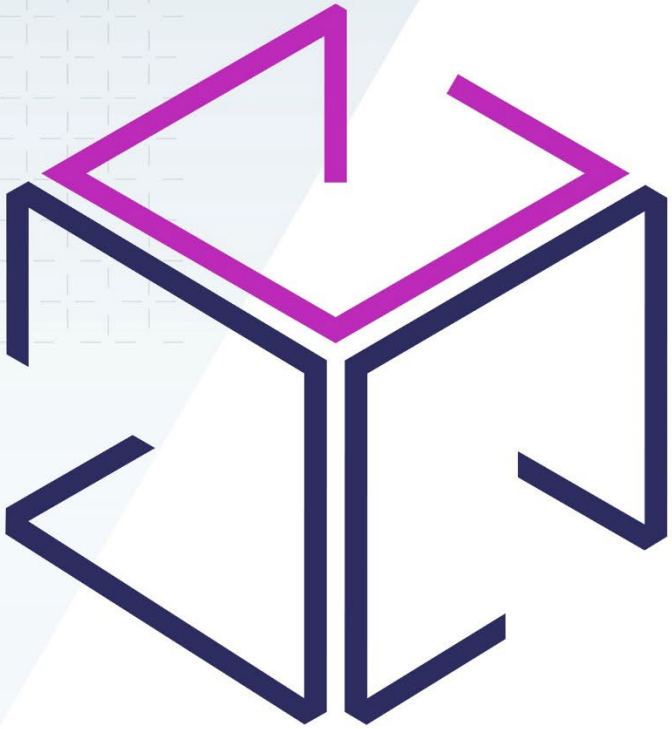
Workforce Foresighting Hub



The adoption of robot automation in metalworking SMEs

Equipping SMEs and the automation supply chain with the skills necessary to enable successful investment in robot technologies, from evaluation through procurement to implementation and operation, helping the SMEs to address their productivity and labour availability challenges.

Workforce Foresighting Hub findings report in collaboration with MTC, a member of the High Value Manufacturing Catapult.

Date: March 2025

Acknowledgements

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

The ONet data used is under CC BY 4.0 license. (O*NET® is a trademark of USDOL/ETA.) The Workforce Foresighting Hub team has modified all or some ONet information. USDOL/ETA has not approved, endorsed, or tested these modifications.

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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 November 2024 – January 2025 using the data set and tools available at that time.

Contents

Executive summary

Executive summary

This report outlines findings from the Workforce Foresighting cycle: ***Develop an integrated process for the adoption of robot automation in metalworking SMEs from evaluation, through procurement, implementation to operation.*** The study was convened by MTC 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 cycle was commissioned to identify the new capabilities the metalworking SME sector needs to gain momentum in automation adoption. While this is the primary focus, no sector can undergo a transformation without working with its closest supply chain partners who will also need to adapt to realise this ambition. In this cycle, examples of the enabling supply chain partners are robotic manufacturers, system integrators, and finance organisations. The analysis looks at all four partners and the capabilities each needs to improve or gain to enable automation adoption in the Metalworking SME sector. This means that while the study identifies specific areas of focus for SMEs in various areas of the supply chain to work on, it also takes into account that wider sector change is needed to help with the aim of SMEs adopting more robotics and automation. The two are intrinsically linked and need to be looked at together to understand the full implication of the changes needed. This report will, however, highlight specific focus areas for SME organisations that were identified.

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

Workforce Foresighting Topic

The UK metalworking sector is crucial to the economy, contributing significantly to GDP and supporting industries like construction and automotive. Automation can enhance productivity, reduce costs, and improve quality, addressing challenges such as labour shortages and high energy costs. National growth plans, including the Steel Strategy (Department for Business & Trade, 2025) and Invest 2035 aim to modernise the industry, promote sustainability, and create jobs (Department of Business and Trade, 2024).

The UK has seen significant growth in the adoption of robotics across various sectors, including metalworking. In 2023, the UK installed a record 3,830 industrial robots, marking a 51% increase from the previous year (Automate UK, 2024). This growth was driven largely by the automotive sector, but there was also notable demand from the metal industry, which saw a 20% increase in robot installations (International Fedaration of Robotics, 2024). Despite this growth, the UK's overall use of robotics and automation remains relatively low compared to other Western European countries. For instance, Germany, Italy, and France have significantly higher numbers of operational industrial robots. In 2023, the UK's operational stock of industrial robots was 28,831 units, whereas Germany had about nine times as many (International Fedaration of Robotics, 2024).

The UK metalworking sector faces several significant challenges that impact its efficiency and profitability. High energy costs are a major concern, as the industry is energy-intensive and rising costs can significantly affect profitability. Automation can help optimise energy usage by ensuring machines operate at peak efficiency, thereby reducing overall energy consumption

(Wilson, 2025). Additionally, the sector is grappling with labour shortages and a skills gap, with many experienced workers retiring and fewer young professionals entering the field. Automation can address this by taking over repetitive and labour-intensive tasks, allowing the existing workforce to focus on more complex and value-added activities, thus reducing dependency on a large workforce.

Cost management remains a constant challenge, as balancing cost and quality while staying within budget is essential. Automation can reduce labour costs and material waste, leading to significant cost savings and more efficient use of resources. Furthermore, the metalworking industry involves hazardous tasks that pose risks to workers. Automation can handle dangerous tasks, reducing the risk of workplace accidents and improving overall safety. By addressing these challenges through automation, the UK metalworking sector can enhance efficiency, reduce costs, and improve safety and quality, ultimately driving growth and sustainability. While the importance of integrating automation is obvious, technological adaptation without the right skills and workforce to enable such transformations is ineffective. A sustainable approach should consider both technology and workforce development to fully realise its potential. According to McKinsey & Company, the adoption of automation and AI will significantly change skill requirements, necessitating workers to deepen existing skills or acquire new ones (Bughin, et al., 2018).

This Workforce Foresighting report is designed to help the industry understand the skills needed for the rapid adoption of robotics. By identifying the right skills and ensuring they are in the right place at the right time, the industry can maximise its return on investment.

Participants and stakeholders

Thank you to all the participants who provided strong representation of the views, interests and needs of the relevant stakeholders including participants from the SME metalworking end users, technology providers, system integrators and educationalists.

The Findings and insights

The analysis of over 175 future state capabilities needed by the metalworking SME industry for robotic and automation integration has revealed significant insights that require the attention of both educators and employers. A common theme is that many of these future state capabilities are already in use by larger organisations at varying levels of intensity. However, larger organisations typically equip their employees with these capabilities through on-the-job training or internal programs, an approach not feasible for SMEs due to their limited resources.

Therefore, alternative solutions are critical for the sector to encourage a major automation transformation. These solutions include integrating the relevant content into degree or apprenticeship courses and supporting SMEs in upskilling their employees in these skills. Hopefully, this report will inform and enable relevant stakeholders to action such interventions efficiently.

While future state capabilities are the foundation of the research, further analysis has been conducted. One key analysis is the Future Occupational Profiles (FOPs), which combine capabilities to generate future job roles. FOPs can effectively identify gaps that job roles may face due to technological changes. In this cycle, there are 28 FOPs spread across the four supply chain partners. Detailed discussions about the FOPs can be found in section 3 of the report.

In summary, the report recommends key areas of intervention, each with detailed reasoning. Readers are encouraged to review these areas and further analyse the data set using the visualisation tool to make informed, data-supported decisions. The key areas are listed in section 3 along with links to the Visualisation Tool and how-to guides.

The Next Steps

To meet the needs of the SME End Users it is important the gaps in provision related to procurement are addressed with an appropriate provision that is also accessible. Given this is a current issue it would be worthwhile developing appropriate short courses to provide upskilling to existing staff. In the longer term these should then be considered as additional content for the relevant Level 3 and Level 4 apprenticeships.

It is suggested that a working group is convened with interested parties from the educational sector and led by Automate UK, as the lead convener for this foresighting cycle, to develop this work further and leading to the delivery of the appropriate training programmes. This would be to address both the short term, procurement related issues as well as the longer-term gaps identified within the cycle. The key activities for this group would be to disseminate the outcomes of the report and lead the detailed analysis to enable an action plan to be implemented.

It is anticipated that the outcomes will be a range of reskilling and upskilling courses, modular changes to existing training programmes and in some cases a more major revision of existing provision. This will need regular dialogue between the educators, awarding bodies and employers to ensure the output is both appropriate and meets the needs of the sector. The working group should also regularly review findings with stakeholders, adapting Future Occupational Profiles (FOPs) as needed, to ensure a good fit as robot automation technology develops and new roles emerge.

In conclusion, a number of clear gaps have been identified within the skills provision. These are proving to be a barrier to robot automation adoption and should therefore be addressed as a high priority. The importance of immediate and coordinated efforts by educators, employers, and other stakeholders to address these skills gaps should be emphasised.

1. Introduction

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1.1 Background to Workforce Foresighting

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

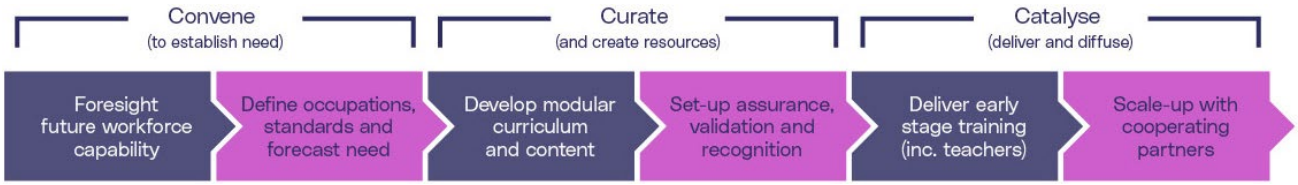


Figure 1: The Skills Value Chain

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

1.2 Workforce Foresighting - process overview

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

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

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

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

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

Preparing – The convening of specialists and scheduling of workshops

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

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

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

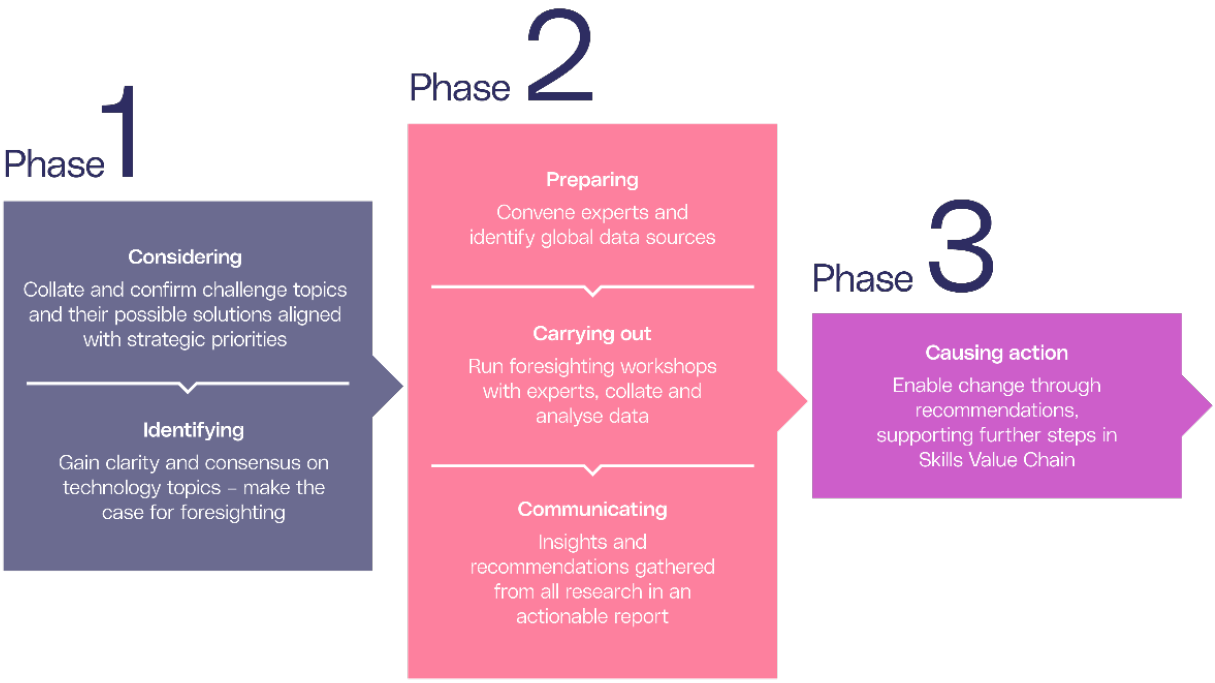


Figure 2 - The workforce foresighting process

1.3 Foresighting vs forecasting

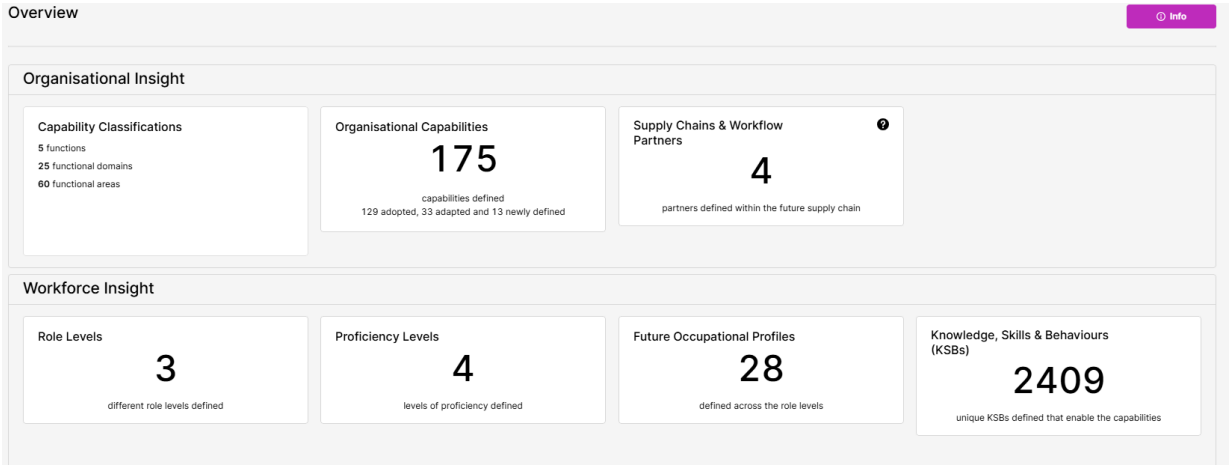
Although this study is focussed on workforce foresighting (capabilities required) it is important to keep in mind parallel findings from forecasting (required capacities and numbers). Forecasting, alongside foresighting, provides vital input to the sector, feeding into recruitment and development targets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

1.4 Introducing the Visualisation Tool

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

The data is generated by the foresighting cycles, integrating the expertise of technologists/domain specialists, employers and educators. The data informs the development of future curriculums 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.

Link to Visualisation Tool Data Set



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

2. Aligning the challenges and solutions with the national priorities

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2.1 Positioning and context of challenges

Manufacturing is important to the UK contributing £224 billion to the economy and providing more than 2.6 million jobs. It also accounts for over 40% of R&D expenditure and delivers almost 50% of UK exported goods (MakeUK, Impact Report 2024, 2024).

The manufacturing sector largely consists of smaller businesses. Of the 140,000 manufacturing businesses across the UK, using the employment banding definition, more than 110,000 are micro manufacturers with fewer than 10 employees and around 27,000 are SMEs with between 10 and 249 employees (MakeUK, Start-up to Scale-up: Supporting SMES to grow, 2021). Growth is currently hindered by persistently poor productivity, current labour and skills shortages and low levels of investment.

Various reports have demonstrated the strong, positive impact that increased implementation of robot automation would provide to the UK:

- If UK automation levels matched the most automated country our productivity would increase by 22.3% (Kromann, Malchow-Møller, Rose Skaksen, & Sørensen, 2020)
- Automation & Robotics technologies could contribute £184Bn to UK society in the next 10 years (BEIS, Made Smarter Review, 2017)
- "The problem for the UK labour market and our economy is not that we have too many robots in the workplace, but that we have too few" (BEIS, Automation and Future of Work, 2019)

Not only would the increased use of robot automation systems drive increased productivity, it will also address labour and skills shortages, increase output and provide greater resilience to meet the current geopolitical trade challenges of today.

Improved productivity will enable growth and reshoring of manufacturing driving greater revenues and resilience (by strengthening local supply chains):

- "If 75% of Britain's smaller businesses with lower productivity upped their game to the output of top 25% - UK GDP could see a boost of £270 billion, as estimated by the Bank of England" (MakeUK, Start-up to Scale-up: Supporting SMES to grow, 2021)
- Removing the labour shortage constraint will allow this growth to be realised:
- According to Make UK there are 61,000 unfilled vacancies in UK manufacturing resulting in a loss of £6.5B in potential output each year (MakeUK, Makers' Manifesto 2024, 2024)

Typically, robots are applied to the dull, dirty, dangerous, and demanding tasks relieving workers to undertake tasks where their skills and abilities add value to the product. These roles are often better paid which the businesses can afford because of their higher productivity. Regarding skills gaps, for example welders, robot automation can handle the higher volume, mundane work leaving the skilled staff to undertake the more complex parts with smaller batches providing more interesting and rewarding work.

In 2023, the UK saw a 51% increase in robot installations, with 3,830 units installed, driven largely by the automotive sector (Automate UK, 2024). This trend is expected to continue, with 63% of manufacturers planning capital investments in robotics over the next 24 months (Peters, 2024).

2.2 Potential and prioritised Solutions to Challenge

The UK is out of step with our competitors for robot use. With 119 robots per 10,000 employees in manufacturing we currently rank 23rd, significantly behind all our competitors and below the world average (World Robotics 2024, International Federation of Robotics). As the 12th largest manufacturing nation (Make UK), to be in a comparable and competitive situation, we should be placed much higher in terms of robot density.

Many of the larger enterprises have the skills and resources to implement robot automation without external assistance. The major challenge is the SME community which constitutes 99% of UK manufacturing businesses (see above), provides the supply chain to the larger enterprises and often has the potential for the largest growth (see above).

Of the 27,000 small and medium sized companies (10 to 249 employees) approximately 40% are operating in the metalworking sector (ONS) which therefore provides both a significant population and suitable focus for the foresighting activity. It is worth noting that much of the technology and automation solutions are proven and commercially available so the barrier to adoption is the implementation by end users rather than technology development. There are also a small number of SMEs who have developed their own capabilities to implement robot automation, thereby providing a good source of input to the project

The adoption of robotics and automation is therefore crucial for the metalworking sector to improve productivity and competitiveness. Overall, the UK metalworking sector is integral to the country's economic and social fabric, supporting a wide range of industries and contributing to sustainability efforts. Addressing its challenges, particularly the skills gap, will be essential for its continued growth and competitiveness.

2.3 Workforce Foresighting for Chosen Prioritised Technology Solutions

The metalworking sector's ability to innovate and adopt new technologies, such as robotics and automation, is vital for maintaining its competitiveness and supporting the broader manufacturing ecosystem.

The UK metalworking sector faces significant national challenges, particularly around the skills gap and the need for automation and robotics. As an example, according to the DCMS Sector Skills Shortages and Skills Gaps 2022 report, the skills gap in these sectors is exacerbated by an ageing workforce and difficulties in attracting talent, with 33.4% of all vacancies in the sector attributed to skills shortages (DCMS, 2024). This makes it crucial for the industry to invest in training and upskilling initiatives.

It is recognised the implementation of the first robot system is the most challenging, due to the steep learning curve required, and over coming this barrier is key to greater adoption. The challenge comes from a lack of knowledge and skills within the SMEs.

- Procurement - SMEs can often lack the necessary knowledge to specify requirements for procuring robotic systems. This includes understanding what type of robots are needed, the integration requirements, and the potential ROI.
- Project Management - SMEs can struggle with project management roles required for implementing robotic solutions. This includes planning, coordinating, and overseeing the installation of robotic systems.

- Implementation and Operation Challenges - There is a significant skill gap in operating and maintaining robotic systems. This includes programming robots, troubleshooting issues, and performing regular maintenance.

The focus of this workforce foresighting cycle is therefore aimed at equipping metalworking SMEs and the automation supply chain with the skills necessary to enable successful investment in robot technologies, from evaluation through procurement to implementation and operation, helping the metalworking SMEs to address their productivity and labour availability challenges.

2.4 Key Stakeholders

The input provided by the following organisations who have contributed to this Workforce Foresighting Hub cycle is greatly appreciated.

Industry Participants	Skills Participants	Technology Participants
Walsall Wheelbarrow Company	University College Birmingham	Automate UK
Contracts Engineering	University of Cranfield	Pentangle Automation
Arrowsmith Engineering	Make UK	Cyberweld
Newby Foundries	University of Warwick	FANUC
JJ Churchill	University of Loughborough	Olympus Technologies
Swiftool Precision Engineering	MTC	Expert Technologies Group
Technoset	Health and Safety Executive	KUKA
A&M Pure Precision		ABB
ECAM Engineering		Mechtech Automation Group
		WMH Transmission & Robotics

3. Findings and results

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3.1 Methodology and findings

Summary information is provided with a narrative based on the underlying data which is also provided using bespoke visualisations to enable greater insight and access to detail. The report is aligned to the needs of those responsible for workforce planning – employers, educators, and skills providers.

Step One – How will the supply chain change - *Organisational Changes*

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

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

Step Two – How will the workforce change - *Occupational Changes*

The foresight process produces a set of Future Occupational Profiles (FOPs) to demonstrate how current occupations may need to change in the future. FOPs are generated using attributes from the underlying capability classification and data collected in workshops. It combines the future capabilities to potential job roles.

As part of the foresight process, the generated FOPs are reviewed, revised, and refined by the Employer group. The agreed set of FOPs is then compared with selected current education provisions, primarily using the Institute for Apprenticeships and Technical Education (IfATE) apprenticeship standards as a reference. This comparison assesses which current training and education provisions could be used in the future.

Two bespoke metrics, match and surplus, are used to evaluate the alignment of current provisions with the proposed FOPs. Summaries of the key findings related to each Supply Chain partner are presented. Findings are aimed at both Employers, and Education and Training Providers, and identify matches and gaps in future training needs compared with current provision to guide further detailed investigation.

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

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

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

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

Organisation functions

The Workforce Foresighting process uses an information architecture built on five functional areas which are common to any business:

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

The functional structure is developed to levels of detail that enable the foresight process to reference external data sets including ONET (US) Occupational Information Network [9F[1]], ESCO – European Skills, Competences, Qualifications and Occupations [10F[2]], IfATE (UK) Institute for Apprenticeships and Technical Education [11F[3]] .

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

The data architecture is implemented in a bespoke ‘data-cube’ which underpins the foresight process, workshops, and enables extensive use of LLM and AI tools. Additionally, a key feature of the data-cube is that the data from each foresight topic cycle is added into the data

[1] ONET - Occupational Information Network - https://www.onetcenter.org/
[2] ESCO - European Skills, Competences, Qualifications and Occupations - https://esco.ec.europa.eu/en
[3] IfATE – Institute for Apprenticeships and Technical Education - https://www.instituteforapprenticeships.org/

set and can then be used, where relevant, in future cycles. This ensures that the capabilities of the system are dynamic and up to date.

Identifying the Future Supply Chain Capabilities

The following charts indicate the shift in capabilities from the current state to the future state, informing readers on domain-wise demand changes at a macro scale. The current state is based on existing education provisions commonly used in the industry, serving as a proxy for the actual current state. Other factors should be considered when drawing conclusions. However, more rigorous research has been conducted to visualise the future state through capability classification.

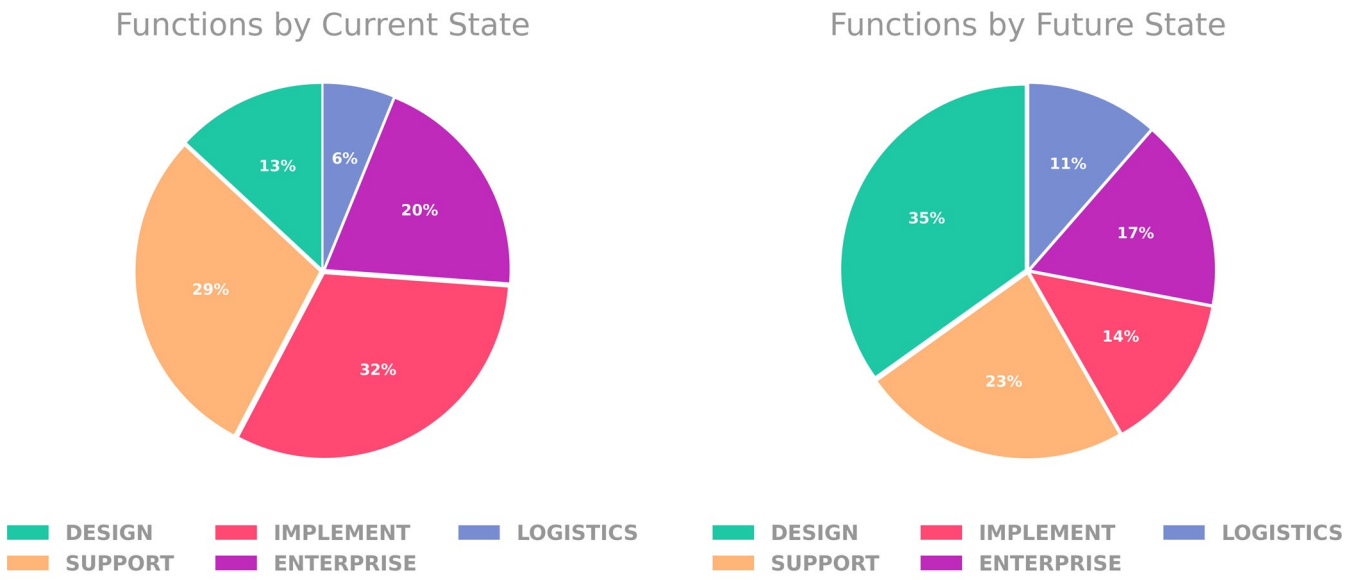


Figure 3: Current and Future – Whole Supply Chain - Capability Function Distribution %

To gain an in-depth understanding of how capabilities are distributed across various functions and supply chain partners, readers are encouraged to review the following visualisation page.

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
Link	*The page provides a list of all capabilities and shows how they are distributed across the five functions. It also indicates whether there is a matching training provision within IfATE duty statements. The percentage is a binary factor with a threshold of 54%, meaning anything above 54% is deemed to have a match.*

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

Insight into occupational change uses the understanding of how capabilities will change across business functions (section 3.2) to inform proposals for how occupations and their associated skills sets for each supply chain partner may need be revised to reflect change for each role level within that partner.

Supply Chain partner organisation types

The workforce foresighting process recognises that different partners in a Supply Chain will require appropriate capabilities, and these are determined and agreed in the initial workshops.

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

1. SME End Users - The primary recipients of the robotic solutions, SMEs (Small and Medium-sized Enterprises) are the final users who benefit from automation in their manufacturing processes. They provide requirements for customisation, oversee practical implementation, and assess operational impact.

2. Equipment / Product Providers - Suppliers of the physical robotic equipment and necessary components for automation, responsible for delivering high-quality, reliable products that meet the technical needs of SMEs. They collaborate on specifications, ensure product readiness, and support integration within manufacturing environments.

3. System Integrators - Experts who bring together various elements of the automation system, the integrators ensure seamless interaction between robotics, software, and existing infrastructure. They handle system design, installation, and optimisation to ensure a cohesive and efficient automated process.

4. Finance Organisations - Financial partners who facilitate funding options and provide financial mechanisms to support SME investments in robotic automation. They offer financial products, support cash flow management, and help with capital accessibility to enable technology adoption.

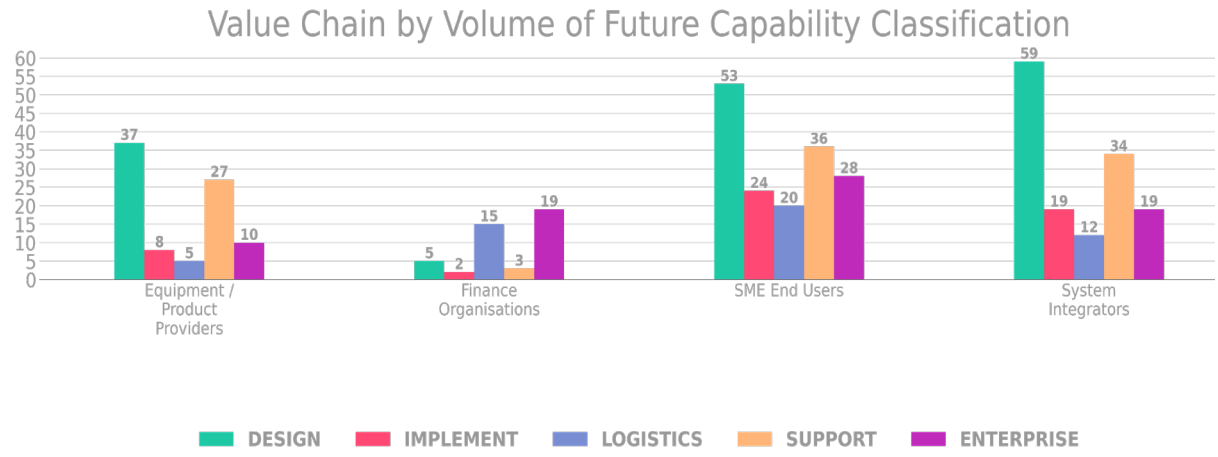


Figure 4: Distribution of Functions across each Supply Chain Partner

The graph illustrates the distribution of capabilities by function across the Supply Chain Partners. These capability sets form the Future Occupational Profiles within each role level. For a more in-depth analysis of the distribution of capabilities, readers are encouraged to use the visualisation tool.

Visualisation Instructions

Detailed instructions can be found in the appendix.

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

Role Levels

The foresighting process uses the concept of Role Levels to represent a collection of future occupations. Utilising this approach acknowledges that the workforce is not homogeneous, there will be varying levels of proficiency required across a workforce and qualifications and training may be aligned/require different types of vocational or academic qualifications. Additionally, the role level approach seeks to avoid presuming that the future workforce will be operating at a different level to the current state.

Role Levels determined through workshops:

1. Senior/ Chartered Engineer
2. Junior Engineer/ Engineering Technician
3. Technicians / Apprentices

Proficiencies

Each of these role levels will require proficiency that reflects their role and the needs of each Supply Chain Partner. The foresight process uses a three-point scale to capture and differentiate the proficiencies required. This information is used both in the generation of the Future Occupational Profiles, and to assist the definition of training needs identified. Within the workforce foresight process proficiency is defined as:

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

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

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

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

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

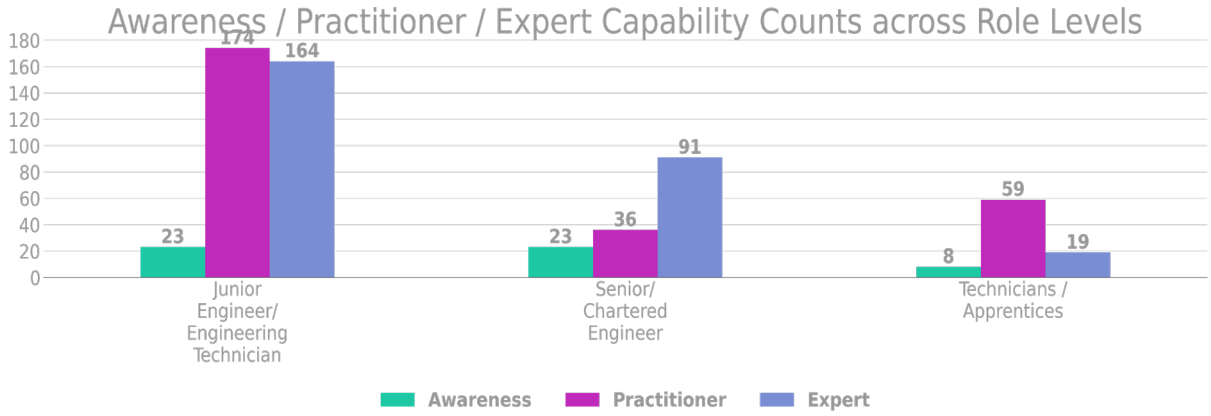


Figure 5: Proficiency details by Role Level

Above graph is a macro indication of how proficiencies are distributed across the three role levels. The key insight of proficiency information is better interpreted when they are combined with the respective FOPs. More details on practical applications will be explained below.

Future Occupational Profiles (FOPs)

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

Educators can review current apprenticeship standards against the requirements of the FOPs and interpret which need to be changed to fill the gaps between the current and future state.

Employers can consider existing apprenticeship standards and make a judgement on adapting an existing apprenticeship standard to upskill their workforce to meet the requirements of a particular FOP.

FOPs and indicative skills need

The FOPs Identified during this cycle are as follows:

Supply chain partner: SME End Users

FOP Name	Role Level
Manufacturing Engineer	Junior Engineer/ Engineering Technician
Simulation Engineer	Junior Engineer/ Engineering Technician
Production Engineer	Senior/ Chartered Engineer
Procurement Support Officer	Junior Engineer/ Engineering Technician
Manufacturing Design Engineer	Senior/ Chartered Engineer
Automation Engineer	Junior Engineer/ Engineering Technician
Maintenance Technician	Technicians / Apprentices
Operator/Setter	Technicians / Apprentices
Inspection Tech	Technicians / Apprentices
Data Engineer	Junior Engineer/ Engineering Technician

Supply chain partner: Equipment / Product Providers

FOP Name	Role Level
Health & Safety Practitioner	Junior Engineer/ Engineering Technician
Controls Engineer	Junior Engineer/ Engineering Technician
Maintenance and Training Engineer	Junior Engineer/ Engineering Technician
Application and Project Engineer	Senior/ Chartered Engineer
Automation & Mechatronics Engineer	Junior Engineer/ Engineering Technician

Supply chain partner: System Integrators

FOP Name	Role Level
Technicians (Build & Integration Support)	Technicians / Apprentices
Digital Engineer	Junior Engineer/ Engineering Technician
Mechanical Engineers	Junior Engineer/ Engineering Technician
Mechatronics, Robotics and Automation System Engineers (Design)	Junior Engineer/ Engineering Technician
Mechatronics, Robotics and Automation System Engineers (Operations)	Junior Engineer/ Engineering Technician
Controls and Instrumentation Engineers	Junior Engineer/ Engineering Technician
Project Engineer	Junior Engineer/ Engineering Technician
Chief Engineer	Senior/ Chartered Engineer
Maintenance /Service Engineer	Junior Engineer/ Engineering Technician
Technical Sales	Junior Engineer/ Engineering Technician
Project manager	Senior/ Chartered Engineer

Supply chain partner: Finance Organisations

FOP Name	Role Level
Technology Specialist	Senior/ Chartered Engineer
Regional Managers	Senior/ Chartered Engineer

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 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.

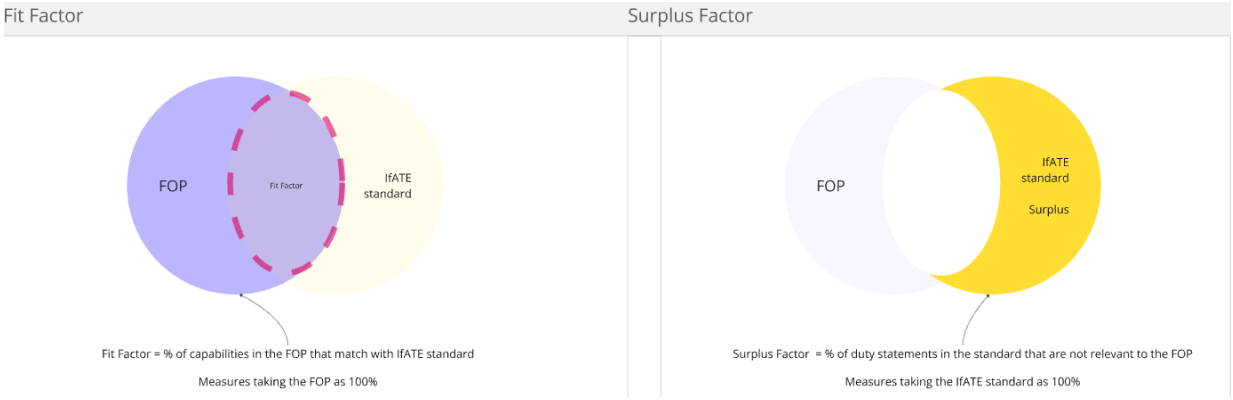


Figure 6: Fit and Surplus Factors

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

Review matching standards along with their fit and surplus matrix using this link.

Figure 7: 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.

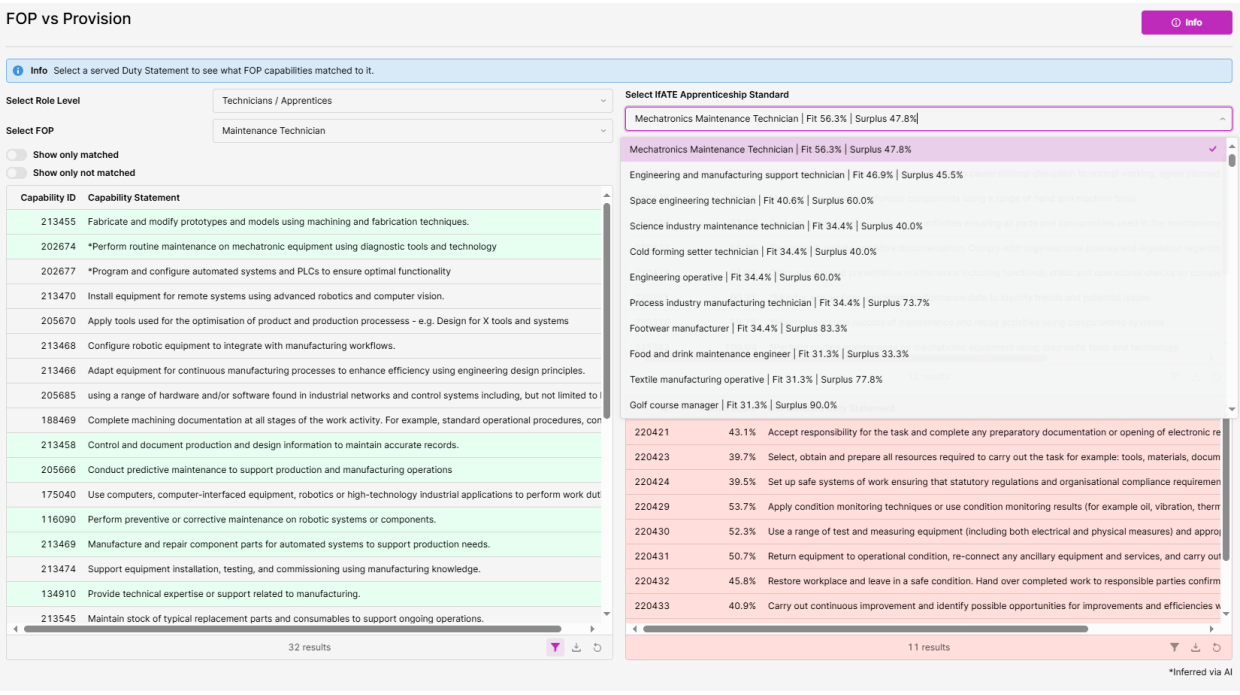


Figure 8: Example of a FOP - Education provisions list

4. Conclusion and next steps

4. Conclusions and next steps

4.1 Summary of key insights

Readers are encouraged to utilise the data and visualisation tool. For further analysis and actions, some initial suggestions have been provided, based on expert analysis from an industry perspective. While significant areas are discussed below, the full list of capabilities can be found in the Visualisation Tool here.

Capabilities Lacking Provision

The following key suggestions are capabilities which were found to lack provision and are therefore important for the education providers to consider. It should be noted that these are not specific to one element of the supply chain with the highly technical points being much more applicable to the equipment providers and system integrators. Some of these capabilities are new to the industry whereas others have been addressed via “on the job” training and development. This latter approach is particularly challenging for SME businesses. The respective capabilities that informed these themes can be found in the subsequent discussion and within the Visualisation Tool.

1. **Incorporate 3D Printing and Rapid Prototyping:** Enhance programs to include theoretical and practical knowledge of rapid prototyping to enhance the production capability and efficiency.

2. **Modelling, Simulation, and Digital Twin Technology**: Expand training and capabilities by developing courses that focus on creating and using advanced digital models and simulations, including modules on implementing digital twin technology.

3. **Advanced Control Algorithms, Machine Learning, and Communication Protocols**: Train on seamless integration of automation systems by incorporating advanced cutting edge control algorithms and machine learning related methodologies into the curriculum.

4. **Quality Control and Data Recording:** Ensure programs cover these skills to meet industry standards.

5. **Dexterous Robotic Manipulation:** Develop systems and tools for precision tasks.

6. **Advanced virtual support methodologies including Augmented Reality (AR):** To develop capabilities that can provide virtual support and training for operators to provide instant access to expert technical advice, which is crucial for resolving issues quickly and efficiently.

7. **Benchmarking and Knowledge Sharing:** This will aid in evaluating the performance of various technologies against established benchmarks, ensuring that systems achieve the necessary standards for efficiency, accuracy, and reliability while facilitate knowledge sharing between installers.

8. **Access and Security:** Standardise and communicate security protocols.

9. **Material and Labour Requirements:** Optimise resource allocation and planning.

10. **Innovative Financing Solutions:** Explore alternative funding sources and financial strategies to obtain financing solutions for manufacturing robotic projects, focusing on short and long return on investments (ROI).

11. **Communicating Automation Strategy:** Ensure clear and effective communication of automation initiatives to promote automation and robotics. Effective communication makes sure that all stakeholders, including those without technical expertise, grasp the goals, benefits, and processes of automation.

12. **Create reconfigurable, agile and flexible production systems:** to enable rapid changes to production pathways/processes as products change. Also having the ability and skills to modify processes to integrate automation workflows into traditional techniques.

13. **Explore innovative supplier engagement strategies beyond traditional methods. like proof of concept and simulations for supplier selection:** This knowledge helps in selecting suppliers and products that offer the best value, quality, and efficiency, ultimately reducing costs and waste.

14. **Knowledge and skills to review material and labour requirements**: to support effective and accurate proposal generation, project management and cost benefit analysis.

SME end user Capabilities

Detailed analysis of the data demonstrates short comings in the provision of training for the SME End Users. The key steps of robot automation procurement and implementation have been identified as follows:

1. **Automation Strategy**
   This is not a critical issue for a single installation, but it is often very worthwhile to develop a longer-term plan to encompass staged introduction of robot automation solutions including other important elements, such as training and financing. This then provides a route map for the introduction of robot automation.

2. **Application Identification**
   It is imperative that the most appropriate application is selected. This must be technically feasible and provide a reasonable return on investment. Many businesses would start with the greatest challenge within the production operation. However, this could be difficult to automate and therefore of greater risk. It is often better to start with a relatively simple application, reducing the risk, moving on to more complex applications later.

3. **Business Case**
   It is important to determine the appropriate budget for an application taking account of all the costs as well as understanding the financial value of the benefits of the installation. This will be used to justify the investment and must provide enough finance to achieve the goals that have been identified otherwise there is a risk the investment will not deliver the anticipated performance or returns.

4. **User Requirements Specification (URS) and Request for Quotation (RFQ)**
   It is very important to be able to provide to the potential vendors a written document detailing the key requirements to be met by an automation solution as well as details

as to how the project will be conducted and important process and facility information. This enables proper comparison between the alternative offers as well as ensuring the vendors fully understand the requirements for the robot solution.

5. **Supplier selection and project management**
   Selecting the supplier is a key element of any project. It is not always the lowest cost offer which provides the best choice. It is also important to undertake internal management of the project to ensure the vendor does achieve the objectives for the project rather than being fully reliant on the vendor.

6. **Operational**
   Once the vendor has handed the system over to the end user, they will need to operate the automation system which includes planned maintenance and addressing breakdowns.

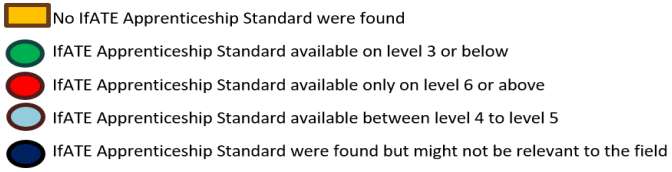
The most important steps for the procurement process are Application Identification, Business Case, URS and RFQ preparation and Supplier selection and project management. Automation Strategy is useful to provide an overall guide and direction of travel and is often developed once the business understands what opportunities there might be for robot automation within their business.

The 47 capabilities, identified as being relevant to the SME End Users, were then allocated to each of these key steps (see table below). Further analysis of these capabilities found the following:

- 8 capabilities were available in Level 3 (or below) courses but all bar one related to the Operational aspect.
- Only 3 capabilities had no educational provision available.
- However, 11 capabilities were only available in Level 6 courses or above which although available a Level 6 course is unlikely to be appropriate for SME end users.
- 7 capabilities were available but within apprenticeship standards which are not considered to be relevant.

For example, the capability “Evaluate capital purchase and finance options for new equipment to assess their impact on business performance” is only available via an Assistant Farm Manager, Level 4 course and is therefore not accessible and may not be relevant.

It is therefore clear that the procurement process (excluding Automation Strategy and Operational) is not well served within the existing and relevant apprenticeship standards with 29 capabilities identified but only 15 available at both the appropriate level and within accessible courses.



Identified SME End User Capabilities & IfATE Apprenticeship Standards Evaluation

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
➢ Lead research into new technologies and identify opportunities for their potential application within the business.	➢ Identify constraints and capture technical requirements for robotics projects.	➢ Develop business cases to address investment needs and/or to inform asset management decision making.	➢ Create detailed product specifications for manufacturing equipment and disposables using industry-standard documentation tools i.e., Product Requirement documents (PRDs) and Functional Requirement Documents (FRDs)	➢ Evaluate robotic systems or prototypes.	➢ Use computers, computer-interfaced equipment, robotics or high-technology industrial applications to perform work duties.
Education provision matches (examples and the match %)					
• *Game Programmer – Level 7 (100%)* • *Engineering manufacturing technician – Level 4 (62%)*	• *Robotics engineer – degree – Level 7 (100%)* • *Advanced robotics engineer – Level 7 (65.9%)* • *Robotics engineer – degree – Level 6 (100%)*	• *Infrastructure asset management professional – Level 7 (65.3%)* • *Manufacturing manager (integrated degree) – Level 6 (62.0%)* • *Robotics engineer – degree – Level 6 (58.5%)*	• *Materials process engineer (degree) – Level 7 (57.1%)* • *Engineering manufacturing technician – Level 4 (56.2%)*	• *Advanced robotics engineer – Level 7 (69%)* • *Robotics engineer – degree – Level 6 (67.9%)*	• *Engineering operative – Level 2 (54.7%)*
Education provision review					
					

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
➢ Develop manufacturing infrastructure to integrate new manufacturing processes and technologies.	➢ Select appropriate technology for autonomous or collaborative robotic systems to enhance operational efficiency.	➢ Determine the feasibility, costs, or performance benefits of new mechatronic equipment.	➢ Articulate business objectives in procurement specifications using appropriate tools and techniques, such as LEAN sourcing	➢ Identify potential suppliers based on specific criteria using market research	➢ Operate manufacturing systems and equipment to produce products
Education provision matches (examples and the match %)					
• *Digital manufacturing engineering leader – Level 7 (58%)* • *Science industry process and plant engineer (degree) – Level 6 (58.1%)*	• *Advanced robotics engineer – Level 7 (54.3%)*	• *Robotics engineer – degree – Level 6 (57.2 %)*	*N/A*	• *Procurement and supply chain practitioner – Level 4 (59.5%)*	• *Science manufacturing technician 2014 – Level 3 (100%)* • *Engineering operative – Level 2 (70.1%)*
Education provision review					
			N/A		
➢ Incorporate new and automated manufacturing methods or processes to improve existing operations.	➢ Identify opportunities to improve manufacturing processes, products or to reduce costs using e.g knowledge of fabrication processes, tooling and production equipment, assembly	➢ Identify and apply for project funding.		➢ Research and assess market, regulatory environment, and supplier landscape before initiating the tendering process	➢ Start monitor and adjust robotic programs.
Education provision matches (examples and the match %)					
• *Engineering manufacturing technician- Level 4 (59.9%)*	• *Lead engineering maintenance technician* • *Level 4 (66.8%)* • *Engineering manufacturing technician – Level 4 (63.5%)*	• *Community energy specialist – Level 4 (70.6%)*		• *Procurement and supply chain practitioner – level 4 (100%)*	• *Cold forming setter technician – level 3 (54.9%)*
Education provision review					
					

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
➢ Support the improvement of the agility and productivity of workforces and organisations, to enable innovation and collaborative working using technology.	➢ Identify ways to improve processes by monitoring production process and end product.	➢ Evaluate capital purchase and finance options for new equipment to assess their impact on business performance.		➢ Apply selection and award criteria for sourcing requirements from external suppliers	➢ Procure and manage projects, products, and services from external suppliers, setting of objectives for suppliers and performance measurement of suppliers in line with organisations asset management approach. Use Through Life Service providers to support the process for specific asset groups.
Education provision matches (examples and the match %)					
• *People professional – Level 5 (100%)* • *Actuarial technician – Level 4 (58%)*	• *Mineral products technician – Level 5 (100%)* • *Product design and development engineer (degree) Level 6 (61.3%)* • *Engineering manufacturing technician – Level 4 (57.7%)*	• *Assistant farm manager – Level 4 (55.3%)*		• *Procurement and supply chain practitioner- Level 4 (100%)*	• *Asset manager – Level 4 (77.4%)* • *Procurement and supply chain practitioner – Level 4 (61.2%)*
Education provision review					
					

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
➢ Assist in the implementation of new manufacturing technologies and systems	➢ Identify opportunities for improvements in quality, cost, or efficiency of automation equipment.	➢ Assist in the evaluation of sources of financial capital investment, including suitability and risk.		➢ Undertake market research and benchmarking through desk top activities and stakeholder engagement in order to assist and inform the wider procurement team in their sourcing	➢ Implement and maintain efficient and reliable maintenance procedures to prevent equipment failures and optimise asset performance
Education provision matches (examples and the match %)					
• *Engineering and manufacturing support technician – Level 3 (100%)* • *Textile manufacturing operative – Level 2 (60%)*	• *Lead engineering maintenance technician – Level 4 (57%)* • *Robotics engineer – degree – Level 6 (55.3%)*	• *Accountancy or taxation professional – level 7 (63.3%)* • *Accounting finance manager- Level 6 (61.1%)*		• *Procurement and supply chain practitioner – level 4 (62.3%)*	• *Crop technician – Level 3 (71.8%)* • *Engineering operative – Level 2 (64.8%)* • *Mechatronics Maintenance Technician – Level 3 (61.0%)* • *Engineering operative – Level 2 (64.8%)*
Education provision review					
		 			

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
➢ Develop an automation strategy to align operational processes with business objectives.		➢ Understand budgetary constraints to ensure financial feasibility of projects		➢ Supporting commercial/procurement team in negotiations with customers and suppliers	➢ Monitor test, fault-find, and maintain manufacturing plant equipment while carrying out scheduled service activities on production infrastructure.
Education provision matches (examples and the match %)					
• Operations manager – Level 5 (54.9%)		• Operations manager – Level 5 (56.2%) • Construction design and build technician – Level 4 (58.5%)		• Manufacturing manager (integrated degree) – level 6 (100%) • Procurement and supply chain practitioner – level 4 (60.1%)	• Space engineering technician – Level 4 (85.2%) • Process industry manufacturing technician – Level 3 (67.3%) • Engineering and manufacturing support technician – Level 3 (55.1%) • Engineering operative – Level 2 (62.4%)
Education provision review					
					

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
➢ Communicate the automation strategy effectively to ensure positive culture change and gain buy-in from the workforce, incorporating input from task performers.				➢ Work as part of a team to select and obtain suitable equipment, materials and consumables, checking it on delivery, ensuring suitable safety certificates and dealing with any problems.	➢ Perform preventive or corrective maintenance on robotic systems or components.
Education provision matches (examples and the match %)					
N/A				• *Stained glass craftsperson – Level 4 (59.9%)*	• *Broadcast and media systems technician – Level 5 (54.9%)* • *Mechatronics Maintenance Technician – Level 3 (59.0%)* • *Aviation maintenance mechanic – Level 2 (54.3%)*
Education provision review					
N/A					
Lead change management for robotic and autonomous systems adoption, ensuring team readiness and acceptance.				Manage the procurement products for a specific project.	Perform routine maintenance on mechatronic equipment using diagnostic tools and technology manage and maintain manufacturing systems and equipment to ensure optimal performance.
Education provision matches (examples and the match %)					
• *Project manager (integrated degree) – Level 6 (59.8%)* • *Advanced robotics engineer – Level 7 (54.3%)*				• *Procurement and supply chain practitioner – level 4 (59.9%)*	• *Food and drink engineer – Level 5 (69.5%)* • *Engineering and manufacturing support technician – Level 3 (55.6%)* • *Engineering operative – Level 2 (62.4%)*
Education provision review					
					

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
➢ Review emerging technologies to guide investment strategies in small and medium enterprises.				➢ Oversee the procurement process and tendering of specialist contractors to select the most suitable options	
Education provision matches (examples and the match %)					
• *Materials process engineer (degree) – Level 7 (55.3%)*				• *Construction quantity surveyor (degree) – level 6 (100%)* • *Procurement and supply chain practitioner – Level 4 (58.3%)*	
Education provision review					
					
				➢ Explore innovative supplier engagement strategies beyond traditional methods. like proof of concept and simulations for supplier selection.	
Education provision matches (examples and the match %)					
				N/A	
Education provision review					
				N/A	
				➢ Produce and agree delivery schedules with suppliers.	
Education provision matches (examples and the match %)					
				• *Buying and merchandising assistant – level 4 (57%)*	
Education provision review					
					

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
				➢ Devise procedures or systems to evaluate or select suppliers	
Education provision matches (examples and the match %)					
				• *Procurement and supply chain practitioner – level 4 (62%)*	
Education provision review					
					
				➢ Gather all relevant material for bid processes, and coordinate bidding and contract approval.	
Education provision matches (examples and the match %)					
				• *Design and construction management (degree) – Level 6 (59.8%)*	
Education provision review					
					
				➢ Negotiate details of contracts and payments.	
Education provision matches (examples and the match %)					
				• *Chartered surveyor (degree) – Level 6 (80.5%)* • *Procurement and supply chain practitioner – Level 4 (57.2%)*	
Education provision review					
					

Automation Strategy	Application Identification	Business Case	URS / RFQ	Supplier Selection & Project Management	Operational
				➢ Managing the commercial and financial aspects of automation projects, including cost management, resource allocation, and profitability analysis.	
Education provision matches (examples and the match %)					
				• *Process automation engineer (degree) – Level 7 (100%)* • *Hospitality manager – Level 4 (58.3%)*	
Education provision review					
					
				➢ Monitor costs, measure progress against budget, and record financial and legal constraints	
Education provision matches (examples and the match %)					
				• *Construction design and build technician – Level 4 (100%)* • *Manufacturing engineer (degree) – Level 6 (55%)* • *Project manager (integrated degree) – Level 6 (60.7%)* • *Associate project manager – Level 4 (66.2%)*	
Education provision review					
					

4.2 Recommended next steps

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

There are both short term and longer-term actions that should be undertaken as a result of this foresighting cycle. These specifically include skills related to procurement of robot automation solutions by SMEs as well as technology related skills that relate to other elements of the supply chain.

To meet the needs of the SME End Users, it is important that the gaps in provision related to procurement are addressed with an appropriate provision that is also accessible. Given this is a current issue, it would be worthwhile developing appropriate short courses to provide upskilling to existing staff. In the longer-term, these may then be considered as additional content for the relevant Level 3 and Level 4 apprenticeships.

Therefore, it is suggested that a working group is convened with interested parties from the education sector and led by Automate UK, as the lead convener for this foresighting cycle, to develop this work further and leading to the delivery of the appropriate training programmes. The key activities for this group are identified below.

1. **Dissemination**

Firstly, the outputs from this cycle and this report, should be discussed more widely with the sector to generate interest and support for the development and implementation of appropriate training programmes.

2. **Detailed Analysis**

The analysis already performed should be investigated further to clearly identify sets of key capabilities for the key elements of the supply chain, existing provision against these capabilities and whether any work is required to adapt or modify this to suit the specific needs of this group.

3. **Action Plan**

This will then enable the development of an action plan covering short course development, modification or adaption of existing material and creation of new material, where existing provision is not appropriate, or no provision exists.

The action plan should identify the parties who will be developing and delivering the newly created provisions including the timing for both the development and also the commencement of delivery. It should also include the anticipated delivery mechanisms such as online, short course and apprenticeship.

This may include short term actions, for example specific short courses, and longer term, for example new elements of apprenticeship programmes. This should also include details of the funding and sources of funding required to achieve the plan.

4. Implementation

It is anticipated that the outcomes will be a range of reskilling and upskilling courses, modular changes to existing training programmes and in some cases a more major revision of existing provision. This will need regular dialogue between the educators, awarding bodies and employers to ensure the output is both appropriate and meets the needs of the sector. The working group should also regularly review findings with stakeholders, adapting Future Occupational Profiles (FOPs) as needed, to ensure a good fit as robot automation technology develops and new roles emerge.

In conclusion, a number of clear gaps have been identified within the skills provision. These are proving to be a barrier to robot automation adoption and should therefore be addressed as a high priority. The importance of immediate and coordinated efforts by educators, employers, and other stakeholders to address these skills gaps should be emphasised.

5. References

References

Bughin, J., Hazan, E., Lund, S., Dahlström, P., Wiesinger, A., & Subramaniam, A. (2018, May 23). *Skill shift: Automation and the future of the workforce.* Retrieved from McKinsey.Org: https://www.mckinsey.org/featured-insights/future-of-work/skill-shift-automation-and-the-future-of-the-workforce

Department of Business and Trade. (2024). *Invest 2035.*

Automate Team. (2024, December 20). *Forging Ahead: How Automation is Reshaping Metalworking.* Retrieved from Automate: https://www.automateshow.com/blog/forging-ahead-how-automation-is-reshaping-metalworking

Automate UK. (2024). *The Rise of Robotics in UK Manufacturing: A 2024 Perspective.* Retrieved from https://www.automate-uk.com/news-publications/the-rise-of-robotics-in-uk-manufacturing-a-2024-perspective/

BEIS. (2017). *Made Smarter Review*. Retrieved from https://www.gov.uk/government/publications/made-smarter-review

BEIS. (2019, September 18). *Automation and Future of Work.* Retrieved from publications.parliament.uk: https://publications.parliament.uk/pa/cm201719/cmselect/cmbeis/1093/1093.pdf

Cole, S. (2024, April 11). *Automate UK's 2024 Industry Report Highlights.* Retrieved from MEPCA Magazine: https://mepca-engineering.com/automate-uks-2024-industry-report-highlights/

Department For Business & Trade. (2024, November 2024). *Invest 2035: the UK's modern industrial strategy*. Retrieved from GOV.UK: https://www.gov.uk/government/consultations/invest-2035-the-uks-modern-industrial-strategy/invest-2035-the-uks-modern-industrial-strategy

Department for Business & Trade. (2025, February 16). *The steel strategy: the plan for steel*. Retrieved from Gov.Uk: https://www.gov.uk/government/consultations/input-into-the-steel-strategy/the-steel-strategy-the-plan-for-steel

Department for Culture, Media and Sport. (2024). *DCMS Sector Skills Shortages and Skills Gaps: 2022, UK*. [online] Available at: https://www.gov.uk/government/statistics/dcms-sector-skills-shortages-and-skills-gaps-2022-uk [Accessed 24 Mar. 2025].

International Fedaration of Robotics. (2024). *Robot Boom in the UK Hits All-Time High.* Retrieved from https://ifr.org/downloads/press2018/2024-SEP-24_IFR_press_release_World_Robotics_2024_-_UK.pdf

Jacques Bughin, E. H. (2018, May 23). *Skill shift: Automation and the future of the workforce.* Retrieved from McKinsey.Org: https://www.mckinsey.org/featured-insights/future-of-work/skill-shift-automation-and-the-future-of-the-workforce

Kromann, L., Malchow-Møller, N., Rose Skaksen, J., & Sørensen, A. (2020). Automation and Productivity: A Cross-country, Cross-industry Comparison. *Industrial and Corporate Change*, 265–287.

Make UK, infor. (2023).

MakeUK. (2021). *Start-up to Scale-up: Supporting SMES to grow.* Retrieved from www.makeuk.org: https://www.makeuk.org/insights/reports/2021/12/03/start-up-to-scale-up-supporting-smes-to-grow

MakeUK. (2024). *Makers' Manifesto 2024.* Retrieved from https://www.makeuk.org/insights/reports/makers-manifesto-2024

MakeUK. (2024). *Impact Report 2024.* Retrieved from makeuk.org: https://www.makeuk.org/insights/reports/impact-report-2024

Peters, S. (2024). *Could UK manufacturing optimism spark a new wave of automation?* Retrieved from HowToRobot: https://howtorobot.com/expert-insight/could-uk-manufacturing-optimism-spark-new-wave-automation

Skills for Life . (2024). *SME Skills Horizon.*

Tavener, A. (n.d.). *Industry Talk .* Retrieved from Supply Chain IT: https://www.supplychainit.com/automations-role-in-alleviating-uk-labour-shortage-pressures/

UK Metals Council. (2024). *State of the Metals Industy in the UK.* UK Metals Council.

Wilson, M. (2025, January 27). *From challenges to change: how automation is transforming UK Manufacturing by Mike Wilson, Chief Automation Officer.* Retrieved from MTC: https://www.the-mtc.org/challenges-change-how-automation-transforming-uk-manufacturing-mike-wilson-chief-automation-officer

6. Appendix

6. Appendices

Section	Title
6.1	Cycle timeline
6.2	Glossary - common language
6.3	Visualisation links and illustrations

6.1 Cycle timeline

Workforce Foresighting cycle started the Carry Out phase in November 2024. The Carry Out phase concluded in January 2025. The Findings report was prepared following the data validation period and published in March 2025.

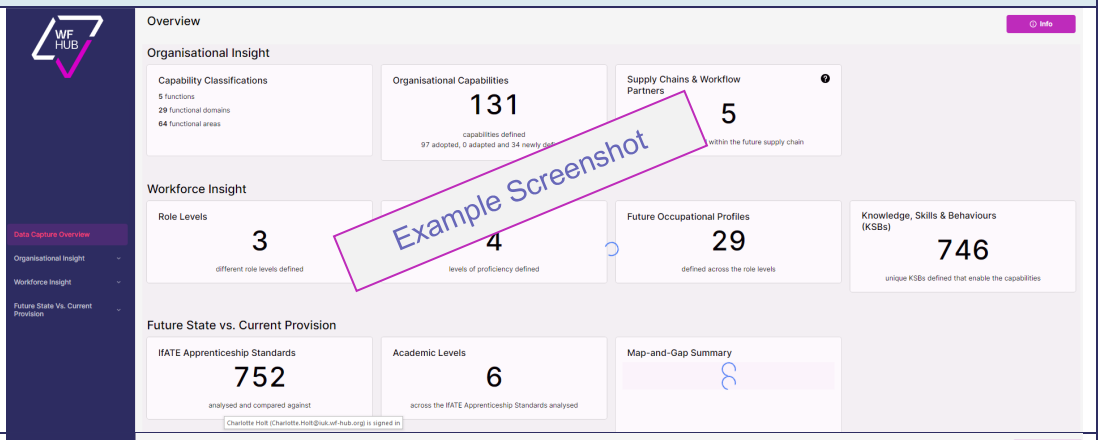
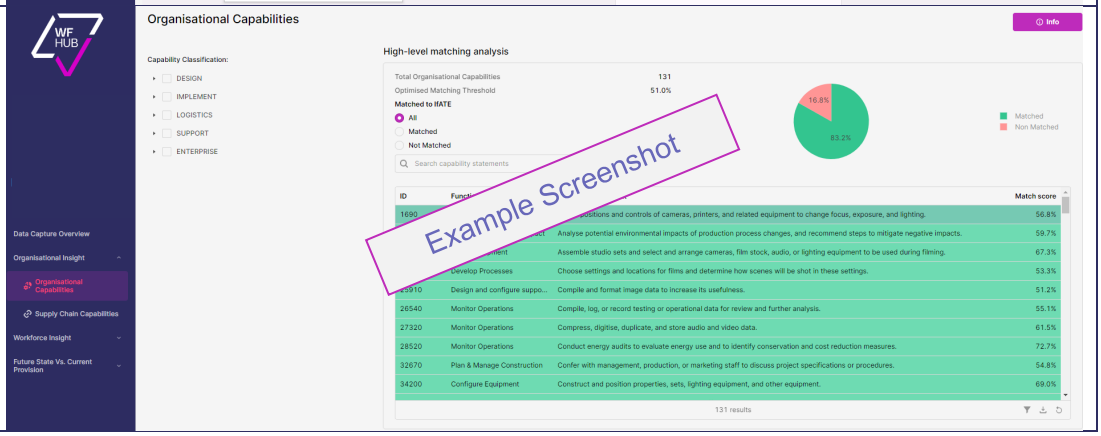
6.2 Glossary - common language

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

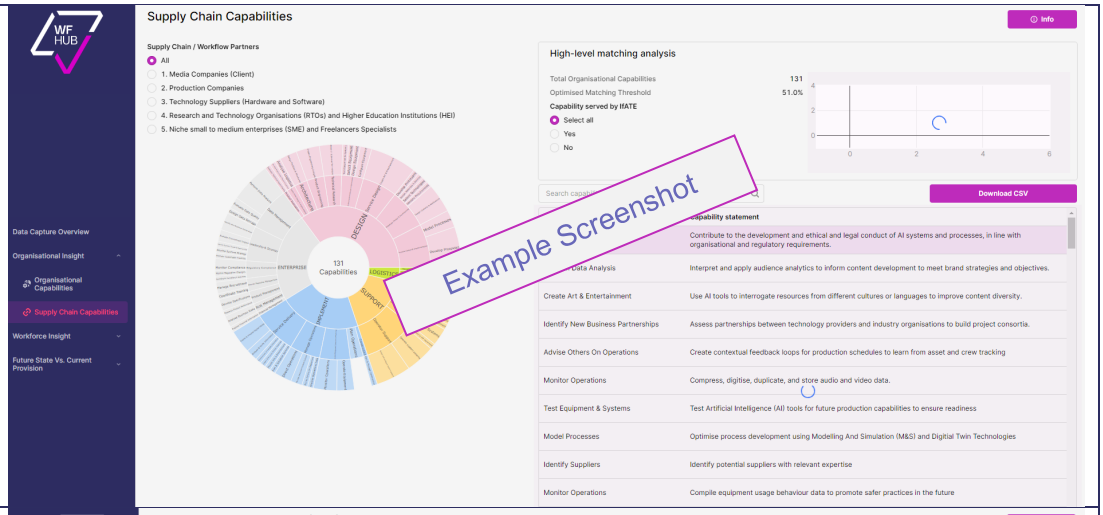
Project Sponsor	Typically, a stakeholder in the challenge being successfully met who requires information to under-write plans to act
Role Level	Role level are a collective of roles that exist in a typical manufacturing business / industrial sector
Syntax	The way in which a statement is phrased to ensure 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

6.3 Visualisation links and Illustrations

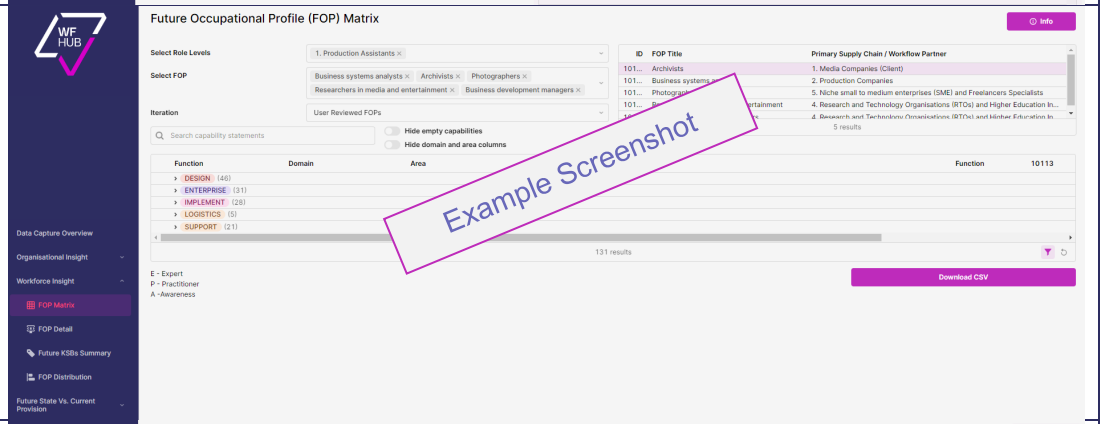
Link to full data set - Visualisation Instructions

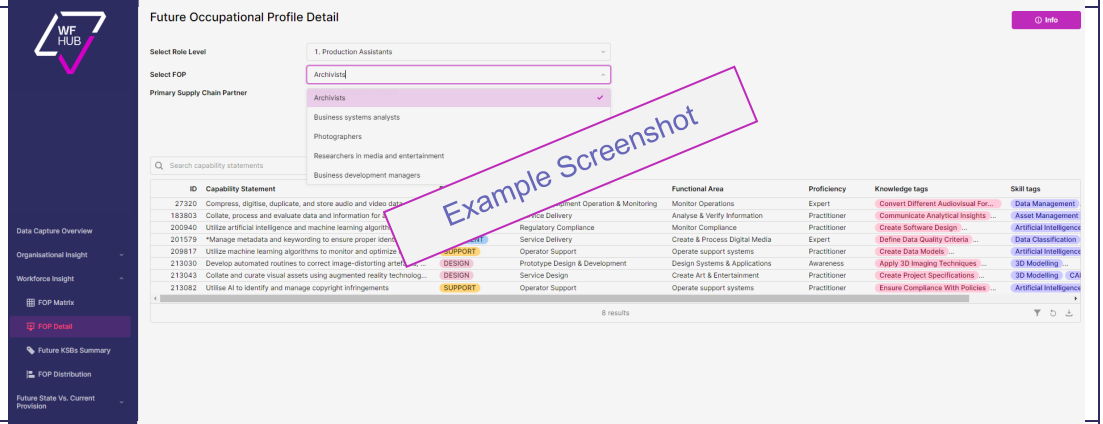
Link to Visualisation	View of data
Data Capture Overview	
Organisational Capabilities	

Supply Chain Capabilities

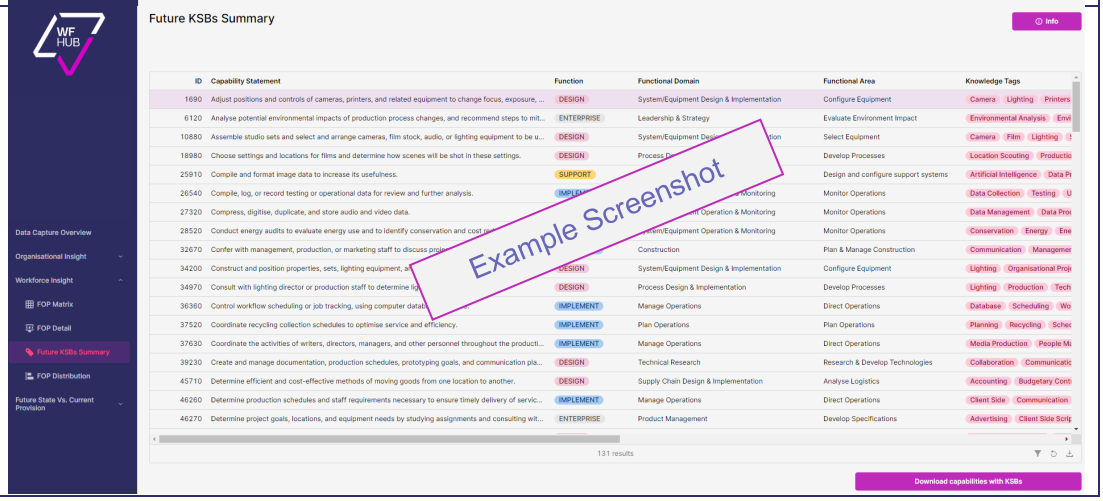


FOP Matrix

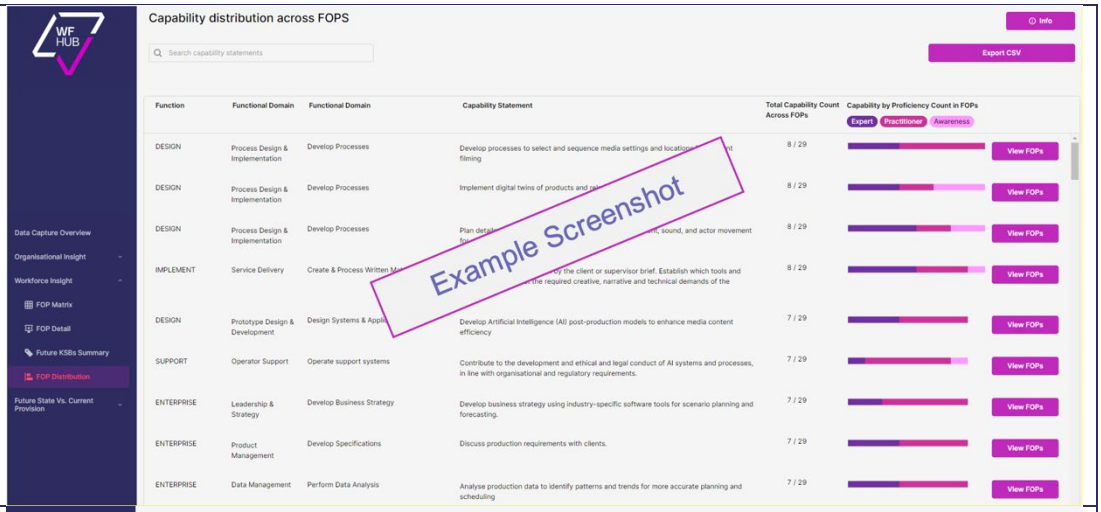




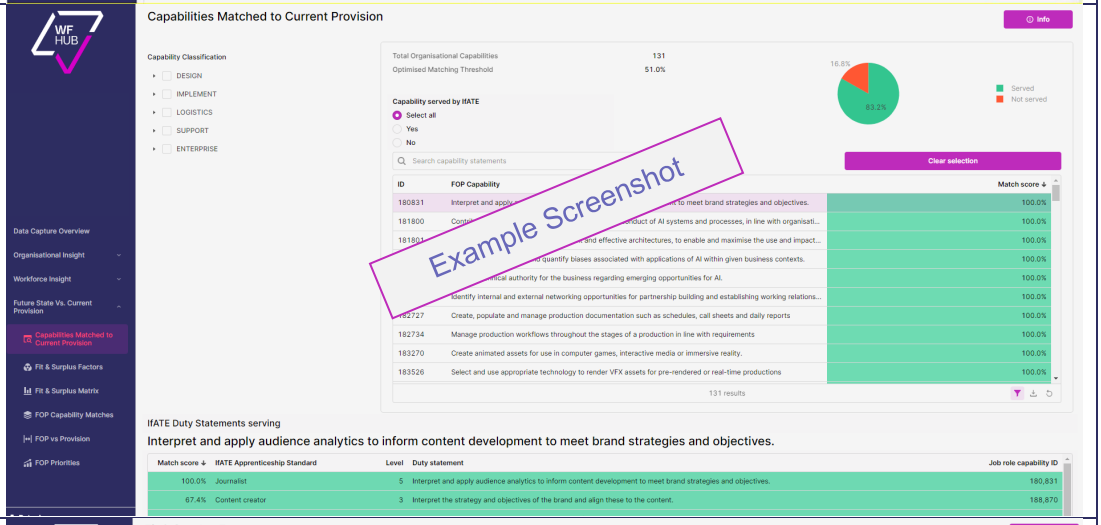
Future KSBs Summary



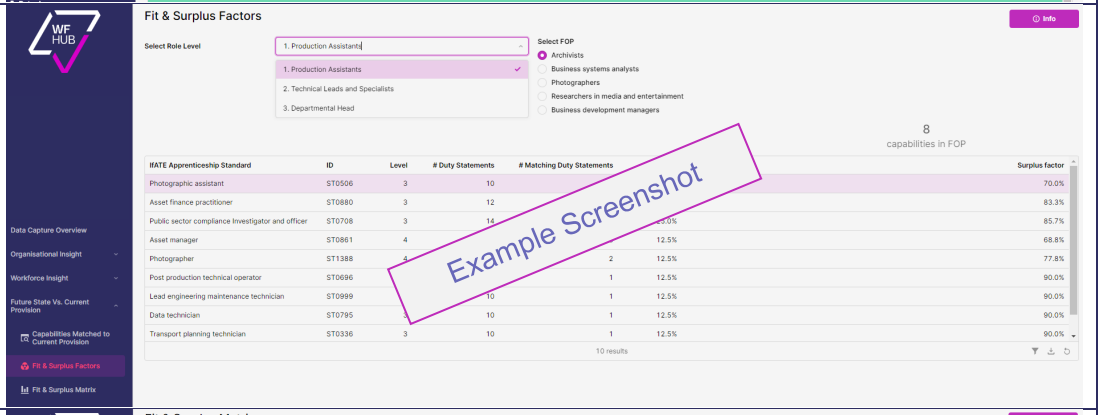
FOP Distribution



Capabilities Matched to Current Provision

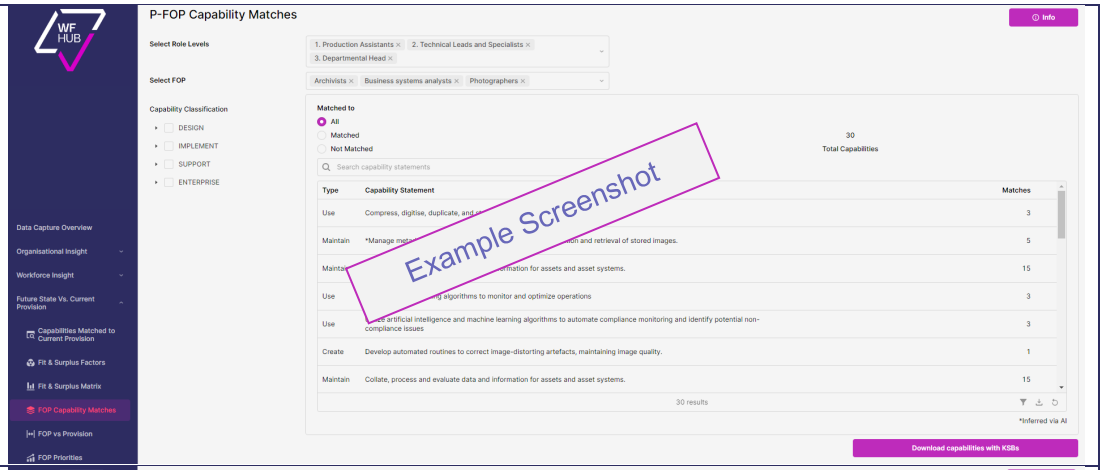


Fit Surplus Factors

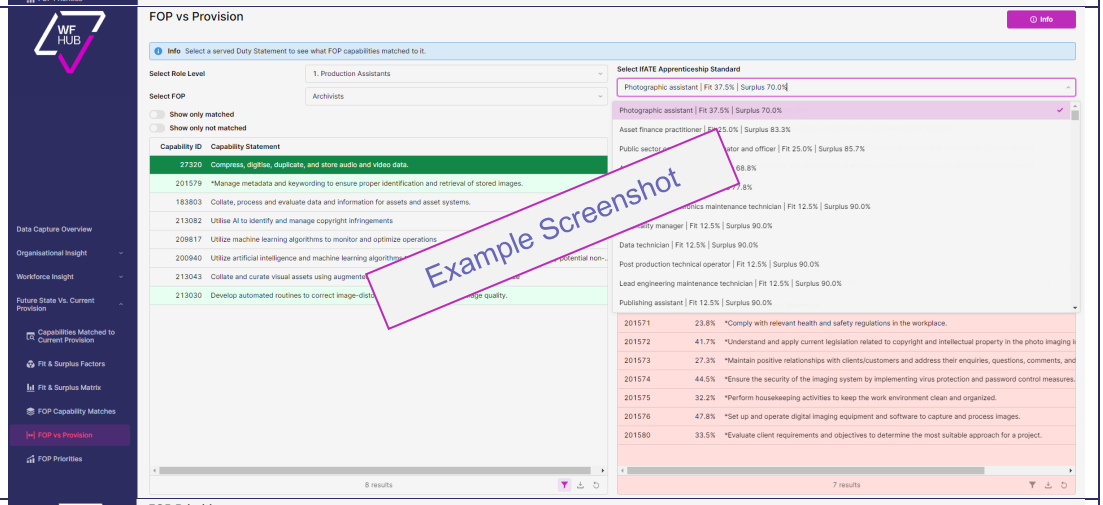


Fit Surplus Matrix

FOP Capability Matches



FOP vs Provision



FOP Priorities