of an ageing population where older passengers may not be able to respond to the rate of change in airport systems quickly.	• Incorporate more customer service roles into the passenger experience to improve passenger journey and efficiency	• Convene and facilitate collaboration between industry, accessibility experts and training providers to ensure that the right skills and training and being provided.	Future passengers having a poor experience of UK airports, low efficiency of movements round the airport system and the UK detracting air passengers.

AUTHORS

Daniel Hobbs
daniel.hobbs@cp.catapult.org.uk

Catherine Hosker
catherine.hosker@cp.catapult.org.uk

Mark Warrilow
mark.warrilow@cp.catapult.org.uk

Daniel Cooney
daniel.cooney@cp.catapult.org.uk

Simeon Goodwin
simeon.goodwin@cp.catapult.org.uk

REFERENCES

1. McDaniel, J. W. 1903 Wright Flyer I. Wright Brothers. [Online].
2. Britannica. The Jet Age. [Online]
3. Aerospace Industry. [Online]
4. Aerospace Growth Partnership. Skills. [Online].
5. Civil Aviation Authority. Unmanned Aircraft System Operations in UK Airspace – Policy and Guidance. [Online] 2022.
6. International Civil Aviation Organization (ICAO). Unmanned Aircraft Systems (UAS). [Online]
7. National Air Traffic Services (NATS). Trainee Air Traffic Controllers. [Online]
8. World Aviation Festival. What is holding young people back from joining the aviation industry. [Online]
9. https://public.tableau.com/app/profile/icaodataanalytics/viz/RegionalPersonnelByGenderAnalysis/PersonnelbyGender
10. Aviation Career Hub. Occupational Gender Differences in the Aviation Industry. [Online]
11. Women's Engineering Society. WES Statistics. [Online]
12. Inman, Phillip. More than a third of employees furloughed in some UK towns. [Online] The Guardian, 11 June 2020.
13. Expansion of the Ultra Low Emission Zone https://researchbriefings.files.parliament.uk/documents/CDP-2022-0240/CDP-2022-0240.pdf
14. https://tas.ac.uk/
15. https://digitaltwinhub.co.uk/
16. Gov.uk. What qualification levels mean. [Online]
17. Department for Science, Innovation & Technology. Science & Technology Framework. [Online] 2023.
18. The Club: British Airways. Vertiports: What are they and when can we expect them? [Online] November 2020.
19. Civil Aviation Authority. Airspace Modernisation Strategy. [Online]
20. https://www.ukri.org/what-we-do/our-main-funds-and-areas-of-support/browse-our-areas-of-investment-and-support/future-flight/
21. Connected Places Catapult. Zero Emission Flight Infrastructure 2: Roadmap Update. [Online] March 2023.
22. Office for National Statistics. Voices of our ageing population: Living longer lives. [Online] 2 November 2022.
23. Aerospace Technology Institute. FlyZero Reports. [Online]
24. Connected Places Catapult. Zero Emission Flight Infrastructure 2: Hydrogen Infrastructure Options for Airports. [Online]
25. Options for Addressing the Cost of Pilot Training https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1159822/options-for-addressing-the-cost-of-pilot-training.pdf
26. SUPPORT STUDY FOR THE DEPARTMENT FOR TRANSPORT'S REVIEW OF UK GROUND HANDLING https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1140098/study-for-dft-review-uk-ground-handling.pdf
27. https://www.instituteforapprenticeships.org/developing-new-apprenticeships/trailblazer-group/
28. Adams, Richard. Degrees underfunded by £1,750 per student, Russell Group says. [Online] 5 May 2022.

Visit Connected Places Catapult's website here

Follow us on Twitter
@CPCatapult

Follow us on LinkedIn
Connected Places Catapult

Email us
info@cp.catapult.org.uk

CATAPULT
Connected Places