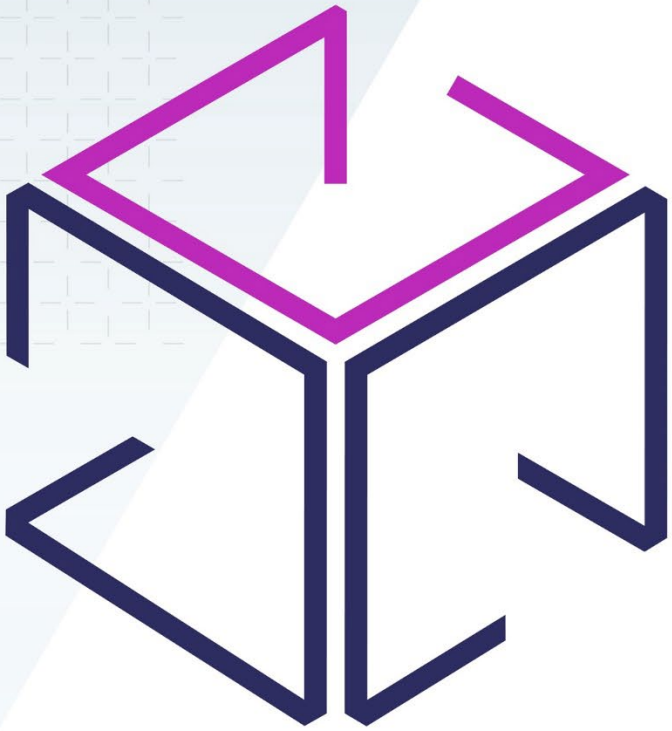
Workforce Foresighting Hub



Digitalisation & Automation for Cell and Gene Therapy at established manufacturing centres to increase production capacity for known health demands.

A Workforce Foresighting Hub findings report
in collaboration with Cell and Gene Therapy Catapult

Date: February 2025

UKRI Innovate UK

Right skills, right time, right place

Acknowledgements

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

IfATE – Institute for Apprenticeships and Technical Education, England

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

ONet – Occupational Networks Online, USA

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

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

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

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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 July – October 2024 using the data set and tools available at that time.

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1.0 Executive Summary

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1.1 Foresighting cycle summary

The UK's life sciences sector is growing, as shown by the Cell and Gene Therapy Catapult Manufacturing Survey 2024 and the Skills Demand Report 2023. As of 2023, the sector, employed 6,232 people, expected to rise to 10,161 by 2028.

Cell and gene therapies, or Advanced Therapies, can address complex diseases and rare conditions. In 2023, four new therapies received UK market authorisation, and three Cell and Gene Therapy Catapult collaborators filed for Biological Licence Applications in the US. These therapies can transform lives by reducing hospital time and alleviating symptoms.

Cell and Gene Therapy Catapult has a vision of a thriving industry, delivering life-changing advanced therapies to the world. The Manufacturing Survey highlighted the need for increased manufacturing flexibility and capacity planning. Embracing new technology is crucial for efficiency and sustainability, driving demand for scarce skill sets. The workforce grew from 3,033 in 2019 to 6,232 in 2023, with an additional 3,929 people expected by 2028.

Cell and Gene Therapy Catapult's Skills team collaborates with industry, technology, and academia to address critical skills and capability risks. The sector must integrate new technology and ways of working, with manufacturing, total quality, and digital automation identified as barriers in multiple surveys and roundtables.

A detailed foresighting cycle, convened by Cell and Gene Therapy Catapult and supported by 22 organisations, aims to address challenges through industry and academic collaboration. The report summarises work capturing over 130 capabilities essential for digitisation and automation, supported by data on Knowledge, Skills, and Behaviours (KSB), Functions, and Supply chain distributions. Further analysis and collaboration with industry, academia, and technologists are needed to ensure the UK takes a leading position in Cell and Gene Therapy.

The most notable outcome of the report is the disparity between the future state and current provision, with the majority of future occupational profiles identified as requiring immediate and substantial action to ensure the sector's future success. This reassures us that, while we have many actions to implement, we have successfully pinpointed a key theme which, if addressed effectively, will enable businesses to thrive. Although this project primarily focuses on future skills in a specific technology (i.e., automation in production), it signals the market to reconsider current educational provisions to prepare the workforce for anticipated changes.

It is paramount that the cycle is used as a springboard to continue collaboration between the parties, resulting in a continual evaluation of the sector's future training and educational needs.

1.2 Organisational change

To meet increased demand, the industry must adopt new capabilities, enhancing existing skills and acquiring new ones to implement advanced technologies and processes. These changes are essential for maintaining competitiveness and efficiency across the value chain. This shift is illustrated within functions for digitalisation and automation in the sector.

Functional Shifts

The Foresighting process identified five primary functional areas where organisational changes are most pronounced. Patterns and shifts in the demand are explained in section (3.2).

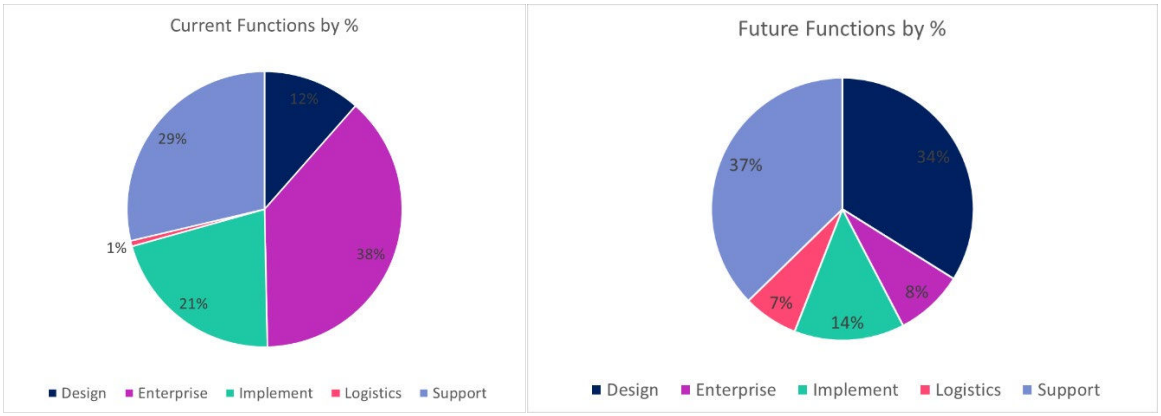

Figure 1: Current and Future Supply Chain - Capability Functions Summary by %

1.3 Future Occupational Profile Highlights

The Future Occupational Profiles (FOPs) identified in this cycle are crucial for aligning current workforce capabilities with future industry needs. Created through workforce Foresighting workshops, these profiles combine existing occupational standards with new data. FOPs provide a framework for comparing current occupations with future requirements, identifying skills gaps, and informing workforce development strategies.

Important: These FOPs were based on capabilities identified during a workshop focused on digitisation and automation. However, as most job roles extend beyond this project's scope, they address capabilities not captured in this cycle. Consequently, while the FOPs don't fully encompass all job roles capabilities, they do highlight industry gaps, future changes and help us understand technology needs.

Key Applications:

Role Adaptation and Development:

- FOPs outline the expected evolution of current roles, suggesting necessary adaptations to meet future demands. This includes identifying areas where current occupational standards require updates and where new capabilities should be incorporated

- Employers can use FOPs to evaluate and modify existing apprenticeship standards, ensuring their workforce has the skills needed for future roles. Depending on the gap, this can also be achieved through targeted short courses and continuous professional development (CPD) initiatives.

Education and Training Alignment:

- Educators are encouraged to review and adapt current curricula based on the requirements highlighted by FOPs. This ensures that new entrants to the workforce are trained in line with future industry needs.

- The alignment between current educational provisions and FOPs is quantitatively evaluated using fit and surplus metrics. These metrics measure how much existing standards cover the FOPs (fit) and identify any potential redundant material not required for future roles, and/or capabilities that are out of the scope for this cycle (surplus).

Priority Future Occupational Profiles:

- The report identifies priority FOPs across various role levels, these priority profiles highlight the most critical areas for development to meet future capabilities. - This information is highlighted within the visualisation tool under “Priority FOPs” section.

In summary, the Future Occupational Profiles (FOPs) strategically bridge the gap between current workforce capabilities and future industry needs, offering actionable insights for employers and educators. Understanding the industry's ongoing changes is crucial for both industry and trainers to discuss how these changes may create new roles and alter existing ones, ensuring adaptability for the future. These profiles, based on capabilities identified during a workshop, guide role adaptation and educational content development, preparing a future-ready workforce. While they don't fully capture all job roles or future changes, they highlight industry gaps and help us understand technology needs.

1.4 Specific areas of concern

The report identifies several critical areas requiring attention to ensure that the industry's workforce can meet future demands. These areas are based on the comparison of current Institute for Apprenticeships and Technical Education (IfATE) standards with the Future Occupational Profiles (FOPs). The specific concerns are as follows:

1/3 of capabilities are not supported by current educational provisions: Approximately 32% of the identified capabilities (43/137) do not have duty statements within the IfATE standards to support upskilling.

Low Suitability of Existing Standards: Majority of future roles have low suitability with the current education standards, demanding serious attention to updating the content to match the industry demands. A few such FOPs are:

- Software Developers
- Automation and Maintenance Technicians
- Quality Lead
- Clinical trials Coordinators

- Biomedical Scientists

Need for Enhanced Collaboration: The findings emphasise the necessity for increased collaboration between industry stakeholders, educators, and standard-setting bodies. Such collaboration is essential to develop and implement new standards that can adequately prepare the workforce for future challenges. This includes regular updates to training programmes and the incorporation of new technologies and methodologies.

Addressing these areas of concern is crucial for the industry to effectively navigate future challenges and leverage new opportunities. This will require a coordinated effort across various sectors to update and refine educational and training standards continually.

To Summarise:

- None of the Future Occupational Profiles (FOPs) have high levels of suitability and coverage in the current IfATE occupational standards, this is due to there not being occupational pathway or standards available.

- 3 out of 23 future profiles have some levels of suitability and partial coverage in the current IfATE occupational standards, the potential requirement could be to update and create new standards which will then inform impact on qualifications and training but also should impact employer workforce planning.

1.5 Recommended next steps

Cell and Gene Therapy Catapult will now establish a working group with the aim of creating an action plan to continue through the Skills Value Chain. To do this we will share findings widely with our different stakeholder communities, industry groups and local skills bodies and encourage them to participate in this process.

Working closely with our lead education provider, University of Hertfordshire, we will work with educators to look at how we collaborate to build new qualifications and short courses. For instance, apprenticeship standards have been highlighted as not sufficiently addressing the challenges and therefore we will work with Skills England to review standards, frameworks and influence updates to content where required.

We have begun to engage with other completed foresighting cycles to identify any areas where we can collaborate, and we will use our findings from this to feed into futures cycles. Technology is changing at pace, and we require the continued input from the technologists who contributed to this cycle.

We recognise that more input is required from regulators and the cell and gene therapy manufacturing community in order to address the skills gaps that are identified across the whole supply chain. Failure to address these gaps will risk shortages in skilled workers, hindering the UK's overall objectives.

The recommendations in this report emphasise the importance of immediate and coordinated efforts by educators, employers, and other stakeholders to address the anticipated skills gap in the cell and gene therapy sector.

The following recommendations are largely common across all foresighting cycles.

Review and Dissemination of Findings

Convener and Sponsor to set up working group to take the findings and recommendation and create an action plan and advance through the Skills Value Chain to cause action. It is essential to share the findings widely among stakeholders, industry groups, and local skills bodies. This will promote access to the insights gained and influence the strategic direction of workforce development initiatives.

Short-term action

As part of the working group, educators and employers should collaborate to deliver timely short-term training solutions for the current workforce. This includes developing and offering Continuing Professional Development (CPD) courses that address immediate skills gaps and ensure workers are equipped with the necessary competencies.

Mid-term actions

The ongoing working group mid-term action planning should include a concerted effort to integrate new skills and knowledge into existing training programs. Educators and employers need to update curricula and training standards to reflect the evolving demands of the sector, ensuring that both current employees and new entrants are adequately prepared.

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

Employers and educators must work together to review and influence the update of IfATE Occupational Standards and relevant qualifications. This involves using the insights from the Workforce Foresighting process to inform the development of new standards and qualifications that align with future workforce needs. This will contribute to the working group skills framework.

Further foresighting subjects

The working group should seek additional sponsors and propose further subjects for Foresighting. This continuous cycle of Foresighting will help to stay ahead of emerging trends and technologies, ensuring the workforce remains adaptable and prepared.

1.6 Introducing the Visualisation Tool

The Workforce Foresighting Hub's Visualisation Tool complements the report and supports the cycle's in-depth findings. While the report sets the context with macro-analyses, the visualisation tool allows for deeper insight exploration. Links throughout the report guide easy navigation of the tool.

The data is generated by the Foresighting cycles, integrating expertise from technologists, domain specialists, employers, and educators. The tool visualises the data in various useful formats, with all pages and data sets downloadable for further analysis. Using AI tools validated by human oversight and linking to external data sources, the tool identifies differences at the occupation/role level and detailed changes needed in knowledge, skills, and behaviours, delivering insights for learners, providers, creators, and skill assurers.

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

Access the visualisation tool here.

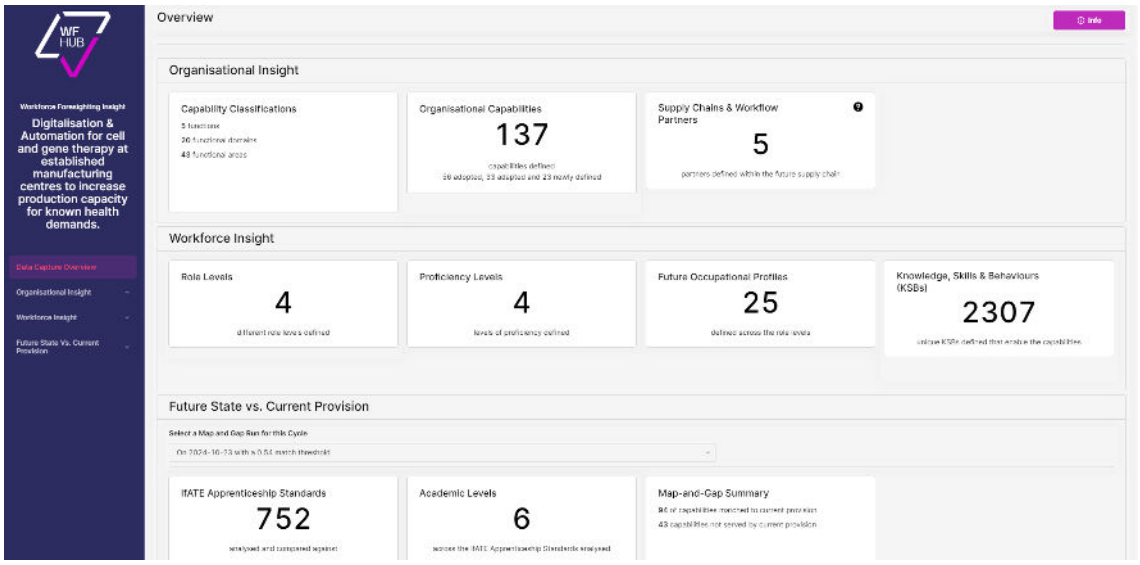

Figure 2 - Visualisation Tool Dashboard

2.0 Aligning the Challenge and Solutions with national priorities

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Section	Title
2.1	Positioning and context of national challenge
2.2	Potential and Prioritised Technology Solutions to the Challenge
2.3	Workforce Foresighting for Chosen Prioritised Technology Solutions
2.4	Current and Predicted Scale of Technology Deployment in the UK
2.5	Key Stakeholders – Sponsor, convener and participating organisations

2.1 Positioning and context of national challenge

Cell and gene therapies represent some of the most advanced and complex medical treatments currently in development. These therapies are revolutionising how we treat a wide range of diseases, particularly those with limited or no effective treatment options.

In the advanced therapies industry, automation and digitalisation are no longer optional; they are essential for maintaining competitiveness, ensuring regulatory compliance, improving product quality, and meeting patient demands effectively. As the industry grows, these technologies will be key to driving innovation, improving cost-efficiency, and optimising production capabilities and overcoming barriers in scalability and therefore delivering lifesaving therapies to patients.

CAR-T (Chimeric Antigen Receptor T-cell) therapy is a type of gene therapy that involves modifying a patient's T cells in the lab to better detect and destroy cancer cells. Developed and actively used in the UK, the NHS has been a pioneer in making CAR-T therapies available, being the first health system in Europe to agree on a full access deal for this breakthrough treatment. Researchers at University College London (UCL) have also been at the forefront of developing new CAR-T therapies. In 2021, approximately 4,000 doses of CAR-T were manufactured, despite there being over 500,000 eligible patients. This gap is expected to widen, with the number of eligible patients projected to reach two million by 2029.

The challenge we face is ensuring that these innovative therapies can be scaled to meet the growing demand. Scaling up the manufacture of cell and gene therapies is critical to making them available to more people and ensuring the future success of this sector.

2.2 Potential and Prioritised Technology Solutions to the Challenge

Technological Solutions

To address the challenge of scaling up the manufacture of cell and gene therapies, several potential technology solutions have been identified:

- **Implementation of Robotic Platforms:** Automating production processes to increase efficiency and reduce human error.
- **Digital Twins:** Creating digital replicas of physical manufacturing processes to optimise performance and predict potential failures.
- **Federated Database System**: A distributed data system allowing for secure sharing of manufacturing data across multiple sites to improve collaboration and streamline processes.
- **Improvements in Supply Chain:** Enhancing logistics, material flow, and production planning to reduce bottlenecks.
- **Reducing Energy Usage:** Implementing energy-efficient technologies to lower production costs and minimise environmental impact.

2.3 Workforce Foresighting for Chosen Prioritised Technology Solutions

To enable the sector to improve cost-efficiency and overcome barriers in scalability and therefore delivering lifesaving therapies to patients, the following technologies have been prioritised for further investigation:

- **Robotic Platforms:** Automation for faster, more reliable production.
- **Digital Twins:** Digital simulations to enhance efficiency and predict process issues.
- **Supply Chain Improvements:** Optimising logistics to meet the growing demand.

2.4 Current and Predicted Scale of Technology Deployment in the UK

The UK's dedication to becoming a leader in Cell and Gene Therapy manufacturing is evident in the scaling up of production and the integration of advanced technologies. Key highlights include:

- Expansion of automated manufacturing capabilities.
- Increased adoption of digital twins for process optimisation.
- Implementation of energy-efficient manufacturing processes to reduce costs and minimise the environmental footprint.

Further work will be undertaken to liaise with employers in the sector to understand future demand for roles and, consequently, education provision. This effort will build on the insights from the Cell and Gene Therapy Catapult Manufacturing Survey 2024 and the Skills Demand Report 2023. By collaborating with industry stakeholders, we aim to ensure that the workforce is adequately prepared to meet the evolving needs of the sector.

2.5 Key Stakeholders – Sponsor, convener and participating organisations

- **Sponsors**: BIA BioIndustry Association
- **Conveners**: Cell and Gene Therapy Catapult
- **Lead Industry Stakeholders**: Various pharmaceutical and biotechnology firms involved in Cell and Gene Therapy development.
- **Lead Research Institutes**: Collaborating to address skills gaps and technological challenges.

You can view the full list of participating organisations in this cycle in Appendix 4.2.

The successful scaling of Cell and Gene Therapy manufacturing requires collaboration between key industry and government stakeholders, including:

- UK Government
- Life Sciences Companies
- Research Institutes and Universities
- Technology Providers for Automation and Data Systems

3.0 Results – Findings, Data and Insight

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Section	Title
3.1	Findings, methodology and presentation
3.2	Insight into organisational changes
3.3	Occupational change insight
3.4	Future Occupational Profiles compared with current provision
3.5	Summary and use of the findings
3.6	Recommended next steps

3.1 Findings, Methodology and Presentation

This section outlines the future organisational capabilities needed to address the Challenge using the proposed technology. It identifies which occupations will evolve to support these capabilities. The summary includes a narrative based on underlying data, enhanced by bespoke visualisations for deeper insight. This section is tailored for workforce planners, including employers, educators, and skills providers. The report provides generic macro analyses standard for all cycles, while the visualisation tool offers more in-depth information for further analysis.

The two parts of this section interpret data findings and link to relevant visualisations. The report and visualisation tool are designed to complement each other for comprehensive analysis.

Organisational changes

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

Typically, this will also require the adoption of new capabilities and a change in the distribution of these capabilities across value chain partners. This change in capabilities for an organisation and their value chain partners then defines the skill changes required in the different role levels of each supply chain partner.

Occupational changes

This section demonstrates how current occupations may need to change in the future. Future Occupation Profiles (FOPs) are generated using attributes from the capability classification and data collected in workshops. An expert panel of employers, supported by a digital tool, refines these FOPs based on attributes like functions, supply chains, and role levels.

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

Findings are aimed at both Employers and Education and Training Providers and identify matches and gaps in future training needs compared with current provision to guide further detailed investigation.

Highlighted changes to future provision

The report identifies suggested changes to education and training provision – principally occupational standards that will deliver the knowledge, skills and behaviours required by future occupations. In some cases, this will include the development of short courses and continued professional development (CPD) to upskill the current workforce to meet future needs. Additionally, foresighting outputs can be used to develop programmes, qualifications, and occupational standards for new entrants to the workforce joining via apprenticeship, taught qualification, or other training programme.

The insight and data in this part of the report are primarily aimed at educators training providers, occupational standards bodies, and awarding organisations. Combined with insight arising from the supply chain capability changes, the provision insight offers an effective way for employers to identify training opportunities that align to their future needs.

Use of Artificial Intelligence

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

3.2 Insight into organisational changes

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

Organisation functions

The Workforce Foresighting Hub process uses a data structure built on five functional areas which are common to any business:

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

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

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

Identifying the Future Supply Chain Capabilities

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

The initial pie charts illustrate the changing proportions of the five functions comparing future needs with current state. This indicates an overall relative:

- Increase of Design, Implementation, Logistics and Support related capabilities
- Decrease of Enterprise related capabilities

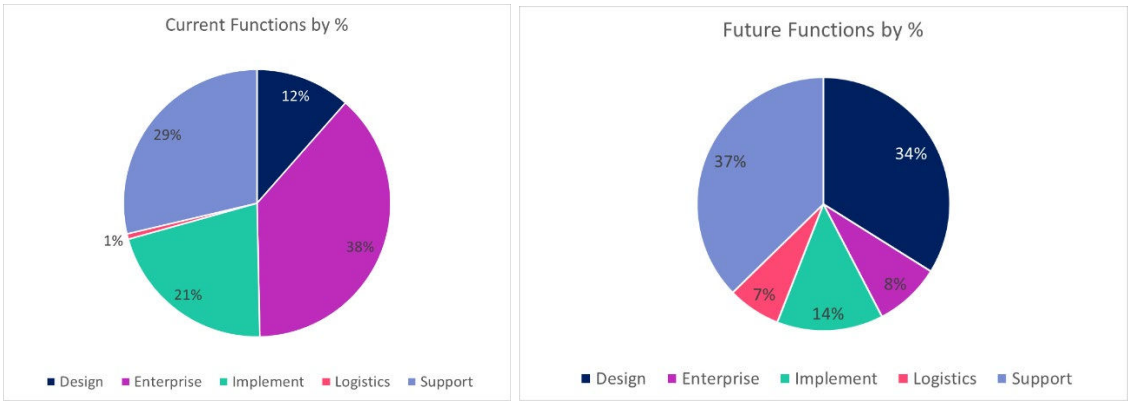


Figure 3: Current and Future Supply Chain - Capability Functions summary by %

Please note the current state has been built by proxy using a review of the existing commonly used apprenticeships standards in the industry, while the future state is dependent on data captured through the workshops which may have omissions, so this information is to be used to provide context to trends rather than specific analysis.

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

Design: The design function will see an increased emphasis on new product engineering and evaluation ahead of development and implementation phases. This shift reflects a need for more innovative and adaptable design capabilities to meet future demands.

Implementation: New capabilities related to implement function seem to have decreased in numbers. This could be either because those capabilities are already captured in current

provisions, or activities such as implementing digital and automation technologies are taken up by other industries who are specialists in their respective fields. Furthermore, this could be attributed to data gathering omissions and requires further analysis to confirm.

Logistics: As production scales up, logistics functions will need to be adapted to ensure smooth procurement, delivery, and materials management. This includes integrating advanced supply chain management practices to support higher production levels.

Support: The support functions may see a relative increase.

Enterprise: There is a significant decrease in enterprise capabilities, likely due to a lack of focus on the enterprise domain during data capture. This is specific to the implementation-focused topic, with three of the four supply chain partners minimally engaged in enterprise—they are the adopters.

Visualisation Instructions

Detailed instructions can be found in the appendix.

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

3.3 Occupational Change Insight

This insight into occupational change uses the understanding of how capabilities will change across business functions (section 3.2) to inform proposals for how occupations and their associated skills sets for each value chain partner may also need be updated to reflect change for each role group within that Partner. [1]

Supply chain partner organisation types

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

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

- Automation Equipment Suppliers
- Automation Technology Integrators/consultants
- Cell and Gene (C&G) Manufacturer
- Point of care partners
- Quality and regulatory

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

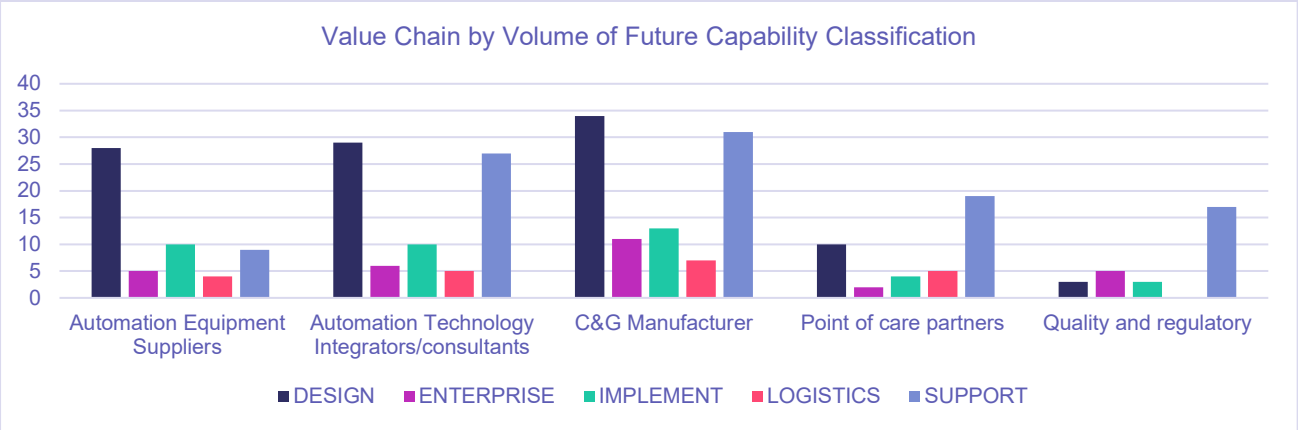


Figure 4: Supply Chain by Volume of Future Capability Classification

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

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

Visualisation Instructions

Detailed instructions can be found in the appendix.

Visualisation Data Link	What is it and what can it be used for?
Supply Chain Capabilities | HVMC Foresighting	This page provides an overview of the identified capabilities at a Supply Chain / Workflow Partner level. By selecting/deselecting each Supply Chain / Workflow Partner you can review the capabilities identified as required in that area of the Supply Chain / Workflow. This can be used to generate organisational capability profiles for each area of the workflow /supply chain to help prioritise and focus the acquisition of new capabilities that will be required in the future. It can also be used to generate combined organisational profiles, where an organisation may be involved in more than one area of the supply chain.

Role Levels

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

For this cycle, the following role levels were determined through the workshops:

- Cell and Gene (C&G) Scientists
- Cell and Gene (C&G) Senior Manager / Manager
- Cell and Gene (C&G) Apprentices and Technician
- Cell and Gene (C&G) Senior Scientists / Lead

Proficiencies

Each of these role levels will require proficiency that relates to their role and the needs of each Supply Chain Partner. The foresight process uses the following proficiencies:

Awareness (A) - Has a foundational knowledge of tools, technology, techniques relevant to sector, industry, and company. Sufficient comprehension to know where to seek further information/details as necessary for a particular issue.

Practitioner (P) - Has the ability to apply and use independently a tool, system, or process. Understands the implications, consequences, and impact for their role/function. Knows what key actions are required and in what context.

Expert (E) - Has detailed knowledge of process, system, tool, or technology. Can support others and identify improvements required for a process, system, or tool. Can implement improvements personally or direct and guide others.

In the workshops participants apply their insight to assign proficiency for each role group for each capability. Individual responses are aggregated to arrive at a consensus.

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

	C&G Scientists	C&G Senior Manager / Manager	C&G Apprentices and Technician	C&G Senior Scientists / Leads
Awareness	5%	2%	10%	24%
Practitioner	65%	30%	29%	54%
Expert	30%	68%	61%	22%

Figure 5: Proficiency details by Role Level

While this information is insufficient for definitive conclusions, it helps estimate a few trends. For example, the abundance of expert proficiencies in all roles may indicate that the technology is becoming generalised across the industry, regardless of level and seniority.

Future Occupational Profiles

The FOPs (Future Occupational Profiles) are a construct created and used during workforce Foresighting workshops and analysis to capture future skills needs in a form that may be compared with current occupation definitions – typically occupational standards.

The familiar nature and structure of 'FOP's assists with their evaluation and validation by employers and educators and enables the analytical comparison that results in useful indications of matches, surplus and gaps of future skills needs compared with current state. This then allows recommendations for action to be made based on future need and current fit to those needs.

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

> **Educators** can review current occupational standards against the requirements of the FOPs and interpret which need to be changed to fill the gaps between the current and future state.
> **Employers** can consider existing apprenticeship standards and make a judgement on adapting an existing apprenticeship standard to upskill their workforce to meet the requirements of a particular FOP.
> **Educators** may react to these specified skill requirements from Industry by editing, adapting, or creating new content.

FOPs and indicative skills need

The following graphs represent the distribution of capability proficiency levels across various FOPs segregated by the role levels. While the following graphs only discuss the information at a higher level, more detailed analysis can be done by accessing the data visualisation portal.

C&G Scientists Role Level FOPs

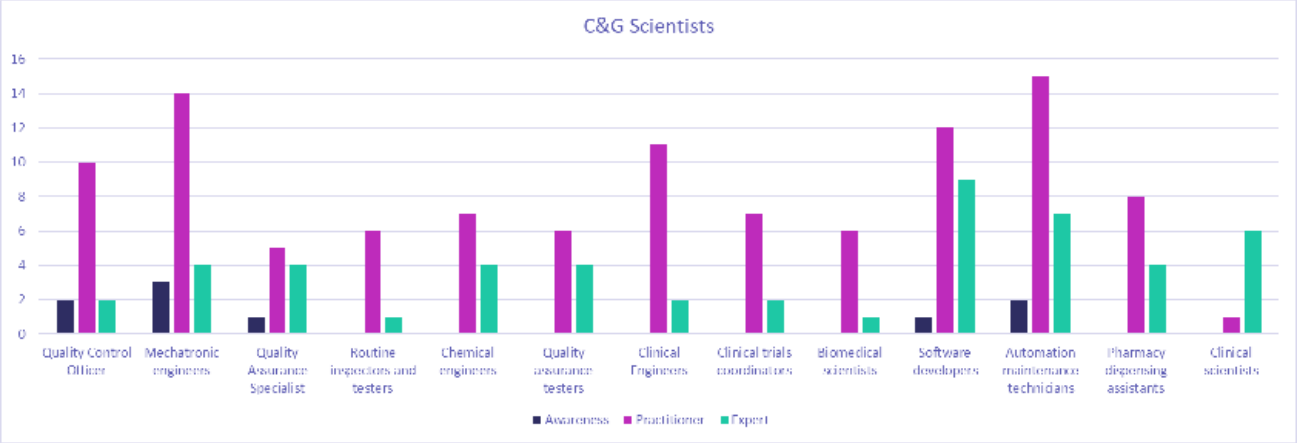


Figure 6: FOPs – C&G Scientists Role Level

C&G Senior Scientists / Lead Level FOPs

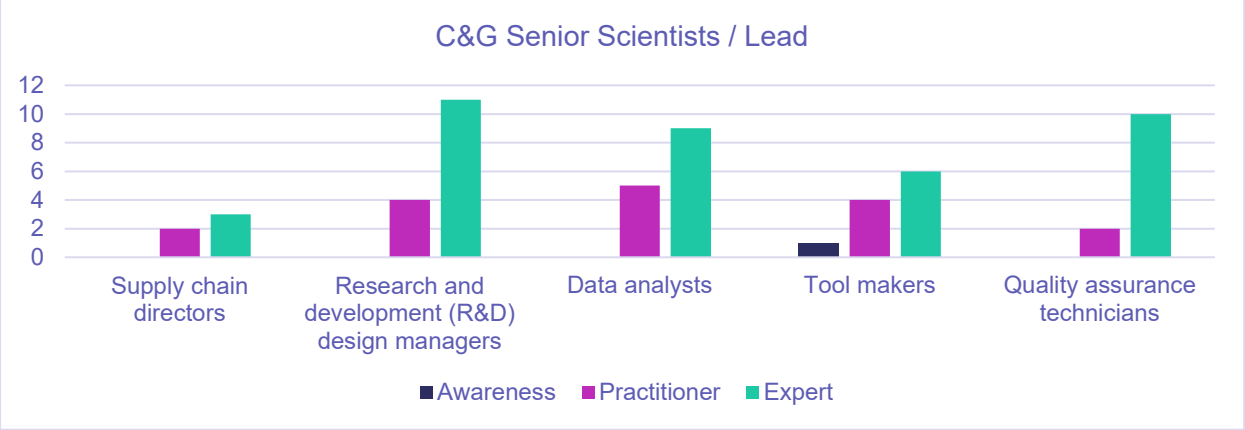


Figure 7: Priority FOPs – C&S Senior Scientists / Lead Role Level

C&G Senior Manager / Manager Role Level FOPs

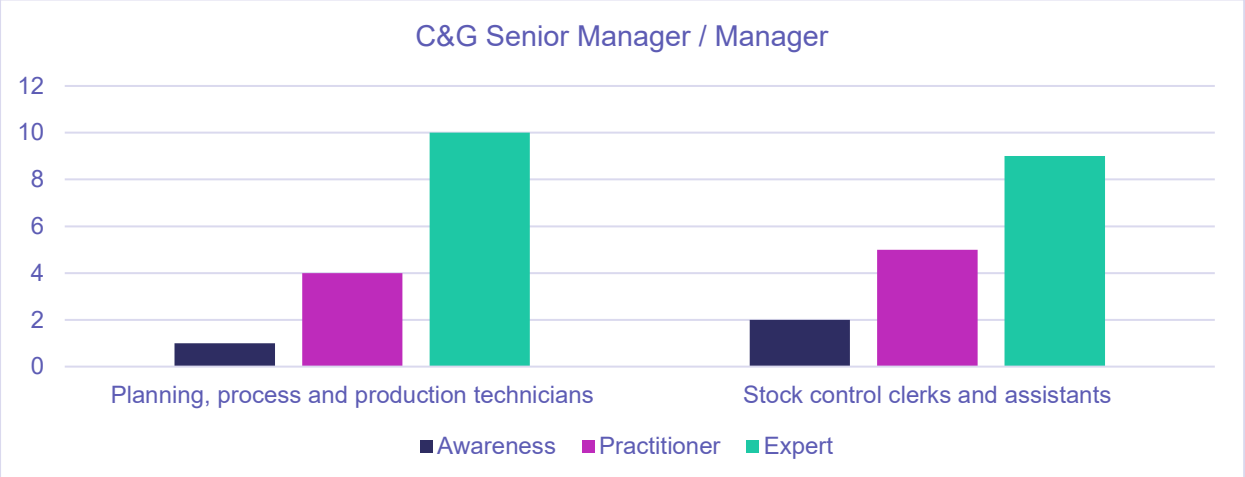


Figure 8: Priority FOPs – C&G Senior Manager / Manager Role Level

C&G Apprentices and Technician Role Level FOPs

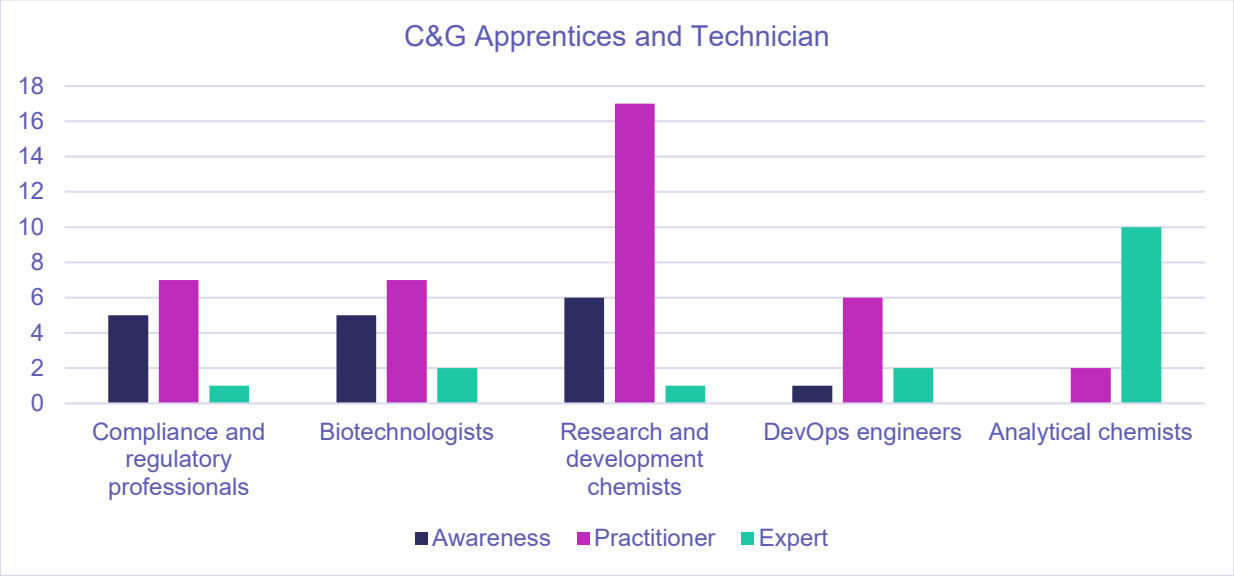


Figure 9: Priority FOPs – C&G Apprentices and Technician Role Level

Visualisation Instructions

Detailed instructions can be found in the appendix.

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

3.4 Future Occupational Profiles compared with current provision

The List of identified FOPs (Future Occupational Profiles) for the cycle are as follows.

- Scientists - Quality Control Officer
- Senior Scientists / Lead - Compliance and regulatory professionals
- Scientists - Mechatronic engineers
- Scientists - Quality Assurance Specialist
- Scientists - Routine inspectors and testers
- Scientists - Chemical engineers
- Scientists - Quality assurance testers
- Senior Scientists / Lead - Biotechnologists
- Senior Manager / Manager - Research and development (R&D) design managers
- Scientists - Clinical Engineers
- Apprentices and Technician - Data analysts
- Scientists - Clinical trials coordinators
- Scientists - Biomedical scientists
- Senior Manager / Manager - Supply Chain Lead
- Scientists - Software developers
- Scientists - Automation maintenance technicians
- Apprentices and Technician - Quality assurance technicians
- Apprentices and Technician - Planning, process and production technicians
- Senior Scientists / Lead - Research and development chemists
- Scientists - Clinical scientists
- Senior Scientists / Lead - DevOps engineers
- Apprentices and Technician - Stock control clerks and assistants
- Senior Scientists / Lead - Quality Lead
- Apprentices and Technician - Mechatronic Technician
- Senior Scientists / Lead - Automation Development Specialist

While the FOPs do not provide a complete list of job profiles, the map comparison with the current provision helps readers understand the future skill gaps by comparing future skills demand against current standards. The foresighting process uses an AI semantic match of FOPs against all IfATE standards, matching each capability in the FOP with duty statements in IfATE standards.

To avoid data misinterpretations, each FOP is mapped only with standards at the same or adjoining academic levels (e.g. a Level 6 role is matched with standards between Levels 5 and 7).

Each semantic match provides a percentage of confidence, the “Fit Factor,” indicating the degree of similarity between a FOP and a standard. This information helps employers and educators understand which education provisions to focus on to address challenges within specific job roles.

The data also provides a matrix to help readers make informed judgements by showing the surplus of each IfATE standard when used to educate a future job role. The Surplus Factor indicates the percentage of capabilities in an IfATE standard that are not relevant to the capabilities listed in a FOP. For example, comparing IfATE standard (x) against FOP (P), the

Surplus Factor shows the excess in (x) relative to (P). This information helps users decide whether to adopt an entire standard or tailor a course to fit specific requirements.

Finally, it is worth noting that the fit factor and surplus factor are two different matrixes that does not add up to a 100%. The following diagrams visualise that concept.

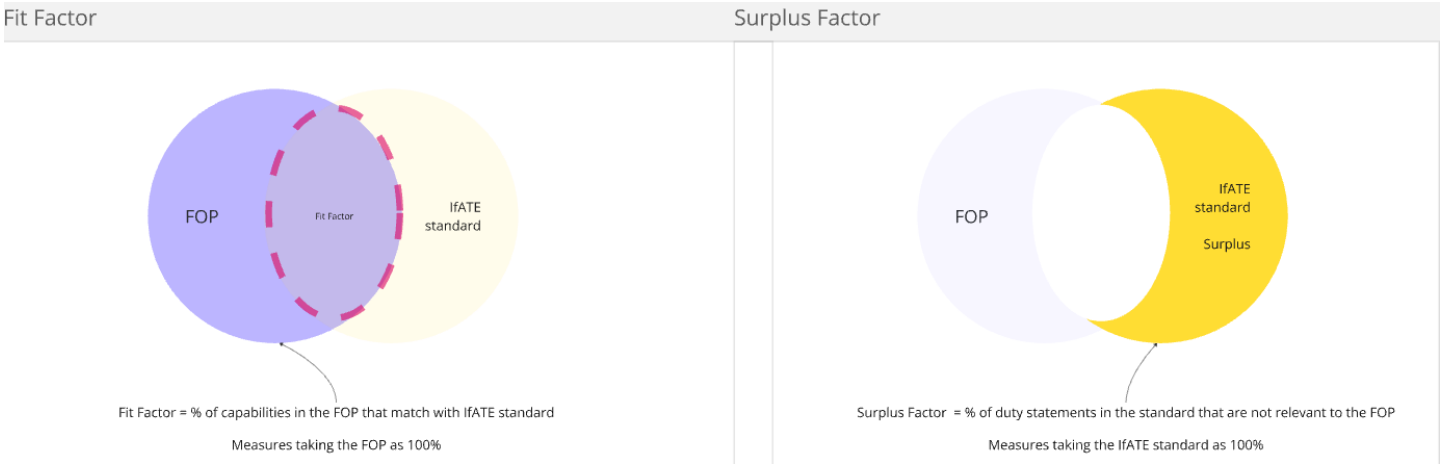


Figure 10: Fit and Surplus Factors

The visualisation tool enables analysis of the FOP comparison data in various ways. One of the commonly used pages is the Fit & Surplus Matrix page. This page shows all the potential candidates for adaptation in a single matrix by comparing their fit and surplus factors.

You can review matching standards along with their fit and surplus matrix using [this link.]

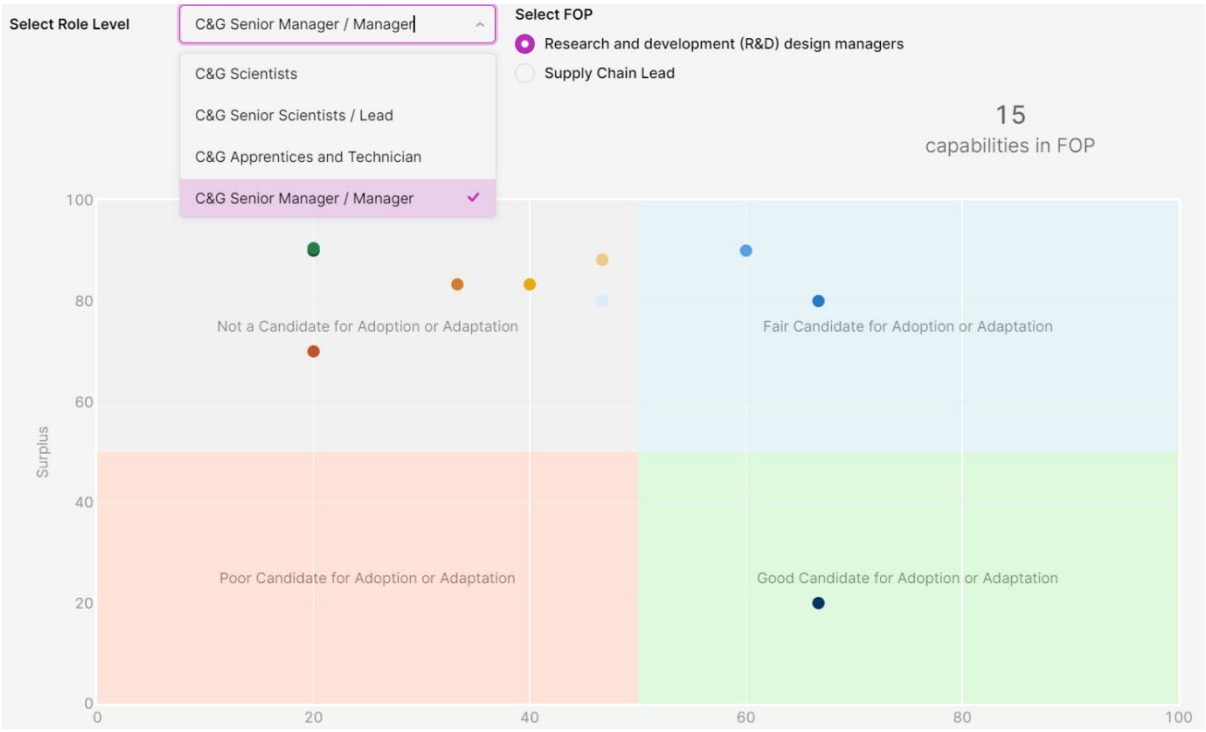


Figure 11: Example of a FOP - Education provisions matrix

After narrowing your search to specific standards, you can take a deeper dive in the [FOP Vs Provision section.]

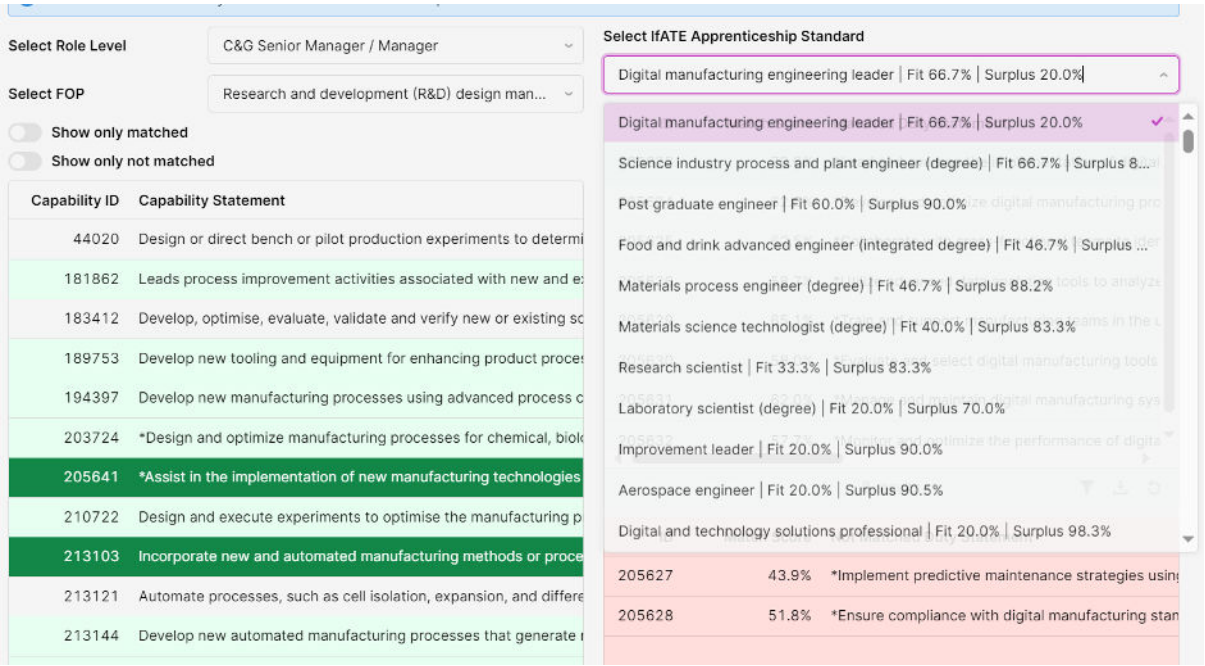


Figure 12: Example of a FOP comparison to a standard

The FOP comparison section is a valuable part of the data, enabling various analyses. It is important to remember that these FOPs focus solely on roles from a digitisation and automation perspective. Consequently, the matching provisions only consider capabilities within these FOPs. Therefore, readers should treat these recommendations as a basis for further research, not as absolute conclusions.

3.5 Summary of findings

To prioritise the action plan, the FOP priority section of the visualisation tool provides a list of priority FOPs to review. This prioritisation is based on the number of capabilities with limited or no educational provisions covered in each FOP. The higher the number of unsupported capabilities, the higher the priority. Addressing these FOPs will help cover a majority of such capabilities.

While most of the FOPs are common within the industry as existing roles, the added capabilities from digitalisation and automation challenge their future readiness and demand upskilling.

The report has provided a crucial insight into the priorities needed in the sector to address the opportunity and challenge posed by digitalisation and automation. The gap between future occupational profiles and provision was stark and has clearly shown the level of action required to ensure that the sector can successfully scale. The detail behind each FOP will allow the entire supply chain to have more visibility of the future skills and capabilities required, supporting everybody from recruiters to training providers as well as industry.

The gap analysis is incredibly powerful and shows the actions needed to be taken to influence updates for certain apprenticeship standards to include future focused capabilities and to enable them to meet requirements. For instance, the Data Analyst standard was seen as an ideal way to upskill and reskill existing employees however it was shown to have only a 15% fit. Whilst still a powerful standard to enable learning, additional content will be needed to increase its relevance to advance therapies.

Use of the findings

Whilst some of the Future Occupational Profiles (FOPS) are generic, some are more specific to this cycle. Building on this initial highlighting of opportunities and issues, further direction from Employers is required regarding workforce development plans and the level of demand for specific roles. This feedback shared with Educators can enable the development of the education and training provision for the future. Using the analysis of current IfATE occupational standards to inform the content, level, and delivery of this provision. This deeper investigation will be supported by the data sets and visualisation tools accompanying this report.

Within an organisation, a job role might incorporate several occupational profiles or only parts of one depending on the size and scope of the employer. Similarly, a college course might be designed to address one or several occupational profiles alongside or independent of other pre-existing course material. The Future Occupational Profiles and the associated capability sets provide employers with building blocks to help in the design of future roles and inform workforce planning. Similarly, the findings and data provide educators with building blocks to guide the development of course modules and content to prepare the future workforce.

In summary, FOPs can be used to:

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

Lessons learnt

The Foresighting process is continually updated and improved for future cycles. Some areas for further consideration include:

- Capturing the “Current state” in terms of existing workforce capabilities at the outset would enable helpful comparisons and remove the need to develop a “proxy” current state as for this cycle.
- Additional consultation with stakeholders during the ‘Identify’ and ‘Prepare’ phase of the Foresighting Cycle to ‘seed’ the process with capability sets and existing workforce occupational profiles could reduce the need for level of quality assurance and prevent potential data omissions.
- Allowing sufficient time, 2 weeks has been suggested, for Technologists to quality assure the ‘Data-Cube’ future capability outputs in between the early workshops in the ‘Carry-out’ phase of the Foresighting cycle, would remove a need for further data cleansing later in the process.

The above points will be drawn into future Cell and Gene workforce Foresighting projects.

Visualisation Instructions

Detailed instructions with illustrations can be found in the appendix.

Visualisation Data Link	What is it and what can it be used for?
Prototype Future Occupational Profile (P-FOP) Detail | HVMC Foresighting	This page allows you to review a specific Occupational Profile, including the capabilities contained within it and the Knowledge, Skills & Behaviour (KSB) tags associated with the capability. You can select an individual Role Family and linked P-FOP in the two available dropdowns. The table in the lower section of the page will then be populated with all relevant capabilities. The search control above the table allows you to filter content of any of the columns of data. A key piece of functionality in this table is the presence of the KSB tags associated with the capabilities.
Future KSBs Summary | HVMC Foresighting	This page 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 the superset of all details displayed on the P-FOP detail page. This is used to: • To review the identified Knowledge, Skill, and Behaviour tags for a given capability, to support development of future education and learning material. • To review the requirements from a capability level, rather than a role family/occupational profile grouping.
Capabilities Matched to Current Provision | HVMC Foresighting	This page allows you to review and compare individual capabilities against 'Duty' statements in an Apprenticeship / Occupational Standard. You can select individual capabilities to review their specific matches. These matches are shown in the bottom panel, including the Standard, the Level, and the Duty Statement this is matched to. You can filter in several ways to focus your review: • By the Capability Classification Framework (left-hand panel). • By capabilities that **are** served by the reference mapping framework – the default is Institute for Apprenticeships and Technical Education (IfATE) provision. • By capabilities that **are not** served by the reference mapping framework, e.g., IfATE provision – these are capabilities required in the future that may require new/bespoke training and CPD materials to be developed to upskill/re-skill the workforce. This page can be used to identify where existing provision may exist across the broad spectrum of Occupational Standards, and not just within a narrow range of sector-specific Standards. The data also allows you to identify where provision may already exist to support specific capabilities.
Fit & Surplus Factors | HVMC Foresighting	This page allows you to review the 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (P-FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). It is possible for the 'Fit' and 'Surplus' comparison to total over 100%, as they are two separate calculations based on a two-way comparison.
	This page is a visual representation of the 'Fit and Surplus Factor' insight. You can visually review 'Fit' and 'Surplus' of Prototype Future Occupation

fit_surplus_matrix - 3.0 | HVMC Foresighting	Profiles (P-FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). This can help you identify which provision may align strongest, or which may require adaptation, to provide the suitable provision fit for each future role. It will help you focus in on which provision to focus your attention for analysis.
P-FOP Capability Matches | HVMC Foresighting	This page allows you to view the matches between Capabilities and Institute for Apprenticeships and Technical Education (IfATE) Duty Statements. Clicking the arrow next to a number in the 'Matches' column will open a popup with more detail for each Capability. Each capability also includes Knowledge, Skill, and Behaviour Tags, to support with scaffolding future education provision. You can review individual Prototype Future Occupational Profiles (P-FOPS) or review all P-FOPs under a Role Family, to give a more holistic view of Capabilities and Matches Where a future capability has been matched to existing provision (currently, by default, IfATE apprenticeship standards) it is possible to interrogate the data and identify specific statements in standards that align to enable identification of existing training materials and activities that could be used or adapted to meet future requirements. This can be used to review the capability requirements for Role levels and P-FOPs, from Job / Occupation level through to Knowledge, Skill, and Behaviour level.
fop_vs_provision - 3.0 | HVMC Foresighting	This page allows you to compare FOPs against existing IfATE Standards. 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 IfATE Standards for that Occupational Profile.
p-fop_priorities - 3.0 | HVMC Foresighting	This page provides a summary of the maximum Education/Training Provision's Fit Factors identified for each P-FOP

3.6 Recommended next steps

The initial first step will be to establish a working group to tackle the opportunities and challenges which will allow the future growth of the sector. By analysing and interpreting the data, we can identify gaps, surpluses and prioritise action. Communicating with stakeholders will help everyone to understand how future roles will evolve and the skills and capability requirements.

Initially partnering with education providers to offer short-term courses, the focus gradually shifts to adapting curricula and developing tailored upskilling and reskilling programs. These programs aim to equip individuals with the skills necessary to address the skills gap across the industry.

Effective workforce planning will harness both the foresighting report and the bi-annual forecasting report (Skills Demand Survey) to look at talent development strategies and investigate how we can recruit talent from adjacent sectors and industries with overlapping skills requirements. In the long term, a review of standards/frameworks for apprenticeships and redesign is required including the need to add content where relevant as well as building new modules for programmes at degree level.

The only way to succeed is to collaborate. The first part of the journey has seen great collaboration between industry, academia and technologists. There is a desire to continue this work and Cell and Gene Therapy Catapult will convene a working group to take this report forwards and enable the sector to achieve its ambitions with scalability and cost effectiveness and ultimately value to the patient.

The recommendations in this report emphasise the importance of immediate and coordinated efforts by educators, employers, and other stakeholders to address the anticipated skills gap in the Advanced Therapies Sector. Actions can be divided into short-term and mid-term strategies and will be delivered subject to availability of resource.

	Topic	Actions	Who	When	Result
Short Term Actions	Educators and employers collaborate to deliver timely short term training courses for current workforce	Cell and Gene Therapy Catapult to convene group to look at immediate available training and build a delivery plan	Cell and Gene Therapy Catapult, Educators, Employers	Q1 2025	Plan for delivery of short-term courses
	Reskilling and Upskilling Current Workforce	Tailor course content to match new capabilities with existing occupational standards, focusing on design and other lifecycle activities.	Educators, Awarding Bodies, Employers	Prepare ahead of the scale-up need	Availability of short-term training for the current workforce to meet immediate technology demands.
	Recruitment from adjacent sectors and industries with similar skills & capability requirements	Identify and reskill individuals with transferable skills from other sectors, particularly for high-demand roles such as Automation	Employers, Training Providers	Immed-iate	Mitigation of workforce shortages in high-demand areas through targeted recruitment and

		Technicians or QA and QC.			training initiatives.
Medium term actions	Integrate newly identified skills and knowledge into existing training programmes	Formalise changes to occupational standards and training programmes for new entrants, integrating future skills requirements defined by the Future Occupational Profiles (FOPs).	Educators, Awarding Bodies, Employers	As soon as possible for prioritis-ed FOPs	Development of training programmes that meet both current and future skills needs, reducing lead time for new workforce entrants
	Modular Approach to Course Updates	Build new modules to update existing courses which are still relevant. A modular approach will be quicker and more effective than reworking entire courses and will allow a more agile approach to an evolving need.	Educators, Training Providers	Ongoing	Flexibility in educational programmes, enabling rapid response to industry needs.
General Actions for Educators	Review English Apprenticeship standards and support development of Scottish Modern Apprenticeships	Review Institute for Apprenticeships and Technical Education (IfATE) standards and relevant qualifications with employers, providing feedback and identifying gaps.	Educators, Employers	Ongoing	Comprehensive understanding of current training provisions and identification of areas for improvement.
	Develop and commission new continuing professional development (CPD) courses with relevant accreditation	Evaluate existing CPD provisions, commission new courses where necessary, and facilitate collaboration to maintain a unified approach.	Educators, Training Providers	Medium Term	Enhanced CPD offerings to upskill current workforce members across all role levels.
Additional Recommen-dations	Dissemination of Findings	Set up a working group to create an action plan, share findings widely among stakeholders to influence workforce	Convener, Sponsor, Stakeholders, Industry Groups	Follow-ing Publica-tion	Broad access to insights and strategic direction for workforce initiatives

		development initiatives.			
	Ongoing Review and Adaptation	Regularly review findings with stakeholders and adapt Future Occupational Profiles to better fit emerging roles	Stakeholders, Sponsor Leads, Participants	Before Formal Publica-tion	Robust and validated actions.
	Future Foresighting Cycles	Contribute to future foresighting cycles and integrate learning	Convener, Participants	Ongoing	Effective foresighting process ensuring robust outcomes.

Table of abbreviated recommendations leading to action:

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

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

4.0 Appendices

4.0 Appendices

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

4.1 Mission – What is workforce Foresighting?

Addressing future workforce challenges

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

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

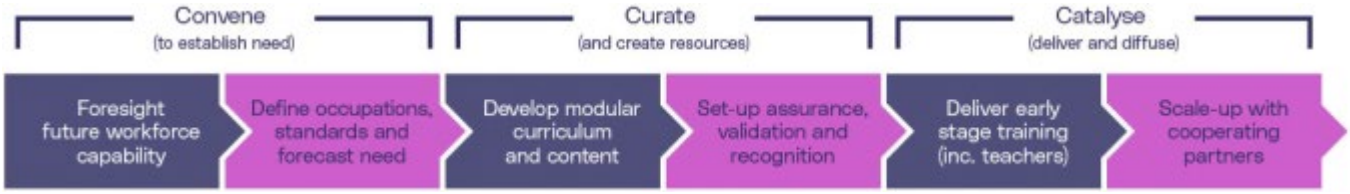
Developing this workforce and preventing a skills shortfall will provide future-thinking organisations with the capabilities to successfully adopt innovation and enable the UK to build a prosperous economy.

The Skills Value Chain

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

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

And it starts with workforce foresighting.



The Skills Value Chain

Workforce Foresighting

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

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

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

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

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

Our Goals:

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

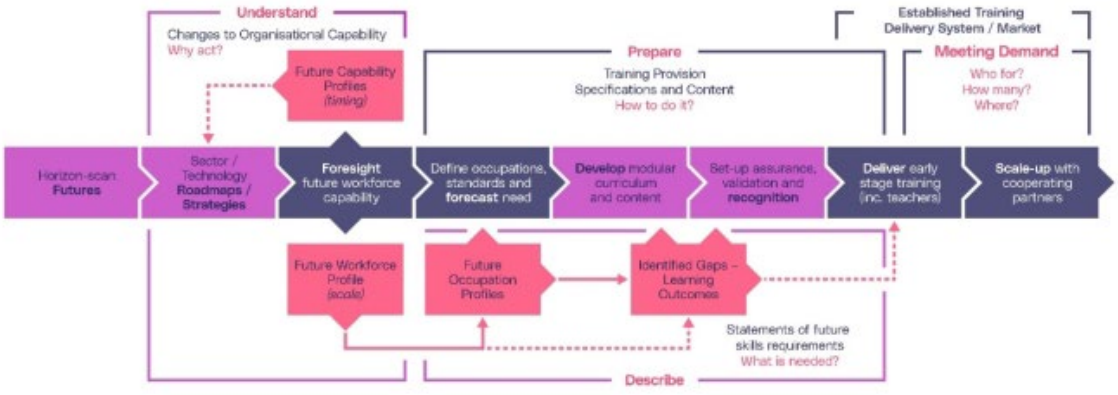
Understand and explain gaps between technology adoption, organisational capability and workforce profiles that could hamper innovation.

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

Enable and deliver a consistent approach to workforce Foresighting.

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

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



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.

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

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

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

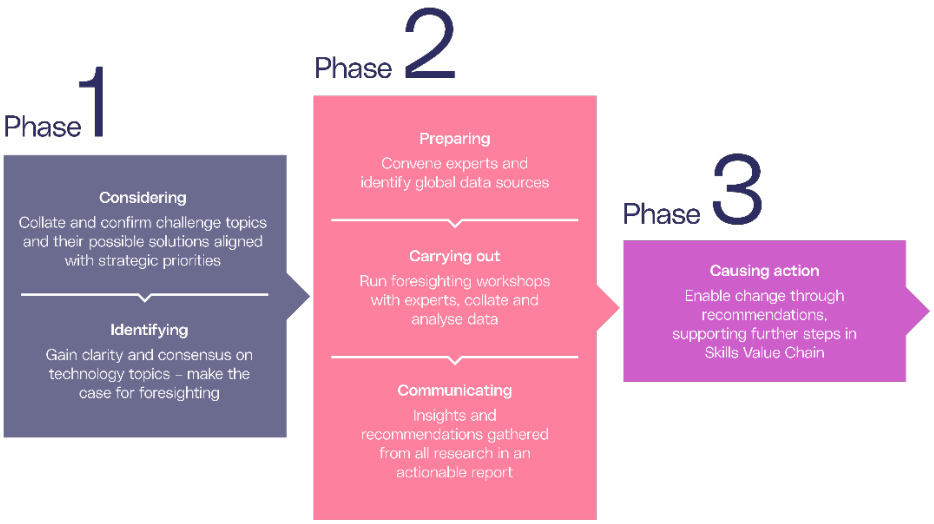
Identifying – Gain clarity and consensus about the solutions to be put forward – make the case for Foresighting

Preparing – The convening of specialists and scheduling of workshops

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

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

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



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 Workforce Foresighting Hub team will support the production of a report that provides targeted recommendations that require action to address gaps in training and education provision relevant to the challenge and planned technology solution.

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

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

Short term CPD – topics required across the workforce to upskill members of current workforce

Medium term – topics to be included as current provision / standards are reviewed and updated
Longer term – new qualifications and standards that may be needed to equip new entrants

The insight produced by a workforce Foresighting cycle provides:

Technologists and technical leads with insight of the organisational capability sets required across future supply chain partners in response to the identified challenge.

Employers with insight about possible future roles and occupations that may be required across the whole workforce, operators to researchers, to ensure they are equipped and ready.

Educators with details of the gaps to be addressed by short-course training to upskill the existing workforce and insight about qualifications and provision that will be required to support new entrants in the future.

4.2 List of Participants

Industry Participants	Skills Participants	Technology Participants
Oxford Biomedica	Kings College London	Cell and Gene Therapy Catapult
Extracellular	University of Hertfordshire	MaxCyte
Adaptiumme	BioIndustry Association	Miltenyi
Aviadobio	Northeastern University London	Oxford Biomedica
Immunebio	Cambridge Spark	Fourplus
Pharmaron	North Hertfordshire College	Sartorius
OriBiotech		Heriot-Watt – National Robotarium
RoslinCT		Microfluidx

4.3 Cycle timeline

This cycle started the workshops as part of the Carry Out phase in July 2024. The Carry Out phase concluded in October 2024. This report was prepared following the data validation period and published in February 2025.

4.4 Access to output data - link and authorisation

Data Capture Overview | HVMC Foresighting

4.5 Glossary - common language

Term	Definition
Impact Domains	Innovate UK domains used as Strategic Categories to assist setting and monitoring priorities
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary
Challenge Response	Specific intervention aimed at the challenge
Capability (Organisation)	The collective abilities, and expertise of an organisation to carry out a function, because provision and preparation have been made by the organisation
Capability Classification	Classification provides a common, structured vocabulary to define capability
Capability Statements	Description of the depth and nature of each capability within an organisation
Capability Syntax	Common language to describe each capability application within organisation type
Competencies (Workforce / Individual)	'Proficiency, aptitude, capacity, skill, technique, experience, expertise, facility, fitness related to capability
Competency definition 'KSBs' (Knowledge, Skills, and Behaviours)	Knowledge, Skills, and Behaviours are the elements used to express the required competencies for each Role Group
Competency Domain	Used during Foresighting analysis to provide focus on existing and emerging competency needs
Delphi Process	Foresighting takes a Delphi approach which has come to represent consulting expert opinion. (Harking back to the Delphic Oracle of ancient Greece)
Foresight Cycle	Set of workshops, analysis and reporting that implements the Foresight Process for each subject
Foresight Process	A series of activities which are convened to understand future competence needs, the opportunities available and actions required to deliver the right skills at the right time and place
Foresighting Champion	An individual nominated within a new user organisation of Foresighting to facilitate and lead the use of Foresighting processes and tools with the support of the Project Team
Foresighting Subject	The application of specific technologies in the context of a given challenge and which are candidates for Foresighting
Future Competency Set	The KBS output from the Educator workshop for each Role Group

Map and Gap Analysis	A combined expert and automated process that maps the Future Competency Set against a selected reference framework
Organisation Type	Simple description of nature of organisation for which capability is required
Proficiencies	Proficiencies differentiate the degree of competencies required from differing Role levels to support capabilities
Project Sponsor	Typically, a stakeholder in the challenge being successfully met who requires information to under-write plans to act
Role Group	Role levels are a collective of roles that exist in a typical manufacturing business / industrial sector
Syntax	The way in which a statement is phrased to ensure reliable, repeatable, and meaningful interpretation
Technologies	The technology that could be used to address the challenge
Working Scenario	To provide further context in relation to the subjects and used to position participants thinking during the detailed identification of future capabilities
Workshops	Online sessions used to undertake each step in the foresight process
Roadmaps	Sector, Industry, Regional view of emerging opportunities and their market entry
Participants	Technologists, Educators, Employers

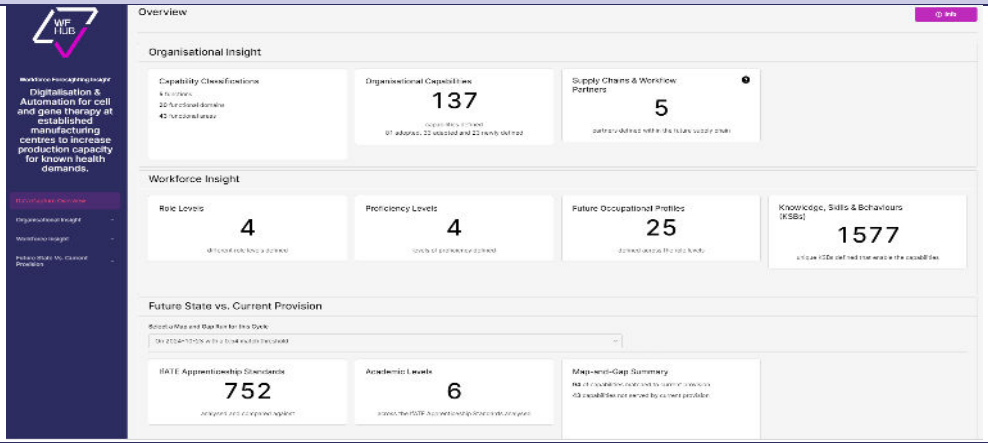
4.6 References

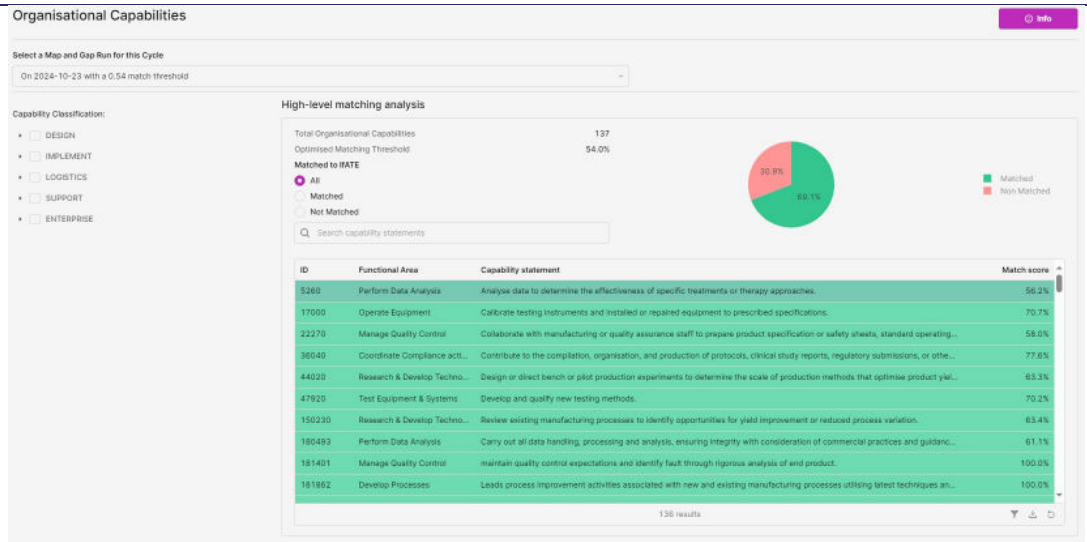
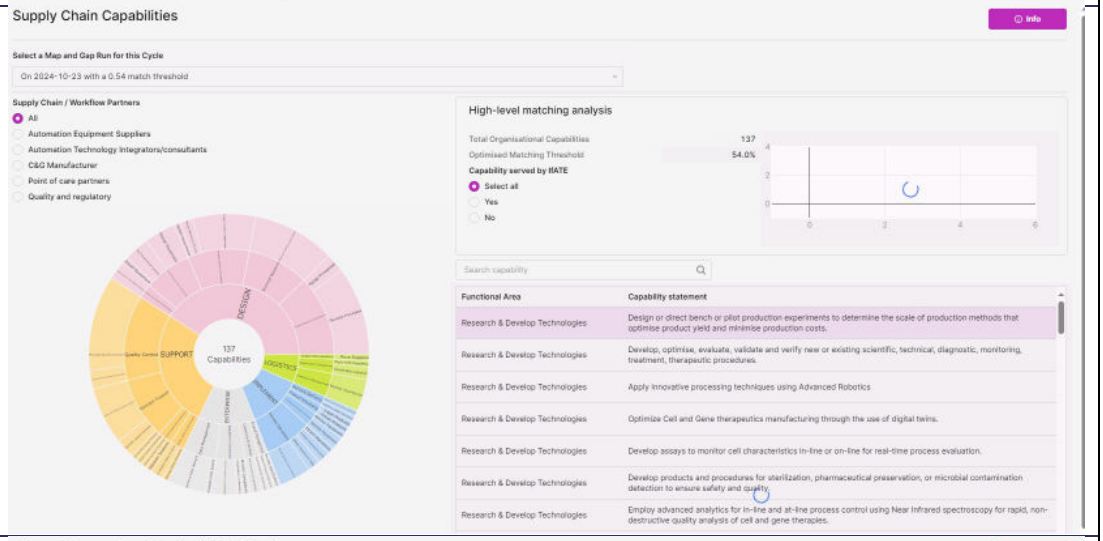
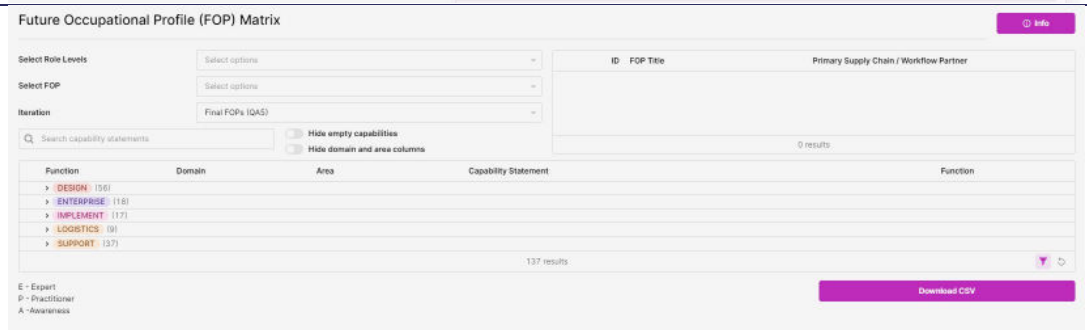
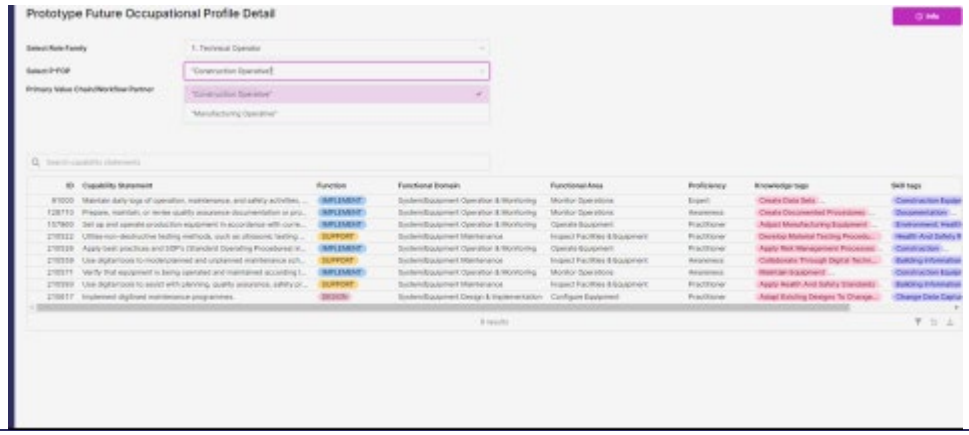
Cell and Gene Therapy Catapult. (2023). *Cell and Gene Therapy UK Skills Demand Report Contents*.

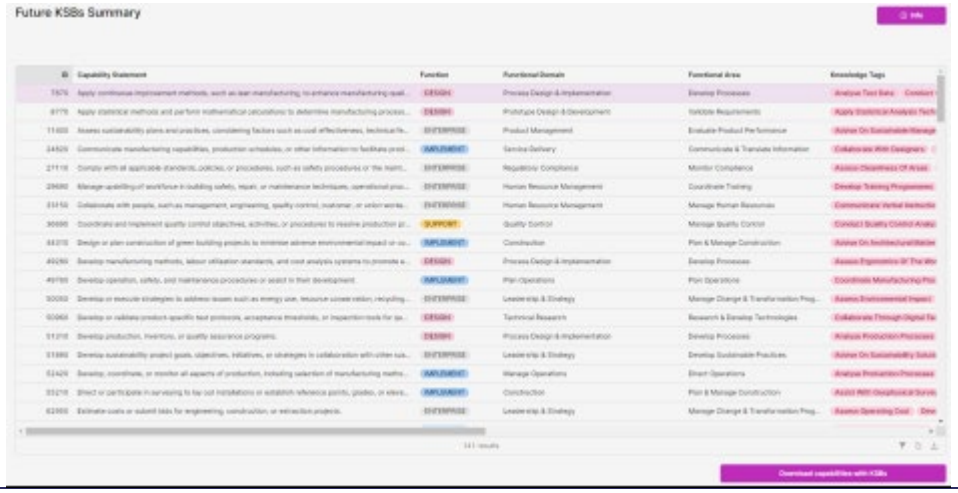
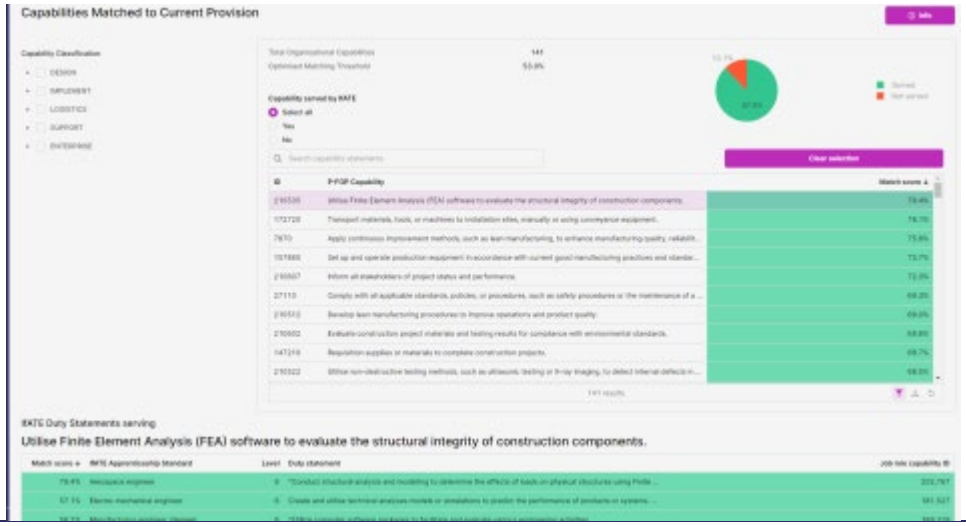
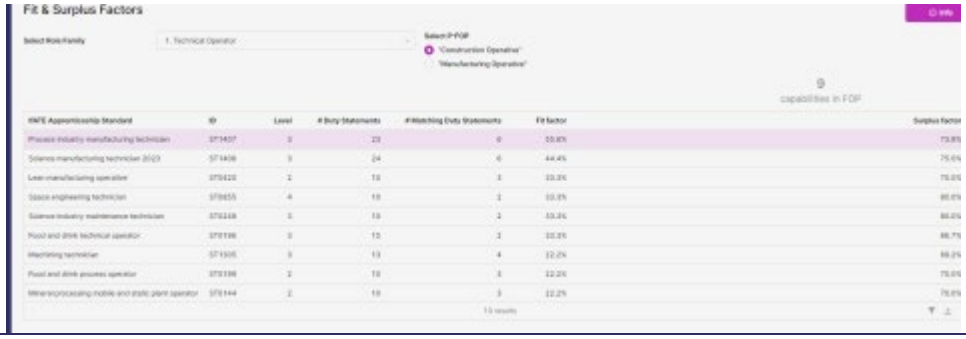
Cell and Gene Therapy Catapult. (2024a). *Cell and Gene Therapy GMP Manufacturing in the UK*.

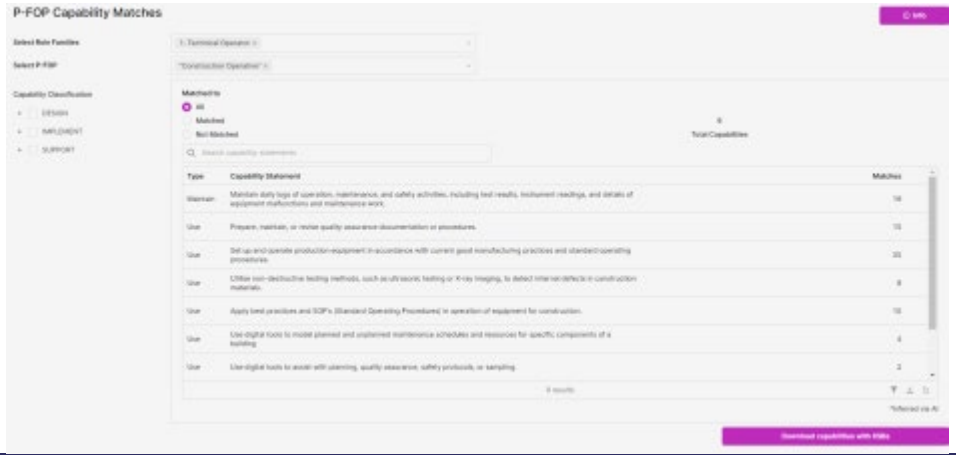
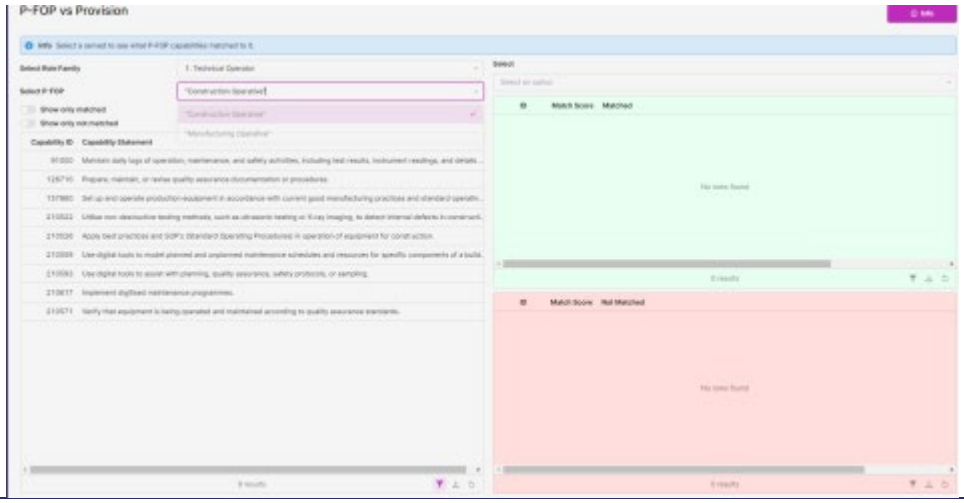
Cell and Gene Therapy Catapult. (2024b). *Transforming healthcare with advanced therapies*.

4.7 Visualisation links and Illustrations

Link to Visualisation	View of data
Data Capture Overview | HVMC Foresighting	

[Organisational Capabilities | HVMC Foresighting]	
[Value Chain Capabilities | HVMC Foresighting]	
[Prototype Future Occupational Profile (P-FOP) Matrix | HVMC Foresighting]	
[Prototype Future Occupational Profile (P-FOP) Detail | HVMC Foresighting]	

Future KSBs Summary | HVMC Foresighting	
Capabilities Matched to Current Provision | HVMC Foresighting	
Fit & Surplus Factors | HVMC Foresighting	
fit_surplus_matrix - 3.0 | HVMC Foresighting	

	
[P-FOP Capability Matches | HVMC Foresighting]	
[fop_vs_provision - 3.0 | HVMC Foresighting]	
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P-FOP Priorities