Workforce Foresighting Hub

Adopting NDT analysis systems within in-service nuclear submarines for condition monitoring and predictive maintenance

Workforce Foresighting Hub findings report in collaboration with MTC as part of the High Value Manufacturing Catapult.

Date: September 2025

Acknowledgements

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

Skills England Occupational Standards

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

*O*Net – Occupational Networks Online, USA*

In accordance with license and publishing requirements of these organisations for the use of their data sets, the Workforce Foresighting Hub team states that –

The Skills England Occupational Standards data used contains public sector information licensed under the Open Government License v1.0.

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

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Any errors, omissions and incorrect data are the responsibility of the Workforce Foresighting Hub 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 January – February 2025 using the data set and tools available at that time.

Contents

Executive Summary

Executive Summary

This report outlines findings from the Workforce Foresighting cycle focussing on adopting NDT analysis systems within in-service nuclear submarines for condition monitoring and predictive maintenance. The study is sponsored by Defence Nuclear Enterprise (DNE) and conducted by the MTC as part of HVM Catapult in collaboration with the Workforce Foresighting Hub, an Innovate UK initiative.

Workforce foresighting is a systemic approach to planning ahead and anticipating future skills and capability needs associated with new technologies and government transformation targets. It involves identifying and understanding the skills required for tomorrow's jobs, ensuring our education and training systems are prepared so that our workforce is ready to adopt new technologies and support future industrial growth.

This report sets out the findings of the workforce foresighting study and suggests the next recommended actions required by various stakeholders to ensure a workforce is created that is prepared to effectively implement these new technologies in the sector.

Workforce Foresighting Topic

The nuclear deterrent is the Ministry of Defence's number one priority. The UK has maintained a Continuous-At-Sea Deterrent (CASD), delivered by the Royal Navy, since April 1969 under Operation RELENTLESS. It consists of at least one nuclear-powered submarine on patrol at all times, armed with the Trident missile system and UK sovereign nuclear warheads.

The Defence Nuclear Enterprise (DNE) is the partnership of organisations that operate, maintain, renew and sustain the UK's nuclear deterrent, including submarines. Their mission covers all aspects of maintenance, development and delivery. The DNE is working with the 3 prime contractors (BAE Systems, Babcock and Rolls-Royce) and a supply chain of over 3,000 small, medium and large businesses, with a combined workforce demand of around 42,000 jobs. This workforce will need to grow, and its skills develop in order to support the UK Governments aspirations and commitments in regard of the nuclear deterrent. [1]

Taking an overarching challenge to increase the UK's in-service nuclear submarine availability and readiness to deploy, this Workforce Foresighting cycle was commissioned by DNE, to identify opportunities in enabling a reduction in the Deep Maintenance Period (DMP) for in-service submarines at Devonport Dockyard, supplied to the Royal Navy by Babcock.

The field of NDT was selected in discussion with the DNE and Babcock as one which, through technology change, could provide decreases in the Deep Maintenance Period, but that would require significant skills changes.

[1] Delivering the UK's Nuclear Deterrent as a National Endeavour March 2024, ISBN: 978-1-5286-4782-3

Participants and stakeholders

Technology Participants	Industry / Employer Participants	Education & Skills Participants
Rolls-Royce	Babcock International	Babcock International
Babcock International	BAE Systems	Ministry of Defence
MTC	Rolls-Royce	British Institute of Non-Destructive Testing
Technology Centre & National Composites Centre	Ministry of Defence	MTC
		University of Cardiff

The Findings and Insights

Educational Provision for Individual Capabilities

A total of 120 capabilities were identified in the cycle, 110 of which had matching provision in the Skills England Occupational Standards.

However, these came from a wide range of standards therefore when developing course material for these capabilities employers and educators should also reference other industry related technology roadmaps such as the NDE 4.0 Roadmap developed by the British Institute for Non-Destructive Testing (BINDT) to identify common areas of priority and opportunities to work in collaboration.

The most important five engineering related standards, matching 36% of cycle capabilities, and should be considered as important sources of current provision are:

- Non-destructive testing engineer (degree) Level 6
- Non-destructive testing engineering technician Level 3
- Electro-mechanical engineer Level 6
- Robotics engineer Level 6
- Advanced robotics engineer Level 7

Unmatched Capabilities

Only 8% of all capabilities in the cycle were found to have no match with current Skills England provision. Several of these capabilities have been included in FOPs that employers have indicated are going to play an important role in the future including NDT Data Analyst, NDT & Condition Monitoring Engineer and Design Engineer. Development of course material for these capabilities will need to be completed alongside the process of accessing and reviewing what is current provision.

Future Occupational Profile (FOP)

By reviewing the FOPs for suitability against Skills England Occupational Standards, it was found that none of the FOPs scored highly. Only two were found to have fair to good suitability against some standards whilst several other FOPs were found to have fair suitability. These are:

1. Network Engineer (NDT Condition Monitoring)
2. Marine Engineers and Naval Architects

There were some standards that had a reasonable level of fit and could be used as starting points for educators in understanding what is already available and what the most efficient approaches may be for addressing the gaps.

The Next Steps

Employers need to take proactive steps, both individually and collectively to ensure that the development of skilled professionals meets future sector needs.

The Defence Nuclear Enterprise partnership is ideally positioned to play a meaningful role in this activity by acting as overall champion and taking ownership of an agreed plan of action. They will convene a working group to:

- Coordinated action is required to agree on priorities and resource allocation to most effectively develop short course and program provision to support the supply chain partners.
- Enabling prompt validation of content and results amongst key partners will establish the credibility
- Engaging with other organisations such as the British Institute for Non-Destructive Testing (BINDT) to establish necessary validation and recognition for courses developed.
- Supporting the delivery of early stage training once courses have been developed and scale up.

Finally, this cycle has identified a generic development that potentially needs to be recognised across all areas relating to NDT, and beyond into wider engineering in multiple fields and sectors, that being the increased use of data, data management, machine learning and AI techniques to analysis and interpret that data, and the application of information generated.

Further this is moving into ‘live’ integrations of sources applied at the point of use, this requires deeper scientific and application understanding but is likely in horizon 2 to 3 timescale to be required in many areas of skill development.

1. Introduction

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1.1 Background to Workforce Foresighting

The report “Manufacturing the Future Workforce” (Collier et al., 2020) recommended the Skills Value Chain as an approach to avoid shortfalls in workforce capabilities relating to future innovations (see Figure 1). This is the genesis of the workforce foresighting programme, which is sponsored by Innovate UK and delivered through the Innovate UK Catapult Network.

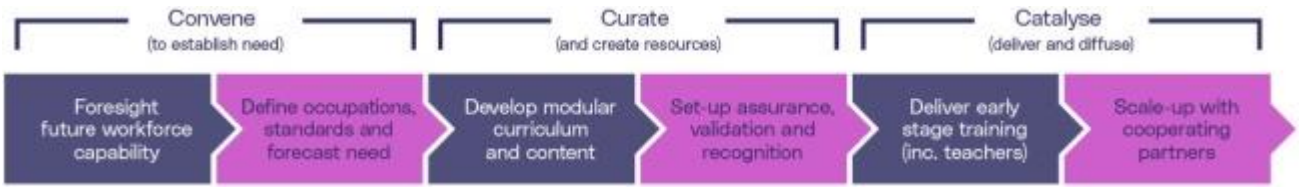

Figure 1: The Skills Value Chain

The first step of the skills value chain is to “Foresight future workforce capability”: This calls for technology, industry, education, and training partners to convene using government missions and national challenges as a focal point, to “foresight and articulate future skills needs, standards and qualifications associated with emerging technologies” (Collier et al., 2020).

1.2 Workforce Foresighting - Process Overview

The core of the workforce foresighting process is to convene three groups of specialists (technical, industrial (employers) and educational), and 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.

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 organisation collaboration and integration of data. Additionally, the classification enables data from a number of national and international open-source workforce datasets to be integrated through the same common language. The 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 a 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 and/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, based on a consistent set of 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

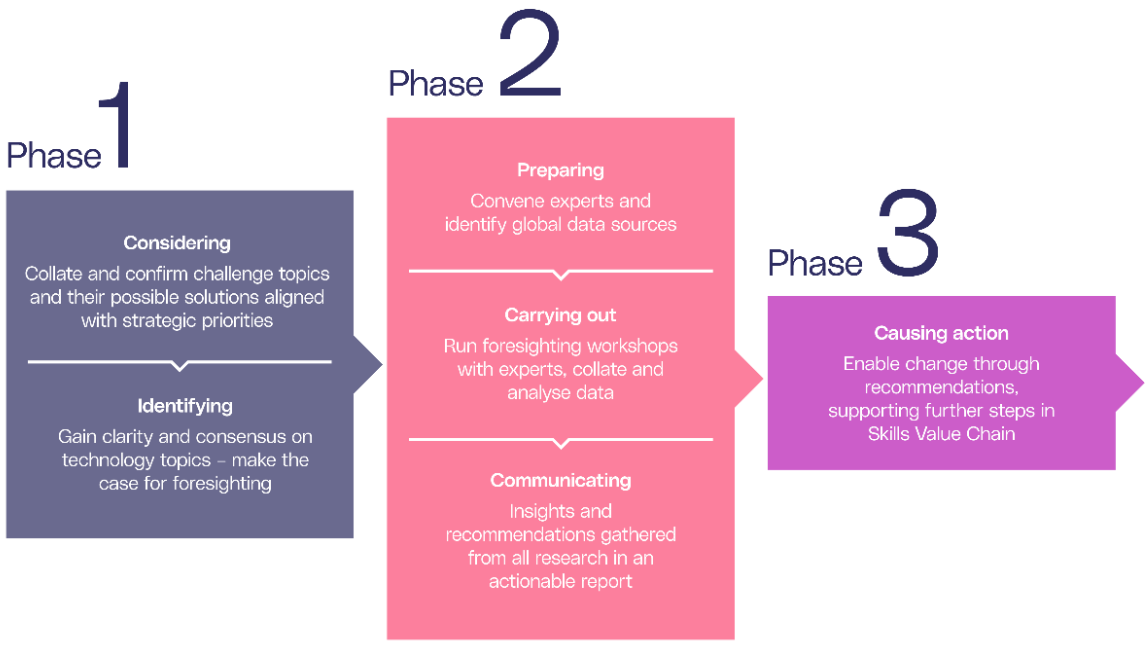

Figure 2 - The workforce foresighting process

1.3 Foresighting vs Forecasting

Although this study is focussed on workforce foresighting (capabilities required) it is important to keep in mind parallel findings from forecasting (required capacities and numbers) activities. Forecasting, alongside foresighting, provides vital input to the sector, feeding into recruitment and development targets for employers, and consideration of economic class sizes and recruitment targets for educators. However, it is beyond the scope of the foresighting study to carry out independent forecasting, and as such readers should refer to referenced studies for detail on forecasting.

1.4 Introducing the Visualisation Tool

The Workforce Foresighting Hub's Visualisation Tool is a powerful, innovative system, which will enable the reader of the report 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 on which the findings and recommendations are based, is generated by the foresighting cycles, integrating the expertise of technologists/domain specialists, employers and educators. The data informs the development of future curriculums and course content as determined by an action plan. By linking to external data sources and utilising AI tools, validated by human oversight, the tool identifies differences at the level of occupation/role as well as detailed changes required to help update/refresh 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 Appendix 5.5

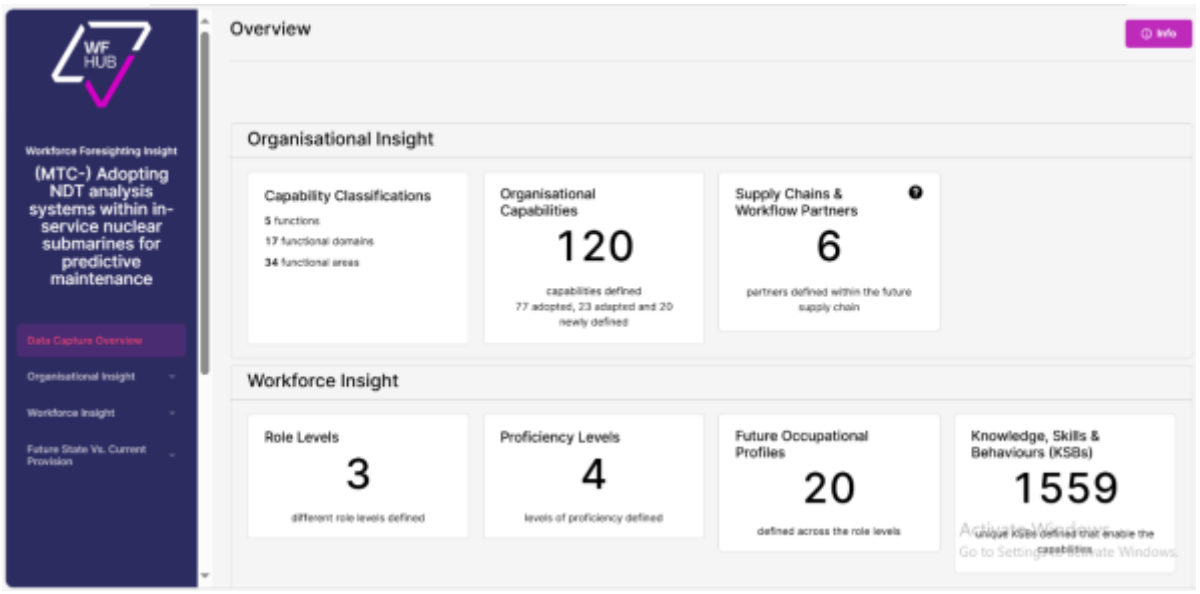

Figure 3: Data Capture Overview

Figure 3 gives a summary of the data captured in this cycle. Organisational insights covered:

- 5 functions
- 17 functional domains
- 34 functional areas

The process identified 120 Organisational Capabilities, 77 of which were adopted without change, 23 adapted to suit the requirements of the cycle, 20 which have been newly defined. The process engaged 6 supply chain partners.

Workforce foresighting insights cover 3 role levels, and 4 proficiency levels. 20 Future Occupational Profiles were defined across the 3 role levels. These capabilities were underpinned by a total of 1559 different Knowledge, Skills, or Behavioural (KSBs) traits. All capabilities within the cycle along with the associated KSBs can be viewed using the Visualisation Tool using the Future KSB Summary report.

2. Aligning the Challenge and Solutions with National Priorities

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2.1 Positioning and Context of National Challenge

The nuclear deterrent is the Ministry of Defence's number one priority. Royal Navy submarines operate a "silent and vigilant" service undertaking "tracking and securing our interests. They safeguard Trident, our nuclear deterrent". The UK maintain has maintained a Continuous-At-Sea Deterrent (CASD), delivered by the Royal Navy, since April 1969 under Operation RELENTLESS. It consists of at least one nuclear-powered submarine on patrol at all times, armed with the Trident missile system and UK sovereign nuclear warheads.

The Defence Nuclear Enterprise (DNE)[2] is the partnership of organisations that operate, maintain, renew and sustain the UK's nuclear deterrent, including submarines. Their mission covers all aspects of maintenance, development and delivery. To support this the UK government is investing in a project relating to infrastructure and construction that will develop new, or update existing, facilities across all regions of the England, Scotland and Wales[i]. The DNE is working with the 3 prime contractors (BAE Systems, Babcock and Rolls-Royce) and a supply chain of over 3,000 small, medium and large businesses, with a combined workforce demand of around 42,000 jobs. This workforce will need to grow, and its skills develop in order to support the UK Governments aspirations and commitments in regard of the nuclear deterrent.

The Deep Maintenance activity is supplied to the Royal Navy by Babcock and their commitment to CASD can be seen in their recent £200 million refurbishment[3], of the UK's Vanguard Class maintenance facilities to enable the completion of deep maintenance periods more quickly, allowing them to redeploy faster. David Lockwood, CEO of Babcock, stressed the importance of the project, stating, "Supporting the Continuous at Sea Deterrent is the most important thing we do. The huge investment and increase in digital technology in this submarine facility ensures the UK has a sovereign, fit-for-purpose, deep maintenance capability now and in the future."

Taking an overarching challenge to increase the UKs in-service nuclear submarine availability and readiness to deploy, this Workforce Foresighting cycle was commissioned by the DNE. Although this section focuses primarily on the application of Non-Destructive Testing (NDT) techniques by Babcock engineers, it is important to consider the broader implications across the wider submarine enterprise. The adoption of NDT is not limited to the immediate maintenance cycle; it also has significant ramifications for the design of the submarine itself. This includes considerations around material selection, structural integrity, and long-term supportability. Furthermore, NDT will be essential in the ongoing assessment and maintenance of the propulsion system and all onboard systems and equipment. Onshore, deep maintenance facilities will also need to evolve, incorporating new diagnostic tools, updated procedures, and enhanced training to support these advanced capabilities. By acknowledging these wider applications, we gain a clearer understanding of how these emerging skills and technologies will be required across multiple domains, not just within the confines of the current maintenance framework.

[2] Delivering the UK's Nuclear Deterrent as a National Endeavour March 2024, ISBN: 978-1-5286-4782-3
[3] Royal Navy on path to resolve submarine maintenance capacity

2.2 Potential and Prioritised Technology Solutions to the Challenge

Taking an overarching challenge to increase the UKs in-service nuclear submarine availability and readiness to deploy, this Workforce Foresighting cycle was commissioned by DNE, to identify opportunities to enable a reduction in the Deep Maintenance Period (DMP) for in-service submarines supplied to the Royal Navy by Babcock. The DNE sought input from Babcock International Welding Design & Non-Destructive Test (NTD) Group at Devonport Royal Dockyard.

NDT as the mainstay of the Deep Maintenance process for submarines became the focus for analysis, as making NDT more efficient would support the challenge of reducing DMP's. This will require the introduction of new NDT technologies and related skills sets in the domain labelled in the industry as NDT 4.0, i.e. the fourth industrial revolution e.g. NDT: Automation, AI, digital twins, augmented / virtual reality, data driven analysis and so on.

Initially the possible solution technologies discussed in response to the challenge were:

- Structural health / condition monitoring of submarine hull
- Robotic engineering for in-water inspection technologies
- Alternative technology to radiography for ship-systems survey
- Automation sentencing software for post-testing analysis
- NDT computational modelling for optimised set-ups

The sponsoring organisation, lead employer, technology lead, and workforce team discussed the prioritisation of technology solutions over a number of workshops. It became apparent early on that while each of the technology areas were valid and would form part of an overall change in NDT in the future, the core of the change was the transition from ‘mechanical’ testing and individual data points to an NDT environment where a significant increase in data from multiple sources would be available. In this environment the role of the NDT test and maintenance engineers would shift to world of increasing data, data integration, and analysis to ascertain the condition of, and action to be taken concerning, any part of the submarine or its systems. The workshops recorded that:

- Future design would develop connection methods and interfaces for existing sensor and monitoring equipment to feed data into a predictive maintenance system.
- Sensor equipment would likely be made by the same people as today but that **software** that links the sensors will **probably be different and more complex and will require systems expertise.**
- For installation of those sensor capabilities, it was assumed that installation will be similar to current processes and will be conducted by existing suppliers.
- The **most notable** difference of these changes would be from a **use perspective**. The **purpose of this technology is to allow for in-service repairs and reduce the need to take the platform out of service**. Therefore, the platform crew will need to be suitably trained and equipped to operate the new system, as well as those involved in the Deep Maintenance.
- Regulations will likely still be covered by BINDT as the system is NDT based. Also, will have to follow conventional SDA/MOD regulations.

The focus of the cycle became the **adoption NDT analysis systems within in-service nuclear submarines for condition monitoring and predictive maintenance.**

2.3 Workforce Foresighting for Chosen Prioritised Technology Solutions

The consensus was that the workforce cycle should focus on the introduction of a Condition Monitoring and Predictive Maintenance System (CMPM) based on NDT sensing and analysis. Such a system would be an Industrial 4.0 digital system utilising Artificial Intelligence and Machine Learning approaches, to monitor the condition of the submarine structure, equipment and systems to predict maintenance needs whilst in-service allowing for adaptations to maintenance schedules based on live data. It should also support the streamlining of maintenance activity when the submarine is in dry-dock undergoing a Deep Maintenance Check.

In development, analysis at component or sub-system level is already done currently. This systems level inspection involves more sophisticated sensing generating complex and integrated data opportunities and the introduction of data analysis to informed decision making, which will be introduced in the next 5 years.

The Workforce team concluded that it was unlikely that there would be any major supply chain changes. The equipment (sensors) and CMPM systems providers would be the same people. However, the content within (software) will change. This challenge is about bringing various systems together. There may be new sensor additions, but these will likely come from the existing suppliers but could come from new suppliers, the systems assembler is likely to remain the same.

The cycle title agreed: **Adopting NDT analysis systems within in-service nuclear submarines for condition monitoring and predictive maintenance.**

2.4 Current and predicted scale of technology deployment in UK

The current state of technology is practitioner based using standard technology in standard ways. These are standard physics-based tests and procedures that staff are trained to implement. These have quality acceptance standards that people are trained to interpret resulting in a “go no-go” scenario. These processes are highly manual and time consuming, resulting in testing only being possible at planned service intervals.

A more sophisticated digital form of these tests is gradually beginning to be employed. Industries such as aerospace where the criticality of the testing is very high are at the forefront of implementing these more sophisticated approaches.

These newer types of tests produce more detailed data which requires more interpretation and longer-term trend analysis providing a richer and more nuanced picture of test outputs. Also emerging are inspection models which allow design and optimisation of inspection processes ahead of deployment. Related models are allowing more sophisticated interpretation of the resulting outputs.

Foundational practitioner-based skills are still going to be the core of the skills required for the in-service non-destructive testing of our submarines. However, organisations in the supply chain will need to develop complimentary skill sets that relate to increasingly digital and cyber-physical world that is starting to emerge.

Although non-destructive testing is only applied in specific industries today the need for these additional skills are going to be required across a broader range of industries such as power,

transport, the built environment and bio-sciences. This increase in the scope of where non-destructive testing is going to be required is will place significant pressure on the supply of both the foundational and complimentary skills across all sections of the supply chain organisations. The skills of current incumbents across the supply chain will become increasingly hybrid where core skills will be augmented by technology.

The core output of this cycle highlights the need upgrade the skills of the In-service Maintenance organisations, and the opportunity for the RTO supply chain organisations to further develop technology solutions to support these organisations.

2.5 Participating Organisations

Technology Participants	Industry / Employer Participants	Education & Skills Participants
Rolls-Royce	Babcock International	Babcock International
Babcock International	BAE Systems	Ministry of Defence
MTC	Rolls-Royce	British Institute of Non-Destructive Testing
Technology Centre & National Composites Centre	Ministry of Defence	MTC
		University of Cardiff

3. Findings and Results

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3.1 Methodology and Findings

The report is aligned to the needs of those responsible for workforce planning – employers, educators, and skills providers. 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. The report is aligned to the needs of those responsible for workforce planning – employers, educators, and skills providers. This covers:

- How will the Supply chain change - Organisational Changes
- How will the Workforce change - Occupational Changes
- How the current Education provision meets the future need - Highlighted Changes to Future Provision

Below is an explanation of how insights are generated and what it will tell the supply chain employers, and educators.

Step One – How will the Supply chain change - Organisational Changes

Exploration of organisational changes provides insights into how organisations will need to adapt their current capabilities to implement the solutions that respond to the challenge addressed by the foresighting cycle.

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

Step Two – How will the Workforce change - 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 levels, function, proficiency and capability similarity. As part of the foresight process the generated FOPs are reviewed, revised and distilled by the Employer group. The agreed set of FOPs are then compared with selected current education provision; the default reference is the set of Skills England 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.

Step Three – How the current Education provision meets the future need - Highlighted Changes to Future Provision

The report identifies suggested changes to education and training provision – principally apprenticeship 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 apprenticeship 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, apprenticeship 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.

3.2 Step One – How will the Supply Chain change - Organisational Changes Insight

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.

The functional structure is developed to levels of detail that enable the foresight process to reference external data sets including O*NET (US) Occupational Information Network[4], ESCO – European Skills, Competences, Qualifications and Occupations[5], Skills England Occupational Standards[6].

The five root functions comprise around 40 domains which are broken down to around 140 functional areas. The 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, whilst 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.

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 of the capability classification. The future state data was captured in three technology focused workshops. The current state data[7] was derived from information collected on apprenticeship standards used across current supply chain partners. sector. This latter information is not as detailed as that produced by the workshops but is indicative and used to provide a point of comparison.

These initial pie charts summarise the changes that will be required by the whole supply chain, across the five functions. These five functions for this cycle for the supply chain involved in the production and implementation of a CMPMS in Nuclear Submarines, which comprises are:

- **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.

[4] O*NET - Occupational Information Network - https://www.onetcenter.org/
[5] ESCO - European Skills, Competences, Qualifications and Occupations - https://esco.ec.europa.eu/en
[6] Skills England Occupational Standards - https://www.instituteforapprenticeships.org/

[7] Current state data was drawn from the Skills England Occupational Standards that the stakeholders identified as currently in use by organisations in the sector. These were the NDT related standards (x3) and the nuclear welding inspection standard.

There is an overall increase in the Design function reflecting the emphasis on the importance of the role design will play in the adoption of these new systems. The Enterprise function has seen a relative decrease compared with the current state possibly due to the focus of the cycle on the adoption of systems rather than the operation of the system. The Support function remains consistent between current and future state indicating the important role that the In-service Support Organisations will continue to play in the ongoing maintenance of submarines.

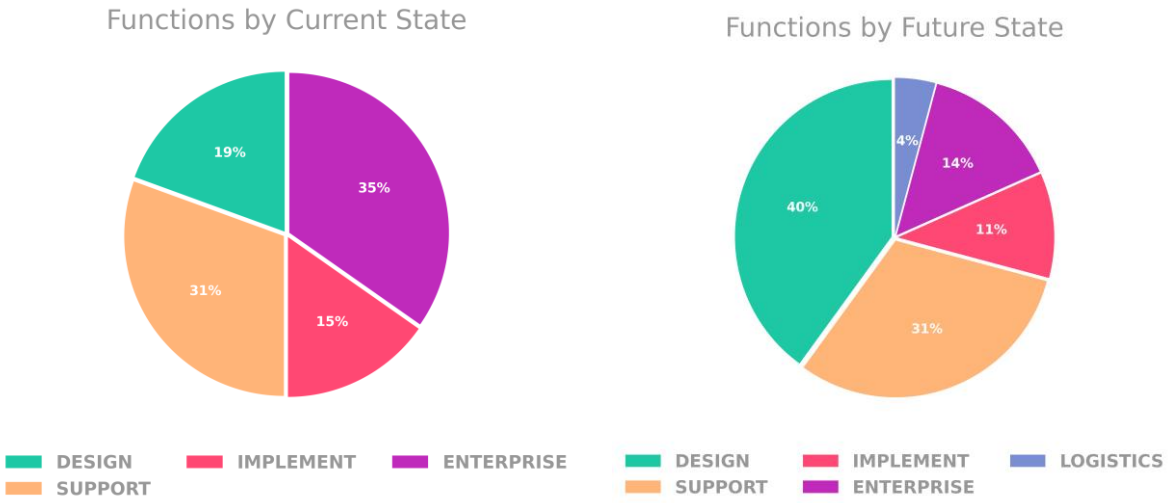


Figure 4: Current and Future – Whole Supply Chain - Capability Function Distribution %

Whilst the information on current and future Supply Chain capabilities is useful to indicate relative changes, factors such as volume of activity will also determine which functions may have greater future significance as the production and implementation of CMPMS in Nuclear Submarines comes into service.

The graphs below show the distribution of capabilities assigned at domain level within the five main functions for this cycle, where a domain is a sub-category of the main function. These graphs provide insight into the relative importance of each domain for the production and implementation of CMPMS in nuclear submarines in the future.

Design Domains

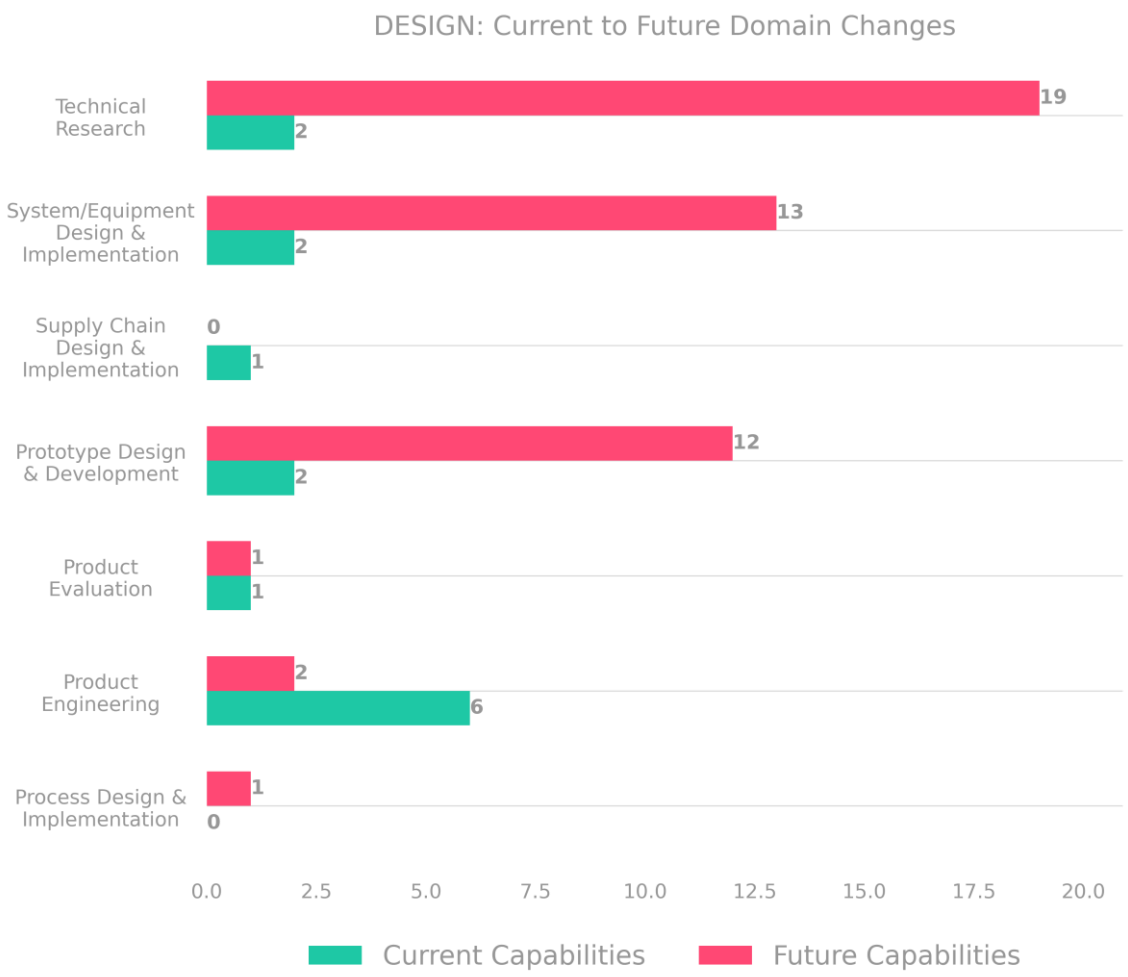


Figure 5: Design Future Domain Spread of Capabilities

The Design function has the highest number of capabilities identified in the cycle with 48 out of a total of 120 capabilities reflecting the importance of the design aspect in the cycle. At the domain level the highest numbers of capabilities are found within the Technical Research domain including capabilities around the research of areas such as the interoperability of complex systems, advanced techniques and new methodologies. The domain with the second highest number of capabilities within the design function was System/Equipment Design & Implementation extending the design theme to include new capabilities and the analysis and evaluation of new tools.

Enterprise Domains:

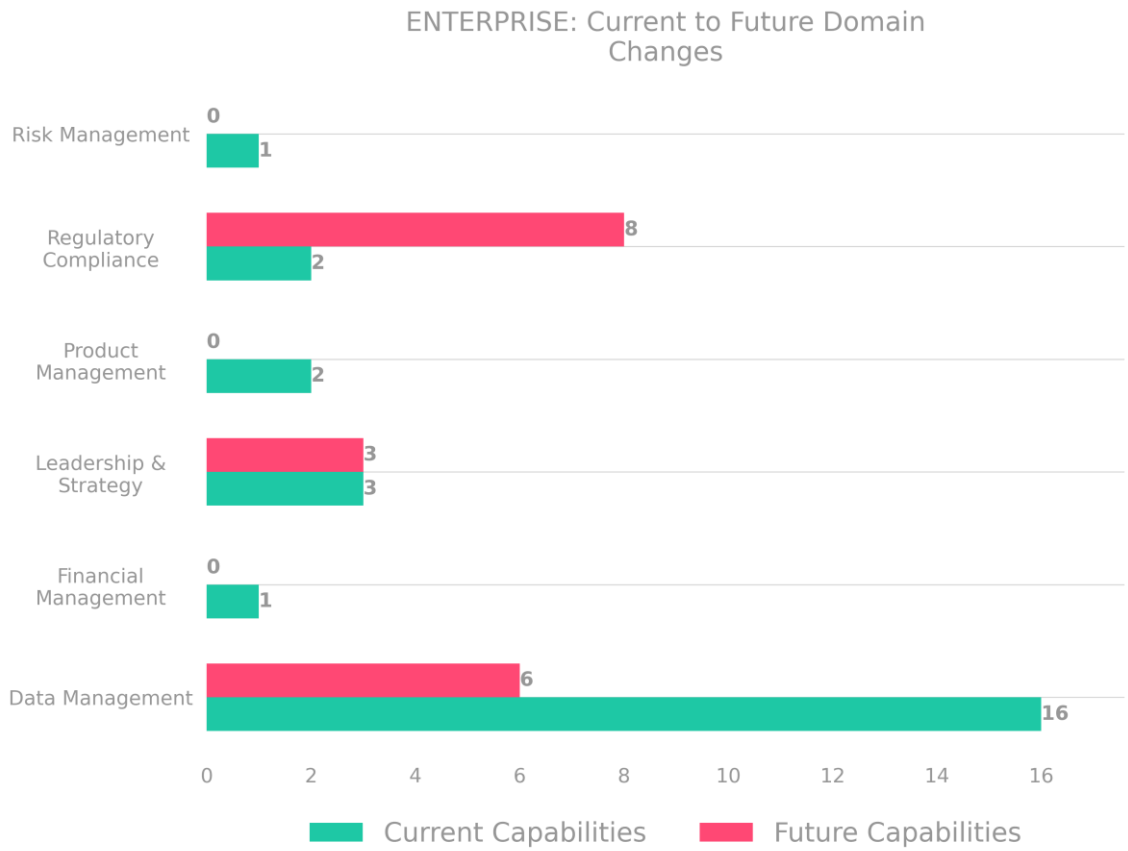


Figure 6: Enterprise Future Domain Spread of Capabilities

The largest domain within the Enterprise function is the Regulatory Compliance domain with 8 capabilities anticipating a future state where increased attention will be required from all parties due to the additional complexity of new and integrated systems. The Data Management domain contains 6 capabilities around data security and data analysis reflecting the need to manage and analyse greater amounts of data produced by new and integrated systems. This reflects that as the system becomes more sufficient and complex and integrates an increasing amount of data, to give better and stronger condition and predictive maintenance information, more sensors, equipment and systems, and data integration functions, will require regulatory scrutiny.

Implementation Domains

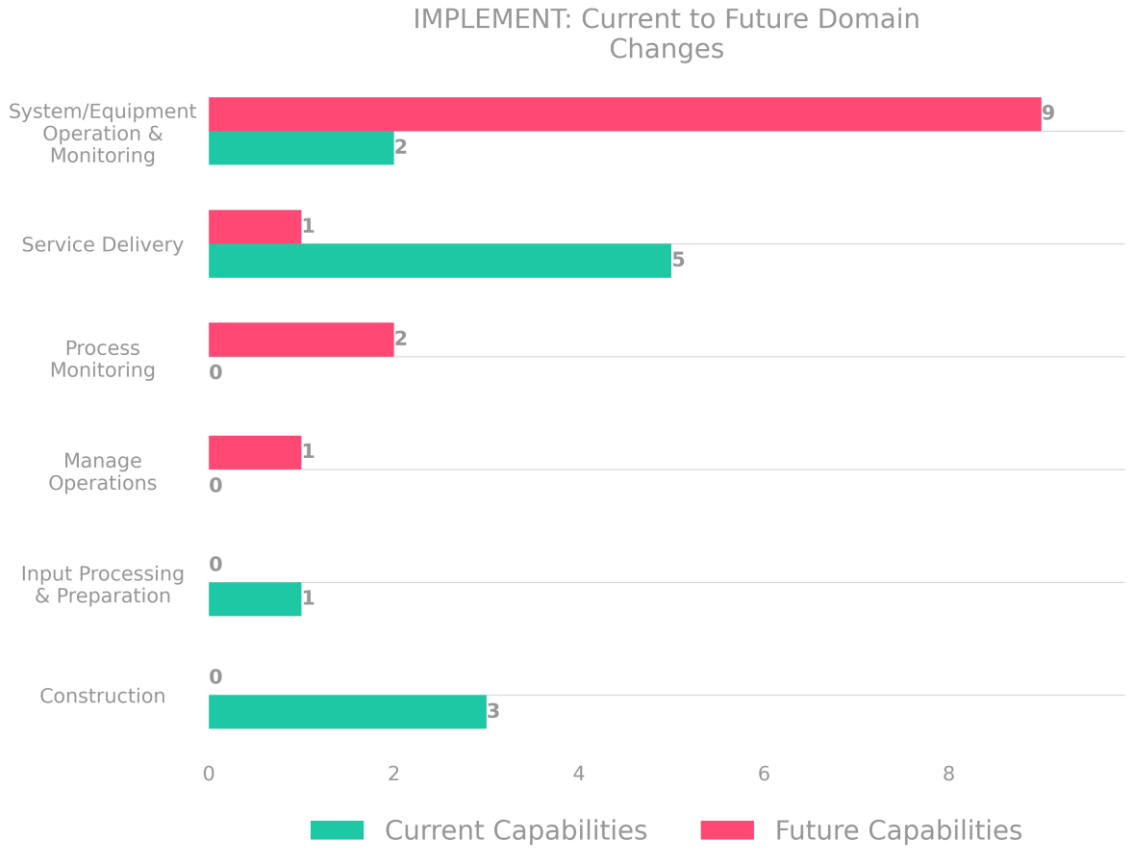


Figure 7: Implementation Future Domains Spread of Capabilities

Of the 13 capabilities identified by the cycle that fall within this function majority are found within the System/Equipment Operation and Monitoring in the future state as opposed to the current state where the focus was on the Service Delivery domain. The focus around these future state capabilities is around the implementation and monitoring of real time data from new systems. The nature of this change is logical given the nature of CMPM systems, where data and its integration across sensors, equipment and systems on the submarine are paramount.

Logistics Domains

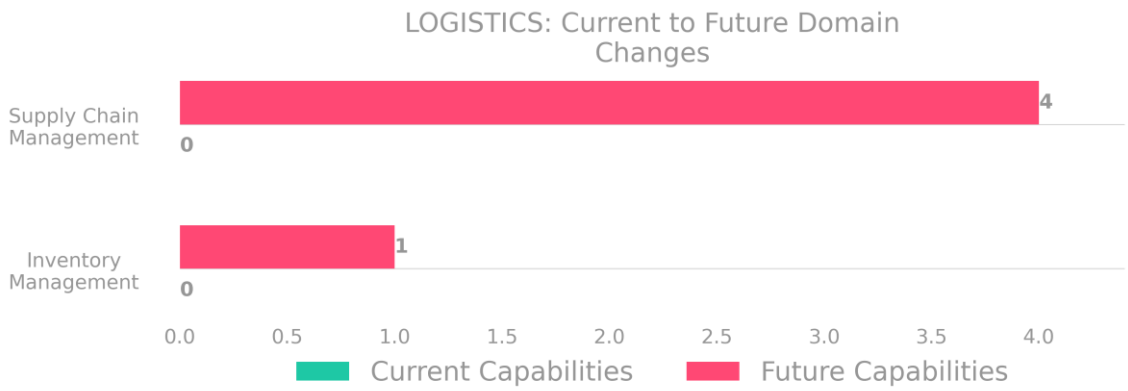


Figure 8: Logistics Future Domains- Future Spread of Capabilities

Although not present in the current state a few capabilities in this function mostly in the Supply Chain domain relating to collaboration with supply chain partners and regulatory agencies have been identified through the work of the cycle.

Support Domains

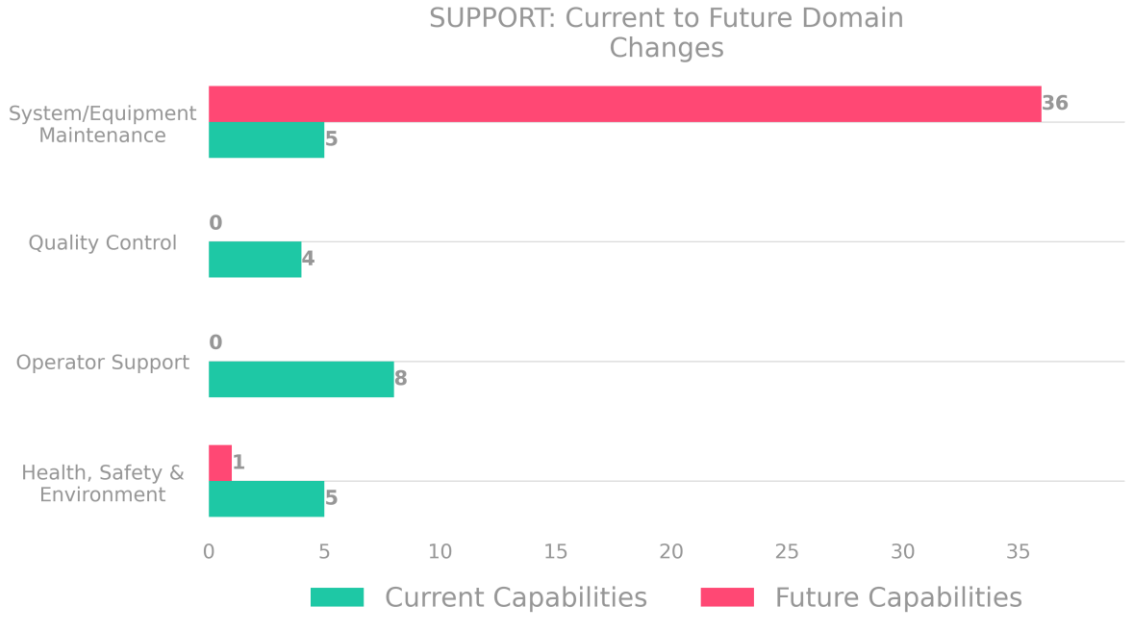


Figure 9: Support Future Domains - Future Spread of Capabilities

The ‘support’ function has 37 of the 120 capabilities for the cycle. As the focus of the cycle is around predictive maintenance the domain with the majority of the capabilities is understandably the System/Equipment Maintenance domain with a focus on predictive maintenance, condition monitoring and non-destructive testing.

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
Organisational Capabilities	*The page provides details of the capabilities required by each supply chain partner and the supply chain as whole. The information is presented using the Capability Classification Framework, Design / Implement / Logistics / Support / Enterprise and can be interrogated and then exported to suit specific user requirements and interest.* *The information provided also identifies capabilities supported by existing provision, and also where there may be gaps that require new development to support to equip the future workforce.*

3.3 Step Two – How will the Workforce change - Occupational Change Insight

Analysis to gain 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 supply chain partner may need be revised to reflect change for each role level within that partner.

Supply Chain partner organisation types

The workforce foresighting process recognises that different partners in a Supply Chain will require different capabilities, and these are determined and agreed in the initial workshops. In this cycle, the following Supply Chain partners were identified and engaged in participant workshops and data analysis to determine the organisational needs:

1. Research & Technology Organisation; Centre of Innovation
Organisations that drive innovation by conducting advanced research, developing new technologies, and providing expertise to industries. They bridge the gap between academia and industry, support SMEs, and enhance national competitiveness through collaborative projects, technology transfer, and commercialization of research outcomes. They will normally perform activities between TRL3-6 for this cycle.

2. Submarine Operator (Navy)
The organisation that manages the deployment, maintenance, and operational readiness of submarines. They ensure crew training, oversee missions, and maintain safety and security protocols. Their role is crucial for national defence, strategic deterrence, and maritime security.

3. Build Contractor (BAE)
Undertakes the build and delivery of submarines and related complex systems or equipment to the Submarine Operator. They manage project planning, coordination, and execution, ensuring quality, compliance, and timely completion. Their responsibilities include subcontractor management and procurement of equipment and systems (including the CMPMS) risk mitigation, analysis and improvement of systems and maintaining communication with stakeholders to meet project objectives.

4. OEM/Equipment Manufacturers/Systems Integrators
Organisation that design, produce, and supply components or products used in end products, including NDT sensors and equipment. They ensure high-quality standards and innovation, often providing bespoke solutions. Systems integrators combine these components into cohesive, functioning systems, ensuring compatibility and efficiency such as the CMPMS.

5. In-service Support Contractor (Babcock)
Bodies responsible for the comprehensive maintenance, through life engineering, and technical support of the submarine, ensuring operational readiness, safety, and efficiency.

6. Regulatory Authority
The body that establishes and enforces standards to ensure the safety, reliability, and effectiveness of technologies. They oversee compliance, conduct audits, and evaluate

systems to maintain operational readiness. Their role includes updating regulations to address emerging threats and technological advancements.

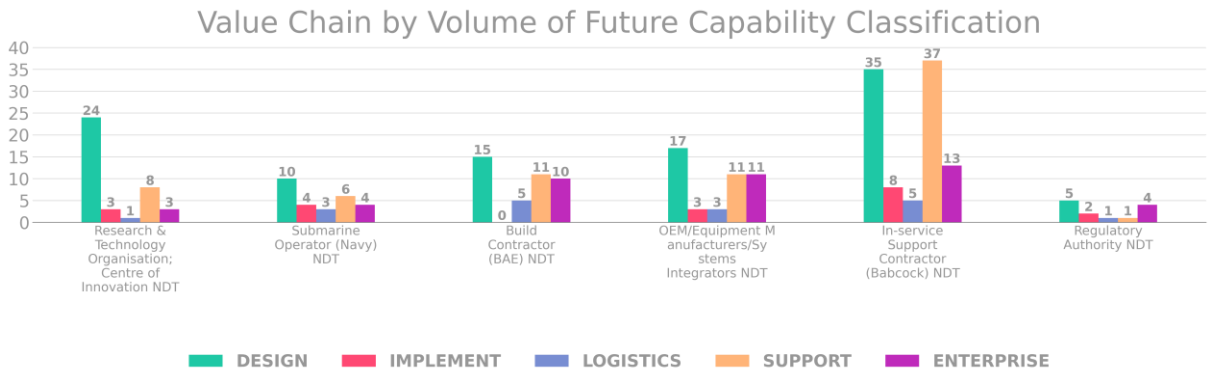


Figure 10: Distribution of Functions across each Supply Chain Partner

The graph illustrates the distribution of capabilities by function across the Supply Chain Partners. These capability sets are used to form the set of Future Occupational Profiles within each role level and this process is explained in the next section.

Visualisation Instructions

Detailed instructions can be found in Appendix 5.5.

Visualisation Data Link	What is it and what can it be used for?
Supply Chain Capabilities	*This page provides an overview of the identified capabilities at a Supply Chain Partner level.* *By selecting/deselecting each Supply Chain Partner you can review the capabilities identified as required in that area of the Supply Chain.* *This can be used to generate organisational capability profiles for each area of the 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 the future occupations required. Utilising 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 level approach seeks to avoid presuming that the future workforce will be operating at a different level to the current state.

Role Levels determined through workshops:

1. Operator
2. Technician/Supervisor
3. Principal / Senior Engineer

Proficiencies

Each of these role levels 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 proficiencies required. This information is used both in the generation of the Future Occupational Profiles, and 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, or organisation. 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. A Practitioner 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. An Expert can implement improvements personally or direct and guide others.

During the workshops participants applied their insight to assign proficiency for each role group to each capability. Individual responses were aggregated by the system to arrive at a consensus.

A summary of the distribution of required proficiency for the role levels in this cycle are:

	Operator	Technician/Supervision	Principal / Senior Engineer
Awareness	1	7	0
Practitioner	0	92	24
Expert	0	44	125

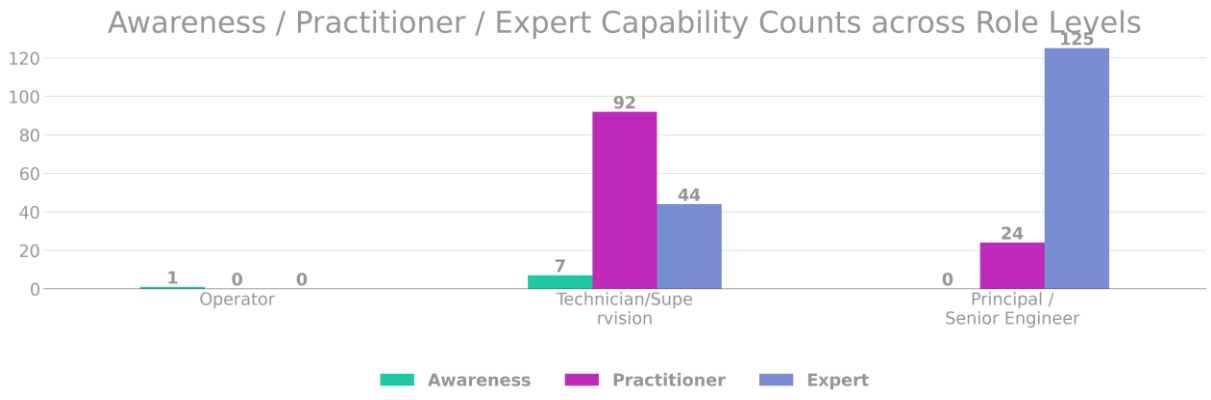


Figure 11: Proficiency details by Role Level

The above graph is an indication of how proficiencies are distributed across the different role levels. Key insights into proficiency levels are better understood when combined with the relevant Future Occupational Profiles (FOPs) as described in the section that follows. It is expected that as specific technology decisions are made in the area of predictive maintenance that the range and proficiency levels of capabilities required by the Submarine Operator will need to change.

Future Occupational Profiles

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 apprenticeship 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.

**It should be noted that currently the primary mapping exercise within the data cube is done against Skills England standards only. There are no common standards for qualifications across universities as is found in the apprenticeship space. Progress is being made towards how this can be included in the future.*

FOPs and indicative skills need

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

Operator Role Level FOPs:

In this cycle the Operator role level was defined as occupations and roles requiring Level 2 and 3 qualifications or apprenticeships.

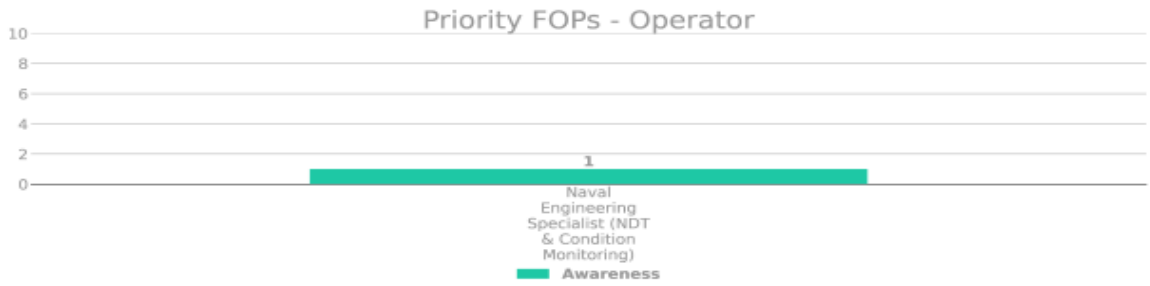


Figure 12: Priority FOPs - Operator Role Level

**It should be noted that the focus of this cycle was on the design and implementation of a CMPMS not on its use and operation. Therefore, in this case only a single entry has been made. A future cycle reviewing the impact on the maintenance and operational operators of that system may reflect a different distribution of role level and proficiency.*

Technician/Supervision Role Level FOPs:

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

Priority FOPs – Technician / Supervision

Figure 13: Priority FOPs - Technician/Supervision Role Level

These are the practitioners and experts in how the CMPMS needs to be used, what it needs to output and 'tell' the operator.

Principal / Senior Engineer Role Level FOPs:

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

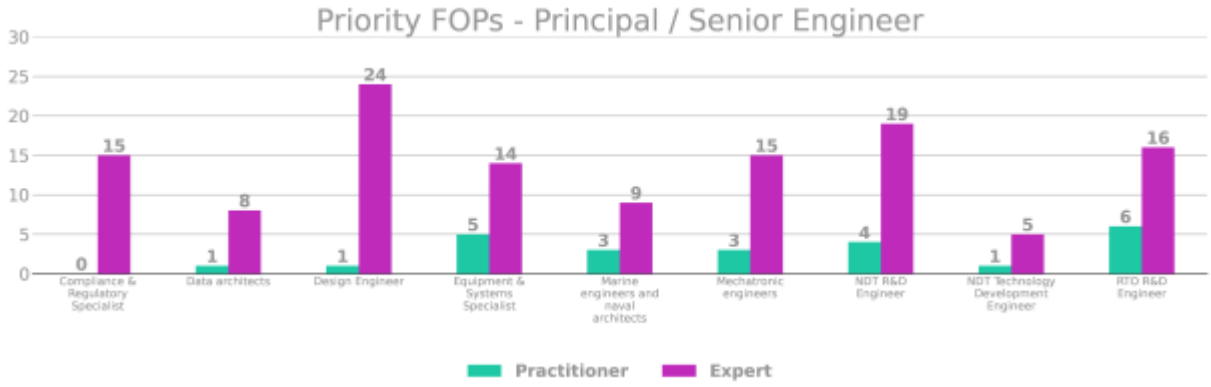


Figure 14: Priority FOPs - Principal / Senior Engineer Role Level

This group are the experts and practitioners with the core knowledge and skill that feeds into and builds the CMPMS.

Visualisation Instructions

Detailed instructions can be found in the Appendix 5.5.

Visualisation Data Link	What is it and what can it be used for?
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 FOPs in a role level by selecting one (or more) of these from the drop down. This will then allow you to select the FOPs aligned to that role level.* *The populated table allows you review and compare different FOPs within or across role levels. You can view the capabilities in each FOP and the assigned proficiency levels.*

3.4 Step Three – How the current Education provision meets the future need - Highlighted Changes for Future 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.

Our 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

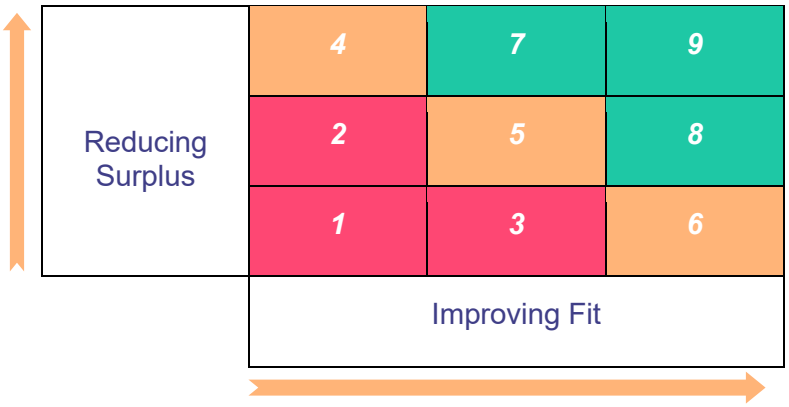


Figure 15: Fit Factor scores and Suitability Grid

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

High Suitability – 7,8,9 – for standards that have good coverage of FOPs.

Represents good candidates from current apprenticeship 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, which 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 apprenticeship standards selected from the Skills England Occupational Standards 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.

Considering the criteria for the suitability of a current standard or qualification for a FOP very few standards were found to meet the requirements for high suitability. The reason for this low suitability relates to the nature and scope of the cycle, which is quite specific and limited to a specialised area. Capabilities identified in the cycle were focused on what was required to achieve the goal of the cycle rather than a broader approach that included many capabilities that were already in place in various supply chain organisations that would still be required as foundational to most of the functions. This can be seen in the high bias towards future capabilities found within the Design and Support functions. As a result of the focus of the cycle a number of mapping outcomes found a reasonably good fit to a standard but had a high surplus factor which negatively impacted on the overall suitability score.

Employers in the key supply chain organisations are encouraged to use the Fit & Surplus and the Fit & Surplus Matrix views within the Visualisation tool to better understand which standards have a good fit as a starting point for considering the best approach to creating provision for FOPs that are important for future skills requirements.

Current standards relating to non-destructive testing also have an important role to play in supporting the development of these capabilities. The Non-destructive Testing Engineer (ST0369) shows a good fit for the Design Engineer, RTO R&D Engineer and the NDT Technology Development Engineer with a reasonable fit with three other FOPs. Although surplus should be a factor when considering learners commencing a qualification this standard may be a good signpost for organisations assessing their current workforce for future development needs relating to one or more of these FOPs.

As this is a new and developing area, it is no surprise that there are gaps in standards and provision. Having adopted a technology agnostic approach for this cycle it may be expected that higher matches could develop around some of these FOPs as specific technologies are implemented.

Supply Chain Partner - Research & Technology Organisation; Centre of Innovation NDT

Detailed breakdown:

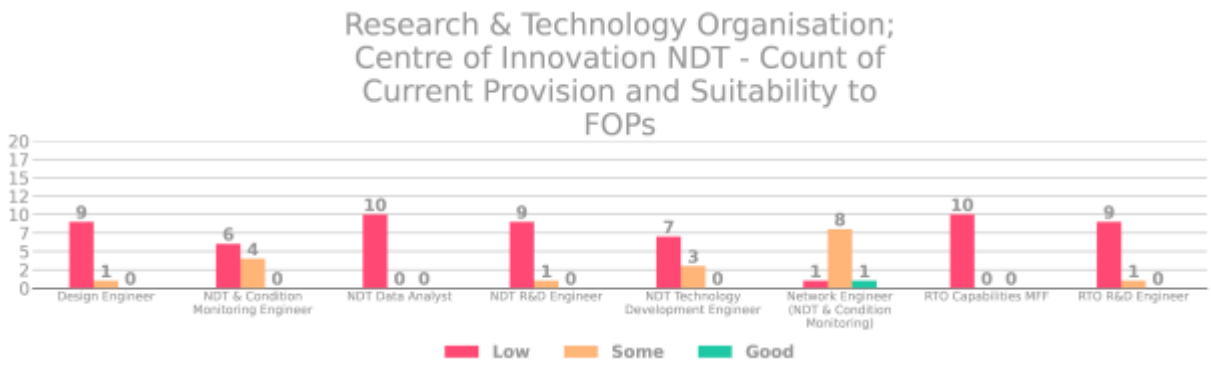


Figure 16: Suitability Summary - Research & Technology Organisation; Centre of Innovation NDT

Supply Chain Partner - Submarine Operator (Navy) NDT

Detailed breakdown:

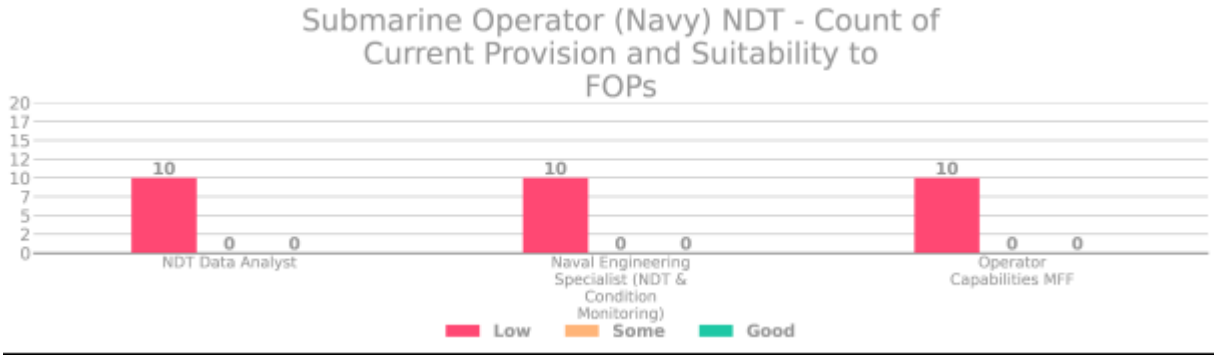


Figure 17: Suitability Summary - Submarine Operator (Navy) NDT

Supply Chain Partner - Build Contractor (BAE) NDT

Detailed breakdown:

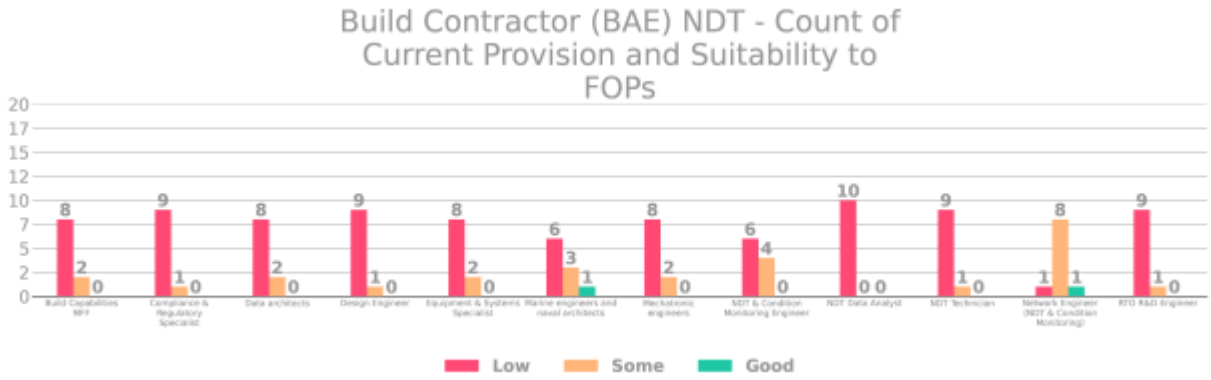


Figure 18: Suitability Summary - Build Contractor (BAE) NDT

Supply Chain Partner - OEM/Equipment Manufacturers/Systems Integrators NDT

Detailed breakdown:

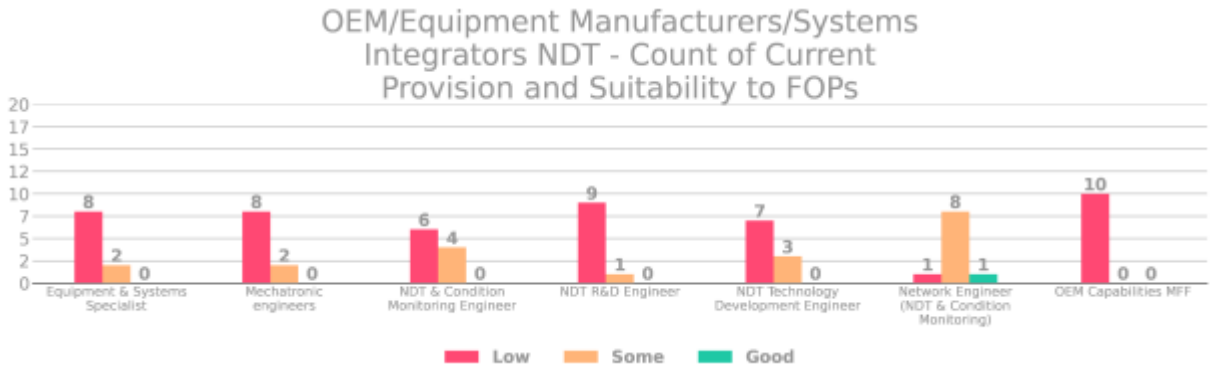


Figure 19: Suitability Summary - OEM/Equipment Manufacturers/Systems Integrators NDT

Supply Chain Partner - In-service Support Contractor (Babcock) NDT

Detailed breakdown:

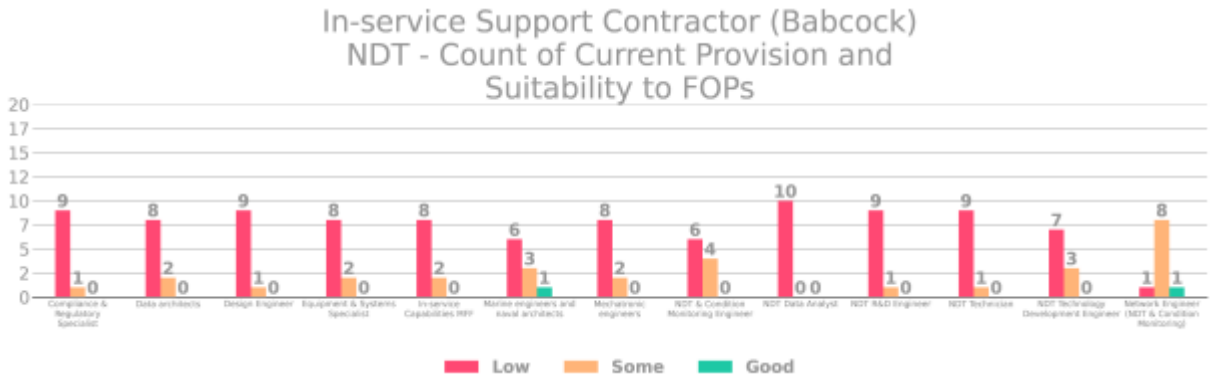


Figure 20: Suitability Summary - In-service Support Contractor (Babcock) NDT

Supply Chain Partner - Regulatory Authority NDT

Detailed breakdown:

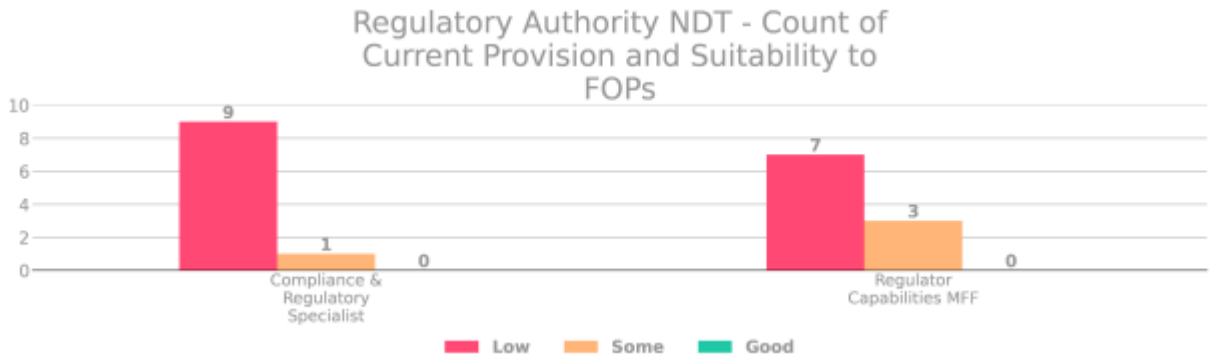


Figure 21: Suitability Summary - Regulatory Authority NDT

Link to full data set - Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
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 Level and linked 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 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 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 level/occupational profile grouping.*
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 Skills England Occupational Standards provision.* • *By capabilities that **are not** served by the reference mapping framework, e.g., Skills England Occupational Standards 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 Apprenticeship 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 Future Occupation Profiles (FOP) against existing training provision e.g. Skills England Occupational Standards.* *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 Future Occupation Profiles (FOP) against existing training provision e.g. Skills England Occupational Standards.* *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.*
FOP Capability Matches	*This page allows you to view the matches between Capabilities and Skills England Occupational Standards 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 Future Occupational Profiles (FOPs) or review all FOPs under a Role Level, to give a more holistic view of Capabilities and Matches* *Where a future capability has been matched to existing provision (currently, by default, Skills England Occupational 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 Levels and FOPs, from Job / Occupation level through to Knowledge, Skill and Behaviour level*

4. Conclusion and Next Steps

4. Conclusion and Next Steps

4.1 Summary of Key Insights

Educational Provision for Individual Capabilities

One of the goals of Workforce Foresighting is to identify what current training provision is available for the capabilities identified in the cycle. Understanding current provision is the foundation for then understanding the gaps that exist where there is no provision. When mapping the capabilities of the cycle against the current education provision of Skills England Occupational Standards a matching threshold is set to support the identification of duty statements[8] (and their related standards) that match each capability.

When analysing the top matching result for each of the capabilities the matching duty statements were found to originate from a broad range of Skills England Occupational Standards. Of the 110 capabilities that had a match above the established matching threshold, duty statement were found to originate from 53 different Skills England Occupational Standards. Although many of these standards are from engineering or fields adjacent to engineering some were found to be from fields such as data management, risk and compliance management and artificial intelligence, giving employers and educators direction as to new fields that need to be included in future learning interventions.

Summary of capabilities and top matching Skills England Occupational Standards

Capability ID	Capability Statement	Top Matching Standard	Academic Level	Match
181529	Develop, define and execute testing of products or systems including: a) Gathering and use of existing data to establish test needs b) Development testing of concept solutions and alternative designs c) Qualification testing of final design, including safety cases	Electro-mechanical Engineer	6	1
181687	Keep abreast of current and emerging industry advances and their application in an engineering capacity. Promoting the case for vessel upgrades or the adoption of emerging technologies to optimise performance.	Marine technical superintendent (degree)	7	1
182476	Embed reliability centred maintenance strategies and techniques.	Food and drink engineer	5	1
182961	Identify defects in mechanical equipment and categorise them appropriately	Engineer surveyor	4	1
188326	Carry out inspection activities on equipment. For example, pressures, flows, temperatures, installation checks, material state and feasibility studies.	Lead engineering maintenance technician	4	1
188364	Fault finding and diagnosis to prevent or address equipment failures.	Rail engineering technician	3	1

[8]Duty Statements are the individual elements that describe what an apprentice needs to be able to achieve to successfully complete the standard. Together they make up the whole standard. The mapping exercise compares these duty statements against the capabilities for matches.

188387	Monitor engineering operational parameters whilst vessel is at sea for example, engine temperatures, and fuel, and oil and water consumption, adjusting engine and propulsion parameters to maximise fuel efficiency and minimise pollution.	Small vessel chief engineer	4	1
188389	Undertake planned maintenance of engineering components in accordance with the planned vessel maintenance system and manage others undertaking maintenance. Recommend improvements.	Small vessel chief engineer	4	1
188667	Select techniques, components and materials appropriate for application in the mission environment. For example, vacuum-compatible materials, or electronic components that can withstand radiation.	Space systems engineer	6	1
201942	*Undertake testing and inspection of fabricated and/or installed pipework using appropriate techniques.	Engineering construction pipefitter	3	1
202461	*Stay updated on advancements in naval architecture and incorporate innovative technologies into designs	Naval architect	6	1
202844	*Analyse research and information to propose solutions for nuclear technology application	Nuclear technician	5	1
202944	*Inspect weld appearance and identify defects through visual inspection after welding and conduct non-destructive testing.	Nuclear welding inspection technician	4	1
204525	*Gather, analyse, and share data to inform risk assessment using data management software systems.	Regulatory compliance officer	4	1
205036	*Seek out and apply contemporary, high-quality evidence-based resources and existing and emerging technology as appropriate	Advanced clinical practitioner (integrated degree	7	1
205040	*Inspect materials using advanced NDT methods to identify faults and imperfections	Non-destructive testing engineer (degree)	6	1
205041	*Collaborate with other industry sectors to apply best practice in NDT	Non-destructive testing engineer (degree)	6	1
205595	*Troubleshoot and diagnose electrical faults in maritime systems, using appropriate testing methods and tools.	Maritime electrical fitter	3	1
220448	Ensure that designs, developments or modifications or updates comply with national and/or international legislation, compliance testing or regulatory requirements.	Product design and development engineer (degree)	6	1
214242	Conduct rigorous analyses to assess materials failure in engineering components, and report findings on such failures from specific test environments or field conditions.	Materials science technologist (degree)	6	0.953
214255	Design an integrated Through Life Engineering Service asset and service (create verified and validated service and product integrated designs)	Through life engineering services specialist (in	7	0.862
214256	Commission electrical and electronic inspection and monitoring systems and conduct sea trials to ensure operational readiness.	Marine electrician	3	0.799
214235	Inspect welded joints for defects using advanced NDT technology.	Non-destructive testing engineer (degree)	6	0.773

214245	Develop and apply preventative maintenance strategies using advanced diagnostic techniques to enhance equipment reliability.	Rail engineering advanced technician	4	0.768
209893	Develop and implement maintenance procedures using advanced techniques for optimizing equipment performance.	Food and drink advanced engineer (integrated	6	0.742
6490	Analyse test data to diagnose malfunctions, to determine performance characteristics of systems, or to evaluate effects of system modifications.	Electro-mechanical engineer	6	0.725
214244	Ensure conformance of all onboard equipment to specific operational standards and conduct regular maintenance to uphold these standards.	Boatmaster	3	0.71
214240	Conduct condition surveys on submarines to verify compliance with appropriate standards and industry practices.	Marine surveyor (degree)	6	0.7
210127	Maintain and support use of models and simulations using manual or automated tools, to analyse or predict system performance under different operating conditions	Electro-mechanical engineer	6	0.696
214246	Deploy predictive maintenance systems using IoT technology to anticipate and prevent equipment failures.	Digital manufacturing engineering leader	7	0.693
100710	Monitor nuclear reactor equipment performance to identify operational inefficiencies, hazards, or needs for maintenance or repair.	Nuclear reactor desk engineer	6	0.69
205739	Maintain predictive maintenance techniques to optimise equipment performance and prevent breakdowns	Food and drink advanced engineer (integrated	6	0.69
214252	Investigate new or existing methods to utilise robots and AI for submarine applications to enhance operational capabilities.	Robotics engineer - degree	6	0.684
134480	Provide responses to regulatory agencies regarding product information or issues.	Compliance and risk officer	3	0.68
83900	Interpret the results of all methods of non-destructive testing (NDT), such as acoustic emission, electromagnetic, leak, liquid penetrant, magnetic particle, neutron radiographic, radiographic, thermal or infrared, ultrasonic, vibration analysis, and visual testing.	Non-destructive testing engineering technician	3	0.677
189976	Develop advanced inspection techniques using advanced imaging technology.	Non-destructive testing engineer (degree)	6	0.677
201330	Analyse operational performance, specification and data to support certification compliance.	Aerospace engineer	6	0.677
214239	Conduct detailed inspections of specific structural components to ensure compliance with non-destructive testing (NDT) work instructions and established processes.	Non-destructive testing engineer (degree)	6	0.676
201320	Validate equipment and process to ensure compliance with regulatory requirements.	Engineering technician	3	0.66
213149	Manage logistics using supply chain management software to track inventory, monitor shipments, and optimize transportation routes.	Supply chain leadership professional (integrate	6	0.66

28630	Conduct environmental, operational, or performance tests on marine machinery and equipment.	Maritime mechanical fitter	3	0.656
6170	Analyse problems and take appropriate action to ensure continuous and reliable operation of equipment and systems.	Robotics engineer - degree	6	0.652
50940	Develop or use new non-destructive testing methods, such as acoustic emission testing, leak testing, and thermal or infrared testing.	Non-destructive testing engineer (degree)	6	0.651
214237	Inspect structures, nuclear reactors, and pipelines using non-destructive testing techniques to identify defects and assess overall integrity.	Non-destructive testing engineer (degree)	6	0.648
5110	Analyse complex systems to determine potential for further development, production, interoperability, compatibility, or usefulness in a particular area, such as aviation.	Aerospace engineer	6	0.646
201312	Devise and implement maintenance and inspection management systems.	Mine management	6	0.646
214249	Monitor equipment and systems for proper operation using real-time data analytics.	Mechatronics Maintenance Technician	3	0.646
214243	Maintain non-destructive and condition monitoring systems to ensure optimal functionality and replace worn-out components as necessary.	Power industry substation fitter	3	0.643
214216	Plan maintenance inspections using big data analytics techniques to optimise maintenance schedules.	Digital manufacturing engineering leader	7	0.638
214217	Develop maintenance schedules for non-destructive and condition monitoring systems.	Power industry substation fitter	3	0.635
214236	Apply existing NDT techniques with an enhanced digital NDE 4.0 orientation.	Non-destructive testing engineer (degree)	6	0.632
214253	Investigate and develop corrosion measuring tools for submarine applications to ensure structural integrity.	Non-destructive testing engineer (degree)	6	0.628
214234	Design efficient data storage systems to ensure scalability, accessibility, and data integrity.	Data engineer	5	0.624
6520	Analyse test readings, computer printouts, and trouble reports to determine equipment repair needs and required repair methods.	Creative industries production technician	3	0.623
189226	*Implement health and safety competencies related to the specific NDT method, including awareness of specific risks such as working at heights and in confined spaces.	Non-destructive testing engineering technician	3	0.622
201531	Create validation and verification tools for system, sub-system and component-level analysis using virtual models recognising the limits and validity of digital/virtual models	Aerospace engineer	6	0.622
209657	Use data analytics to monitor compliance with regulatory requirements	Hospitality manager	4	0.622
214224	Develop partnerships with design and operation teams to define specific product data requirements.	Data engineer	5	0.622
205882	Coordinating with suppliers and managing procurement processes Using Supply Chain Management Tools	Supply chain practitioner (fast-moving consumer goods)	3	0.619

25360	Communicate with regulatory agencies regarding pre-submission strategies, potential regulatory pathways, compliance test requirements, or clarification and follow-up of submissions under review.	Compliance and risk officer	3	0.617
31240	Conduct surveillance testing to determine safety of nuclear equipment.	Nuclear welding inspection technician	4	0.617
205700	Monitor equipment using sensors and telemetry data	Mechatronics Maintenance Technician	3	0.617
214219	Use non-destructive material characterisation to monitor non-classical defects and identify high-risk failure regions.	Non-destructive testing engineer (degree)	6	0.616
214250	Research methodologies to develop condition monitoring systems for dynamic cable systems.	Power industry substation fitter	3	0.608
58150	Document non-destructive testing methods, processes, or results.	Non-destructive testing engineering technician	3	0.607
25350	Communicate with regulatory agencies regarding compliance documentation or validation results.	Compliance and risk officer	3	0.604
214233	Develop new non-destructive testing capabilities to meet specific industry needs.	Non-destructive testing engineer (degree)	6	0.603
205715	Maintain or repair sensors systems used for through life monitoring of products	Space engineering technician	4	0.601
221499	Assess and approve design proposals based on new non-destructive testing technology or methodology to ensure compliance with industry standards.	Non-destructive testing engineer (degree)	6	0.601
210508	Analyse data from remote equipment inspections.	Electro-mechanical engineer	6	0.6
221500	Review and update approval methodologies to incorporate specific requirements of emerging non-destructive testing technologies.	Non-destructive testing engineering technician	3	0.6
209596	Implement automated inspection and maintenance using sensor-equipped autonomous underwater vehicles	Uncrewed marine vehicle specialist	5	0.599
214238	Inspect structures to assess serviceability, quality, safety, and obsolescence, and initiate maintenance, repair, and disposal.	Ordnance munitions explosives technician	4	0.599
214248	Utilise artificial intelligence techniques to review quality assurance of real-time data, operating parameters, and modelling results for regulatory compliance.	Electro-mechanical engineer	6	0.599
221497	Develop skill sets in new non-destructive testing technologies to support the design and implementation of methodologies compliant with industry regulations.	Non-destructive testing engineer (degree)	6	0.599
205701	Implement real-time monitoring and adjustment using advanced sensors and monitoring technology	Crop technician	3	0.595
221501	Verify that new non-destructive evaluation system designs are operated according to specified standards.	Lifting equipment technician	3	0.594
50960	Develop or validate product-specific test protocols, acceptance thresholds, or inspection tools for quality control testing or performance measurement.	Electro-mechanical engineer	6	0.591

210414	Utilise Artificial Intelligence (AI) tools for design, manufacturing, and planning support.	Advanced robotics engineer	7	0.591
214231	Design inspection tools and systems to enhance product maintainability.	Electro-mechanical engineer	6	0.587
221498	Consult with design teams to influence effective design decisions and conformance to industry standards.	Engineering design technician	3	0.584
214229	Evaluate NDE system performance quantitatively to detect defects and predict failures effectively.	Non-destructive testing engineering technician	3	0.581
210505	Operate Artificial Intelligence (AI) tools for efficient operational support.	Hospitality manager	4	0.58
214241	Inspect underwater materials to assess their condition.	Non-destructive testing engineer (degree)	6	0.58
201549	Utilise holistic data integration solutions for organisations and relevant supply chain partners	Supply chain practitioner (fast-moving consumer goods)	3	0.578
69240	File appropriate compliance reports with regulatory agencies.	Hospitality manager	4	0.577
214223	Utilise quantum sensing technologies to improve non-destructive evaluation capabilities.	Non-destructive testing engineer (degree)	6	0.576
214251	Develop submarine technologies to optimize their performance. Operate and maintain submarine systems to ensure their reliability and safety.	Uncrewed marine vehicle specialist	5	0.576
155740	Select, calibrate, or operate equipment used in the non-destructive testing of products or materials.	Non-destructive testing engineer (degree)	6	0.575
214257	Evaluate non-destructive testing AI tools to assess their suitability for specific future applications, ensuring they meet operational readiness.	Non-destructive testing engineer (degree)	6	0.569
210453	Develop active control algorithms for offshore robotic and autonomous systems to optimise performance.	Robotics engineer - degree	6	0.568
213148	Develop efficient data collection and data management procedures that are fit for the purposes of the digital and automated environment.	Data engineer	5	0.568
210258	Ensure the reliability and functionality of robotic and autonomous systems through regular updates.	Advanced robotics engineer	7	0.565
214227	Integrate new non-destructive testing systems with specific manufacturing, operation, and maintenance processes from the inception to improve targeted efficiency and effectiveness metrics.	Non-destructive testing engineer (degree)	6	0.56
201565	Develop new analytical techniques or sensor systems for through life monitoring	Aerospace engineer	6	0.558
214254	Utilise robotic and autonomous methods to assess submarine equipment for stress, fatigue effects, and damage	Uncrewed marine vehicle specialist	5	0.557
205927	Develop policies and procedures based on real-time regulatory data using compliance management systems	Senior insurance professional	6	0.555
214221	Combine NDT, condition monitoring, and structural health monitoring into a holistic solution.	Through life engineering services specialist (in	7	0.554

214232	Model defect types in materials and evaluate their effects to inform acceptance criteria.	Food industry technologist	3	0.553
210594	Model the testing, operation, maintenance, or repair of facilities or equipment for future demands.	Electro-mechanical engineer	6	0.552
214225	Verify the compatibility of selected technology with specific onboard systems to prevent adverse interactions.	Robotics engineer - degree	6	0.551
209186	Implement autonomous robotics for inspection and maintenance in confined spaces.	Robotics engineer - degree	6	0.549
210710	Establish a cross-functional team to coordinate compliance activities and ensure alignment with regulatory standards.	Post graduate engineer	7	0.548
214220	Understand advanced repair systems to accommodate novel materials and processes.	Non-destructive testing engineer (degree)	6	0.548
210389	Deploy novel sensor technologies to enhance the versatility of robotic and autonomous systems.	Advanced robotics engineer	7	0.547
51990	Develop technical specifications for data management programming and communicate needs to information technology staff.	Craft carpentry and joinery	3	0.542
214222	Leverage AI advancements to enable automated decision-making and autonomous operations.	Artificial intelligence (AI) data specialist	7	0.535
214215	Verify ERP software compatibility to maintain accurate inventory monitoring	Supply chain practitioner (fast-moving consumer goods)	3	0.534
34940	Consult with government regulatory and licensing agencies to ensure the institution's conformance with applicable standards.	Hospitality manager	4	0.53
188939	Design systems to meet Operations & Maintenance i.e. tow-to-port and plug & play	Maritime electrical fitter	3	0.526

Although 110 out of the total of 120 capabilities were found to have matching provision within Skills England Occupational Standards, the range of standards covered may present a challenge to employers and educators in identifying which existing sources of provision would be worthwhile investigating to access potential provision. When prioritising work to develop course material for these capabilities employers and educators should also reference other industry related technology roadmaps such as the NDE 4.0 Roadmap developed by the British Institute for Non-Destructive Testing (BINDT) to identify common areas of priority and opportunities to work in collaboration.

Five engineering related standards should be considered as important sources of current provision. These standards are:

- Non-destructive testing engineer (degree) Level 6
- Non-destructive testing engineering technician Level 3
- Electro-mechanical engineer Level 6
- Robotics engineer Level 6
- Advanced robotics engineer Level 7

These standards account for the top education provision matches for 36% of the capabilities in the cycle.

Unmatched Capabilities

Only 8% of all capabilities in the cycle were found to have no match with current Skills England Occupational Standards provision, confirming that majority of capabilities in the cycle could be matched with current provision, albeit that this provision is spread across numerous standards. Several of these capabilities have been included in FOPs that employers have indicated are going to play an important role in the future including NDT Data Analyst, NDT & Condition Monitoring Engineer and Design Engineer. Development of course material for these capabilities will need to be completed alongside the process of accessing and reviewing what is current provision.

Future Occupational Profile (FOP) Fits

By reviewing the FOPs against the suitability grid, we can determine which of the groups of current apprenticeship standards are more applicable than others. Although none of the FOPs scored high in the Overall Suitability category (a combination of Fit & Surplus scores) two were found to have fair to good suitability against some standards whilst several other FOPs were found to have fair suitability.

FOPs that have Skills England Occupational Standards identified as 'some suitability' when compared with current standards and provision are:

1. Network Engineer (NDT Condition Monitoring)
2. Marine Engineers and Naval Architects

Suitable standards are listed in the table below:

Role Level	Future Occupation Profile	Skills England Occupational Standards	Suitability
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Rail engineering technician	Good
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Utilities engineering technician	Fair
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Mechatronics Maintenance Technician	Fair
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Rail engineering advanced technician	Fair
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Food and drink maintenance engineer	Fair
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Food and drink advanced engineer (integrated degree)	Fair
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Small vessel chief engineer	Good
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Maintenance and operations engineering technician	Fair
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Heat network maintenance technician	Fair
Technician/Supervision	Network Engineer (NDT Condition Monitoring)	Food and drink engineer	Fair

Principal / Senior Engineer	Marine engineers and naval architects	Uncrewed marine vehicle specialist	Good
Principal / Senior Engineer	Marine engineers and naval architects	Marine technical superintendent (degree)	Good

When viewing the mapping results for the remaining FOPs most standards that have some degree of fit with a FOP have a material surplus score making them unsuitable as candidates to be adopted for education provision in their current state. Standards with a reasonable level of fit are worth noting as starting points for educators in understanding what is already available and what the most efficient approaches may be for addressing the gaps.

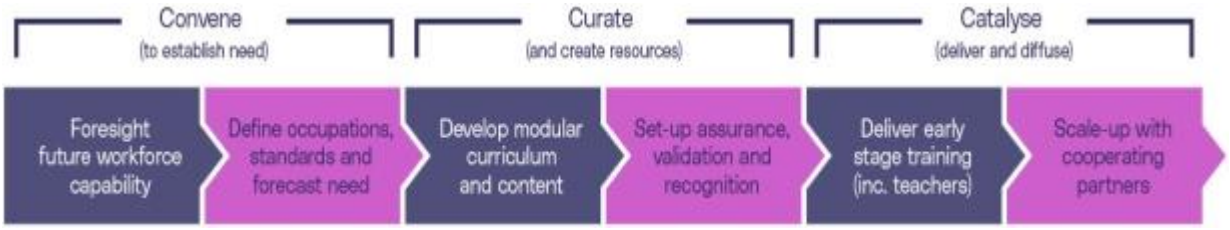
FOPs and Fit Percentage

Role Level	Future Occupational Profile	Skills England Occupational Standards	Level	Fit %
Technician/Supervision	NDT Technician	Mechatronics Maintenance Technician	3	42%
Technician/Supervision	NDT & Condition Monitoring Engineer	Non-destructive testing engineer (degree)	6	43%
Technician/Supervision	NDT & Condition Monitoring Engineer	Electro-mechanical engineer	6	43%
Technician/Supervision	NDT & Condition Monitoring Engineer	Nuclear welding inspection technician	4	39%
Technician/Supervision	NDT & Condition Monitoring Engineer	Mechatronics Maintenance Technician	3	39%
Principal/Senior Engineer	Data Architects	Data engineer	5	44%
Principal/Senior Engineer	Compliance and Regulatory Specialist	Regulatory affairs specialist	7	40%
Principal/Senior Engineer	Equipment and Systems Specialist	Aerospace engineer	6	42%
Principal/Senior Engineer	Equipment and Systems Specialist	Electro-mechanical engineer	6	37%
Principal/Senior Engineer	Mechatronics Engineers	Advanced robotics engineer	7	39%
Principal/Senior Engineer	Mechatronics Engineers	Robotics engineer - degree	6	33%
Principal/Senior Engineer	RTO R&D Engineer	Non-destructive testing engineer (degree)	6	73%
Principal/Senior Engineer	Design Engineer	Non-destructive testing engineer (degree)	6	60%
Principal/Senior Engineer	NDT R&D Engineer	Non-destructive testing engineer (degree)	6	35%
Principal/Senior Engineer	NDT R&D Engineer	Food and drink advanced engineer (integrated degree)	6	35%
Principal/Senior Engineer	NDT Technology Development Engineer	Non-destructive testing engineer (degree)	6	67%

The use of the data visualisation tool is recommended to access the next layer of detail and review the specific standards that have been identified.

4.2 What this means for Industry and the Workforce

Foresighting has been developed to provide insight and the detailed information required to enable action by relevant stakeholders but is the first step of the Skills Value Chain. Collective action will be required by all stakeholders to ensure that the changes identified by foresighting – to the supply chain, the workforce and education provision are implemented.



This section summarises the actions required as a result of this foresight cycle.

Employers in the various supply chain organisations will need to take proactive steps, both individually and collectively to ensure that the development of skilled professionals meets future industry needs.

With the spread of current provision across a broad range of standards a strategic and coordinated effort amongst stakeholders would enable an efficient use of resources. Short courses or programs developed around capabilities applicable across a number of supply chain partners are likely to have the highest impact on skills levels while spreading the required investment across a range of organisations. However coordinated action will be required to agree on priorities and resource allocation.

The Defence Nuclear Enterprise partnership is ideally positioned to play a meaningful role in this activity by acting as overall champion and taking ownership of an agreed plan of action.

The DNE partnership can also play a significant role in supporting the delivery of early-stage training once courses have been developed. Prompt validation of content and results amongst key partners will establish the credibility of the courses/programs and support the necessary scale up of training when required.

Once priorities of work have been agreed to, DNE will also be well placed to engage with other organisations such as the British Institute for Non-Destructive Testing (BINDT) to establish necessary validation and recognition for courses developed.

4.3 What this means for Education

The insights from the foresighting study indicate that current provision may only be suitable for two of the FOPs namely the Network Engineer and the Marine Engineers and Naval Architects.

However, on closer analysis at individual capability level there are five apprenticeship standards worth further investigation due to the number of capabilities they match. These standards are:

- Non-destructive Testing Technician Level 3
- Non-destructive Testing Engineer Level 6
- Robotics Engineer Level 6
- Advanced Robotics Engineer Level 7
- Electro-mechanical Engineer Level 6

A modular approach could be considered for incumbent employees with these types of qualifications where gaps need to be filled based on a particular FOP requirement. Educators should note that four out five of these standards are at level 6 or above whereas a number of the FOPs are at the Technician/Supervisor role level.

Due to the spread of current provision across a broad range of standards it would be worthwhile for educators to undertake a deeper analysis of this landscape using the data from the visualisation tool to better understand where the best opportunities may exist to leverage existing provision. This investigation could include mapping where provision or partnerships to deliver these standards already exists within the supply chain partner organisations. Further action should also be taken to explore how related qualifications within the higher education landscape can complement the work of the cycle and fill some of the gaps now identified.

Educators should coordinate their development activities with employers in the sector ideally through the DNE to ensure that there is alignment on priorities and timeframes and support for early-stage training and eventual scaling up of training.

4.4 Recommended next steps

To ensure that the nuclear submarine sector and the supply chain partners involved with the ongoing maintenance of the fleet is prepared for the technology changes identified in the cycle the following actions are recommended:

Short-term Actions

- Convene a working group through the Defence Nuclear Enterprise that will bring together key organisations from the supply chain partners and take responsibility for the coordination of the actions required to deliver a revised set of capabilities and skills as identified in the next five years.
- To communicate the results of this foresighting report to a broader group of stakeholders to increase the understanding of the skills required in the future and to build consensus on how these skills can be developed within the requisite time frame.
- Through the Defence Nuclear Enterprise (DNE) convene a working group of key stakeholders to agree on which areas to be prioritised and a plan of action to achieve the priorities.
- Using the Future Occupational Profiles developed by the cycle identify which areas related to professional development may need to be updated or introduced to align more closely with the identified future needs.
- Survey supply chain partners to better understand where current education provision that has been mapped to capabilities that may already be used within the sector.

Medium term

- Based on the survey results of current provision within existing supply chain partners identify those opportunities where current provision can be accessed and repurposed to deliver modular courses for upskilling purposes.

- Convene a regular meeting of organisations within the supply chain partners to understand how future skills needs are evolving as technology is implemented and how FOPs and capabilities for this area need to be revised.

- Engage with industry and professional bodies such as the British Institute of Non-destructive Testing on the recognition of achievements through the development and implementation of new courses and programs.

Finally, this cycle has identified a genetic development that potentially needs to be recognised across all areas relating to NDT, and beyond into wider engineering in multiple fields and sectors, that being the increased use of data, data management, machine learning and AI techniques to analysis and interpret that data, and the application of information generated.

Further this is moving into ‘live’ integrations of sources applied at the point of use, this requires deeper scientific and application understanding but is likely in horizon 2 to 3 timescale to be required in many areas of skill development.

5. Appendix

5. Appendices

Section	Title
5.1	List of participants
5.2	Cycle timeline
5.3	Access to output data - link
5.4	Glossary - common language
5.5	Visualisation links, illustrations and instructions

5.1 List of Participants

Technology Participants	Industry / Employer Participants	Education & Skills Participants
Rolls-Royce	Babcock International	Babcock International
Babcock International	BAE Systems	Ministry of Defence
HVMC – Manufacturing Technology Centre	Rolls-Royce	British Institute of Non-Destructive Testing
Technology Centre & National Composites Centre	Ministry of Defence	HVMC – Manufacturing Technology Centre
		University of Cardiff

5.2 Cycle timeline

Workforce Foresighting cycle started the Carry Out phase in January 2025. The Carry Out phase concluded in February 2025. The Findings report was prepared following the data validation period and published in.

5.3 Access to output data - link

Data Capture Overview

5.4 Glossary - common language

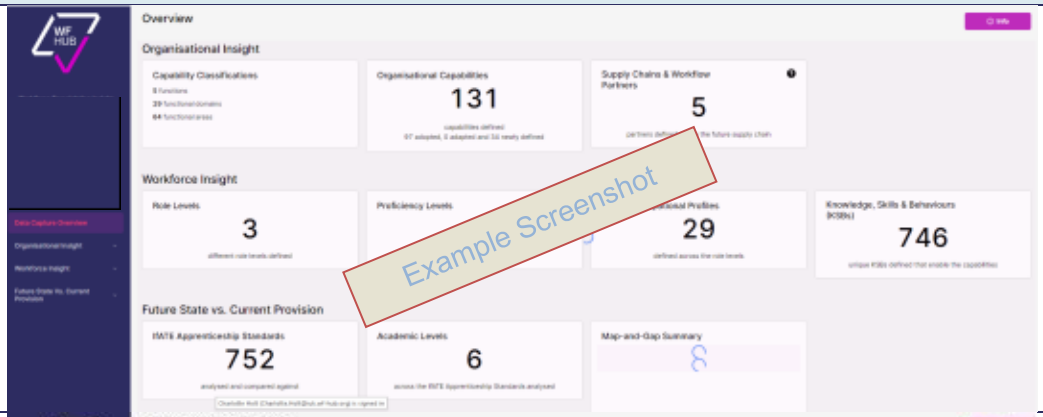
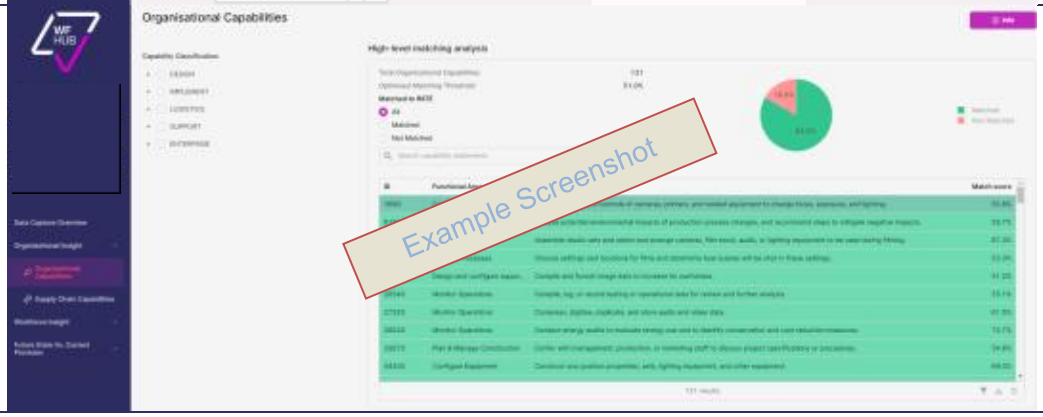
Term	Definition
Impact Domains	Innovate UK domains used as Strategic Categories to assist setting and monitoring priorities
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary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

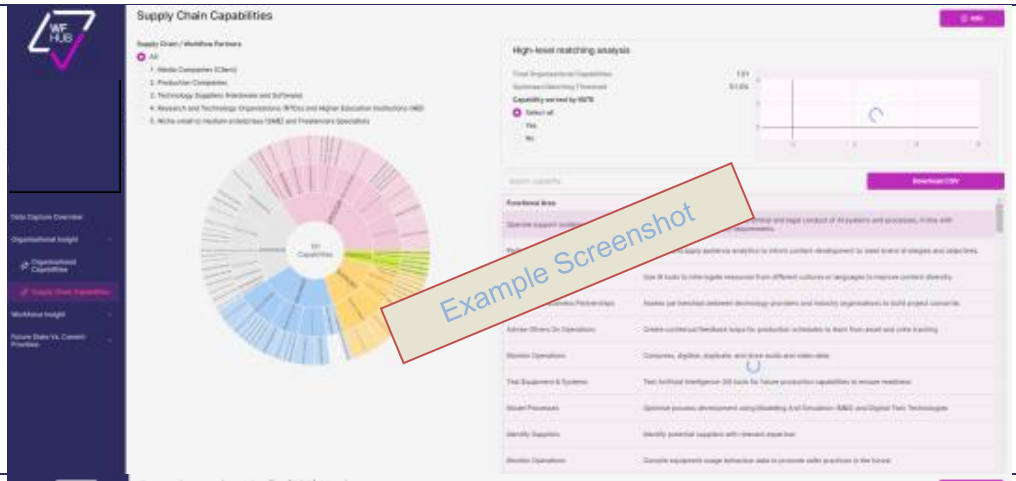
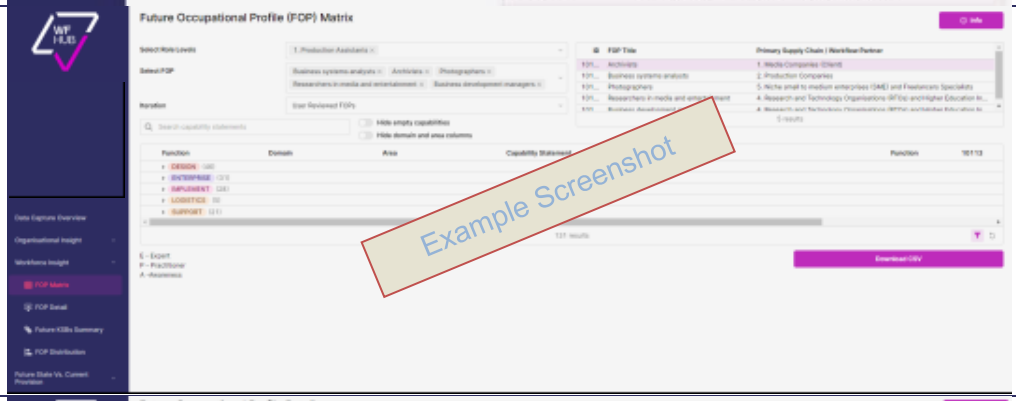
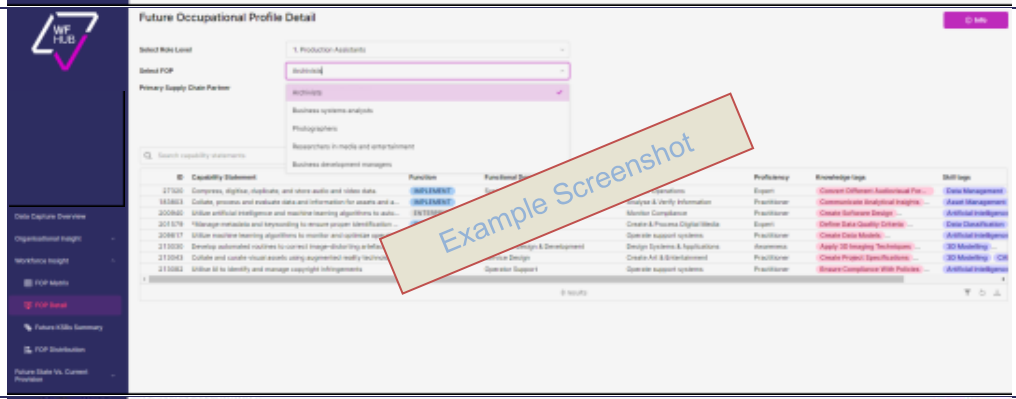
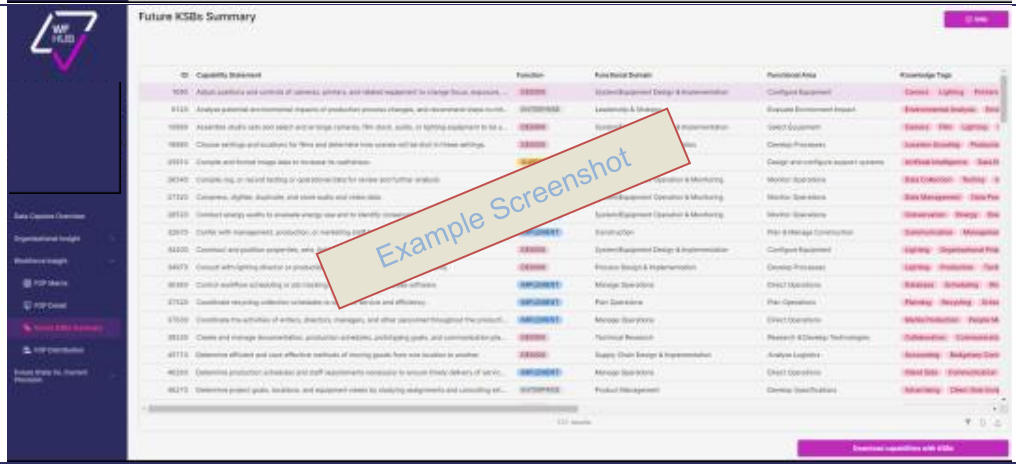
Technologies	The technology that could be used to address the challenge
Working Scenario	To provide further context in relation to the subjects and used to position participants thinking during the detailed identification of future capabilities
Workshops	Online sessions used to undertake each step in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

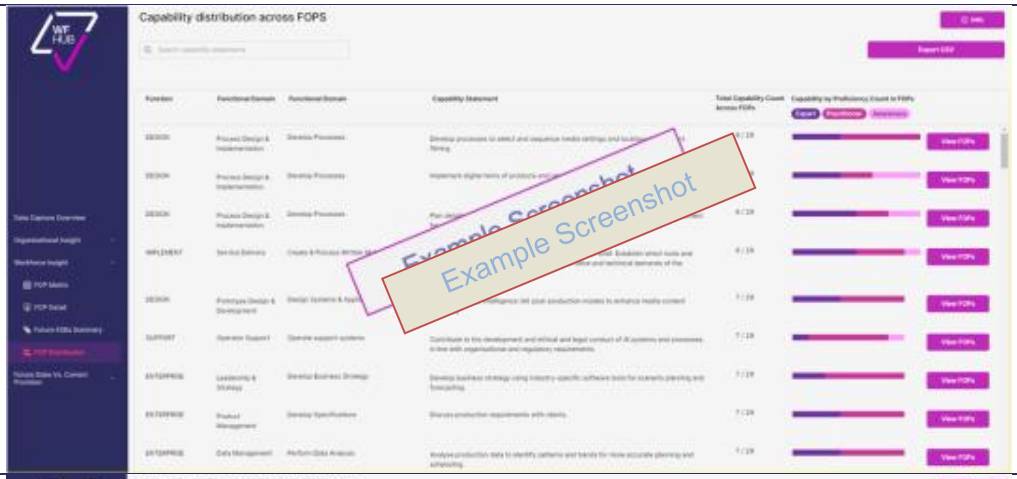
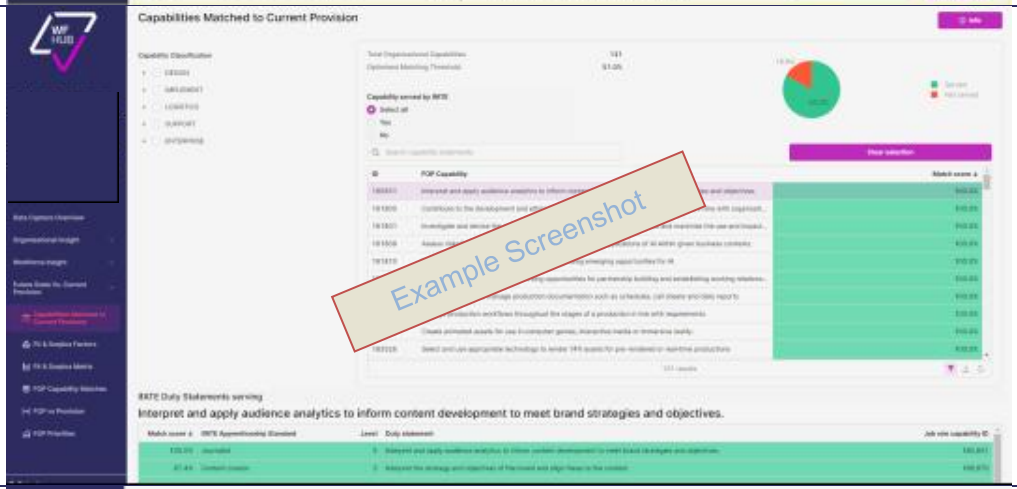
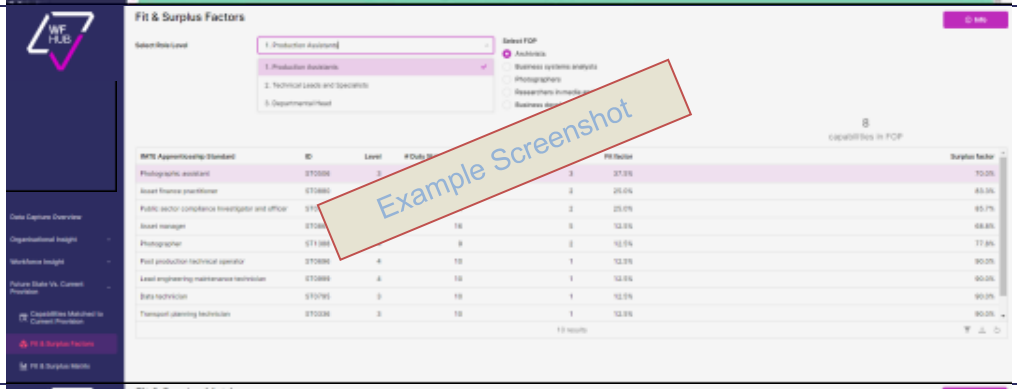
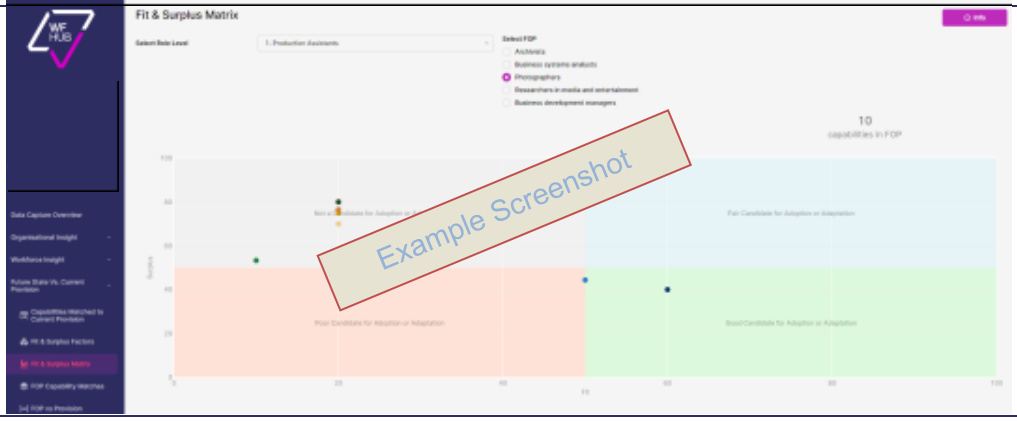
5.5 – Visualisation links and Illustrations

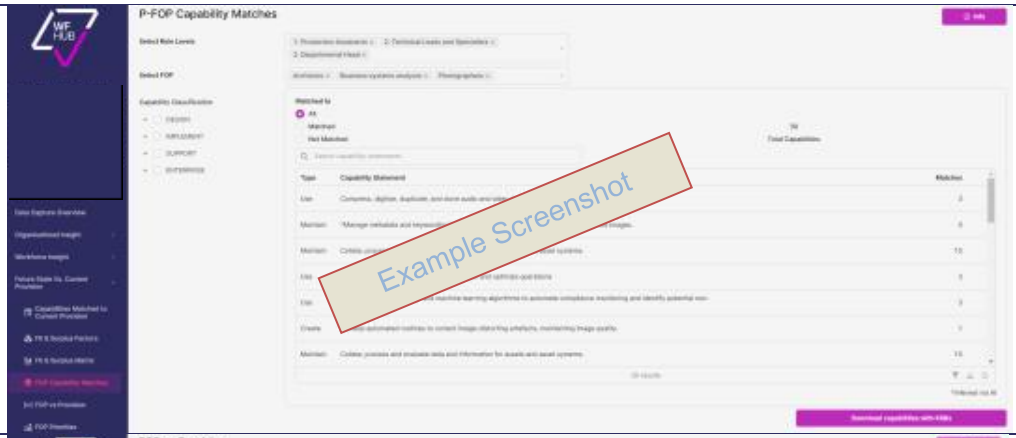
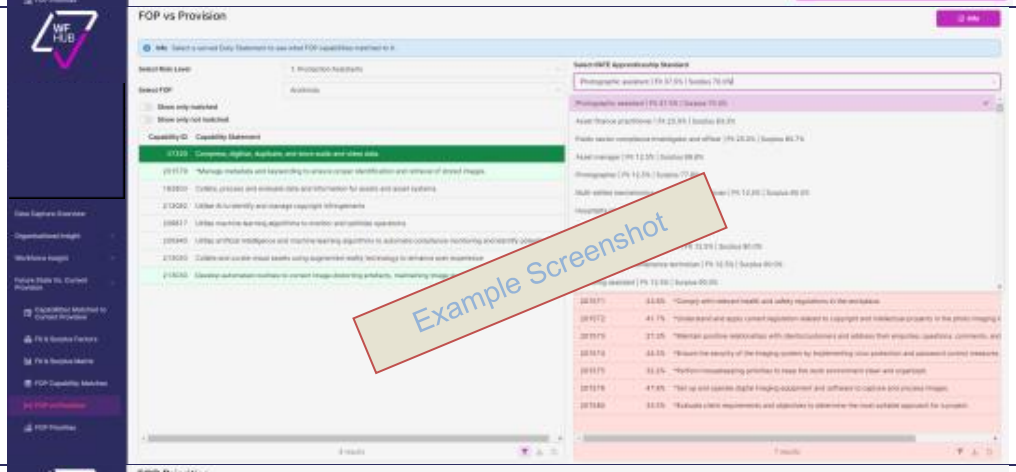
Images are not cycle specific and just for guidance purposes

Links

Link to Visualisation	View of data
Data Capture Overview	
Organisational Capabilities	

[Supply Chain Capabilities]	
[FOP Matrix]	
	
[Future KSBs Summary]	

FOP Distribution	
Capabilities Matched to Current Provision	
Fit Surplus Factors	
Fit Surplus Matrix	

FOP Capability Matches	
FOP vs Provision	
FOP Priorities	

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.*
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.*
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.*
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.*
P-FOP Distribution	*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 Skills England Occupational Standards provision.* • *By capabilities that **are not** served by the reference mapping framework, e.g., Skills England Occupational Standards 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. Skills England Occupational Standards.* *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. Skills England Occupational Standards.* *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 Skills England Occupational Standards 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, Skills England Occupational 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*
P-FOP vs Provision	*This page allows you to compare P-FOPs against existing Skills England Occupational 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 Skills England Occupational Standards for that Occupational Profile.* *Where a future capability has been matched to existing provision (currently, by default, Skills England Occupational 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.*