Workforce Foresighting Hub

Increase the application of advanced therapeutics by adopting modular and point of care manufacturing

Authors:	
Cycle Sponsor:	The Advanced Therapy Treatment Centre (ATTC) network
Centre of Innovation:	Cell and Gene Therapy Catapult
Workforce Foresighting Hub	

Powered by UKRI Innovate UK

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.

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 between November 2025 and February 2026 using the data set and tools available at that time.

Executive Summary

This report outlines findings from the Workforce Foresighting cycle focussing on the title: Increase the application of advanced therapeutics by adopting modular and point of care manufacturing. This industry challenge was sponsored by The Advanced Therapy Treatment Centre (ATTC) network and study conducted by Cell and Gene Therapy 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.

Strategic context and purpose for Workforce Foresighting

This cycle aims to understand NHS workforce capabilities to deliver **decentralised, point-of-care advanced therapies** by 2030. This is supported by the Medicines and Healthcare products Regulatory Agency (MHRA), the first competent to bring forward regulations[1] and associated guidance to enable modular and point-of-care manufacturing for advanced therapies.

Decentralised and point of care manufacturing could transform how advanced therapies (i.e. Advanced Therapy Medicinal Products) are delivered to patients enabling treatments to be manufactured closer to patients through a **hub and spoke model, directly within a hospital environment**. This would allow increased access, localised production and more personalised care for patients.

Significant evolution in technologies is required which will lead to the need for enhanced workforce capabilities within industry and the NHS, infrastructure readiness, and cross-functional coordination across clinical and manufacturing teams.

This cycle aims to explore and define the **future organisational capabilities, skills, roles, required to successfully implement decentralised manufacturing solutions** for advanced therapy delivery across the UK. Through workforce foresighting, the goal is to get ahead of the skills curve to have a skilled workforce ready to take on the upcoming technological revolution of decentralised manufacturing.

Summary of Findings

The foresighting cycle highlights the need to develop point-of-care manufacturing capabilities within realistic timelines and proactively prepare the workforce that the MHRA's Human medicines Modular Manufacture and Point of Care regulations 2025 will involve. Priorities include identifying early capability needs, mapping current roles to future requirements, raising strategic awareness, engaging key stakeholders, and delivering targeted training.

---

[1] *https://www.gov.uk/government/publications/human-medicines-modular-manufacture-and-point-of-care-regulations-2025-overview/human-medicines-modular-manufacture-and-point-of-care-regulations-2025-overview*

Ongoing adaptability will ensure skills remain aligned with evolving technologies and industry developments.

Next Steps

Key actions to ensure the relevant workforce is prepared include prioritising early capability needs, mapping role gaps, raising awareness, and creating short, targeted training. For industry, decentralised manufacturing increases regulatory, digital and validation demand. Educators must collaborate closely with NHS and industry partners to support focused upskilling and adapt training to growing digital and compliance expectations.

Participants and Stakeholders

This research is a combined effort of varied stakeholders who will play a critical role in supporting and implementing the technologies and practices, and educators who will own upskilling. Over 20 participants were engaged within the cycle across 15+ organisations listed below.

Thanks 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.

Technology Participants	**Industry Participants**	**Skills Participants**
Cambridge University Hospitals NHS Foundation Trust	The Newcastle Upon Tyne Hospitals NHS Foundation Trust	NHSBT (Education & training)
Cytiva	NA-ATTC	NA-ATTC
Guy's and St Thomas' NHS Foundation Trust	Lab Corp	University College London
Miltenyi	CGT Catapult	University of Hertfordshire
Lab Corp	Cytiva	Miltenyi
Northern Alliance Advanced Therapies Treatment Centre (NA-ATTC)	NHSBT	Teeside University
The Newcastle Upon Tyne Hospitals NHS Foundation Trust	Cambridge University Hospitals NHS Foundation Trust	The Newcastle Upon Tyne Hospitals NHS Foundation Trust
NHS Scotland	Speciality Pharmacy Services	Speciality Pharmacy Services
NHSBT		
Scottish National Blood Transfusion Service		
Speciality Pharmacy Services		
Scottish National Blood Transfusion Service		

Table 1: Participants and stakeholders

Glossary

Term	Definition
Challenge Response	Specific intervention aimed at the challenge
Capability (Organisation)	The collective abilities, and expertise of an organisation to carry out a function, because provision and preparation have been made by the organisation
Capability Classification	Classification provides a common, structured vocabulary to define capability
Capability Statements	Description of the depth and nature of each capability within an organisation
Capability Syntax	Common language to describe each capability application within organisation type
Carbon Accounting	The process of measuring, tracking, and reporting greenhouse gas emissions produced by an organisation or activity
Competencies (Workforce / Individual)	'Proficiency, aptitude, capacity, skill, technique, experience, expertise, facility, fitness related to capability
Competency definition 'KSBs' (Knowledge, Skills and Behaviours)	Knowledge, Skills, and Behaviours are the elements used to express the required competencies for each Role Group
Competency Domain	Used during foresighting analysis to provide focus on existing and emerging competency needs
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
Foresighting Champion	An individual nominated within a new user organisation of foresighting to facilitate and lead the use of foresighting processes and tools with the support of the Project Team
Foresighting Subject	The application of specific technologies in the context of a given challenge and which are candidates for foresighting
Future Competency Set	The KSB output from the Educator workshop for each Role Group
Map and Gap Analysis	A combined expert and automated process that maps the Future Competency Set against a selected reference framework
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary
Organisation Type	Simple description of nature of organisation for which capability is required
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
Roadmaps	Sector, Industry, Regional view of emerging opportunities and their market entry
Role Group	Role groups are a collective of roles that exist in a typical manufacturing business / industrial sector
Technologies	The technology that could be used to address the challenge
Working Scenario	To provide further context in relation to the subjects and used to position participants thinking during the detailed identification of future capabilities
Workshops	Online sessions used to undertake each step in the foresight process

Table 2: Glossary

Table of Contents

Figures and Tables

1. Introduction

1. Introduction

1.1 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.

This report outlines findings from a Workforce Foresighting cycle focused on Increase the application of advanced therapeutics by adopting modular and point of care manufacturing The study is sponsored by The Advanced Therapy Treatment Centre (ATTC) and study conducted by Cell and Gene Therapy Catapult, in collaboration with the Workforce Foresighting Hub, an Innovate UK initiative. This report is designed to support strategic decision making and inform the next steps on the Skills Value Chain.

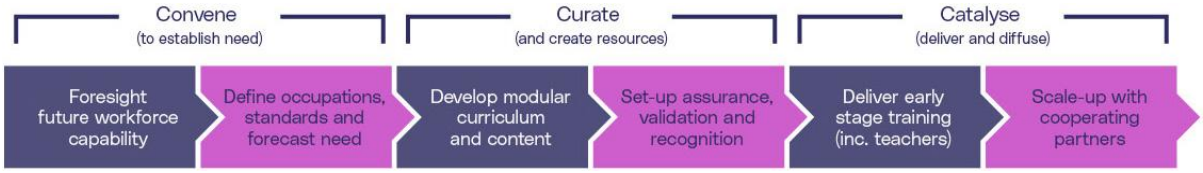

Figure 1: Skills Value Chain

1.2 Defining the Workforce Foresighting Topic

This workforce foresighting topic focuses on the workforce capabilities required to enable decentralised, hub-and-spoke manufacturing models for advanced therapies within the NHS. In this model, manufacturing and quality activities are distributed between hospital-based spoke sites and centralised control sites/hubs providing oversight, coordination and assurance.

Delivery depends on effective capability and integration across four key supply chain partners: **equipment providers** supplying modular and point-of-care manufacturing technologies; **data integration and automation providers** enabling digital connectivity, process control and quality oversight; **logistics and supply chain partners** managing material, and information flows; and the **NHS workforce and control sites/hubs** responsible for operating, coordinating and governing these systems within clinical settings. This cycle will explore how roles, skills and interfaces across these partners must evolve to support safe, scalable implementation.

2. Findings & Insights

2. Findings and Insights

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 and visualisation tool.

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 Visualisation Tool***[2]

Detailed instructions on how to use the Visualisation Tool can be found in the appendix B (**Appendix B - Online Data visualisation Tool**

[2] Link to Visualisation tool https://hvmcatapultforesighting.retool.com/embedded/public/e869283b-4b8a-437c-973e-64ab292e5b87?token=eaa250b5f67ebebd98d49fef6a03bcdf

2.1 Industry - Identified Organisational Capabilities

Insight:
During the data gathering and analysis phase,**78 unique future organisational capabilities** were identified. These capabilities were then used as the basis of further analysis though the research approach. Most of the capabilities followed 11 themes, listed below, which indicate potential areas of focus; however, detailed analysis of the individual capabilities is always encouraged for decision making.

The themes identified as follows.

1. **Modular plug-and-play PoC architecture:** Establish a modular, plug-and-play facility and equipment architecture that can be rapidly deployed, scaled, and reconfigured across NHS -spoke sites and the hub while preserving validated conditions.

2. **Automation & robotics at scale:** Implement end-to-end automation and robotics for manufacturing and analytics to increase throughput, reduce variability, and generate real-time data that drives process control and product release.

3. **Interoperable digital manufacturing backbone:** Build an interoperable digital manufacturing backbone (eBMR/ eBR, PQS, SOPs, training) that connects hubs and spokes, and provides centralised, audit-ready records.

4. **Real-time PAT & in-process control:** Adopt real-time in-line/on-line monitoring and process analytical technology (PAT) to track CQAs, trigger in-process alarms, and proactively steer processes for consistent product quality.

5. **Digital GMP & shared validation:** Operationalise a digital GMP quality system with shared validation libraries and standardised protocols to qualify modules quickly, digitise QC, and minimise defects across multiple sites.

6. **Equipment lifecycle, qualification & uptime:** Institutionalise equipment lifecycle management (IQ/OQ, qualification, preventive maintenance, remote troubleshooting) to sustain uptime, performance, and compliance in spoke environments.

7. **Traceable, compliant supply chain orchestration:** Orchestrate a traceable, compliant supply chain and logistics network—including procurement, NHS-specific inventory models, cold chain, and digital tracking—to ensure right-time availability of materials and therapies.

8. **Hub-and-spoke regulatory governance & audits:** Embed hub-and-spoke regulatory governance with self-inspection and real-time audit capability to assure MHRA/HTA/JACIE compliance and manage change control efficiently across decentralised sites.

9. **Workforce digital capability & training:** Define workforce digital/automation capability profiles and deliver integrated, role-based training to enable safe, consistent point-of-care manufacturing in non-expert spoke settings.

10. **Process development, SPC & tech-transfer:** Accelerate process and product development with modifiable parameters, SPC-driven improvement, and standardised tech-transfer to replicate validated performance across sites.

11. **Standardised data models & interfaces:** Standardise data models and interfaces for universal accessibility and traceability to seamlessly integrate manufacturing, QC, environmental monitoring, and logistics data across the network

2.1.1 Highlighted capabilities

A further analysis was completed to identify the most likely to prompt consumers to prioritise action. Although all 80 capabilities are expected to have a meaningful impact on the industry, the shortlisted capabilities outlined below are anticipated to exert the greatest influence. This report provides a more detailed review of these areas. Equivalent data and insights can be readily generated for all remaining capabilities using the visualisation tool.

Proficiency Key - This elaborates the level of engagement a FOP would have with a capability.

Expert = 3, Practitioner = 2, Awareness = 1

Capability 1:
Ensure traceability by implementing integrated software for sample tracking and data management.

Reason to Highlight:
The fundamental change of spoke sites manufacturing products under the requirements of control sites (hubs) will require real-time visibility of manufacturing processes alongside data capture and management - to enable robust and efficient scale-out and safety of product.

Associated FOPs:

FOP	Proficiency
Chief Pharmacist	3
Designated Individual (HTA)	1
Pharmacy Aseptic Services Manager (ATMP)	3
Compliance Officer (Logistics)	1
Cryogenic Expert	1
Inventory Manager	3
Shipping and Transport Manager	2
Supply Chain and Cold Chain Lead	3

Table 3: Associated FOPs and proficiency levels for capability 1

Supported by current provisions:
Best match: No match found.
Standard: N/A.

Capability 2:
Implement new processes, methodologies, and plant equipment to support product development and scale-out manufacturing.

Reason to Highlight: Important as processes and equipment requirements to enable scale-out manufacturing of different products at multiple spokes sites will likely be distinct to current provision.

Associated FOPs:

FOP	Proficiency
Project Manager	3
Compliance Officer (Logistics)	1
Cryogenic Expert	1
Inventory Manager	2

Table 4: Associated FOPs and proficiency levels for capability 2

Supported by current provisions:
Best Partial Match: Implement and develop new processes and plant equipment to support product development.
Standard: Science industry process and plant engineer (degree).

Capability 3:
Collect in-process manufacturing data to support real-time quality control analysis and quality assurance processes.

Reason to Highlight:
Critical as products will be released on the basis of validated processes that rely on these real time data rather than conventional QP release at end of the process (due to short shelf life of product).

Associated FOPs:

FOP	Proficiency
Data Integration Specialist	3
Application Specialist	2
Software Integration Analysts	3
Validation/Manufacturing Operative	2
Quality Control Operative	2

Table 5: Associated FOPs and proficiency levels for capability 3

Capability 4:
Support compliance audits within spoke sites to meet regulatory requirements e.g. HTA, JACIE and MHRA.

Reason to Highlight: Essential spoke site capability to reflect regulatory requirements for arrangements between control and spoke sites.

Associated FOPs:

FOP	Proficiency
Project manager	1
Technical Support Specialist	1
Validation Engineer	3
Head of Quality	2
Qualified Person	2

FOP	Proficiency
Quality Assurance Operative	2
Clinical and Sponsor Liaison	2

Table 6: Associated FOPs and proficiency levels for capability 4

Supported by current provisions:
Best Match: Support internal audits to ensure regulatory compliance.

Capability 5:
Implement maintenance plans to sustain equipment uptime and qualified status, including preventive maintenance capabilities.

Reason to Highlight:
New arrangements between control and spoke sites regarding responsibility for and implementation of these plans. Likelihood that some spoke sites will have no experience of advanced therapy manufacturing equipment.

Associated FOPs:

FOP	Proficiency
Pharmacy Aseptic Services Manager (ATMP)	2
Service Engineer	3
Technical Support Specialist	2
Head of Production	2
Validation/Manufacturing Operative	2

Table 7: Associated FOPs and proficiency levels for capability 5

Capability 6:
Facilitate compliance audits within spoke sites to meet regulatory requirements e.g. HTA, JACIE and MHRA.

Reason to Highlight:
Essential spoke site capability to reflect regulatory requirements for arrangements between control and spoke sites.

Associated FOPs:

FOP	Proficiency
Chief Pharmacist	3
Clinician (including PI/CI)	2
Designated Individual (HTA)	3
Governance committee members	3
Quality Assurance Officer	2
R&D/R&I Manager	1
Compliance Officer (Logistics)	3
Cryogenic Expert	2
Inventory Manager	2
Shipping and Transport Manager	2

Table 8: Associated FOPs and proficiency levels for capability 6

Capability 7:

Develop new automated manufacturing processes that generate real time data for enhancing process/product characterisation.

Reason to Highlight:
Important as these automated processes will produce data on critical quality attributes (CQAs) that will then be used for final product manufacture at spoke sites; the product will be released on basis of real time data of CQAs rather than conventional QP release at end of process (due to short shelf life of product).

Associated FOPs:

FOP title	Proficiency
Process Development Support Specialist	3
Head of Production	3

Table 9: Associated FOPs and proficiency levels for Capability 7

Supported by current provisions:
Best match: Develop and optimize digital manufacturing processes and workflows.
Standard: Digital manufacturing engineering leader.

Capability 8:

Maintain a centralised record-keeping system to enable quality assurance, quality control, and qualified person teams to review data and approve manufacturing decisions.

Reason to Highlight:
New arrangements between control and spoke sites regarding generation, capture and sharing of records to meet regulatory requirements and enable safe use of product following manufacture at spoke site.

Associated FOPs:

FOP	Proficiency
Chief Pharmacist	3
Clinical Trial Coordinator	2
Data Integration Specialist	1
Designated Individual (HTA)	3
Governance committee members	3
Pharmacy Aseptic Services Manager (ATMP)	2
Quality Assurance Officer	3
Cell Therapy Laboratory Operatives	2
Point of Care Manufacturing Coordinator	2
Project Manager	2
Software Integration Analysts	3
Head of Quality	3
Qualified Person	3
Quality Assurance Operative	3

Table 10: Associated FOPs and proficiency levels for capability 8

Supported by current provisions:
Best match: Ensure that the organisation's documentation and quality control processes and procedures are adhered to.

Standard: Control systems engineer (degree).

Capability 9:
Operate a digital interface to execute manufacturing steps, integrate data into batch records and share with remote QP teams.

Reason to Highlight: Most spoke sites won't have experience of advanced therapy manufacturing or of the required interaction with control sites.

Associated FOPs :

FOP	Proficiency
Clinical Pharmacist (ATMP/Oncology)	2
Nurse / Research Nurse	2
Pharmacy Aseptic Services Manager (ATMP)	2
Cell Therapy Laboratory Operatives	2
Application Specialist	2
Technical Support specialist	2
Validation/Manufacturing Operative	3

Table 11: Associated FOPs and proficiency levels for capability 9

Supported by current provisions:
Best Match: Operate a manufacturing batch or continuous process following Standard Operating Procedures.
Standard: Science manufacturing technician 2014.

Capability 10:
Use integrated digital environments to manage trainings, manufacturing processes, and product releases, ensuring efficient operations at multiple operational sites.

Reason to Highlight:
Important for scale out of product manufacture to spoke sites by control sites and to deliver product manufacture by spoke sites.

Associated FOPs:

FOP	Proficiency
Clinical Pharmacist (ATMP/Oncology)	1
Clinical Trial Coordinator	2
Clinician (including PI/CI)	2
Data Integration Specialist	1
Nurse / Research Nurse	2
Point of Care Manufacturing Coordinator	2

Table 12: Associated FOPs and proficiency levels for capability 10

Supported by current provisions:
Best match: No appropriate match found.
Standard: N/A.

Capability 11: Maintain equipment qualification status throughout the manufacturing lifecycle through scheduled checks and documented compliance.

Reason to Highlight:
Likelihood that some spoke sites will have no experience of advanced therapy manufacturing equipment.

Associated FOPs:

FOP	Proficiency
Pharmacy Aseptic Services Manager (ATMP)	2
Cell Therapy Laboratory Operatives	2
Service Engineer	2

Table 13: Associated FOPs and proficiency levels for capability 11

Supported by current provisions:
Best match: *Perform necessary checks such as quality control or compliance testing, using the correct procedures and equipment.
Standard: Engineering technician.

Capability 12: Perform installation and operational qualification of manufacturing devices to meet regulatory and performance requirements.

Reason to Highlight: Reflects new arrangements between control and spoke sites needed to meet regulatory requirements.

Associated FOPs:

FOP	Proficiency
Service Engineer	3
Validation Engineer	3
Validation/Manufacturing Operative	3

Table 14: Associated FOPs and proficiency levels for capability 12

Supported by current provisions:
Best match: No appropriate match found.
Standard: N/A.

Capability 13: Manage compliant storage facilities to meet current Good Manufacturing Practice (GMP) standards for raw materials and finished products.

Reason to Highlight:
Likelihood that some spoke sites will have no experience of GMP and associated requirements for compliant storage facilities.

Associated FOPs:

FOP	Proficiency
Pharmacy Aseptic Services Manager (ATMP)	2
Cell Therapy Laboratory Operatives	2
Service Engineer	1
Validation Engineer	2
Compliance Officer (Logistics)	2

FOP	Proficiency
Cryogenic Expert	2
Inventory Manager	3
Shipping and Transport Manager	2
Supply Chain and Cold Chain Lead	2

Table 15: Associated FOPs and proficiency levels for capability 13

Supported by current provisions:
Best match: No appropriate match found.
Standard: N/A.

Capability 14:
Develop validation protocols for each manufacturing process step to ensure compliance with regulatory standards.
Reason to Highlight:
Critical as the product will be released based on a validated manufacturing process rather than rely rather on conventional QP release at end of the manufacture (due to short shelf life of product).

Associated FOPs:

FOP	Proficiency
Validation Engineer	3
Qualified Person	1
Validation/Manufacturing Operative	2

Table 16: Associated FOPs and proficiency levels for capability 14

Supported by current provisions:
Best match: Follow quality procedures and standards to ensure compliance with regulatory requirements.
Standard: Science industry maintenance technician.

Capability 15:
Develop systems to ensure closed and automated manufacturing processes are translated safely and consistently to non-cleanroom environments.

Reason to Highlight:
Essential as product will be manufactured close to patient and in a non-cleanroom environment i.e. a significant step-change.

Associated FOPs:

FOP	Proficiency
Process development support specialist	3

Table 17: Associated FOPs and proficiency levels for capability 15

Supported by current provisions:
Best match: Start and maintain aseptic manufacturing process and equipment in line with operational parameters.
Standard: Science manufacturing technician 2023.

Capability 16:
Design a self-inspection program that incorporates the hub and spoke model to enforce regulatory compliance, where regulatory compliance lies with the site.

Reason to Highlight:
Spoke and control sites will be required to ensure compliance with their defined roles and responsibilities around product manufacture – it will be essential for spoke sites to ensure they meet their necessary regulatory requirements.

Associated FOPs:

FOP	Proficiency
Chief Pharmacist	3
Designated Individual (HTA)	3
Governance committee members	3
Quality Assurance Officer	2

Table 18: Associated FOPs and proficiency levels for capability 16

Supported by current provisions:
Best match: No match found.
Standard: N/A.

Capability 17:
Embed point of care manufacturing governance and processes into routine hospital care.

Reason to Highlight:
Development and implementation of de novo governance arrangements for manufacturing within a hospital (spoke site) setting will be essential (as they will be regarding control hub and spoke responsibilities).

Associated FOPs:

FOP	Proficiency
Chief Pharmacist	3
Clinician (including PI/CI)	2
Designated Individual (HTA)	3
Governance committee members	3
Quality Assurance Officer	3

Table 19: Associated FOPs and proficiency levels for capability 17

Supported by current provisions:
Best match: No match found.
Standard: N/A.

Capability 18:
Develop capability for in-line monitoring and control of critical quality attributes using real-time process analytical tools (PAT) such as Raman spectroscopy.

Reason to Highlight:
Important as data on critical quality attributes (CQAs) from in-line monitoring will be used to identify issues with product quality and be relied on for product release on the basis of real

time data rather than conventional QP release at the end of the manufacturing process (due to short shelf life of product).

Associated FOPs:

FOP	Proficiency
Process Development Support Specialist	3
Quality Control Operative	2

Table 20: Associated FOPs and proficiency levels for capability 18

Supported by current provisions:
Best match: No match found.
Standard: N/A.

Capability 19:
Describe digital capability requirements for spoke sites as a part of the eligibility checks.

Reason to Highlight:
Control sites will need to ensure that spoke sites have, or can develop to meet the requirements for, digital capability for manufacture of products; this particularly important due to the way that the manufacturing process will be monitored and product released by spoke sites.

Associated FOPs:

FOP	Proficiency
Project Manager	3
Software Integration Analysts	3
Quality Assurance Operative	1
Clinical and Sponsor Liaison	3

Table 21: Associated FOPs and proficiency levels for capability 19

Supported by current provisions:
Best match: No match found.
Standard: N/A.

2.1.2 Future Supply Chain

To understand how supply chains must evolve in response to emerging technologies, the research creates 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, and the research is largely based on those supply chain partners. This ensures that the analysis is grounded in real-world contexts and considers the full ecosystem of organisations and partners involved.

The following table describes the focus supply chain partners and their descriptions for this cycle.

Supply chain partner	Description
Equipment, Data integration & Automation Providers	These partners deliver the specialised machinery, digital infrastructure, and automation technologies essential for modular and point-of-care manufacturing in cell and gene therapy. Also, they advise on cleanroom design and implementation of the respective technology. They enable the seamless integration of equipment with data systems, supporting real-time monitoring, traceability, and process control. By aligning physical tools with digital workflows, they help decentralise production, enhance operational efficiency, compliance to PoC regulations and accelerate the delivery of advanced therapeutics.
Logistics & Supply Chain	These partners design and manage localised logistics frameworks that support the delivery and coordination of materials, equipment, and therapies within point-of-care manufacturing environments. Their expertise lies in streamlining supply flows across clinical sites, ensuring timely availability of components and maintaining compliance with regulatory and quality standards.
NHS workforce	This partner group includes clinical, pharmacy and a range of operational staff across NHS settings who are directly involved in the delivery and support of point-of-care cell and gene therapies or the governance. Their responsibilities span patient care, therapeutic handling, quality assurance, and coordination within decentralised manufacturing models.
Control sites (hubs/ advance therapy developer)	These partners operate as central quality and regulatory hubs within the hub-and-spoke model, facilitating the manufacture of advanced therapies at nearby clinical (spoke) sites. They house specialised facilities and skilled teams to enable high-quality, scalable production closer to patients. Acting under an appropriate manufacturing authorisation, they develop and standardise processes for manufacturing, quality control analysis, and all aspects of quality assurance. Responsible for all manufacturing activities, they support technology transfer and ensure timely supply of starting material and equipment to spoke sites.

Table 22: Supply chain partner descriptions

A distribution of the 78 capabilities across these supply chain partners can be found in the visualisation tool. FOP Distribution[3]

2.1.3 Cycle Capabilities Currently Not Served Though Skills England Standards

As a part of the analysis all capabilities are semantically matched against Skills England duty statements. Skills England is identified as a proxy for national availability of education provisions. Research identifies that there could be provisions within other education bodies that are not present in Skills England standards. This information will further narrow down the search when it comes to causing action.

Out of the 80 future capabilities identified for this cycle to adopt this technology across the supply chain, 40 are not currently well matched with any duty statements found in existing apprenticeship standards.

[3] FOP Distribution https://hvmcatapultforesighting.retool.com/embedded/public/ce67cca1-5beb-4557-8482-8a0b6e174933?token=db88d1a3c945e14da7f5bf1cc1741efe

The unmatched capabilities mean that there are no reasonably good duty statements across any of the 649 apprenticeship standards considered. However, match capabilities do not imply that no intervention is required. The matches could be from a standard that is does not align with the industry. Therefore, contextual expertise is required to understand what needs further attention. The table with the list of capabilities without identified provisions can be found in the Appendix A. (**Appendix A - Capabilities without identified provisions**)

2.2 Workforce Insight

2.2.1 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.

Links: Link to FOP Matrix[4]

2.2.2 Role Levels

Organisations rely on structured role levels 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 level builds on the last in terms of complexity, autonomy and impact enabling effective collaboration and accountability.

Workforce Foresighting uses a common way of defining role levels across supply chain partners but adapts it to each technology and sector. This shared framework supports consistency, while still reflecting the specific capabilities and workforce needs for each challenge

Role Levels selected for this cycle are:

1. ***Strategic & Operational Management***
   Lead teams, assess systems, design solutions and manage resources.
2. ***Operational Leadership***
   leading teams, assessing performance and improve systems
3. ***Professional & Delivery***
   Analysis, Execution and Tactical Delivery within defined systems.

[4] FOP Matrix https://hvmcatapultforesighting.retool.com/embedded/public/f99a913f-8827-4730-8893-d618d489bc84?token=db88d1a3c945e14da7f5bf1cc1741efe

2.2.4 Priority FOPs

The FOPs were reviewed by our expert cycle participants against the context of importance to the sector, demand and mapping against current provision. The following FOPs have been prioritised for initial action and further analysis. The FOPs outlined below have been identified as key roles within the future workforce, essential for delivering the capabilities required to drive industry transformation.

As part of our strategic workforce planning, we identify and prioritise Future Occupational Profiles (FOPs) based on a set of key criteria. A **Priority FOP** is a role that is critical to our future success and must be developed ahead of others to meet evolving business needs.

These roles are prioritised because they:

- Were strategically important to the sectors long-term goals
- Faced existing or anticipated capability gaps
- Had a high impact across multiple functions
- Required early talent planning and pipeline development
- Needed to be ready within a defined timeframe

Insight:
Cycle selected Priority Future Occupational Profiles (FOPs) and descriptions.

FOP Name	Description
Automation Digitalisation Specialist	Designs modular robotic systems and integrated digital environments to automate assays, optimise workflows, and enable real-time monitoring. Implements flexible manufacturing, digitises quality control, and ensures seamless data transfer for compliance and efficiency across advanced therapy production networks.
Cell Therapy Laboratory operatives	Operates GMP-compliant processes using digital batch monitoring, automated QMS, and modular systems. Maintains equipment qualification, manages controlled thawing, and ensures traceability to deliver safe, high-quality cell therapies within decentralised NHS facilities.
Chief Pharmacist	Leads governance for point-of-care manufacturing by embedding compliance frameworks into routine hospital care. Oversees digital inventory systems, cold chain integrity, and audit programmes to maintain regulatory standards and optimise therapeutic supply across decentralised NHS networks.
Clinical and Sponsor Liaison	Coordinates regulatory strategies and digital governance across hub-and-spoke networks. Implements integrated environments for training, manufacturing, and product release, while managing audits and eligibility checks to ensure compliance and continuity in advanced therapy delivery.
Clinical Pharmacist (ATMP/Oncology)	In collaboration with relevant clinical and laboratory teams, manages therapy handling and digital workflows for advanced treatments. Operates integrated systems for batch execution, thawing, and labelling, while supporting quality control and training across multiple sites to ensure safe, efficient delivery of cell and gene therapies.
Clinician (including PI/CI)	Oversees governance and digital workflows for hospital care of patients treated with POC manufactured advanced therapies. Oversees controlled thawing, compliance audits, and real-time tracking while using integrated environments to manage training, manufacturing, and product release across multiple NHS sites.

FOP Name	Description
Compliance Officer (Logistics)	Manages advanced logistics for decentralised therapy production by implementing where appropriate real-time tracking, cold chain systems, and digital inventory models. Oversees all regulatory aspects including good manufacturing and distribution practice (GmDP) compliant storage and integrated environments to maintain product integrity and streamline supply flows across hub-and-spoke networks.
Cryogenic Expert	Maintains cold chain integrity for raw materials, intermediate and if applicable finished therapies through advanced cryogenic systems. Implements real-time tracking, contingency planning, and compliant storage solutions to safeguard product quality and enable efficient logistics in P.O.C manufacturing environments.
Designated Individual (HTA)	Leads compliance for human tissue governance in point-of-care manufacturing. Oversees digital tracking, inventory models, and automated quality systems, self-inspection programmes and governance frameworks to maintain regulatory standards across local licenced spoke activity.
Head of Production	Responsible for GMP compliance for all development, validation and manufacturing activities. Named on MHRA manufacturers authorisation.
Head of Quality	Responsible for all quality assurance and quality control activities in relation to P.O.C.M. Named on MHRA manufacturers authorisation.
Nurse / Research Nurse	Supports advanced therapy delivery by operating digital interfaces for batch execution, monitoring process data, and managing controlled thawing. Use tracking systems and integrated environments to ensure compliance, traceability, and efficient coordination within own NHS spoke site.
Pharmacy Aseptic Services Manager (ATMP)	Manages GMP-compliant aseptic operations for advanced therapies using modular systems and automated QMS processes. Oversees digital tracking, environmental monitoring, and equipment qualification to maintain validated conditions and ensure safe, efficient production within decentralised NHS facilities.
Point of Care Manufacturing Coordinator	In liaison with the hub, contribute to the development of modular manufacturing solutions and integrated digital environments for hub operations. Collaborates on equipment design, automation, and quality systems to optimise therapy production and accelerate innovation implementation.
Process Development Support Specialist	Develops automated, modular manufacturing processes with real-time analytics and PAT tools to optimise therapy production. Leads process improvement using SPC, configures digital fill-and-finish systems, and creates adaptable automation kits for rapid adoption in decentralised NHS facilities.
Qualified Person	Key personnel responsible for batch certification and oversight of all quality and manufacturing activities. Named on MHRA manufacturers authorisation. (Certification can be retrospective for POCM).
Quality Assurance Officer	Drives compliance in decentralised manufacturing through automated quality systems, integrated data platforms, and self-inspection programmes. Oversees digital record-keeping and audit processes to maintain regulatory standards and minimise defects in advanced therapy production.
R&D/R&I Manager	Supports clinical trials using point of care manufacturing of product by facilitating execution of governance and approvals, ensuring regulatory, ethical and patient safety requirements are met, managing documentation, legal and non-legal contracts, and liaising between

FOP Name	Description
	hub and local services so all activities will be done safely and compliantly.
Validation Engineer	Develops robust validation protocols and shared libraries for modular equipment, ensuring cGMP compliance and rapid deployment across NHS sites. Designs audit models, self-inspection programmes, and integrated digital environments to maintain quality and regulatory alignment in advanced therapy manufacturing.
Validation/Manufacturing Operative	Executes approved automated manufacturing and validation processes using modular systems and digital interfaces. Ensures equipment maintenance qualification, monitors environments, and applies PAT tools for real-time quality control, ensuring GMP compliance and operational efficiency across advanced therapy production sites.

Table 23: Priority FOPs

Links: *Full detailed list of all FOPs can be obtained in the visualisation tool.*[5]

[5] Visualisation tool https://hvmcatapultforesighting.retool.com/embedded/public/81d272f0-ad80-421c-8926-86655913acdf?token=db88d1a3c945e14da7f5bf1cc1741efe

2.3 Education and Provision Insight

2.3.2 Knowledge, Skills, and Behaviour tags and its observations.

For each capability in a foresighting cycle, a team of expert educators have determined the relevant knowledge, skills, and behaviours (KSBs) required by the workforce to deliver the capability. 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 must evolve to support that transformation. 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.

This intersection between capability relevance and KSB evolution is critical for identifying where curriculum updates are needed to keep pace with industry transformation.

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:

1. **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.

2. **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 strongly 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.

2.3.3 Most frequent tags

The following graphic highlights the most frequently used tags across all capabilities in the foresighting cycle. These tags reveal macro trends that can guide the focus of training provisions.

Insight: Insight provides the key knowledge & skills tags of high frequency across all capabilities. This can act as a starting point to understand the relative position of a specific knowledge or a skill against where such a skill is placed within a current curriculum or a job description.

This high-level analysis can be utilised as a starting point to narrow down further research.

However, KSB tags can be utilised in more in-depth analysis to gain detailed indications updating training content. The entire list of KSBs can be downloaded using the visualisation tool.

Most frequent Knowledge Tags

Tag	Tag Frequency
Life Cycle Assessment	15
Sustainability	14
Process Optimization	12
Waste Reduction	12
Manufacturing Processes	10
Process development	10
Regulatory Compliance	10
Sustainable Design	10
Chemical Process Engineering	9
Process Control	9
Continuous Manufacturing	8
Corporate Sustainability	8
Equipment Design	8
Process Engineering	8
Quality Control	8
Sustainable Product Development	8
Environmental Compliance	7
Resource Recovery	7
Waste Management	7
Analytical Chemistry	6
Analytical Techniques	6
Automation Technologies	6
Process Analytical Technology (PAT)	6
Process Design	6
Regulations	6
Solvent Recovery Techniques	6
Sustainable Business	6

Table 24: Most frequent Knowledge Tags

Most frequent Skills Tags

Tag	Tag Frequency
Perform Data Analysis	20
Improve Chemical Processes	11
Analyse Production Processes for Improvement	9
Promote Sustainability	9
Use modelling & simulation for process development	9
Assess Environmental Impact	7
Optimise Production Processes Parameters	7
Identify Process Improvements	6
Implement Sustainable Procurement	6
Select Sustainable Technologies In Design	6

Table 25: Most frequent 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. It also highlights expected tags that rank lower than anticipated, potentially indicating a decline in demand.

Using this insight, readers can explore the visualisation tool to examine the knowledge, skills, and behaviours (KSBs) unique to a specific capability or Future Occupational Profile (FOP), enabling more informed decision-making.

3. Conclusion & Next Steps

3. Conclusions and Next Steps

Decentralised therapy is showing strong signs of progress from governing bodies. Although the scale and impact may differ from region to region, it is essential that everyone involved, including hubs, NHS staff and developers, takes proactive steps to prepare for the changing skills landscape.

The report highlights that new capabilities will be needed to run the hub and spoke model effectively. This includes a stronger and more consistent approach to governance, GMP compliance and future regulatory inspections across all sites. There is also a growing focus on digitalisation and automation. The workforce will need new skills to manage and maintain equipment using digital systems that can track, monitor and support safer production, ensuring the sector is ready for a more digital way of working.

3.1 Next Steps

While future capabilities have been identified through this research, it is important to map them against realistic timescales for when these skills will be needed and then work backwards to prepare teams accordingly. Taking a proactive approach to introducing new concepts across all affected roles is a crucial first step.

The immediate next steps include:

1. Prioritising the capabilities that will be needed first and identifying who will require upskilling.
2. Mapping current roles and responsibilities at NHS sites against the new capabilities to highlight gaps and understand how future structures may need to evolve. This also enables central hub sites to build a clearer view of capability levels across their spoke sites and plan targeted support.
3. Raising awareness at a strategic level to create the conditions for these capabilities to develop, including early engagement with chief pharmacists, specialist clinicians and other key stakeholders.
4. Building wider awareness across all affected parties to encourage understanding and interest in the changes ahead.
5. Developing short training programmes that support both general awareness and the development of specific skills.
6. Remaining adaptive to industry changes and technological advancements so that skills alignment can be updated proactively.

3.2 What this means for Industry

Key observations from the research include:

- Increasing requirements for NHS sites and staff in relation to audits, governance and regulatory compliance, particularly as more activity moves to spoke locations.

- A stronger reliance on integrated digital systems to maintain standardisation across multiple hub and spoke sites, supporting consistent delivery and reducing variation.
- A potential need to develop new equipment that enables GMP-standard manufacturing in environments outside traditional clean rooms.
- Additional responsibilities for Manufacturing Authorisation Holders, with greater emphasis on validation to ensure the quality of manufacturing at spoke sites.
- The need for more robust data sharing and communication between hub and spoke locations to maintain consistency and quality.

3.3 What this means for Educators

Given the rapid pace of change within the sector, it is essential that educators work closely with both NHS and industry partners to prepare learners for the hub and spoke model and the increasing digital and compliance expectations within future cell and gene therapy roles. This also presents opportunities for ATAC to collaborate with apprenticeship providers delivering digital and automation standards.

With new regulations allowing levy funding to be used for short courses, there is a strong case for targeted upskilling. In many cases, responsibilities will remain with existing staff rather than new roles being created, making short, focused training particularly valuable. The report recommends that industry and education partners maintain ongoing, structured conversations and use the insights from this research as a common starting point.

4. Appendix

Appendix

Appendix A - Capabilities without identified provisions

The list of capabilities without identified provisions are listed below. It also identifies associated supply chain partners a specific capability is associated with.

Table Key: Supply chain partners

1. Equipment, Data integration & Automation Providers
2. Logistics & Supply Chain
3. Logistics & Supply Chain
4. Control sites (hubs/ advance therapy developer)

An interactive table for easy access can be found in the visualisation tool.[6]

Capability statement	1	2	3	4
Develop real-time visibility and tracking capabilities to monitor the location and condition of supplies during transportation.		✓	✓	
Develop capability for in-line monitoring and control of critical quality attributes using real-time process analytical tools (PAT) such as Raman spectroscopy.	✓	✓		
Create reconfigurable, agile and flexible production systems to enable rapid changes to production pathways/processes as products change.		✓		
Ensure cold chain capacity for supply of raw materials into the manufacturing process and drug product produced.	✓		✓	✓
Develop assays to monitor cell characteristics in-line or on-line for real-time process evaluation.		✓		
Configure and implement fill and finish systems using automated and digital technologies to enhance efficiency and accuracy.		✓		
Automate assays on laboratory robotics to improve efficiency.	✓	✓		
Coordinate clinical biochemistry workflows using automation and computer-assisted processes.		✓		
Implement remote QP release with real-time digital batch review to ensure timely and compliant product distribution.		✓		
Coordinate shared-use logistics hubs to supply to NHS sites to streamline movement of raw materials and finished therapies.			✓	
Develop contingency planning protocols for supply disruptions in decentralised manufacturing environments.	✓	✓	✓	✓
Develop NHS-specific inventory models for modular manufacturing units to optimise stock levels and minimise waste.	✓		✓	✓
Implement digital tracking systems to monitor the transport of therapies between and within hospitals, ensuring real-time visibility and regulatory compliance.		✓	✓	✓
Design modular cleanroom pods for rapid deployment and scaling across multiple NHS sites to support decentralised manufacturing.		✓		
Design audit models to enable real-time collaborative reviews of manufacturing compliance by regulators and NHS teams.	✓	✓		
Create shared validation libraries for modular equipment to accelerate approval and deployment across multiple NHS locations.	✓	✓		
Develop plug-and-play automation kits for existing NHS facilities to enable quick adoption of point-of-care manufacturing processes.		✓		
Comply with governance systems with relevant stakeholders and non-expert manufacturing spokes to ensure consistent quality and compliance in outsourced manufacturing.	✓	✓	✓	

[6] Visualisation tool https://hvmcatapultforesighting.retool.com/embedded/public/f56f84e9-8ab8-414f-aa1a-0b42ab5c71df?token=db88d1a3c945e14da7f5bf1cc1741efe

Capability statement	1	2	3	4
Implement modular flexible manufacturing systems that allow optimisation and lock parameters to maintain validated conditions.	✓	✓		✓
Design modular equipment configurations and workflows that enable seamless integration of various modules for flexible manufacturing.		✓		
Develop integrated digital environments for Hub operations including PQS, training, manufacturing and product release for point-of-care implementation at spokes.	✓	✓		✓
Establish contamination control processes and mobile cleanroom environments tailored to meet the specific technology and process requirements of advanced therapeutic manufacturing.		✓		
Distribute detailed guidelines on Good Manufacturing Practices as digital documents to all spoke sites to ensure compliance and uniformity.	✓			
Design in-process alarms to alert operators to system deviations and enable immediate troubleshooting.		✓		
Establish new optimal labelling processes to ensure adequate tractability within product manufacturing limitations.	✓	✓	✓	✓
Format production data for universal accessibility and seamless transfer between different digital systems.	✓	✓		
Perform controlled-rate thawing of starting material to preserve dose efficacy and meet therapeutic quality standards.	✓	✓		✓
Capture data on the thawing process of starting materials to ensure traceability and meet compliance standards.	✓	✓		✓
Design a self-inspection program that incorporates the hub and spoke model to enforce regulatory compliance.	✓	✓		✓
Describe digital capability requirements for spoke sites as a part of the eligibility checks.	✓	✓		
Design automation-ready consumables suitable for upscaling on robotic manufacturing systems.		✓		
Ensure service provision for all instruments in spoke sites, and define model		✓		
Ensure manufacturing devices provide product release data that can easily be pulled into a BMR for QP release.		✓		
Deploy a digital document distribution system to distribute SOPs, training records, and manufacturing instructions across multiple manufacturing sites, ensuring consistent therapeutic production standards.		✓		
Provide batch manufacture progression reports to qualified personnel to enable rapid decision-making.		✓		
Ensure traceability by implementing integrated software for sample tracking and data management.			✓	
Embed point of care manufacturing governance and processes into routine hospital care				✓
Design a self-inspection program that incorporates the hub and spoke model to enforce regulatory compliance, where regulatory compliance lies with the site.				✓
Establish suitable eligibility criteria for control sites.	✓			
Adhere to defined local governance processes to comply with eligibility criteria.				✓

Table 26: Capabilities without identified provisions

Appendix B - 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. 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?_environment=production&token=db88d1a3c945e14da7f5bf1cc1741efe
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=db88d1a3c945e14da7f5bf1cc1741efe
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=db88d1a3c945e14da7f5bf1cc1741efe

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 review and compares 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/f99a913f-8827-4730-8893-d618d489bc84?token=db88d1a3c945e14da7f5bf1cc1741efe
Future KSBs Summary	Provides a view of the complete set of capabilities within the cycle along with all of the associated KSB tags which are linked to them. It is, essentially, the superset of all details displayed on the FOP detail page. This is used to: • To review the identified Knowledge, Skill and Behaviour tags for a given capability, to support development of future education and learning material. • To review the requirements from a capability level, rather than a role family/occupational profile grouping. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/8634650f-9700-4627-8431-068b4b764222?token=db88d1a3c945e14da7f5bf1cc1741efe
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=db88d1a3c945e14da7f5bf1cc1741efe

Visualisation Tool Section	What is it and what can it be used for?
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=db88d1a3c945e14da7f5bf1cc1741efe
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=db88d1a3c945e14da7f5bf1cc1741efe
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=db88d1a3c945e14da7f5bf1cc1741efe

Visualisation Tool Section	What is it and what can it be used for?
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=db88d1a3c945e14da7f5bf1cc1741efe
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=db88d1a3c945e14da7f5bf1cc1741efe
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=db88d1a3c945e14da7f5bf1cc1741efe

Table 27: Online Data visualisation Tool

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.

Workforce foresighting

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

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

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

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

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

Our Goals:

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

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

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

Enable and deliver a consistent approach to workforce Foresighting.

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

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

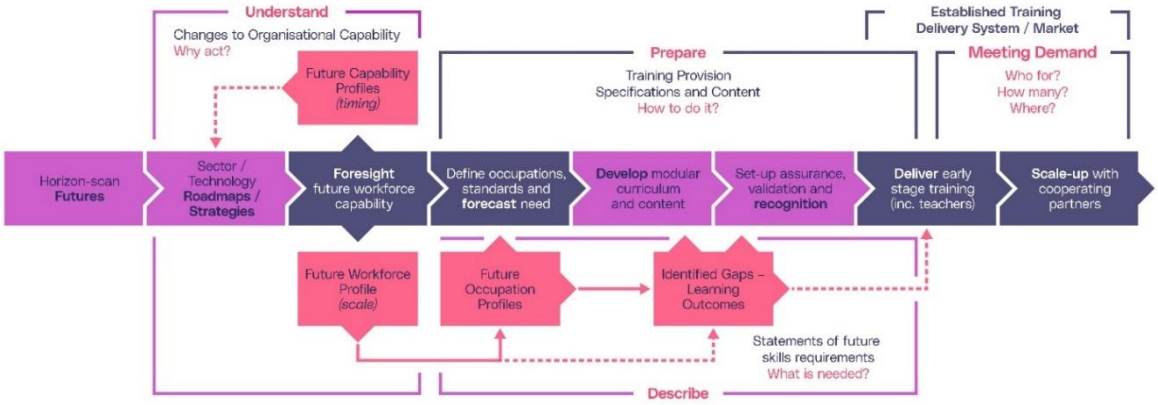

Figure 2: Workforce Foresighting & Skills Value Chain

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

Organisational capabilities are captured using a bespoke classification that has been developed by the Workforce Foresighting Hub. The classification uses a structured common language to enable cross sector and cross-centre collaboration and integration of data.

Additionally, the classification enables data from a number of other national and international open-source workforce datasets to be integrated through the same common language. This data is held in a cloud based “data-cube” that is dynamically growing as each workforce Foresighting cycle adds to the shared data relating to future workforce capabilities.

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

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

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

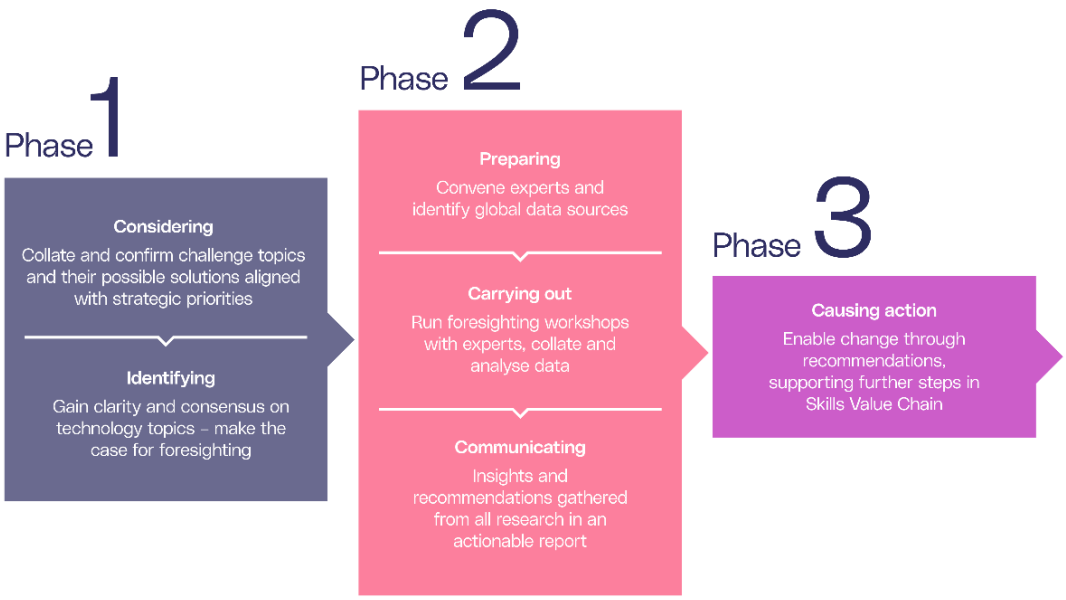

Figure 3: The workforce foresighting process

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 fulfil 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.