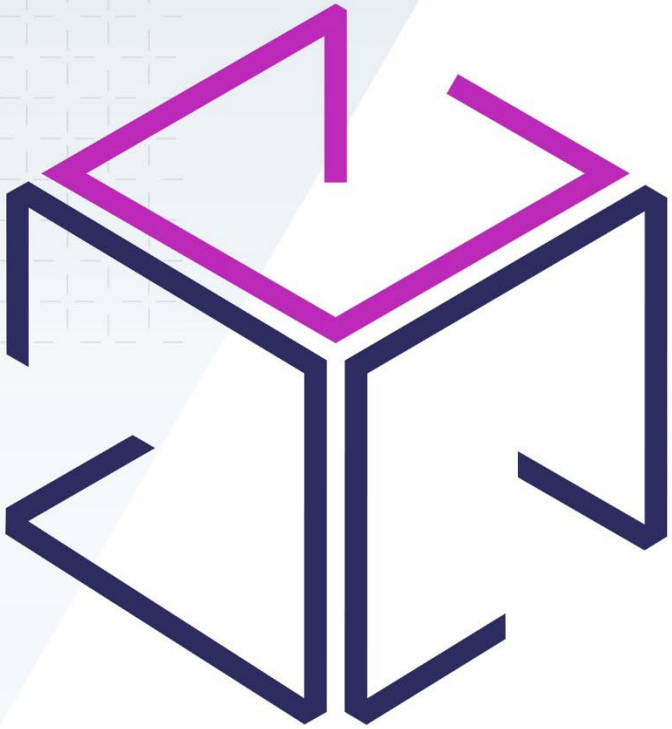
Workforce Foresighting Hub



The Design, Installation and Operations of Automation Robotics

Including welding, joining and inspection in sub-optimal (confined / dangerous) spaces

Workforce Foresighting Hub report.

Date: July 2024

UKRI Innovate UK

Right skills, right time, right place

Acknowledgements

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 Workforce Foresighting Hub team states that –

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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 March – June 2024 using the data set and tools available at that time.

Contents

1.0 Executive Summary

1.0 Executive Summary

Introduction

The National Manufacturing Institute of Scotland's (NMIS) Findings Report outlines critical insights and recommendations for Automation and Robotics for welding, joining and inspection in confined spaces within the Shipbuilding sector.

The Workforce Foresighting cycle was driven by the key priorities within the UK's National Shipbuilding Strategy (March 2022). The strategy outlines ambitions in green technology, productivity, skills, autonomy, and exports, with specific goals such as zero-emission vessels by 2025 and productivity parity with Northern European shipyards by 2030.

Workshops led by NMIS and the Shipbuilding Skills Taskforce focused on exploring challenges and potential solutions, prioritising green propulsion and productivity improvements. From these discussions, technology solutions such as hydrogen, ammonia, wind propulsion, and advanced data, AI, and robotics for shipbuilding processes were identified.

The foresighting topic narrowed down to automation and robotics for welding, joining, and inspection in confined spaces, addressing skills shortages and improving safety and productivity. This focus not only benefits shipbuilding but also has applications across other industrial sectors like offshore wind, oil and gas, construction, and rail vehicles.

The report, developed by the Workforce Foresighting Hub, provides an in-depth analysis based on data from international datasets and workshops conducted from March to June 2024.

With shipbuilding being vital to the UK economy, supporting over 44,600 jobs and contributing £3.1bn, the foresighting initiative aims to start to prepare the workforce for future technological advancements and maintain the UK's competitive edge in the global market. Key stakeholders, including NMIS, BAE, and other industry and government entities, are collaborating to ensure the foresighting efforts align with industry needs and future workforce requirements.

1.1 Foresighting cycle summary

The Foresighting Cycle is a structured, collaborative process designed to anticipate future workforce requirements in response to technological innovation. This cycle integrates insights from domain specialists, technologists, employers, and educators to inform the development of future curricula and course content. The process consists of several key stages:

1. **Considering**: Defining the challenges to be addressed and aligning foresighting topics with strategic priorities.
2. **Identifying**: Reaching consensus on the solutions to be pursued.

3. **Preparing**: Convening specialists and scheduling workshops.
4. **Carrying Out**: Conducting workshops to gather and analyse data.
5. **Communicating**: Reporting insights, findings, and recommendations.
6. **Causing Action**: Driving actions based on the recommendations to address skills gaps and align training provision with future needs.

The foresighting cycle employs a combination of workshops, surveys, and advanced AI tools to capture and analyse data. AI tools assist in comparing capability statements with existing occupational standards, with outputs validated by participant groups. This ensures the identification of necessary changes in knowledge, skills, and behaviours for future roles.

The outcomes of the foresighting process include detailed insights and recommendations for industry sponsors and stakeholders. This includes prototype future occupational profiles, changes required to current training provisions, and dynamic data sets for ongoing analysis. These insights help in identifying short-term CPD needs, medium-term updates to current provisions, and long-term requirements for new qualifications and standards.

In summary, the Foresighting Cycle is crucial for aligning workforce capabilities with emerging technological demands, ensuring that educational and training systems are prepared to equip the future workforce effectively.

1.2 Organisational change

The organisational changes necessary for aligning future capabilities with the challenges faced by the value chain are critical. This report highlights several key areas where functional changes are imperative:

1. **Leadership and Strategy:**
    - **Manage Change & Transformation Programmes:** Organisations need to lead and influence projects that deliver strategic objectives, including agile transformation, product diversification, and enhancing customer experience.
    - **Develop Business Strategy:** Decision-making about resource allocation (budgets, people, technology) must be informed by strategic insights and reliable evidence.
    - **Identify Business Threats & Opportunities:** Responding to crises and assessing risks and opportunities are vital to maintain performance and address stakeholders' needs responsibly and ethically.
2. **Human Resource Management:**
    - **Manage Human Resources:** Effective people development, including talent management, succession planning, workforce design, and mentoring, is essential.
3. **Sustainable Practices:**
    - **Promote Sustainable Practices:** Cultivating an ethical, inclusive, and innovative culture is crucial for continuous improvement and staying updated with relevant trends and developments.
4. **Business Relationships and Communication:**

- **Manage Existing Business Relationships:** Maintaining collaborative relationships with key stakeholders and influencing decision-makers is essential for strategic alignment.
- **Communicate Strategy:** Shaping the approach to communications and ensuring alignment with broader organisational strategies is necessary for coherent external and internal messaging.

5. **Compliance and Performance Evaluation:**
    - **Coordinate Compliance Activities:** Ensuring compliance with internal and external governance standards is fundamental.
    - **Evaluate Business Performance:** Regular reporting to governance structures on operational activities towards achieving business goals is needed for accountability and continuous improvement.

Understanding these areas provides a comprehensive foundation for anticipating and implementing the necessary changes in organisational structures and processes. This insight is crucial for adapting to future demands and ensuring the organisation remains competitive and resilient.

1.3 Future Occupational Profile Highlights

The Workforce Foresighting Hub's recent findings emphasize the evolution and future needs of occupational profiles across various role levels. The highlights provide valuable insights into the anticipated changes and requirements in the workforce to align with technological advancements and industry demands.

Role Levels and Proficiency Needs

1. **Qualified/Skilled Operator**: Roles at this level typically require Level 3 qualifications or apprenticeships. The proficiency distribution for this group indicates:
    - Awareness: 3%
    - Practitioner: 55%
    - Expert: 43%
2. **Technician**: These roles necessitate Level 4/5 qualifications or apprenticeships, with the following proficiency needs:
    - Awareness: 2%
    - Practitioner: 58%
    - Expert: 40%
3. **Engineer**: Roles in this category require Level 5/6 qualifications or apprenticeships. Proficiency distribution includes:
    - Awareness: 1%
    - Practitioner: 35%
    - Expert: 65%
4. **Senior Engineer**: Occupations at this level require advanced qualifications and apprenticeships (Level 5/6), with proficiency needs as follows:
    - Awareness: 4%
    - Practitioner: 24%
    - Expert: 72%

Future Occupational Profiles (FOPs)
FOPs are developed to capture future skill needs, allowing comparison with current occupational standards. They facilitate the evaluation of the gaps between existing roles and future requirements, aiding educators and employers in adjusting training and apprenticeship standards accordingly.

- **Qualified/Skilled Operator**: Identified roles include Quality Control Inspector in Shipbuilding and Welding Engineer.
- **Technician**: Includes Robotics Integration Engineer and Sustainable Manufacturing Engineer.
- **Engineer**: Roles like Industrial Equipment Engineer and Industrial Standards and Safety Compliance Engineer are highlighted.
- **Senior Engineer**: Focuses on advanced roles such as Maritime Safety and Compliance Engineer and Robotics Systems Design and Implementation Engineer.

Findings and Applications
- **Proficiency Distribution**: The data reflects a significant need for practitioners and experts across all role levels, highlighting the importance of advanced training and upskilling in the workforce.
- **Alignment with Current Standards**: The FOPs indicate varying levels of alignment with current apprenticeship standards. Some roles, like Robotics Integration Engineer, show better suitability, suggesting targeted areas for curriculum development and industry training programs.
- **Future Skills Needs**: The identified FOPs underscore critical future skills, including advanced robotics, automation, and sustainable manufacturing. These insights help prioritise training initiatives and inform policymaking to support the evolving industry landscape.

This foresight into future occupational profiles ensures that both educational institutions and industries can proactively address the skills gap, fostering a workforce equipped to meet future technological and operational challenges.

1.4 Specific areas of concern

The NMIS Findings Report highlights several specific areas of concern that need immediate attention to align with the future occupational profiles (FOPs). These concerns are derived from the comparison of current occupational standards with the requirements of FOPs and are categorized based on their suitability scores.

1. **Low Suitability Scores for Certain Standards**:
    - Some current standards exhibit low suitability scores, indicating that they do not sufficiently cover the necessary aspects of the FOPs. This suggests that these standards are unlikely to meet future needs without significant adaptation or redevelopment. Specific examples include roles within ship design and shipbuilding where there is inadequate coverage of future occupational requirements.
2. **Gaps in Robotics and Automation Skills**:
    - There are identified gaps in skills related to robotics and automation, especially within the roles of Robotics System Design and Implementation Engineers. These gaps highlight the need for updated standards and training programs to ensure that the workforce is equipped to handle advanced robotics systems.
3. **Inconsistent Coverage Across Role Families**:
    - The analysis revealed inconsistent coverage of FOPs across different role families within the supply chain. For instance, while some roles within the shipbuilder category show stronger alignment with current standards, others, such as systems integrators, have poor coverage, necessitating targeted interventions to bridge these gaps.
4. **Need for Enhanced Technical and Safety Training**:
    - There is a significant need to enhance technical and safety training, particularly for roles involving welding and inspection in confined or hazardous spaces. The current standards do not adequately address the safety and technical competencies required for these high-risk environments.
5. **Emerging Skill Requirements**:
    - New and emerging skill requirements, particularly in sustainable manufacturing and compliance with industrial standards, are not adequately reflected in the current occupational standards. This misalignment poses a challenge for meeting future demands and requires the development of new standards or the substantial revision of existing ones.
6. **Fit and Surplus Factor Discrepancies**:
    - The analysis using fit and surplus factors indicates that many existing qualifications and standards have a low fit and high surplus. This means they cover a small portion of the FOPs and include a lot of irrelevant material, making them inefficient for future workforce needs. Addressing these discrepancies is crucial for optimising training and qualification frameworks.

These specific areas of concern underscore the need for a strategic overhaul of current occupational standards to ensure they align with the future skills landscape. Immediate action and continuous evaluation are essential to prepare the workforce for emerging technologies and industry demands.

1.5 Recommended actions

1. **Utilise Future Occupational Profiles (FOPs)**:
    - **Adopt and Integrate**: Use the FOPs to align current workforce capabilities with future needs, ensuring that employees are prepared for emerging technologies and processes.
    - **Enhance Training Programs**: Update training programs to reflect the competencies identified in the FOPs, incorporating new skills and knowledge areas essential for future roles.
2. **Develop New Educational Standards**:
    - **Create Targeted Curricula**: Develop new educational standards and curricula based on the insights from the foresighting process, ensuring they are aligned with the future occupational profiles.
    - **Short Courses and CPD**: Implement short courses and continuous professional development (CPD) programs to bridge gaps in current knowledge and skills within the workforce.
3. **Leverage the Visualisation Tool**:
    - **Data-Driven Decisions**: Use the Workforce Foresighting Hub's Visualisation Tool to make informed decisions about capability development and role evolution within the organisation.
    - **Identify Training Needs**: Pinpoint where existing standards meet future role requirements and where new standards are needed, facilitating the development of a skilled workforce ready to adopt new technologies.
4. **Engage Stakeholders**:
    - **Collaborate with Industry and Education**: Foster collaboration between technologists, employers, educators, and policymakers to integrate diverse perspectives and ensure the development of relevant and forward-looking training programs.
    - **Feedback Mechanisms**: Establish regular feedback mechanisms with key stakeholders to continuously refine and validate the FOPs and educational standards.
5. **Monitor and Adapt**:
    - **Continuous Improvement**: Regularly review and update the FOPs and training programs to keep pace with technological advancements and changing industry needs.
    - **Future Foresighting Cycles**: Plan and execute future foresighting cycles to stay ahead of emerging trends and maintain a competitive edge.

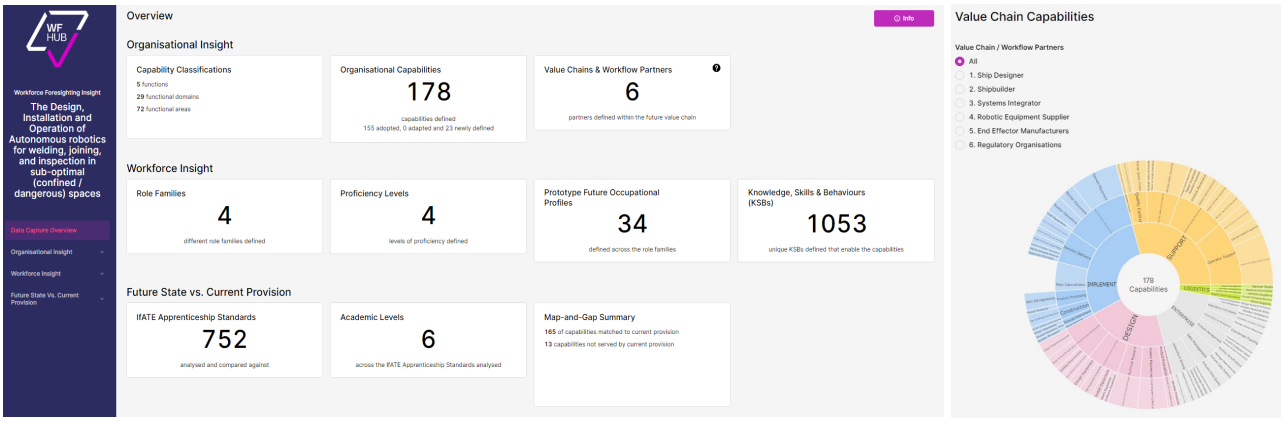
By implementing these recommended actions, organisations can effectively prepare their workforce for the future, ensuring they have the necessary skills and knowledge to thrive in an evolving technological landscape.

1.6 Introducing the Visualisation Tool

The Workforce Foresighting Hub's Visualisation Tool is a powerful, innovative system, which will enable the reader to explore and analyse foresighting data to determine the capabilities required for future roles. Links throughout this report make it easy to identify existing standards which meet the needs of these future roles and pinpoint where new standards are necessary to develop a skilled workforce equipped to adopt new technologies.

The data is generated by the foresighting cycles, integrating the expertise of technologists/domain specialists, employers and educators. The data informs the development of future curriculum and course content as determined by the action plan. Using AI tools validated by human oversight, and by linking to external data sources, the tool identifies differences at the level of occupation/role as well as detailed changes required to knowledge, skills and behaviours thus delivering insights for learners, providers, creators and assurers of skills.

Detailed instructions on how to use the Visualisation Tool can be found in the appendix.



2.0 Aligning the Challenge and Solutions with National Priorities

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Section	Title
2.1	Positioning and context of challenges
2.2	Potential and prioritised Solutions to Challenge
2.3	Workforce foresighting for chosen prioritised technology solution
2.4	Background information - reports that informed the consider, identify, etc
2.5	Current and predicted scale of technology deployment in UK
2.6	Key Stakeholders in industry and government
2.7	Expected timing of solutions to impact workforce
2.8	Prioritisation of cycle Foresighting topics based on solutions

2.1 Positioning and context of national challenge

The impetus for this Workforce Foresighting Challenge is defined by the government's National Shipbuilding Strategy (March 2022) which outlines key priorities and sets out timescales for implementing change.

National Strategy

The following areas were taken from the National Shipbuilding Strategy and provided the initial discussion points in identifying key areas to foresight.
The key ambitions for the shipbuilding sector are as follows.

Green Technology

- By 2025 all new vessels for UK waters are designed with zero emission capabilities.
- By 2035 bunkering of zero emission fuels is widely available across the UK
- By 2050 the UK domestic shipping sector is net zero

Productivity

- UK civil shipyards achieve productivity equivalent to Northern European shipyards by 2030 helping them to win commercial business.
- UK naval shipyards to achieve international upper quartile levels of productivity by 2030.

Skills

- By 2024, complete skills foresighting for the shipbuilding sector and update in 2027 and 2030
- By 2024, complete modelling of skills shortages. Reduce skills shortfalls by 35% by 2027 and by 50% by 2030.
- Employers reporting improvements in skills availability and quality increases by 25% in 2024, 50% in 2027 & 75% in 2030.

Autonomy

- Develop a domestic regulatory framework for maritime autonomy, so the UK can lead the way within the International Maritime Organisation.
- Reduced crewing and autonomy will be a starting principle for all new Royal Navy vessels designed after 2030.

Exports

- By 2030, shipbuilding, boat building and marine engineering exports increase by 45%.

These ambitions will be realised by:

- Launching an empowered and independent National Shipbuilding Office to ensure strategic alignment across Government activity.
- Providing transparency on our future orders and a stable baseline of work through a 30 year cross-Government shipbuilding pipeline, including the new National Flagship
- Establishing a Maritime Capability Office to ensure the coherent pursuit of export opportunities.
- Developing a model for the Home Shipbuilding Credit Guarantee Scheme to level the playing field for domestic orders.
- Investing £206 million in a UK Shipping Office for Reducing Emissions to fund R&D in zero emission vessels and infrastructure, ensuring our place as global leader in green technology.
- Engaging with industry to deliver the Royal Navy Technology Priorities to provide battle winning capabilities to the Royal Navy.
- Creating a UK Shipbuilding Skills Taskforce to help ensure a pipeline of skilled workers into the future.
- Identifying Centres of Excellence to optimise the production of key systems and shipbuilding processes.
- Optimising our approach to naval shipbuilding by developing bespoke strategies and plans for the key shipbuilding elements.

This will enable

- The UK shipbuilding sector to be globally successful, innovative and sustainable.
- By 2030, the UK will be at the forefront of the technological and environmental innovations driving the sector.
- Domestic and export success will be built on high quality, innovative, value for money designs, equipment and services and enabled by a highly skilled and talented workforce; advanced infrastructure and production techniques and cross-Government policies.

Identifying Solutions to meet Challenges

Taking the objectives in the National Shipbuilding Strategy, NMIS and our initial stakeholders from the Shipbuilding Skills Taskforce carried out a series of workshops to explore the challenges and identify potential solutions where foresighting would be most impactful.

The objectives were to:

- Establish Challenge and Mission responses, suggesting potential Technologies and Solutions
- Prioritise Challenges, with their enabling technologies and Solutions, to inform future Foresighting Cycles
- Identify additional industry stakeholders to be approached using structured interviews to gather further information.
- Enable workshop participants to gain a better understanding of the Workforce Foresighting Challenge based approach.

Challenge Areas of interest

- Green propulsion

  "By 2025 all new vessels for UK waters are designed with zero emission capabilities."

- Productivity improvements

  "UK civil shipyards achieve productivity equivalent to Northern European shipyards by 2030 helping them to win commercial business"

Through developing and analysing the data, feedback from discussions was identified as being either:

- Challenges with their solutions that could be developed for future workforce foresighting analysis
  or
- Issues that will need to be reviewed and considered by conveners and leads in future discussions and not taken forward as workforce foresighting subjects (some being short term)

2.2 Potential and prioritised technology solutions to the challenge

The following table lists ranges of technology Solutions related to Challenges:

	Technology Solutions
Green Propulsion	• Hydrogen, Ammonia, Wind
Productivity	• **Data & AI** - Digital manufacturing data - Digital representations of people, product, facilities, processes etc. - Enterprise architecture systems & modelling - AI scheduling - AI supply chain optimisation - Cyber security for manufacturing data • **Robotics & Automation** - Robotic installation of primary systems - Design & manufacture of robotic systems for shipbuilding. - Programming & plant simulation - Welding, joining & inspection. - Confined space work - Installation of pipe runs. - Robotic welding of complex structures • **Design** - Design for remanufacture. - Design for circularity. - Design for advanced materials. - Design for additive manufacturing. Sustainable design

The selection of the initial foresighting topic by industry stakeholders was carried out by stakeholder interview and discussion to select the most appropriate subjects with wide application across the groups in the table above.

The wider stakeholder groups across the shipbuilding skills taskforce and UK shipbuilding industry have a diverse range of skills needs from craft skills in traditional boatbuilding through to high technology skills required for warship construction. This ensures that each part of the shipbuilding sector have different challenges and priorities and therefore we focussed on challenges that would have the widest potential application and impact higher percentages of the workforce.

This led to a concise list drawn from the table:

- Robotics & Automation
  - Autonomous robotics for installation in sub-optimal (confined / dangerous) spaces
  - Autonomous robotics for welding & joining in sub-optimal (confined / dangerous) spaces
  - Autonomous robotics for inspection in sub-optimal (confined / dangerous) spaces

- Data & AI
  - Smart data flow to enable more effective supply chain management
  - Use of AI for supply chain optimisation
  - Productivity improvements by data enabling deskless workers
  - Design for data enabled installation

After feedback from the wider stakeholder group, we focussed on automation and robotics for welding, joining and inspection as out initial foresighting topic. This was seen as having the widest applications and impact in the sector and would help address ongoing skills shortages in this area. The topic was refined further to include confined and dangerous spaces as this would deliver also help reduce personnel working in higher risk areas.

2.3 Workforce foresighting for chosen prioritised technology solution

The remainder of this report will now focus on automation & robotic systems for welding, joining and inspection. The scope of this Workforce Foresighting cycle excludes the particular welding, joining and inspection technologies that will be paired with the robotic systems and will focus solely on the design, installation, commissioning of systems and their ongoing maintenance and operation.
Increasing the use of automation and robotic systems for this application will help improve productivity and alleviate the well-publicised shortage of skilled welding engineers. In addition, automating some of the tasks that require personnel to work within confined spaces, will assist in reducing the health & safety risk. Although this report focusses on the shipbuilding industry, the skills and job roles developed here will apply across many industrial sectors, including:

- Offshore / onshore wind fabrication
- Oil & Gas infrastructure.
- Construction
- Infrastructure
- Rail Vehicles

In choosing to focus on Automation & robotic systems for welding, joining and inspection, a tighter and more clearly defined scope for the first of the workforce foresighting cycles and subsequent analysis was able to be defined. This provided the opportunity to review, and where necessary, build on the known skill sets that were already in existence for similar solutions.

2.4 Current and predicted scale of technology deployment in UK

Shipbuilding is a strategically important sector to the UK, supporting over 44,600 jobs across the four nations in 2021 and adding £3.1bn to the UK economy in 2022.

Scottish shipbuilding alone now employs over 7000 people with more than 1000 apprentices.

A key indicator of the potential impact of the chosen technology solution is highlighted in the following extract from the National Shipbuilding Strategy:

“As set out in the Maritime 2050 Strategy, the skills profile of the maritime sector will change significantly over the next 30 years. The importance of STEM subjects will only increase as jobs become more skilled and data driven in response to new technology. Industry roles will be multidisciplinary, potentially requiring the ability to create, operate and maintain autonomous and technological systems.”

2.5 Key Stakeholders in industry and government

Participating stakeholders collectively ensure that the output from the foresighting cycle on Automation & robotic systems for welding, joining and inspection in confined spaces, integrating perspectives from innovation, education, industry, and policymaking to address the future needs. This included:

- Convener: National Manufacturing Institute Scotland (Manufacturing Skills Academy)
- Industry Sponsor: BAE (Naval Ships)
- Innovate UK
- If ATE (Institute for Apprenticeships and Technical Education)
- Shipbuilding Skills Taskforce
- Shipyard of the future working group
- National Shipbuilding Office
- Manufacturing Technology Centre (MTC)
- Advanced Manufacturing Research Centre (AMRC)
- CPI
- MARI UK
- Prospect Trade Union
- Skills Development Scotland
- University of Strathclyde
- University of Glasgow
- Liverpool John Moore University
- Newcastle University
- Intermarine
- Babcock
- University of Southampton
- KUKA
- Fanuc

2.7 Background information and references

National Shipbuilding Strategy (Refresh)
https://www.gov.uk/government/publications/refresh-to-the-national-shipbuilding-strategy

UK Shipbuilding Skills Taskforce
https://www.gov.uk/government/groups/uk-shipbuilding-skills-taskforce-uksst

A Step Change in UK Shipbuilding Skills
https://www.cityofglasgowcollege.ac.uk/uk-shipbuilding-skills-taskforce-report

3.0 Results – Findings, Data and Insight

3.0 Results – Findings, Data and Insight

3.1 Findings, methodology and presentation

This findings report summarises the foresighting cycle undertaken.
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.

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 the changes 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 demonstrates 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 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 provision to guide further detailed investigation.

Highlighted changes to future provision

The report identifies suggested 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 programme.

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 Technologist 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 of Design and Implementation
- Decrease in Enterprise

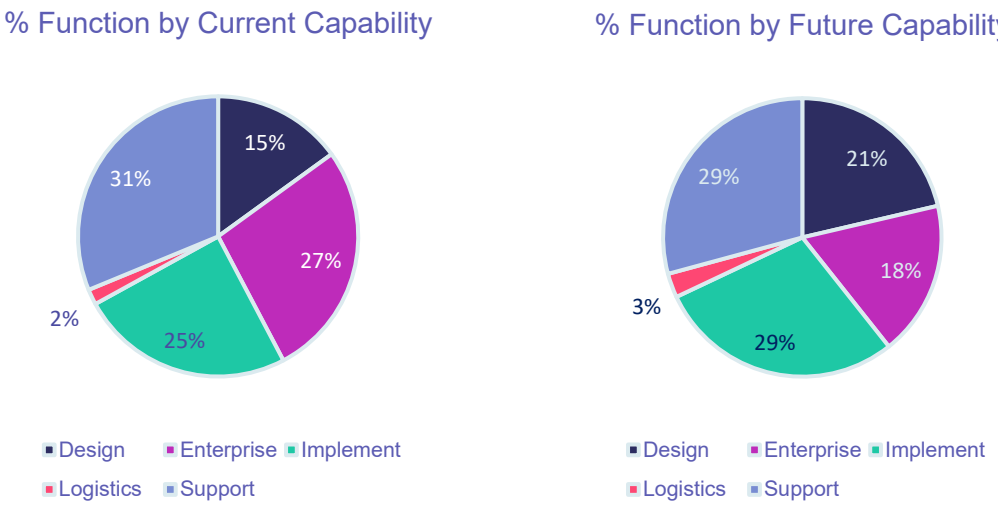


Figure 1: Current and Future Supply Chain - Capability Functions summary by %

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 thew five main Functions. The domain data is ranked with greatest change at 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 that highlight the domain changes across different cycles, will have some variability and empty rows due to the nature of the data.

Design Domains:

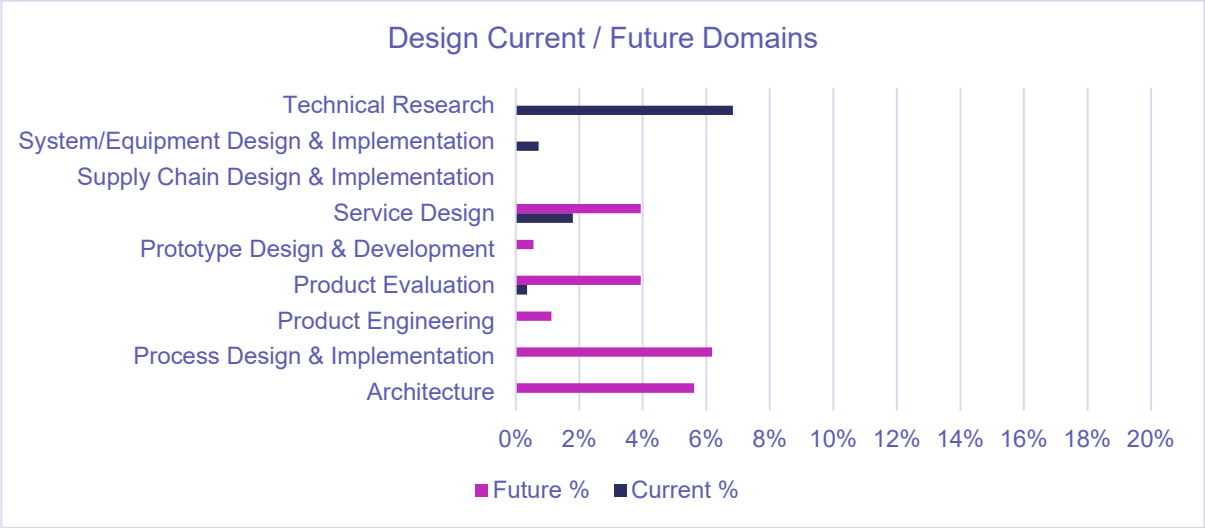


Figure 2: Design Function - Current to Future - Domain changes

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.

Enterprise Domains:

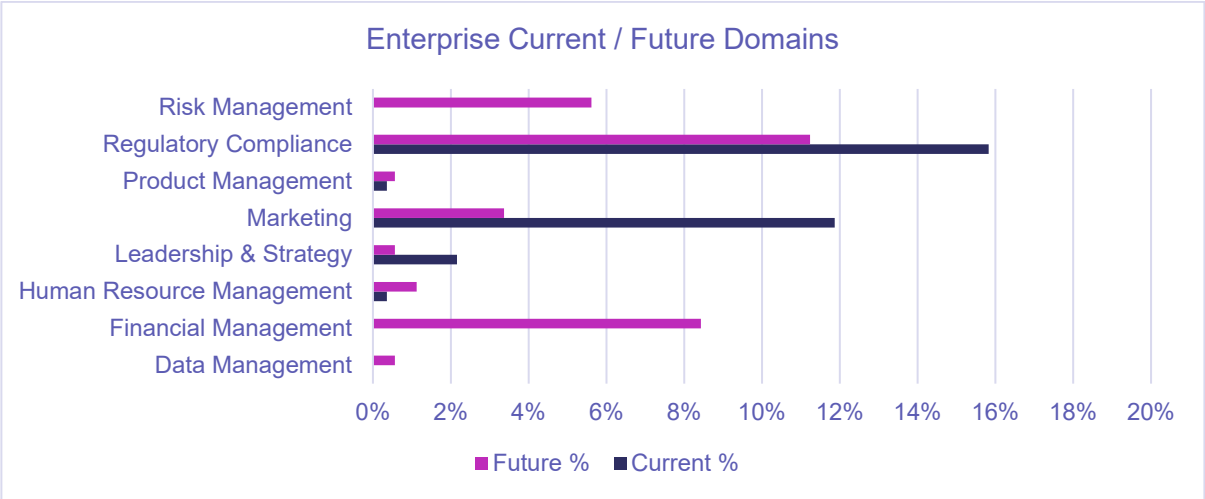


Figure 3: Enterprise Function - Current to Future - Domain changes

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.

Implementation Domains:

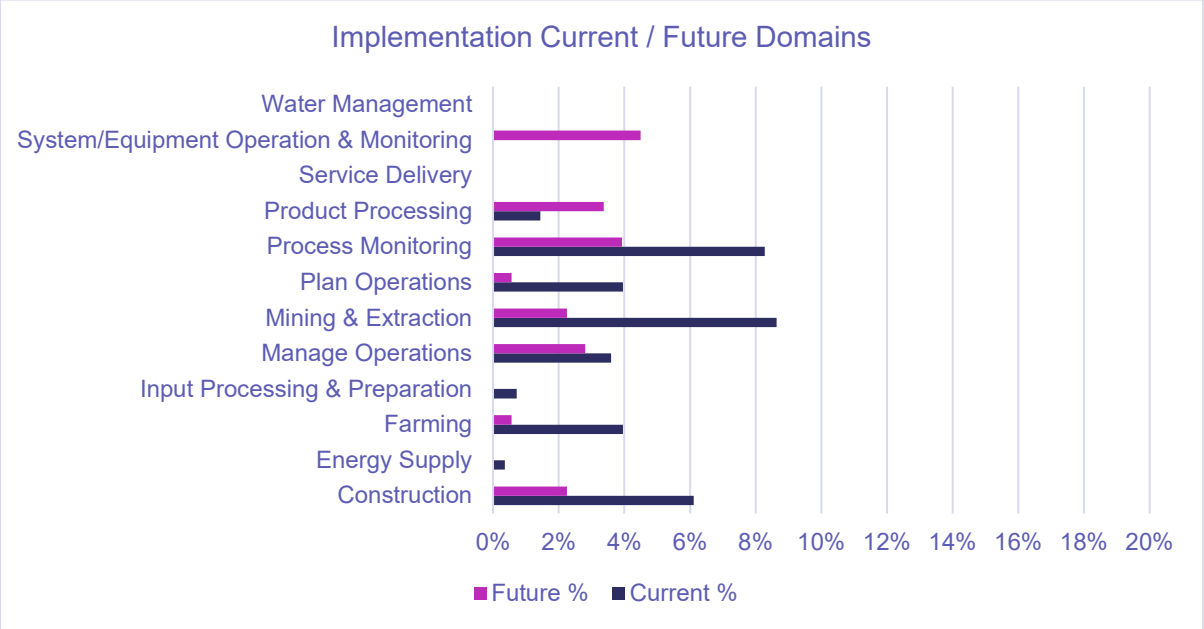


Figure 4: Implement Function - Current to Future - Domain changes

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

Logistics Domains:

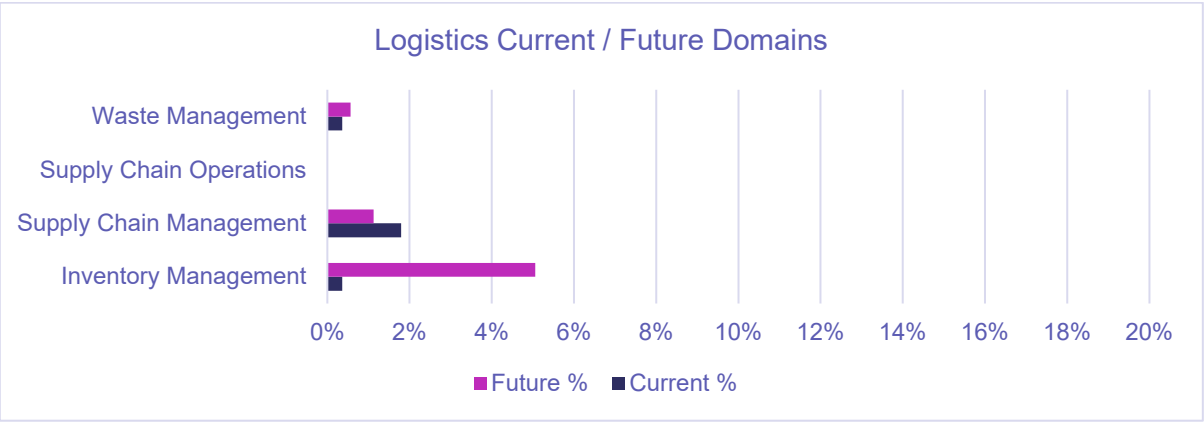


Figure 5: Logistics Function - Current to Future - Domain changes

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

Support Domains:

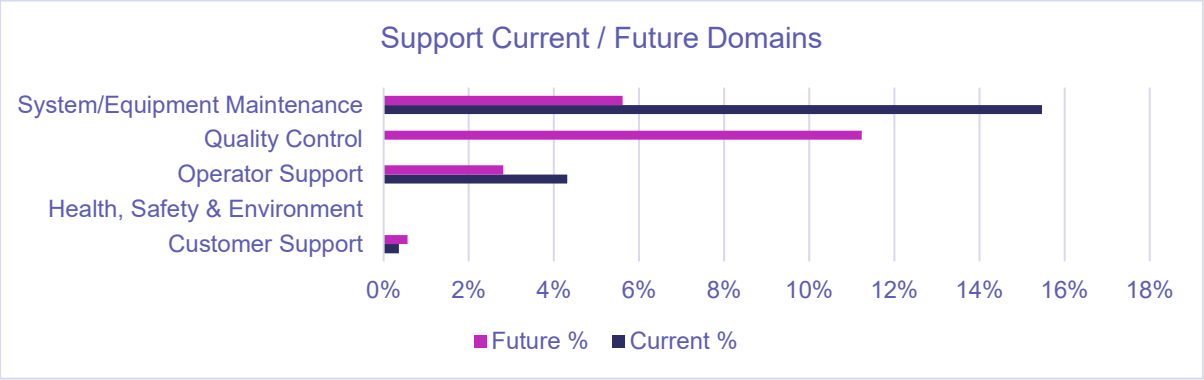


Figure 6: Support Function - Current to Future - Domain changes

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

Visualisation Instructions

Detailed instructions can be found in the appendix.

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 (section 3.2) 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.

Please note that this report is based on the functionality of the Visualisation report from July 2024 - However due to the Foresighting Hub continued development of the system / processes and tools the visualisation tool, there may be additional tabs / information that has been developed following this report publication.
Following the publication of the report new standards may have come about which will not feature in this data set. If you have any questions, please contact the Workforce Foresighting Hub.

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. Ship Designer
2. Shipbuilder
3. Systems Integrator
4. Robotic Equipment Supplier
5. End Effector Manufacturers
6. Regulatory Operations

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.

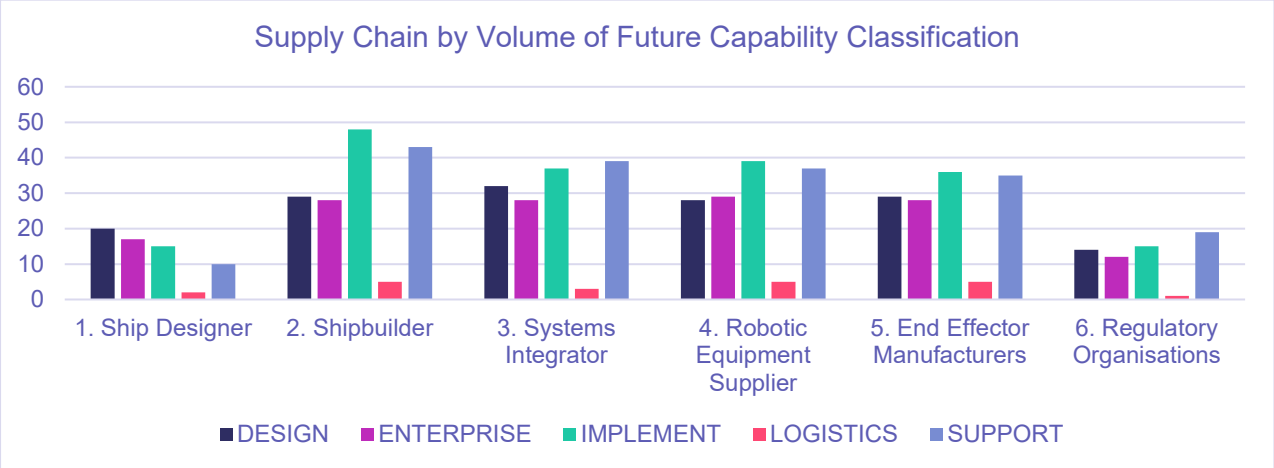


Figure 7: Value Chain by Volume of Future Capability Classification

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 Level.

Visualisation Instructions

Detailed instructions can be found in the appendix.

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 Levels

The foresighting process uses the concept of Role Levels 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 Levels were determined through the workshops:

1. Qualified/ Skilled Operator
2. Technician
3. Engineer
4. Senior Engineer

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:

	1. Qualified/ Skilled Operator	2. Technician	3. Engineer	4. Senior Engineer
Awareness	3%	2%	1%	4%
Practitioner	55%	58%	35%	24%
Expert	43%	40%	64%	72%

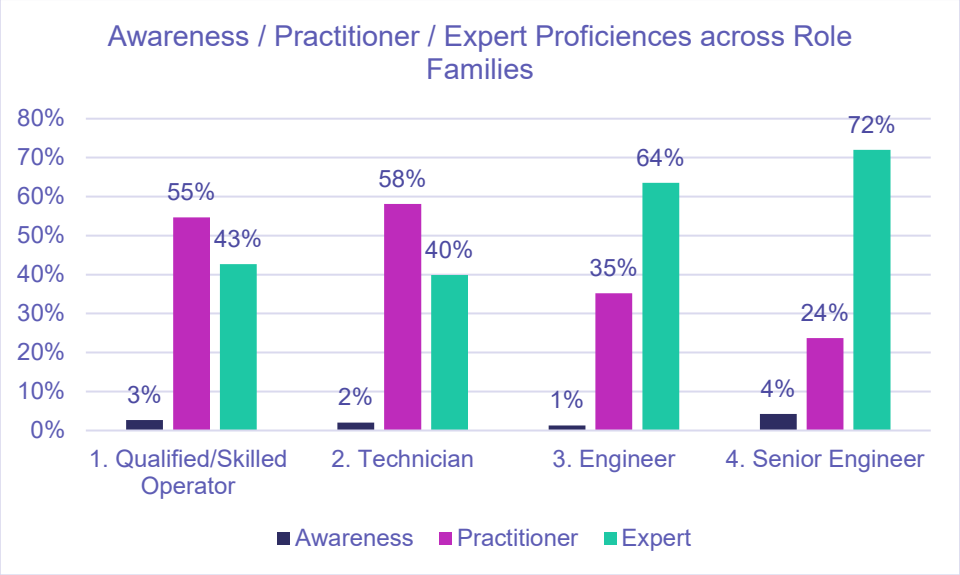


Figure 8: Proficiency details by Role Family

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 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.

Qualified/ Skills Operator Role Level FOPs:

In this cycle the Technician / Operator role family was defined as occupations and roles requiring Level 3 qualifications or apprenticeships.

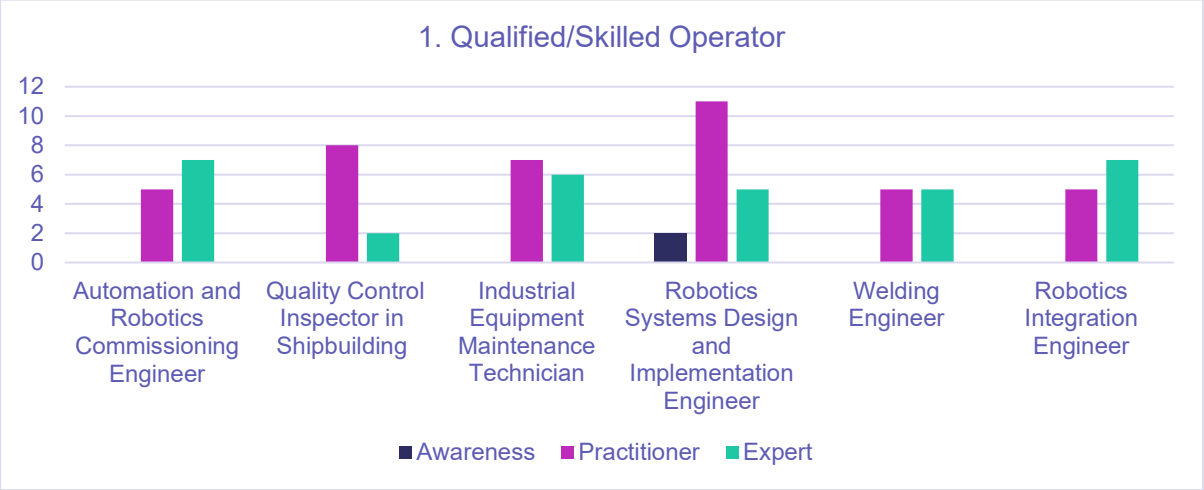


Figure 9: Priority FOPs – Qualified/ Skilled Operator Role Family

Technician Role Level FOPs:

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

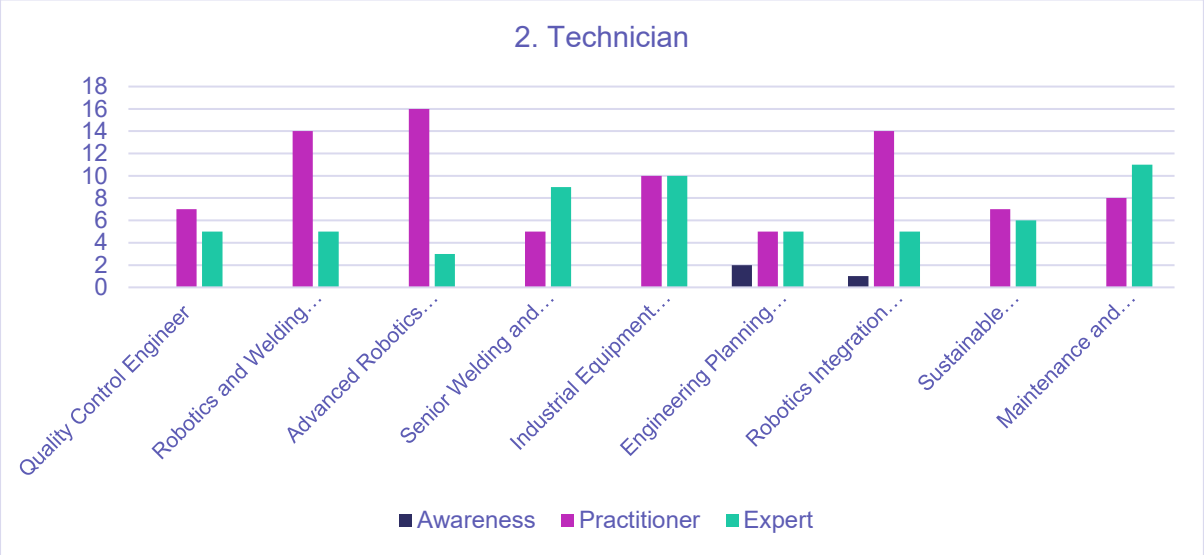


Figure 10: Priority FOPs – Technician Role Level

Engineer Role Level FOPs:

In this cycle the Senior Engineer role family was defined as occupations and roles requiring Level 5/6 qualifications or apprenticeships.

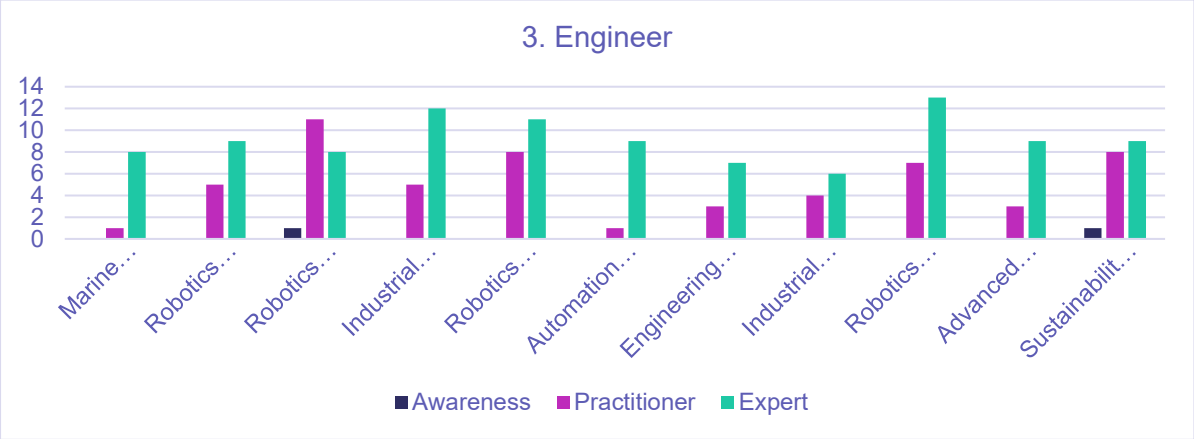


Figure 11: Priority FOPs - Engineer Role Level

Senior Engineer Role Family FOPs:

In this cycle the Senior Engineer role family was defined as occupations and roles requiring Level 5/6 qualifications or apprenticeships.

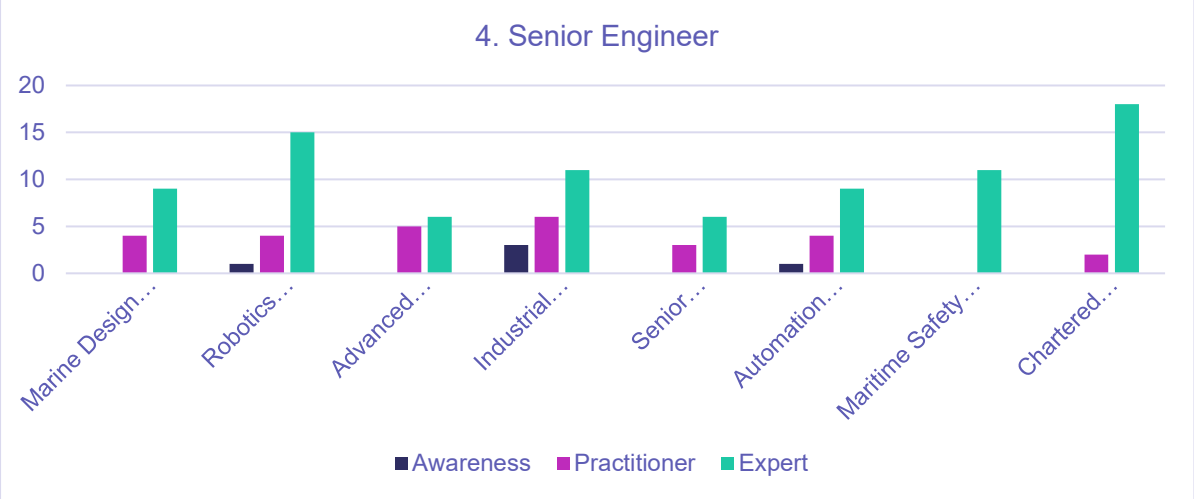


Figure 12: Priority FOPs - Senior Engineer Role Family

Visualisation Instructions

Detailed instructions can be found in the appendix.

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.

3.4 Future Occupational Profiles compared with current provision

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 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

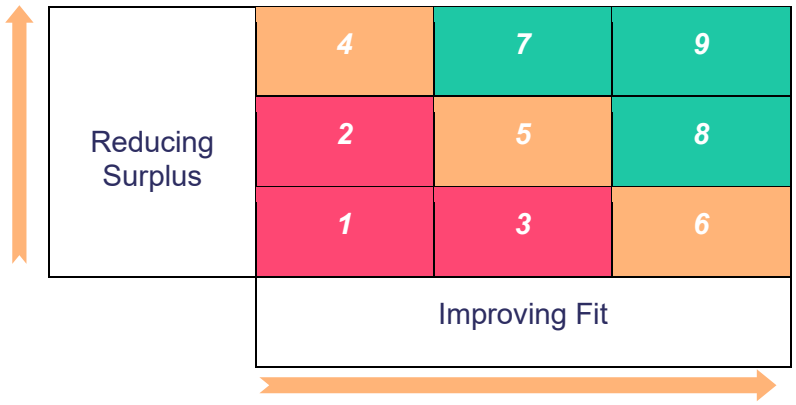


Figure 12: Fit Factor scores and Suitability Grid

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 – for standards that have good coverage of FOPs.
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 – for standards that have only partial coverage of FOPs.
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 coverage of FOPs.
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 4. Robotic Equipment Supplier as an example, all four role families are represented, and from looking at the data extracted we can identify that there is some coverage of Future Occupations in the role of Robotics System Design and Implementation Engineer based on the current IFATE standards.

The IFATE standards provision is slightly stronger for the Shipbuilder role groups than for Ship Designer or Systems Integrator, however there is not a truly leading role group and there are no 'Good suitability's'.

Supply Chain Partner – 1. Ship Designer

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
1. Qualified/Skilled Operator	Quality Control Inspector in Shipbuilding	
2. Technician	Robotics and Welding Engineer	
2. Technician	Robotics Integration Engineer	
2. Technician	Sustainable Manufacturing Engineer	
3. Engineer	Industrial Equipment Engineer	
3. Engineer	Industrial Standards and Safety Compliance Engineer	
4. Senior Engineer	Maritime Safety and Compliance Engineer	

Detailed breakdown:

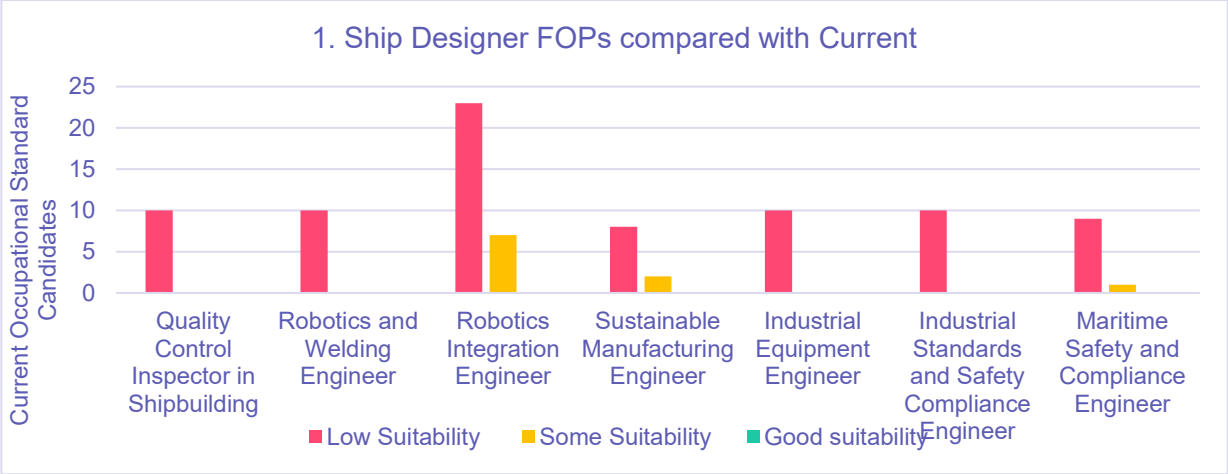


Figure 14: 1. Ship Designer - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner – 2. Shipbuilder

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
1. Qualified/Skilled Operator	Quality Control Inspector in Shipbuilding	
2. Technician	Robotics and Welding Engineer	
2. Technician	Robotics Integration Engineer	
2. Technician	Sustainable Manufacturing Engineer	
3. Engineer	Industrial Equipment Engineer	
3. Engineer	Industrial Standards and Safety Compliance Engineer	
4. Senior Engineer	Maritime Safety and Compliance Engineer	

Detailed breakdown:

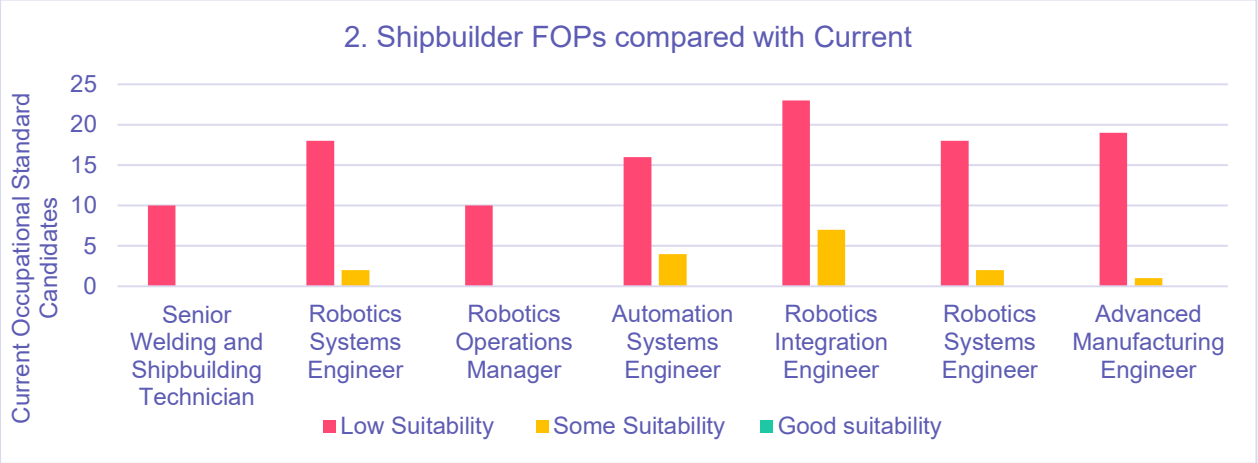


Figure 15: 2. Shipbuilder - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner – 3. Systems Integrator

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
1. Qualified/ Skilled Operator	Industrial Equipment Maintenance Technician	
3. Engineer	Robotics Systems Production Engineer	
4. Senior Engineer	Senior Engineering Analyst	

Detailed breakdown:

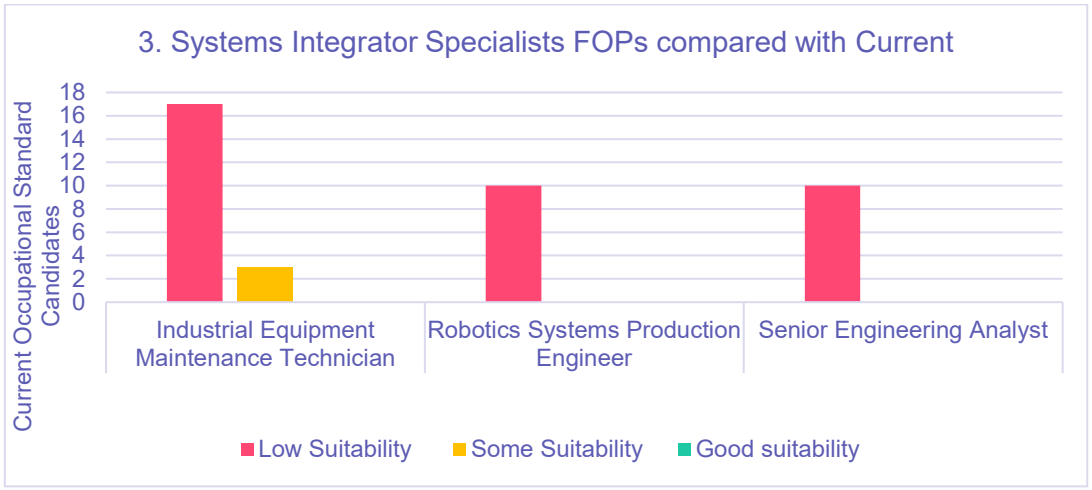


Figure 16: 3. Systems Integrator Specialists - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner – 4. Robotic Equipment Supplier

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
1. Qualified/Skilled Operator	Robotics Systems Design and Implementation Engineer	
2. Technician	Advanced Robotics Development Engineer	
2. Technician	Industrial Equipment Maintenance Technician	
3. Engineer	Engineering Process Coordinator	
3. Engineer	Advanced Manufacturing Engineer	
4. Senior Engineer	Industrial Robotics Engineer	

Detailed breakdown:

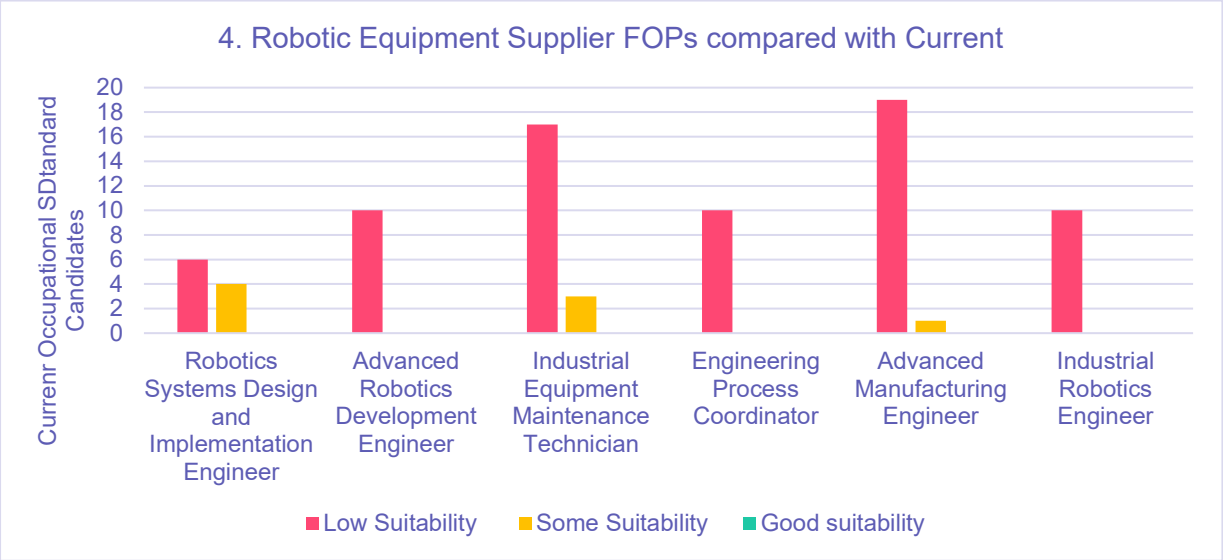


Figure 17: 4. Robotic Equipment Supplier - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner – 5. End Effector Supplier

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
2. Technician	Maintenance and Facilities Engineer	
3. Engineer	Sustainability Engineer	
4. Senior Engineer	Automation Systems Engineer	
4. Senior Engineer	Chartered Engineer in Industrial Automation	

Detailed breakdown:

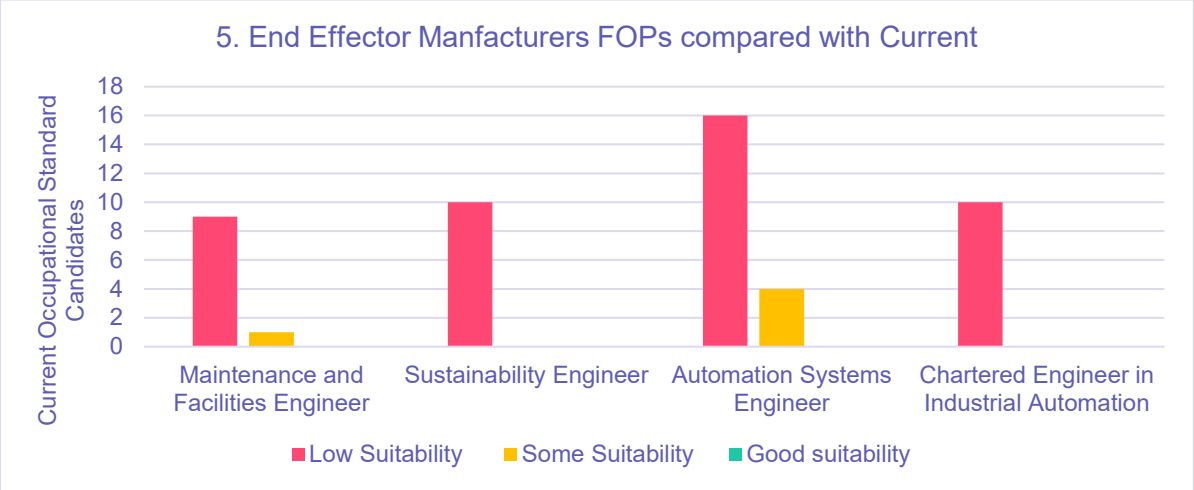


Figure 18: Maintenance & Operation - Count of current provision (IfATE Standards) and suitability to FOPs

Supply Chain Partner - Maintenance and Operation

Role Family	Selected Future Occupational Profiles	Current Suitability Summary
1. Qualified/Skilled Operator	Automation and Robotics Commissioning Engineer	
1. Qualified/Skilled Operator	Welding Engineer	
1. Qualified/Skilled Operator	Robotics Integration Engineer	
2. Technician	Quality Control Engineer	
2. Technician	Engineering Planning Analyst	
3. Engineer	Marine Structural Engineer	
4. Senior Engineer	Marine Design Engineer	

Detailed breakdown:

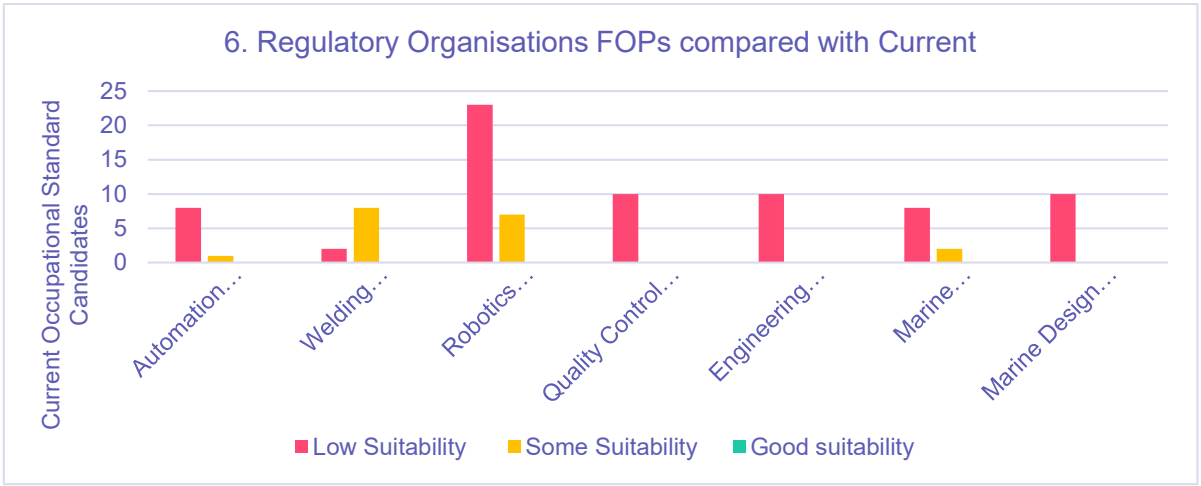


Figure 19. Maintenance & Operation - Count of current provision (IfATE Standards) and suitability to FOPs

4.4 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 Occupation Profiles	Low Suit-ability	Some Suit-ability	Good Suit-ability	Overall Suitability RAG
1. Qualified/ Skilled Operator	1. Ship Designer	Quality Control Inspector in Shipbuilding	10	0	0	
2. Technician	1. Ship Designer	Robotics and Welding Engineer	10	0	0	
2. Technician	1. Ship Designer	Robotics Integration Engineer	23	7	0	
2. Technician	1. Ship Designer	Sustainable Manufacturing Engineer	8	2	0	
3. Engineer	1. Ship Designer	Industrial Equipment Engineer	10	0	0	
3. Engineer	1. Ship Designer	Industrial Standards and Safety Compliance Engineer	10	0	0	
4. Senior Engineer	1. Ship Designer	Maritime Safety and Compliance Engineer	9	1	0	
2. Technician	2. Shipbuilder	Senior Welding and Shipbuilding Technician	10	0	0	
3. Engineer	2. Shipbuilder	Robotics Systems Engineer	18	2	0	
3. Engineer	2. Shipbuilder	Robotics Operations Manager	10	0	0	
3. Engineer	2. Shipbuilder	Automation Systems Engineer	16	4	0	
3. Engineer	2. Shipbuilder	Robotics Integration Engineer	23	7	0	
4. Senior Engineer	2. Shipbuilder	Robotics Systems Engineer	18	2	0	
4. Senior Engineer	2. Shipbuilder	Advanced Manufacturing Engineer	19	1	0	
1. Qualified/ Skilled Operator	3. Systems Integrator	Industrial Equipment Maintenance Technician	17	3	0	
3. Engineer	3. Systems Integrator	Robotics Systems Production Engineer	10	0	0	
4. Senior Engineer	3. Systems Integrator	Senior Engineering Analyst	10	0	0	
1. Qualified/ Skilled Operator	4. Robotic Equipment Supplier	Robotics Systems Design and Implementation Engineer	6	4	0	
2. Technician	4. Robotic Equipment Supplier	Advanced Robotics Development Engineer	10	0	0	
2. Technician	4. Robotic Equipment Supplier	Industrial Equipment Maintenance Technician	17	3	0	
3. Engineer	4. Robotic Equipment Supplier	Engineering Process Coordinator	10	0	0	
3. Engineer	4. Robotic Equipment Supplier	Advanced Manufacturing Engineer	19	1	0	
4. Senior Engineer	4. Robotic Equipment Supplier	Industrial Robotics Engineer	10	0	0	
2. Technician	5. End Effector Manufacturers	Maintenance and Facilities Engineer	9	1	0	
3. Engineer	5. End Effector Manufacturers	Sustainability Engineer	10	0	0	
4. Senior Engineer	5. End Effector Manufacturers	Automation Systems Engineer	16	4	0	
4. Senior Engineer	5. End Effector Manufacturers	Chartered Engineer in Industrial Automation	10	0	0	
1. Qualified/ Skilled Operator	6. Regulatory Organisations	Automation and Robotics Commissioning Engineer	8	1	0	

1. Qualified/ Skilled Operator	6. Regulatory Organisations	Welding Engineer	2	8	0	
1. Qualified/ Skilled Operator	6. Regulatory Organisations	Robotics Integration Engineer	23	7	0	
2. Technician	6. Regulatory Organisations	Quality Control Engineer	10	0	0	
2. Technician	6. Regulatory Organisations	Engineering Planning Analyst	10	0	0	
3. Engineer	6. Regulatory Organisations	Marine Structural Engineer	8	2	0	
4. Senior Engineer	6. Regulatory Organisations	Marine Design Engineer	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.

There are no FOPs with good suitability, however, the FOPs with some suitability score resulting from their comparison with current IFATE standards and provision are:

1. Robotics Integration Engineer (across 1. Qualified/Skilled Operator / 2. Technician / 3. Engineer)
2. Robotics Systems Design and Implementation Engineer
3. Welding Engineer

Suitable standards are listed in the table below:

Role Family	Future Occupation Profiles	IfATE Apprenticeship Standard	Suitability
2. Technician	1. Ship Designer	Robotics Integration Engineer	
3. Engineer	2. Shipbuilder	Robotics Integration Engineer	
1. Qualified/ Skilled Operator	4. Robotic Equipment Supplier	Robotics Systems Design and Implementation Engineer	
1. Qualified/ Skilled Operator	6. Regulatory Organisations	Welding Engineer	
1. Qualified/ Skilled Operator	6. Regulatory Organisations	Robotics Integration Engineer	

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 Good 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 the lowest scores are:

- Quality Control Inspector in Shipbuilding
- Robotics and Welding Engineer
- Sustainable Manufacturing Engineer
- Industrial Equipment Engineer
- Industrial Standards and Safety Compliance Engineer
- Maritime Safety and Compliance Engineer
- Senior Welding and Shipbuilding Technician
- Robotics Systems Engineer
- Robotics Operations Manager
- Automation Systems Engineer
- Robotics Systems Engineer
- Advanced Manufacturing Engineer
- Industrial Equipment Maintenance Technician
- Robotics Systems Production Engineer
- Senior Engineering Analyst
- Advanced Robotics Development Engineer
- Industrial Equipment Maintenance Technician
- Engineering Process Coordinator
- Advanced Manufacturing Engineer
- Industrial Robotics Engineer
- Maintenance and Facilities Engineer
- Sustainability Engineer
- Automation Systems Engineer
- Chartered Engineer in Industrial Automation
- Automation and Robotics Commissioning Engineer
- Quality Control Engineer
- Engineering Planning Analyst
- Marine Structural Engineer
- Marine Design Engineer

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 dropdowns. 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 KBSs 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 Appendices

4.0 Appendices

Section	Title
4.1	Mission – What is workforce foresighting
4.2	List of participants
4.3	Cycle timeline
4.4	Access to output data - link and authorisation
4.5	Glossary - common language
4.6	Visualisation links and illustrations
4.7	Supply Chain Capabilities

4.1 Mission – What is workforce foresighting?

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.

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.

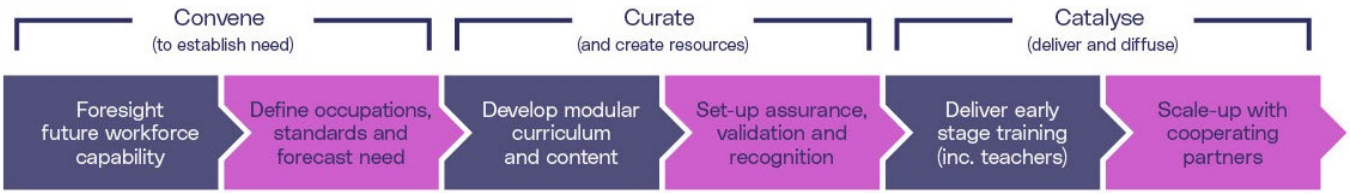


Figure 1: The Skills Value Chain

Workforce foresighting

Using the Skills Value Chain approach, the UK can 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.

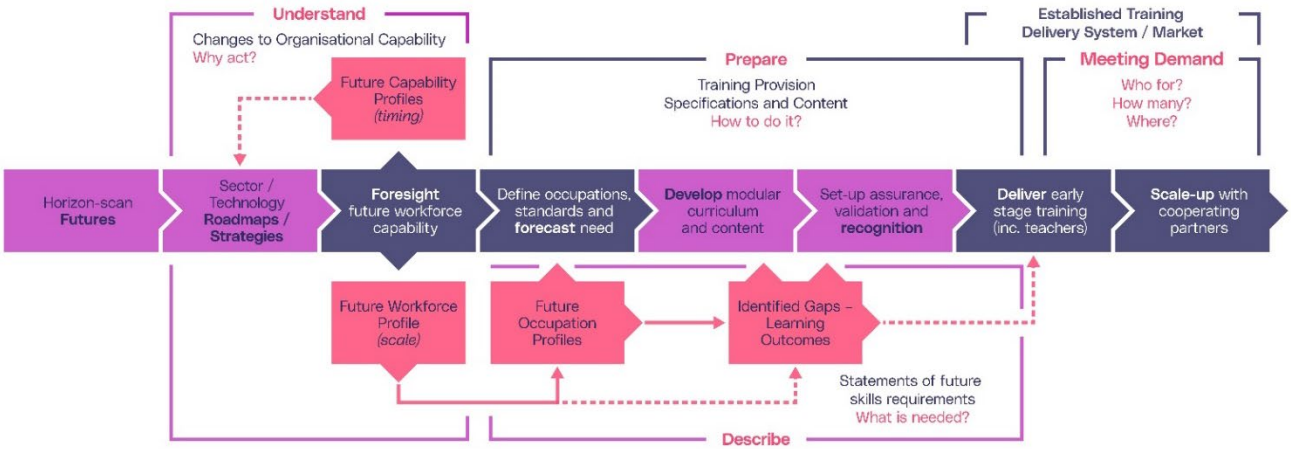


Figure 2: Workforce Foresighting & Skills Value Chain

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 Workforce Foresighting Hub team are constantly evolving and improving the detailed workshop process and workshop approach, but 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 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

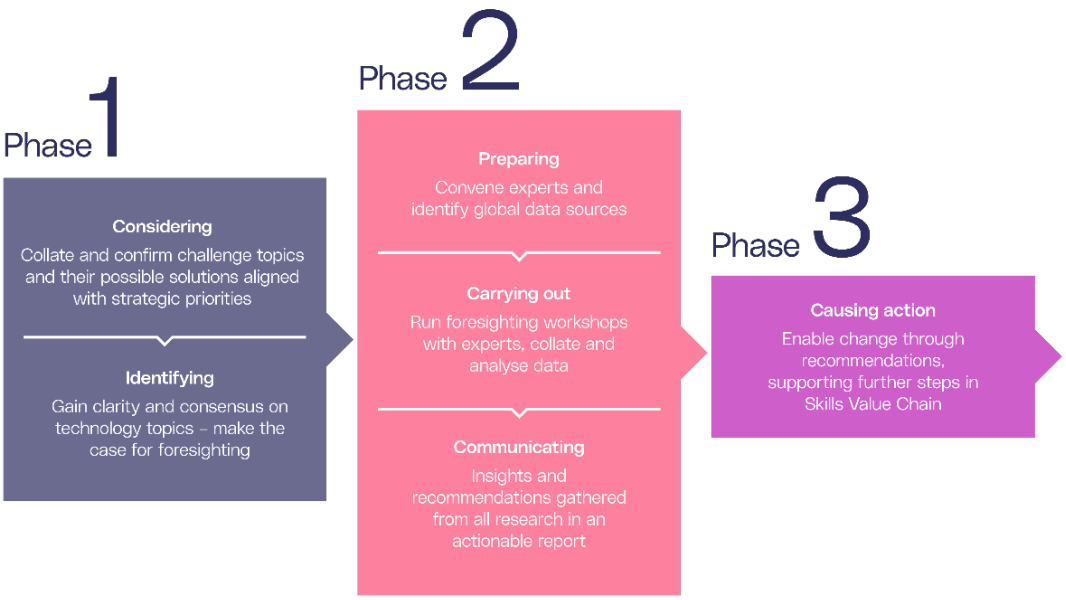


Figure 3 - The workforce foresighting process

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.

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 Workforce Foresighting Hub 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 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.

4.2 List of Participants

Industry Participants	Skills Participants	Technology Participants
BAE Naval Ships Babcock Intermarine MARI UK	NMIS Manufacturing skills academy University of Strathclyde University of Glasgow University of Southampton John Moore University University of Newcastle	NMIS MTC AMRC KUKA Fanuc

4.3 Cycle timeline

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

4.4 Access to output data - link and authorisation

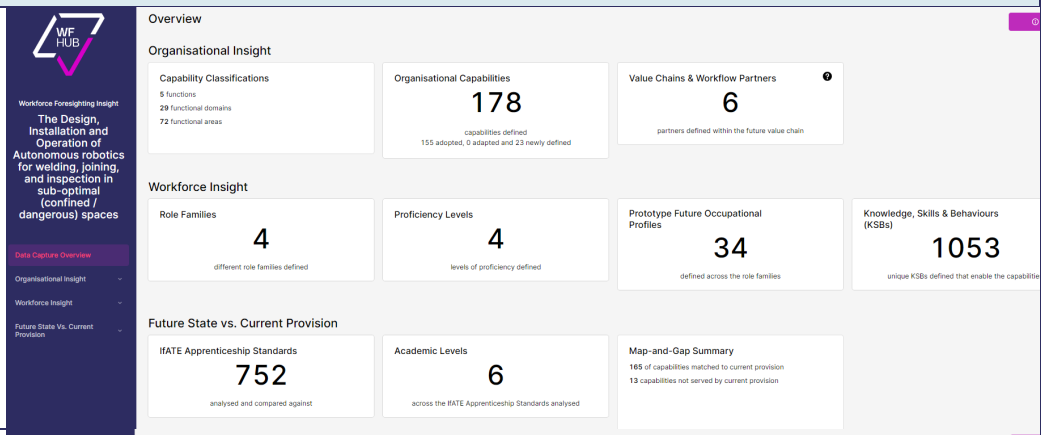
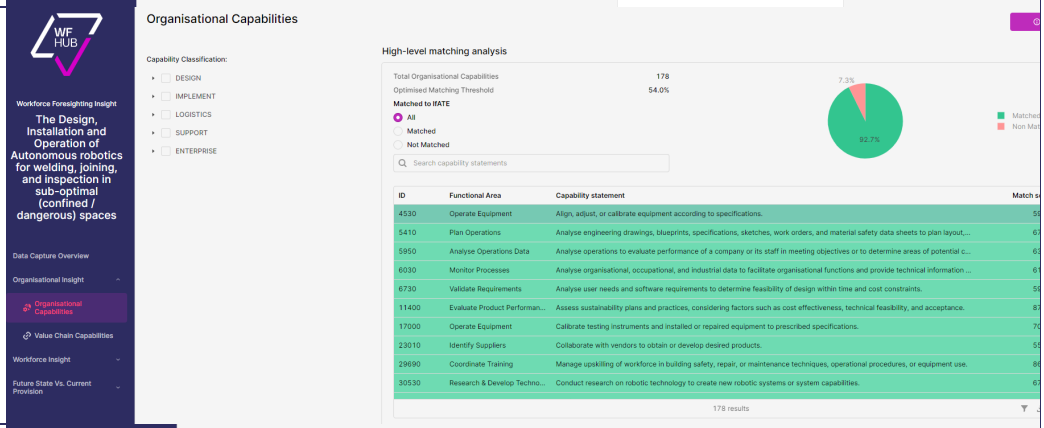
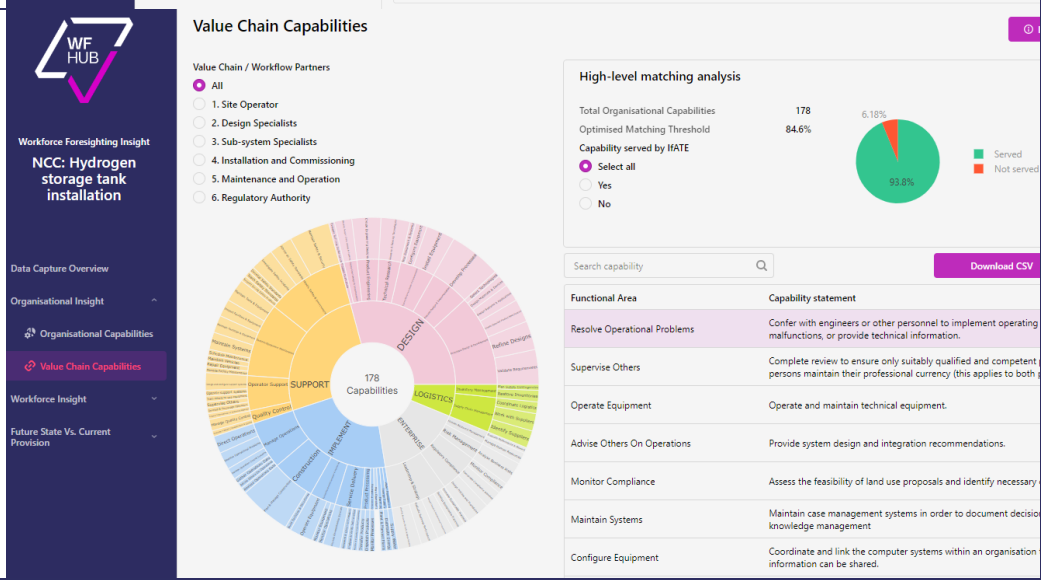
Add link

4.5 Glossary - common language

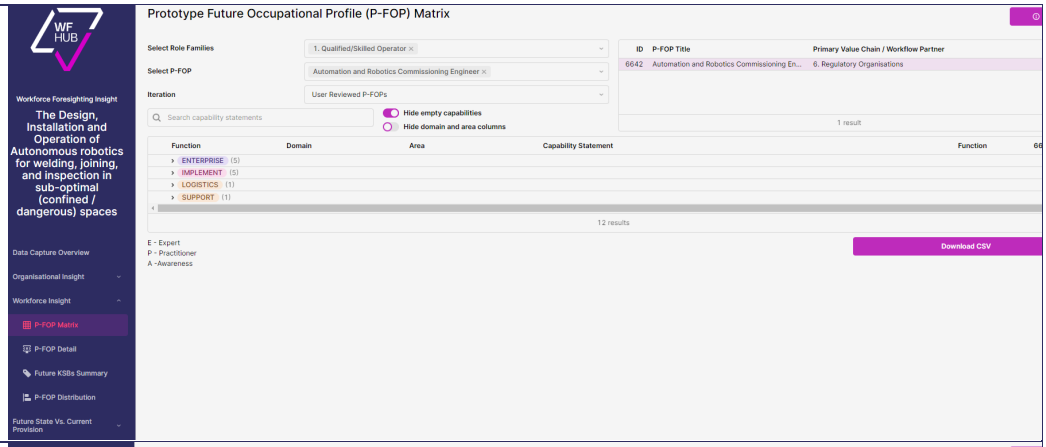
Term	Definition
Impact Domains	Innovate UK domains used as Strategic Categories to assist setting and monitoring priorities
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary
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

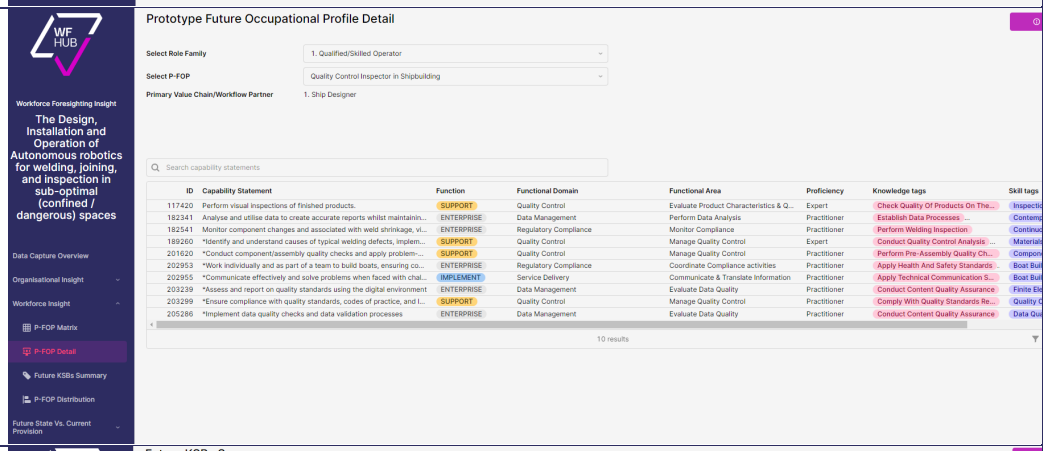
4.6 – Visualisation links and Illustrations

Link to Visualisation	View of data
Data Capture Overview	
Organisational Capabilities	
Value Chain Capabilities	

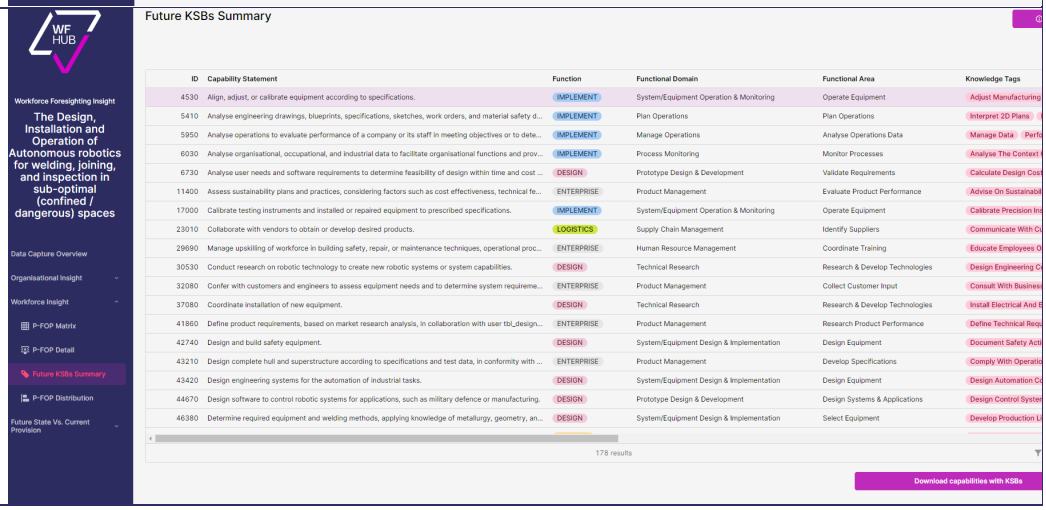
P-FOP Matrix

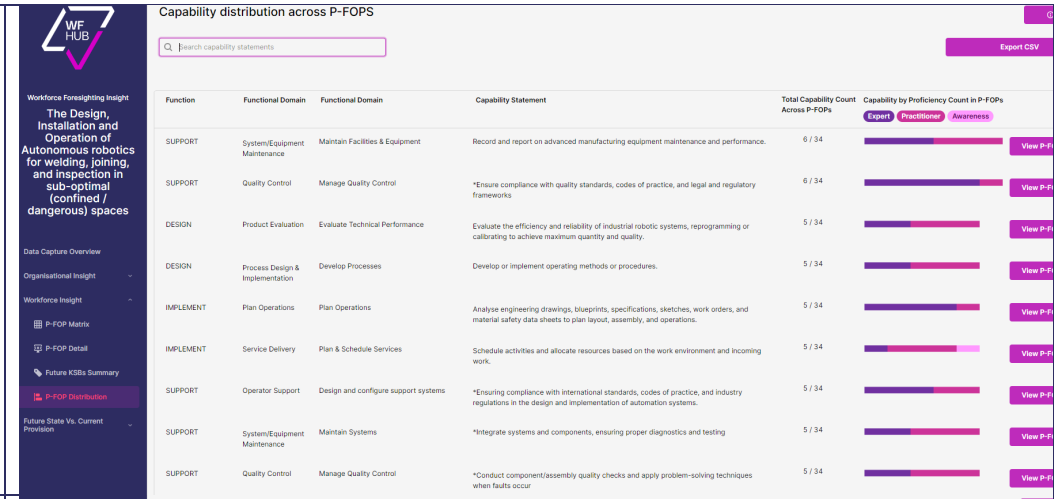
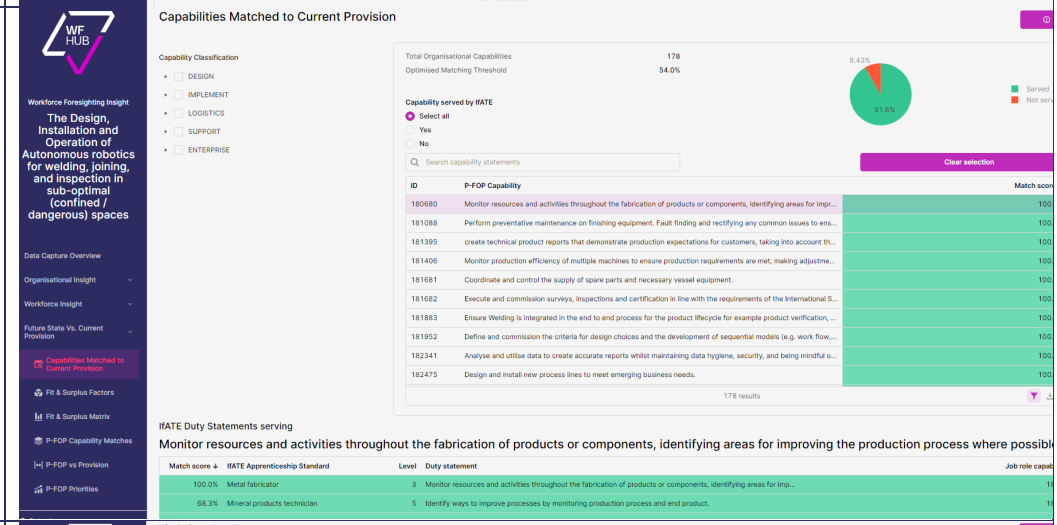
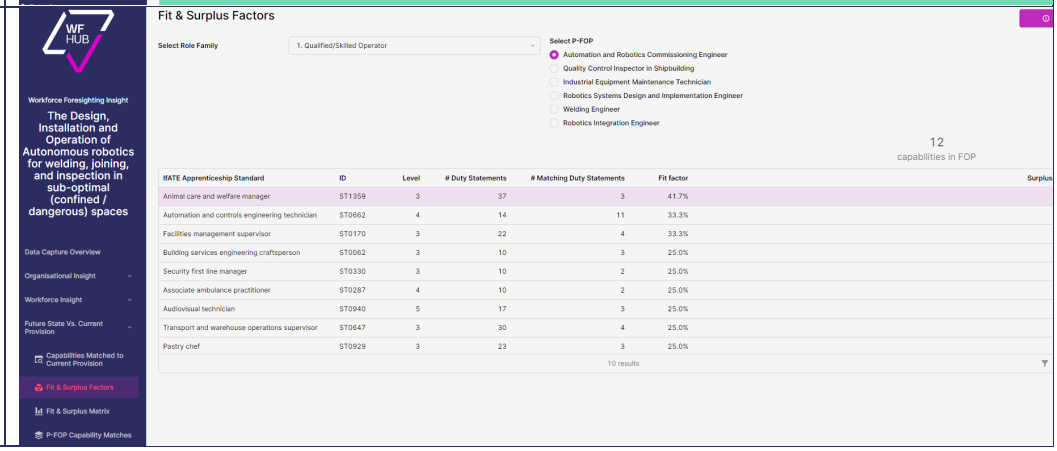


P-FOP Detail

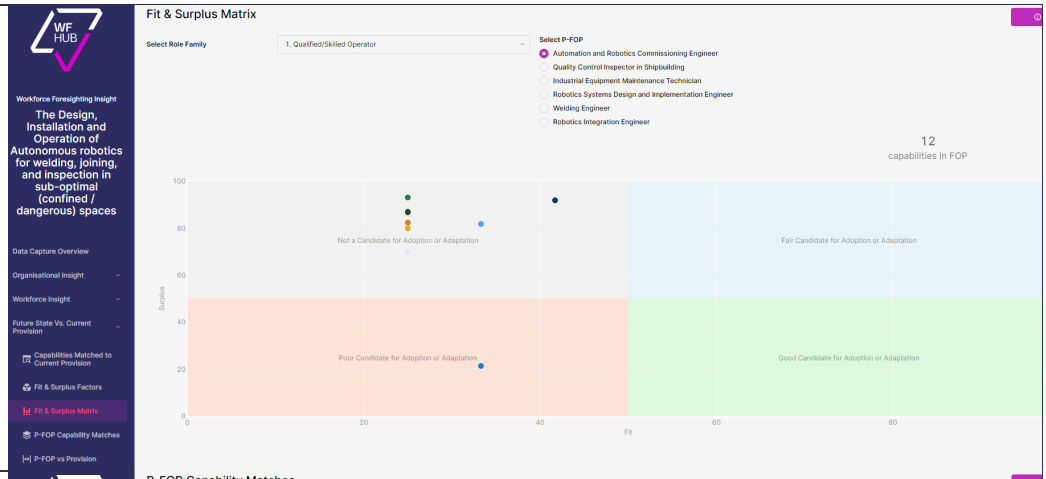


Future KBSs Summary

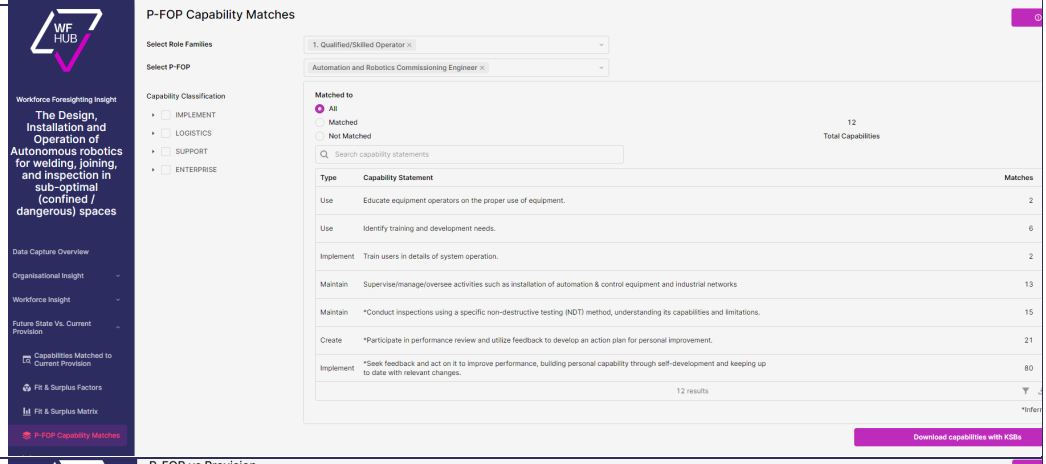


Capability distribution across P-FOPS	
Capabilities Matched to Current Provision	
Fit & Surplus Factors	

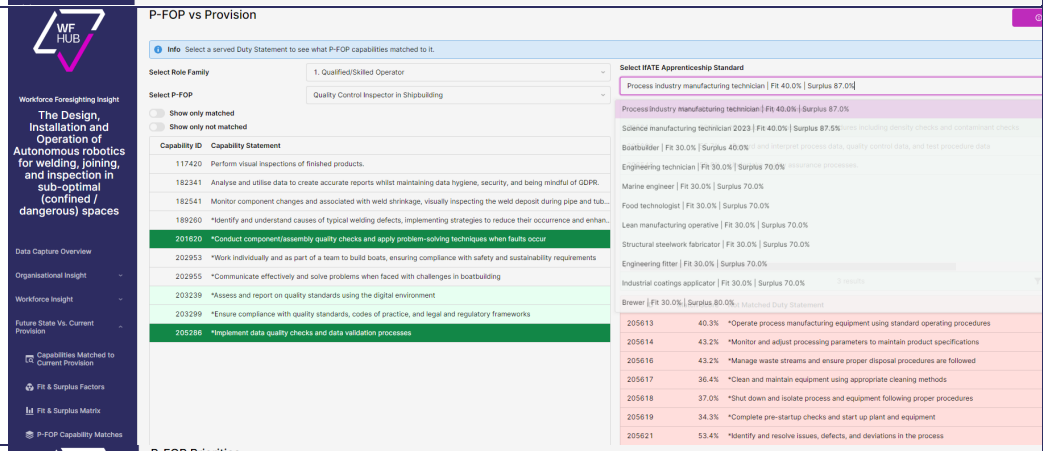
Fit & Surplus Matrix



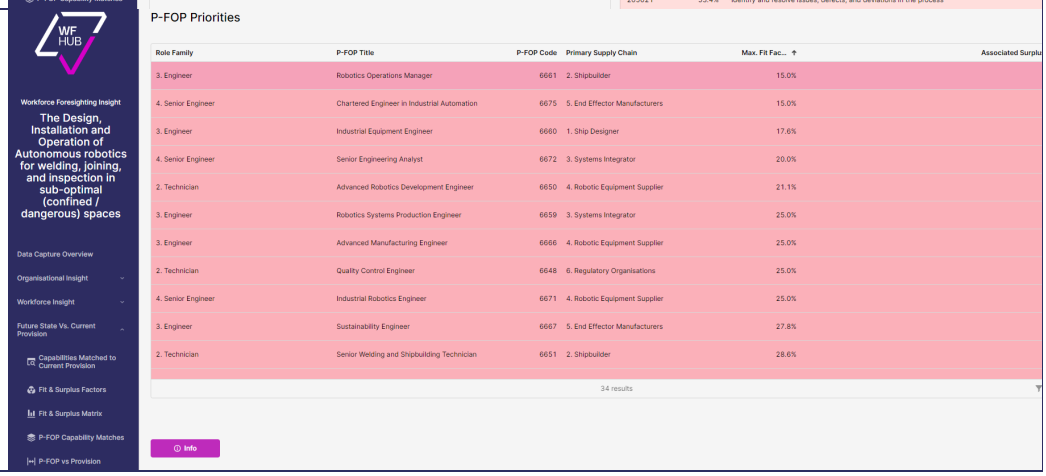
P-FOP Capability Matches



P-FOP- vs Provision



P-FOP Priorities



4.7 – 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. Ship Designer	- 66 organisational capabilites with 9 not adequately covered by existing IfATE provision. - Key areas for future development include design related activities, development of standards / guidence and benchmarking new processes.
2. Shipbuilder	- 154 organisational capabilities with 12 not edequately covered by existing IfATE provision - Key areas for development include method development for welding processes, process and cost evaluation, robotic repair & maintenance and development of standards / guidence.
3. Systems Integrator	- 140 organisational capabilites with 12 not adequately covered by existing IfATE provision. - Key areas for future development include benchmarking product performance, robotic repair & maintenance procedures and upskilling and development of equipment specifications
4. Robotic Equipment Supplier	- organisational capabilites with 11 not adequately covered by existing IfATE provision. - Key areas for development include process and cost evaluation, robotic repair & maintenance, development & assesment of product technical capabilities and upskilling existing personnel for new market.
5. End Effector Manufacturers	- 135 organisational capabilites with 10 not adequately covered by existing IfATE provision. - Key areas for development include design / process / cost evaluation and specification and upskilling workforce for new markets
6. Regulatory Organisations	- 62 organisational capabilities with 4 not adequately covered by existing IfATE provision. - Key areas for development include development of new standards & methods.