Workforce Foresighting Hub

Accelerating Subsea Survey in Offshore Wind using Autonomous Systems and AI

A Workforce Foresighting Study

Authors:	
Cycle Sponsor:	RenewableUK
Centre of Innovation:	Offshore Renewable Energy (ORE) Catapult, Danielle Portsmouth, Paul Hatchett
Workforce Foresighting Hub:	Evelyn Hadley

CATAPULT Offshore Renewable Energy

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Right skills, right time, right place

Acknowledgements

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

Skills England (formerly IfATE – Institute for Apprenticeships and Technical Education, England)

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

ONet – Occupational Networks Online, USA

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

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

This report was produced following workshops undertaken 2026 Q1 using the data set and tools available at that time.

Executive Summary

This report outlines findings from the Workforce Foresighting cycle focussing on Accelerating Subsea Survey in Offshore Wind using Autonomous Systems and AI. This industry challenge was sponsored by RenewableUK and study conducted by Offshore Renewable Energy (ORE) 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.

1.3.1 Strategic context and purpose for Workforce Foresighting

This cycle explores the expansion of autonomous platforms and AI into subsea survey for offshore wind. This topic is identified as an "expand" programme in Renewable UK's Offshore Wind Industrial Growth Plan (2024). An investment of around £10M-£20M is forecast between 2026 and 2030; and the expected result is a reduction in offshore wind consenting times by 40%. Expanding the deployment of Autonomous underwater vehicles (AUVs) for subsea survey should generate more than £0.2Bn in gross value-add for the UK economy.

Subsea survey is essential in the early stages of windfarm development. Data is needed about water depth and seabed topography; identifying hazards like large boulders or unexploded ordnance is essential for safe turbine siting, cable routing, and foundation design. However, subsea survey currently presents a critical bottleneck in offshore wind development, consuming up to 40% of the ten-year typical timeline from conception to commissioning. Current vessel-based survey methods are costly, weather-dependent, and time-intensive. Autonomous underwater vehicles, unmanned surface vessels, and AI-driven data analysis promise significant improvements in time, safety and cost.

This technological and operational transition will require significant changes in the workforce. For example, Remotely operated vehicle (ROV) pilots will shift from offshore hands-on piloting roles to onshore remote monitoring of multiple autonomous systems; survey specialists are expected to move post-processing and verification of AI outputs; and engineers and technicians familiar with robotic platforms will be needed to configure, task, deploy, and maintain them as their use becomes routine.

1.3.2 Participants and Stakeholders

Thank you to all those organisations for their time and commitment to providing insights and data for this study, in the hope that this process will have a significant impact on the sector.

Offshore Renewable Energy (ORE) Catapult
Soil Machine Dynamics (SMD)
Reach Subsea
Fugro
Eiva
The Crown Estate
Underwater Diving Services (UDS)
Newcastle University
Plymouth University
National Oceanography Centre
The Alan Turing Institute

1.3.3 Summary of Findings

This cycle identified 122 capabilities, which were consolidated into 14 Future Occupational Profiles (FOPs). Collectively, these findings provide a foundation for the adoption of autonomous, AI-enabled, and robotic systems across the subsea and offshore operations ecosystem.

Key capability themes include advanced autonomous systems design, AI-driven analysis, digital twin development, remote and uncrewed operations, and regulatory governance.

These outputs provide a practical framework for both industry and education providers. For industry, they support more effective workforce planning by identifying the capabilities required to deploy emerging technologies and enabling targeted upskilling and reskilling strategies. For education providers, they offer a clear evidence base to inform curriculum development, focusing on new and differentiating capabilities rather than duplicating existing provision.

Together, this enables stronger alignment between training provision and industry demand, clearer progression pathways, and a more agile response to evolving skills needs.

1.3.4 Next Steps

ORE Catapult will build on its workforce foresighting approach by expanding the use of “role archetypes” to simplify and scale the application of the future occupational profiles and new capabilities identified. This approach enables agile skills development, by layering specialist capabilities onto foundational roles, rather than creating entirely new qualifications (with the exception if identified skills course opportunities to support upskilling).

The approach will support education providers in aligning curricula to emerging industry needs, focusing on new and differentiating skills while enabling clearer progression and reskilling pathways.

ORE Catapult are currently piloting the adaptation and use of a software skills platform (skillsminer.ai) under an Innovate UK funded project, looking at how workforce foresighting data can be operationalised and taken into effective action by employers and educators. Subject to the success of the pilot (and future funding), data from this study will be incorporated within the next stages of the ‘cause action’ project. Digital enablement through this platform will help to scale the impact of workforce foresighting by embedding insights into a platform that supports workforce planning, skills matching, and reskilling across the sector.

Other recommended actions include:

- Governance and working groups will be established to ensure industry validation, accountability, and the translation of insights into tangible training and workforce interventions.
- To maintain momentum and coordination, a national industry champion is recommended to provide leadership and drive sector-wide alignment.
- Cross-sector collaboration will be enhanced to support workforce mobility and shared capability development, improving resilience and reducing investment risk.

Glossary

Term	Definition
AI	Artificial intelligence
AUV	Autonomous underwater vehicle
BVLOS	Beyond visual line-of-sight
Challenge Response	Specific intervention aimed at the challenge
Capability	The collective abilities, and expertise of an organisation to carry out a function, because provision and preparation have been made by the organisation– typically expressed as a verb-noun pair.
Competencies (Workforce / Individual)	Proficiency, aptitude, capacity, skill, technique, experience, expertise, facility, fitness related to capability
CPD	Continued Professional Development
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
GIS	Geographic Information Systems
GVA	Gross Value Add
HV	High Voltage
KSBs	Knowledge, Skills, and Behaviours – these are elements used to add additional detail to a capability and help when translating into other frameworks or education.
ML	Machine learning
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary
NQF	National Qualification Framework
Organisation Type	Simple description of nature of organisation for which capability is required
OWIGP	Offshore Wind Industrial Growth Plan (RenewableUK, 2024)
Participants	Technologists, Educators, Employers
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
RAS	Robotics Autonomous Systems
Roadmaps	Sector, Industry, Regional view of emerging opportunities and their market entry
Role Family	Role families are a collective of roles or proposed occupational profiles that exist in the sector (or are expected to exist in the future), aligned to NQF levels.
ROV	Remotely operated vehicle
UUV	Uncrewed underwater vehicle
USV	Uncrewed surface vessel
UXO	Unexploded ordnance (typically WW2 bombs in the North Sea)
Working Scenario	To provide further context in relation to the subjects and used to position participants thinking during the detailed identification of future capabilities
WTG	Wind turbine generator

Table 1: Glossary

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Figures and Tables

1. Introduction & Challenge Definition

Introduction

1.4 Purpose of this Report

This report is a summary of output from Phase 2 ('Carrying Out') of a workforce foresighting study on Accelerating Subsea Survey in Offshore Wind using Autonomous Systems and AI. The study is sponsored by RenewableUK and conducted by the Offshore Renewable Energy Catapult, with the Workforce Foresighting Hub facilitating the foresighting process through structured workshops and detailed analysis.

The report is intended principally for participants and interested stakeholders to review and access the capability sets and prototype future occupational profiles ('FOPs') developed by the study so far. This provides an opportunity for comment, before the "causing action" phase of the study. FOPs are intended to support industry and the training / education sector in the design of roles and course content, but they are not intended as prescriptions for job descriptions or specific course modules.

The report briefly summarises the foresighting topic and its selection, presents the future occupational profiles, and provides the capability sets within the Appendices. The appendices to the report also contain further information about the workforce foresighting process, and links to an online visualisation tool, where the generated data can be viewed in various ways.

1.5 Introduction to Workforce foresighting

Workforce foresighting is essential in addressing the skills challenge, by aligning the skills value chain — from early education through to advanced training — with the demands of emerging technologies. By identifying future occupational profiles and the capabilities required for new roles, foresighting enables educators, employers, and policymakers to proactively adapt curricula, qualifications, and training pathways. This ensures the workforce is not only prepared for technological change but also equipped to drive innovation and productivity. In doing so, it transforms the skills gap from a reactive challenge into a strategic opportunity for national growth and resilience.

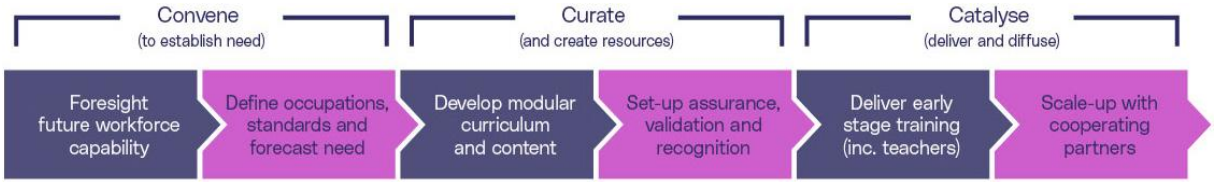

Figure 1: The Skills Value Chain (SVC)

1.6 Defining the Challenge

1.6.1 Policy and Industrial Context (National)

According to the UK's Clean Power Action Plan 2030 (Department for Energy Security and Net Zero, 2024), power generation from offshore wind is a vital part of the UK's future energy security and achievement of CO_2 reduction targets. The UK has a target of 43-50GW of power from offshore wind by 2030. Alongside nuclear, this is seen as the backbone of a clean electricity system in the UK. The gap between current installed capacity and future targets is illustrated in Figure 2 below.

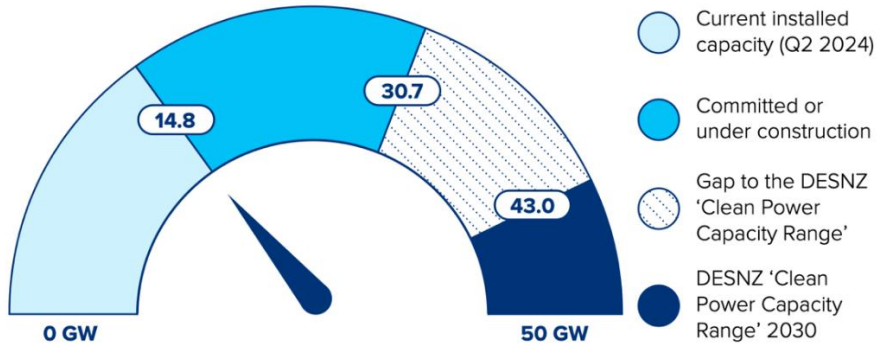

Figure 2: Offshore Wind installed capacity vs 'Clean Power Capacity Range' in 2030 (Department for Energy Security and Net Zero, 2024)

The need for new technologies and capabilities to support this increase in the UK's installed offshore wind generating capacity, is the top-level challenge being addressed through ORE Catapult's workforce foresighting studies.

1.6.2 Topic Selection Approach

The foresighting topic has been selected through review of the UK's "Offshore Wind Industrial Growth Plan" (RenewableUK, 2024) to identify focal technology areas for foresighting; review of the UK's "Clean Power 2030 Action Plan" (Department for Energy Security and Net Zero, 2024) and the Energy Skills supplement to better understand the strategic landscape, and shortlisting workshops with lead technologists from the Offshore Renewable Energy Catapult ('ORE Catapult').

The Offshore Wind Industrial Growth Plan ('OWIGP') is a recommendation by industry bodies to government, for investment in the growth of UK offshore wind and strengthening of the industrial sector through a focus on five areas:

- Advanced Turbine Technology
- Industrialised Foundations & Substructures
- Future Electrical Systems & Cables
- Smart Environmental Services, and
- Next Generation Installation, Operations & Maintenance

The Clean Power 2030 Action Plan was published by the Department for Energy Security and Net Zero ('DESNZ') in December 2024. The Action Plan describes the UK's transition to clean energy by 2030, such that clean energy should comprise 95% of Great Britain's overall generating capacity (currently 60%) and produce as much power as Great Britain consumes (currently 56%). Great Britain's CO_2 emissions intensity should also reduce below 50g per KWh by 2030 (currently 171g CO_2 / KWh).

Skills are referenced in both the OWIGP and the Clean Power 2030 plan (the only addendum to the report focusses on skills and notes that the offshore wind sector has reported persistent skills gaps in high-level electrical, digital, and consenting skills; and for roles like Senior Authorised Persons, data analysts and scientists, and regulators). Workforce Foresighting is referenced as a component in resolving the skills challenge in both the OWIGP and the Clean Power 2030 plan, citing ORE Catapult's study on Dynamic Cable Systems (Hatchett et al., 2023).

From these three sources and analyses, two clusters of foresighting topics resulted:

Cluster 1 (studies completed in 2025 H1):

- **Structures – automated welding:** The development and application of automated welding solutions for foundations, transition structures and tower sections.
- **Advanced production methods in wind turbine blades**: Design and production utilising advanced and automated production methods.
- **HVDC Cable Systems:** Development and production of high voltage direct current (HVDC) cables and associated equipment in the UK.

Cluster 2:

- **Smoothing power delivery to grid from Offshore Wind: The** topic described in this report.
- **Autonomous survey:** Robotic & autonomous systems application for autonomous subsea environmental, site and geotechnical survey (pre-construction).
- **Alternative materials for Floating Offshore Wind moorings / structures:** Use of synthetic ropes, alternative and synthetic materials for mooring lines / Use of novel concrete materials and forming; in floating offshore wind.

1.3.3 Topic Selection and Description

The Strategic Challenge

Offshore survey is a foundational activity in the lifecycle of offshore assets, including wind farms. Data gathered during these surveys is essential for site development and consenting. Knowledge of the water depth, seabed topography, sub-surface and hydrological conditions are essential to ensure that turbine foundations are appropriately specified, sited and installed (Mitchell et al., 2022). Cable routes, turbine locations and safety during construction may all be affected by hazards such as boulders or unexploded ordnance ('UXO') (The Crown Estate, 2024).

At present, subsea survey is a significant constraint and a primary bottleneck in the development of offshore wind farms. This increases the overall development timelines, also increasing cost and risk. The time from conception of an offshore wind to commissioning (the generation of first power) can be a decade or more, and delays during planning and early development phases can account for 40% of that time (Mitchell et al., 2022; The Crown Estate, 2024). Wind farm developers can't reach financial close until site assessments are complete, so there is a risk of attrition until site surveys are completed. More recently, the Crown Estate has sought to take on some of this risk by carrying out early surveys ahead of the leasing rounds, so that developer decision making is more informed.

The Offshore Wind Industrial Growth Plan (RenewableUK, 2024) estimates an investment need of between £10M and £20M to expand the deployment of autonomous surveys between 2026 and 2030.This is targeted to reduce consenting time by 40%, and over a ten year period is expected to return a gross value-add (GVA) or between £0.2Bn and £0.3Bn to

the UK. The AUV market globally is expected to be worth around $4.9Bn globally by 2028, with a compound annual growth rate of around 22.4% from 2022 (Hariram, 2024).

1.6.3 The Future Technology

As in other areas of offshore wind, there are increasing benefits in safety and cost in transitioning from human to robotic solutions (Bernardini et al., 2020). Traditional survey methods use manned vessels and specialised crews. Typically, data is collected via sonar or other sensors deployed on remotely operated vehicles (ROVs) or towed arrays – and more recently autonomous underwater vehicles (AUVs) - traversing “lawnmower patterns” to collect measurements via interleaved sonar swaths (Williams et al., 2012).

Although there is some use of AUVs, greater automation of the survey tasks can reduce the need for crewed vessels. Deploying unmanned vehicles is less resource intensive and much work can transition from the vessel to onshore remote operations centres. This improves safety (removing people from hazardous locations), reduces operational constraints from weather windows, and reduces fuel and labour costs. This has a direct positive improvement on the levelised cost of energy. As such, there is significant effort to develop the capabilities and uses of AUVs.

Whilst earlier studies showed significant reductions in survey time (in one day, an AUV covered 60% of a site that took a vessel 1.5 weeks to survey), the quality of data generated lagged traditional approaches (Koltsidopoulos et al., 2021). However, sensor fusion - combining data from several sensors and potentially multiple platforms - and advances in processing and visualising this data are rapidly developing. Combining data into geographic information systems (GIS) and generating detailed topographical data in these tools is extremely useful in offshore wind – and other sectors.

AI and machine learning can be applied to automate analysis of survey data, but also in real-time during the collection of data. This enables a move from mission pre-planning, which can be flawed due to over- or under-estimation of sonar coverage (Williams et al., 2012), to decision making and self-navigation – where AUVs can ‘decide’ to change a path to investigate features in more detail, such as a newly formed scour hole, or unexploded ordnance (Thierauf, 2025; Wegner, 2025). Platforms like the Autonomous Benthic Explorer are capable of terrain-following using onboard intelligence (Yoerger et al., 2007).

1.6.4 Impact on Skills

Design and development of the platforms are important roles, but changes in these are likely to be relatively evolutionary. However, in operational areas there are likely to be greater disruptions, and certain roles (and job changes) will be needed to facilitate the industry transition.

Once systems are designed by PhD-level engineers and scientists, offshore technicians will be engaged to maintain and service robotic hardware once their deployment becomes “business as usual” (Koltsidopoulos et al., 2021).

In terms of conducting the survey operations and data gathering, ROV pilots currently work in shifts onboard a vessel during surveys. These roles are likely to transition from hands-on piloting on vessels, via remote piloting beyond visual line-of-site (BVLOS), towards monitoring multiple autonomous systems in supervisor roles from shore-based remote operations centres (Koltsidopoulos et al., 2021; Mitchell et al., 2022). This work will require greater familiarity and trust in AI-decision making, and the ability to manage complex human-robot interactions. To help bridge these gaps, industry is adopting virtual and augmented reality tools, to allow practice in a “fail safe” digital twin environment (Bernardini et al., 2020).

Lastly, in the processing of the collected data, survey experts will move from carrying out the analysis of data themselves, towards post-processing and verification of AI analysis.

2. Findings & Insights

2. Findings

2.3 Findings and Results

This report outlines a three-step foresighting process to understand how emerging technologies will reshape supply chain capabilities and workforce needs.

- **Industry** - First, it explores how organisational capabilities must evolve to enable the adoption/deployment of new and emerging technology, identifying which supply chain partner and functions will be most impacted.
- **Workforce** - Next, these capabilities are grouped into Future Occupational Profiles (FOPs), which show the occupations that will need to change.
- **Provision** - Finally, the FOPs are compared against current education and training provision—using Skills England occupational standards as a benchmark—to identify where existing programmes align and where gaps exist.

The report summarises priority capabilities, FOPs, and knowledge, skills, and behaviours (KSBs). Full details of the data and findings are available in the Appendix A. Online Data visualisation Tool and visualisation tool.

2.3.1 Introduction to the Visualisation Tool

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

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

Links: Link to the **Visualisation Tool** [1]

Detailed instructions on how to use the Visualisation Tool can be found in the Appendices to this report. **Table 11: A. Visualisation Tool Links**

[1] Visualisation Tool: https://hvmcatapultforesighting.retool.com/embedded/public/e869283b-4b8a-437c-973e-64ab292e5b87?token=ebd446c565bc99de1ba8d3db6cc5e7ae

2.4 Industry - Identified Organisational Capabilities

2.4.1 Capabilities Identified

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 project.

Insight: The study identified **122** capabilities required to enable the adoption of autonomous, AI-enabled and robotic systems across the subsea and offshore operations ecosystem. Key capability themes include advanced autonomous systems design, AI-driven data analysis, digital-twin development, remote and uncrewed mission operations, and regulatory governance—highlighting a shift toward embedding autonomy, data integrity and safety assurance throughout the full lifecycle of offshore mission delivery.

2.4.2 Future Supply Chain

To understand how supply chains must evolve in response to emerging technologies, we create a forward-looking view of what future supply chain operations will look like, compared to how they function today. This comparison helps highlight the areas where change is needed to meet new demands and opportunities.

Throughout the process, we work closely with participants to identify which **supply chain partners** will be affected by the technology in question. This ensures that the analysis is grounded in real-world contexts and considers the full ecosystem of organisations involved.

Survey operators

Deliver autonomous survey systems to offshore operators. Core activities include autonomous fleet management, remote updates, and lifecycle optimisation, alongside conducting subsea surveys to meet development and regulatory requirements. Services encompass installation and commissioning of resident systems, periodic integrity surveys, and post-decommissioning assessments to support asset lifecycle and decommissioning activities

Data Analytics and AI Development

Specialises in AI-driven solutions for marine survey operations. Core activities: developing survey data analysis tools, designing digital twins, and creating system architectures for autonomous underwater vehicle (AUV) fleets. Deliver agile, modular AI platforms with HMI interfaces, commission and integrate these systems with offshore assets, and ensure data flow integrity, governance, and compliance. Operational services cover processing survey data, training agentic AI models, and maintaining platform uptime

Developers and Windfarm operators

Support offshore wind projects. Core activities include continuous environmental monitoring and faster baseline surveys, evidence gathering for regulatory bodies such as MMO, Marine Scotland, and NRW, and preparing offshore wind Environmental Impact Assessments (EIAs) and cable route models. They collate survey data for bid development and ensure compliance with environmentl and operational standards.

Robotic, AUV/Platform and Sensors OEMs

Focus on the design and manufacture of autonomous underwater platforms and sensor systems. Core activities include innovating niche technologies such as sensors and edge AI, rapid prototyping and agile development, and supporting commissioning and diagnostics. Design full autonomy systems, modular AUV platforms, and AI-ready hardware, and scale production of autonomous fleets and AI-embedded systems. Additional services: delivering cloud-based data platforms and mission control systems, providing cyber security, connectivity, and data governance tools. Fleet operation and management activities cover remote diagnostics, AI model retraining, and fleet health monitoring.

Seabed Authorities, RTO and regulators

Operate within regulatory and governance functions for offshore & autonomous systems. Core responsibilities: certifying autonomous systems and ensuring safety compliance, overseeing ethical use of AI and data, and aligning operations with international maritime law. Designate seabed areas for lease rounds and adapt regulatory frameworks to support autonomous data collection & analysis. Approving AI data methodologies and validating survey data as part of bid evaluation.

2.4.3 New versus Existing Capabilities

In total across the various supply chain partners, **122** capabilities were identified (see Appendix B for the full detail). Out of the 122 future capabilities identified in this cycle, 60 were newly defined or adapted (17) with 64 capabilities not currently well matched with any duty statements found in existing apprenticeship standards Skills England (24th Feb 2026).

2.4.4 Prioritised Capability Themes

To help make sense of the full set of capabilities, four themes were identified, which are seen as critical to the technology adoption. These four themes were:

- AI, Data & Digital Twinning Applications for Offshore Autonomy and Survey
- Influence Regulatory Frameworks for Autonomous Operations
- Mission Planning for Offshore Autonomous Operations
- Autonomous Survey Platforms & Multi Vehicle Autonomy (AUV/USV/Swarm)

The capabilities grouped under each theme were:

AI, Data & Digital Twinning Applications for Offshore Autonomy and Survey

- Manage secure data communications with autonomous systems to safeguard AUV telemetry, command links and data return.
- Develop digital twins of automation systems to monitor assets remotely.
- Develop efficient data collection and data management procedures that are fit for the purposes of the digital and automated environment.
- Utilise data visualisation tools to present regulatory compliance data in a clear and informative manner
- Integrate AI-based control systems to monitor specific operational processes.
- Create digital twins for rapid assessment of new robotic and autonomous systems or changes.
- Apply artificial intelligence and machine learning techniques to analyse meteorological and oceanographic data to derive specific and actionable insights.
- Implement AI models to detect unexploded ordnance (UXO) and identify seabed hazards

Influence Regulatory Frameworks for Autonomous Operations:

- Collaborate with regulatory agencies to adapt advanced tools, including AI, to enhance safety protocols and ensure compliance.
- Influence regulatory frameworks for robotic and autonomous systems in offshore wind.

Mission Planning for Offshore Autonomous Operations

- Specify mission planning tools for tasking robotic systems in offshore wind operations.
- Create mission planning tools for tasking robotic systems in offshore wind operations.

Autonomous Survey Platforms & Multivehicle-Autonomy (AUV/USV/Swarm)

- Develop swarm-capable autonomous underwater vehicle systems to increase area coverage rates during subsea missions.
- Create mission planning tools for tasking robotic systems in offshore wind operations.

2.5 Workforce Insight

2.5.1 Future Occupational Profiles (FOPs)

Future Occupational Profiles (FOPs) indicate how roles in the industry will need to evolve as the sector becomes more productised, systemised, and technology driven. They define the key responsibilities and the knowledge, skills, and behaviours required for each role, ensuring alignment with the industry's transformation.
The FOPs defined for this cycle do not capture the full extent of a current or future job role. Workforce Foresighting identifies new capabilities and changes required in an in an occupation required in the future to allow technology adoption.

Link to **FOP Matrix**[2]

Role Families

Organisations rely on structured role families to manage talent, drive performance, and support sustainable growth. A clear hierarchy from entry level to executive leadership ensures responsibilities are well defined and expectations aligned. Each family builds on the last in terms of complexity, autonomy and impact enabling effective collaboration and accountability.

The Role families used in ORE Catapult workforce foresighting cycles are:

1. Role Family #1 Technician/Operator (no FOPs assigned in this cycle).
2. Role Family #2 Senior Technician.
3. Role Family #3 Engineers.
4. Role Family #4 Senior Engineers.

The Future Occupational Profiles

This cycle defined 14 future occupational profiles - bundles of capabilities associated by focus on particular expected occupation types and emerging themes: System integration; digital, data and simulation; mission planning and control; and creation of the right regulatory environment. These FOPs can be seen below listed by role family and across the supply chain partners identified.

Supply Chain Partner (SCP)

1. Survey Operators
2. Data Analytics and AI Development
3. Developers & Wind Farm Operators
4. Robotic AUV Platform and Sensors OEMS
5. Seabed authorities, RTO and Regulators

[2] FOP Matrix: https://hvmcatapultforesighting.retool.com/embedded/public/f99a913f-8827-4730-8893-d618d489bc84?token=ebd446c565bc99de1ba8d3db6cc5e7ae

RF	FOP	SCP1	SCP2	SCP3	SCP4	SCP5
2	RAS Operations Supervisor	✓			●	
3	AI Survey Data Quality Lead	●	✓			
	AUV Communications Data Links Engineer	●			✓	
	AUV Safety and Assurance Lead	●		●	✓	
	Marine Mechatronics Design Engineer				✓	
	Mission Planning Engineer	✓			●	
	RAS Operations Engineer	✓		●		
	Software Engineer AUV USV design				✓	
4	Data and AI Development Scientist *		✓			
	Data architect		✓			
	Governance, Assurance and Consenting Lead*			✓		●
	Hydrographic surveyor*	✓				●
	Mission Simulation and Digital Twinning Architect*	✓	●		●	
	RAS Technology Design and Engineering Lead Systems Architect*				✓	
✓ Primary Supply Chain Partner, ● other relevant supply chain partners, * indicates Priority FOP						

Table 2: Future Occupational Profiles and Supply Chain Partner Alignment

2.5.2 Prioritising Future Occupational Profiles

A **Priority FOP** is a profile that is seen as critical to future success. They are areas where workforce foresighting suggests that attention should be first to meet evolving sector needs. The Priority Future Occupational Profiles (FOPs) were identified based firstly on the proportion of **new or significantly changing capabilities** within each profile. FOPs were then reviewed against the **criticality of those capabilities to delivering the cycle objectives**, including technology adoption, regulatory readiness and operational impact. The prioritised profiles suggested are:

- RAS Technology Design & Engineering Lead Systems Architect
- Mission Simulation & Digital Twinning Architect
- Governance, Assurance & Consenting Lead
- Hydrographic Surveyor
- Data & AI Development Scientist

These priority FOPs are described further over the next pages. For full details of all Future Occupational Profiles see Appendix (Appendix B. List of full Future Occupational Profiles FOPs)

2.6 Education & Training Provision Insights

2.6.1 Provision Analysis of FOPs and Capabilities

Below is a comparison of each priority FOP against highest scoring existing education provision. The tables highlight the highest-scoring standard for each and identify capabilities that are not currently addressed by the selected standard. These unmet capabilities could inform the development of future education and training provision, either by adapting existing programmes or through the creation of short continuing professional development (CPD) courses aimed at upskilling the current workforce.

A detailed comparison of current apprenticeship provision against the capability requirements of the identified FOPs is available in the visualisation tool on the **FOP vs Provision**[3] page.

RAS Technology Design & Engineering Lead Systems Architect

Key Tasks: Designs and defines system architectures for autonomous underwater vehicles, ensuring coherent integration of sensors, control systems, communications, and mission logic. Continues to design mission-specific underwater vehicle platforms with robust sensing and communications. Future development focuses on modular, AI-ready architectures with integrated autonomy models, advanced sensing, and swarm-system capability

Aligned to supply chain partners: Robotic AUV Platform and Sensors OEMS

In FOP vs Provision there was a 25% Fit with Skills England Uncrewed marine vehicle specialist. The unmatched FOP capabilities are shown in the table below:

Capability Statement	Proficiency Level
Ensure interoperability of AI models across specific use cases to achieve optimised solutions.	Practitioner
Develop swarm-capable autonomous underwater vehicle systems to increase area coverage rates during subsea missions.	Expert
Investigate new or existing methods to utilise robots and AI for marine applications to enhance operational capabilities.	Expert
Design autonomous underwater vehicles to conduct high-resolution geophysical surveys for subsea infrastructure assessment.	Practitioner
Design scalable, modular autonomous underwater vehicle platforms with AI-ready hardware to support high levels of autonomy and efficient fleet production.	Awareness
Design protocols for multiple vehicles to collaborate autonomously.	Awareness
Select technologies for prototype development using advanced research and analysis	Expert
Design robotic or autonomous systems for transporting or deploying other robotic and autonomous systems.	Expert

[3] FOP vs Provision https://hvmcatapultforesighting.retool.com/embedded/public/d9f485a2-6d23-45dd-ab48-4c4c87ced0c7?token=ebd446c565bc99de1ba8d3db6cc5e7ae

Capability Statement	Proficiency Level
Develop communication methods for near-real-time operation and larger data transmission.	Practitioner
Implement AI models to detect unexploded ordnance (UXO) and identify seabed hazards	Practitioner
Design autonomous marine systems to ensure safety, seaworthiness and cost-effectiveness.	Expert
Install navigation equipment on prototype vessels to enhance maritime safety and efficiency.	Practitioner
Validate robotic and autonomous equipment functionality through rigorous performance, environmental, and operational testing.	Expert
Apply navigation equipment on prototype vessels to enhance maritime safety and efficiency.	Practitioner
Deploy robotic and autonomous systems to minimise windfarm operations and maintenance costs.	Awareness
Manage secure data communications with autonomous systems to safeguard AUV telemetry, command links and data return.	Practitioner
Incorporate safety features and fail-safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours	Practitioner
Integrate AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Practitioner
Accredit test and validation facilities for simulated and real-world environments to ensure technology meets safety benchmarks.	Practitioner
benchmark autonomy performance against acceptance criteria to determine mission readiness and residual risk	Practitioner

Table 3: RAS Technology Design & Engineering Lead Systems Architect capabilities unmatched

Mission Simulation & Digital Twinning Architect

Key Tasks: Continues to assure systems meet regulatory, legal, and safety standards. Future responsibilities widen to certifying autonomous systems, evaluating AI performance, and shaping new regulatory frameworks for robotic offshore operations.

Aligned to supply chain partners: Survey Operators, Data Analytics and AI Development, Robotic AUV Platform and Sensors OEMs

In FOP vs Provision there was a 18% Fit with Skills England Uncrewed marine vehicle specialist[4]. The unmatched FOP capabilities are shown in the table below:

Capability Statement	Proficiency Level
Conduct mission simulation to validate and rehearse offshore autonomous operations, ensuring all support systems are integrated and functional.	Practitioner
Create digital twins for rapid assessment of new robotic and autonomous systems or changes.	Expert
Create mission planning tools for tasking robotic systems in offshore wind operations.	Practitioner
Design sustainable robotic and autonomous support systems that meet relevant standards and specific customer requirements.	Expert
Develop AI-driven digital twin architectures to enhance predictive maintenance and operational efficiency in autonomous underwater vehicle fleets.	Expert
Develop communication methods for near-real-time operation and larger data transmission.	Awareness
Develop digital twins of automation systems to monitor assets remotely.	Expert
Develop swarm-capable autonomous underwater vehicle systems to increase area coverage rates during subsea missions.	Expert
Enhance mission planning tools with AI capabilities for tasking robotic systems in underwater operations.	Expert
Establish secure communications links for operational use.	Practitioner
Explore the use of artificial intelligence techniques for process optimisation and predictive modelling.	Practitioner
Implement AI-based navigation software in autonomous underwater vehicles to improve mapping efficiency and reduce operator intervention.	Awareness
Implement remote operations and maintenance systems of digital platforms to ensure efficient performance and availability.	Expert
Model physics based digital twins of vessels, environment, and support systems to simulate end to end behaviour safely onshore.	Expert
Use digital-twin simulation software to optimise robotic equipment.	Expert

Table 4: Mission Simulation & Digital Twinning Architect capabilities unmatched

[4] https://skillsengland.education.gov.uk/apprenticeships/st0975

Governance, Assurance & Consenting Lead

Key Tasks: Leads safety governance, regulatory compliance, certification, and consenting for autonomous marine systems. Continues to manage safety frameworks, assurance evidence, risk controls, and regulatory submissions to support mission approval and compliant deployment. Future development focuses on digital assurance, model-based safety validation, AI-supported risk assessment, and more adaptive consenting processes for autonomous multi-vehicle operations.

Aligned to supply chain partners: Developers & Wind Farm Operators, Seabed authorities, RTO and Regulators

In FOP vs Provision there was a 22% Fit with Skills England Marine Technical superintendent (degree)[5], The unmatched FOP capabilities are shown in the table below:

Capability Statement	Proficiency Level
Automate regulatory monitoring using AI-powered data analysis tools	Expert
Coordinate with international maritime organisations to harmonise autonomy standards, facilitating cross-border operations and reducing regulatory fragmentation.	Expert
Design protocols for multiple vehicles to collaborate autonomously.	Expert
Influence regulatory frameworks for robotic and autonomous systems in offshore wind.	Expert
Investigate new or existing methods to utilise robots and AI for marine applications to enhance operational capabilities.	Awareness
Set industry standards for safety features and fail safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours.	Expert
Utilise data visualisation tools to present regulatory compliance data in a clear and informative manner	Expert

Table 5: Governance, Assurance & Consenting Lead capabilities unmatched

[5] https://skillsengland.education.gov.uk/apprenticeships/st0623-v1-1

Hydrographic Surveyor

Key Tasks: Collects, processes and validates hydrographic and seabed data to produce accurate bathymetric and geospatial outputs for marine and subsea activities. Continues to acquire and quality-check survey data using acoustic, optical and navigation systems, including from autonomous platforms, and to analyse and report results to support engineering, construction and compliance needs. Future development focuses on increased automation in data processing and quality assurance and further integrate survey activities with autonomous and uncrewed systems.

Aligned to supply chain partners: Survey Operators and Seabed authorities, RTO and Regulators

In FOP vs Provision there was a 21% Fit with Skills England Geospatial mapping and science specialist (degree)[6] apprenticeship. The unmatched FOP capabilities are shown in the table below:

Capability Statement	Proficiency Level
Analyse data to map seabed for engineering and construction projects	Expert
Apply artificial intelligence and machine learning techniques to analyse meteorological and oceanographic data to derive specific and actionable insights.	Practitioner
Collect and measure data accurately using surveying tools and technology.	Expert
Conduct field surveys to analyse project site details.	Expert
Conduct hydrographic surveys and marine activities to support operational objectives.	Expert
Coordinate multiple autonomous vehicles participating in the survey.	Practitioner
Deliver output reports on geospatial data from autonomous/un-crewed vehicle missions to relevant stakeholders.	Expert
Develop efficient data collection and data management procedures that are fit for the purposes of the digital and automated environment.	Practitioner
Employ robotics and autonomous systems for subsea survey and intervention operations.	Practitioner
Employ robotics and autonomous systems to identify sunken objects for recovery.	Expert
Identify and agree with Client the required surveys before commencing work to ensure compliance and readiness.	Expert
Identify required surveys before commencing work to ensure compliance and readiness.	Expert
Manage and analyse observational data to derive actionable insights.	Expert
Organise survey results for data analysis.	Expert
Oversee site and seabed investigations to ensure accurate data collection.	Expert
Prepare summaries and analyses of survey data to inform organisational decision-making.	Expert
Provide visualisation portals for stakeholders to review geospatial evidence.	Practitioner
Use AUV mounted sonars and echo sounders to collect survey data (e.g., bathymetry and backscatter) for seabed mapping in engineering and construction projects.	Expert
Utilise autonomous vehicles to detect unexploded ordnance (UXO) and to identify seabed hazard.	Expert

Table 6: Hydrographic Surveyor capabilities unmatched

[6] https://skillsengland.education.gov.uk/apprenticeships/st0492-v1-0

Data & AI Development Scientist

Key Tasks: Analyses sensor, survey, and mission data to extract insight and improve operational performance. Continues to deliver robust analytical products and interpretations. Future development focuses on real-time analytics, predictive modelling, and AI-enhanced understanding of complex subsea datasets.

Aligned to supply chain partner: Data Analytics and AI Development, Developers & Wind Farm Operators, Seabed authorities, RTO and Regulators

In FOP vs Provision there was an 18% Fit with Skills England Machine learning engineer[7]. The unmatched FOP capabilities are shown in the table below:

Capability Statement	Proficiency Level
Analyse data to map seabed for engineering and construction projects	Practitioner
Analyse platform operational data using relevant techniques including AI and Machine Learning.	Practitioner
Develop AI systems and processes in line with ethical, legal and regulatory requirements.	Expert
Develop and implement standardised data governance protocols to ensure secure and interoperable multi-party collaboration in autonomous maritime operations.	Practitioner
Develop efficient data collection and data management procedures that are fit for the purposes of the digital and automated environment.	Practitioner
Enhance mission planning tools with AI capabilities for tasking robotic systems in underwater operations.	Practitioner
Ensure interoperability of AI models across specific use cases to achieve optimised solutions.	Expert
Explore the use of artificial intelligence techniques for process optimisation and predictive modelling.	Expert
Implement AI models to detect unexploded ordnance (UXO) and identify seabed hazards	Expert
Implement AI-based navigation software in autonomous underwater vehicles to improve mapping efficiency and reduce operator intervention.	Expert
Implement data quality checks for robotic and autonomous systems operations.	Practitioner
Improve implementation of technology by reviewing feedback from analysis of survey operational data.	Practitioner
Integrate AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Expert
Maintain standards for data architectures, models, tools, and databases.	Awareness
Monitor and analyse survey and scientific data to produce timely reports and actionable deliverables	Practitioner
Process and analyse data to ensure integrity and compliance with commercial practices.	Expert
Provide artificial intelligence and machine learning techniques to analyse meteorological and oceanographic data to derive specific and actionable insights.	Expert
Use AI (Artificial Intelligence) and data analysis to develop digital solutions.	Practitioner
Utilise AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Practitioner
Utilise artificial intelligence and machine learning technologies for advanced data analysis.	Expert
Utilise artificial intelligence techniques to review quality assurance of real-time data, operating parameters, and modelling results.	Practitioner

Table 7: Data & AI Development Scientist capabilities unmatched

[7] https://skillsengland.education.gov.uk/apprenticeships/st1398-v1-0

2.6.2 FOPs with the biggest Education provision gaps

By definition, Workforce Foresighting is designed to identify capabilities and occupational profiles that aren't well served by existing education provision. Therefore, we do not expect to see high fit when comparing the outputs of foresighting (the FOPs) to current apprenticeships or standards. However, the best fit current standard against each FOP is shown below.

Table Key – Role Family

- Role Family #2 Senior Technician
- Role Family #3 Engineers
- Role Family #4 Senior Engineers

Role Family	FOP Title	Best Fit Standard/s	Fit Factor (%[8])
2	RAS Operations Supervisor	Uncrewed marine vehicle specialist	24
3	AI Survey Data Quality Lead	Machine learning engineer	14
3	AUV Communications Data Links Engineer	Uncrewed marine vehicle specialist	12
3	AUV Safety and Assurance Lead	Systems engineer (degree)	12
3	Marine Mechatronics Design Engineer	Advanced robotics engineer	33
3	Mission Planning Engineer	Uncrewed marine vehicle specialist	21
3	RAS Operations Engineer	Uncrewed marine vehicle specialist	24
3	Software Engineer AUV USV design	Uncrewed marine vehicle specialist	19
4	Data and AI Development Scientist	Machine learning engineer	20
4	Data architect	Machine learning engineer	10
4	Governance, Assurance and Consenting Lead	Marine technical superintendent (degree)	22
4	Hydrographic surveyor	Uncrewed marine vehicle specialist	25
4	Mission Simulation and Digital Twinning Architect	Uncrewed marine vehicle specialist	17
4	RAS Technology Design and Engineering Lead Systems Architect	Uncrewed marine vehicle specialist	25

Table 8 - FOPs vs Closest Existing Apprenticeship Provision

For a deeper exploration of these FOPs within the Visualisation Tool, see the FOP Distribution[i9] page

[8]Fit Factor is determined based on semantic matching between the capability statements within a profile and the duty statements within an apprenticeship profile. 100% would indicate a match above the threshold for linguistic matching, for all capabilities within a FOP

[9] FOP Distribution Link https://hvmcatapultforesighting.retool.com/embedded/public/ce67cca1-5beb-4557-8482-8a0b6e174933?token=ebd446c565bc99de1ba8d3db6cc5e7ae

2.6.3 Knowledge, Skills, and Behaviour Tagging

For each capability, the workforce foresighting approach aligns knowledge, skills and behaviours. This approach enables two key use cases:

1. **Informing / Guiding understanding of the alignment between future-state capability requirements and current educational provision.**

2. **Driving action by equipping educators to embed these capabilities into their curriculum.**

While capabilities define what organisations need to thrive in the future, KSBs provide a practical framework for how education can evolve to support development of those capabilities. Tags associated with capabilities that align well with current educational provisions may also reveal shifts in KSBs. Capabilities introduced during the cycle will also have the relevant tags that will support educators to integrate those capabilities into curriculum effectively.

Application

The complete list of KSBs associated with each capability is available within the visualisation tool, alongside all other relevant contextual information.
The application of this data can be broadly divided into two key areas:

- **Macro Trend Analysis**
  By examining KSB tags at an aggregate level across all capabilities, educators can identify major shifts in demand. This high-level view helps narrow the focus to areas where change is most significant or emerging.
- **Detailed Research**
  Once priority areas are identified through the macro lens, educators can drill down into specific capabilities or explore the detailed KSBs linked to a particular tag. This supports more targeted curriculum development and informed decision-making.

This report presents a selection of aggregated insights intended to illustrate potential use cases. Readers are encouraged to explore the Visualisation Tool for a more detailed and interactive engagement with the data. The tool offers deeper context, flexible filtering, and access to the full range of capabilities and KSB tags, enabling users to tailor their exploration to specific interests or needs.

2.6.4 Tagging Frequency

The following table lists the most frequently used tags across all capabilities in the foresighting cycle.

Most frequent Knowledge Tags

Tag	Tag Frequency
Unmanned Underwater Vehicles (UUV)	36
Unmanned Surface Vessels (USV)	26
Robotics	20
Artificial Intelligence (AI)	15
Remotely Operated Vehicles (ROVs)	15
Marine Technology	14
Offshore Engineering	9
Regulatory Compliance	9
Hydrographic Surveying	8
Industrial Robotics	8
Predictive Analytics	8
Robot Control	8
Surveying	8
Systems Engineering	8
Data Analysis	7
Data Science	7
Machine Learning	7
Software Engineering	7
Marine Electronics	6
Marine Safety (USCG)	6
Simulation Software	6
Control Systems	5
Geophysical Surveys	5
Marine Engineering	5
Predictive Maintenance	5
Automation	4
Bathymetry	4

Table 9: Frequency of Knowledge Tags

Most frequent Skills Tags

Tag	Tag Frequency
Develop robotic systems and software	21
Supervise autonomous vehicles	14
Develop AI tools	11
Conduct underwater surveys and investigations	10
Guide AI tools to analyse and interpret data	10
Guide AI tools to process and transform data	10
Integrate systems and software	9
Assess robot system safety	8
Pilot remotely operated vehicles (ROVs)	7
Pilot underwater vehicles	7

Table 10: Frequency of Skills Tags

This data serves as a starting point to identify emerging knowledge and skill areas that may not be traditional within the industry but are gaining traction due to the adoption of new technologies.

3. Conclusion & Next Steps

3. Conclusions and Next Steps

3.1 Key Findings & Conclusions

As always, the scope and depth of the insights generated through workforce foresighting is a function of the number and contributions of attendees. In previous cycles ORE Catapult have carried out a detailed prior background review and preparation stage, including supply chain mapping, triage of potential participating organisations, identification of and outreach to individual workshop participants, and giving longer notice to a wider net of cycle contributors.

In this cycle, attendance varied considerably across sessions, with only a handful achieving robust participation numbers. The lower participation in this cycle has been a direct result of not including a preparation phase in the study, as well as the late “cold start” to the cycle. Nevertheless, this study has yielded valuable insights from a small number of experienced and engaged participants.

From the Workforce Foresighting Cycle the following data points were identified and focus areas were developed.

3.2 Key Findings

3.2.1 Priority Capabilities Themes:

These capability themes have been prioritised because they directly address the most pressing challenges and opportunities in the process of **Cycle title: Accelerating Subsea Survey in Offshore Wind using Autonomous Systems and AI.**

- AI, Data & Digital Twinning Applications for Offshore Autonomy and Survey
- Influence Regulatory Frameworks for Autonomous Operations
- Mission Planning for Offshore Autonomous Operations
- Autonomous Survey Platforms & Multi-vehicle- Autonomy (AUV/USV/Swarm)

3.2.2 High-Priority Occupational Profiles:

The following future occupational profiles will be instrumental in driving industry-wide change by facilitating informed decision-making and ensuring the compliance and economic viability of new technologies:

- RAS Technology Design & Engineering Lead Systems Architect
- Mission Simulation & Digital Twinning Architect
- Governance, Assurance & Consenting Lead
- Hydrographic Surveyor
- Data & AI Development Scientist

3.2.3 Summary of Next Steps

The uneven distribution of participants in this cycle may have limited the breadth of industry perspectives captured and could affect the applicability of findings across the wider sector. To strengthen confidence in the findings, future validation activities are recommended, involving structured engagement with both industry practitioners and educational institutions not represented in these initial workshops. Such follow-up work would help confirm whether identified needs are consistent across wider audiences and sectors, thereby enhancing the robustness and applicability of the research conclusions.

To build on the findings from this workforce foresighting cycle, the following next steps are proposed to support the operationalisation of insights and acceleration of skills development for **Autonomous Systems and AI Surveys.**

Expand and Apply the Role Archetype Approach

Continue the established coding and analysis approach used across previous ORE Catapult cycles to identify common emerging themes and core role archetypes. This will simplify the application of the growing library of Future Occupational Profiles and capability sets by focusing on foundational roles, onto which specialist capabilities, such as those linked to autonomous systems and AI, can be layered. This provides a more agile and scalable solution for both industry and education, enabling targeted development of new skills without requiring entirely new qualifications for each emerging role.

Enable Education Alignment and Curriculum Development

Use role archetypes to support educators in designing provision that focuses on new and differentiating capabilities, rather than duplicating existing standards. ORE Catapult will continue to validate and map skills across role families and levels, enabling clearer progression pathways, reskilling opportunities, and alignment with industry demand.

Strengthen Working Groups and Governance

Existing and future working groups will incorporate insights from this cycle to ensure cross-sector alignment and consistency. These groups will establish clear governance structures to drive accountability, validate findings with industry, and build a robust evidence base. Their role will be to prioritise and initiate training and course delivery, ensuring that foresighting insights translate into tangible education and workforce interventions with national strategic impact.

Appoint a National Industry Champion

To accelerate progress and maintain sector-wide focus, it is recommended that a senior, respected industry champion is appointed, potentially through organisations such as the Offshore Wind Growth Partnership. This role would provide leadership, coordinate stakeholders, and ensure momentum in developing skills aligned to emerging technologies.

Enable Cross-Sector Collaboration and Workforce Mobility

Establish structured engagement with adjacent sectors (e.g. automotive, advanced manufacturing) to identify shared and emerging capabilities. This will support the development of flexible career pathways, enabling individuals to enter, progress, and transition across sectors—thereby reducing investment risk and strengthening workforce resilience.

Scale Digital Enablement through work with skillsminer.ai

Working in partnership with skillsminer.ai (subject to funding) ORE Catapult will support the further development and extension of the platform to embed these further Workforce Foresighting outputs, including capabilities, FOPs, and role archetypes. This will enable the tool to act as a dynamic intelligence layer, supporting workforce planning, skills matching, and reskilling at scale across the sector.

References

Bernardini, S., Jovan, F., Jiang, Z., Watson, S., Weightman, A., Moradi, P., Richardson, T., Sadeghian, R., & Sareh, S. (2020). A Multi-Robot Platform for the Autonomous Operation and Maintenance of Offshore Wind Farms. *New Zealand*.

Hatchett, P., Esson, A., & Lanham, J. (2023). *Supply chain capability requirements for UK Floating Offshore Wind Farms: Inter-Array Dynamic Cable Systems* (Nos TV000188-RPT-001; Workforce Foresighting). ORE Catapult. https://ore.catapult.org.uk/wp-content/uploads/2024/02/Supply-chain-capability-requirements-for-UK-Floating-Offshore-Wind-Farms-Inter-Array-Cables-Report.pdf

Hariram, V. (2024). *Bathymetry, the Future Potential of Ocean Mapping, and the Seafloor Revolution*. SSRN. https://doi.org/10.2139/ssrn.4977191

Koltsidopoulos, D. A., Wavell, D., & Gray, D. A. (2021). *Quantifying the impact of Robotics in Offshore Wind* (Industry Insight Series). Offshore Wind Innovation Hub.

Mitchell, D., Blanche, J., Harper, S., Lim, T., Gupta, R., Zaki, O., Tang, W., Robu, V., Watson, S., & Flynn, D. (2022). A review: Challenges and opportunities for artificial intelligence and robotics in the offshore wind sector. *Energy and AI*, *8*, 100146. https://doi.org/10.1016/j.egyai.2022.100146

RenewableUK. (2024). *2024 Offshore Wind Industrial Growth Plan: Expanding the Horizon of the UK's Offshore Wind Supply Chain*. Renewable UK, OWIC, Crown Estate Scotland, The Crown Estate.

The Crown Estate. (2024). *Future of Offshore Wind: Considerations for development and leasing to 2030 and beyond* (Marine Delivery Routemap). The Crown Estate. https://www.datocms-assets.com/136653/1742378325-future-offshore-wind-2024.pdf

Thierauf, C. (2025). *Deployment and Development of a Cognitive Teleoreactive Framework for Deep Sea Autonomy* (arXiv:2510.10716). arXiv. https://doi.org/10.48550/arXiv.2510.10716

Wegner, D. C. (2025). A review on the advances in underwater inspection of subsea infrastructure: Tools, technologies, and applications. *Communication in Physical Sciences*, *12*(5), 1624–1635. https://doi.org/10.4314/cps.v12i5.15

Williams, D. P., Vermeij, A., Baralli, F., Groen, J., & Fox, W. L. J. (2012). In situ AUV survey adaptation using through-the-sensor sonar data. *2012 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2525–2528. https://doi.org/10.1109/ICASSP.2012.6288430

Yoerger, D. R., Jakuba, M., Bradley, A. M., & Bingham, B. (2007). Techniques for Deep Sea Near Bottom Survey Using an Autonomous Underwater Vehicle. *The International Journal of Robotics Research*, *26*(1), 41–54.

4. Appendices

4. Appendices

Appendix A. Visualisation tool and instructions for use

Appendix B. List of full FOPs by Role Level including Capabilities

Appendix C. Background to the Workforce Foresighting Hub

Appendix A. Online Data visualisation Tool

The interested reader may wish to access the online data visualisation tool which provides several different ways to view the cycle data. Links to relevant parts of the tool are given with brief guidance below[10]. This content is provided and maintained by the Workforce Foresighting Hub.

Visualisation Tool Section	What is it and what can it be used for?
Data Capture Overview	Provides a summary of the data captured across the foresight cycle, bringing together the work of the Technologists / Domain Specialists, Employers and Educators into one overview. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/e869283b-4b8a-437c-973e-64ab292e5b87?token=ebd446c565bc99de1ba8d3db6cc5e7ae
Supply Chain Capabilities	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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/3573002a-ab48-4fad-9765-bee00876a42e?token=ebd446c565bc99de1ba8d3db6cc5e7ae
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 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/81d272f0-ad80-421c-8926-86655913acdf?token=ebd446c565bc99de1ba8d3db6cc5e7ae

Visualisation Tool Section	What is it and what can it be used for?
FOP Matrix	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 family by selecting one (or more) of these from the drop down. This will then allow you to select the FOPs aligned to that role family. The populated table allows you to review and compare different FOPs within or across role families. You can view the capabilities in each 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/81d272f0-ad80-421c-8926-86655913acdf?token=ebd446c565bc99de1ba8d3db6cc5e7ae
Future KSBs Summary	Not yet completed in this cycle. Provides a view of the complete set of capabilities within the cycle along with all 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 family/occupational profile grouping. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/8634650f-9700-4627-8431-068b4b764222?token=ebd446c565bc99de1ba8d3db6cc5e7ae

Visualisation Tool Section	What is it and what can it be used for?
FOP Distribution	This page allows provides a breakdown of the Capabilities within the selected Cycle and how they are distributed across the FOPs with the addition of a distribution chart showing the required proficiency across those FOPs. Clicking the "View FOPs" button alongside each capability will provide a list of the proficiencies (EPA) with the 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 Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/ce67cca1-5beb-4557-8482-8a0b6e174933?token=ebd446c565bc99de1ba8d3db6cc5e7ae
Capabilities Matched to Current Provision	This page allows you to review and compare individual capabilities against 'Duty' statements in an Apprenticeship / Occupational Standard. You can select individual capabilities to review their specific matches. These matches are shown in the bottom panel, including the Standard, the Level, and the Duty Statement this is matched to. You can filter in several ways to focus your review: • By the Capability Classification Framework (left-hand panel). • By capabilities that **are** served by the reference mapping framework – the default is Institute for Apprenticeships and Technical Education (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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/219ff6af-36ea-4b5e-bda1-b0b989c0e3f0?token=ebd446c565bc99de1ba8d3db6cc5e7ae

Visualisation Tool Section	What is it and what can it be used for?
Fit & Surplus Factors	This page allows you to review the 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/c699e504-3f64-45a0-b52e-ad44a95f9aa4?token=ebd446c565bc99de1ba8d3db6cc5e7ae
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. Institute for Apprenticeships and Technical Education (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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/1c4e204b-3927-4226-9f8e-2f62ce0643c5?token=ebd446c565bc99de1ba8d3db6cc5e7ae
FOP Capability Matches	This page allows you to view the matches between Capabilities and Institute for Apprenticeships and Technical Education (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 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 FOPs, from Job / Occupation level through to Knowledge, Skill, and Behaviour level. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/6a205e7e-8f33-4765-b39b-82f1f549217a?token=ebd446c565bc99de1ba8d3db6cc5e7ae

Visualisation Tool Section	What is it and what can it be used for?
FOP vs Provision	This page allows you to compare 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 FOP to the Duties in a Standard. The left-hand side allows you to select the Role Family and 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/d9f485a2-6d23-45dd-ab48-4c4c87ced0c7?token=ebd446c565bc99de1ba8d3db6cc5e7ae
FOP Priorities	Provides a list of all the 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/ad0f6dcb-9535-4239-96a7-c8d0e005477a?token=ebd446c565bc99de1ba8d3db6cc5e7ae

Table 11: A. Visualisation Tool Links

Appendix B. List of full Future Occupational Profiles FOPs

FOP Title: Data and AI Development Scientist
ROLE FAMILY #4: Senior engineer
Required for supply chain partners: Developer and Wind Farm operator, Data Analytics and AI Development, Seabed authorities, RTO and Regulator, Survey operator

ID	Capability Statement	Proficiency
311482	Maintain standards for data architectures, models, tools, and databases.	Awareness
320122	Use AI (Artificial Intelligence) and data analysis to develop digital solutions.	Practitioner
323211	Enhance mission planning tools with AI capabilities for tasking robotic systems in underwater operations.	Practitioner
323215	Improve implementation of technology by reviewing feedback from analysis of survey operational data.	Practitioner
322902	Analyse platform operational data using relevant techniques including AI and Machine Learning.	Practitioner
322959	Monitor and analyse survey and scientific data to produce timely reports and actionable deliverables	Practitioner
229589	Utilise artificial intelligence techniques to review quality assurance of real-time data, operating parameters, and modelling results.	Practitioner
323213	Utilise AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Practitioner
322950	Store manage and share data securely, ensuring adherence to applicable compliance and governance standards.	Practitioner
210282	Implement data quality checks for robotic and autonomous systems operations.	Practitioner
322931	Analyse data to map seabed for engineering and construction projects	Practitioner
210188	Manage and analyse observational data to derive actionable insights.	Practitioner
213148	Develop efficient data collection and data management procedures that are fit for the purposes of the digital and automated environment.	Practitioner
322853	Develop and implement standardised data governance protocols to ensure secure and interoperable multi-party collaboration in autonomous maritime operations.	Practitioner

Table 12: B1. Data and AI Development Scientist FOP

FOP Title: Data architect
ROLE FAMILY #4: Senior engineer
Required for supply chain partners Developer and Wind Farm operator, Data Analytics and AI Development, Seabed authorities, RTO and Regulator, Survey operator

ID	Capability Statement	Proficiency
323261	Develop communication methods for near-real-time operation and larger data transmission.	Awareness
213151	Collaborate with regulatory agencies to adapt advanced tools, including AI, to enhance safety protocols and ensure compliance.	Awareness
229598	Ensure interoperability of AI models across specific use cases to achieve optimised solutions.	Practitioner
205671	Create integrated validation and verification systems in line with customer requirements and the project environment	Practitioner
323210	Provide artificial intelligence and machine learning techniques to analyse meteorological and oceanographic data to derive specific and actionable insights.	Practitioner
323213	Utilise AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Practitioner
306381	Develop or apply data mining and machine learning algorithms.	Practitioner
194415	Explore the use of artificial intelligence techniques for process optimisation and predictive modelling.	Practitioner
320122	Use AI (Artificial Intelligence) and data analysis to develop digital solutions.	Expert
210488	Deploy robotic and autonomous systems to minimise windfarm operations and maintenance costs.	Expert
209653	Develop proactive risk management strategies for emerging autonomous systems in offshore wind farms	Expert
323215	Improve implementation of technology by reviewing feedback from analysis of survey operational data.	Expert
322945	Apply artificial intelligence and machine learning techniques to analyse meteorological and oceanographic data to derive specific and actionable insights.	Expert
195651	Implement remote monitoring capabilities using IoT sensors and cloud computing technology.	Expert
322950	Store manage and share data securely, ensuring adherence to applicable compliance and governance standards.	Expert
323251	Design operational data storage for robotic and autonomous systems with lineage and access control	Expert
322928	Provide visualisation portals for stakeholders to review geospatial evidence.	Expert
213148	Develop efficient data collection and data management procedures that are fit for the purposes of the digital and automated environment.	Expert
322853	Develop and implement standardised data governance protocols to ensure secure and interoperable multi-party collaboration in autonomous maritime operations.	Expert
311482	Maintain standards for data architectures, models, tools, and databases.	Expert

Table 13: B2. Data architect FOP

FOP Title: Governance, Assurance and Consenting Lead
ROLE FAMILY #4: Senior engineer
Required for supply chain partners: Developer and Wind Farm operator, Seabed authorities

ID	Capability Statement	Proficiency
304434	Develop AI systems and processes in line with ethical, legal and regulatory requirements.	Awareness
205671	Create integrated validation and verification systems in line with customer requirements and the project environment	Practitioner
322909	Certify autonomous remote systems for inspection and repair tasks of underwater infrastructure.	Practitioner
322948	Develop protocols to standardise AUV mission planning and execution ensuring safe and efficient operation of uncrewed marine vehicles.	Practitioner
323254	Utilise safety features and fail-safe modes within autonomous vehicle designs to ensure reliable surfacing, abort and geofence behaviours.	Practitioner
322952	Incorporate safety features and fail-safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours	Practitioner
322957	Develop methods for safe recovery of lost remote systems to mitigate risk of AUV loss and environmental impact.	Practitioner
323270	Set industry standards for safety features and fail-safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours.	Practitioner
322932	benchmark autonomy performance against acceptance criteria to determine mission readiness and residual risk	Practitioner
210467	Influence regulatory frameworks for robotic and autonomous systems in offshore wind.	Practitioner
210468	Monitor regulatory changes and ensure compliance for robotic and autonomous systems.	Practitioner
322858	Evaluate autonomous navigation systems to ensure compliance with international maritime collision regulations.	Practitioner
323206	Create integrated validation and verification systems in line with regulatory requirements and the project environment	Expert
322929	Apply navigation equipment on prototype vessels to enhance maritime safety and efficiency.	Expert
209653	Develop proactive risk management strategies for emerging autonomous systems in offshore wind farms	Expert
322852	Accredit test and validation facilities for simulated and real-world environments to ensure technology meets safety benchmarks.	Expert
213151	Collaborate with regulatory agencies to adapt advanced tools, including AI, to enhance safety protocols and ensure compliance.	Expert

Table 14: B3. Governance, Assurance and Consenting Lead FOP

FOP Title: Hydrographic surveyor
ROLE FAMILY #4: Senior engineer
Required for supply chain partners: Seabed authorities, RTO and Regulator, Data Analytics and AI Development, Survey operator

ID	Capability Statement	Proficiency
323273	Specify autonomous underwater vehicles to conduct high-resolution geophysical surveys for subsea infrastructure assessment.	Awareness
305699	Design scientific experiments and collate findings to improve hydrographic mapping techniques.	Practitioner
322958	Design offshore missions utilising remote and autonomous systems to optimise line plans, way-points and contingencies for autonomous underwater vehicles.	Practitioner
323266	Coordinate multiple autonomous vehicles participating in the survey.	Practitioner
322945	Apply artificial intelligence and machine learning techniques to analyse meteorological and oceanographic data to derive specific and actionable insights.	Practitioner
322942	Employ robotics and autonomous systems for subsea survey and intervention operations.	Practitioner
323248	Utilise autonomous vehicles to detect unexploded ordnance (UXO) and to identify seabed hazard.	Practitioner
322928	Provide visualisation portals for stakeholders to review geospatial evidence.	Practitioner
213148	Develop efficient data collection and data management procedures that are fit for the purposes of the digital and automated environment.	Practitioner
303846	Conduct hydrographic surveys and marine activities to support operational objectives.	Expert
322959	Monitor and analyse survey and scientific data to produce timely reports and actionable deliverables	Expert
322906	Employ robotics and autonomous systems to identify sunken objects for recovery.	Expert
323217	Use AUV-mounted sonars and echo sounders to collect survey data (e.g., bathymetry and backscatter) for seabed mapping in engineering and construction projects.	Expert
322955	Conduct hydrographic surveys and marine activities to produce survey-grade bathymetry maps and collect backscatter data for project development and consent processes.	Expert
322919	Oversee site and seabed investigations to ensure accurate data collection.	Expert
303812	Conduct field surveys to analyse project site details.	Expert
307429	Collect and measure data accurately using surveying tools and technology.	Expert
323216	Identify and agree with Client the required surveys before commencing work to ensure compliance and readiness.	Expert
315122	Prepare summaries and analyses of survey data to inform organisational decision-making.	Expert
322931	Analyse data to map seabed for engineering and construction projects	Expert
210188	Manage and analyse observational data to derive actionable insights.	Expert
313715	Organise survey results for data analysis.	Expert
322927	Deliver output reports on geospatial data from autonomous/un-crewed vehicle missions to relevant stakeholders.	Expert
309270	Identify required surveys before commencing work to ensure compliance and readiness.	Expert

Table 15: B4. Hydrographic surveyor FOP

FOP Title: Mission Simulation and Digital Twinning Architect
ROLE FAMILY #4: Senior engineer
Required for supply chain partners Developer and Wind Farm operator, Robotic AUV Platform and Sensors OEM, Data Analytics and AI Development, Survey operator

ID	Capability Statement	Proficiency
322761	Integrate advanced geophysical systems into autonomous underwater vehicles to enhance subsea survey capabilities.	Awareness
322762	Implement AI-based navigation software in autonomous underwater vehicles to improve mapping efficiency and reduce operator intervention.	Awareness
323261	Develop communication methods for near-real-time operation and larger data transmission.	Awareness
343857	Develop digital twins of automation systems to monitor assets remotely.	Awareness
322948	Develop protocols to standardise AUV mission planning and execution ensuring safe and efficient operation of uncrewed marine vehicles.	Practitioner
210395	Create mission planning tools for tasking robotic systems in offshore wind operations.	Practitioner
307809	Establish secure communications links for operational use.	Practitioner
322933	Conduct mission simulation to validate and rehearse offshore autonomous operations, ensuring all support systems are integrated and functional.	Practitioner
194415	Explore the use of artificial intelligence techniques for process optimisation and predictive modelling.	Practitioner
322763	Develop swarm-capable autonomous underwater vehicle systems to increase area coverage rates during subsea missions.	Expert
322770	Develop AI-driven digital twin architectures to enhance predictive maintenance and operational efficiency in autonomous underwater vehicle fleets.	Expert
323204	Design sustainable robotic and autonomous support systems that meet relevant standards and specific customer requirements.	Expert
322903	Use digital twin simulation software to optimise robotic equipment.	Expert
323249	Implement AI models to detect unexploded ordnance (UXO) and identify seabed hazards	Expert
322934	Model physics based digital twins of vessels, environment, and support systems to simulate end-to-end behaviour safely onshore.	Expert
323211	Enhance mission planning tools with AI capabilities for tasking robotic systems in underwater operations.	Expert
322943	Implement remote operations and maintenance systems of digital platforms to ensure efficient performance and availability.	Expert
210439	Create digital twins for rapid assessment of new robotic and autonomous systems or changes.	Expert

Table 16: B5. Mission Simulation and Digital Twinning Architect FOP

FOP Title: RAS Technology Design and Engineering Lead Systems Architect
ROLE FAMILY #4: Senior engineer
Required for supply chain partners Robotic AUV Platform and Sensors OEM

ID	Capability Statement	Proficiency
323258	Design protocols for multiple vehicles to collaborate autonomously.	Awareness
322920	Design scalable, modular autonomous underwater vehicle platforms with AI-ready hardware to support high levels of autonomy and efficient fleet production.	Awareness
210488	Deploy robotic and autonomous systems to minimise windfarm operations and maintenance costs.	Awareness
322761	Integrate advanced geophysical systems into autonomous underwater vehicles to enhance subsea survey capabilities.	Practitioner
322900	Design autonomous underwater vehicles to conduct high-resolution geophysical surveys for subsea infrastructure assessment.	Practitioner
322762	Implement AI-based navigation software in autonomous underwater vehicles to improve mapping efficiency and reduce operator intervention.	Practitioner
229598	Ensure interoperability of AI models across specific use cases to achieve optimised solutions.	Practitioner
323261	Develop communication methods for near-real-time operation and larger data transmission.	Practitioner
323249	Implement AI models to detect unexploded ordnance (UXO) and identify seabed hazards	Practitioner
322918	Install navigation equipment on prototype vessels to enhance maritime safety and efficiency.	Practitioner
322958	Design offshore missions utilising remote and autonomous systems to optimise line plans, way-points and contingencies for autonomous underwater vehicles.	Practitioner
322929	Apply navigation equipment on prototype vessels to enhance maritime safety and efficiency.	Practitioner
322954	Manage secure data communications with autonomous systems to safeguard AUV telemetry, command links and data return.	Practitioner
322952	Incorporate safety features and fail-safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours	Practitioner
229590	Integrate AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Practitioner
322852	Accredit test and validation facilities for simulated and real-world environments to ensure technology meets safety benchmarks.	Practitioner
322932	benchmark autonomy performance against acceptance criteria to determine mission readiness and residual risk	Practitioner
322899	Investigate new or existing methods to utilise robots and AI for marine applications to enhance operational capabilities.	Expert
322763	Develop swarm-capable autonomous underwater vehicle systems to increase area coverage rates during subsea missions.	Expert
196970	Select technologies for prototype development using advanced research and analysis	Expert
210383	Design robotic or autonomous systems for transporting or deploying other robotic and autonomous systems.	Expert
322915	Design autonomous marine systems to ensure safety, seaworthiness and cost-effectiveness.	Expert
322939	Design marine and autonomous systems for long term deployment	Expert
322908	Validate robotic and autonomous equipment functionality through rigorous performance, environmental, and operational testing.	Expert

Table 17: B6. RAS Technology Design and Engineering Lead Systems Architect FOP

FOP Title: AI Survey Data Quality Lead
ROLE FAMILY #3: Engineer
Required for supply chain partners Developer and Wind Farm operator, Robotic AUV Platform and Sensors OEM, Data Analytics and AI Development, Survey operator

ID	Capability Statement	Proficiency
323249	Implement AI models to detect unexploded ordnance (UXO) and identify seabed hazards	Awareness
322945	Apply artificial intelligence and machine learning techniques to analyse meteorological and oceanographic data to derive specific and actionable insights.	Awareness
320122	Use AI (Artificial Intelligence) and data analysis to develop digital solutions.	Practitioner
322944	Implement specific technologies in data modelling and processing to enhance the accuracy and speed of data analysis.	Practitioner
323213	Utilise AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Practitioner
322919	Oversee site and seabed investigations to ensure accurate data collection.	Practitioner
307429	Collect and measure data accurately using surveying tools and technology.	Practitioner
308853	Process and analyse data to ensure integrity and compliance with commercial practices.	Practitioner
322950	Store manage and share data securely, ensuring adherence to applicable compliance and governance standards.	Practitioner
306381	Develop or apply data mining and machine learning algorithms.	Practitioner
322913	Utilise artificial intelligence and machine learning technologies for advanced data analysis.	Practitioner
315122	Prepare summaries and analyses of survey data to inform organisational decision-making.	Practitioner
313715	Organise survey results for data analysis.	Practitioner
311482	Maintain standards for data architectures, models, tools, and databases.	Practitioner
194625	Utilise data visualisation tools to present regulatory compliance data in a clear and informative manner	Practitioner
323215	Improve implementation of technology by reviewing feedback from analysis of survey operational data.	Expert
322902	Analyse platform operational data using relevant techniques including AI and Machine Learning.	Expert
322959	Monitor and analyse survey and scientific data to produce timely reports and actionable deliverables	Expert
229589	Utilise artificial intelligence techniques to review quality assurance of real-time data, operating parameters, and modelling results.	Expert
210282	Implement data quality checks for robotic and autonomous systems operations.	Expert
323207	Prescribe data quality checks for robotic and autonomous systems operations.	Expert

Table 18: B7. AI Survey Data Quality Lead FOP

FOP Title: AUV Communications Data Links Engineer
ROLE FAMILY #3: Engineer
Required for supply chain partners Robotic AUV Platform and Sensors OEM, Survey operator

ID	Capability Statement	Proficiency
322905	Program unmanned autonomous vessels based on local conditions.	Awareness
322943	Implement remote operations and maintenance systems of digital platforms to ensure efficient performance and availability.	Practitioner
322947	Implement systems for remote operations and maintenance of physical assets to ensure efficient performance and availability	Practitioner
195651	Implement remote monitoring capabilities using IoT sensors and cloud computing technology.	Practitioner
323261	Develop communication methods for near-real-time operation and larger data transmission.	Expert
322954	Manage secure data communications with autonomous systems to safeguard AUV telemetry, command links and data return.	Expert
227019	Provide tools for remote monitoring and enable changes to systems to enhance decision making and system adjustment.	Expert
307809	Establish secure communications links for operational use.	Expert

Table 19: B8. AUV Communications Data Links Engineer FOP

FOP Title: AUV Safety and Assurance Lead
ROLE FAMILY #3: Engineer
Required for supply chain partners Developer and Wind Farm operator, Robotic AUV Platform and Sensors OEM, Seabed authorities, RTO and Regulator, Survey operator

ID	Capability Statement	Proficiency
322899	Investigate new or existing methods to utilise robots and AI for marine applications to enhance operational capabilities.	Awareness
323258	Design protocols for multiple vehicles to collaborate autonomously.	Expert
323270	Set industry standards for safety features and fail-safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours.	Expert
322901	Automate regulatory monitoring using AI-powered data analysis tools	Expert
194625	Utilise data visualisation tools to present regulatory compliance data in a clear and informative manner	Expert
210467	Influence regulatory frameworks for robotic and autonomous systems in offshore wind.	Expert
210468	Monitor regulatory changes and ensure compliance for robotic and autonomous systems.	Expert
210222	Ensure compliance of future operations with regulations.	Expert
322854	Coordinate with international maritime organisations to harmonise autonomy standards, facilitating cross-border operations and reducing regulatory fragmentation.	Expert

Table 20: B9. UV Safety and Assurance Lead FOP

FOP Title: Marine Mechatronics Design Engineer
ROLE FAMILY #3: Engineer
Required for supply chain partners Seabed authorities, RTO and Regulator

ID	Capability Statement	Proficiency
322899	Investigate new or existing methods to utilise robots and AI for marine applications to enhance operational capabilities.	Awareness
323258	Design protocols for multiple vehicles to collaborate autonomously.	Awareness
196970	Select technologies for prototype development using advanced research and analysis	Awareness
322939	Design marine and autonomous systems for long term deployment	Awareness
229350	Design , test and install new systems to monitor system performance post-commissioning.	Awareness
343857	Develop digital twins of automation systems to monitor assets remotely.	Awareness
323204	Design sustainable robotic and autonomous support systems that meet relevant standards and specific customer requirements.	Practitioner
210383	Design robotic or autonomous systems for transporting or deploying other robotic and autonomous systems.	Practitioner
322922	Select subcomponents and payloads for robotic and autonomous systems to meet project requirements efficiently.	Practitioner
322904	Install advanced robotics and computer vision technology on remote autonomous systems.	Practitioner
322908	Validate robotic and autonomous equipment functionality through rigorous performance, environmental, and operational testing.	Practitioner
209699	Implementing autonomous control systems for operations using ROS (Robot Operating System) and sensor fusion techniques.	Practitioner
343858	Use digital twins of automation systems to monitor assets remotely.	Practitioner
210250	Troubleshoot robotic and autonomous support systems for optimal functionality.	Practitioner
322914	Design advanced sensing and visualisation computer vision systems for underwater autonomous and robotic platforms.	Expert

Table 21: B10. Marine Mechatronics Design Engineer FOP

FOP Title: Mission Planning Engineer
ROLE FAMILY #3: Engineer
Required for supply chain partners Developer and Wind Farm operator, Robotic AUV Platform and Sensors OEM, Data Analytics and AI Development, Survey operator

ID	Capability Statement	Proficiency
322919	Oversee site and seabed investigations to ensure accurate data collection.	Awareness
205671	Create integrated validation and verification systems in line with customer requirements and the project environment	Practitioner
322942	Employ robotics and autonomous systems for subsea survey and intervention operations.	Practitioner
322906	Employ robotics and autonomous systems to identify sunken objects for recovery.	Practitioner
303812	Conduct field surveys to analyse project site details.	Practitioner
322905	Program unmanned autonomous vessels based on local conditions.	Practitioner
322858	Evaluate autonomous navigation systems to ensure compliance with international maritime collision regulations.	Practitioner
210395	Create mission planning tools for tasking robotic systems in offshore wind operations.	Expert
322903	Use digital twin simulation software to optimise robotic equipment.	Expert
322922	Select subcomponents and payloads for robotic and autonomous systems to meet project requirements efficiently.	Expert
322909	Certify autonomous remote systems for inspection and repair tasks of underwater infrastructure.	Expert
210488	Deploy robotic and autonomous systems to minimise windfarm operations and maintenance costs.	Expert
322948	Develop protocols to standardise AUV mission planning and execution ensuring safe and efficient operation of uncrewed marine vehicles.	Expert
323273	Specify autonomous underwater vehicles to conduct high-resolution geophysical surveys for subsea infrastructure assessment.	Expert
229590	Integrate AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Expert
322933	Conduct mission simulation to validate and rehearse offshore autonomous operations, ensuring all support systems are integrated and functional.	Expert
322932	benchmark autonomy performance against acceptance criteria to determine mission readiness and residual risk	Expert
323208	Specify mission planning tools for tasking robotic systems in offshore wind operations.	Expert
323250	Develop protocols for AUV mission planning and execution to ensure safe and efficient operation of uncrewed marine vehicles.	Expert

Table 22: B11. Mission Planning Engineer FOP

FOP Title: RAS Operations Engineer
ROLE FAMILY #3: Engineer
Required for supply chain partners Robotic AUV Platform and Sensors OEM, , Seabed authorities, RTO and Regulator, Survey operator

ID	Capability Statement	Proficiency
322954	Manage secure data communications with autonomous systems to safeguard AUV telemetry, command links and data return.	Awareness
322948	Develop protocols to standardise AUV mission planning and execution ensuring safe and efficient operation of uncrewed marine vehicles.	Awareness
322935	Rehearse multi-asset operations with human-in-the-loop roles to align vessels, control rooms, and support teams.	Awareness
323215	Improve implementation of technology by reviewing feedback from analysis of survey operational data.	Awareness
210239	Track and manage records of robotics and autonomous systems fleet asset operations and maintenance.	Awareness
322942	Employ robotics and autonomous systems for subsea survey and intervention operations.	Awareness
322906	Employ robotics and autonomous systems to identify sunken objects for recovery.	Awareness
323250	Develop protocols for AUV mission planning and execution to ensure safe and efficient operation of uncrewed marine vehicles.	Awareness
322922	Select subcomponents and payloads for robotic and autonomous systems to meet project requirements efficiently.	Practitioner
210392	Deploy robotic and autonomous system missions from ground control stations for offshore tasks.	Practitioner
322947	Implement systems for remote operations and maintenance of physical assets to ensure efficient performance and availability	Practitioner
323273	Specify autonomous underwater vehicles to conduct high-resolution geophysical surveys for subsea infrastructure assessment.	Practitioner
229350	Design, test and install new systems to monitor system performance post-commissioning.	Practitioner
322778	Provide lifecycle support and upgrades to ensure sustained operational performance of AUV fleets.	Practitioner
322924	Operate and maintain underwater systems to ensure their reliability and safety.	Practitioner
322904	Install advanced robotics and computer vision technology on remote autonomous systems.	Expert
229591	Integrate AI-based control systems to monitor specific operational processes.	Expert
323213	Utilise AI algorithms to analyse sensor data and proactively detect potential equipment failures.	Expert
322911	Operate and maintain shore site support systems for offshore operations.	Expert
210250	Troubleshoot robotic and autonomous support systems for optimal functionality.	Expert
312808	Monitor application and software system performance to ensure functionality.	Expert

Table 23: B12. RAS Operations Engineer FOP

FOP Title: Software Engineer AUV USV design
ROLE FAMILY #3: Engineer
Required for supply chain partners: Developer and Wind Farm operator, Robotic AUV Platform and Sensors OEM, Data Analytics and AI Development, Seabed authorities, RTO and Regulator, Survey operator

ID	Capability Statement	Proficiency
304434	Develop AI systems and processes in line with ethical, legal and regulatory requirements.	Awareness
205671	Create integrated validation and verification systems in line with customer requirements and the project environment	Practitioner
210467	Influence regulatory frameworks for robotic and autonomous systems in offshore wind.	Practitioner
210468	Monitor regulatory changes and ensure compliance for robotic and autonomous systems.	Practitioner
322858	Evaluate autonomous navigation systems to ensure compliance with international maritime collision regulations.	Practitioner
322909	Certify autonomous remote systems for inspection and repair tasks of underwater infrastructure.	Practitioner
322932	benchmark autonomy performance against acceptance criteria to determine mission readiness and residual risk	Practitioner
322948	Develop protocols to standardise AUV mission planning and execution ensuring safe and efficient operation of uncrewed marine vehicles.	Practitioner
322952	Incorporate safety features and fail-safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours	Practitioner
322957	Develop methods for safe recovery of lost remote systems to mitigate risk of AUV loss and environmental impact.	Practitioner
323254	Utilise safety features and fail-safe modes within autonomous vehicle designs to ensure reliable surfacing, abort and geofence behaviours.	Practitioner
323270	Set industry standards for safety features and fail-safe modes in autonomous vehicle designs to assure reliable surfacing, abort and geofence behaviours.	Practitioner
209653	Develop proactive risk management strategies for emerging autonomous systems in offshore wind farms	Expert
213151	Collaborate with regulatory agencies to adapt advanced tools, including AI, to enhance safety protocols and ensure compliance.	Expert
322852	Accredit test and validation facilities for simulated and real-world environments to ensure technology meets safety benchmarks.	Expert
322929	Apply navigation equipment on prototype vessels to enhance maritime safety and efficiency.	Expert
323206	Create integrated validation and verification systems in line with regulatory requirements and the project environment	Expert

Table 24: B13. Software Engineer AUV USV design FOP

FOP Title: RAS Operations Supervisor
ROLE FAMILY #2: Senior technician
Required for supply chain partners Developer and Wind Farm operator, Robotic AUV Platform and Sensors OEM, Data Analytics and AI Development, Seabed authorities, RTO and Regulator, Survey operator

ID	Capability Statement	Proficiency
322955	Conduct hydrographic surveys and marine activities to produce survey-grade bathymetry maps and collect backscatter data for project development and consent processes.	Awareness
322911	Operate and maintain shore site support systems for offshore operations.	Awareness
322919	Oversee site and seabed investigations to ensure accurate data collection.	Practitioner
303812	Conduct field surveys to analyse project site details.	Practitioner
322905	Program unmanned autonomous vessels based on local conditions.	Practitioner
210250	Troubleshoot robotic and autonomous support systems for optimal functionality.	Practitioner
312808	Monitor application and software system performance to ensure functionality.	Practitioner
322943	Implement remote operations and maintenance systems of digital platforms to ensure efficient performance and availability.	Expert
323266	Coordinate multiple autonomous vehicles participating in the survey.	Expert
210392	Deploy robotic and autonomous system missions from ground control stations for offshore tasks.	Expert
343858	Use digital twins of automation systems to monitor assets remotely.	Expert
323254	Utilise safety features and fail-safe modes within autonomous vehicle designs to ensure reliable surfacing, abort and geofence behaviours.	Expert
322947	Implement systems for remote operations and maintenance of physical assets to ensure efficient performance and availability	Expert
322953	Monitor the performance of autonomous systems using sensor analytics to reduce re-survey rates and improve system up-time.	Expert
210239	Track and manage records of robotics and autonomous systems fleet asset operations and maintenance.	Expert
322942	Employ robotics and autonomous systems for subsea survey and intervention operations.	Expert
323248	Utilise autonomous vehicles to detect unexploded ordnance (UXO) and to identify seabed hazard.	Expert
322957	Develop methods for safe recovery of lost remote systems to mitigate risk of AUV loss and environmental impact.	Expert
322924	Operate and maintain underwater systems to ensure their reliability and safety.	Expert
209596	Implement automated inspection and maintenance using sensor-equipped autonomous underwater vehicles	Expert
302599	Perform routine maintenance on vehicles and auxiliary equipment to ensure operational efficiency.	Expert

Table 25: B14. RAS Operations Supervisor FOP

Appendix C. Background to Workforce Foresighting Hub

Addressing future workforce challenges

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

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

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

The Skills Value Chain

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

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

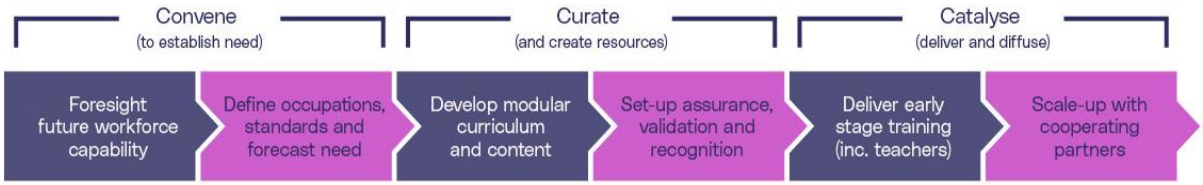

Figure 1: The Skills Value Chain

Workforce foresighting

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

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

The Workforce Foresighting Hub, initiated and funded by Innovate UK, and built in collaboration with the Catapult Network, provides the processes and data that inform insight and support the recommendations required for industry, policymakers, and educators to respond to continuing change.
Our Vision: To foster the organisational capabilities and workforce skills required to adapt to continuing change and enable adoption of innovative technologies to enable a prosperous UK industry.

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

Our Goals:

Define future capabilities required across a sector in response to a challenge, or technology innovation and consequently define the skill sets of the workforce of the future.
Understand and explain gaps between technology adoption, organisational capability, and workforce profiles that could hamper innovation.
Identify and communicate insights, future requirements and the action required by industry and educators.
Enable and deliver a consistent approach to workforce Foresighting.

Outcomes:

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

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

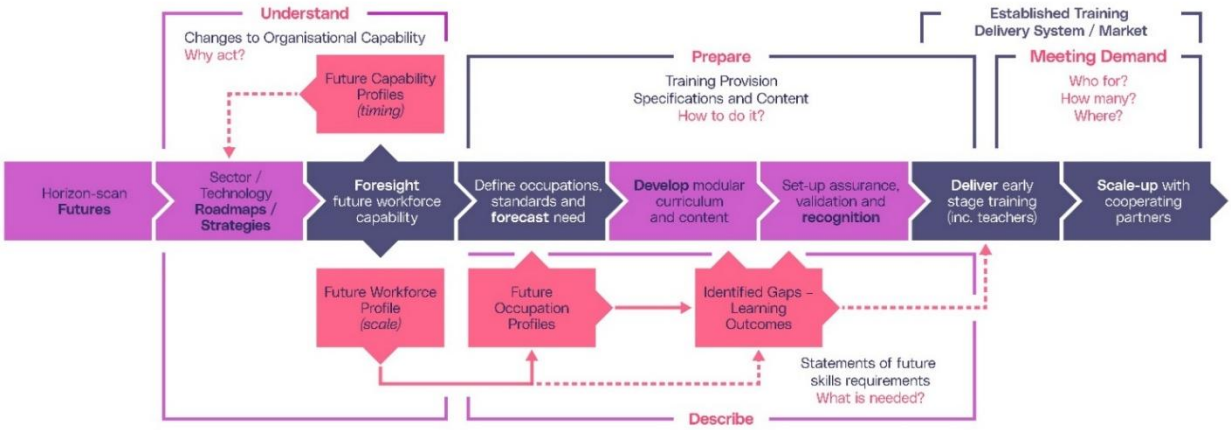

Figure 3: C1. Workforce Foresighting & Skills Value Chain

Approach used - principles and implementation

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

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

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

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

Considering – Clarifying the Challenge to be met (the 'what' and the 'when') and collating solutions (the 'how') as Foresighting topic suggestions align with strategic priorities

Identifying – Gain clarity and consensus about the solutions to be put forward – make the case for Foresighting

Preparing – The convening of specialists and scheduling of workshops

Carrying out – Run Foresighting workshops with experts, collate and analyse data

Communicating – Insights, findings and recommendations gathered from all research in an actionable report

Causing action – The driving of action based on the recommendations (promoting progress down the rest of the skills value chain) built on the findings and recommendations of Foresighting

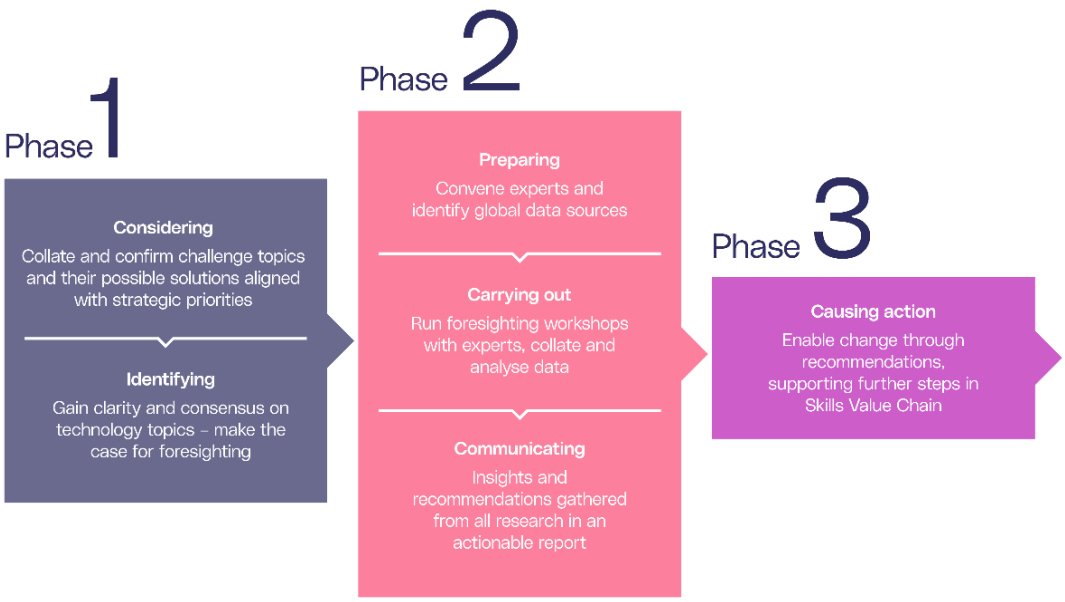

Figure 4: C2. The Workforce Foresighting process

Forecasting and Foresighting

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

Outcomes - insights and recommendations

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

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

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

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

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

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

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