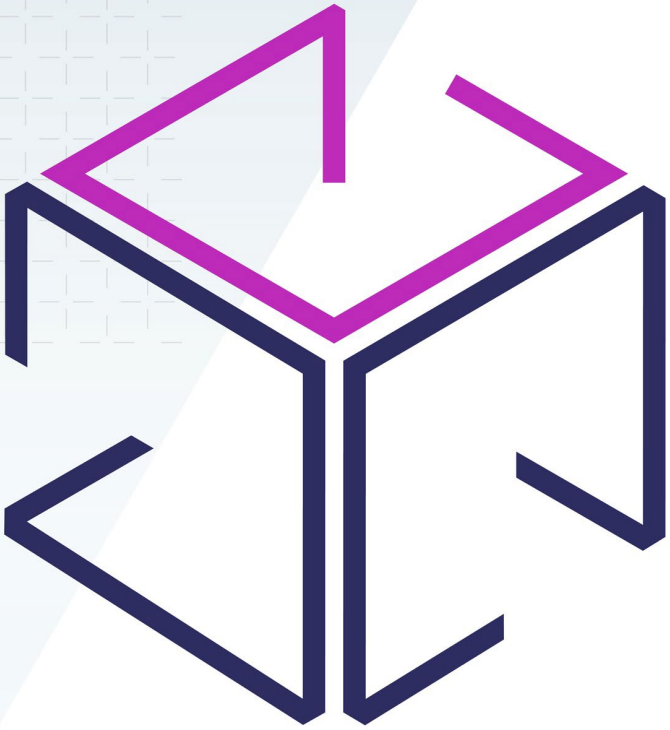
Workforce Foresighting Hub



Satellite Applications – Active Debris Removal

Active Debris Removal including disposal and relocation to parking orbit (as defined in National Space Strategy) focusing on prepared (but including unprepared) spacecraft

A Workforce Foresighting Hub report.

Date: July 2024

UKRI Innovate UK

Right skills, right time, right place

Attributions - The Workforce Foresighting process integrates data from the following international data sets:

IfATE – Institute for Apprenticeships and Technical Education, England

ESCO – European Skills, Competencies, Qualifications & Occupations, EU

ONet – Occupational Networks Online, USA

In accordance with licence and publishing requirements of these organisations for the use of their data sets, the WFH team states that –

The IfATE data used contains public sector information licensed under the Open Government Licence v1.0.

The ESCO data is used in accordance with the EUROPEAN UNION PUBLIC LICENCE v. 1.2 EUPL © the European Union 2007, 2016

*The ONet data used is under CC BY 4.0 license. (O*NET® is a trademark of USDOL/ETA.) The WFH team has modified all or some ONet information. USDOL/ETA has not approved, endorsed, or tested these modifications.*

Any errors, omissions and incorrect data are the responsibility of the WFH team and all queries should be addressed to info@iuk.wf-hub.org

The method and process used in the Workforce Foresighting process is under development and there may be errors and omissions in the data provided.

This report was produced following workshops undertaken February – May 2024 using the data set and tools available at that time.

Contents

0.0 Executive Summary

0.0 Executive Summary

0.1 Foresighting Cycle Summary

The foresighting cycle integrates insights from domain specialists, employers, and educators through structured workshops and data analysis. This process ensures a comprehensive understanding of future workforce requirements in response to technological advancements and strategic priorities.

Key stakeholders for this Foresighting Cycle were identified as:

Companies who are active in the domain (including Astroscale, GMV-NSL, Growbotics, Satellite Applications Catapult and Clearspace), universities researching the area and those delivering courses which currently service the sector (members of the Space Universities Network and Space Academic Network) and government experts (UKSA and CAA).

These stakeholders collectively ensure that the report is comprehensive, integrating perspectives from innovation, education, industry, and policy-making to address the future needs of the Space sector.

Outcomes and Insights

The foresighting cycle aims to understand why and how skills requirements will change to adopt innovative technologies. It helps define future occupations and address short-term skills gaps. The process results in detailed insights that guide stakeholders in preparing programs to deliver the necessary skills.

Recommendations

The foresighting cycle's recommendations include maintaining collaboration among stakeholders, aligning existing skills with new demands, and focusing on skill development to keep up with global sustainability trends and technological advancements.

Overall, the foresighting cycle is a dynamic and data-intensive approach that provides detailed insights and actionable recommendations to prepare the workforce for future challenges and opportunities.

0.2 Organisational change

The organisational insight within the Active Debris Removal Foresighting report highlights the necessary functional changes diverse organisations in the value chain must undertake to align their capabilities with future demands. These changes are driven by the need to address the challenges posed by active debris removal and the transition to advanced technologies and processes.

The foresighting process identifies how these organisations must adapt, providing a comprehensive understanding of the future occupational skill sets required to meet these challenges.

Presented in three parts, the findings of the workshops and analysis, provide key insight into the future organisational and occupational changes required.

Organisational Functions

The report categorises organisational functions into five primary areas, each critical to business operations:

1. Design: Focuses on product, service, or solution design.
2. Implement: Concerns the production or provision of products or services.
3. Logistics: Involves procurement and delivery of materials or services necessary for operations.
4. Support: Relates to in-service support, repair, maintenance, and end-of-life disposal.
5. Enterprise: Covers core organisational functions such as strategic planning, human resources, and regulatory compliance.

These functions are further divided into approximately 40 domains and 140 functional areas, forming a detailed architecture used to position around 25,000 capability statements that underpin the workforce foresight process.

The analysis includes visual representations of the current and future capabilities across these functions, indicating shifts in relative importance.
Key findings include:

- Increased Capabilities: Design and Logistics functions are expected to see an increase in required capabilities.
- Decreased Capabilities: There will be a relative decrease in the capabilities needed for Enterprise, Implementation, and Support functions.

These changes are illustrated through pie charts and domain-level comparisons, highlighting the necessary adaptations within each function to meet future demands.

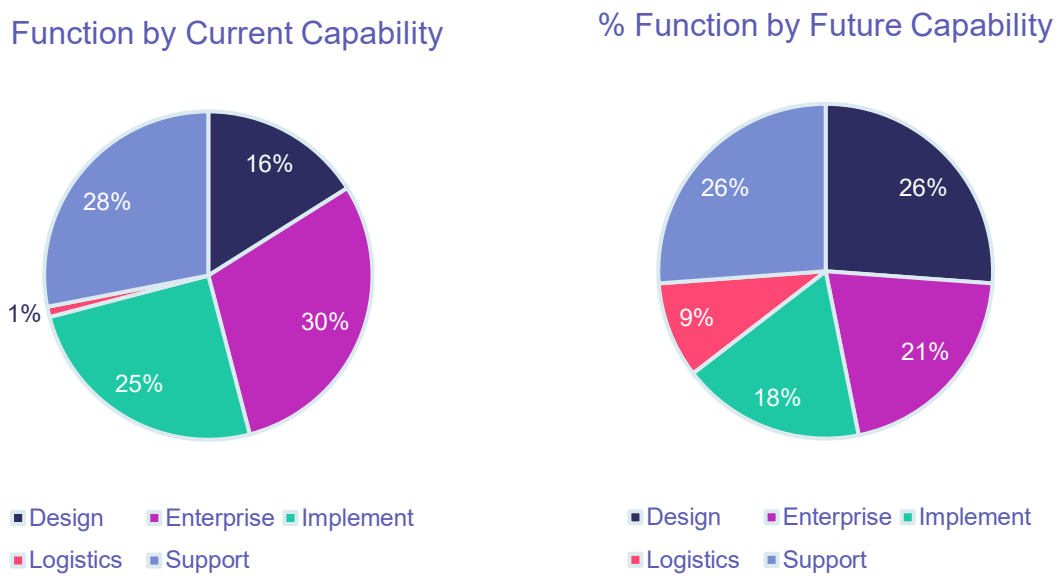


Figure 1: Current and Future Supply Chain - Capability Functions summary by %

Data Architecture and Foresight Process

The report utilises a bespoke 'data-cube' to capture and analyse data through workshops, enabling dynamic updates and detailed foresight. This architecture supports the extensive use of AI tools to parse and analyse content, ensuring the insights remain relevant and up-

to-date. This process is integral to identifying the future supply chain capabilities and ensuring that the foresight outputs are robust and actionable.

By understanding these organisational changes, stakeholders can better prepare for future workforce requirements, ensuring that capabilities are aligned with the evolving demands of the active debris removal sector.

0.3 Future Occupational Profile Highlights

The report outlines future occupational profiles (FOPs) for various role families in the space sector, focusing on Active Debris Removal. These profiles are developed through a combination of expert input and global data, detailing the duties, knowledge, skills, and behaviours (KSBs) required for future occupations.

Key Findings:

- FOP Development: The Workforce Foresighting process has intelligently crafted FOPs for each role family, describing potential future roles and the corresponding KSBs necessary to fulfil these roles.
- Current vs. Future Standards: There is a systematic comparison of current Institute for Apprenticeships and Technical Education (IfATE) standards with future occupational needs. This comparison uses two metrics:
  - Fit: Measures how well existing standards cover the future profiles.
  - Surplus: Indicates the extent of irrelevant material in current standards that is not required for future profiles.
  - Fit and Surplus Analysis: Profiles are categorised based on their fit and surplus scores into a suitability grid, helping identify which current standards are most adaptable for future needs. For example, a high fit and low surplus score suggest that minimal adjustments are needed to meet future requirements.
- Priority Role Families: Specific role families such as Engineering Technicians, Engineers, and Senior Engineers are highlighted, with detailed graphs indicating priority needs across the supply chain to deliver future capabilities.
- Capability Matching: Detailed capability requirements for each role family are mapped against existing training provisions, allowing for targeted adaptations to meet future demands.

Implications and Recommendations:

- Update Existing Standards: Current standards like the Space Engineering Technician (ST0855) and Aerospace Engineer (ST0010) show potential for adaptation to meet future needs, particularly for Active Debris Removal technologies.
- Continuous Professional Development (CPD): Short courses and CPD events should be developed to update skills for incumbent or transitioning workers, aligning with the future profiles.
- Employer and Educator Collaboration: Employers should communicate specific role requirements to educators to ensure targeted training. The report's data and visualisations support this collaboration by providing clear, consistent skills data aligned with future needs.

- Modular Course Updates: Implementing modular changes rather than complete redesigns can facilitate quicker adaptation to evolving skills requirements, ensuring flexibility and responsiveness in educational programs.
- Overall, the FOPs provide a framework for designing future roles and guiding course development, aiming to address skill gaps and ensure a well-prepared workforce for the UK's space sector.

0.4 Specific areas of concern

The "Areas of Concern" section of the Satellite Application Catapult Active Debris Removal Foresighting report highlights several critical issues related to the alignment of current standards with future occupational profiles (FOPs). The analysis focuses on the suitability of the Institute for Apprenticeships and Technical Education (IfATE) standards in addressing the capabilities required for future roles in the active debris removal (ADR) sector. The primary areas of concern identified are:

- Suitability of Current Standards:
  - High Suitability Scores: Some FOPs are well covered by the current IfATE standards. These profiles require minimal adjustments to the existing training standards.
  - Low Suitability Scores: A significant number of FOPs are not adequately supported by the current IfATE standards. These profiles necessitate substantial development as the existing standards cannot meet the identified capabilities.
- Coverage and Gaps:
  - Out of 30 future profiles, only a few have adequate coverage within the current IfATE training standards. The majority either have partial coverage or lack sufficient coverage, indicating the need for new standards or major revisions.
  - Specific roles such as Space Engineering Technicians are better covered compared to roles like Engineer/Graduate/Scientist and Senior Engineer (Chartered)/Senior Scientist.
- Future Occupational Profiles:
  - The data reflects a misalignment between the current training provisions and the future needs of the ADR sector. There is an opportunity to develop new course content and supplementary learning opportunities through apprenticeship programs and continuous professional development (CPD).
- Sector-Specific Concerns:
  - For ADR service providers, roles such as Spacecraft Design Manager, Space Systems Manager, and Space Security Manager lack adequate support from current standards.
- For regulatory bodies, roles like Regulatory and Compliance Officer and Manager also show insufficient coverage, necessitating targeted development to meet future regulatory demands.

In summary, the report emphasizes the urgent need for updating and expanding the current training standards to align with the future occupational requirements of the ADR sector. This alignment is critical to ensure that the workforce is adequately prepared to support the UK's objectives in space exploration and debris removal.

0.5 Recommended actions

Use the Future Occupational Profiles to:

- To address skill gaps, leverage Future Occupational Profiles (FOPs) to update standards and provide CPD courses for current and transitioning workers.
- Advocate for revised standards aligned with future workforce needs.

The majority of the contributors focused on the design and implementation of in-space capabilities, therefore most of the FOPs target this area. We recognise that more input is required from Regulators and the Defence community in order to address the skills gaps that are identified across the whole supply value chain. Failure to address these gaps will risk shortages in skilled workers, hindering the UK's overall space objectives.

The recommendations in this report emphasise the importance of immediate and coordinated efforts by educators, employers, and other stakeholders to address the anticipated skills gap in the space sector as new missions focusing on in-orbit servicing and manufacturing, specifically Active Debris Removal, are developed and launched. The actions are divided into short-term and mid-term strategies to ensure a smooth transition towards the UKs objective to be a global leader in the space economy.

	Topic	Actions	Who	When	Result
Short Term Actions	Reskilling and Upskilling Current Workforce	Tailor course content to match new capabilities with existing occupational standards, focusing on design and other lifecycle activities.	Educators, Awarding Bodies, Employers	Prepare ahead of the scale-up need	Availability of short-term training for the current workforce to meet immediate technology demands.
	Recruitment from Other Industries	Identify and reskill individuals with transferable skills from other sectors, particularly for high-demand roles such as Maintenance and Operations Engineering Technicians.	Employers, Training Providers	Immediate	Mitigation of workforce shortages in high-demand areas through targeted recruitment and training initiatives.
Medium term actions	Integration of Future Skills Training	Formalise changes to occupational standards and training programs for new entrants, integrating future skills	Educators, Awarding Bodies, Employers	As soon as possible for prioritised FOPs	Development of training programs that meet both current and future skills needs, reducing lead time for new

		requirements defined by the Future Occupational Profiles (FOPs).			workforce entrants
	Modular Approach to Course Updates	Implement modular changes to existing courses rather than complete redesigns, facilitating quicker adaptation to evolving skills requirements.	Educators, Training Providers	Ongoing	Flexibility in educational programs, enabling rapid response to industry needs.
General Actions for Educators	Assessment and Feedback	Review Institute for Apprenticeships and Technical Education (IFATE) standards and relevant qualifications with employers, providing feedback and identifying gaps.	Educators, Employers	Ongoing	Comprehensive understanding of current training provisions and identification of areas for improvement.
	Commissioning New Continuing Professional Development (CPD) Courses	Evaluate existing CPD provisions, commission new courses where necessary, and facilitate collaboration to maintain a unified approach.	Educators, Training Providers	Short-term	Enhanced CPD offerings to upskill current workforce members across all role families.
Additional Recommendations	Dissemination of Findings	Set up a working group to create an action plan, share findings widely among stakeholders to influence workforce development initiatives.	Convener, Sponsor, Stakeholders, Industry Groups	Following Publication	Broad access to insights and strategic direction for workforce initiatives

	Ongoing Review and Adaptation	Regularly review findings with stakeholders and adapt Future Occupational Profiles to better fit emerging roles	Stakeholders, Sponsor Leads, Participants	Before Formal Publication	Robust and validated actions.

By addressing these recommended actions, the report aims to ensure that the UK's space sector is equipped with a skilled workforce, capable of meeting the demands of new missions, particularly in Active Debris Removal. These strategies involve immediate and coordinated efforts from educators, employers, and other stakeholders to bridge the anticipated skills gap and support the country's ambitions to be a global leader in the space economy.

Table of abbreviated recommendations leading to action:

A/B Review and Dissemination of Findings	Convener and Sponsor to set up working group to take the findings and recommendation and create an action plan and advance through the Skills Value Chain to cause action. It is essential to share the findings widely among stakeholders, industry groups, and local skills bodies. This will promote access to the insights gained and influence the strategic direction of workforce development initiatives.
C Short-term action	As part of the working group, educators and employers should collaborate to deliver timely short-term training solutions for the current workforce. This is to cause action regarding developing short term training solutions for the future workforce. This includes developing and offering Continuing Professional Development (CPD) courses that address immediate skills gaps and ensure workers are equipped with the necessary competencies.
D Mid-term actions	The ongoing working group mid-term action planning should include a concerted effort to integrate new skills and knowledge into existing training programs. Educators and employers need to update curricula and training standards to reflect the evolving demands of the space sector, ensuring that both current employees and new entrants are adequately prepared.
E. General action for Educators to support Employers' demand for future skills	Employers and educators must work together to review and influence the update of IfATE standards and relevant qualifications. This involves using the insights from the Foresighting process to inform the development of new standards and qualifications that align with future workforce needs. This will contribute to the working group skills framework.
F Further foresighting subjects	The working group should seek additional sponsors and propose further subjects for Foresighting. This continuous cycle of Foresighting will help to stay ahead of emerging trends and technologies, ensuring the workforce remains adaptable and prepared.
G Lesson Learnt	The Workforce Foresighting Hub should promote the value gained from participation in workshops. Sharing lessons learned will help to refine the Foresighting process and enhance the quality of future outputs
H Recommendations to Workforce Foresighting Steering Board	Through engagement with the working group, the Workforce Foresighting Steering Board should encourage and enable collaborative solution development by maintaining a focus on both current needs and future requirements. The steering board should facilitate ongoing dialogue among stakeholders to ensure that the actions taken are dynamic and responsive to changing industry landscapes.

By implementing these recommended next steps, stakeholders can ensure that the space sector is supported by a skilled and adaptable workforce, capable of meeting the challenges and opportunities of a rapidly evolving industry.

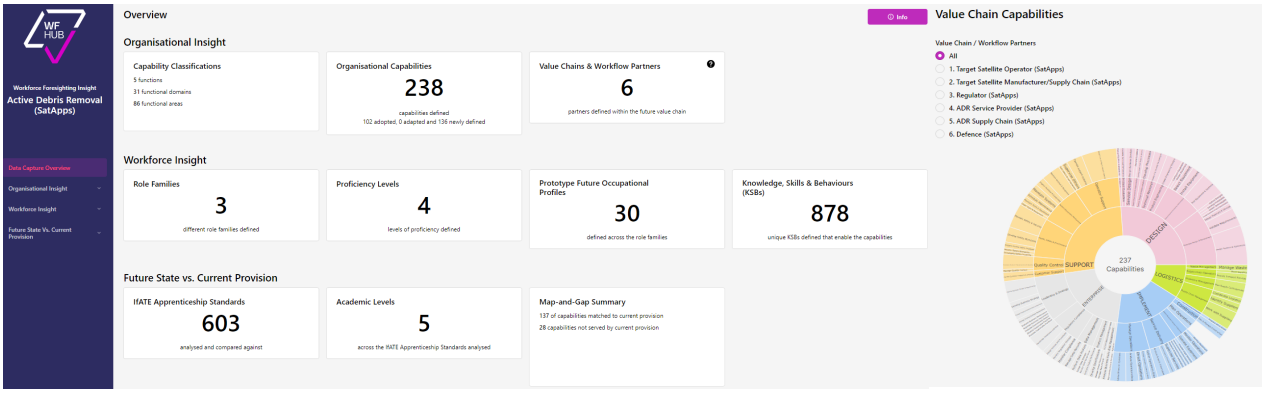
0.6 Introducing the Visualisation Tool

The Visualisation tool provides all of the data captured through the Foresighting Cycle. It brings together the work from the technologists / domain specialists, employers and educators into one space.

Using the data in the Visualisation Tool, employers and educators can understand changes to capabilities within organisations, the potential occupational differences as well as the detailed skills, knowledge and behaviours.

The data also supports the development of future curriculum and course content, as determined by the action plan.

Detailed instructions can be found in the appendix.



1.0 The Mission – Providing foresight for future change

1.0 The Mission – Providing foresight for future change

1.1 Addressing future workforce challenges

The global marketplace is changing at a rapid pace and the continued development of innovative technologies is creating opportunities for growth in all sectors.

Whilst we are well placed to take advantage in the UK, the Government and industry have identified that we need a workforce able to adapt to new capabilities that require different and often higher skill sets. The 'Manufacturing the Future Workforce' report, published in 2020, states: "Failure to address the workforce development challenge will mean missing out on opportunities to build the UK's manufacturing base and to take market leading positions."

Developing this workforce and preventing a skills shortfall will provide future-thinking organisations with the capabilities to successfully adopt innovation and enable the UK to build a prosperous economy.

1.2 The Skills Value Chain

A Skills Value Chain (SVC) approach promotes connectivity between upstream UK innovation and downstream skills systems, as well as enabling better co-operation within education and training provider eco-systems. It aligns and integrates innovation and skills strategies with a common purpose.

The SVC approach was proposed in the 'Manufacturing the Future Workforce' report, which examined global best practice and convened UK pioneers to explore how the UK can develop skills to exploit innovative technologies.
And it starts with workforce foresighting.

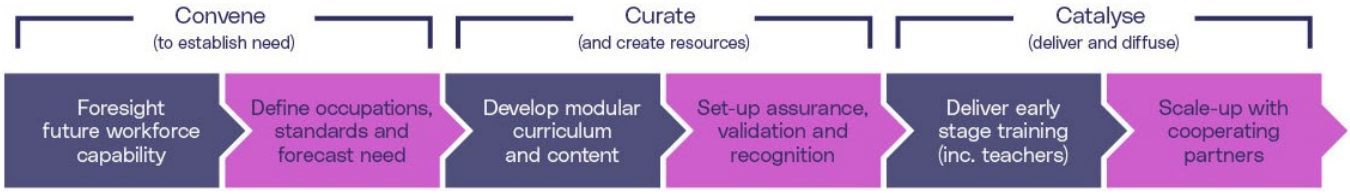


Figure 1: The Skills Value Chain

1.3 Workforce foresighting

Using the Skills Value Chain approach, the UK will start building the skilled workforce required by tomorrow's industries and employers, and understanding what these future needs will be is where workforce Foresighting comes in.

Workforce Foresighting is a systemic approach to identifying the organisational capabilities and workforce skills necessary to enable industry to adopt and exploit innovative technologies which respond to global, national and sector challenges.

The Workforce Foresighting Hub, initiated and funded by Innovate UK, and built in collaboration with the Catapult Network, provides the processes and data that inform insight and support the recommendations required for industry, policymakers and educators to respond to continuing change.

Our Vision: To foster the organisational capabilities and workforce skills required to adapt to continuing change and enable adoption of innovative technologies to enable a prosperous UK industry.

Our Mission: To provide the process, insight and recommendations required to identify and address future skills demands to enable the UK to adopt innovation and succeed in the dynamic global marketplace.

Our Goals:

Define future capabilities required across a sector in response to a challenge, or technology innovation and consequently define the skill sets of the workforce of the future.

Understand and explain gaps between technology adoption, organisational capability and workforce profiles that could hamper innovation.

Identify and communicate insights, future requirements and the action required by industry and educators.

Enable and deliver a consistent approach to workforce Foresighting.

Outcomes:

The process integrates insight from experts in three categories – domain specialists/technologists, employers, and educators. Using a structured and facilitated series of collaborative information-gathering workshops, combined with data from open-source global data sets, the workforce Foresighting process can produce a wealth of detailed quantitative data to inform action.

At the heart of the Foresighting process are working groups consisting of the industry sponsor and centre of innovation, with support from the Workforce Foresighting Hub team, who undertake detailed analysis to report and summarise key data insights and recommendations for action. This report details future supply chain capabilities, prototype future occupational profiles and identifies changes required to current training provision for the sponsor to take forward and address skills challenges relating to the specific topic.

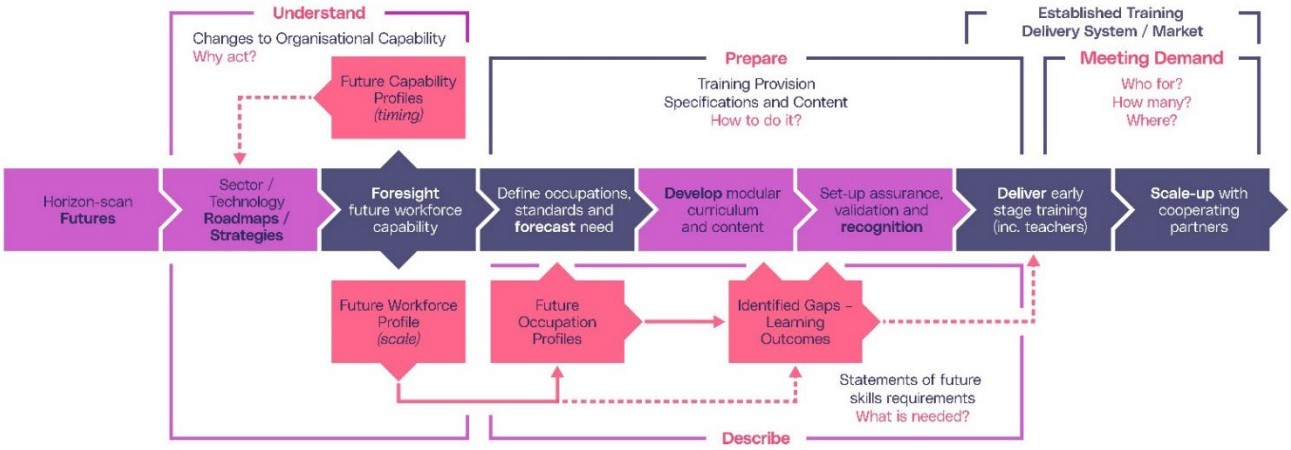


Figure 2: Workforce Foresighting & Skills Value Chain

1.4 Approach used - principles and implementation

The core of workforce Foresighting is convening three groups of relevant specialists to conduct structured, Delphi-style, facilitated workshops to capture and discuss the set of organisational capabilities that will be required to respond to and exploit technology innovation. Lists of workshop participants are provided in Section 5.1

Organisational capabilities are captured using a bespoke classification that has been developed by the Workforce Foresighting Hub. The classification uses a structured common language to enable cross sector and cross-centre collaboration and integration of data. Additionally, the classification enables data from a number of other national and international open-source workforce datasets to be integrated through the same common language. This data is held in a cloud based "data-cube" that is dynamically growing as each workforce Foresighting cycle adds to the shared data relating to future workforce capabilities.

Using cutting edge AI and Large Language Model data tools, the data-cube is used to undertake detailed analysis to 'map' future workforce capability requirements against the current education and training provision to identify where existing provision can be used and where new provision, CPD or qualifications are required.

As an agile development project, the WFH team are constantly evolving and improving the detailed workshop process and workshop approach, but essentially always consists of the following stages:

Considering – Clarifying the Challenge to be met (the 'what' and the 'when') and collating solutions (the 'how') as Foresighting topic suggestions align with strategic priorities
Identifying – Gain clarity and consensus about the solutions to be put forward – make the case for Foresighting
Preparing – The convening of specialists and scheduling of workshops
Carrying out – Run Foresighting workshops with experts, collate and analyse data
Communicating – Insights, findings and recommendations gathered from all research in an actionable report
Causing action – The driving of action based on the recommendations (promoting progress down the rest of the skills value chain) built on the findings and recommendations of Foresighting

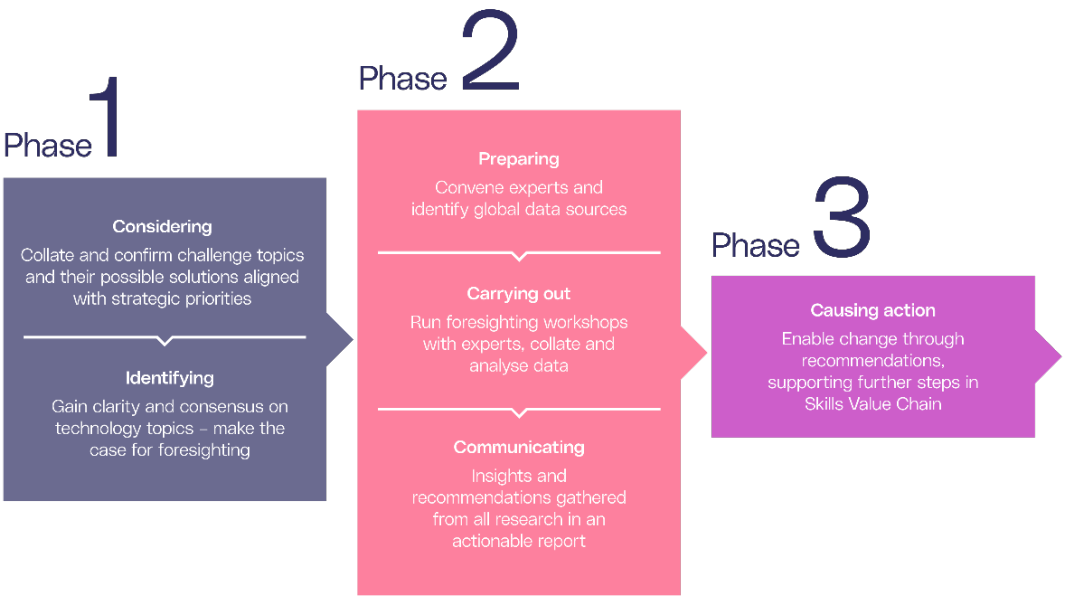


Figure 3 - The workforce foresighting process

1.5 Forecasting and Foresighting

The result of workforce Foresighting is understanding why skills requirements will need to change to enable the adoption of innovative technologies, and to define what this change is likely to be in terms of future occupations and shorter-term skills gaps. Forecasting of demand can then take these future focused findings and work with industry and government stakeholders to estimate the quantity of workers necessary for an industry to fulfill emerging skill demands at a given time and place. The two approaches are linked in that workforce Foresighting identifies the requirements and forecasting can then determine the quantity needed, the people needing the skills and therefore prepare programmes to deliver them.

1.6 Outcomes - insights and recommendations

Workforce Foresighting is a data intensive approach that can provide sponsors, stakeholders and participants with detailed insight about future workforce requirements. A dynamic data set is provided for each cycle to allow all stakeholders and participants to freely access and interrogate the data. Additionally, the WFH team will support the production of a report that provides targeted recommendations that require action to address gaps in training and education provision relevant to the challenge and planned technology solution.

The dynamic data portal provides a range of standard data sets and visualisations. Additionally, users can download data to undertake their own more detailed interrogation of data to guide and inform subsequent actions.

The key aspect is to provide insight about gaps – which capabilities required in the future are NOT addressed by aspects of current provision – apprenticeship standards, qualifications or other provision. Gaps represent:

- **Short term CPD** – topics required across the workforce to upskill members of current workforce
- **Medium term** – topics to be included as current provision / standards are reviewed and updated
- **Longer term** – new qualifications and standards that may be needed to equip new entrants

The insight produced by a workforce Foresighting cycle (project) provides:

- **Technologists** and technical leads with insight of the organisational capability sets required across future supply chain partners in response to the identified challenge.
- **Employers** with insight about possible future roles and occupations that may be required across the whole workforce, operators to researchers, to ensure they are equipped and ready.
- **Educators** with details of the gaps to be addressed by short-course training to upskill the existing workforce and also insight about qualifications and provision that will be required to support new entrants in the future.

2.0 Aligning the Challenge and Solutions with national priorities

2.0 Aligning the Challenge and Solutions with national priorities

Section	Title
2.1	Positioning and context of challenges
2.2	Potential and prioritised technology solutions to the challenge
2.3	Workforce foresighting for chosen prioritised technology solution
2.4	Current and predicted scale of technology deployment in UK
2.5	Key Stakeholders in industry and government
2.6	Sponsors, convenors, and participating organisations
2.7	Background information and references

2.1 Positioning and context of national challenge

The UK space sector is poised at a pivotal juncture where national strategy and industry capability must align to address the multifaceted challenges presented by increasing space activities. The National Space Strategy outlines ambitious goals for the UK to become a global leader in space technology, emphasizing sustainability, innovation, and collaboration.

Key components of this strategy include:

- **National Space Strategy in Action**: A framework that sets the stage for the UK to harness the benefits of space for its economy, security, and global standing. This strategy calls for the development of new space capabilities, fostering international partnerships, and ensuring sustainable use of space.
- **Defence Space Strategy**: This document focuses on operationalising the space domain for defence purposes, highlighting the importance of space situational awareness, resilience, and the protection of space assets.

The anticipated timelines for these workforce requirements align with the strategic missions, with key milestones set for 2025 and 2026.

By focusing on these strategic areas and investing in the necessary technology and workforce, the UK aims to secure its position as a global leader in space operations. The collaboration between industry and government will be crucial in achieving these objectives, ensuring that the UK can meet the challenges and leverage the opportunities in the rapidly evolving space sector.

2.2 Potential and prioritised technology solutions to the challenge

To meet these strategic goals, the UK must focus on specific technological advancements and capabilities. The following are prioritised technologies that address critical challenges within the space sector:

1. **Rendezvous and Proximity Operations (RPO)**: Essential for active debris removal and satellite servicing missions, this technology enables spacecraft to safely approach and interact with other objects in orbit with high precision.
2. **Space Situational Awareness (SSA)**: Involves monitoring, tracking, and managing space traffic to prevent collisions and manage space debris. This includes the development of sophisticated surveillance and tracking systems.
3. **Spacecraft and System Design**: Advanced design techniques for spacecraft that ensure they are not only capable of handling the rigours of space missions but including end-of-life disposal and debris mitigation measures.

2.3 Workforce Foresighting for chosen prioritised technology solution

To support these technological solutions, a robust and skilled workforce is essential. The Foresighting process involves:

- **Identifying Future Skills Needs**: Engaging with industry stakeholders to pinpoint the skills required for developing and sustaining the prioritised technologies. This includes advanced engineering, systems integration, and data analytics.
- **Training and Education Initiatives**: Collaborating with educational institutions and industry partners to develop training programs and apprenticeships that align with the identified skills needs.

2.4 Current and predicted scale of technology deployment in UK

The deployment of these technologies is expected to scale significantly over the next decade. Key projections include:

- **Active Debris Removal Missions**: Launching initial missions by 2026, scaling up operations as technologies mature and regulatory frameworks are established.
- **Expansion of SSA Capabilities**: Gradually increasing the number of ground-based and space-based sensors to enhance tracking and monitoring capabilities.

2.5 Key Stakeholders in industry and government

A collaborative approach involving key stakeholders is crucial for the success of the UK's space initiatives. Key stakeholders include:

- **Innovate UK**: Driving innovation through funding and support for R&D projects.
- **UK Space Agency**: Providing strategic direction and oversight for national space activities.
- **Ministry of Defence (MoD)**: Ensuring that space capabilities align with national security objectives.
- **Private Sector Companies**: Engaging with firms like Astroscale and others that are leading technological advancements in space.
- **Civil Aviation Authority (CAA)**: Providing regulatory framework within which all UK operations must comply.

2.6 Sponsors, convenors, and participating organisations

Active collaboration among sponsors, convenors, and participating organisations is fundamental to achieving strategic objectives:

- **Astroscale**: A leading company in active debris removal and satellite servicing, playing a critical role in advancing RPO technologies.

- **Growbotics**: A young and innovative company, focussing on serviceability-by-design, delivering strategic thought leadership and technology and process innovation.
- **Satellite Applications Catapult**: Acting as a central hub for innovation and collaboration, facilitating discussions and initiatives across the industry.

2.7 Background information and references

Key references that provide the foundation for the strategies and plans outlined include:

- **National Space Strategy.** Link
- **National Space Strategy in Action**: Link
- **Defence Space Strategy: Operationalising the Space Domain**: Link
- **UK Space In-Orbit Servicing and Manufacturing Priorities Paper**: Link.
- **UK In-Orbit Servicing Capability – A Platform for Growth**: Link.

These documents collectively guide the strategic direction and operational frameworks necessary to advance the UK's position in the global space sector.

3.0 Results – Findings, Data and Insight

3.0 Results – Findings, Data and Insight

3.1 Findings, methodology and presentation

This section describes the future organisational capabilities that will be required to meet the Challenge using the proposed Solution (technology) and which occupations are likely to change to deliver these capabilities.

Summary information is provided with a narrative based on the underlying data which is also provided using bespoke visualisations to enable greater insight and access to detail. This section of the report is aligned to the needs of those responsible for workforce planning – employers, educators, and skills providers.

The two parts interpret the data findings and contain links to the relevant visualisation elements.

Actions necessary to meet the skills and training requirements for the changed occupations are considered in Section 4 with recommendations to be considered by the Foresighting Sponsor, Convenor, and others on behalf of the stakeholder and participant groups.

Organisational changes

Providing insight into Organisational Changes – this indicates how organisations will need to adapt their current capabilities in order to implement the Solutions that respond to the Challenge addressed by this Foresighting project.

Typically, this will also require the adoption of new capabilities and a change in the distribution of these capabilities across value chain partners. This change in capabilities within an organisation as well as their value chain partners will determine knowledge and skill changes required by the role groups within the workforce of each supply chain partner.

Occupational changes

A set of 'Future Occupational Profiles' (FOPs) is produced by the foresight process that demonstrate how current occupations may need to change in the future. FOPs are generated using a combination of attributes from the underlying capability classification and from data collected in the workshops.

The capabilities in the Foresighting data-cube are an integration of Onet, ESCO & IfATE. The Foresighting cycles use/adapt which ever statement best expresses the required capability. As these other frameworks evolve, reflecting new technologies that are developed and deployed, ONet and ESCO libraries will evolve and so the data-cube will also evolve as we absorb these changes on a periodic basis.

- ONet – is a US data framework that describes occupations and breaks them down into activities and tasks.
- ESCO – is an EU data framework that focuses more on knowledge and skills related to occupations.

The FOP generation algorithm works to group capabilities into logical sets reflecting role families, function, proficiency and capability similarity. As part of the foresight process the generated FOPS are reviewed, revised and distilled by the Employer group. This agreed set

of FOPs are then compared with selected current education provision; the default reference is the set of Institute for Apprenticeships and Technical Education (IfATE) occupational standards; to assess which current training and education provision could be used in the future. Two bespoke metrics, match and surplus are used to evaluate the alignment of current provision with the set of FOPs proposed. Summaries are presented of the key findings related to each supply chain partner.

Findings are aimed at both Employers and Education and Training Providers and identify matches and gaps in future training needs compared with current apprenticeship provision to guide further detailed investigation. These findings will also provide evidence for university course and module development.

Recommended actions for future provision

The outputs from Workforce Foresighting identify recommended changes to education and training provision – principally occupational standards that will deliver the knowledge, skills and behaviours required by future occupations. In some cases, this will include the development of short courses and continued professional development (CPD) to upskill the current workforce to meet future needs. Additionally, Foresighting outputs can be used to develop programmes, qualifications, and occupational standards for new entrants to the workforce joining via apprenticeship, taught qualification, or other training programmes. The insight and data in this part of the report are primarily aimed at educators training providers, occupational standards bodies and awarding organisations. Combined with insight arising from the supply chain capability changes, the provision insight offers an effective way for employers to identify training opportunities that align to their future needs.

Method

The Workforce Foresighting process uses a series of structured workshops and surveys to capture and summarise input from relevant sector experts – covering technology, workforce development and education. At a number of points in the workshop and analysis sequence the foresighting process utilises large language models (LLM) and artificial intelligence (AI) tools to parse and assist in the analysis of the content generated by workshop participants. For example, the AI model can compare capability statements with existing occupational standards more thoroughly and rapidly than human comparison. All AI derived outputs are reviewed and validated by the participant groups through the workshops and the integral quality assurance reviews of the foresight process.

3.2 Insight into organisational changes

Organisational insight indicates how diverse types of organisations in the value chain will need to make functional changes to align their future capabilities to those required to respond to the Challenge being addressed. This provides useful insight for these organisations and in turn, provides a data rich and well-founded basis to understand how future occupations and their skillsets may need to change to meet that challenge. This is developed in section 3.3 of this report.

Organisation functions

The Workforce Foresighting process uses an information architecture built on five functional areas which are common to any business:

Design	The function of an organisation that focuses on activities relating to product, service, or solution design.
Implement	The function of an organisation that focuses on activities relating to producing / making / providing its products or services.
Logistics	The function of an organisation that focuses on activities relating to procurement, delivery, materials, or services necessary for operations – service / manufacturing, etc.
Support	The function of an organisation that focuses on activities relating to users, in-service support, repair / maintenance, recycling, end of life disposal.
Enterprise	Core functions of an organisation - e.g., strategic planning, leadership and management, human resources. Digital backbone and data systems. Integration of relevant statutory / regulatory requirements and compliance.

This functional structure is developed to levels of detail that enable the foresight process to reference external data sets including ONET (US) Occupational Information Network [1], ESCO – European Skills, Competences, Qualifications and Occupations[2], IfATE – (UK) Institute for Apprenticeships and Technical Education[3] .

The five root functions comprise ~ 40 Domains which are broken down to ~ 140 Functional Areas. This architecture is used to position ~ 25,000 capability statements which are the building blocks used in the workforce foresight process. Each capability statement has several attributes. Some are static and reflect the position of the capability statement in the architecture, others are dynamic and are assigned values through a cycle and set of workshops.

The data-architecture is implemented in a bespoke ‘data-cube’ which underpins the foresight process, workshops, and enables extensive use of LLM and AI tools. Additionally, a key feature of the data-cube is that the data from each foresight topic cycle is added into the data set and can then be used, where relevant, in future cycles. This ensures that the capabilities of the system are dynamic and up to date.

[1] ONET - Occupational Information Network - https://www.onetcenter.org/
[2] ESCO - European Skills, Competences, Qualifications and Occupations - https://esco.ec.europa.eu/en
[3] IfATE – Institute for Apprenticeships and Technical Education - https://www.instituteforapprenticeships.org/

Identifying the Future Supply Chain Capabilities.

The following charts and graphs summarise the changes in the set of capabilities that will be required by the supply chain in the future. The pie-charts reflect the distribution of capabilities across the five functions. The future state data is captured in three Technologists workshops and the current state data is generated using information collected about current occupational standards used across the existing supply chain. This latter information is not as detailed as that produced by the workshops and is indicative and used to provide a point of comparison.

These initial pie charts illustrate the changing proportions of the five functions between the current and future. This indicates an overall relative:

- increase in capabilities for Design and Logistics
- decrease in capabilities Enterprise, Implementation and Support

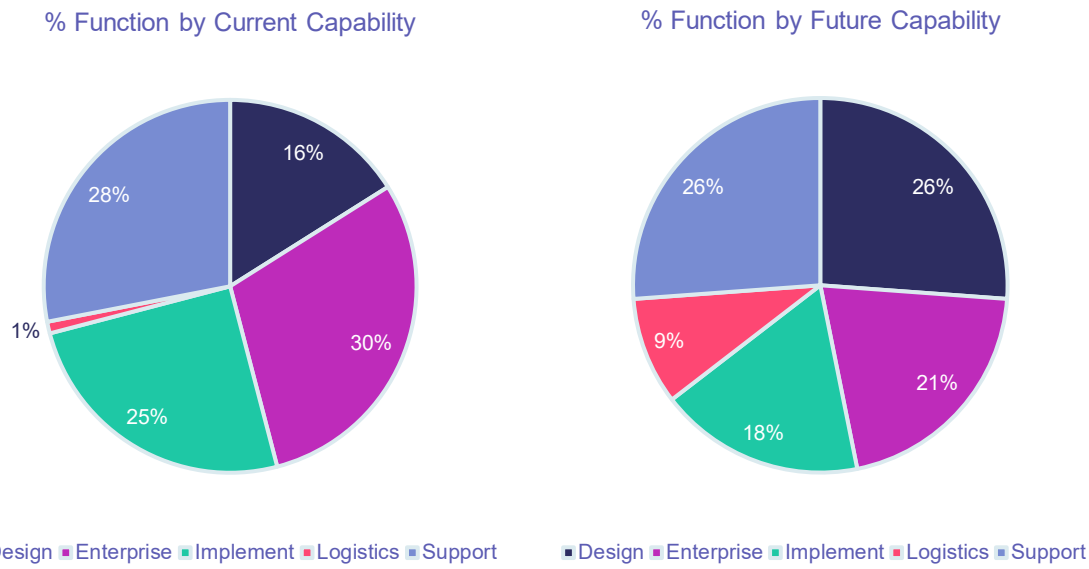


Figure 2: Current and Future Supply Chain - Capability Functions summary by %

This information is useful to indicate relative changes, but the underlying change will be a result of future scale as well as how functions change relative to each other. To gain more detailed insight, these overall comparisons of functional areas are analysed using the current and future capability counts within each function using the next level of classification architecture – Functional Domain.

The graphs show the change in capabilities at domain level within each of the five main Functions. The domain data is ranked with greatest change at the top of the list. These graphs provide insight into both the relative importance of each domain and scale of the changes that will be required from the current state.

The charts utilised below highlight the domain changes across different cycles, and therefore will have some variability across different sectors, and empty rows due to the nature of the data.

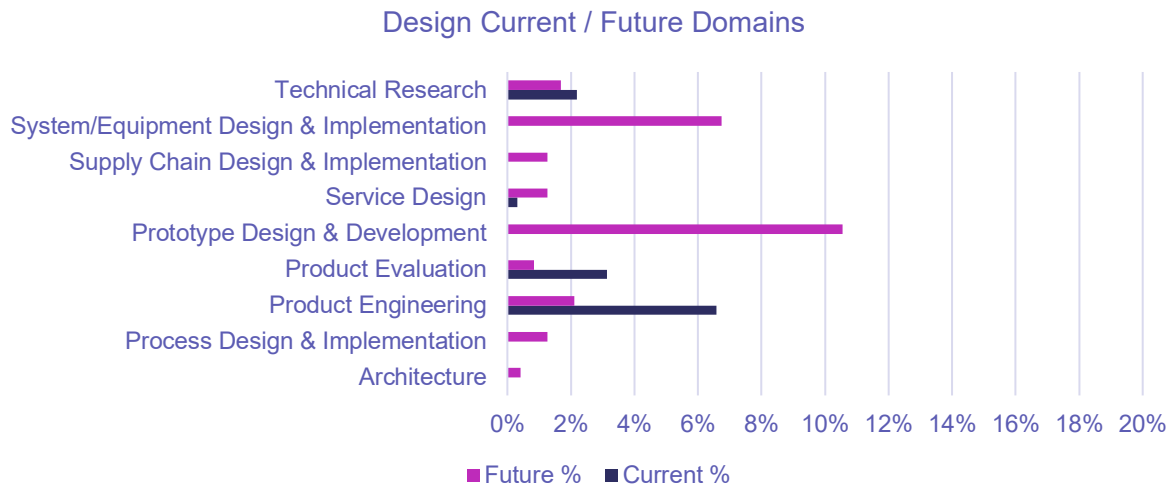


Figure 3: Design Function - Current to Future - Domain changes

The current / future comparison for Design reflects the foresighted transition to an increase in new products, engineering and evaluation ahead of the development and implementation phase.

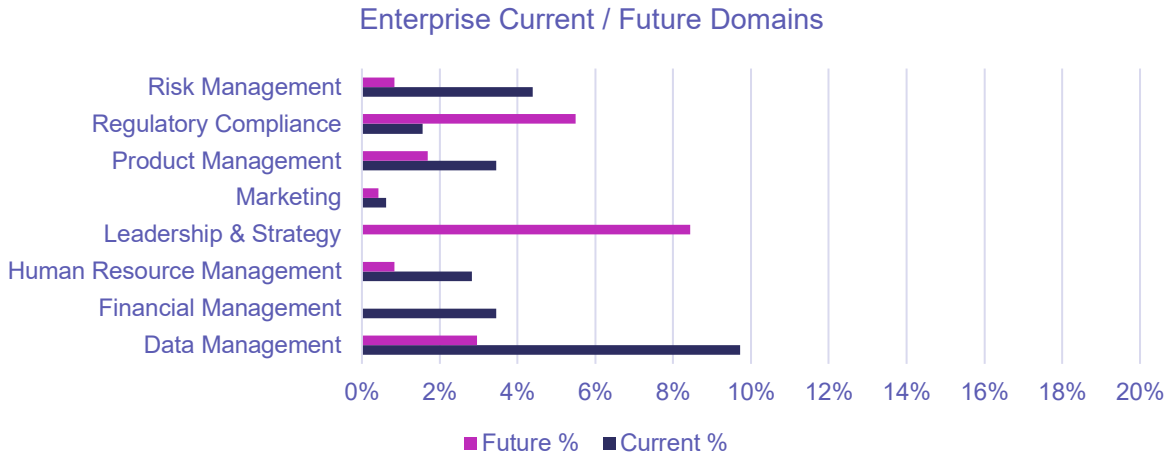


Figure 4: Enterprise Function - Current to Future - Domain changes

The current / future comparisons in the Enterprise area show the increased need associated with a maturing and competitive regulated market and the need to increase human resources.

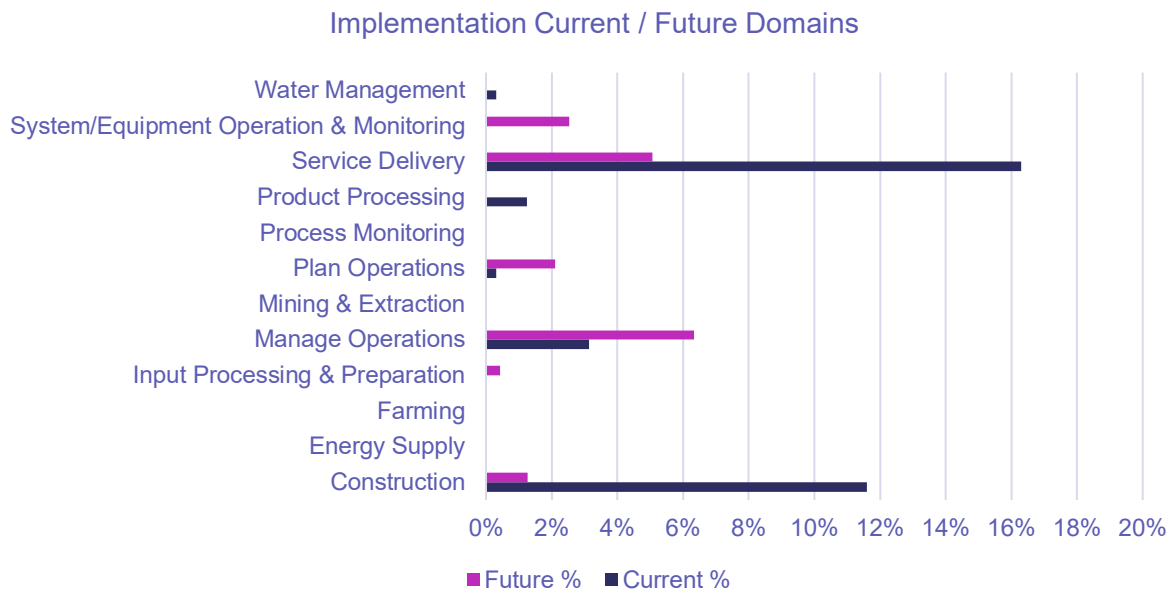


Figure 5: Implement Function - Current to Future - Domain changes

The current / future comparison of implementation functions reflects the changes associated with greater adoption and product sales volume.

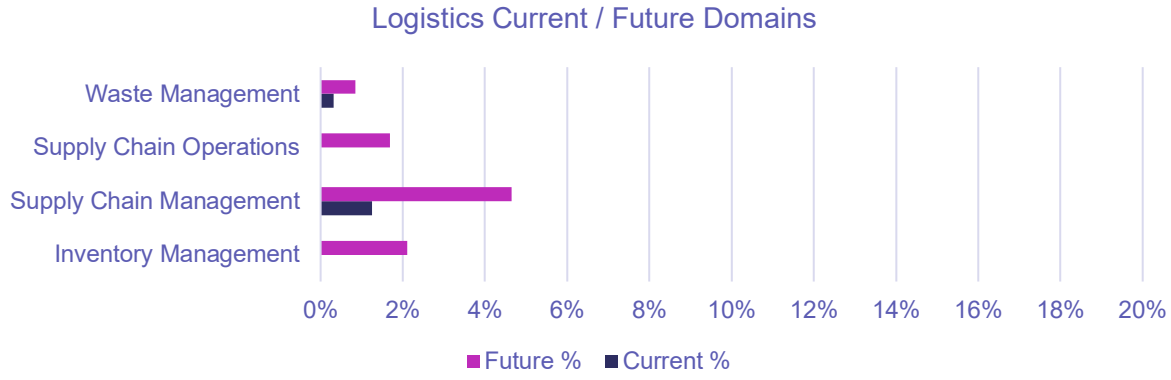


Figure 6: Logistics Function - Current to Future - Domain changes

The current and future comparison for logistics is as expected for organisations gearing up to work at a higher scale of production.

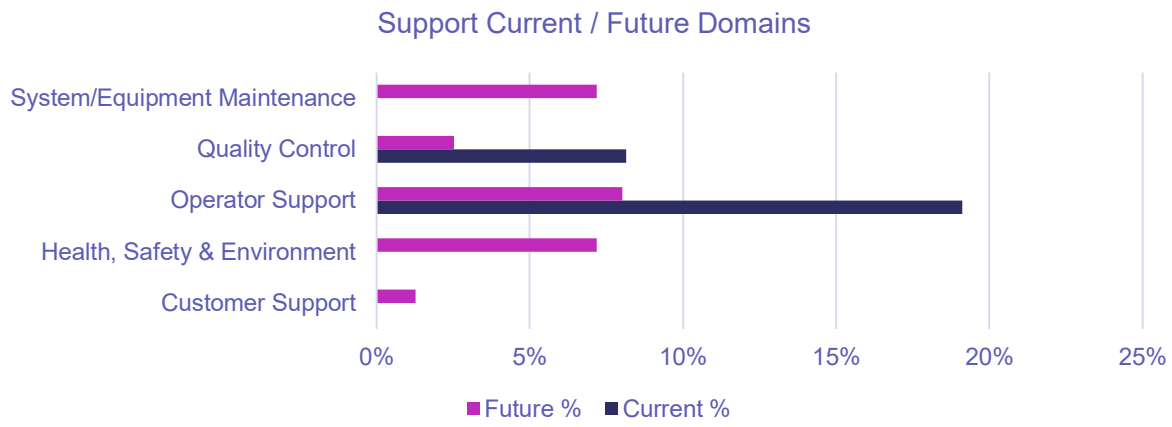


Figure 7: Support Function - Current to Future - Domain changes

The current and future support comparison reflects the current prominent levels of Health and Safety – the concept that these levels are reducing may be due to omissions during the data gathering and analysis.

From the Space sector perspective, the definition of the support function may differ from other Foresighting cycles in different sectors.

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
Organisational Capabilities	Generally, the data presented here can provide an indication of how well served the sector is. This page provides a high-level summary of each capability statement generated in the cycle. The capability statement describes the depth and nature of each capability within an Organisation against a defined reference. The page also provides a way of reviewing the capabilities through the lens of the Capability Classification Framework (Design/ Implement/ Logistics/ Support/ Enterprise). This information can be used to provide insight about the types of capabilities and their distribution across the classification framework. This can be used to identify which capabilities may be supported by existing provision, and where there may be gaps that require new development to support.

3.3 Occupational change insight

This insight into occupational change uses the understanding of how capabilities will change across business functions to inform proposals for how occupations and their associated skills sets for each value chain partner may need be revised to reflect change for each role family within that Partner.

Supply chain partner organisation types

The workforce foresighting process recognises that different partners in a supply chain will require appropriate capabilities and these are determined and agreed in the initial workshops.

In this cycle, the following Supply Chain Partners were identified and then used during participant workshops and data analysis to determine the organisational needs:

1. Target Satellite Operator
2. Target Satellite Manufacturer / Supply Chain
3. Regulator
4. ADR Service Provider
5. ADR Supply Chain
6. Defence

This categorisation enables the analysis and reporting of the major areas of occupational change by business function for each partner, recognising that each will have distinctive characteristics and requirements.

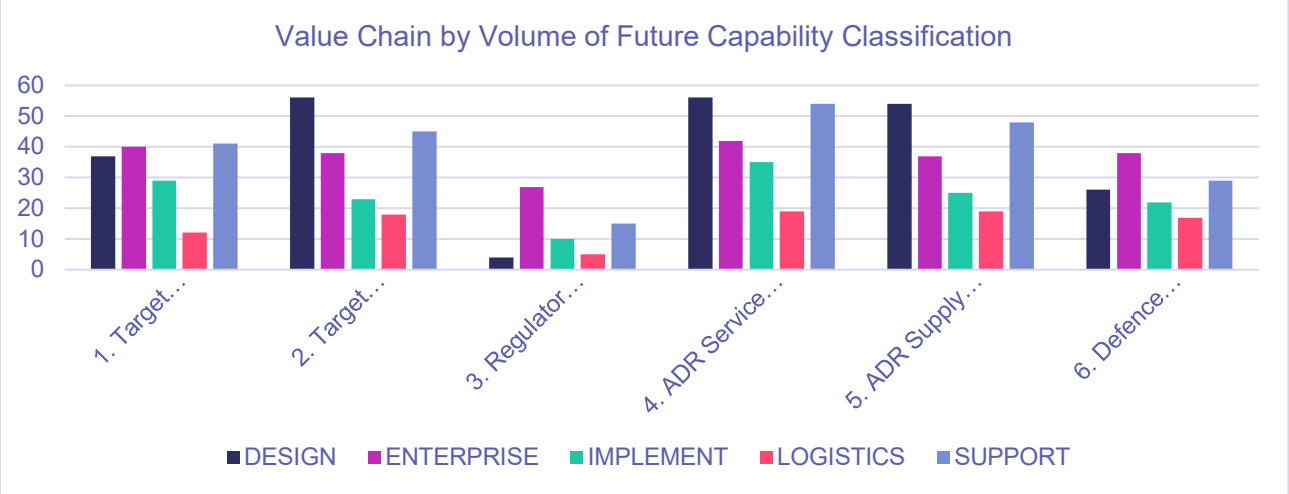


Figure 8: Value Chain by Volume of Future Capability Classification

This graph illustrates the distribution of capabilities by function across the Value Chain Partners. These capability sets are used to form the set of Future Occupational Profiles within each Role Family.

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
Value Chain Capabilities	This page provides an overview of the identified capabilities at a Supply Chain / Workflow Partner level. By selecting/deselecting each Supply Chain / Workflow Partner you can review the capabilities identified as required in that area of the Supply Chain / Workflow.

	This can be used to generate organisational capability profiles for each area of the workflow /supply chain to help prioritise and focus the acquisition of new capabilities that will be required in the future. It can also be used to generate combined organisational profiles, where an organisation may be involved in more than one area of the supply chain.

Role Families

The foresighting process uses the concept of Role Families to represent future occupations. This approach acknowledges that the workforce is not homogeneous, there will be varying levels of proficiency required across a workforce and qualifications and training may be aligned/require different types of vocational or academic qualifications. Additionally, the role family approach seeks to avoid presuming that the future workforce will be "current state plus."

For this cycle, the following Role Families were determined through the workshops:

1. Engineering Technician
2. Engineer / Graduate / Scientist
3. Senior Engineer (Chartered) / Senior Scientist

Proficiencies

Each of these role families will require proficiency that reflects their role and the needs of each Supply Chain Partner. The foresight process uses a three-point scale to capture and differentiate the proficiency required. This information is used in the generation of the Future Occupational Profiles and also to assist the definition of training needs identified. Within the workforce foresight process Proficiency is defined as:

Awareness (A) - Has a foundational knowledge of tools, technology, techniques relevant to sector, industry, and company. Sufficient comprehension to know where to seek further information/details as necessary for a particular issue.
Practitioner (P) - Has the ability to apply and use independently a tool, system, or process. Understands the implications, consequences, and impact for their role/function. Knows what key actions are required and in what context.
Expert (E) - Has detailed knowledge of process, system, tool, or technology. Can support others and identify improvements required for a process, system, or tool. Can implement improvements personally or direct and guide others.

In the workshops participants apply their insight to assign proficiency for each role group to each capability. Individual responses are aggregated by the system to arrive at a consensus. A summary of the distribution of required proficiency for the role families in this cycle are:

	Operator / Technician	Engineer	Senior Engineer
Awareness	0%	5%	4%
Practitioner	71%	61%	21%
Expert	29%	35%	75%

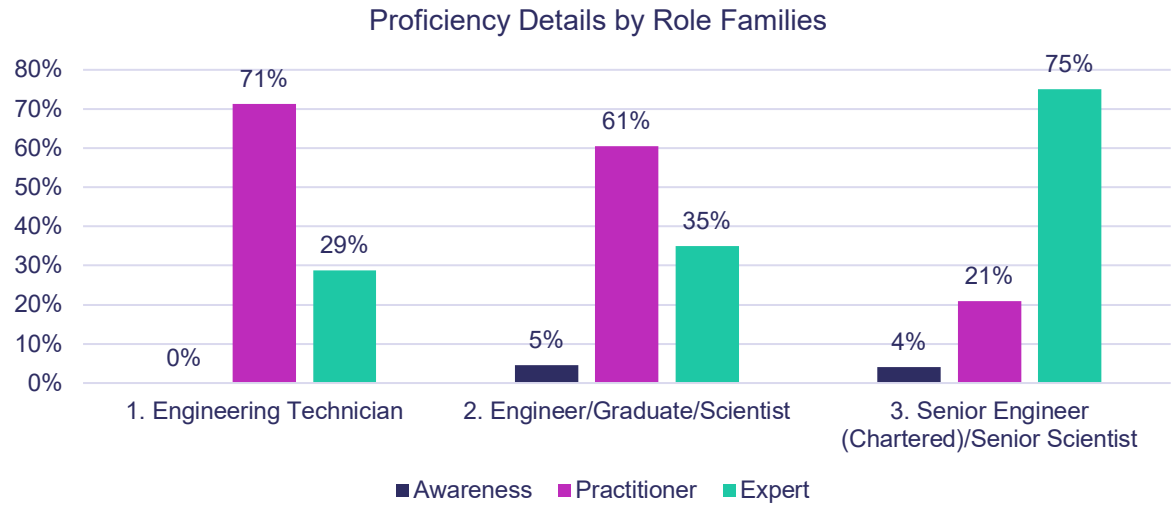


Figure 9: Proficiency details by Role Family

Future Occupational Profiles

The FOPs (Future Occupational Profiles) are a construct created and used during workforce foresighting workshops and analysis to capture future skills needs in a form that may be compared with current occupation definitions – typically occupational standards.
The familiar nature and structure of 'FOP's assists with their evaluation and validation by employers and educators and enables the analytical comparison that results in useful indications of matches, surplus and gaps of future skills needs compared with current state. This then allows recommendations for action to be made based on future need and current fit to those needs.

FOPs are used to describe and suggest occupations, or roles, that may be required in the future and provide a framework to indicate capabilities and related duties. They can be used to review the impact on current roles and the adaptation that may be required in the future.

> **Educators** can review current occupational standards against the requirements of the FOPs and interpret which need to be changed to fill the gaps between the current and future state.

Employers can consider existing qualifications and apprenticeship standards and make a judgement on adapting an existing apprenticeship standard to upskill their workforce to meet the requirements of a particular FOP.
Educators may react to these specified skill requirements from Industry by editing, adapting, or creating new content.

FOPs and indicative skills need

Combining proficiency with the identified FOPs, the following graphs indicate the priority needs across the supply value chain for each Role Group to deliver future capabilities.

Engineering Technician Role Family FOPs:

In this cycle the Engineering Technician role family was defined as occupations and roles requiring Level 4/5 qualifications or apprenticeships.

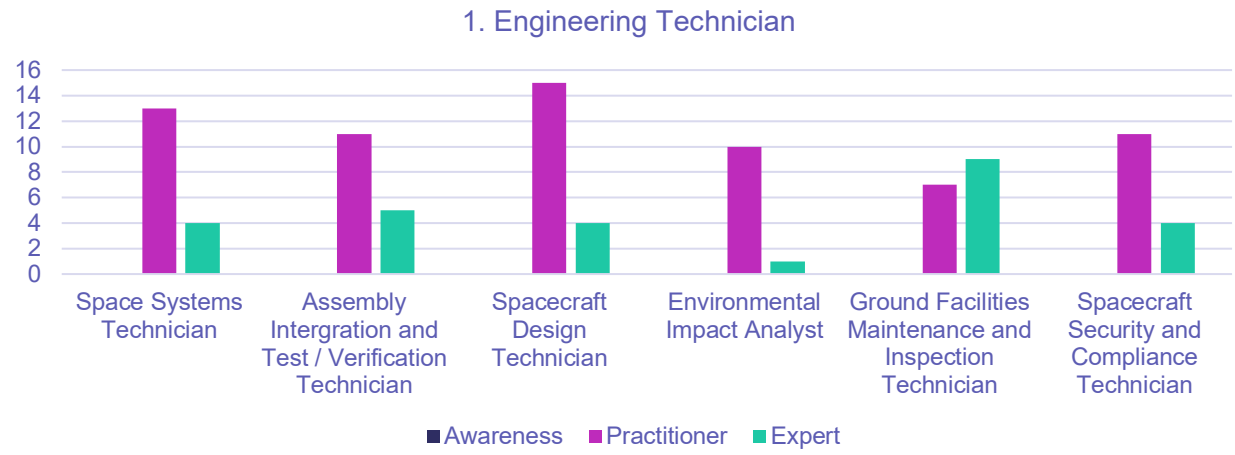


Figure 10: Priority FOPs – Engineering Technician Role Family

Engineer Role Family FOPs:

In this cycle the Engineer role family was defined as occupations and roles requiring Level 6/7 qualifications or apprenticeships.

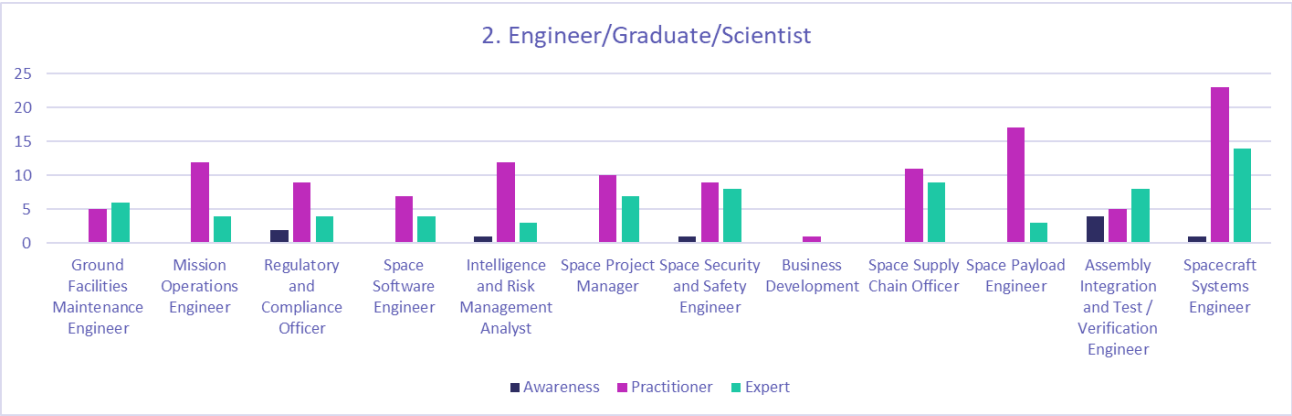


Figure 11: Priority FOPs – Engineer/Graduate/Scientist Role Family

Senior Engineer Role Family FOPs:

In this cycle the Senior Engineer role family was defined as occupations and roles requiring Level 6/7/8 + experience qualifications or apprenticeships.

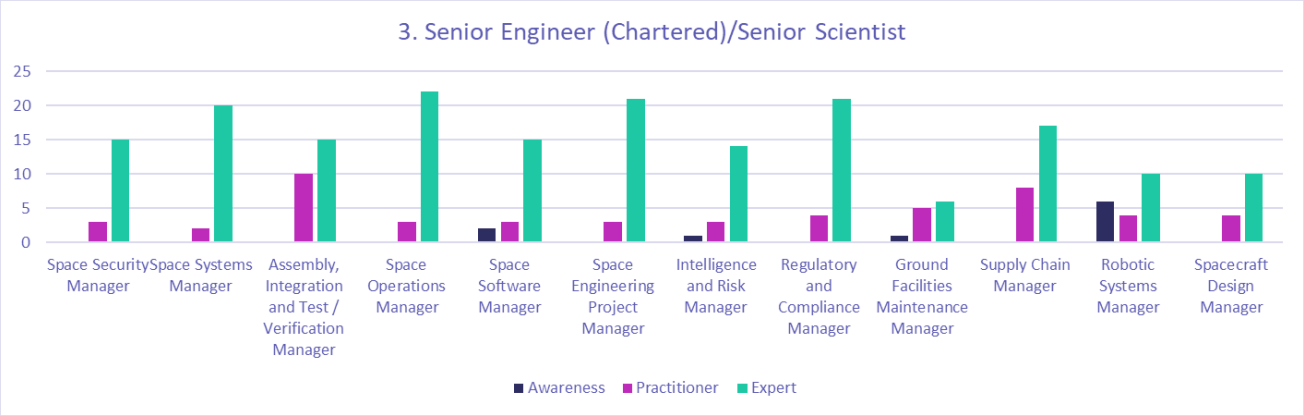


Figure 12: Priority FOPs - Senior Engineer Role Family

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
P-FOP Matrix	This page provides a detailed breakdown of future occupational profiles that could be required in the future workforce. These were generated using a combination of attributes collected through the workshops and an algorithm. These suggested profiles were then reviewed and ratified by small groups of employers who were able to add/remove capabilities and uprate/downrate proficiency levels required. You can view all the P-FOPs in a role family by selecting one (or more) of these from the drop down. This will then allow you to select the P-FOPs aligned to that role family. The populated table allows you review and compare different P-FOPs within or across role families. You can view the capabilities in each P-FOP and the assigned proficiency levels. You can also toggle 'Hide Empty Capabilities' on/off to reduce the view down to only those capabilities included in the role family you are reviewing.

Comparison with current state

The Workforce Foresighting process has developed two metrics to quantify the alignment between a FOP and a current standard or qualification:

Fit – expressed as a %, it is a measure of the proportion of a FOP that is covered by an existing standard or qualification.

Surplus – expressed as a %, it is a measure of the not relevant material in an existing standard that is not required for a FOP.

An ideal existing qualification or standard would have a high fit and low surplus – this implies high suitability or good coverage of the FOP but with little material that is not relevant to the FOP. Conversely a poor candidate would have a low fit and high surplus. Using these two

metrics it is possible to quantitively evaluate, rank, and compare a range of existing provisions against a set of FOPs describing future needs.

By looking at how current occupational standards fit the Future Occupational Profiles, the most suitable and efficient route for change can be determined, e.g. a fit factor of less than 33% probably indicates that the current standard is unlikely to a good candidate for change, however a fit factor of 66% suggests that less adaptation will be necessary to meet future needs.

This interpretation is represented by a simple nine-box model to position the suitability of a given current occupational standard to a future occupational profile:

Factor scores

Fit Factor	Fit score	Surplus Factor	Surplus score
0 - 32%	1	81-100%	1
33-65%	2	51-80%	2
66-100%	3	0 - 50%	3

(Multiplying the Fit score by the Surplus score gives a Suitability Grid score of 1-9 as below)

Suitability Grid

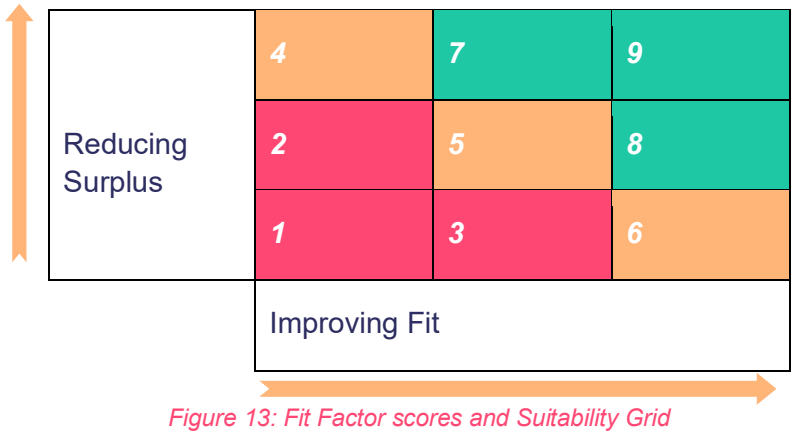


Figure 13: Fit Factor scores and Suitability Grid

For this foresighting cycle, it was found that a higher threshold on surplus factor is more useful in filtering out the less relevant IfATE standards, whilst a slightly lower threshold on fit factor is useful to ensure relevant standards might be included.

Using this score and indicated 'RAG status' the following interpretation can be made:

High Suitability – 7,8,9 – Standards have good coverage for the FOPs identified

Represents good candidates from current occupational standards used as the basis of development to meet FOP requirements and inform elements of short course and CPD provision.

Some Suitability– 4,5,6 – Standards that have some / partial coverage for the FOPs identified.

These are likely to require extended work to meet FOP requirements, further review of the data may be necessary. They are likely to contain some useful information to inform elements of short course and CPD provision.

Low Suitability – 1,2,3 – for standards that have poor / low coverage for the FOPs identified.

These are unlikely to be adaptable to meet future needs but may contain some useful information to inform elements of short course and CPD provision. This can be assessed using the data visualisation tools.

FOP findings compared with current standards

Using the approach described above and applying the 'RAG' scores to each FOP indicating the suitability of current occupational standards selected from the IFATE set, the following table begins to identify areas of action and concern for the provision of future skills for each Supply Chain Partner to respond to the Challenge.

Using ADR Service Provider as an example, all three role families are represented, and from looking at the data extracted we can identify that there is good coverage of Future Occupations in the roles of Space Engineering Technician based on the current IFATE standards.

As expected, the IFATE standards provision is stronger for the Engineering Technician role groups than for Engineer/Graduate/Scientist and the Senior Engineer (Chartered) / Senior Scientist and this is reflected in the suitability findings for Assembly Intergration and Test / Verification roles.

The majority of the Future Occupational profiles have been realigned by the participants in the cycle as ADR Service provider being the main Primary Value Chain. The following data reflects this change.

The data below presents the initial headlines and demonstrates that the overall information illustrates that the Future Occupational Profiles are not well supported by the current IFATE Standards. There is therefore an opportunity to develop new course content by apprentice training providers /universities providing supplementary learning opportunities to existing courses and CPD provision.

Supply Chain Parter – Target Satellite Operator

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
Engineer Graduate Scientist	Mission Operations Engineer	
Engineer Graduate Scientist	Business Development	
Senior Engineer Chartered Senior Scientist	Supply Chain Manager	

Detailed breakdown:

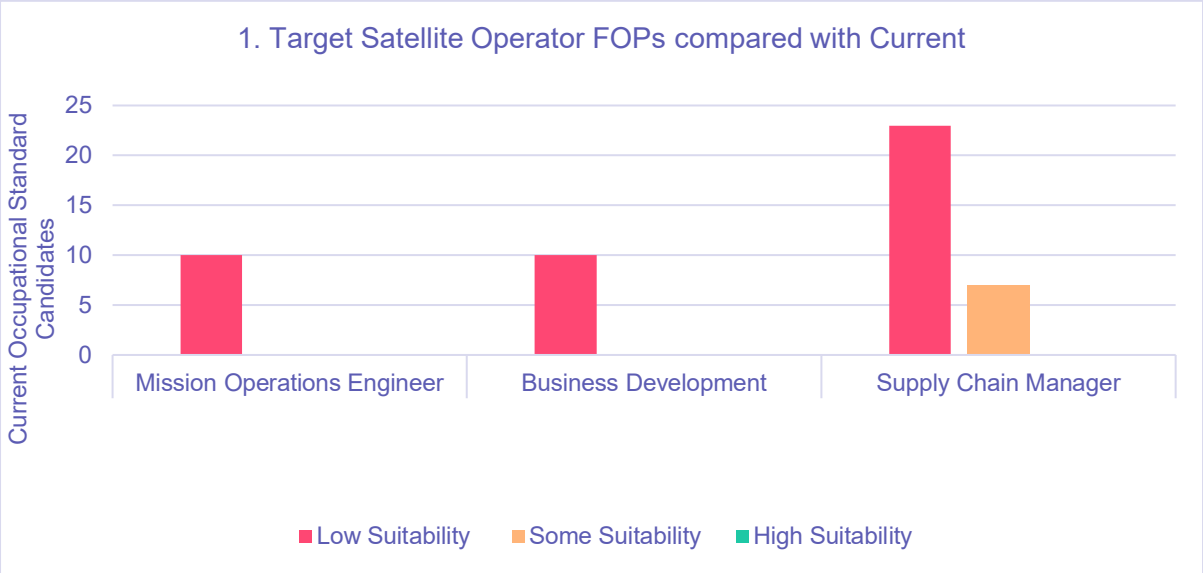


Figure 14: Target Satellite Operator - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner - Regulator

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
Engineer Graduate Scientist	Regulatory and Compliance Officer	
Senior Engineer Chartered Senior Scientist	Regulatory and Compliance Manager	

Detailed breakdown:

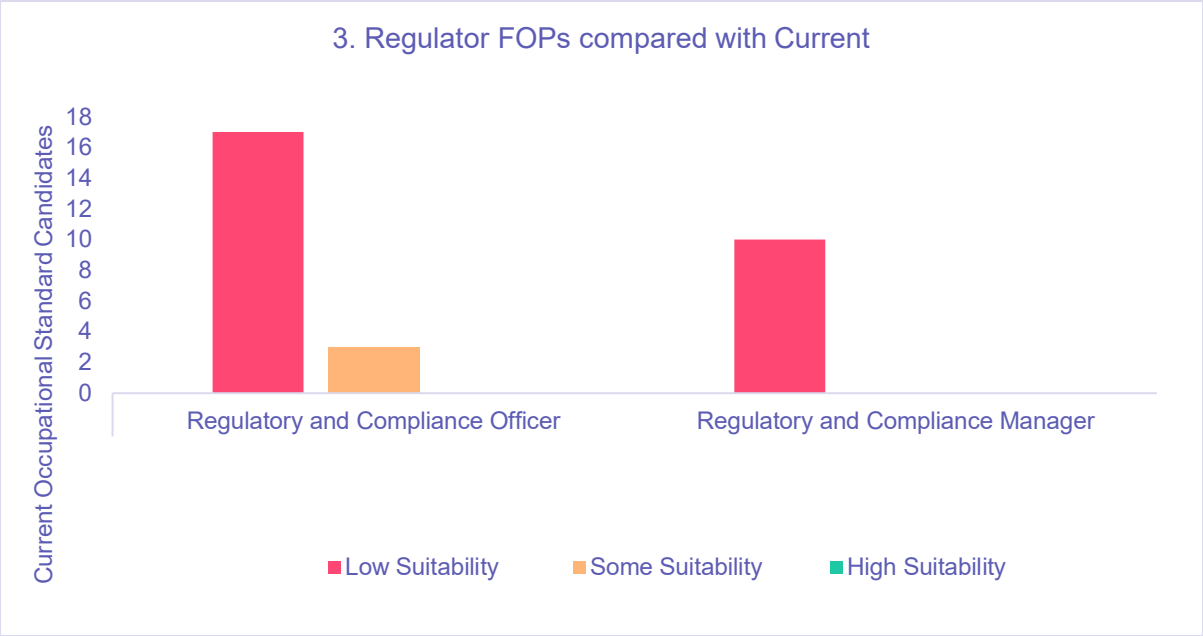


Figure 15: Regulator - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner – ADR Service Provider

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer Chartered Senior Scientist	Spacecraft Design Manager	
Senior Engineer Chartered Senior Scientist	Space Systems Manager	
Senior Engineer Chartered Senior Scientist	Space Software Manager	
Senior Engineer Chartered Senior Scientist	Space Security Manager	
Senior Engineer Chartered Senior Scientist	Space Operations Manager	
Senior Engineer Chartered Senior Scientist	Space Engineering Project Manager	
Senior Engineer Chartered Senior Scientist	Intelligence and Risk Manager	
Senior Engineer Chartered Senior Scientist	Ground Facilities Maintenance Manager	
Senior Engineer Chartered Senior Scientist	Assembly, Integration and Test / Verification Manager	

Engineer Graduate Scientist	Spacecraft Systems Engineer	
Engineer Graduate Scientist	Space Supply Chain Officer	
Engineer Graduate Scientist	Space Software Engineer	
Engineer Graduate Scientist	Space Security and Safety Engineer	
Engineer Graduate Scientist	Space Project Manager	
Engineer Graduate Scientist	Space Payload Engineer	
Engineer Graduate Scientist	Intelligence and Risk Management Analyst	
Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	
Engineer Graduate Scientist	Assembly Integration and Test / Verification Engineer	
Engineering Technician	Spacecraft Security and Compliance Technician	
Engineering Technician	Spacecraft Design Technician	
Engineering Technician	Space Systems Technician	
Engineering Technician	Ground Facilities Maintenance and Inspection Technician	
Engineering Technician	Environmental Impact Analyst	
Engineering Technician	Assembly Intergration and Test / Verification Technician	

Detailed breakdown:

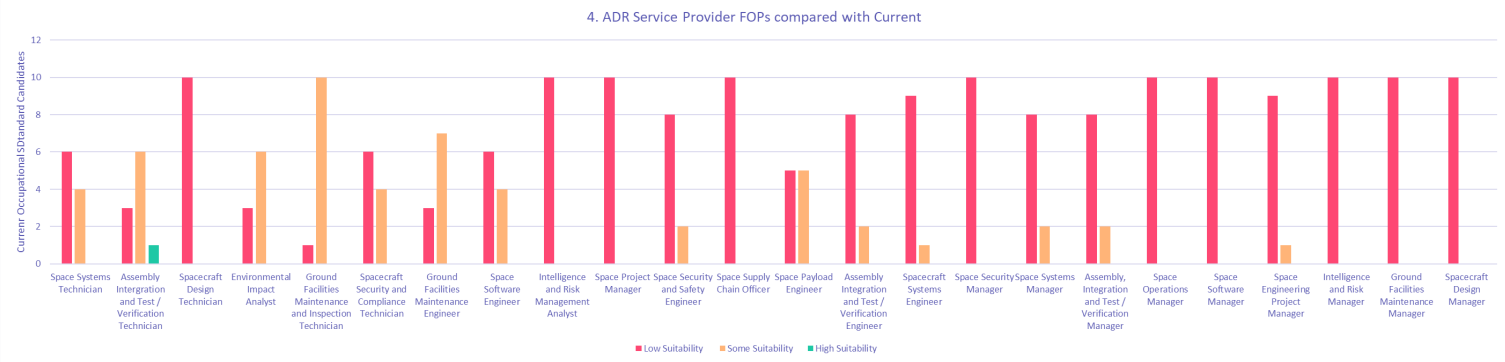


Figure 16: ADR Service Provider - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner – ADR Supply Chain

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer Chartered Senior Scientist	Robotic Systems Manager	

Detailed breakdown:

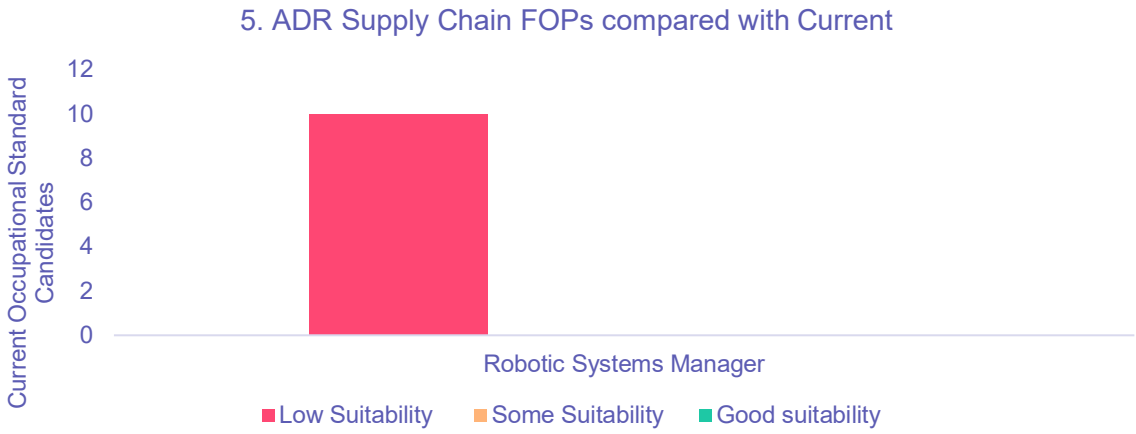


Figure 17: ADR Supply Chain - Count of current provision (IfATE Standards) and suitability to FOPs

3.4 Summary of findings

The below table counts the number of IFATE standards by Suitability score for each FOP.

Role Family	Primary Value Chain / Workflow Partner	Future Occupational Profile	Low Suitability	Some Suitability	HighSuitability	Overall Suitability RAG
Senior Engineer Chartered Senior Scientist	1. Target Satellite Operator (Satellite Applications Catapult)	Supply Chain Manager	0	0	0	
Engineer Graduate Scientist	1. Target Satellite Operator (Satellite Applications Catapult)	Mission Operations Engineer	10	0	0	
Engineer Graduate Scientist	1. Target Satellite Operator (Satellite Applications Catapult)	Business Development	10	0	0	
Senior Engineer Chartered Senior Scientist	3. Regulator (Satellite Applications Catapult)	Regulatory and Compliance Manager	10	0	0	
Engineer Graduate Scientist	3. Regulator (Satellite Applications Catapult)	Regulatory and Compliance Officer	10	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Spacecraft Design Manager	10	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Systems Manager	8	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Software Manager	10	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Security Manager	10	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Operations Manager	10	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Engineering Project Manager	9	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Intelligence and Risk Manager	10	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Ground Facilities Maintenance Manager	10	0	0	
Senior Engineer Chartered Senior Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Assembly, Integration and Test / Verification Manager	8	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Spacecraft Systems Engineer	9	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Supply Chain Officer	10	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Software Engineer	6	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Security and Safety Engineer	8	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Project Manager	10	0	0	

Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Space Payload Engineer	5	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Intelligence and Risk Management Analyst	10	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Ground Facilities Maintenance Engineer	3	0	0	
Engineer Graduate Scientist	4. ADR Service Provider (Satellite Applications Catapult)	Assembly Integration and Test / Verification Engineer	8	0	0	
Engineering Technician	4. ADR Service Provider (Satellite Applications Catapult)	Spacecraft Security and Compliance Technician	6	0	0	
Engineering Technician	4. ADR Service Provider (Satellite Applications Catapult)	Spacecraft Design Technician	10	0	0	
Engineering Technician	4. ADR Service Provider (Satellite Applications Catapult)	Space Systems Technician	6	0	0	
Engineering Technician	4. ADR Service Provider (Satellite Applications Catapult)	Ground Facilities Maintenance and Inspection Technician	1	0	0	
Engineering Technician	4. ADR Service Provider (Satellite Applications Catapult)	Environmental Impact Analyst	3	0	0	
Engineering Technician	4. ADR Service Provider (Satellite Applications Catapult)	Assembly Intergration and Test / Verification Technician	3	0	0	
Senior Engineer Chartered Senior Scientist	5. ADR Supply Chain (Satellite Applications Catapult)	Robotic Systems Manager	10	0	0	

Top Fits

From a FOP perspective and utilising the suitability grid we can determine which of the groups of current occupational standards are more applicate than others.

The FOPs with a high/ some suitability score resulting from their comparison with a range of current IFATE standards and provision are:

1. Space Systems Technician
2. Assembly Integration and Test / Verification Technician
3. Environmental Impact Analyst
4. Ground Facilities Maintenance and Inspection Technician
5. Spacecraft Security and Compliance Technician
6. Ground Facilities Maintenance Engineer
7. Space Software Engineer
8. Space Security and Safety Engineer
9. Space Payload Engineer
10. Assembly Integration and Test / Verification Engineer
11. Spacecraft Systems Engineer
12. Space Systems Manager
13. Assembly, Integration and Test / Verification Manager
14. Space Engineering Project Manager

Potential Suitable standards are listed in the table below:

Role Family	Future Occupation Profiles	IfATE Apprenticeship Standard	Suitability
1 Engineering Technician	Space Systems Technician	Space engineering technician	
1 Engineering Technician	Space Systems Technician	Space systems engineer	
1 Engineering Technician	Space Systems Technician	Aerospace engineering technician	
1 Engineering Technician	Space Systems Technician	Aerospace engineer	
1 Engineering Technician	Assembly Intergration and Test / Verification Technician	Space engineering technician	
1 Engineering Technician	Assembly Intergration and Test / Verification Technician	Electro-mechanical engineer	
1 Engineering Technician	Assembly Intergration and Test / Verification Technician	Aerospace engineering technician	
1 Engineering Technician	Assembly Intergration and Test / Verification Technician	Aerospace engineer	
1 Engineering Technician	Assembly Intergration and Test / Verification Technician	Creative industries production technician	
1 Engineering Technician	Assembly Intergration and Test / Verification Technician	Aerospace software engineer	
1 Engineering Technician	Assembly Intergration and Test / Verification Technician	Space systems engineer	
1 Engineering Technician	Environmental Impact Analyst	Composites technician	
1 Engineering Technician	Environmental Impact Analyst	Polymer processing technician	
1 Engineering Technician	Environmental Impact Analyst	Robotics engineer - degree	
1 Engineering Technician	Environmental Impact Analyst	Engineering technician	
1 Engineering Technician	Environmental Impact Analyst	Ordnance munitions and explosives (OME) professional (integrated degree)	
1 Engineering Technician	Environmental Impact Analyst	Electro-mechanical engineer	
1 Engineering Technician	Environmental Impact Analyst	Engineering manufacturing technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Space engineering technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Maintenance and operations engineering technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Science industry maintenance technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Creative industries production technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Process industry manufacturing technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Science manufacturing technician 2023	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Utilities engineering technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Machining technician	
1 Engineering Technician	Ground Facilities Maintenance and Inspection Technician	Installation and maintenance electrician	
1 Engineering Technician	Spacecraft Security and Compliance Technician	Space engineering technician	

1 Engineering Technician	Spacecraft Security and Compliance Technician	Information manager	
1 Engineering Technician	Spacecraft Security and Compliance Technician	Cyber security technologist (2021)	
1 Engineering Technician	Spacecraft Security and Compliance Technician	Security first line manager	
2 Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	Space engineering technician	
2 Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	Control technical support engineer	
2 Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	Lead engineering maintenance technician	
2 Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	Broadcast and media systems technician	
2 Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	Electrical power protection and plant commissioning engineer	
2 Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	Propulsion technician	
2 Engineer Graduate Scientist	Ground Facilities Maintenance Engineer	Aerospace engineer	
2 Engineer Graduate Scientist	Space Software Engineer	Aerospace engineer	
2 Engineer Graduate Scientist	Space Software Engineer	Aerospace software engineer	
2 Engineer Graduate Scientist	Space Software Engineer	Electro-mechanical engineer	
2 Engineer Graduate Scientist	Space Software Engineer	Post graduate engineer	
2 Engineer Graduate Scientist	Space Security and Safety Engineer	High speed rail and infrastructure technician	
2 Engineer Graduate Scientist	Space Security and Safety Engineer	Cyber security technologist (2021)	
2 Engineer Graduate Scientist	Space Payload Engineer	Space engineering technician	
2 Engineer Graduate Scientist	Space Payload Engineer	Electro-mechanical engineer	
2 Engineer Graduate Scientist	Space Payload Engineer	Aerospace engineer	
2 Engineer Graduate Scientist	Space Payload Engineer	Advanced robotics engineer	
2 Engineer Graduate Scientist	Space Payload Engineer	Space systems engineer	
2 Engineer Graduate Scientist	Assembly Integration and Test / Verification Engineer	Space engineering technician	
2 Engineer Graduate Scientist	Assembly Integration and Test / Verification Engineer	Aerospace engineer	
2 Engineer Graduate Scientist	Spacecraft Systems Engineer	Space engineering technician	
3 Senior Engineer Charterec Senior Scientist	Space Systems Manager	Space systems engineer	
3 Senior Engineer Charterec Senior Scientist	Space Systems Manager	Aerospace engineer	
3 Senior Engineer Charterec Senior Scientist	Assembly, Integration and Test / Verification Manager	Aerospace engineer	

3 Senior Engineer Charterec Senior Scientist	Assembly, Integration and Test / Verification Manager	Electro-mechanical engineer	
3 Senior Engineer Charterec Senior Scientist	Space Engineering Project Manager	Aerospace engineer	
Operator / Technician	Maintenance Technician	Water industry network technician	
Operator / Technician	Maintenance Technician	Maintenance and operations engineering technician	
Operator / Technician	Maintenance Technician	Utilities engineering technician	
Operator / Technician	Maintenance Technician	Food and drink maintenance engineer	
Operator / Technician	Maintenance Technician	Aircraft maintenance technician	
Operator / Technician	Maintenance Technician	Multi-skilled mechatronics maintenance technici	
Operator / Technician	Safety Technician	High speed rail and infrastructure technician	
Operator / Technician	Safety Technician	Cellular network field engineer	
Engineer	Revised - Safety Specialist	High speed rail and infrastructure technician	
Engineer	Revised - Safety Specialist	Aircraft certifying technician	
Senior Engineer	"Senior Engineer - Quality and Risk Management"	Risk and safety management professional (degree)	

These might provide useful data for individuals in these roles who might be good candidates for conversion courses to the space sector.
This is a wide-ranging field so use of the data visualisation tool is recommended to access the next layer of detail and review the specific standards that have been identified as having High Suitability / Some Suitability or Low Suitability.

As a comparison we can also list the standards that score lowest against the required FOPs. This suggests that there is very little suitable in the IFATE standards to support these Future Role Profiles.

FOPs with a low suitability or coverage score resulting from their comparison with a range of current IFATE standards and provision are:

- Space Systems Technician
- Assembly Integration and Test / Verification Technician
- Spacecraft Design Technician
- Environmental Impact Analyst
- Ground Facilities Maintenance and Inspection Technician
- Spacecraft Security and Compliance Technician
- Ground Facilities Maintenance Engineer
- Mission Operations Engineer
- Regulatory and Compliance Officer
- Space Software Engineer
- Intelligence and Risk Management Analyst
- Space Project Manager
- Space Security and Safety Engineer
- Business Development
- Space Supply Chain Officer
- Space Payload Engineer
- Assembly Integration and Test / Verification Engineer

- Spacecraft Systems Engineer
- Space Security Manager
- Space Systems Manager
- Assembly, Integration and Test / Verification Manager
- Space Operations Manager
- Space Software Manager
- Space Engineering Project Manager
- Intelligence and Risk Manager
- Regulatory and Compliance Manager
- Ground Facilities Maintenance Manager
- Supply Chain Manager
- Robotic Systems Manager
- Spacecraft Design Manager

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
P-FOP Detail	This page allows you to review a specific Occupational Profile, including the capabilities contained within it and the Knowledge, Skills & Behaviour (KSB) tags associated with the capability. You can select an individual Role Family and linked P-FOP in the two available drop-downs. The table in the lower section of the page will then be populated with all relevant capabilities. The search control above the table allows you to filter content of any of the columns of data. A key piece of functionality in this table is the presence of the KSB tags associated with the capabilities.
Future KSBs Summary	This page provides a view of the complete set of capabilities within the cycle along with all of the associated KSB tags which are linked to them. It is, essentially, the superset of all details displayed on the P-FOP detail page. This is used to: • To review the identified Knowledge, Skill and Behaviour tags for a given capability, to support development of future education and learning material. • To review the requirements from a capability level, rather than a role family/occupational profile grouping.
Capability distribution across P-FOPS	This page allows provides a breakdown of the Capabilities within the selected Cycle and how they are distributed across the P-FOPs with the addition of a distribution chart showing the required proficiency across those P-FOPs. Clicking the “View P-FOPs” button alongside each capability will provide a list of the proficiencies (EPA) with the P-FOPs that fall into them. The exported version of this data will include a full breakdown of the FOP IDs which contain the capability within a specific proficiency. This is used to; • understand the levels/volumes of common/crossover Capabilities, to support prioritisation of Capability Development • identify which Occupational Profiles contain these common/crossover capabilities, and so which may be prioritised for development activity
Capabilities Matched to Current Provision	This page allows you to review and compare individual capabilities against ‘Duty’ statements in an Apprenticeship / Occupational Standard. You can select individual capabilities to review their specific matches. These matches are shown in the bottom panel, including the Standard, the Level and the Duty Statement this is matched to. You can filter in several ways to focus your review: • By the Capability Classification Framework (left-hand panel). • By capabilities that **are** served by the reference mapping framework – the default is Institute for Apprenticeships and Technical Education (IfATE) provision.

	• By capabilities that **are not** served by the reference mapping framework, e.g., IfATE provision – these are capabilities required in the future that may require new/bespoke training and CPD materials to be developed to upskill/re-skill the workforce. This page can be used to identify where existing provision may exist across the broad spectrum of Occupational Standards, and not just within a narrow range of sector-specific Standards. The data also allows you to identify where provision may already exist to support specific capabilities.
Fit & Surplus Factors	This page allows you to review the 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (P-FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). It is possible for the 'Fit' and 'Surplus' comparison to total over 100%, as they are two separate calculations based on a two-way comparison.
Fit & Surplus Matrix	This page is a visual representation of the 'Fit and Surplus Factor' insight. You can visually review 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (P-FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). This can help you identify which provision may align strongest, or which may require adaptation, to provide the suitable provision fit for each future role. It will help you focus in on which provision to focus your attention for analysis.
P-FOP Capability Matches	This page allows you to view the matches between Capabilities and Institute for Apprenticeships and Technical Education (IfATE) Duty Statements. Clicking the arrow next to a number in the 'Matches' column will open a popup with more detail for each Capability. Each capability also includes Knowledge, Skill and Behaviour Tags, to support with scaffolding future education provision. You can review individual Prototype Future Occupational Profiles (P-FOPS) or review all P-FOPs under a Role Family, to give a more holistic view of Capabilities and Matches Where a future capability has been matched to existing provision (currently, by default, IfATE apprenticeship standards) it is possible to interrogate the data and identify specific statements in standards that align to enable identification of existing training materials and activities that could be used or adapted to meet future requirements. This can be used to review the capability requirements for Role Families and P-FOPs, from Job / Occupation level through to Knowledge, Skill and Behaviour level.

4.0
Recommendations

4.0 Recommendations

4.1 Use of the findings

Naturally some FOPs (Future Occupational Profiles) are generic, while others are tailored to the Active Debris Removal technologies. Employers should communicate specific role requirements to educators for targeted training. This report's data and visualisations will aid in this process.

Real-world jobs may blend multiple occupational profiles, and courses can adapt to cover various profiles. FOPs offer a framework for designing future roles and guiding course development.

Few existing standards directly address skills for Active Debris Removal.
IFATE Standard Space Engineering Technician (ST0855) show potential and could be a candidate for Standard revision. This standard is currently under revision.
Other IFATE standards that could serve as a source for CPD Modules could be Aerospace Engineer (ST0010) or Aerospace Software Engineer (ST0013).

In summary, FOPs can be used to:

- Highlight where roles related to a current occupational standard require updating. For incumbent or transferring workers this could be met by short course and CPD events
- Influence and inform changes to occupational standards used to define the education and training of new entrants to the future workforce.

The adoption of the following recommendations is critical to ensure the solutions to the Challenge can be delivered. The Space Skills Task Force building on the work of the Space Skills Advisory Panel will be able to provide a framework to highlight the different knowledge, skills and behaviours required by future occupations and identify as well as pursue the actions required to deliver these recommendations.

4.2 Future State vs Current State

750 IFATE standards across all 6 academic levels were used for comparison with the derived FOPs.
Educators can use the Suitability Grid and visualisation tools to find relevant IfATE standards for further examination. While this doesn't automatically create requirement statements or a fully defined curriculum, it does helps educators work more efficiently, by accessing clear and consistent skills data, aligned with employers' actual future needs.

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
Fit & Surplus - Ground Facilities Maintenance and Inspection Technician	This page allows you to review the 'Fit' and 'Surplus' of the Ground Facilities Maintenance Engineer Future Occupational Profile against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE).

For the Ground Facilities Maintenance engineer the core capabilities for Educators to focus on are:

- Inspect work Of Employees Performing Manufacturing Assembly Integration And Testing Activities And Operators Performing In Space Activities To Ensure Adherence To Standards And Procedures
- Support maintenance activities. For example, help engineering in set-up and calibration tasks, report faults, conduct routine preventative maintenance such as inspecting machinery.
- Perform preventive or corrective maintenance on robotic systems or components.
- Ensure comprehension of secure Assembly, Integration and Testing (AIT) facilities.
- Implement predictive maintenance strategies using digital tools and technologies
- Build and maintain spacecraft test facilities to specified standards.
- Maintain work area according to cleanroom or other processing standards.
- Monitor, test, fault find, and maintain manufacturing plant and equipment (such as thermal vacuum chambers, composite layup systems, and soldering stations) and carry out scheduled service activities on production infrastructure.
- Carry out inspection activities on equipment, components and systems (for example, use of microscopes to inspect electronics assemblies; helium leak testing of thermal vacuum chambers, thermal cycling and optical alignment).
- Plan and conduct maintenance tasks for ground facilities
- Prepare, check, control, and maintain machinery and equipment

There is one apprenticeship standard 'Space Engineering Technician' that has been identified as matching to 7 of the 9 capability statements.

It is advised that industry review which IFATE standards are the usual 'Go To's' and which alternatives the industry could use. Most of this data is already available, but most IfATE standards are only used by large companies, few SMEs have embarked to date.

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
P-FOP vs Provision	This page allows you to compare P-FOPs against existing IfATE Standards. The information here allows you to prioritise effort or action over the short, medium or long-term. This is displayed as a Matched/Not Matched Capability, comparing the Capability in a P-FOP to the Duties in a Standard. The left-hand side allows you to select the Role Family and P-FOP, while the right-hand modal allows you to compare against the top 10 matched IfATE Standards for that Occupational Profile. Where a future capability has been matched to existing provision (currently, by default, IfATE apprenticeship standards) it is possible to interrogate the data and identify specific statements in standards that align to enable identification of existing training materials and activities that could be used or adapted to meet future requirements.
P-FOP Priorities	This page provides a list of all the P-FOPs within the selected cycle with details of their fit and surplus factors. The information here allows you to prioritise effort or action over the short, medium or long-term.

4.3 Recommended actions

These recommendations highlight the short and mid-term actions needed by employers and educators. Collaboration is essential to ensure future skills are available for implementing innovative technologies to address identified challenges.

A potential shortage of skilled technicians, engineers, and senior engineers could significantly hinder the UK's ambition to be a global leader in In-orbit Servicing and Manufacturing – Active Debris Removal, a core focus of government space sustainability policy and strategy.

A. Review of Findings

The findings of Section 3 should be reviewed by those involved in the process. Whilst the data acquisition and analysis were quality assured during the workshops and reporting, review and feedback will secure the validity of the following recommendations.

The Future Occupational Profiles are the major output of the process and are used to evaluate the need for action. Further work to adapt combinations of FOPs to better fit emerging roles is anticipated as employers plan for future needs.

What	Review of findings
Who	Stakeholders, Sponsor, Leads, Participants
When	Before formal publication

Result	Robust actions

B. Dissemination of Findings

These findings indicate where there are likely to be future gaps in skills which if not addressed will cause delays in:

Technology development and deployment –

- Lack of capacity and capability in the sector will hinder early lifecycle technology design and development work.
- Delays in testing and proving will impede innovative technology uptake in a risk-averse sector.
- Educators to review Design standardswith Technologists.
- Working Group to identify gaps and priorities to align with emerging skills frameworks.

Scaling-up production –

- Scaling up production of innovative technologies requires time.
- Process involves developing at-scale production methodologies, investing in and installing capital equipment, and recruiting and training the workforce.

Project delivery –

- Shortage of skilled workers will act as a major supply chain bottleneck.
- Increased costs and future delivery inefficiency.

Current (as listed in Section 2) and future stakeholders in both aspects should be made fully aware of the foresighted gaps and the workforce skills and training actions necessary to mitigate the risk. The Sponsor can play a key role in this.

The findings should also be reviewed by WF-Hub Steering Board members to identify scope for departmental support for actions.

What	Dissemination of Findings
Who	Stakeholders, Industry and Sector groups, Government and Regions
When	Following publication
Result	Web hosted reports and traffic

C. Short term actions

The understanding gained from the FOPs enables short-term re-skilling and upskilling of the current workforce, which is crucial for meeting emerging technology demands, particularly in early lifecycle activities like design. Educators must tailor course content to match specific new capabilities with existing provisions which can be found in various occupational standards.

Some roles may see high demand, surpassing opportunities for current workforce development, but there is potential for recruiting individuals with transferrable skills from other industries requiring similar capabilities.

What	Short term action
Who	Educators, Awarding Bodies, Employers
When	Prepare ahead of scale-up need

Result	Timely availability of short-term training for current workforce

D. Mid term actions

Short-term solutions to address incumbent workforce needs are available within one to two years following analysis and preparation. However, formal changes to occupational standards and training programmes for new entrants requires a considerably longer lead time, typically involving years of review, program development, and individual training.

Efforts aimed at the current workforce and those for new entrants should be integrated to meet the same future needs defined by the FOPs, thereby reducing preparation time. The long lead-time for new entrants demonstrates the importance of incorporating future skills training into programmes from the start.

What	Mid term actions
Who	Educators, Awarding Bodies, Employers
When	As soon as possible for prioritised FOPs to update current standards
Result	Take up of programmes meeting future skills needs as well as current

E. General action for Educators to support Employers' demand for future skills

A modular approach to change is feasible within the timescales, compared to re-designing entire courses to meet FOPs requirements.

Educators can help Employers determine their training needs by assessing gaps.

- Short-term CPD: Topics to upskill current workforce members across all role families.
- Medium-term program updates: Topics to integrate into existing occupational standards through review and incorporation.
- Longer-term changes: New qualifications and standards required to prepare new entrants.

For the short term CPD solutions, Educators should:

- Review IFATE standards and relevant qualifications for roles described by the FOPs with Employers and seek advice from universities on how they can best utilise the data.
- Assess FOPs data against selected Standards and Qualifications, providing feedback to employers
- Evaluate existing CPD provision for possible incorporation.
- Commission new CPD courses if none are available.
- Facilitate collaboration to identify core education needs, maintaining a joined-up approach.

F. Identify further workforce foresighting

Further cycles of foresighting solutions that respond to requirements for in-space refuelling, the development and use of digital twins.

What	Identify Further workforce foresighting
Who	Stakeholders
When	3 months after publication
Result	Further FOPs and data uncovering new and common skills needs

G. Lessons learnt

- Roles identified in this report will also be affected by Government commitments to the growth of the space economy and the development of sovereign capability in space domains.
- Clear Government policies are crucial to drive demand for the space economy in the UK, as highlighted by the foresighting cycle.

H. Recommendations to Workforce Foresighting Steering Board

- Maintain collaboration: Ensure the group progresses effectively to deliver benefits. Without concerted efforts to develop the right skills, we risk being unprepared for an increasing global emphasis on sustainability and will be unable to capitalise on the UK's current lead in the technology.
- Ensure alignment between existing skills and new demands while focusing on skill development.

5.0 Appendices

5.0 Appendices

Section	Title
5.1	List of Participants
5.2	Cycle timeline
5.3	Access to output data - link and authorisation
5.4	Glossary - common language

5.1 List of Participants

Industry (Employers) Participants	Skills (Educators) Participants	Technology Participants
Satellite Applications Catapult Astroscale Growbotics	Satellite Applications Catapult Astroscale Growbotics	Satellite Applications Catapult Astroscale Growbotics
Rhea Group TAS MDA Space UK Luna Space Clearspace D-orbit In-Space Space Forge Airbus GMV Space Forge Avanti Magdrive Northern Ireland Space RAL Space Lodestar Space Specialists Ltd Liberty 360 Ltd coco software Celestia Technologies Group	UWE University of Portsmouth BlueStream Recruitment Sanderson Plc UWE National Space Academy IET AMRC Space Skills Alliance University of Southampton UCL UKAEA HE Space University of Bristol University of Lincoln Lord Mayor of London's office Northern Ireland Space National Space Academy UCL Oxford Advanced Skills Space Specialists Ltd Cranfield University University of Manchester	Lunasa Space Space Forge Thales Alenia Space Lift Me Off AMRC Airbus GMV Orbit Fab Extend Robotics IOSM Working Group UK Space Agency Clearspace UWE CFMS Lodestar Prof-Space Ltd coco software Space Specialists Ltd Night-sky Consulting OrbitAID MDA Space UK UKAEA UCL Cranfield University University of Manchester

5.2 Cycle timeline

This cycle started the workshops as part of the Carry Out phase in February 2024. The Carry Out phase concluded in May 2024. This report was prepared following the data validation period and published in July 2024.

5.3 Access to output data - link and authorisation

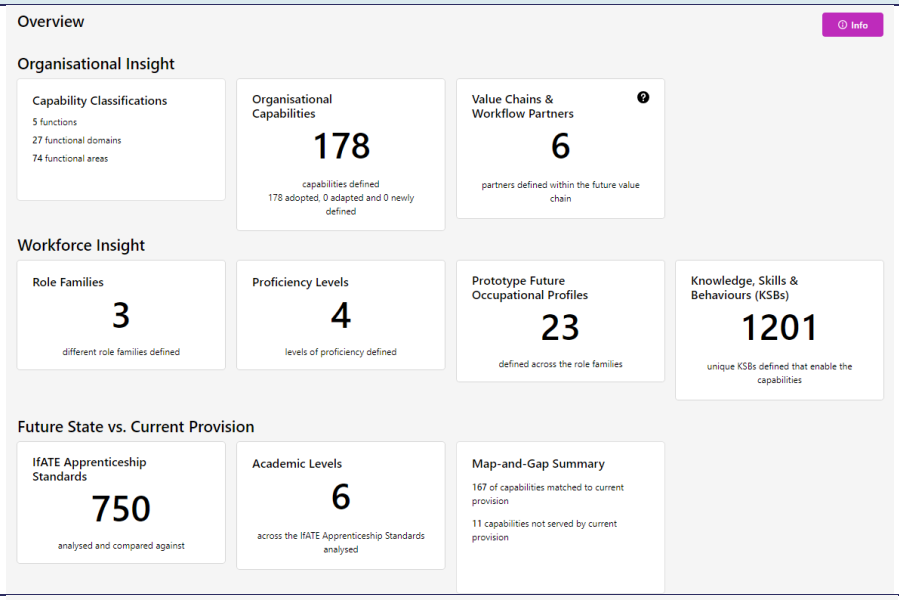
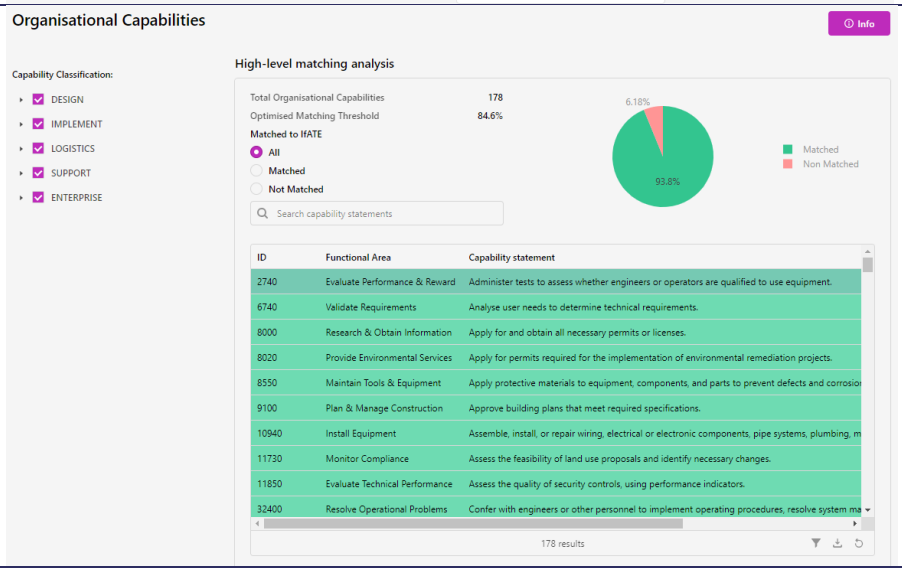
Data Capture Overview – Link to Retool, Visualisation

5.4 Glossary - common language

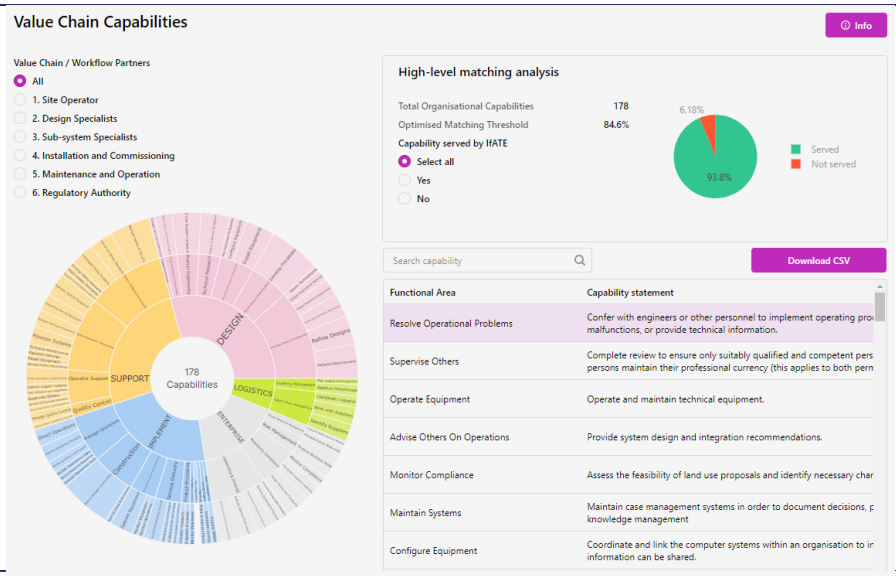
Term	Definition
Impact Domains	Innovate UK domains used as Strategic Categories to assist setting and monitoring priorities
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary
Challenge Response	Specific intervention aimed at the challenge
Capability (Organisation)	The collective abilities, and expertise of an organisation to carry out a function, because provision and preparation have been made by the organisation
Capability Classification	Classification provides a common, structured vocabulary to define capability
Capability Statements	Description of the depth and nature of each capability within an organisation
Capability Syntax	Common language to describe each capability application within organisation type
Competencies (Workforce / Individual)	'Proficiency, aptitude, capacity, skill, technique, experience, expertise, facility, fitness related to capability
Competency definition 'KSBs' (Knowledge, Skills and Behaviours)	Knowledge, Skills, and Behaviours are the elements used to express the required competencies for each Role Group
Competency Domain	Used during foresighting analysis to provide focus on existing and emerging competency needs
Delphi Process	Foresighting takes a Delphi approach which has come to represent consulting expert opinion. (Harking back to the Delphic Oracle of ancient Greece)
Foresight Cycle	Set of workshops, analysis and reporting that implements the Foresight Process for each subject
Foresight Process	A series of activities which are convened to understand future competence needs, the opportunities available and actions required to deliver the right skills at the right time and place
Foresighting Champion	An individual nominated within a new user organisation of foresighting to facilitate and lead the use of foresighting processes and tools with the support of the Project Team
Foresighting Subject	The application of specific technologies in the context of a given challenge and which are candidates for foresighting
Future Competency Set	The KBS output from the Educator workshop for each Role Group
Map and Gap Analysis	A combined expert and automated process that maps the Future Competency Set against a selected reference framework
Organisation Type	Simple description of nature of organisation for which capability is required
Proficiencies	Proficiencies differentiate the degree of competencies required from differing Role Groups to support capabilities
Project Sponsor	Typically, a stakeholder in the challenge being successfully met who requires information to under-write plans to act
Role Group	Role groups are a collective of roles that exist in a typical manufacturing business / industrial sector
Syntax	The way in which a statement is phrased to ensure reliable, repeatable and meaningful interpretation

Technologies	The technology that could be used to address the challenge
Working Scenario	To provide further context in relation to the subjects and used to position participants thinking during the detailed identification of future capabilities
Workshops	Online sessions used to undertake each step in the foresight process
Roadmaps	Sector, Industry, Regional view of emerging opportunities and their market entry
Participants	Technologists, Educators, Employers

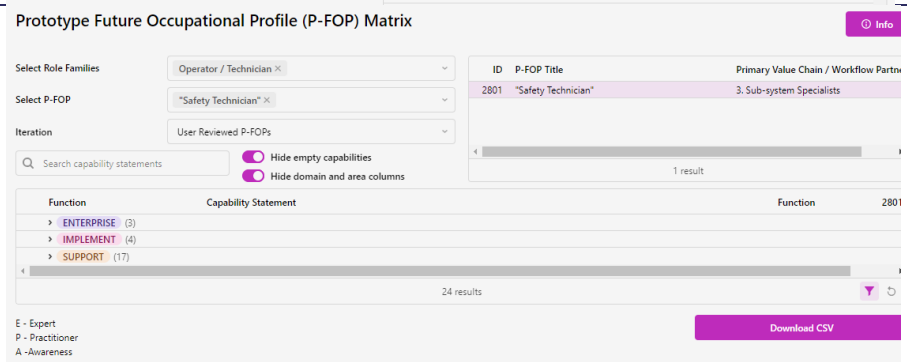
5.5 – Visualisation links and Illustrations

Link to Visualisation	View of data (example data, not cycle specific)
Data Capture Overview	
Organisational Capabilities	

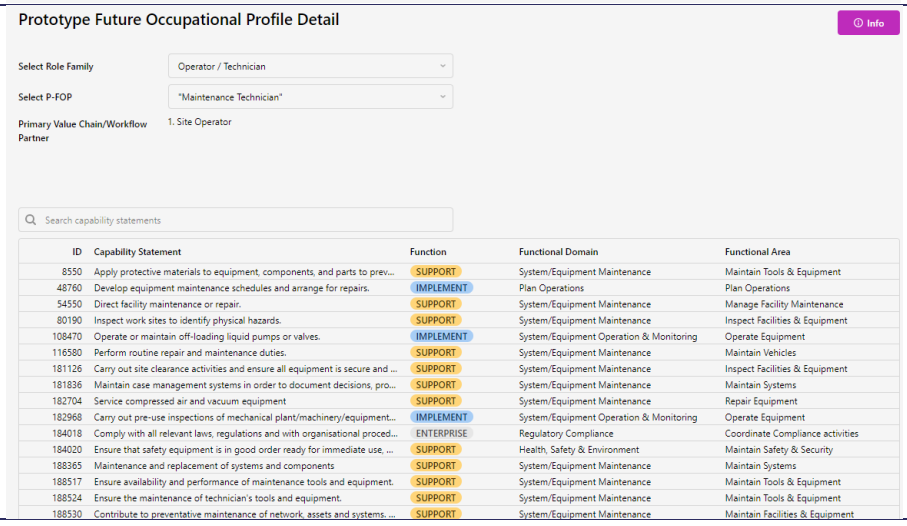
Value Chain Capabilities



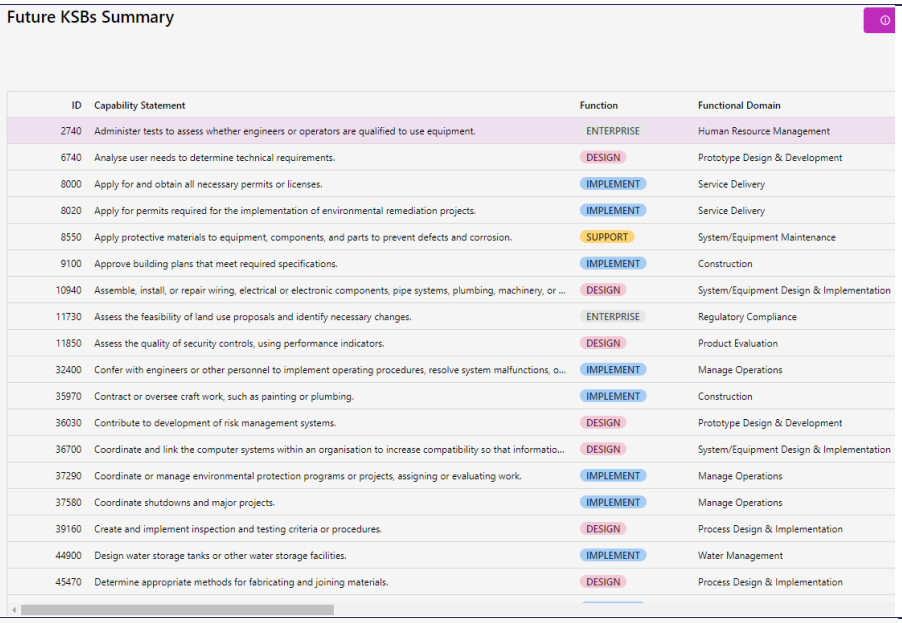
P-FOP Matrix



P-FOP Detail



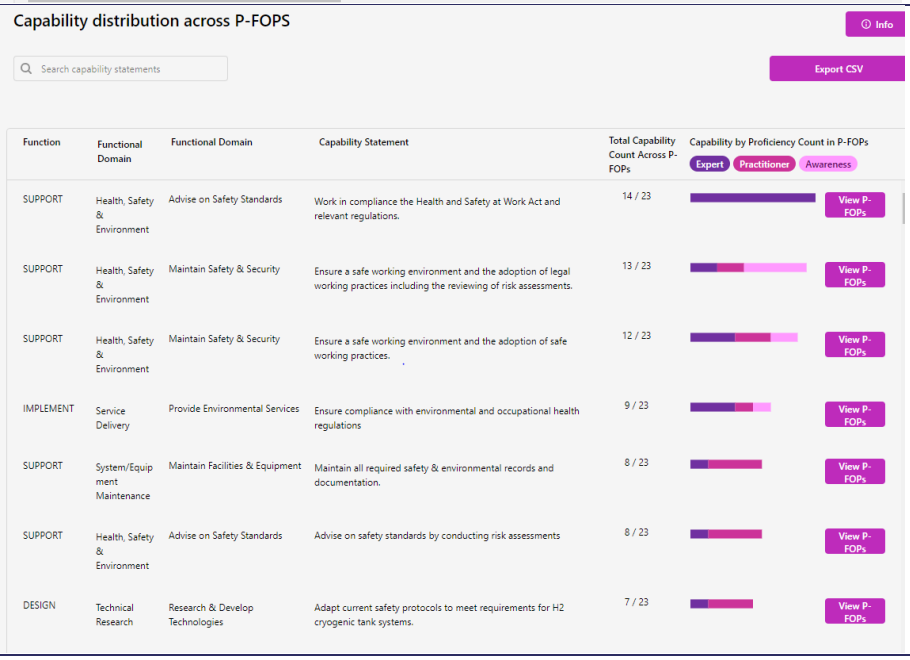
Future KSBs Summary



Future KSBs Summary

ID	Capability Statement	Function	Functional Domain
2740	Administer tests to assess whether engineers or operators are qualified to use equipment.	ENTERPRISE	Human Resource Management
6740	Analyse user needs to determine technical requirements.	DESIGN	Prototype Design & Development
8000	Apply for and obtain all necessary permits or licenses.	IMPLEMENT	Service Delivery
8020	Apply for permits required for the implementation of environmental remediation projects.	IMPLEMENT	Service Delivery
8550	Apply protective materials to equipment, components, and parts to prevent defects and corrosion.	SUPPORT	System/Equipment Maintenance
9100	Approve building plans that meet required specifications.	IMPLEMENT	Construction
10940	Assemble, install, or repair wiring, electrical or electronic components, pipe systems, plumbing, machinery, or ...	DESIGN	System/Equipment Design & Implementation
11730	Assess the feasibility of land use proposals and identify necessary changes.	ENTERPRISE	Regulatory Compliance
11850	Assess the quality of security controls, using performance indicators.	DESIGN	Product Evaluation
32400	Confer with engineers or other personnel to implement operating procedures, resolve system malfunctions, o...	IMPLEMENT	Manage Operations
35970	Contract or oversee craft work, such as painting or plumbing.	IMPLEMENT	Construction
36030	Contribute to development of risk management systems.	DESIGN	Prototype Design & Development
36700	Coordinate and link the computer systems within an organisation to increase compatibility so that informatio...	DESIGN	System/Equipment Design & Implementation
37290	Coordinate or manage environmental protection programs or projects, assigning or evaluating work.	IMPLEMENT	Manage Operations
37580	Coordinate shutdowns and major projects.	IMPLEMENT	Manage Operations
39160	Create and implement inspection and testing criteria or procedures.	DESIGN	Process Design & Implementation
44900	Design water storage tanks or other water storage facilities.	IMPLEMENT	Water Management
45470	Determine appropriate methods for fabricating and joining materials.	DESIGN	Process Design & Implementation

P-FOP Distribution



Capability distribution across P-FOPS

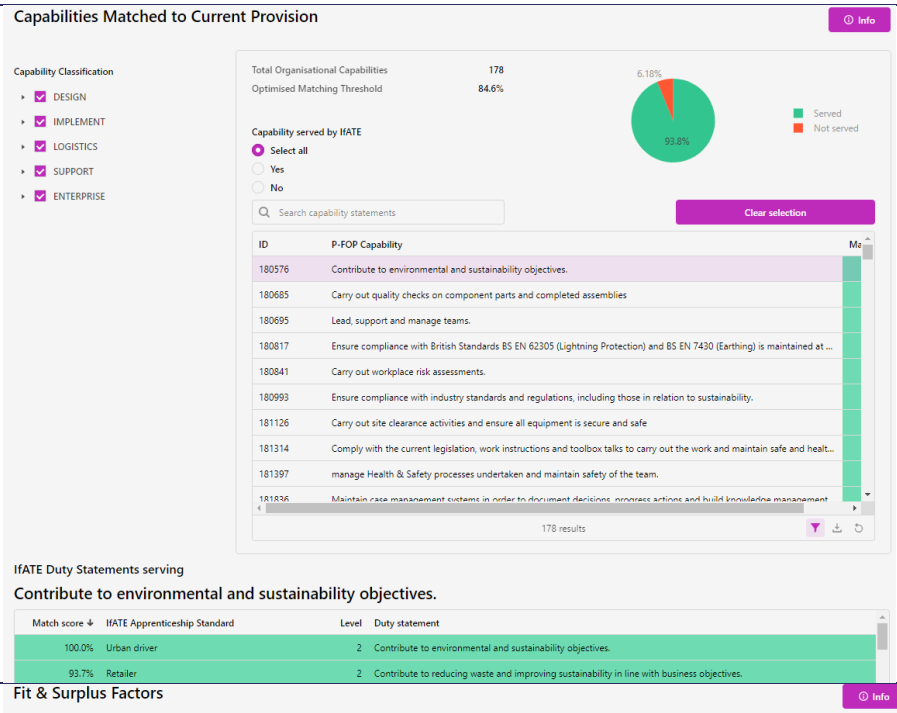
Info

Search capability statements

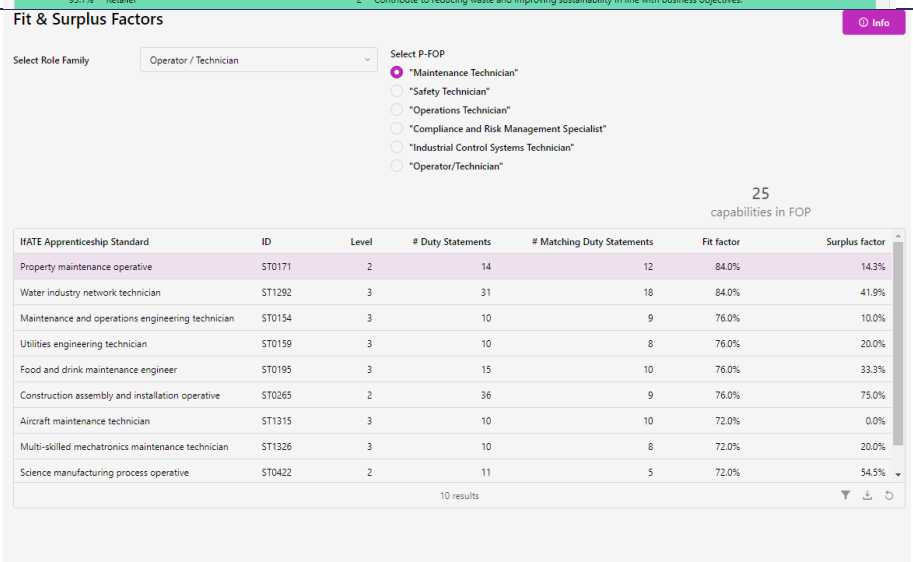
Export CSV

Function	Functional Domain	Functional Domain	Capability Statement	Total Capability Count Across P-FOPs	Capability by Proficiency Count in P-FOPs (Expert / Practitioner / Awareness)	
SUPPORT	Health, Safety & Environment	Advise on Safety Standards	Work in compliance the Health and Safety at Work Act and relevant regulations.	14 / 23		View P-FOPs
SUPPORT	Health, Safety & Environment	Maintain Safety & Security	Ensure a safe working environment and the adoption of legal working practices including the reviewing of risk assessments.	13 / 23		View P-FOPs
SUPPORT	Health, Safety & Environment	Maintain Safety & Security	Ensure a safe working environment and the adoption of safe working practices.	12 / 23		View P-FOPs
IMPLEMENT	Service Delivery	Provide Environmental Services	Ensure compliance with environmental and occupational health regulations	9 / 23		View P-FOPs
SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Maintain all required safety & environmental records and documentation.	8 / 23		View P-FOPs
SUPPORT	Health, Safety & Environment	Advise on Safety Standards	Advise on safety standards by conducting risk assessments	8 / 23		View P-FOPs
DESIGN	Technical Research	Research & Develop Technologies	Adapt current safety protocols to meet requirements for H2 cryogenic tank systems.	7 / 23		View P-FOPs

Capabilities Matched to Current Provision

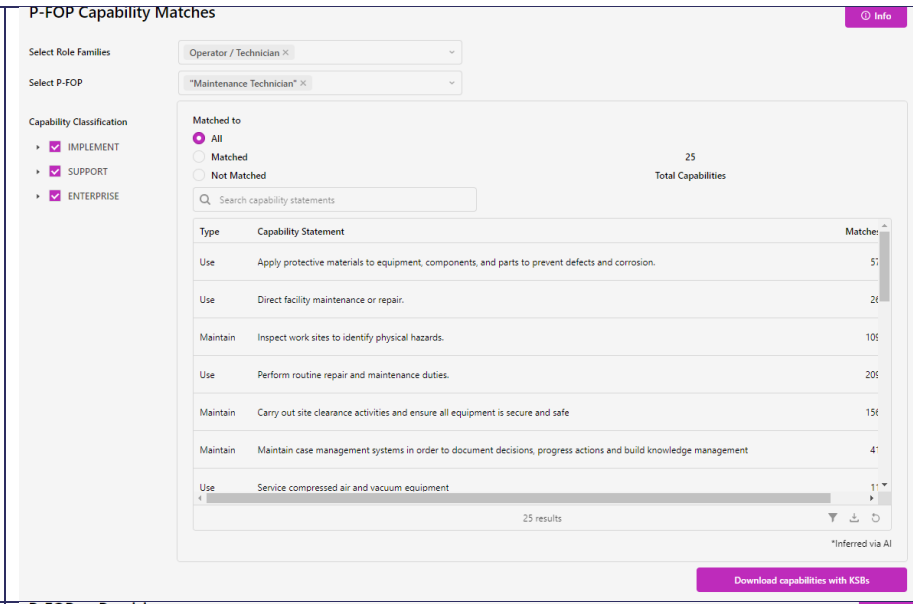


Fit & Surplus Factors

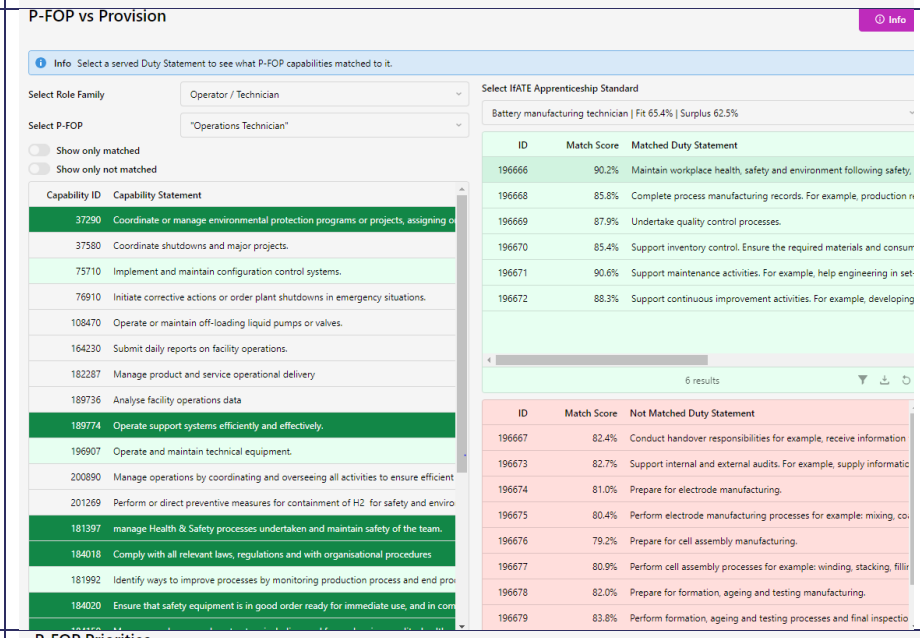


Fit & Surplus Matrix

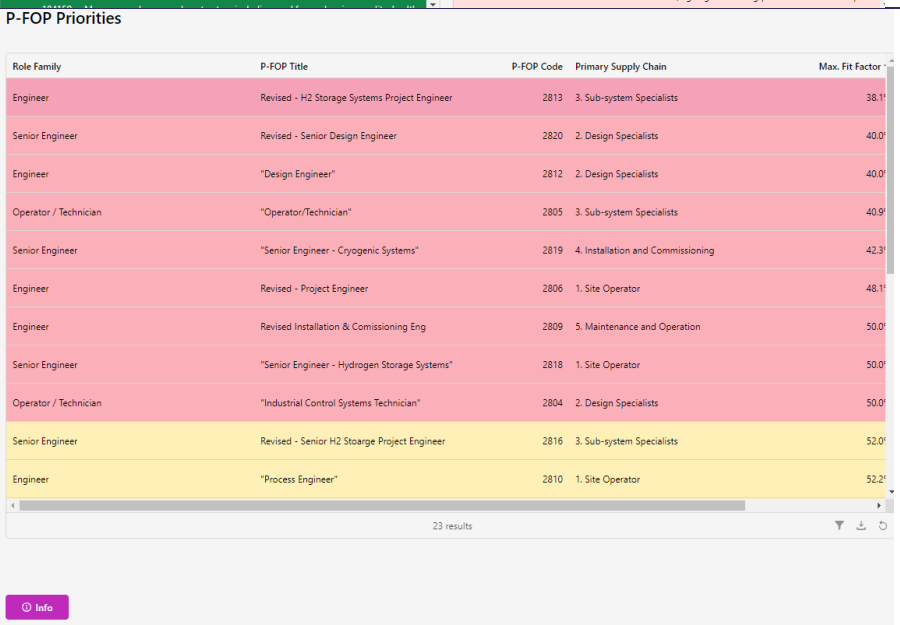
P-FOP Capability Matches



P-FOP vs Provision



P-FOP Priorities



5.6 – Supply Chain Capabilities

This is an overview of the identified capabilities at a Supply Chain / Workflow Partner level and shows how the supply chain organisations' workforce structure needs to change to deliver the required capabilities.

Supply Chain Partner	Example of required change to deliver capabilities
1. Target Satellite Operator	The multifaceted roles in the space sector involve a blend of technical engineering, compliance, risk management, and strategic collaboration to ensure safe, efficient, and innovative space operations. Key responsibilities include designing collision avoidance systems, verifying software quality, assembling mechanical systems in both terrestrial and zero-gravity environments, and assessing server and network security across different domains. Professionals must collaborate with cross-functional teams and adapt products to meet stringent space standards while ensuring regulatory compliance and technical integrity. Essential tasks include developing spacecraft test facilities, defining engineering plans for software solutions, conducting risk assessments, and implementing safety management processes. In addition, meticulous planning, mission coordination, and managing in-orbit operations are crucial, along with innovation and adaptation to emerging technology trends and safeguarding classified information. Through strategic integration of complex systems and standards, space sector professionals propel the advancement of space exploration and industry.
2. Target Satellite Manufacturer/Supply Chain	Effective collision avoidance strategies in space safety require comprehensive analysis and design, encompassing software quality review, assembly and disassembly of complex mechanical systems in zero gravity, and rigorous server and network security assessments to identify vulnerabilities and threats. Ensuring technical integrity through advisory roles, building spacecraft test facilities, and maintaining compliance clarity are crucial. Collaboration across functions like manufacturing and finance integrates diverse products, while industry engagement helps meet space qualifications. Risk assessments, subsystem integration, logistics planning, and In-Orbit Service insights support operational readiness. Coordination of spacecraft manoeuvres and engineering plans, secure network infrastructures, and robust supply chains minimise environmental impact. Design efforts span commercial to military applications, necessitating secure communication and autonomous software systems. Specific needs for Active Debris Removal (ADR) highlight the importance of competency frameworks, safe interfaces, and rigorous testing to ensure spacecraft functionality. Compliance policies, efficient processes, and secure marketing strategies reinforce operational success.

	Diagnosing operational issues and directing hardware and software enhancements are vital, coupled with space research innovation and legal updates. Educating suppliers on sector constraints, using AI for design, and ensuring SCIF requirements are critical. Security throughout mission phases, secure AIT facilities, and maintaining safety standards are paramount. Due diligence in satellite data sharing, trend forecasting, and supply chain optimisation enhance strategic advances. Hardening spacecraft against electronic warfare and developing unique ADR support capabilities are essential for optimal operations and timely project delivery.
3. Regulator	Analysing and designing collision avoidance responses is vital for safety, necessitating thorough software review and quality assurance. This involves handling complex mechanical systems both on Earth and in zero gravity, assessing physical security of servers and networks, and adapting to space industry standards. Building and maintaining spacecraft test facilities, ensuring compliance, and integrating products through cross-functional collaboration are essential. Risk assessments, detailed supply chain analysis, and staff performance reviews help optimise operations. Coordination of spacecraft manoeuvres and defining engineering plans for space software solutions are critical. Secure network infrastructure for commercial and military applications, competency frameworks, and marketing plans for international engagement are required for industry compliance. Developing safe procedures for ADR missions, testing space software, and ensuring regulatory compliance enhance operation safety. Competent processes for performing dangerous tasks, handling classified information, and troubleshooting spacecraft systems are necessary. Overseeing scientific activities aligned with company and regulatory guidelines, managing risk registers, and ensuring mission success mandates careful mission planning and technological scale-ups. Monitoring space objects, negotiating strategic contracts, supporting AI systems, and developing robotic mechanisms contribute to the functionality and safety of space operations.
4. ADR Service Provider	The responsibilities and tasks encompass a broad array of technical, operational, and strategic functions crucial for space operations and related industries. Key tasks involve collision avoidance analysis, software quality review, mechanical system assembly in varying gravitational settings, and physical security assessment of servers and devices against multiple threats. Collaboration with suppliers to meet space standards, authorisation and advisement on technical designs and procedures, and maintenance of spacecraft test facilities are vital. Ensuring regulatory compliance, performing risk assessments, and executing subsystem and spacecraft-level system integration and testing are essential. Additional duties include operational data

	collection, performance analysis, spacecraft manoeuvre coordination, and engineering plan maintenance. The role also involves designing secure network infrastructure, managing data storage for Active Debris Removal operations, developing competency frameworks, marketing plans, safety standards, and support systems for ADR services. Modifications to space vehicles, scaling new technologies, adherence to safety risk management, and integrating COTS components are crucial for innovation. Employee performance inspection, launch readiness verification, awareness of threat environments, supplier education, and enforcement of physical and cyber security measures further ensure mission integrity. Strategic contract negotiation, robotic mechanism research, and ground support system supervision are also imperative to meet space/launch requirements, ensuring efficiency and safety in mission activities.
5. ADR Supply Chain	When analysing and designing collision avoidance responses for safety, evaluating software outputs for quality and functionality is crucial, involving both Earth-based and zero-gravity mechanical assemblies. Physical security assessments for servers and network devices help identify vulnerabilities, while assisting suppliers in adapting to space industry standards ensures compliance. Authorising and advising on technical designs, maintaining spacecraft test facilities, collaborating with cross-functional teams, and engaging with the industry are essential for successful integration and operational planning. Collecting spacecraft performance data, conducting risk assessments, testing subsystems, analysing supply chains, managing transport logistics, and contributing to In-Orbit Service and Manufacture (IOSM) enrich operational safety. Coordinating spacecraft manoeuvring for collision avoidance, defining engineering plans, and designing secure networks and supply chains are critical. Ensuring data storage for Active Debris Removal (ADR), developing competency frameworks, marketing plans, safety standards, and testing spacecraft software enhance workforce and mission capabilities. Policies, standards, regulatory guidance, diagnosing spacecraft issues, and inspecting manufacturing activities ensure robust operations. Understanding MoD requirements, managing in-orbit operations, and modifying space vehicles based on documentation maintain mission compliance. Negotiating contracts, operating ground support systems, organising mission plans, and validating spacecraft systems ensure launch readiness. Training operators, handling satellite incidents, researching robotic mechanisms, and securing physical and cyber assets are critical for operational success. Utilising Product Data Management (PDM) and Space Domain Awareness (SDA) capabilities, verifying standards throughout the product life cycle, and ensuring launch readiness complete the comprehensive responsibilities for technical and operational excellence in space-related activities.
6.Defence	Ensuring the secure operations of spacecraft involves a multiplicity of critical tasks ranging from analysing collision avoidance

	responses and reviewing software outputs to assembling and disassembling complex mechanical systems in both terrestrial and zero-gravity environments. Assessing the physical security of servers and network devices, aiding suppliers in meeting space industry standards, and building and maintaining spacecraft test facilities are essential for maintaining technical integrity and regulatory compliance. Collaborative efforts with cross-functional teams and industry partners, conducting comprehensive risk assessments, and maintaining qualifications are pivotal for successful space operations. Specialised logistics, operational analysis, and collision avoidance manoeuvres require meticulous planning and expert coordination. Designing serviceable and environmentally friendly spacecraft systems, ensuring secure communications, and identifying critical technologies support forward-looking space missions. Strategic oversight includes developing regulatory policies, managing national risk registers, ensuring in-orbit safety, and validating spacecraft systems for launch readiness. By addressing customer needs, statutory requirements, and leveraging innovative technologies, the multifaceted responsibilities underscore the complexity and vital importance of tasks necessary to manage and operate spacecraft systems effectively.