# IDENTIFICATION AND ANALYSIS OF THE ADVANCED AND SUSTAINABLE MANUFACTURING FUTURE SKILLS ON THE ISLAND OF IRELAND

**Report prepared by Skillsvista**
2025

IRISH MANUFACTURING RESEARCH

lmetb
Louth and Meath Education and Training Board

AMTCE
Advanced Manufacturing Training Centre of Excellence

QUEEN'S UNIVERSITY BELFAST

ADVANCED MANUFACTURING INNOVATION CENTRE

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# Acknowledgements

LMETB-Advanced Manufacturing Training Centre of Excellence (AMTCE), Irish Manufacturing Research (IMR) and Queen's University -Advanced Manufacturing Innovation Centre (AMIC), would like to express their appreciation and gratitude to all those who have been instrumental in the development of this report "Identification and Analysis of the Advanced and Sustainable Manufacturing Future Skills on the Island of Ireland."

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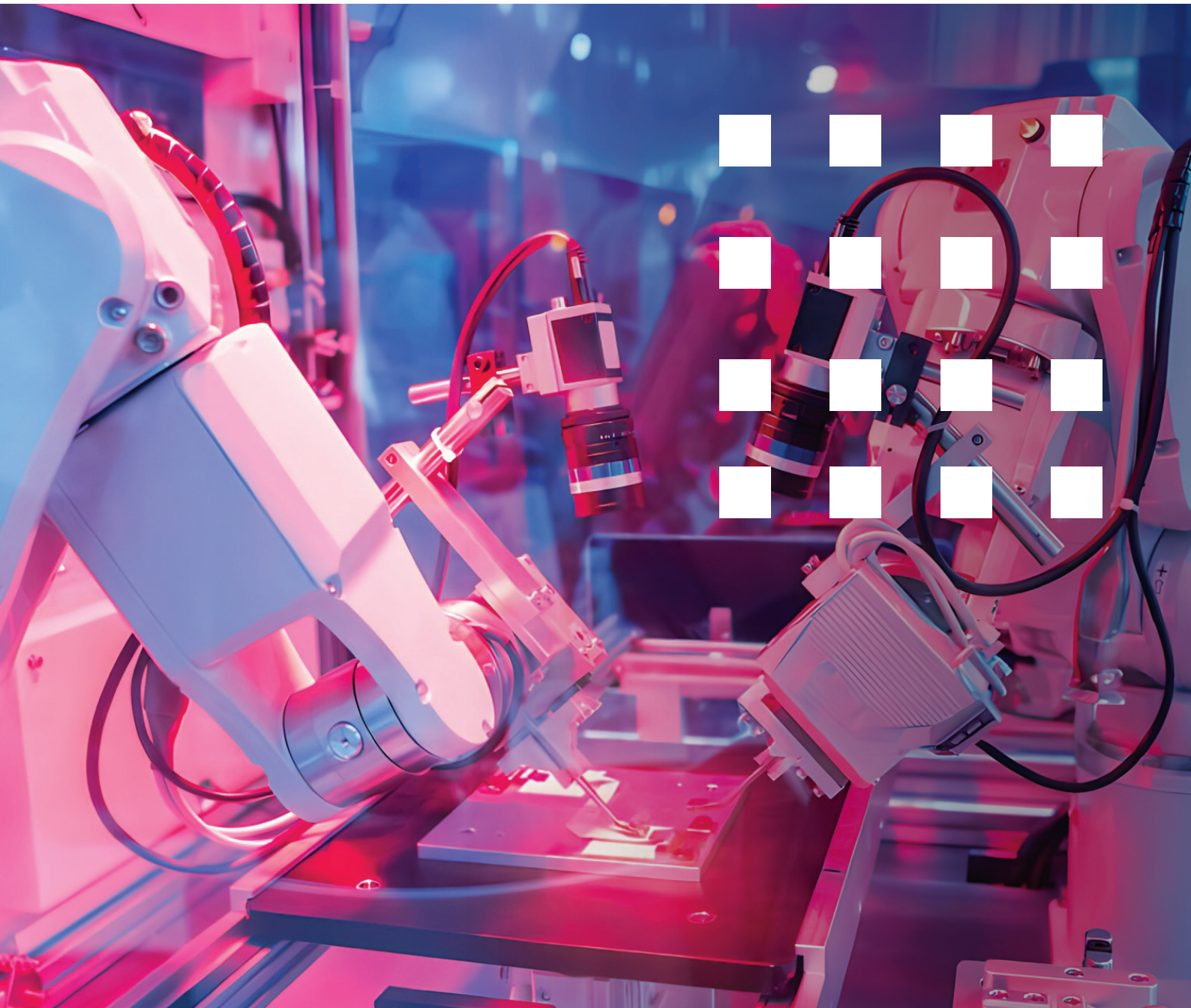
# 1 EXECUTIVE SUMMARY



# 1 Executive Summary

## A highly skilled inclusive workforce is vital to the future growth of the advanced and sustainable manufacturing sectors on the Island of Ireland.

The global demand for advanced skills is escalating, creating significant recruitment challenges, particularly in technology and process-driven industries. Countries are adopting coordinated strategies involving education interventions and industry partnerships, with essential collaboration among government, industry, and education providers. Despite these efforts, diversity issues, low student interest, and difficulties in filling specialised roles persist. Ireland and Northern Ireland faces similar challenges, especially in the technology sector and in the advanced manufacturing sector. Manufacturers in Ireland and Northern Ireland are facing dramatic challenges, driven by changing consumer demands, the rapid pace of advances in technologies of which AI, Robotics and Automation are an important part, and accelerating global competition.

The Ireland and Northern Ireland (sometimes herein termed as 'All-Island' or 'island of Ireland' when referred to collectively) Strategic Partners, LMETB -Advanced Manufacturing Training Centre of Excellence (AMTCE), Dundalk, Queens University Belfast- Advanced Manufacturing Innovation Centre (AMIC), Belfast Metropolitan College, Irish Manufacturing Research (IMR) Dublin, Southern Regional College, Newry and Portview Trade Centre, East Belfast, have taken a bold and innovative step forward in leading the technological, innovation and sustainability challenges and opportunities facing industry on the Island of Ireland through their collective efforts.

The strategic partners have stated that by 2030 the manufacturing landscape on the Island of Ireland will look significantly different. In particular, they believe that the advanced and sustainable manufacturing sector on the Island of Ireland needs to keep pace with the rapid increase in advanced automation, robotics, and the AI digital transformation.

The strategic partners also believe the importance of advanced automation and robotics lies in its wide-ranging impact on the capacity to maintain and expand competitive manufacturing. There are thousands of jobs at stake, with a widening gap between the robotics haves-and-have-nots. Medium and large manufacturers who have invested in new AI-driven robotics are reaping the results. Meanwhile, smaller manufacturers are facing challenges, despite the grants, supports and services available from the Government Departments/State Agencies. There is no doubt that AI, Robotics and Automation are revolutionising manufacturing, enhancing job satisfaction while at the same time increasing productivity.

However, it is a rapidly evolving environment where manufacturers can't afford to fall asleep at the wheel and outdated learning programmes may exacerbate any skills mismatch. Countries are implementing smart-manufacturing strategies and making investments to ensure that their manufacturing enterprises, large and small, are well-positioned.

If the Island of Ireland wishes to remain a leading smart manufacturing economy, policymakers must implement more robust, proactive, and coordinated and aligned public policies that support manufacturers. One of the key areas that needs greater support and collaboration is in the upskilling ecosystem[1]. A recent report by Skillnet[2] stated that 56% of Irish businesses have seen a shift in their core skills within the last

1 OECD Skills Strategy Ireland
2 Future Skills Challenges of Irish Business

two to three years, while half of business managers have accessed or sought upskilling or mentoring supports. 41% of businesses are facing difficulties in hiring employees with the required skills. While all industries have experienced shortages to some degree, the most impacted appear to be in manufacturing and engineering[3]. Many initiatives are underway to tackle these challenges, some of which will be described in this report. How can we utilise technology to supercharge some of the excellent initiatives that are taking place on the island of Ireland? Technology is driving unprecedented change in the manufacturing industry but can also support our education systems to better deliver for industry.

Advanced manufacturing can be defined as manufacturing that involves 'the intensive use of capital and knowledge while requiring a high level of technology utilisation and research & development. Advanced manufacturing, a key industry on the Island of Ireland with over 350,000 (90,000 North /260,000 South) people employed, is at the forefront of industry 4.0, referring to the "smart" and connected systems that are designed to support production in real-time, increasing productivity, efficiency, and sustainability.

The information in this report is based on the latest industry reports and discourse. The report presents the context of the industry and skill profiles that it requires. It presents in detail the numerous challenges facing the industry, including skills shortages, recruitment difficulties, maintaining pace with emerging technologies, and demographic challenges. It is clear that the skills required in this industry are rapidly evolving, with short shelf-lives for skills related to emerging technologies. These challenges are examined in the All-Island context as well as in a global sense. The report then examines the role that the training and education eco-system can play in supporting the sector and overcoming the challenges. The report also examines how government initiatives and supports can have a major impact on the industry, creating the right environment for education and industry to work in partnership to ensure businesses have the skilled workers they need to thrive on the island of Ireland.

Despite numerous initiatives to address skills gaps, significant shortages remain, worsened by declining student engagement in relevant studies. The report highlights the necessity for a cohesive strategy involving industry, government, and education sectors. It is clear that technology is needed to ensure that alignment is maintained between education and industry in terms of where skill gaps exist, and how best graduates and workers can be upskilled or reskilled depending on industry need. Industries are expected to embrace technology to remain competitive, therefore it is critical for the training and education sector to embrace technology that will allow them to support businesses and learners.

The sections below outline 4 key findings from the research, which will be of interest to various stakeholders. With each of these findings, a number of recommendations are provided which can act as a foundation from the challenges identified can be overcome. For some of the recommendations there are also descriptions of developments to-date and related proposals for consideration based on the recommendation.

3 Evaluation Of the Engineering Skills and Training Needs of Manufacturing and Construction Sectors in the Southeast

## 1.1 Finding 1: There is a current and increasing skills shortage

Persistent skills gaps are presenting major challenges for the advanced and sustainable manufacturing industry on the island of Ireland[4] and across Europe and the USA[5], limiting the sector's potential. Numerous surveys have highlighted that the availability of qualified and highly skilled workers is going to be an increasingly critical factor for the future of business success in advanced manufacturing in the coming years.

Skills shortages are a wider problem not just affecting the advanced and sustainable manufacturing industry. The issues identified in this report can be summarised as follows:

- Companies increasingly require data analysis skills, skills in automation, materials engineering, and process analysis. Companies still see the value in interpersonal skills, particularly communication, collaboration skills, critical thinking, problem-solving and an agile mindset.
- Manufacturers believe that young people are not coming through the education and training providers skills system with the necessary advanced and sustainable manufacturing skills.
- Manufacturers are not sufficiently working with education or skills providers to try and ensure their skills needs are met.
- Education and training providers report challenges keeping trainers' expertise and training equipment aligned with changes in industry, and the related shifting skills demand these changes create.
- Education and training Providers report challenges that new emerging technology equipment is ahead of the required curricula and training needed to provide the skills for the new technology.
- Many young people currently do not consider a career in manufacturing. Young women are three times less likely to consider a career in manufacturing than young men.

There are a number of reasons for these skills gaps including:

- There is an increasing acceleration of emerging technologies related to automation, data analyses and process design.
- There is an associated struggle to teach and maintain skills related to these new technologies and define new roles and skillsets.
- Courses are advertised on several systems which adds complexity to creating learning pathways for jobseekers, employees, and managers.

Solutions to this problem involve providing an effective combination of technical and transferable skills. Education and training providers must provide a combination of technical expertise/skills, and transferable skills that enhance one's ability to solve problems, work independently, and collaborate with others are required for the workplace of the future.

4 Midlands Advanced Manufacturing Survey 2022
5 The Kootenay Advanced Manufacturing Sector Assessment

Here are the top transferrable and technical skills identified in this report:

**Transferable Skills**

1. Analytical thinking and innovation
2. Active learning and learning strategies
3. Problem-solving
4. Critical thinking and analysis
5. Leadership and social influence
6. Resilience, stress tolerance, and flexibility
7. Reasoning, problem-solving, and ideation
8. Technical Skills
9. Cybersecurity awareness and resilience
10. Technology use, monitoring, and control
11. Technology design and programming
12. AI technical knowledge

The convergence of emerging technologies such as automation/ digitalisation and the skills connected with them (AI, materials engineering and robotic) is expected to drive unprecedented levels of innovation, efficiency, and sustainability in the advanced manufacturing industry, reshaping the way products are designed, produced, and consumed[6]. This rapid technology evolution is creating rapid changes in industry[7], which has knock on affects for the skills required in industry and what kind of education and training is required. Many organisations believe that advanced and sustainable manufacturing technologies and processes are currently impacting their skills needs. This is leading to a need for quicker turnaround times in terms of turning learners into workers.

6 IBEC Manufacturing in Ireland 2023
7 Deloitte: The future of work in manufacturing

## Recommendation 1.1:

**Matching Advanced and Sustainable Manufacturing Skills to Industry Needs**

This All-Island Industry 4.0 Future Skills Analysis report will ensure that the advanced and sustainable manufacturing skills training provided on the Island of Ireland aligns with the current and future needs of industries and addresses any disconnect between the skills being provided and the skills needed by employers.

## Proposal For Consideration

- It is proposed that there is a Bi-Annual Industry 4.0 Future Advanced and Sustainable Skills Analysis carried out, led by, and funded by the relevant Government Departments / Agencies / Key Stakeholders / Industry on the Island of Ireland.

## Recommendation 1.2:

**Curriculum Sharing and Development**

LMETB-AMTCE, IMR, AMIC, Southern Regional College (SRC), Belfast Metropolitan College and Portview Trade Centre have and will continue to develop and share key advanced manufacturing curricula that addresses identified employer's needs. Incorporating interactive learning methodologies, such as group projects, role-plays, and hands-on activities. LMETB are currently developing, funded by SOLAS, two (2) Micro- Credentials Curriculum in Robotics and Smart Factory, which they will make available to their strategic partners on the Island of Ireland.

## Developments To-Date

- Belfast Met, SRC, and LMETB-AMTCE are developing a proposal for the establishment of an All-Island Curriculum Development Unit for Advanced and Sustainable Manufacturing courses. It is planned that this will be included in their application to Peace Plus under Theme 6.1

## Proposal For Consideration

- Relevant Government Departments/ Agencies to consider the establishment of an All-Island Curricula Development Unit for the Advanced and Sustainable Manufacturing sectors.

## Recommendation 1.3:

**Cross Mapping of Craft Apprenticeships**

There are gaps in curricula content, accreditation on a number of the key existing craft apprenticeships on the Island of Ireland e.g. Electrical Apprenticeship resulting in non-acceptance of qualified craft persons in both jurisdictions on the Island of Ireland.

## Proposal For Consideration

- Relevant government departments/ agencies to review as a "pilot" both electrical apprenticeship curriculum and include all additional content, accreditation etc needed to ensure acceptance of the electrical apprentices' qualifications on the Island of Ireland.
- Consider potential to streamline acceptance criteria for other such apprenticeships.

## Recommendation 1.4:

**All-Island FET Apprenticeship Collaboration**

## Developments To-Date

- LMETB have developed the first FET All-Island Robotics and Automation Apprenticeship (RAA). This apprenticeship is due to commence in Dundalk in early 2025.
- SRC are currently cross mapping the RAA to a relevant qualification body in Northern Ireland and are planning to commence the RAA in September 2025.

## Proposal for Consideration

- It is proposed that the LMETB and SRC FET All-Island Robotics and Automation Apprenticeship (RAA) be open to all Employers and Apprentices on the Island of Ireland.
- It is proposed that consideration be given by the relevant Government Departments/ Agencies to the development of the next potential All-Island Apprenticeship in Modern Methods of Construction.
- Explore opportunities for other Cross-Border (Ireland and Northern Ireland) Apprenticeships.

## 1.2 Finding 2: The Recruitment Struggle

Organisations struggle to fill open positions due to numerous factors, including increased competition for workers, outdated perceptions about the industry (especially among young people and women) and new technologies requiring more technical skills. A recent Korn Ferry Study[8] indicates that there will potentially be a global talent deficit of more than 85.2 million Workers by 2030 even if we fully embrace AI which means the problem is going to get worse.

8 Korn Ferry's Global Talent Crunch study

## Recommendation 2.1:

**Development of Clear Inclusion Pathways into Advanced Manufacturing Careers on the Island of Ireland**

The advanced and sustainable manufacturing sectors and their related skills needs offers a real opportunity to education and training providers to be committed to diversity and equality that will attract and support current and future employees from a wide range of talented people irrespective of religion or belief, gender, gender identity, age, disability, sexual orientation, ethnic origin, political belief, socio economic status, relationship status or caring responsibilities.

While education and training are seen as a key factor in addressing the skills shortage, there are a number of challenges including the shortage of trainers and high quality resources and course content. This speaks to a need for revised/updated student and graduate career pathways, for example greater focus on a Micro-Credentials and Apprenticeship Frameworks. Learners are no-longer learners just during school or college, they are now life-long learners, and perhaps micro-credentials/apprenticeships will allow certain workers to enter the workforce faster, and then scaffold their learning as needed while they work.

## Developments To-Date

**The Advanced Manufacturing Pathways Schools Programme**

- Belfast Unemployed Resource Centre (BURC) and LMETB have run the first All-Island Advanced Manufacturing Pathways Schools Programme for 8 schools (4N/4S) in 23/24 funded by the International Fund for Ireland (IFI) and this will expand this to 12 schools in the 24/25 school year.
- LMETB and Kerry have run the programme for up to 20 schools in 23/24 and plan to continue this in 24/25 school year.
- IMR have also been successfully running this innovative schools programme for a number of years.

**Advanced Manufacturing Technician Programme for Women**

- LMETB-AMTCE are running a very successful advanced manufacturing programme for women with a very high employment outcome of 80% plus.

**Community Advanced Manufacturing Technician Programme**

- LMETB-AMTCE are running a very successful advanced manufacturing programme (L4 QQI) for hard-to-reach young people with a very high employment outcome of 80% plus.
- Portview Trade Centre have received funding from the International Fund for Ireland to commence the LMETB-AMTCE advanced manufacturing programme in October 2024.

## Proposal For Consideration

- It is proposed that the relevant Government Departments/Agencies participate in the Advanced Manufacturing Pathways Schools Programme from 24/25 onwards, review/ evaluate the programme, and support the further expansion of this advanced and sustainable manufacturing talent pipeline schools programme on an All-Island basis.
- LMETB to share the curricula for the advanced manufacturing programmes for women and young people with all partners.

## Recommendation 2.2:

**The Importance of Strategically Directed Local Partnerships**

Industry should form partnerships with schools and colleges/ education & training providers to integrate classroom instruction and relevant work experience. These partnerships can take the form of direct collaboration with local schools and colleges/ education & training providers who provide certification programmes, therefore facilitating recruitment through a wide range of pipelines including, second-level schools, local colleges, and education & training providers. However, a more strategic All-Island wide approach could be used to foster and develop partnerships between industry and colleges /education & training providers to create robust and clear talent pipelines to the advanced manufacturing sector on the Island of Ireland. The key objective is fostering a culture of education& training and lifelong learning.

## Proposal For Consideration

Government Departments/Agencies to consider encouraging and supporting local schools and colleges/education & training providers and manufacturers to actively engage in discussions that address specific talent-pool needs and foster inclusivity for all people in their communities. Talent shortages and mismatches of knowledge, skills and abilities can be solved when local teams leverage the All-Island best practices and strategies, including outreach, onboarding programs and training for reskilling and upskilling.

## 1.3 Finding 3: Fractured and Fragmented Skills System

While skills gaps are recognised and well researched across the manufacturing industry (as evidenced by the research reviewed in this report), there is a lack of joined up thinking among stakeholders in order to align on a strategic response to skills shortages[9]. Many skills eco-systems on the Island of Ireland are complex and have many stakeholders, with many agencies and forums struggling to communicate with each other in terms of their provisions and needs.

9 OECD Skills Strategy Ireland

## Recommendation 3.1:

**All-Island Aligned Skills Policy and Skills Development – The Time is Now**

There are significant differences on the Island of Ireland in terms of range/type of programmes, criteria, eligibility, funding, and access to quality skills training for employed, apprentices and unemployed people on the Island of Ireland. The "Time is Now" for the relevant government departments/agencies and key education and training providers on the Island of Ireland to collaborate together with the objective of having an integrated and open access skills system for all businesses and the current and future workforce. LMETB-AMTCE, AMIC, Southern Regional College (SRC) and Portview Trade Centre have been working together on this key issue and have submitted a range of innovative and realistic proposals that would commence the journey on having one Skills Aligned Policy on the Island of Ireland.

Workforce training programmes developed and provided on the Island of Ireland for advanced and sustainable manufacturing skills will have the highest impact if they are developed in collaboration with advanced technology implementation efforts by manufacturing and sustainable companies and their industry representatives.

Currently employers and their employees cannot participate in training courses run in the other jurisdiction on the Island of Ireland. This is causing a major challenge to employers and their employees due to the lack of relevant and/or access to advanced and sustainable manufacturing courses in their own jurisdiction.

## Proposal for Consideration

- Relevant Government Departments/ Agencies to agree on a pilot and fund All-Island Advanced and Sustainable Manufacturing Training initiatives for employers and employees that will be developed/delivered by the advanced and sustainable stakeholders including LMETB-AMTCE, IMR, AMIC, Southern Regional College, Belfast Metropolitan College, and Portview Trade Centre.
- Relevant Government Departments/ Agencies to review and evaluate this "pilot" initiative that will contribute to the development of an All-Island Skills Development Policy and Plan going forward.

Belfast Metropolitan College are leading, in collaboration with a number of cross-border strategic partners including LMETB's AMTCE, the development of a key skills initiative called C-CASE which stands for 'Cross- Border - Collaboration to Activate the Skills Ecosystem' which will be submitted in 2025 to Peace Plus 6.1.

## Recommendation 3.2:

**More Efficient Skills Reporting**

Formal research projects, such as some of the ones studied as part of this report, may not have quick enough turnaround times to provide information which can be responded to quickly. In order to quickly recognise skill gaps and respond to them, digital tools and platforms are required for organisations to efficiently profile the roles and the skills they currently have within their organisation against what roles and skills are required. This speaks to a dynamic approach, whereby organisation not only recognise current skill gaps, but can also anticipate future skills gaps. Real-time digital tools will allow organisations to anticipate skill shifts as they are occurring—rather than predicting the future—and adapt to those shifts in an iterative, course-corrective way. Of course, the success of such digital tools calls for two-way skills transparency between the organisation (e.g., what skills it needs, what skills it no longer needs, where it's needs are unknown) and the employee (e.g., current skills and interests).

## Developments To-Date

- LMETB-AMTCE have "piloted" an Employer Skills Platform that identifies the current skills, skills gaps and future skills needs of employees and relate these to existing training interventions that addresses these current and future skills gaps. Manufacturing NI are commencing this pilot with one of their clients in 2024.

## Proposal For Consideration

- There should be one fully aligned skills reporting and research system on the Island of Ireland for the advanced and sustainable manufacturing sectors.
- Consideration should be given to expanding an employer/employee skills identification system with the relevant stakeholders in the advanced and sustainable manufacturing ecosystem on the Island of Ireland.
- Digital solutions can be utilised to recognise and flag skills gap before they become apparent and impactful and provide a platform for communication between education and industry, whereby the skills gaps within an industry can be related directly to education and training opportunities (and hence recognise potential gaps in the education and training offerings).
- Companies need to do their own in-depth skills audit using digital support tools where necessary to quantify and codify skills and skill requirements.

## 1.4 Finding 4: The Need for Strong Connections within Industry and between Industry and Academia

With this 'age of acceleration', there is a need for an agile cyclical process with three crucial apexes. Firstly, industry needs to recognise skills shortages, not only for current skill shortages but potential future skill shortages. Secondly, this recognition of skills shortages needs to be directly communicated to education and training bodies, who in turn need to adjust, update, and create curricula to meet the demand for skills. Finally, the non-informed learner (entering education) needs to be transformed into an equipped worker (leaving education) in a short a time as possible to meet the current demands of industry. One estimate puts the half-life of a learned skill at about 5-6 years—meaning 5 years from now, the current technical skill set of a workforce will be worth about half as much as it is today, and this will continue to get shorter due to the pace of technological advancements.

## Recommendation 4.1:

**Network Building and Stakeholder Collaboration (Horizontal and Vertical)**

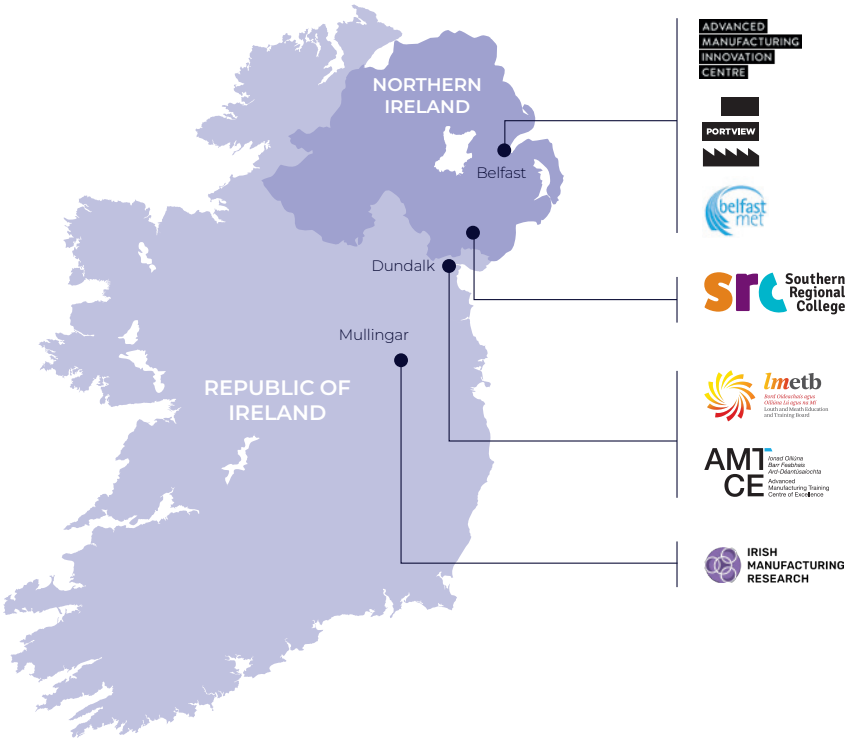
Industry information can only feed into curriculum changes by having closer ties within industry and between industry and academia. This requires formal structures where regular industry reporting can be fed into the analyses and review of curricula. To sense shifting skills, organisations can facilitate cross-organisational networks of stakeholders that can address skills gaps as they arise. Again, digital tools can support this by allowing stakeholders to input and observe information in real time. This collaboration may involve companies up and down the same supply chain working together to find solutions to the skills gaps -– what can be termed 'vertical collaboration', or companies with similar roles and business cases working together – referred to as 'horizontal collaboration'.

## Developments To-Date

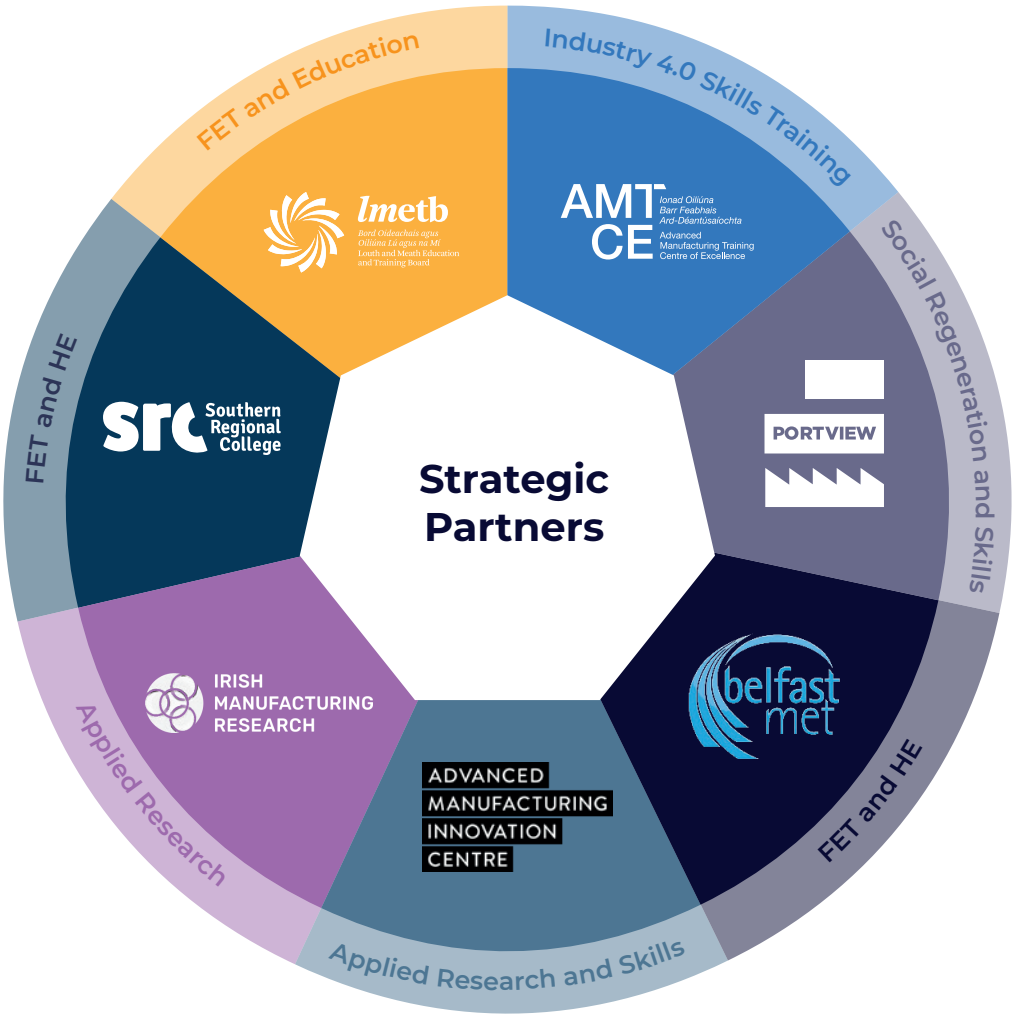
**Island of Ireland Advanced and Sustainable Strategic Partnerships**

- The Strategic Partners, LMETB -Advanced Manufacturing Training Centre of Excellence (AMTCE), Advanced Manufacturing Innovation Centre (AMIC), Irish Manufacturing Research (IMR) , Southern Regional College , Belfast Metropolitan College and Portview Trade Centre, have taken a bold step forward in leading the technological, innovation and sustainability challenges and opportunities facing industry working together as Advanced and Sustainable Manufacturing Training & Business Centres on the Dublin to Belfast Skills Corridor.
- The strategic partners provide the connections, infrastructure, programmes, supports, and services needed to solve the advanced and sustainable manufacturing industry's most pressing challenges.
- By focusing on current and future workforce development, the strategic partnership supports the development of a highly skilled inclusive workforce and business solutions for the advanced and sustainable manufacturing and construction sectors on the Island of Ireland.

The Locations of the All-Island Strategic Partners are shown below.



The Remits of Strategic Partners are also shown below.




## Proposal For Consideration

- The Advanced and Sustainable Manufacturing Training & Business Centres Strategic Partners to be open to expand their network to include other stakeholders and industry clusters, etc., in the advanced manufacturing and sustainable ecosystem on the Ireland of Ireland and globally.

## Recommendation 4.2:

**The Role of National Agencies to Bridge Industry and Academia**

It is important that data from real time digital tools are provided to curriculum designers and education advocates. In the context of the Island of Ireland, the role stakeholders such as the Regional Colleges in Northern Ireland, Education and Training Boards (ETBs), Skillnets, and other Skills Education and Training agencies in Ireland are important here. Greater awareness is needed about the different offerings these bodies provide.

## Proposals For Consideration

- Government Departments/Agencies should consider having a central system that has all of the courses from the different training entities. There could be a search function so that people can quickly see all of the courses that are relevant to the area that they are looking at with filters for location, level, and cost. This would help the Governments Departments/Agencies to advertise key initiatives and people will only have 1 location to remember. It would simplify the learning pathway for everyone, and each training entity can continue to maintain and create new content for their respective parts of the ecosystem.

## Recommendation 4.3:

**All-Island Advanced and Sustainable Promotion and Awareness Campaigns**

Based on the LMETB-AMTCE, IMR, AMIC, SRC, Belfast Metropolitan College and Portview Trade Centre experience to-date, encouraging employers and/or employees to participate in skills training programmes can be a challenge. Factors affecting participation include like lack of awareness, motivation, or accessibility impacts engagement rates.

## Developments To-Date

**All-Island Advanced and Sustainable Manufacturing Showcasing Events**

- Key Stakeholders are working together to identify opportunities for showcasing events and initiatives. For example, LMETB-AMTCE, SRC and Belfast Met are considering opportunities to collaborate on showcasing events and activity.

## Proposal For Consideration

- That the “Pilot “All-Ireland Advanced and Sustainable Manufacturing Training Initiatives” proposed in this report are promoted by the relevant government departments/agencies together with LMETB-AMTCE, IMR, AMIC, Southern Regional College, Belfast Metropolitan College, and Portview Trade Centre.

## Recommendation 4.4:

**Sharing of Advanced and Sustainable Manufacturing Facilities and Equipment**

## Developments To-Date

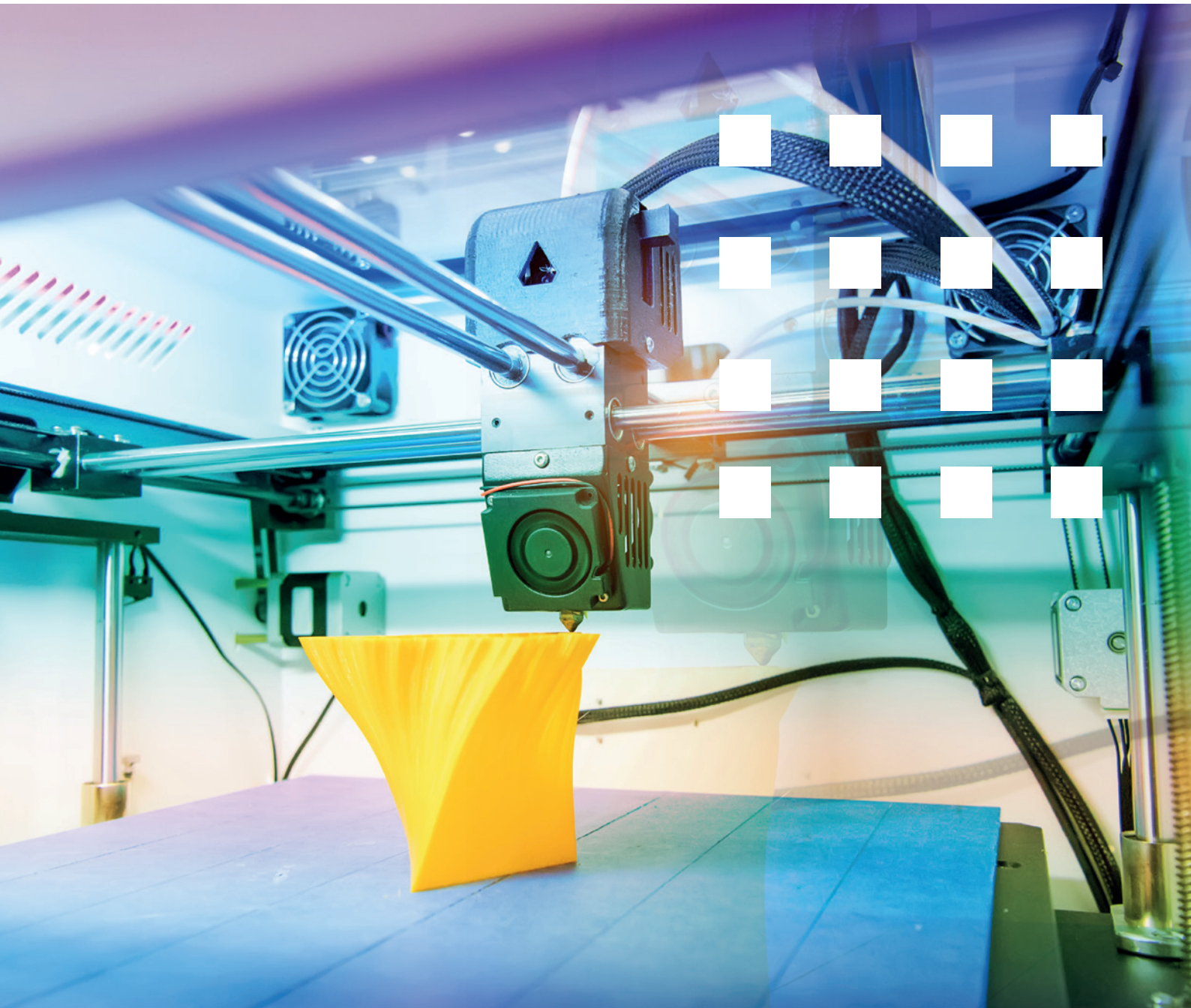
A key LMETB-AMTCE, IMR, AMIC, Southern Regional College, Belfast Metropolitan College and Portview Trade Centre learning experience to-date is the need of sharing of their facilities, equipment, technical advice, virtual classroom etc. The capital cost of advanced and sustainability equipment is high and increasing. It is not viable nor affordable that each partner procures the same equipment, and it is advisable and efficient that this equipment is shared by the partners with one another.

For example, LMETB-AMTCE has a Cybersecurity Security Operations Centre (SOC), Virtual Classroom and a 3D Construction Printer, AMIC has and will continue to procure equipment relevant to its core capability areas of Digital Factory, Smart Design, Sustainable Composites and Polymers and Nanotechnology and Photonics, IMR has XR (AR/VR) Lab and recording studio.

## Proposal for Consideration

- That a database be established of all the advanced manufacturing facilities and equipment in the LMETB-AMTCE, IMR, AMIC, Southern Regional College, Belfast Metropolitan College, and Portview Trade Centre. The data base should be made available to all the partners, stakeholders, networks/clusters, employers etc on the Island of Ireland.

# 2 INTRODUCTION



# 2 Introduction

## 2.1 Background and Scope

The global demand for workers with advanced skills is high, leading to significant challenges in filling positions in a number of industries, especially industries with high demands for technology and process skills. Many countries are adopting coordinated approaches, which may involve various education system interventions and industry partnerships. Regardless of approach, collaboration between government, industry and education providers is crucial for a robust advanced skills pipeline. Despite these efforts, diversity issues, low student interest, and difficulty filling specialised roles persist.

The island of Ireland faces similar challenges, with many recent skills reports indicating that a majority of companies in the technology sector face recruitment challenges. The advanced manufacturing industry is one such example. Advanced manufacturing requires the utilisation of innovative technologies and methods, such as artificial intelligence and composite material engineering, to improve and enhance competitiveness within the manufacturing sector. The advanced manufacturing industry is of major importance to the island of Ireland. There are 260,000 people employed in the Irish manufacturing sector, accounting for over 12% of total employment in the economy. The purpose of this report is to gather and synthesise information related to the state of skills need and skills development within the advanced manufacturing industry.

The report seeks to answer a number of questions including how advanced manufacturing will change in the future, how technological and operational change will impact the future of manufacturing work, how skill needs will evolve, and how training and education requirements will change? The scope will focus on the advanced manufacturing industry specifically with some recommendations from other industries that have demonstrated best practices. The research will involve desktop research focused on industry reports and a sampling of the current discourse form the business and education press. We will analyse and synthesise the key themes emerging from the research to identify current and future trends, as well as some recommendations around sector needs.

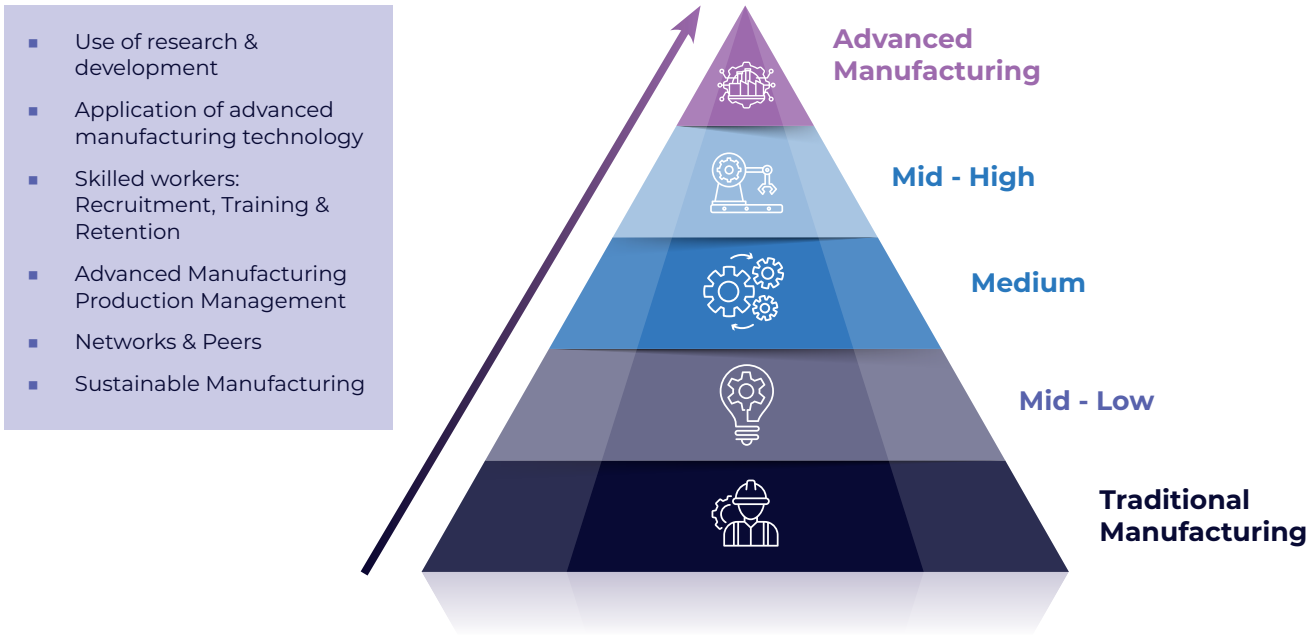
Throughout the research phase of this report, we observed activity aimed at addressing the skills gaps and creating a more cohesive eco-system in which skills demands are identified and met. There are numerous initiatives underway, and all should be commended for their efforts and recognition of the urgency of the issue. However, despite these initiatives, there are still stark skills shortages. There has been a decline in learners engaging in studies related to skills required in the advanced manufacturing industry, which flows onto low numbers graduating. It is evident that Ireland needs to move beyond a fragmented approach and embrace a more collaborative and coordinated strategy that encompasses the collective efforts of industry, government, and the education sector. A key takeaway from this report is the need for industry to collaborate within its ranks and align towards a more cohesive approach to meeting skills demands. The challenges facing the advanced manufacturing industry demands a united approach where resources and knowledge are shared by utilising the power of modern data-driven technology. Collaboration with government and the education sector is also crucial in shaping policies and providing vital infrastructure for effective change. The recommendations included in this report serve as a roadmap towards reducing the skills shortages facing the advanced manufacturing industry.

## 2.2 What is Advanced Manufacturing?

The advanced manufacturing sector can be defined as manufacturing that involves 'the intensive use of capital and knowledge while requiring a high level of technology utilisation and Research & Development'[10]. TWI defines advanced manufacturing as the practice of using innovative technologies and methods, such as artificial intelligence and composite material engineering, to improve and enhance competitiveness within the manufacturing sector.[11] From these definitions we can infer that advancement in cutting edge technology plays a critical role in advanced manufacturing. In terms of what businesses fall under the definition of advanced manufacturing, this is not as easy to discern. The 2023 Kootenay Advanced Manufacturing Sector Assessment refers to this point. During their research into the sector, they noticed that the definition of advanced manufacturing was not clear and precise. Through their analysis of literature and survey data they discovered that some businesses in the sector did not fit neatly into specific sub-sectors of advanced manufacturing, yet they still considered themselves part of the sector. This raised questions about how to determine if a business falls within the advanced manufacturing sector. They provide a useful diagram (Figure 1) that helps to differentiate between more traditional manufacturing industries and those that are considered advanced. They posit that the manufacturing sector operates along

10 https://assets.publishing.service.gov.uk/media/5a801075ed915d74e33f83c7/150626_AM_SLMI_report.pdf
11 https://www.twi-global.com/technical-knowledge/faqs/faq-what-is-advanced-manufacturing

***Figure 1:*** *The spectrum of manufacturing industries and their characteristics*



a spectrum that encapsulates different levels of sophistication and technological advancement, ranging from traditional manufacturing to mid-low, medium, mid-high, and advanced manufacturing. While the adoption of advanced technology for product development is a clear indicator of belonging to the advanced end of the spectrum, there are multiple pathways for businesses to advance within this spectrum.

The triangle shows that Research & Development into advanced technology as well as application of this advanced technology are vital criteria for a business to be considered part of the advanced manufacturing sector. Sustainability is also considered a fundamental consideration.

With this need for advanced research and development and the integration of technologies comes the need for adequate learning pathways to ensure a capable workforce within the sector. This necessitates providing appropriate learning pathways to ensure that potential and current employees possess the latest knowledge and skills required to do their jobs effectively. It also involves implementing strategic recruitment processes to attract skilled talent, offering cutting-edge training programs to enhance skills, and providing attractive benefits to promote employee retention. There may also be a short shelf-life for modern skills related to modern technologies, with some tech-related skills remaining relevant and required for only 3-5 years at a time. While these challenges are not unique to this sector, the advanced manufacturing industry can be exposed to exacerbated challenges due to the rapid change of pace with modern technology, increased pace of automation/digitalisation and the difficulty in maintaining skilled labour pools in a highly competitive market. This report seeks to understand the challenges and needs of the advanced manufacturing industry in both the Irish context and the international context.

## 2.3 Advanced Manufacturing Industry Skills Landscape

Firstly, it would be helpful to outline what kind of skills are required in the advanced manufacturing industry. Table 1 presents an approximate outline of the various competence areas, and the skills within those areas that could be considered as critical within the advanced manufacturing industry. This is not intended to be an exhaustive map, but more an indication of current and future skill areas to provide some context.

*“The advanced manufacturing industry can be exposed to exacerbated challenges due to the rapid change of pace with modern technology, increased pace of automation/ digitalisation and the difficulty in maintaining skilled labour pools in a highly competitive market.*

***Table 1:*** *Competence areas and skills in the advanced manufacturing industry*

| Competence Area | Examples of Skills | Typical Time to Completion |
|---|---|---|
| **Technology** | Cloud and Computing<br>Comms/Network<br>Coding<br>Smart Nano<br>Robotics/Automation<br>Digital Twins<br>Smart Design | AI/ML<br>AR/VR<br>IoT<br>Sensors<br>CNC<br>Data Science<br>Vision Systems |
| **Process** | Connected Supply Chain<br>Lean six sigma | Precision Metrology |
| **Engineering** | Electrical<br>Electronic<br>Process<br>Fabrication<br>Mechanical | Software<br>CAD<br>CNC<br>Materials<br>Digital Twins |
| **Security** | Cyber-Security<br>Tracking | Hygiene |
| **Food and Drink** | Processing<br>Packaging | Mechanical<br>Life Cycle Assessment (LCA) |
| **Sustainability** | Environmental Engineers<br>Net Zero | Sustainable Polymers and Composites |
| **Transversal** | Business Strategy<br>PM and Agile Practice | Governance<br>Supply and Logistics Management |

According to Michael Gretczko, principal and chief business architect at Deloitte Consulting, "The human skills and capabilities required to build, manage, and optimise these machines and processes will have to change as well. "We are on the cusp of one of the most substantial shifts in how things are made, the workforce of the factory of the future will look markedly different than it has looked since the dawn of the Industrial Revolution." Taking the semiconductor industry as an example, there are up to 1,500 steps to follow to create a standard microchip, with 100 to 500 variables in each step. This necessitates intelligent machinery, integrated automation and a robust observation and measurement process. Manufacturers need people with specialised skills to oversee operations, maintain quality, and solve production problems. This also extends to other manufacturing operations which are increasingly using the kind of tech that would previously only be seen in high-

tech manufacturing. The production of everything from cars to yogurt typically entails pursuing a similarly advanced method for production which integrates innovative technologies such as AI and machine learning, digital twins, robotics and automation, laser machining, nanotech, and advanced composite materials. Roles associated with these technologies will be discussed further in Section 3.5, but for now we can be assured that the modern advanced manufacturing worker (regardless of what is being produced) skillsets related to these technologies.

There are also a broad range of advanced digital skills required by workers in the manufacturing industry. Advanced digital skills are those required to control and create with digital technologies[12]. These skills include software programming, developing algorithms, managing, and analysing large amounts of data, implementing, and managing digital hardware, networks, and information security. These are skills required by the digital technology workforce, not the more general digital skills required by the wider population to operate in an ever increasing digital economy. Examples of advanced digital skills considered to be in demand according to the New Zealand 2023 Digital Skills Survey (2023) are below.

- Software development (including Full Stack, python, AWS and .net)
- Software Engineering
- Support, testing and training
- Business analysis
- Management and sales
- Data/Network Architecture
- Data analysis
- Cybersecurity analysis
- Project management

It is also clear that specific skillsets related to the above technologies is not enough. Emerging technology is mutating traditional jobs into hybrid jobs that require skill sets from multiple domains and functions beyond just 'technical' knowledge. A mix of capabilities is in demand, merging new technical proficiencies with process skills such as data analysis and visualisation and 21st century (transversal) skills. These skills include complex problem-solving, collaboration (both with humans and robots) business acumen, innovation and experimentation, design thinking, planning and continuous improvement mindset. The World Economic Forum has found that the average half-life of a skill these days is 6 years, and that's projected to decrease to just 2.5 years by 2030[13]. All of this means that in less than 10 years, the average person will need to learn new skills more than twice as often as they do today. As technology advances the tools to provide suitable learning interventions in the workplace are more readily available. This leads to a number of core transversal skills being necessary within the industry, such as communication skills, teamworking, leadership skills, creativity, technological literacy, etc. Two of the most important skills, however, will be the ability to learn and to adapt to change.

According to the World Economic Forum, to attract and retain the right talent we need to:

- View people and technology as partners – technology is not there to replace people and our people need to know that
- Leverage technology to support or augment people in their jobs – identify how technology can help us do what we do better or more quickly or more safely.
- Plan for life-long learning and use technology to address employees' needs.

12 https://nztech.org.nz/wp-content/uploads/sites/8/2023/08/NZTech-Digital-Skills-Report_final.pdf

13 https://www.tilr.com/blog/the-future-of-work

## 2.4 Addressing skills gaps through learning provision

With skill needs changing at this rate, the way in which we address them needs to match the rate of change. While formal education can provide a solid basis in knowledge there is an ever increasing need to regularly upskill and, at times, to reskill. It is here that the change is needed. What is on offer needs to be available quickly and also flexibly. This has resulted in the development of micro-credentials and micro-qualifications which are more responsive to changing needs than full degree and master's programmes. There is also a need for more bite-sized and flexible learning interventions, many of which need to be available on the job or while someone is in the workplace.

This report will seek to link current identified skills gap to current learning provisions, and how both need and provision must be linked through clever government strategies, collaboration between industry and education providers, and through the support of technology. According to Deloitte[14], the quickening pace of technology development and implementation dramatically reduces the shelf life of training and increases the lag between industry workforce needs and workforce training to keep up, workers must constantly learn new skills, and advanced manufacturing training must adapt, grow, and anticipate them, while a recent quote from John Liu, principal investigator in the MIT Learning Engineering and Practice Group, shows the pressure academia are under to provide these multi-skilled workers, he said that *"industry leaders tell me they wish their technicians had more analytical skills and their engineers had more shop floor skills."*

> *"Industry leaders tell me they wish their technicians had more analytical skills and their engineers had more shop floor skills.*
>
> **John Liu**

The constant influx of technology is mutating traditional jobs into hybrid jobs that require skill sets from multiple domains and functions that never used to be found in the same job description.

Addressing the challenges related to skills gaps in the advanced manufacturing industry requires a multi-faceted approach involving collaboration between industry and learning providers with support from government initiatives. Such initiatives may include investing in education and training programs, promoting diversity and inclusion initiatives, fostering industry-academic partnerships, and providing incentives for skills development and talent retention. Indeed, surveys of industry refer to their desire for stronger connections with educational institutes in order to closely align the needs of industry to the skills being taught at third level and further education. Throughout this report we will refer to different learning pathways and provisions a potential worker may need to gain the skills necessary to fill a role in the advanced manufacturing sector. We may use the terms learning, training, and

14 https://www.sap.com/insights/viewpoints/advanced-manufacturing-skills-workers-will-need.html

education interchangeably, but in this sense, we could mean any of the following learning provisions described in Table 2 which exist within the education and training eco-system in a typical jurisdiction.

These provisions require different levels of standardisation, regulation, and accreditation; however, each learning provision has its place depending on the type of skill or skillset that needs to be acquired by the learner.

***Table 2:*** *Learning provision examples*

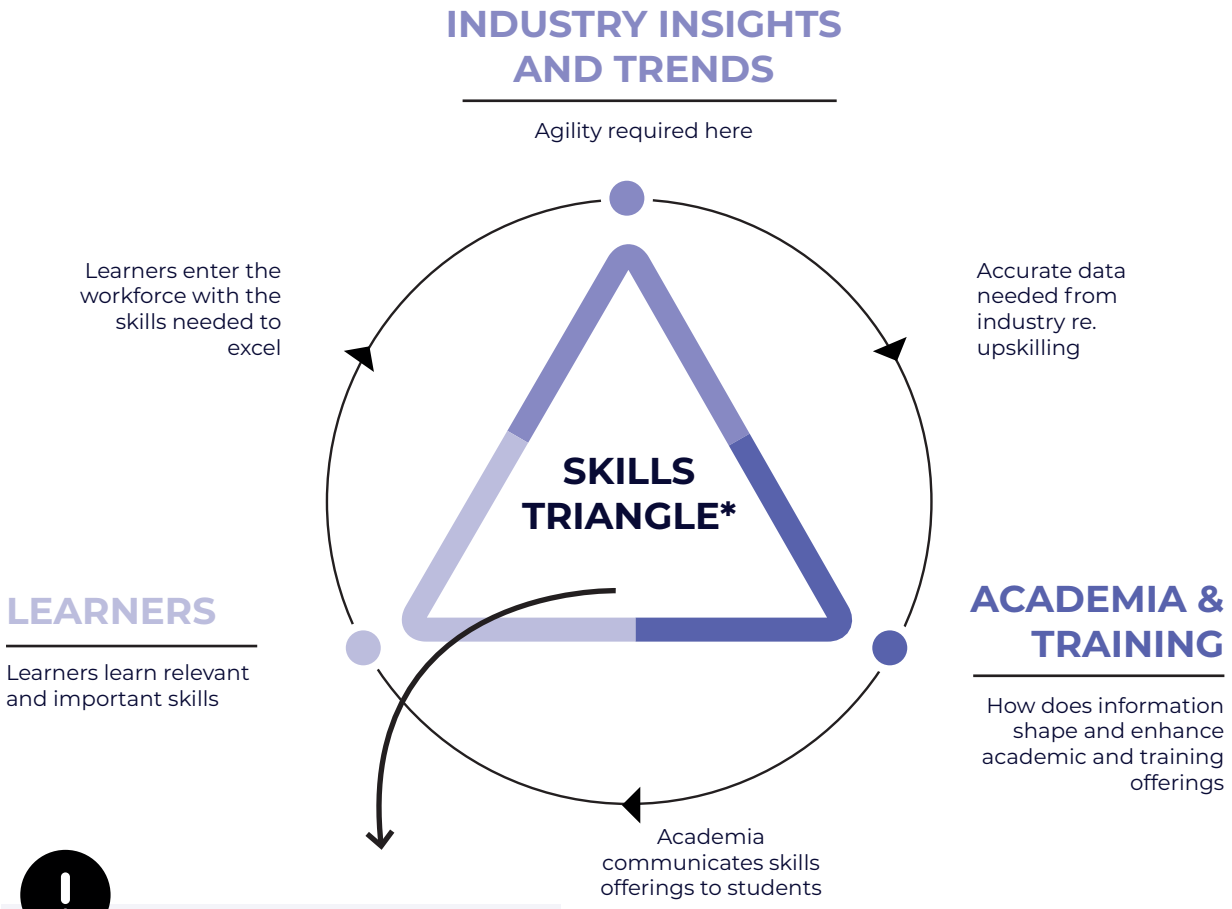
| Learning Provision Type | Examples of Relevance to Advanced Manufacturing | Typical Time to Completion |
|---|---|---|
| **Undergraduate and Graduate Degrees** | **Engineering Degrees:** Degrees in mechanical, electrical, industrial, or manufacturing engineering can provide a strong foundation in the principles and practices of advanced manufacturing. | 3-5 years |
| **Vocational and Technical Schools** | **Certificate Programs:** These programs offer specialized training in manufacturing technologies, for example covering CNC machining, robotics, and automation. | 1-2 years |
| **Apprenticeships and On-the-Job Training** | **Registered Apprenticeships:** These programs combine paid on-the-job training with classroom instruction, allowing participants to earn while they learn.<br>**Internships:** Many companies offer internships for students and recent graduates to gain practical experience in a manufacturing environment. | Up to 5 years for apprenticeships<br>Internships 1-12 months |
| **Industry Certifications** | **Certified Manufacturing Technologist (CMfgT):** For example, offered by the Society of MTU Cork (awarded by the Society of Manufacturing Engineers), this certification demonstrates knowledge and competency in manufacturing technologies and processes.<br>**Six Sigma and Lean Manufacturing Certifications:** These certifications focus on process improvement and efficiency, which are crucial in advanced manufacturing. | 6 months – 2 years |

| Learning Provision Type | | Typical Time to Completion |
|---|---|---|
| **Online Courses and MOOCs** | **Massive Open Online Courses (MOOCs):** Platforms like Coursera, edX, and Udacity offer courses in manufacturing technologies, robotics, data analysis, and more, often developed by and accredited by universities. Many universities themselves also offer online programs that provide flexibility for working professionals.<br>**Micro-Credentials:** Short courses in many subject areas can be taken through platforms like LinkedIn Learning and Skillshare. | Up to 6 months |
| **Industry Continuous Professional Development (CPD) and Networking** | **Courses:** Offered by Skillnets and ETB (see Section 4.1)<br>**Workshops and Seminars:** Attending industry conferences, workshops, and seminars can provide insights into the latest trends and technologies.<br>**Professional Organisations:** Joining organisations like the Society of Manufacturing Engineers (SME) or the Association for Manufacturing Technology (AMT) can offer networking opportunities and access to industry-specific training.<br>**Internal Training:** Many manufacturing companies offer training programs for their employees to keep up with new technologies and methodologies.<br>**Partnership Programs:** Some companies partner with educational institutions to offer specialized training programs tailored to their needs. | Hours – Months |

Figure 2 below illustrates a skills triangle, whereby the relationship between industry and academia is crucial to ensuring that the right learners are produced according to skill requirements of the industry (for example some of the skills listed in Table 2).

This figure illustrates the cycle of industry skill requirements informing the design of training and learning content in the education sector. If this does not happen, then workers will not be equipped with the skills they need.

***Figure 2:*** *Skills triangle*



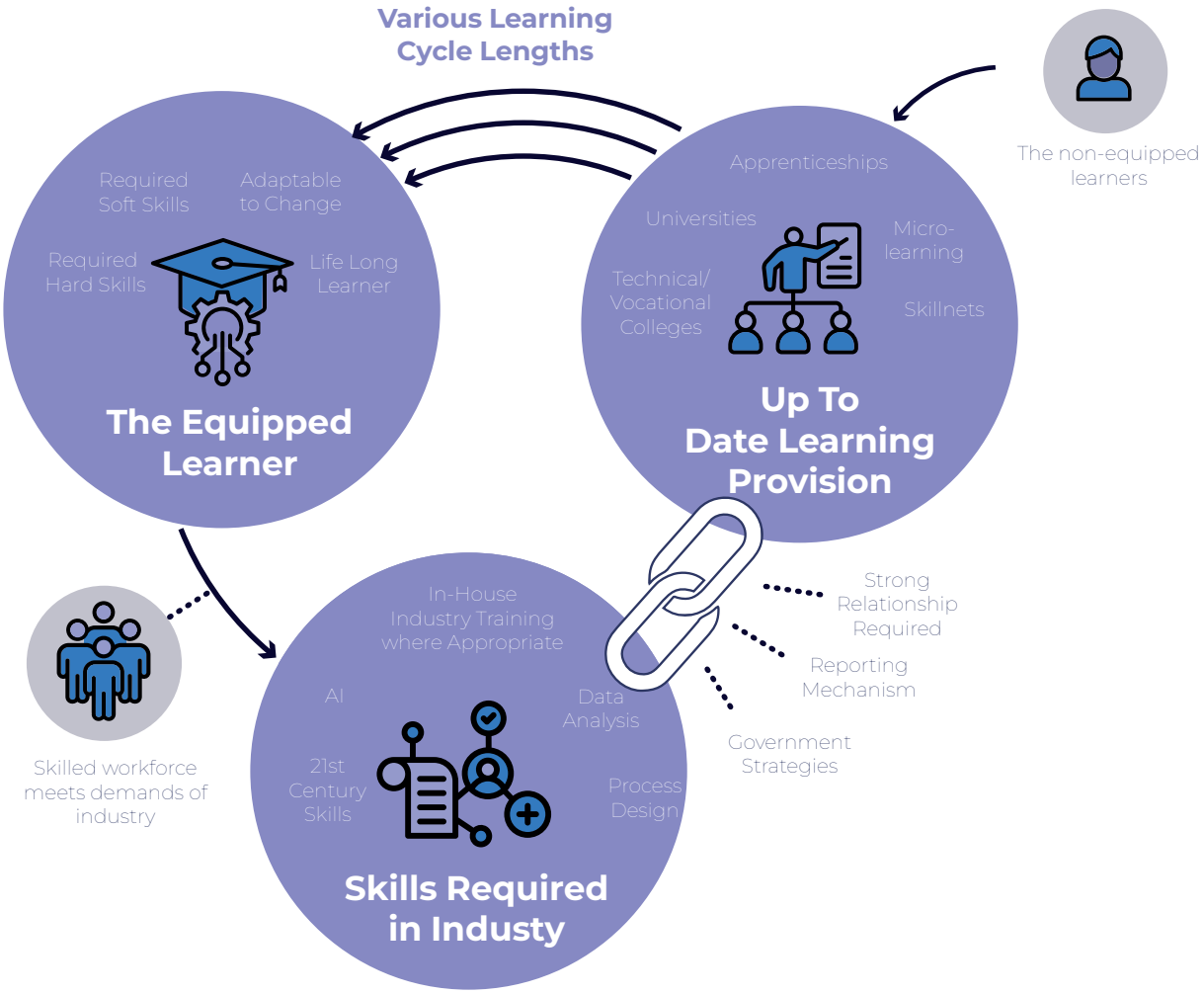

*If one part of this triangle does not work effectively you will get:

- Wrong training/learning being created and rolled out
- Training providers will take too long to design learning to meet the skills gaps
- Poor attendance due to lack of awareness about offerings

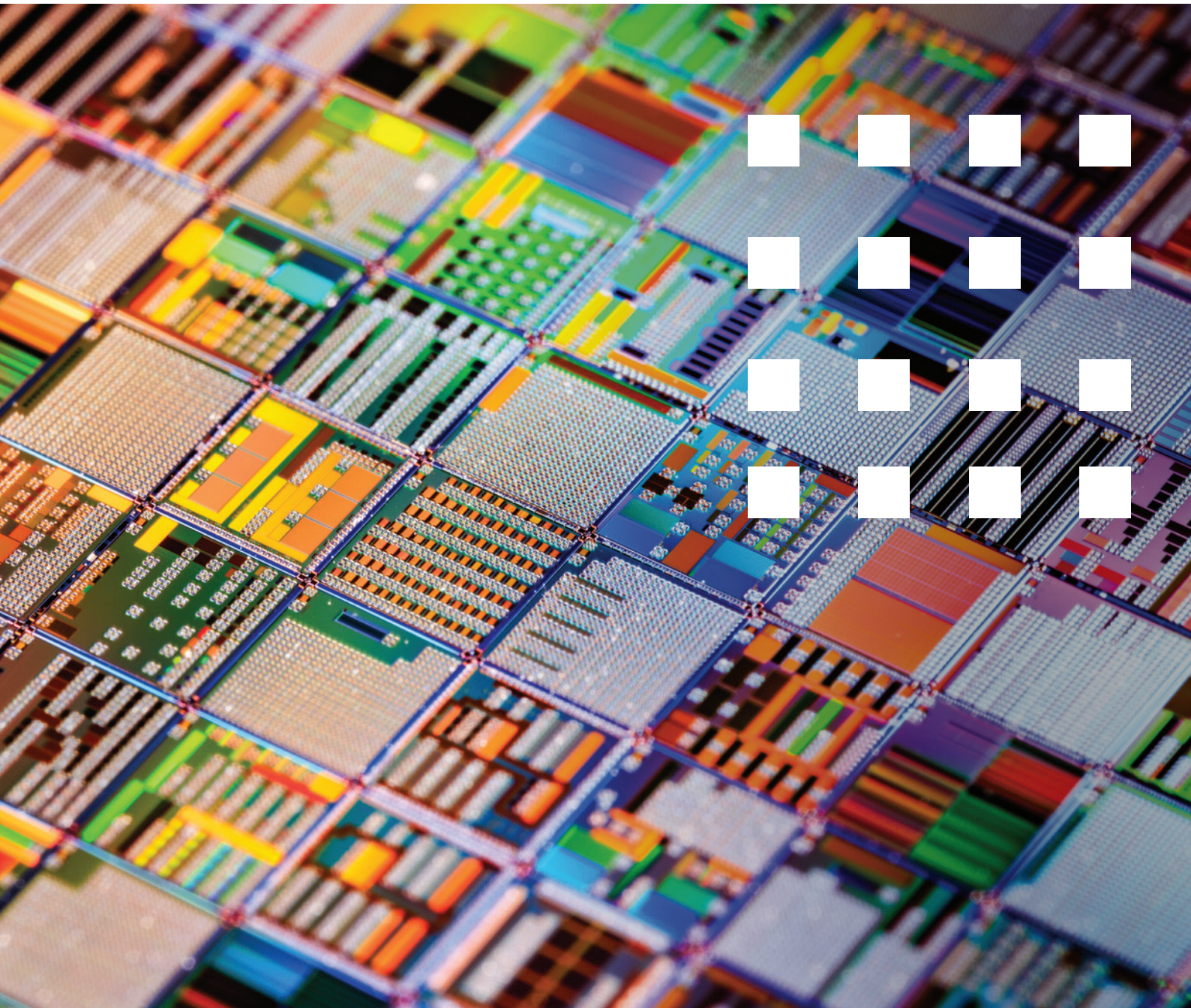
A more detailed version of this cycle is illustrated in Figure 3. In order to maintain the cycle shown in Figure 2 and keep skills updated, learning cycles or varying length are required. However, this requires accurate knowledge of the current skills gaps and learning needs across multiple sectors.

Currently, the advanced manufacturing industry does not have any coordinated skills database. Skills are not connected to roles or training.

***Figure 3:*** *Relationship between learner, industry and learning providers*



# 3 CHALLENGES FACING THE ADVANCED MANUFACTURING SECTOR



# 3 Challenges Facing the Advanced Manufacturing Sector

A significant gap exists between the skills required for roles in emerging technologies and the skills possessed by the existing workforce. There is a current and increasing demand for expertise in areas such as data analytics, artificial intelligence, or additive manufacturing, areas where many industries lack the required expertise, not just the manufacturing industry. The demand for talent in emerging technologies often exceeds the available supply, leading to fierce competition for skilled professionals. Small and medium-sized manufacturers, in particular, may struggle to attract and retain top talent due to competition from larger companies and other industries. We will see this problem in Ireland where many organisations are considered small or medium sized.

## 3.1 Ireland Context

Overall, there are 260,000 people employed in the Irish manufacturing sector, accounting for over 12% of total employment in the economy. Nine of the world's top 10 medical device companies have operations in Ireland. The MedTech industry in Ireland exports medical devices to over 100 countries with 80% of stents used across the world manufactured in Ireland (IBEC 2023). A recent report by Skillnet Ireland (2024)[15] sets out to deepen the understanding of the challenges facing businesses of all sizes, sectors, and regions in Ireland, across strategically important areas for the Irish economy. This comprehensive report is based on findings from a nationally representative survey of business leaders across 500 businesses of all sizes in Ireland. The results reveal valuable insights into the skills needs of businesses in Ireland, as well as the challenges they are facing in meeting those needs. The majority of businesses recognise that upskilling, reskilling, and talent development are increasingly important for them to remain competitive. The major findings from the report which are relevant to the advanced manufacturing industry include:

- Over 60% of businesses highlighted that the availability of qualified and highly skilled workers is going to be an increasingly critical factor for the future of their business success in the coming years.
- Over 41% of businesses surveyed are having difficulties recruiting employees with the necessary skill sets.
- 30% of businesses surveyed said they were struggling to hire employees with technical and engineering skills. 30% of businesses deem technical and engineering skills to be very important for their future business growth.
- Almost two thirds of businesses highlighted that their staff would require some form of upskilling in climate action and sustainability to safeguard their future success. Aligned to this recognition, however, is a clear skills shortage of green talent with businesses experiencing difficulty in sourcing climate action and sustainability skills.
- 9% of businesses surveyed said they were struggling to hire employees with process optimisation skills, 27% of businesses deem process optimisation to be very important for their future business growth.
- 8% of businesses surveyed said they were struggling to hire employees with product development skills. 28% of businesses deem product development to be very important for their future business growth.

15 https://www.skillnetireland.ie/uploads/attachments/SNI_IrelandsTalentLandscape2024.pdf

- One of the leading upskilling requirements highlighted by large businesses included robotic process automation (54%), while 43% cited AI skills as critical to business growth.
- 68% of businesses cited Microsoft office skills as one of the most critical factors for business growth.
- 61% of businesses think that core business skills are likely to change in the next 2 - 3 years, while 56% recognise that core business skills have changed in the last 2 - 3 years.
- 43% of businesses said that existing time commitments are preventing them from dedicating the necessary resources to upskill their employees, while 30% cited cost of training a prohibitive factor.
- 43% of businesses said that less than a quarter of their employees have recently taken any form of upskilling training.
- Only 27% of SMEs surveyed currently have a talent development strategy in place, while only 21% intend to create one.

This Skillnet research is backed up by a recent Recruitment Agency Survey by the Skills and Labour Market Research Unit (SLMRU) in SOLAS (November 2023). The survey gathered the views of selected Irish recruitment agencies in respect of vacancies for occupations that require skills which are in short supply, and in their view, are proving difficult to fill. They concluded that the talent market remains tight and highly competitive within Ireland, with recruiters continuing to have difficulty in hiring for certain roles. This problem is going to get worse as SOLAS anticipate 650,000 new jobs will be created by 2035 and 1.5 million people will need upskilling (National Skills Bulletin, SOLAS).

The findings indicate that despite challenging economic issues such as cost-of-living pressures, the demand for skills in sectors such as ICT, life sciences and construction among others continued in 2023. In particular they found that 41% of the vacancies that are difficult to fill are in technical roles such as software developers, engineers (including networking, dev-ops, security, windows), technical support staff, analysts (data, quality), solutions architects, data scientists, Process, automation, validation, manufacturing, quality control/assurance, environmental health & safety (EHS), mechanical, chemical, electrical, R&D, Regulatory and compliance, pharmacovigilance specialists, technicians (engineering, maintenance, electrical, lab), operatives (packaging, general, food), scientists (process, analytical, microbiologist), procurement, production managers. In a glaring finding, the survey found that 13% of all vacancies are considered ‘too difficult to fill’, while 59% are considered ‘very difficult to fill’.

**59%**

of all vacancies are considered ‘very difficult to fill’

Another critical finding that will be relevant to the advanced manufacturing industry is that agencies stated that remote and hybrid working is now favoured by many employees, meaning that onsite jobs such as those which may be necessary in manufacturing, are not considered attractive for modern young talent. While

many roles in the manufacturing sector, for example in R&D or project management could be carried out in a hybrid manner, young workers may not be aware of this.

Delving deeper into the Irish context, a large proportion of the firms in the Irish Advanced Manufacturing Sector are small-medium in size with a 2022 survey by the Department of Further & Higher Education, Research, Innovation and Science showing that 75% of the companies surveyed employed less than 250 people. More strikingly, according to the IBEC Manufacturing in Ireland Report from 2023, attracting and retaining talent is the biggest issue for CEOs in the manufacturing sector[16]. The report also highlights that over 2/3s of Irish manufacturing companies are introducing digitisation initiatives in the next 1 to 2 years.

16 https://www.ibec.ie/-/media/documents/ibec-campaigns/manufacturing-report/ibec-manufacturing_case-study_-boston-scientific.pdf

The Midlands Advanced Manufacturing Survey (Ireland 2022) ascertained and collated Midlands (Ireland) manufacturers' views in several areas including critical vacancies, skills need, digital transition as it pertains to the manufacturing sector, and curriculum development & provision. The survey consisted of responses from 41 organisations. They outlined critical vacancies in a number of areas. The survey results show that Operatives (both entry-level and experienced) and Engineers (Civil, Mechanical, Process, Automation, Electrical, Radio Frequency, Polymer, and Project) are the most urgent needs currently and projected into the future by regional manufacturers. 60% of respondents selected one or both of the Operative categories (entry-level and experienced) as a critical vacancy and over 50% saw Engineers as a critical vacancy. In terms of skills in demand, they were divided into three categories (Table 3).

***Table 3:*** *Key skills in demand across the advanced manufacturing sector in the Irish midlands*

| Transferable / Functional | Personal Traits / Attitudes | Knowledge Based |
|---|---|---|
| Digital Skills/ Computer Skills | Good Attention to Detail | Welding - MIG, TIG |
| Basic Trade Skills | Teamwork & Communication | Metal Fabrication |
| General Machine Operation | Ability to Work in a Fast-Paced Environment | Concrete Handling |
| Testing Skills | Reliability | Silicone Handling |
| Cleanroom Experience | Motivation | Plate / Section Rolling |
| Familiarity with Modern Equipment | Innovation | Polymer Processing |
| Trouble Shooting | Willingness to Learn | Press Brake |
| Maintenance & Repairs | Good Work Ethic | Lorry Driver/ Fork-Lift Driver |
| Installation Skills | Fitness | Computer Numerical Control (CNC) |
| Understanding Automation | | AutoCAD & BIM Technicians |
| Fabrication Basics | | Product Development |
| | | Project Manager |

The survey also provides very interesting analysis of current vs future skill needs. They asked

respondents in what area they think critical skills are most needed now, and where they think they'll be most needed in the future (Table 4).

***Table 4:*** *Key current and future advanced manufacturing skills required in the Irish midlands*

| Area | Current Need (Percentage of Organisation who said this area is critical current for them) | Future Needs (Percentage of Organisation who said this area is critical future for them) | % Increase |
|---|---|---|---|
| **Technical and Operational** | 54% | 68% | 26% |
| **Robotics and Automation** | 51% | 59% | 15.5% |
| **Data Analysis** | 27% | 34% | 26% |
| **Programming & Coding** | 24% | 34% | 29.5% |
| **Cybersecurity** | 24% | 27% | 12.5% |
| **Use of Digital Tools** | 37% | 49% | 32.5% |
| **Quality and Lean Management** | 44% | 51% | 16% |
| **Communication, Collaboration and Change Management** | 34% | 41% | 20.5% |
| **Critical Thinking** | 46% | 56% | 22% |

A recent report by BioPharma sector in Ireland called specific recruitment challenges in certain skill areas, including:

- Data management and digital skills in addition to core manufacturing skills (this need is mostly related to the rapid changes in manufacturing technologies, and digitalisation of processes and systems).
- Innovation and R&D skills for new product development and for drug delivery.
- QC and regulatory skills.
- Transversal skills including project management, technical writing and team working.
- Skills for Digital Transformation.

The predicted increase in need for these skills in the future will place more pressure on education systems to provide the necessary learning to the workers of the future. This of course calls for closer alignment between industry and education to ensure that learning cycles remain as tight as possible.

## 3.2 Northern Ireland Context

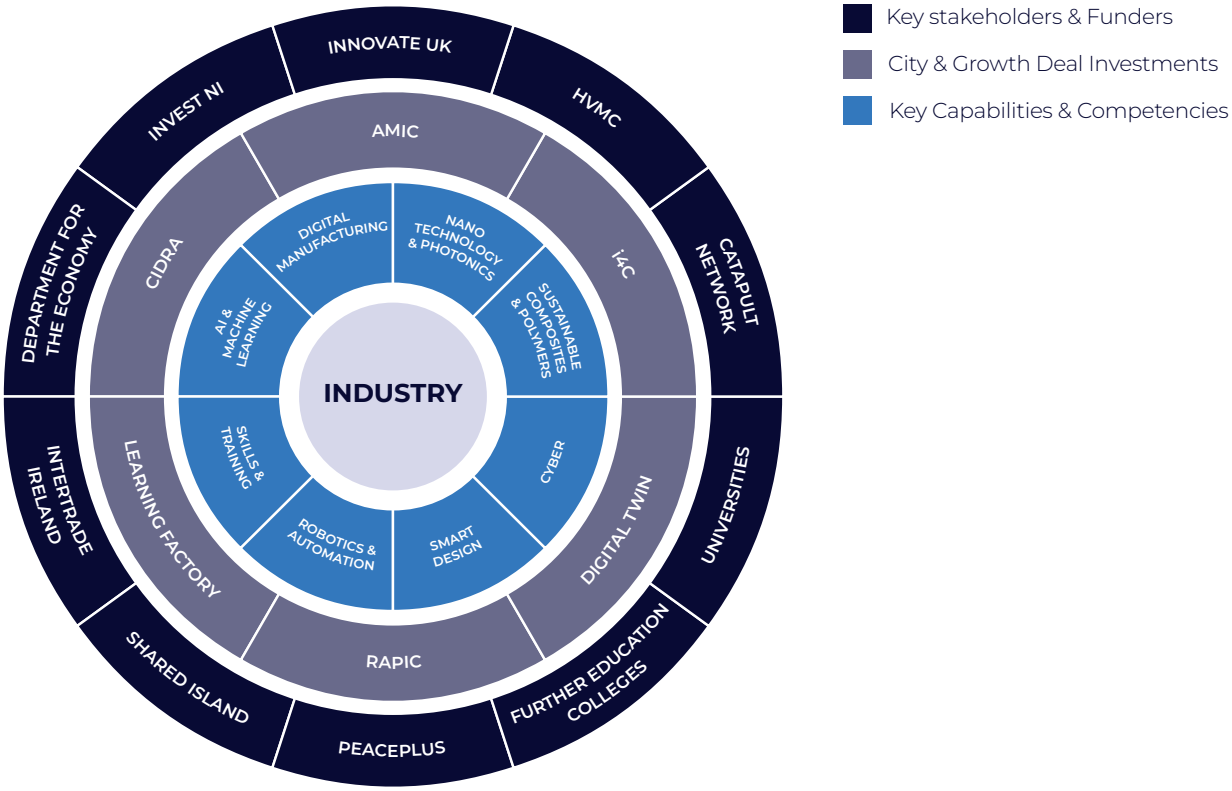
Northern Ireland has a strong cohort of around 4,665 AMME companies, employing around 56,000 people and worth approximately £3.2 billion to the local economy. The sector is one of Northern Ireland's biggest exporters and is key to growing our local economy[17].

Economy Minister Conor Murphy recently launched an Advanced Manufacturing, Materials & Engineering Sectoral Action Plan[18] as one of seven action plans designed to enhance growth across the region's most innovative, productive, and export-orientated economic sectors building on previous recognition by the Department for the Economy of Advanced Manufacturing as one of five clusters ready to adopt enabling technologies. Across Northern Ireland a firm foundation already exists from which the sector can continue to grow and innovate. The report outlines the AMME Ecosystem in Northern Ireland (Figure 4) with contacts across business, local government, tertiary education, arm's length bodies and government departments.

Invest NI describes the Advanced Manufacturing and Engineering Sector in Northern Ireland as a vibrant and highly sophisticated sector which accounts for 11% of employment and 13% of GVA, making it a key sector in the Northern Ireland economy[19]. The region is home to a range of indigenous and international companies, engaged in the full range of activities from R&D through new product development to manufacturing. A strong focus on R&D investment and commitment to product & process and design & development ensure the sector continues to grow and experience success.

17 https://www.economy-ni.gov.uk/sites/default/files/publications/economy/amme-sectoral-action-plan.pdf
18 https://www.economy-ni.gov.uk/sites/default/files/publications/economy/amme-sectoral-action-plan.pdf
19 https://www.investni.com/international-business/our-sectors/advanced-manufacturing-and-engineering

***Figure 4:*** *Advanced Manufacturing Ecosystem in Northern Ireland (diagram by sector representative body, the Makers Alliance).*




A recent Advanced Manufacturing Skills Assessment Report[20] outlines the key challenges faced by the Advanced Manufacturing Sector in Northern Ireland as follows:

- The Skills system is 'fractured and fragmented'. Different institutions govern and deliver different elements and there is an absence of a consistent overall vision for what we expect our skills system to deliver. Addressing this, and the inefficiencies it causes, will require a refreshed approach to how we view and govern the system.
- Skill requirements are changing rapidly. Industry needs support to forecast and plan. Traditional businesses within this sector are struggling to understand and equip themselves with the right skills and capabilities to take advantage of disruption within this sector.
- Digital technologies and automation require continuous learning/upskilling.
- Attracting and retaining talent is a real challenge. There is a particular difficulty in attracting and retaining talent among young people and women, who may have negative perceptions or lack of awareness of the opportunities and benefits of working in advanced manufacturing.

20 Advanced Manufacturing Skills Assessment (Northern Ireland City and Growth Deals)

- The existing apprenticeship offering is dated with regard to both the curriculum and the apprenticeship frameworks (standards) and does not meet the emerging demands of employers in response to the evolving opportunities afforded by technology and the move to more advanced manufacturing. There is now a significant gap between the skills taught by the education/training providers, and the skills demanded by industry.
- Shortage of skills in sustainability. Skills provision for sustainability and reaching net zero in advanced manufacturing is a complex and multifaceted challenge.

Added to these challenges, only 1% of the advanced manufacturing sector in NI consists of companies employing more than 250 people. This has a number of implications:

- The small size of so many of the firms in the industry means that addressing the skills gap and providing associated training paths will present significant challenges since these firms are unlikely to have the same Learning and Development capabilities of larger companies.
- The impact of having employees on training leave is bigger for smaller companies, especially employees in specialist positions who probably need the training most.
- Smaller businesses do not have the same capital to invest in cutting edge technologies, therefore may need to lean more heavily on highly skilled staff.
- The same report points out that Advanced Manufacturing in NI is also facing a challenge with an aging workforce evidenced by the fact that 32% of those working in plan, process and machine operations are over 50.

An Employer Survey carried out as part of the Advanced Manufacturing Skills Assessment identified a number of skills shortages as being the most challenging (Table 5).

The Survey found that many organisations have already started upskilling and multiskilling the workforce to contingency plan and Industry highlighted the importance of succession planning and the need for constant needs analysis to combat skills challenges. Some key common areas organisations highlighted as 'in-demand' included:

- Industry 4.0
- Readiness for future technologies
- Robotics
- Automation
- Technology and processes
- Digital skills
- Lean manufacturing
- Integrating ERP systems
- Sustainability and Net Zero

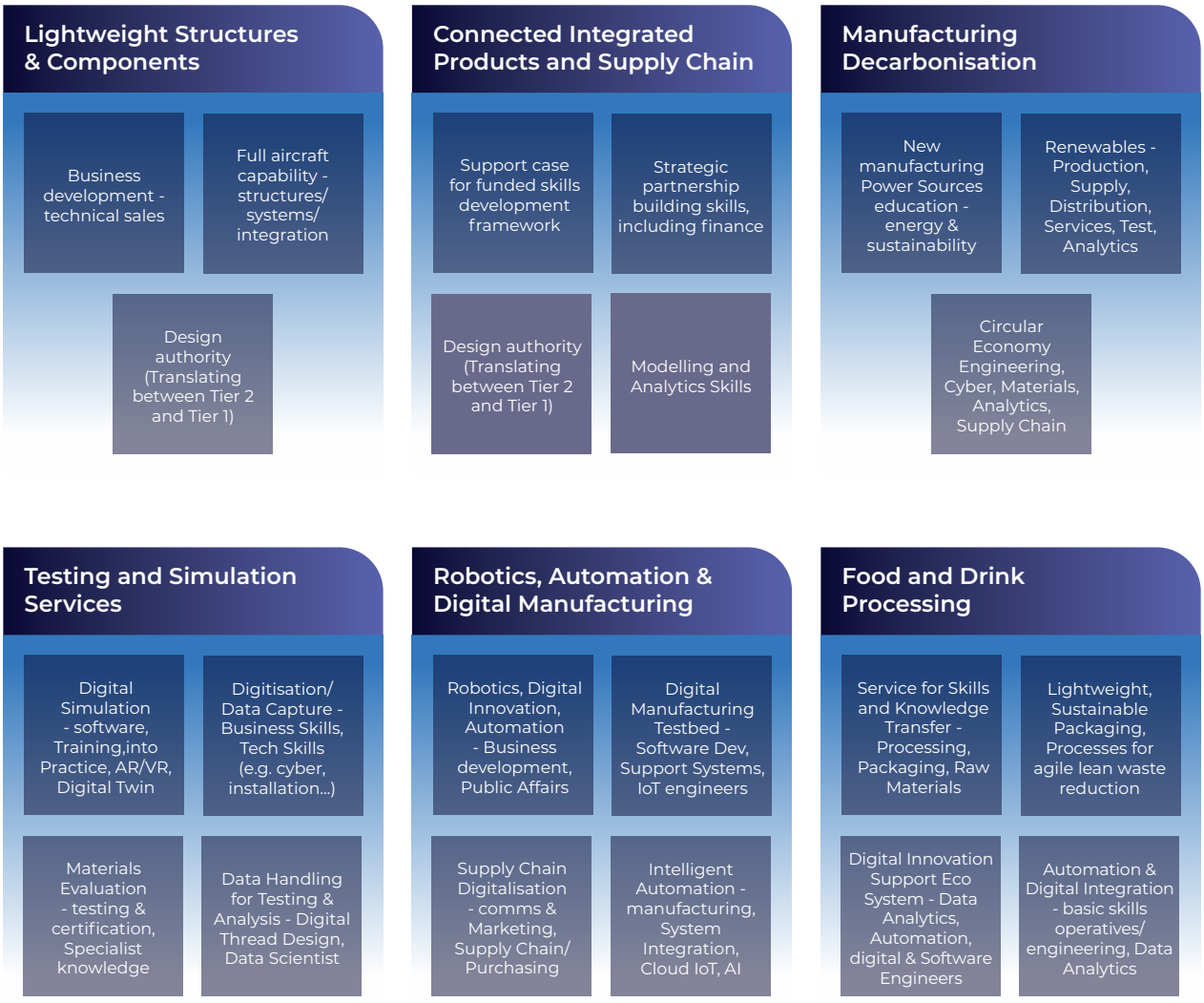
The Advanced Manufacturing Innovation Centre (AMIC) undertook a detailed technology roadmapping exercise with support from IfM (Institute for Manufacturing, Cambridge)[21]. The strategic technology roadmap was developed for Northern Ireland and identified key priorities to improve the region's distinctive strengths in advanced manufacturing (summarised in Figure 5) and outlines how it can support the region's large world-class companies as well as its SMEs. This technology roadmap is shown in the diagram below. A similar technology roadmap may be useful in Ireland.

21 Roadmap | Advanced Manufacturing Innovation Centre | Queen's University Belfast (we-are-amic.com)

***Table 5:*** *Skills shortages identified in the Northern Ireland context*

| Transferable / Functional | Personal Traits / Attitudes | Knowledge Based |
|---|---|---|
| ▪ People with a high-level of technical knowledge<br>▪ Project Management<br>▪ Production Supervisors<br>▪ Warehousing<br>▪ Design Engineers<br>▪ Supply Chain<br>▪ Digital Transformation<br>▪ IT skills<br>▪ Language Skills<br>▪ Commercial Sales and Marketing<br>▪ Sustainability<br>▪ Quality Engineers<br>▪ Electromechanical skills<br>▪ Mechatronics<br>▪ Automation<br>▪ Skilled electricians<br>▪ Data Scientists<br>▪ Robotics and robotics engineers<br>▪ Mechatronics<br>▪ Photonics | ▪ Leadership<br>▪ Problem Solving | ▪ Welders<br>▪ Robotic Welders<br>▪ MIG and TIG Welding<br>▪ Fabricators<br>▪ Robotic and manual spray painting<br>▪ Operators<br>▪ CNC Operators<br>▪ Skilled lathe and milling machine operators<br>▪ Design & fabrication<br>▪ Assembly Operatives<br>▪ Trained maintenance<br>▪ Production tasks (moulding/trimming/painting/assembly)<br>▪ Specific injection moulding skills<br>▪ Semi-conductor knowledge |

***Figure 5:*** *Strategic technology roadmap for advanced manufacturing*



From this technology roadmapping, AMIC has established four capability groups[22] underpinned by its research and industrial innovation strengths:

- Digital Factory
- Sustainable Polymers & Composites
- Smart Design
- Nanotechnology and Photonics

AMIC has also identified three cross-cutting strategic themes spanning across multiple groups including:

- Sustainable Manufacturing
- Supply Chain and Cluster Development
- Workforce and Skills

AMIC is just one of the Innovation Centres to arise from City & Growth Deals, over the next few years, Northern Ireland (NI) will benefit from a package of investment from four City and Growth Deals. These City and Growth Deals will improve the interface between world-leading academia and research and provide access to breakthrough technologies, helping to drive innovation in processes and product development and providing opportunities for businesses both inside and outside Northern Ireland. With a clear focus on Advanced Manufacturing, the City and Growth Deal Activity will change the landscape further.

The Northern Ireland skills Barometer (presented in the Advanced Manufacturing Skills Assessment 2024) also identified the requirement for soft skills' and concludes the ten most 'in-demand' of these types of skills to be:

- Problem solving
- Enthusiasm for upskilling
- Flexibility and adaptability
- Leadership
- Critical Thinking
- Tech Savvy
- Communication
- Emotional Intelligence
- Creativity
- Innovation

Many of the skills in this list could be deemed as life skills and the question is whether academia is responding to the learning requirements of graduates and whether curriculum development is agile enough to meet the needs of industry and equally, are industry quick enough to communicate current and expected future required skills to academic bodies? There seems to be a need to improve communication and agility.

22 https://we-are-amic.com/expertise/

## 3.3 UK Context

A comprehensive analysis of the current and future skills gap present in the UK advanced manufacturing industry was conducted by WorldSkills UK in conjunction with BAE Systems (May 2023). The objective of the report was to identify the barriers preventing the UK becoming a global leader in advanced manufacturing. The report explores how young people can acquire the world-class skills the UK needs to become a global leader in advanced manufacturing. The research provides evidence on the impact of industrial transformation on skills demand and job creation in the manufacturing sector; alignment between industry demand for skills and those developed in third level education; and young people's perceptions and motivations around a career in manufacturing.

The major conclusion of the report, probably unsurprisingly given similar data we have seen in Irish and international contexts, is that persistent skills gaps are presenting major challenges for the advanced manufacturing industry in the UK, limiting the sector's potential. We have selected a number of key findings from the report that are relevant to this report:

- 57% of manufacturers cite challenges accessing a skilled workforce. Over half (55%) of manufacturers are experiencing shortages in advanced manufacturing skills and even more (61%) in traditional manufacturing skills, such as fabrication, welding, and mechanical engineering,
- 63% of manufacturers believe that advanced manufacturing technologies and processes are currently impacting their skills needs, and more (69%) believe they will in the next five years,
- 45% of manufacturers report an increased demand for higher technical qualifications/higher apprenticeships and 38% for degrees/degree apprenticeships. However, demand for qualifications at all levels is expected to increase over the next five years, emphasising the need to increase enrolments,
- 63% of manufacturers surveyed believe that young people are not coming through the education and skills system with the necessary advanced manufacturing skills and 70% believe that they are not coming through with the necessary traditional manufacturing skills,
- 51% of manufacturers are not working with education or skills providers to try and ensure their skills needs are met.

In addition to the technical skills gap, the Advanced Manufacturing Skills Assessment Report highlights gaps in more 'general skills' within the sector:

- Marketing & sales
- Commercial exploitation
- Leadership and management
- Transversal skills

A recent survey by the Chartered Management Institute found that 80% of UK employers believe that current graduates do not arrive fully equipped with the skills required to be work ready, particularly in terms of transversal skills[23].

In their report on the Advanced Manufacturing Sector, the UK Commission for Employment and Skills identified five representative roles in the advanced manufacturing sector and examines the different drivers of change that could impact on each role while also exploring the implications of each driver (Table 6).

23 https://www.managers.org.uk/wp-content/uploads/2021/09/employability-skills-research_work-ready-graduates.pdf

| Transferable / Functional | Personal Traits / Attitudes | Knowledge Based |
|---|---|---|
| Production Managers and Directors | Lack of awareness of latest industry technologies | Difficulty appraising the benefits of new technologies |
| | Growing use of electronic components/micro-parts | QA and fault-checking are more time-consuming |
| | Firms trading in emerging markets | Need for broader, business skills |
| Biological scientists and biochemists | Shift towards personalized treatments (e.g. using bio-markers) | Engineering skills as role becomes increasing automated<br>Need for even more advanced R&D skills |
| Production and process engineers | Shift towards shorter production runs | Increasing the complexity of the production process |
| | Increased use of Computer Numerical Control (CNC) | More complex software |
| Metalworking production and maintenance fitters | Increased use of technology (including 3D printing) | Greater need for complex digital/tech skills |
| Assemblers (including welding, soldering, wiring) | Increased use of silicon electronics and nanotech | Requires new, more specialized tech skills |

## 3.4 International Context

A recent report by the Manufacturing Institute/Rockwell/PTC on future trends in manufacturing (October 2022) in United States context, distilled findings from a series of interviews with future-leaning manufacturing leaders focused on human resources, workforce development and strategic planning, to identify the skills that will be needed over the coming five to ten years in the sector. This report provided insights into how manufacturing will change in the future, how technological and operational change is expected to impact the future of manufacturing work and how skill needs will evolve, both in terms of hiring new employees and upskilling current employees? The report focused on a number of key industries including electric vehicles and battery production, semiconductors, and pharmaceuticals. They uncovered a number of key trends across the sector.

The first thing they reported is a startling skills and labour shortage across the manufacturing sector. Taking the USA

as an example, they estimated that there were 795,000 job openings in the manufacturing industry as of August 2022. The manufacturing industry in the USA has struggled to fill open positions due to numerous factors, including increased competition for workers, outdated perceptions about the industry and new technologies requiring more technical skills. Despite good career progression and earning potential, manufacturing ranks low among prospective job candidates as a preferred career option.

This trend is expected to continue in the next 10 years. Referring to the USA again, 4 million manufacturing jobs will likely be needed and 2.1 million are expected to go unfulfilled if people are not inspired to pursue modern manufacturing careers. The increases in employment can be attributed to a multitude of factors, including rapidly advancing technologies that improve innovation and quality while enhancing overall productivity and competitiveness.

The report went on to analyse a number of industries within the sector, where they noted what key skills were in demand. In particular they found that as technology advances and data accumulates, companies are finding greater need for individuals with data analysis skills. Despite advances in automation, companies still see the value in interpersonal skills, particularly communication and collaboration skills. Critical thinking, problem-solving and an agile mindset are skill sets that manufacturers will need more and more in the future, as technology advancements occur. Companies are looking to invest more heavily in training programs to develop and grow employees in the skills that are needed. The report also identified five further areas of need.

- Necessary Shift in Future Planning
- Need to Educate Students about Manufacturing (including working with curricula developers to ensure the right skills are being taught in education sector)
- Importance of Company Values and Culture
- Value of Diversity, Equity, and Inclusion (This is currently being recognised as a major problem in the EU, leading to the creation of specific projects around DEI in certain industries, see ECDA project)
- Role of Upskilling and Training

The report concludes with a call for agility by both companies and educational bodies. Companies will need to respond to customer demands more quickly, but they will also need to strategically plan for future potential business disruptions and for future skill needs. Education and training providers need to be agile in terms of designing their frameworks and curriculums to respond to the needs of industry. Flexibility of all stakeholders is key.  They make a number of key recommendations:

- Take Inventories of Skills of Current Workers: We need to embrace technology in the education and training industry so that it too can become agile so that it can meet the needs of industry.
- Consider Updating Position Descriptions: Specific language in lists of required soft skills (e.g., strong written communication abilities versus strong verbal communication abilities). Equivalent experience and certifications as an alternative to undergraduate or graduate degrees, where appropriate Up-to-date descriptions of technologies used in roles.

- Offer Apprenticeships: Programs that hire for aptitude in areas that can be harder to train (e.g., critical thinking) and then train for specific, often more technical, skills.
- Foster Inclusivity and Train Company Leaders: Creation of employee resource groups, Training on DEI for managers, potentially with the help of outside contractors
- Work with Curricula Developers: Partnerships with schools to integrate classroom instruction and relevant work experience, Collaboration with local certification programs, hiring through a wide range of pipelines including, but not limited to, high schools, local community colleges and universities.

A report into the Canadian Aviation industry from 2021, like many reports on the Advanced Manufacturing sector, cites the shortage of skilled labour and points out that, in Canada, this had led to considerable 'poaching' in the Aviation industry for certain roles[24]. This 'poaching' is a potentially major issue for SMEs (pertinent in the Irish and NI context), given that larger organisations will be better able to attract skilled workers through more competitive salaries and incentives. Where companies have sought to address the skills gap, it has tended to be very firm-centric through customised training programmes using private providers (for the likes of robotics, data analytics, etc.). The report also highlights that in Toronto, firms have collaborated with other stakeholders to address the issue. More often, this involves companies up and down the same supply chain working together to find solutions to the skills gap – what can be termed 'vertical collaboration. On the other hand, examples of 'horizontal collaboration' that sees competing companies work together are rare. In Japan this is referred to as vertical and horizontal 'keiretsu.'

A recent observation of the advanced technology industry by Ravikumar Ramachandran[25], a Specialist at BNY Mellon, divides the skills required into two areas, Governance/Management and Core Tech. Governance/Management includes areas like Tech Governance and Cyber Security, Risk Management and PM/Agile Practices. Industry leaders see Tech Governance and Cyber Security merging. With the accelerated use of tech, these skills will be highly in demand. In the area of Core tech, he sees Cloud computing, AI, Coding (e.g. Python), Data Science and DevOps as being key future skills. He cites a McKinsey estimate that IoT (cloud computing) has the potential to unlock an economic value somewhere between US$5.5 to $12.6 trillion by 2030. He concludes by stating that both organisations and employees should team together to build up the knowledge and skills required to survive and effectively deliver in the changing market conditions. This includes the need for effective learning and training resources to support this build up the required knowledge and skills, and an effective matching of training and learning content and delivery to the required knowledge and skills.

24 http://www.crimt.net/Files/Industry_4-0_the_Future_of_Work_and_Skills.pdf

25 https://www.isaca.org/resources/news-and-trends/isaca-now-blog/2022/the-future-of-skills-preparing-for-industry-4-0-and-beyond

## 3.5 Demographic Challenges

The lack of diversity and inclusion in the manufacturing workforce is a persistent challenge, with underrepresentation of women, minorities, and individuals from disadvantaged backgrounds. Addressing diversity and inclusion gaps requires proactive efforts to attract, retain, and promote talent from diverse backgrounds. Manufacturing is often negatively perceived as old-fashioned, monotonous, low-paid, physically demanding and male-dominated. In this report we will focus on the trends among the cohorts of young people and women, two cohorts which hold vast potential for talent recruitment for the industry. There are great opportunities for organisations and the wider industry if they tap into this recruitment potential. This section provides an analysis of how changing demographics (e.g., aging workforce, diversity) will affect skill needs, and the related implications for training and recruitment strategies. We will focus on two areas, the gender gaps and age demographic. In general, the findings indicate that while there is a problem in interest and participation among young people and women, this also presents a huge opportunity of untapped potential for the industry.

**Age Related Trends**

Demand for new roles and replacement demand create the urgent need to attract more young people into the sector. However, the literature points to a lack of interest in the sector from new entrants. Manufacturing is often negatively perceived as old-fashioned, monotonous, low-paid, physically demanding and male-dominated. In a recent survey of the industry presented in the 2023 UK Manufacturing Excellence, they found that not only are young people not interested in a career in manufacturing, but that companies may not be doing enough to encourage a younger cohort of talent.

- The majority (60%) of young people surveyed said that they would not consider working in manufacturing. Just over one third (36%) would consider it, with only 26% surveyed responding that they would strongly consider working in manufacturing. This leaves potentially two-thirds of the population uninterested in a career in manufacturing, greatly reducing the recruitment pool. However, when provided with a range of in-demand job roles related to manufacturing (for example specific roles related to AI, design, and data), only 22% of young people reported not finding any appealing. This may mean that the nature of a career in manufacturing and the roles potentially available are not always effectively communicated to young people who may hold outdated stereotypes about manufacturing.
- 83% of young people feel they face barriers to pursuing a career in manufacturing. The most common barriers relate to a lack of knowledge and understanding around the sector. Approximately half (48%) said that they have never received information about a career in manufacturing. This implies a greater need for smart campaigns that can inform, engage, and inspire young people about careers in manufacturing, starting in second level education.
- In order to pursue a career in manufacturing, 88% would find additional information helpful; notably, around manufacturing career options and guidance on the right qualification or training.
- Two in five employers (41%) are not taking any actions to inspire young people to consider a career in manufacturing. Only 14% are helping educators gain industry knowledge and experience, despite 61% believing this could help attract young people to the sector.

- Young people who would consider working in manufacturing are most commonly attracted to the opportunity for 'hands-on' work (42%), followed by the opportunity to work in an innovative, high-tech sector (36%), engage in highly-skilled work (36%), and earn a higher salary than in other sectors/industries.
- For young people unlikely to consider working in manufacturing, the most common reason offered was not wanting to work in a factory environment (71%). This is followed by the physically demanding work (40%), lower salary returns than other sectors (32%), and a preference to work in a more innovative, high-tech sector (29%).
- While this survey covers only the UK, it is probably valid to assume that similar trends are being observed in Europe and North America. The report concludes by stating that the findings indicate that significant misconceptions about roles in the manufacturing sector may be denying young people opportunities to move into higher-value well-paid jobs the UK urgently needs.

**Gender Related Trends**

Manufacturers face difficulties in recruiting and retaining women, particularly at the higher-paid occupational levels. This is contributing to a substantial gender gap, the only occupation in which the majority of employees are women are the lowest-paid elementary occupations (55% female). This points to a need to diversify the existing workforce and attract more women into the sector. In a recent survey of the industry presented in the 2023 UK Manufacturing Excellence they found that there is a major gender disparity in terms of those interested in pursuing a career in manufacturing.

- Men are three times more likely to consider working in manufacturing than women (54% compared to 18%), with almost half (46%) of women responding that they would not at all consider working in manufacturing.

*Men are three times more likely to consider working in manufacturing than women*

- Only 51% of young women have confidence in the UK education system's ability to equip them with the skills needed for a career in manufacturing.
- Most organisations interviewed in the survey agreed that it remains difficult to attract women to the sector as careers advice isn't inspiring young women, and perceptions of a male-dominated sector often discourage women.
- Young women are significantly more likely to cite facing barriers to pursuing a career in manufacturing and are more likely to report the need for additional information.

In a recent report by the EU, they found that the chips / microelectronics sector across the EU is still largely male dominated: employment statistics provide a stark picture of gender balance, with trends and dynamics that are far from encouraging. Women occupy only 22% of all tech roles across European companies, and the chips / microelectronics sector is undermined by an even lower participation rate. The situation is exacerbated by a considerable distance between the world of education and the world of work. Women's graduation rate in STEM in higher educating is gradually declining.

Moreover, the share of women in the workforce is lowest in those tech roles that are growing fastest, such as chips and microelectronics. At current rates, the share of women in tech roles in Europe is heading toward a decline to 21% by 2027 (Source: McKinsey "Women in tech: The best bet to solve Europe's talent shortage" 2023). This low inclusiveness of the chips / microelectronics sector considerably undermines its competitiveness due to the untapped potential of a skilled workforce that could greatly contribute to innovation. There is a considerable untapped talent pool due to gender bias that prevents the female part of the population to actively engage in chips-related education and professions. Moreover, such low inclusiveness is a contributing factor to the skills shortages that the sector is experiencing. Another considerable barrier to inclusion in the industry is that the relevant education and training sector for microchips are also highly male-dominated, with gender-based biases that affect the whole education cycle and system (i.e., administrative staff, teaching staff and learners).

## 3.6 Rapid Emerging Technologies

Emerging technologies are poised to have a rapid and transformative impact on the advanced manufacturing industry, revolutionising processes, products, and business models. Some of the key emerging technologies revolve around automation/ digitalisation. AI, materials engineering, and robotics. The convergence of these emerging technologies is expected to drive unprecedented levels of innovation, efficiency, and sustainability in the advanced manufacturing industry, reshaping the way products are designed, produced, and consumed. However, while the potential is there, the complex and rapidly changing nature of these technologies imply that recruitment and training around these technologies will also be complex. Emerging technologies evolve rapidly, requiring continuous upskilling and reskilling of the workforce to keep pace with new developments and innovations. Recruiting, training, and retaining talent with the necessary skills can be a significant challenge. It can be challenging for organisations to provide ongoing training and development opportunities to keep their workforce updated. The training required can be complex with a lot of content to cover.

Emerging technologies are also crucial due to the trend towards shorter and more 'tailored' manufacturing cycles in the industry. Consumers increasingly expect customised products tailored to their specific preferences and needs. Shorter manufacturing cycles allow companies to respond quickly to changing consumer demands and offer personalised products in a timely manner. Shorter manufacturing cycles require highly efficient and interconnected processes across the entire value chain, from product design to distribution. Managing this complexity can be challenging, especially for companies with legacy systems or fragmented operations. Shorter manufacturing cycles demand a close alignment between emerging technologies and skilled workers. Accelerated manufacturing cycles require a skilled and adaptable workforce capable of rapidly learning about and leveraging advanced technologies and production processes. This requires a need for shorter training cycles to upskill the workforce. Organisations cannot afford for their workers to take extended leaves of absence for training.

Much of the reports we have reviewed make reference to the significant challenge in making the right strategic decisions when it comes to adopting new technology - how can a company be sure it's really worth the investment if the technology is new and

they don't have the expertise to evaluate it? How long will this new technology last and therefore what is the shelf-life of the skills needed to operate this new technology?[26] In the words of a recent article from the HR Daily Advisor, we have entered "the Age of Acceleration—a time when change is happening faster and faster. As the workplace continues to move more rapidly, so does the market value of skills." This section provides an analysis of the impact of emerging technologies on advanced manufacturing skills.

In their report on the Advanced Manufacturing Sector, the UK Commission for Employment and Skills identified a number of emerging technologies that could have significant impacts on the advanced manufacturing sector (Table 7).

26 https://hrdailyadvisor.blr.com/2020/03/25/the-half-life-of-skills/

***Table 7:*** *Emerging Technologies that will have an impact on the sector.*

| Technology | Summary of Potential Impact |
|---|---|
| **Additive manufacturing** | The development of products using digitally-controlled machine tools. Products are built through layering rather than traditional methods of moulding, casting, or welding. |
| **Composite manufacturing** | The joining of two materials together to produce one material with superior mechanical properties. Composites are being increasingly used to replace metal due to their high-tensile strength and low weight. |
| **Nanotechnology** | The manipulation of materials at a subatomic level to create new materials. It is used for both organic and non-organic materials. |
| **Plastic electronics** | Electronics built using semi-conducting plastic polymers. Diodes and transistors are 'printed' on plastic substrates using inks of semi-conducting plastic materials. |
| **Silicon electronics** | The development of electronic circuits built on a single layer of single crystal silicon. It is considered advantageous because it consumes very little power. |
| **Industrial Biotechnology** | The industrial manufacturer of chemical products using biological rather than oil-based materials |
| **Robotics and Artificial Intelligence** | The use of machinery to automate parts of the production process. a potential recent development in this area is artificial intelligence which is solve for that makes decisions on optimising the production process |

It goes without saying that AI will also have a major impact on the industry. AI encompasses many different technologies, some of which are more relevant to the industry than others. Table 8 outlines a number of AI technologies and what they involve, and indeed how they could relate to the Advanced Manufacturing industry.

***Table 8:*** *AI Technologies that will have an impact on the sector.*

| AI Technology | Example of Use in Advanced Manufacturing |
|---|---|
| **Machine Learning:** Understanding of various machine learning algorithms, such as supervised learning, unsupervised learning, and reinforcement learning. | ML algorithms analyse vast amounts of data from manufacturing processes to identify inefficiencies and optimise parameters for improved productivity and resource utilisation. This includes optimising production schedules, adjusting machine settings, and minimising material waste. ML techniques are also used for supply chain management. This includes demand forecasting, inventory optimization, and logistics planning. By analysing historical sales data, market trends, and external factors, manufacturers can optimise inventory levels, reduce stockouts, and streamline supply chain operations. |
| **Deep Learning:** Proficiency in working with deep neural networks, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), and transformers. | Deep learning models are applied for anomaly detection in manufacturing processes, such as detecting deviations from normal operating conditions or identifying unusual patterns in sensor data. These models can uncover abnormalities that may indicate equipment malfunctions, process inefficiencies, or quality issues. |
| **Computer Vision:** Skills in analysing and understanding visual data, including image classification, object detection, and image segmentation. | Computer vision is a critical component of robotic automation. Computer vision systems can inspect products with high accuracy and speed, identifying defects such as surface imperfections, dimensional deviations, or assembly errors. This ensures that only high-quality products reach the market, reducing waste and rework. Computer vision enables robots to perceive and interact with their environment intelligently. Robots equipped with vision systems can perform complex tasks such as pick-and-place operations, assembly, and packaging with precision and adaptability. |

| AI Technology | Example of Use in Advanced Manufacturing |
|---|---|
| **Feature Engineering:** Ability to create new features from raw data to improve model performance. | In advanced manufacturing, various sensors collect data on parameters such as temperature, pressure, vibration, and humidity. Feature engineering involves extracting meaningful features from this sensor data, such as statistical measures (mean, standard deviation, skewness), frequency domain features (FFT coefficients), or time-domain features (autocorrelation, signal entropy). These features can provide insights into the performance of machinery, detect anomalies, and optimise processes. |
| **Model Evaluation and Validation:** Understanding of techniques for assessing the performance and generalisation ability of machine learning models, such as cross-validation and metrics like precision, recall, and F1 score. | Predictive maintenance models are employed to anticipate equipment failures and schedule maintenance activities proactively. Model evaluation helps determine the effectiveness of these models in predicting failures within an acceptable lead time. Validation ensures that the models are robust enough to handle variations in operating conditions and detect early signs of degradation or malfunction. |

The technologies presented in Table 8 require highly skilled engineers and specialists across software, hardware, and process engineering disciplines. Barry Kennedy, the chief executive of the Irish Manufacturing Research, or IMR, organisation, says that by 2030 the manufacturing landscape will look significantly different, and will be virtually unrecognisable from 15 years ago. Mr Kennedy worries that Ireland remains vulnerable to changing investment trends in manufacturing, which in turn has potentially significant implications on Ireland's future prosperity. In particular, he is concerned that manufacturing in Ireland is not keeping pace with the rapid increase in advanced automation, robotics, and the AI digital transformation. From the Table 8 we can infer that it probably will not be sufficient for a company to simply say 'we need an AI expert', but instead will need to define what exact AI technology they need support with and how different AI roles can support and improve their processes.

In a report on the future of work in manufacturing in the United States prepared by Deloitte, the authors use a set of personas to explore how certain roles in Advanced Manufacturing might be impacted by emerging technologies[27]. These roles are viewed from the perspective of the employees themselves and the report aims to highlight how each role will look in 2025 compared to the present. The six roles described by Deloitte are presented in Table 9.

27 https://www2.deloitte.com/content/dam/insights/us/articles/4747_Manufacturing-personas/4747_Manufacturing-personas-Interactive.pdf

***Table 9:*** *Deloitte horizon scanning of future roles.*

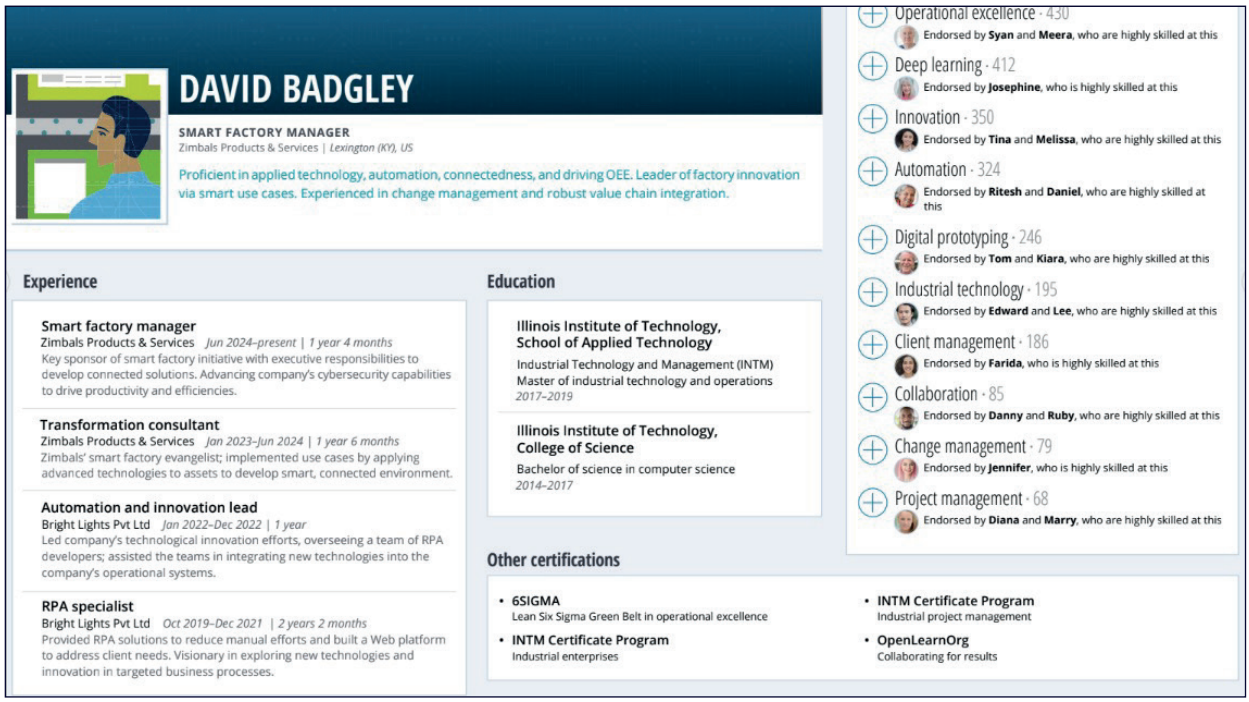
| Role | Anticipated Changes | Examples of Key Tasks |
|---|---|---|
| **Digital Twin Engineer** | ▪ Decreased work on product development and production design<br>▪ Increased collaboration across disciplines and conducting analytics | ▪ Create digital twins using 3D software and run simulations to measure product performance in varying conditions<br>▪ Draw insights from in-use product data to design new products and business models<br>▪ Use machine learning along with real-time usage and performance data to optimise product performance and service |
| **Predictive supply network analyst** | ▪ Decreased workload on reporting<br>▪ Increased requirement for data analysis, decision-making and collaboration | ▪ Evaluates recommendations from the predictive system, such as scheduling and material orders, and makes final decisions<br>▪ Identifies market opportunities and proposes collaborative forecasts to customers based on analysis and insights from machine learning and artificial intelligence (AI) tools |
| **Robot teaming coordinator** | ▪ Decreased work on resource allocation<br>▪ Increased work on evaluating robots and cross-discipline collaboration | ▪ Observes robots and evaluates their performance based on how effectively they can perform predetermined tasks<br>▪ Shares feedback with robot programmers on a robot's performance and recommends areas for improvement<br>▪ Trains human team members to help them work more collaboratively with robots in a coworking environment |

| Role | Anticipated Changes | Examples of Key Tasks |
|---|---|---|
| **Digital offering manager** | ▪ Decreased work on reporting and administrative tasks<br>▪ Increased work on client management, networking, and collaboration | ▪ Works collaboratively with IT, UX designers, and data science and finance teams to design and standardise digital offerings<br>▪ Communicates and builds relationships with clients and external stakeholders |
| **Drone data coordinator** | ▪ Decreased workload on resource planning and reporting<br>▪ Increased work on analysis and collaboration | ▪ Oversee the collection of drone surveillance, safety, inspection, and operation data and conduct analysis on it.<br>▪ Develop standard operating procedures (SOPs) and increase the number of drone data collection opportunities at the site. |
| **Smart factory manager** | ▪ Decreased workload on resource planning and reporting<br>▪ Increased work on process optimisation and analytics | ▪ Identify and facilitate the addition of advanced technologies that will enable self-optimization of the connected assets on the production line(s).<br>▪ Build a variety of automated manufacturing capabilities, including robot cutting, computerised knitting, and 3D printing. |

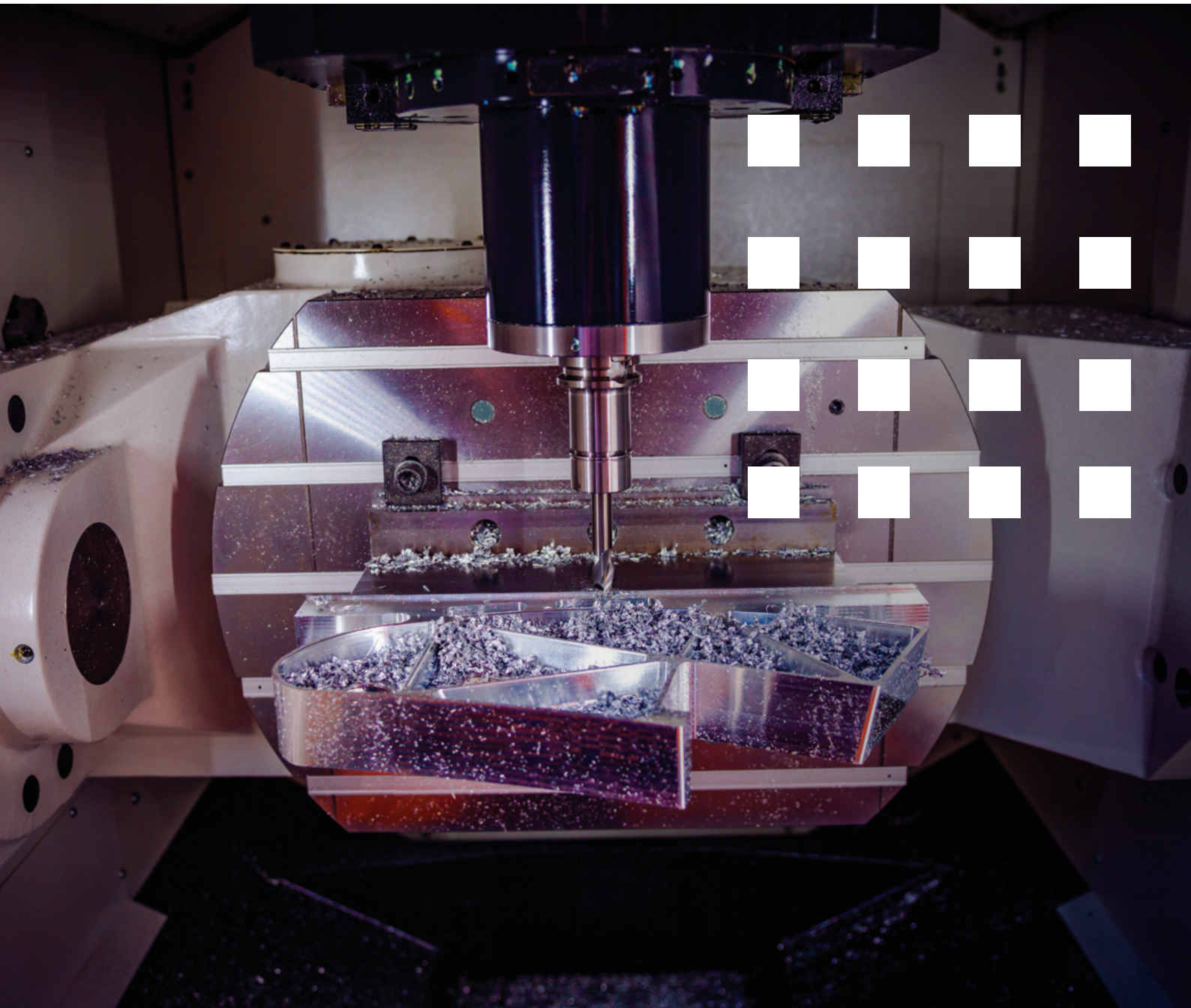
An example of one of these personas, the Smart Factory Manager is shown in Figure 6. The persona includes a profile of where they were educations and what skills certificates or micro-credentials they have acquired or been endorsed for related to their role as Smart factory Manager.

Of course, organisations are now more than ever looking for the complete graduate in terms of skill sets, which does not just encompass the so called 'hard-skills' but also the transversal skills required to be an effective modern worker who can adapt to changing demands and shifting business focus. Numerous employer surveys have identified issues regarding the work readiness of recent recruits with employers citing challenges with the additional skills and experience required to deliver an employable graduate.

***Figure 6:*** *The profile of the Smart Factory Worker*



# 4 HOW CAN LEARNING OVERCOME THESE CHALLENGES?



# 4 How can Learning overcome these Challenges?

This section provides ands overview of how different contexts are trying to address skills gaps through learning provision.

## 4.1 Ireland Context

It is worth exploring the Irish context in terms of how learning is supported by various centres and institutions.

**Universities, Technical Universities and Colleges**

The so-called 'Traditional' Universities, e.g. UCD, TCD, UCC, offer Level 7 to Level 10 courses in a wide variety of areas. Most Universities in Ireland offer Electronic Engineering, Renewable Engineering or similar courses related to advanced manufacturing. Technical Universities, e.g. ATU, TUS, TUD, offer Level 6 to Level 10 courses in areas that are intended to me more practical, they also often offer apprenticeships courses such that students can work as they learn. These are also specialised colleges such as the National College of Art and Design which specialise in particular fields or vocations.

**Skillnet Ireland**

Skillnet Ireland is the national talent development agency of Ireland. It partners with industry and the education and training sector, providing upskilling programmes to enhance business competitiveness. There are 70+ Skillnets in Ireland, for example in manufacturing you have First Polymer, Cobotics, Industry 4.0, BioPharmaChem, MedTech and ICBE advanced productivity). Another example of a Skillnet directly related to the Manufacturing Industry is the MIDAS Ireland Skillnet (covering semi-conductor courses https://www.midasireland.ie/skillnet/)

**Educational and Training Boards (ETBs)**

Education and Training Boards are education authorities with responsibility for education and training, youth work and a range of other statutory functions. Education and Training Boards manage and operate Community National Schools, Post-Primary Schools, Further Education (FE) colleges, and a range of adult and further education centres delivering education and training programmes. There are 16 ETBs in Ireland, with the Louth Meath ETB being an example of one (LMETB).

**Regional Skills Fora**

Regional Skills Fora work with businesses and people in their regions to meet their skills needs and make sure employers and enterprise get the education and training responses they need. Each forum has a voluntary chair and a full-time manager. There are 9 Regional Skills Fora in Ireland, and their intention is to direct businesses in the region to learning provisions, whether it be through universities, Skillnets, further education colleges or other. For example, the Dublin Skills forum[28] lists the following education providers:

- Dublin City University
- Dun Laoghaire Institute of Art, Design and Technology
- National College of Art and Design
- National College of Ireland
- Technological University Dublin
- Trinity College Dublin
- University College Dublin
- City of Dublin Education and Training Board
- Dublin and Dun Laoghaire Education and Training Board
- Skillnet Ireland

28 https://www.gov.ie/en/service/85625-dublin-regional-skills-forum/

**SOLAS**

SOLAS is the Further Education and Training (FET) Authority for Ireland. SOLAS as the funding agency for FET issues annually over 900 million euro for FET provision, primarily to the 16 Education and Training Board of Ireland. The FET system supports over 200,000 unique learners every year and offers a range of education and training provision across Levels 1-6 on the Irish NFQ Framework. FET incudes the above listed Skillnets and ETBs among other learning provisions. SOLAS manages the National Skills Database and provide research, data, and analysis to stakeholders on future skills needs

**National Skills Council**

The National Skills Strategy 2016-2025 (NSS) recommended the establishment of the National Skills Council (NSC). The Council was established in April 2017 by the then Department of Education and Skills as an advisory, non-statutory body made up of high-level officials from public and private organisations. The council brings together education and training providers with representatives from business, to effectively respond to skills needs and advises the minister and department on priority skills needs, the direction of skills and knowledge development in line with emerging global trends, and the opportunities and challenges for learning and work. The National Skills council oversee the region skills fora described above.

**Specialist Training Centres (AMTCE)**

The LMETB Advanced Manufacturing Training Centre of Excellence (AMTCE) is a state-of-the art training facility based in Dundalk, Co Louth which was established in January 2021. The purpose of the AMTCE is to provide training on state-of-the-art equipment and processes which will underpin the transition of Irish companies to industry 4.0 based operations. The centre provides a dynamic catalogue of training courses which are tuned to the needs of industry and delivered by leading industry training practitioners. At present, the AMTCE is offering world class skills training, apprenticeships, and level 5/6 courses in Robotic Processes, Cobotics, Additive Manufacturing, IIoT, CAD/CAM, Industrial Control, Cybersecurity, Process Optimisation (Lean 6 Sigma), BioPharma and Food Processing amongst other areas. The AMTCE Further Education and Training (FET) Advanced Manufacturing Pathways Schools Project incorporates the latest technologies such as Virtual Reality (VR), Augmented Reality (AR) and Robotics available in state-of-the-art FET or similar centres, to enhance and enrich the learning experience. The centre partners with local schools to provide unique opportunities for students and teaching staffs to engage in active learning in a FET or similar centre in the region affording access to state of the art equipment and technologies, and enable, support, and encourage students participating to see career pathways from school to FET and onwards into employment in the areas of Advanced Manufacturing and Digital technologies. These engagements also help provide awareness of the ever-growing manufacturing, advanced manufacturing, and technology sector.

### Irish Manufacturing Research Institute

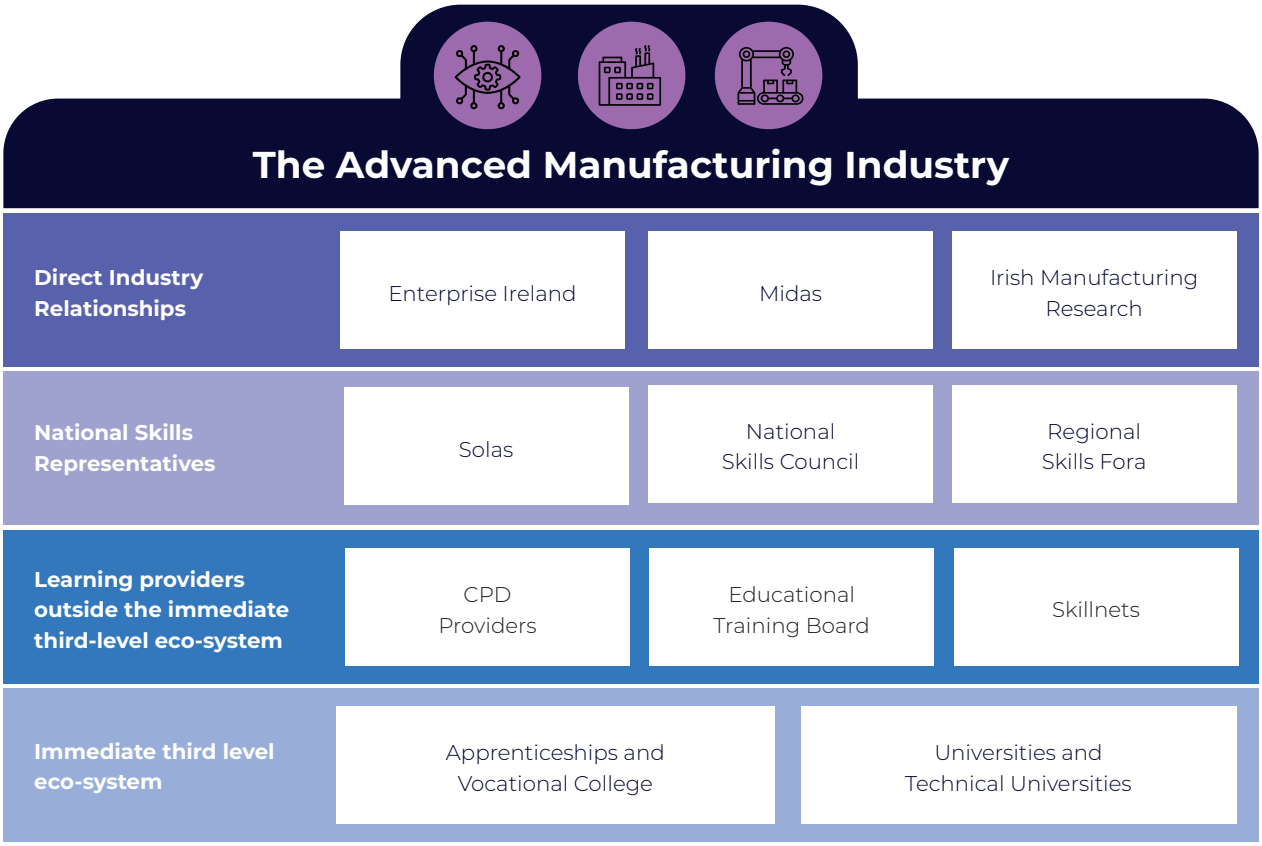
Irish Manufacturing Research (IMR) is an independent manufacturing and industrial energy efficiency research centre focused on delivering solutions for the manufacturing ecosystem throughout Ireland. IMR offers manufacturing industry an environment to collaborate with peers across all manufacturing sectors, and to inform and guide manufacturing research that addresses industry problems

### MIDAS

MIDAS is a representative body for the semiconductor industry in Ireland and works with the various state agencies to facilitate the growth of the semiconductor industry in Ireland. MIDAS work with the 3rd level education sector to ensure the continued supply of quality engineers into the industry and ensure the content of the engineering courses continues to evolve to support our needs. MIDAS also provide specialised training to engineers within the industry to help them enhance their career and they provide advanced courses to college undergrads in order to help enhance their interest in following a career in semiconductors. MIDAS also perform outreach and awareness raising activities, for example in secondary schools.

### Making Sense of the Irish Eco-System

***Figure 7:*** *Irish Learning provision Eco-System*



Within this extensive (and often complex) Irish eco-system (Figure 7), there is an attempt to link critical vacancies in the sector to educational offerings that may be able to create the graduates needed to fill these vaccines. For example, the Midlands Regional Skills Forum Advanced Manufacturing Survey (MRSF), outlines critical vacancy needs in the area of advanced manufacturing. The report provides reference guides of regional certified courses/ programmes relevant to Advanced Manufacturing. It also lists education & training providers with a brief introduction of the provider and a sampling of courses and modules that they offer and provides information regarding Apprenticeship involvement through SOLAS. Finally, it outlines the benefits and assistance available as a member of the Advanced Technology in Manufacturing (ATIM) cluster which facilitates networking among Midlands regional manufacturers of all sizes and manufacturing categories. Reports like these are helpful in enhancing alignment between industry and education sectors and can help point organisations to industries and initiatives that they can partner with to increase their potential to fill critical vacancies.

Some of the courses outlined in the report along with the learning outcomes they achieve are presented in Table 10. The table also shows some examples of lower level courses to fit within a more Micro-Credentials Framework.

***Table 10:*** *Courses offered in the Irish midlands that are linked to regional skills gaps*

| Course | Learning Outcomes | Application in the Advanced Manufacturing Industry |
|---|---|---|
| **PRECISION ENGINEERING (CITY & GUILDS - LEVEL 2)**<br>**Athlone Training Centre, Garrycastle, Athlone** | ▪ Knowledge of material properties and mathematical concepts needed to be an effective Machinist in the<br>▪ Engineering Sector. How engineering businesses are<br>▪ organised and the business improvement techniques<br>▪ they use. How to carry out routine engineering workshop tasks and different manual and/or CNC machining operations. | Business improvement techniques in advanced manufacturing enable companies to optimize processes, reduce costs, enhance quality, and deliver greater value to customers. This can include roles related to Total Quality Management (TQM) and Supply Chain Management Techniques |

| Course | Learning Outcomes | Application in the Advanced Manufacturing Industry |
|---|---|---|
| **Engineering in Polymer Processing – Level 8**<br>**First Polymer Training Skillnet** | ▪ Advanced Polymer Processing & Analysis<br>▪ Energy & Utilities Management<br>▪ Experimental Design<br>▪ Injection Mould Design<br>▪ Recycling of Polymers<br>▪ Statistical Process Control, Quality Management | Advanced polymer processing techniques, such as selective laser sintering (SLS) and fused deposition modelling (FDM), are used in additive manufacturing to produce complex polymer parts with high precision and resolution |
| **AUTOMATION & ROBOTICS**<br>**Bachelor of Engineering Level 7**<br>**TÚS: MMW - Athlone** | ▪ Statistics and Lean Sigma, Mathematics,<br>▪ Robotics Programming and Vision, Control<br>▪ and Mechatronic Systems, Computer<br>▪ Networks, Industrial Placement, Project<br>▪ Evaluation and Management, Manufacturing<br>▪ Systems and Operations Management | Graduates have found employment in the manufacturing sector generally, across a broad range of industries, such as the medical device, electronics, agricultural and pharmaceutical sectors. Typical jobs include process/ machine maintenance, process development, fault-finding, as well as working in multi-disciplinary teams in a modern manufacturing environment. |
| **Cert. in Plastics Injection Moulding - Level 5**<br>**First Polymer Training Skillnet** | ▪ Injection Moulding Modules 1, 2 & 3<br>▪ Plastic Materials & Processing<br>▪ Communications<br>▪ Work Experience<br>▪ Choice of 2 Elective Modules | Injection moulding allows for the production of complex parts with intricate geometries that are difficult or impossible to achieve with other manufacturing methods. This includes features such as undercuts, threads, and internal structures, enabling innovative designs in industries such as automotive and electronics. |

Further research may be required to analyse how these courses are impacting on the industry in the region, in terms of conversion of graduates directly to roles within the sector and what kinds of roles they are acquiring. This OECD Skills Strategy Assessment and Recommendations project reviews how Ireland's existing skills strategy – the National Skills Strategy (NSS) 2025 – might need to be adapted to ensure that it is still fit for purpose. They outline four priorities in the report:

- **Priority 1, Securing a balance in skills through a responsive and diversified supply of skills:** This includes improving information and guidance for individuals on learning and career pathways, strengthening learning and career pathways over the life course (life-long learning) and making education and training provision more responsive to changing skills needs.
- **Priority 2, Fostering greater participation in lifelong learning in and outside the workplace**: This includes strengthening incentives to participate in lifelong learning for individuals, strengthening incentives to participate in lifelong learning for employers, and making lifelong learning more flexible and accessible.
- **Priority 3, Leveraging skills to drive innovation and strengthen firm performance:** This includes better utilisation of Ireland's research talent and public research and innovation system to drive innovation within firms, promoting the continuous improvement of leadership and management skills within enterprises, and incentivising and enabling enterprises to make better use of the skills of their workers through innovative workplace solutions.
- **Priority 4, Strengthening skills governance to build a joined-up skills ecosystem:** This includes promoting a whole-of-government and strategic approach to skills policy, supporting effective engagement with stakeholders throughout the skills policy cycle and strengthening the collection, exchange, and use of skills information.

The question is, is the current Irish eco-system as outlined earlier in Section 4.1 equipped to meet these priorities?

The challenge of shorter turnaround times for graduates is not something that is easily solved. It may call for different model of education. A recent report from the Irish Biopharma called for increased collaboration between industry and academia to better understand the skills needs of the sector and to develop new pathways into the sector, such as apprenticeships tailored to meet the needs of the industry and new and more responsive and flexible models of education and training delivery. This implies that the traditional degree model (3-4 years, with masters etc) may no longer be sustainable or even required for the needs of certain industries. One example of an alternative model is the use micro-credentials. With increased need for upskilling, micro-credentials provide an agile alternative to higher-commitment courses.[29] This model may not only future proof the skills and careers of workers, but also future proof the skill requirements of organisations.

29 https://www.irishtimes.com/special-reports/2023/12/15/micro-credentials-are-a-convenient-way-to-future-proof-your-career/

## 4.2 Northern Ireland Context

There is significant skills provision in Northern Ireland with many organisations providing education and training, yet a number of challenges persist in relation to addressing the skills gap/shortage through Education and Training:

- Lack of joined-up approach,
- Revised/updated graduate career pathways,
- Lack of forecasting future skills,
- A need for more Industry-driven approach,
- Shortage of trainers,
- Need for a Micro-Credentials Framework,
- Tackling the gender gap (only 20% of those working in manufacturing are female).

Below is a summary of the current state of learning and skills provision in Northern Ireland with some challenges and opportunities highlighted:

**Universities**

Institutions like Queen's University Belfast and Ulster University offer degrees in engineering, technology, and related fields, which are essential for advanced manufacturing.

Queen's University Belfast offers a range of relevant undergraduate and postgraduate study options. At undergraduate level, course options include Aerospace Engineering; Electrical & Electronic Engineering; Mechanical Engineering; Product Design Engineering; Software & Electronic Systems Engineering, etc. At postgraduate level, course options include Electronics with Professional Internship; Engineering Management; Materials Science & Engineering; Mechanical Engineering with Management & Industrial Internship, etc. part-time and full-time options are available. Queen's University has also developed an Access Engineering programme in partnership with SERC, primarily to provide a route to higher education for those who have been away from education for an extended period (2 years minimum). The University Access Diploma in Computing and Engineering Sciences (CES) will provide a pathway to further study or employment in a range of disciplines associated with the Faculty of Engineering and Physical Sciences including Electronic Engineering, Civil Engineering, Maths, Physics, Mechanical and Aerospace Engineering, Software Engineering and Computer Science.

The School of Engineering at Ulster University also offers a broad range of engineering courses at undergraduate and postgraduate level. At undergraduate level, bachelor and integrated master's programmes are offered in: Biomedical Engineering, Electronic Engineering, Engineering Management, Mechatronic Engineering (offered also as a part-time route) and Mechanical Engineering. A BSc Hons in Technology with Design – an innovative hybrid programme that straddles the subject areas of technology and design, is also available - the technology aspects of the curriculum are delivered in the School of Engineering and the Design aspects are delivered in the Belfast School of Art.

At postgraduate level, MSc programmes include Advanced Composites & Polymers, Biomedical Engineering, Mechanical Engineering and Manufacturing Management. Postgraduate programmes are offered full-time and part-time, with the part-time courses popular among employees at engineering firms who wish to provide opportunities for training and upskilling among their workforces. Connecting pathways where FE & HE can work together are also beginning to emerge.

The Open University also provides higher education courses.

### Further Education Colleges

The six regional FE colleges across Northern Ireland offer a range of full time and part-time courses and training from levels 1-6 in this field. Foundation Degrees include Electrical and Electronic Engineering, Manufacturing Engineering, Mechatronic Engineering, Mechanical Engineering, Electrical and Electronic Engineering, Mechanical and Manufacturing Engineering.

Southwest College is host of the regional Engineering and Advanced Manufacturing Hub.

The FE Colleges offer a range of Apprenticeships from level 1-6 in Subjects such as: Engineering (Mechanical, Electrical, Electronic, Maintenance, Aeronautical, Manufacturing, Automotive, Mechatronic), Welding, Fabrication, Technical Support and Polymers. There is a need to develop new training curriculum and content to underpin the ambition of the advanced manufacturing sector, this content must align with the development of new apprenticeship frameworks at Level 3 and also feed on into Higher Level Apprenticeships. The new frameworks must be approved by Sectoral Employer Partnerships (SEP).

Higher Level Apprenticeships (HLAs) are emerging in the region and have had positive feedback from employers. Current HLA options include Mechanical, Mechatronics, Automotive and Advanced Engineering, Sustainable Construction, Renewables and Sustainability and Automotive and Advanced Engineering. Higher-Level Apprenticeships, in particular, provide flexible skills offer from the perspective of both industry and participant, and there is a strong case for provision to be enhanced.

### Collaborations between Educational Providers

Collaborations between Educational providers are emerging to meet specialist emerging needs such as the pilot Hydrogen Training Academy in Mid and East Antrim includes FE delivery partners Belfast Met, NRC, QUB and UU[30] this is a great example of where a collaboration of providers and appropriate funding has led to the provision of training to meet emerging industry needs.

### Leadership

Managers in Northern Ireland's manufacturing sector now have access to the Advanced Manufacturing Leadership Programme[31] with support from the Queen's University Bright minds initiative and The Centre for Competitiveness, to help boost the sector's productivity. Further Leadership training is needed.

### Employment Academies

Employment Academies offer a good demand-led solution to skills shortages. Employment Academies provide tailored training in specialised skills such as those in short supply in the advanced manufacturing sector. The training is delivered in short courses for groups of 15 people maximum. The training offering provided by Employment Academies lends itself to the delivery of micro-credentials within an agreed accreditation framework. Such plans, however, are subject to funding (as well as the individual preferences of each Council area) and cannot in their current state be relied upon as a strategic or sustainable model.

30 Hydrogen Training Academy (investmideastantrim.com)
31 https://www.leadershipinstitute.co.uk/ExecutiveProgrammes/AdvancedManufacturingLeadershipProgramme/ delivered by the William J Clinton Leadership Institute

**Short Courses**

DfE, with funding from the Northern Ireland Office and the Department of Finance, supports free short courses, delivered by the local further and higher education providers through the flexible skills programme Skill Up. This offers up to 7,000 free places - comprising opportunities from entry to postgraduate levels - focusing on skills identified by industry and linked to priority economic sectors, including advanced manufacturing. Most courses are delivered online and provide an opportunity to re-skill and upskill into areas where job growth is expected to be high. The need for upskilling will require continued provision for industry focussed short courses.

There are various bodies in specific regions in Northern Ireland tasked with boosting Advanced Manufacturing Activity the most notable of which are:

MEGA (supported by INVEST NI and Mid-Ulster Council) MEGA is an industry-led collaborative network in Mid-Ulster working together towards a common goal. Its mission is to promote the manufacturing and engineering sector as a source of high-value, long-term employment and to create transformational career opportunities that deliver skills for life. MEGA 's core function is to act on behalf of industry to address the skills deficit and attract people into Advanced Manufacturing & Engineering[32].

Mid and East Antrim Borough Council have a Manufacturing Task Force industry-led collaboration aimed at ensuring that Mid and East Antrim has a prosperous future as the home of world class, innovative advanced manufacturing[33].

GEMX[34] is an industry led collaborative network of innovative companies and educational institutes in the Northwest of Ireland. It "exists to bring education industry and leadership together so we can nurture a vibrant, thriving engineering and manufacturing community.

In March the British Government ended its funding for Skill Up and in order to continue the provision, the Northern Ireland government have allocated £6m to be used to fund a new Skill Up programme as part of a £12 million fund for skills interventions[35].

**Advanced Manufacturing Innovation Centre (AMIC)**

To move forward as a region towards a coherent and industry driven skills provision a key priority is for these organisations to collaborate in the design and delivery of training needs. The Advanced Manufacturing Innovation Centre (AMIC) presents a significant opportunity to provide industry-led employability and skills solutions. The £100m project under the Belfast Region City Deal focused on advanced manufacturing in Northern Ireland aims to boost economic growth by creating high-quality jobs and attracting investment through manufacturing innovation. The centre is being delivered by Queen's University Belfast in partnership with Antrim & Newtownabbey Borough Council, Ulster University, and industry. It will place NI in an advanced R&D and Investment Network between the island of Ireland and the UK (See Figure 8). At £100m AMIC is the largest single investment and centre and is working with the other Northern Ireland centres on its Northern Ireland wide brief to drive productivity, growth and jobs in the sector. Economy Minister Conor Murphy has announced various funding initiatives within the Skills Agenda and there is an opportunity to align skills funding with City Deal Investment.

32 https://midulstermega.com/
33 https://investmideastantrim.com/economic-drivers/manufacturing-task-force/
34 https://gemx.uk/
35 Minister's speech - Update on Skills Agenda - 2 July 2024 | Department for the Economy (economy-ni.gov.uk)

***Figure 8:*** *AMIC within an advanced R&D and Investment Network*


AMIC will deliver:

1. Increased size and productivity of the high value advanced manufacturing sector in NI with a focus on low-carbon products, services, manufacturing processes and resilient supply chains.
2. NI based high value advanced manufacturing clusters and jobs through UK and global investment.
3. Workforce and skills development through inclusive and high value jobs

Acting as a conduit between industry, the Catapult Centres as well as leading manufacturing enterprises in the UK, AMIC plays a crucial role in advancing the manufacturing industry in Northern Ireland and has a significant opportunity to add value to the skills and learning provision.

## 4.3 UK Context

The UK Excellence in Manufacturing report calls for greater alignment between industry demand for skills and those developed in third level education. The report highlights priorities that need to be addressed by a range of UK stakeholders (education, industry, and government) in collaboration to help build a more internationally competitive manufacturing sector in the UK. This includes:

- Exchanging expertise between employers and skills providers to keep courses and curriculum in lockstep with emerging skills demand.
- Empowering educators to equip young people with first-rate and up-to-date technical and employability skills required by industry.
- Boosting higher technical education and training to help manufacturers adopt technologies and processes that will enhance productivity and competitiveness
- Increasing enrolment numbers on manufacturing courses at all levels to meet replacement demand and the enduring importance of traditional skills
- Developing a compelling narrative about modern manufacturing to attract young women and men of all backgrounds to careers in the sector, challenging the narrow understanding of manufacturing jobs and skills that many currently hold.

However, this is easier said than done. We go back to the 'Age of Acceleration' quote by the HR Daily Advisor. There is a lot of pressure on the education sector to supply skilled workers to industry. The age of acceleration calls for shorter turnaround times to transform non-equipped earners into equipped workers. However, Gartner Talent Neuron estimates that 33% of the skills needed three years ago may no longer be relevant[36].

A recent report from CMI (Chartered Management Institute), Work-ready Graduates: Building Employability Skills for a Hybrid World, aims to understand the current landscape of employability skills for students and graduates from UK universities. Uniquely, it brings together feedback from academics in higher education institutions (HEIs), HR decision-makers within UK-based businesses, as well as undergraduate students. They presented some interesting findings related to the relationship between higher education institutes (HEIs) and industry.

- It needs to be easier for employers to engage with an HEI. While 57% of employers report that they have been actively involved in shaping HE employability skills since July 2019, only 37% reported it had been very easy to get involved with their chosen HEI,
- This disconnect deters many employers from getting involved with HEIs: 61% of employers who are not currently involved in shaping employability skills with HEIs would like to get involved, but only 11% of this group know how they would go about doing so. Although there are agencies (such as Local Enterprise Partnerships) tasked with making these connections, almost all (92%) employers thought that it would be helpful if there was an organisation that could connect decision-makers in their organisation with HEIs to shape employability.

36 https://www.gartner.com/en/newsroom/press-releases/2020-08-19-gartner-hr-research-finds-employees-are-only-applying-54-percent-of-newly-learned-skills

**57%**

of employers report that they have been actively involved in shaping HE employability skills since July 2019

While these are UK findings, given the complex eco-system or learning providers in Ireland, it is probably safe to infer that similar disjointed relationships may exist in Ireland (and indeed other countries). The report went on to describe what organisations want more of from HEIs, one of which was greater visibility of a graduate's employability. The three most popular approaches to assessing a graduate's employability (with more than 50% of employers agreeing) were:

- Completion of an accredited training course or qualification (55%)
- Completion of internships, placements/ or work-based learning (55%)
- Completion of short, bitesize employability skills training programme (51%)

The report finished with a stark warning for learning providers within the UK context. HEIs are under severe funding pressure and must become more agile to meet rapidly changing skill landscapes. They provide six recommendations for HEIs to meet these new demands.

- Embed accredited employability skills in course modules where possible. Otherwise ensure all students have access to accredited standalone employability modules.
- Take a whole-university approach to employability from the outset of courses. All students need access to employability skills regardless of the degree course that they are taking.
- Make sure students are aware of their employability skills and are able to measure and track their employability skills gain.
- Support students to articulate and convey their skills and be able to demonstrate they are work-ready in an increasingly digital workplace.
- Use existing and emerging national and regional networks to connect with employers to better understand the skills needed for the workplace. This could be a local Chamber of Commerce, Local Enterprise Partnership, or professional body
- Create networking opportunities for students to connect with local employers to provide real-life work-based assignments, mentoring opportunities, and career pathways.

Again, while these are UK specific, but these recommendations would have strong parallels to the Irish context (see similarities to OECD recommendations in section 4.1).

# 5 HOW CAN GOVERNMENTS SUPPORT?

# 5 How can Governments Support?

Government initiatives can play a crucial role in alleviating skills shortages in the advanced manufacturing industry by addressing the root causes of the problem and supporting workforce development. For example, governments can allocate funding to support vocational training, apprenticeship programs, and higher education initiatives focused on emerging technologies relevant to advanced manufacturing. This funding can be used to develop curriculum, provide scholarships or grants for students, and train educators. In section 7 we will see a case study of how the Irish government is attempting to build an advanced manufacturing hub in the Irish midlands by 2030.

This section provides an overview of collaboration opportunities between industry stakeholders, as well an overview of government initiatives supporting the development of advanced manufacturing skills.

## 5.1 Ireland Context

**Midlands Regional Action Plan 2020**

Ireland seeks to 'position and support the Midlands as an advanced manufacturing centre of excellence' (by 2030). The Midlands Regional Action Plan[37] aims to realise the vision that the Midlands Region becomes known internationally as a Centre of Excellence in advanced and sustainable manufacturing and as an ideal location for manufacturing companies to establish and grow their business and exports. In order to outline how this centre of excellence might be achieved, the report presents key information such as:

- Outline the challenges and opportunities with regard to advanced manufacturing in Ireland, including competition from other countries with regards labour costs and scale, aligning manufacturing with climate change responsibilities (sustainable manufacturing), utilising best practice business excellence to create a competitive advantage for Ireland, and implementing an action plan to overcome challenges and take advantage of potential opportunities.
- Key attributes and advantages of the Irish midlands, including proximity to airports, ports and population centres, current presence of manufacturing industry (MNC and native), and proximity to third level institutes.
- Presentation of exemplars that Ireland could learn from, in particular examples from the UK and Europe, and from examples of similar initiatives in related industries, for example Galway's MedTech centre.

A survey was also conducted with agencies and industry representatives. The following key findings were presented from the survey:

- Some technologies are under-utilised e.g. data analytics, Cobotics, ERP / work-flow digitisation.
- Lean Six Sigma not sufficiently embedded - varying level in companies, some 'stop-start' approaches.
- Sustainability - aware, mostly ISO 14000/ ISO 45000 driven, rather than through company strategy.
- SMEs need advice, examples of use, practical help, and more financial supports to adopt.
- Skills training needed in emerging technologies, to meet ongoing skill-set needs of industry.
- Attracting and retaining specialist staff.
- Promote and facilitate apprenticeships as a career and development route.

37 https://enterprise.gov.ie/en/publications/publication-files/midlands-regional-enterprise-plan-to-2020.pdf

- Potential opportunities through more Midlands industry networking/clusters.
- Need for independent expert advice.
- At management level, need for showcasing, educating, and guidance in preparing business case.
- Agencies were well regarded, but varying engagement by companies with agency supports in Higher Education/ Research organisations sector, little with EU.
- Potential opportunities through awareness of inter-agency collaborative initiatives.
- Perceived complexity of support ecosystem.
- Help for companies to explore and pilot technologies to encourage early adoption competitive advantage.

From the findings presented, the report outlines an action plan with a number of key themes:

- Education, Training & Skills
- Research & Innovation
- Support infrastructure & networks
- Strengthening the Midlands manufacturing industry base

**Galway MedTech Hub (Exemplar of Government Support)**

The Irish Government's Midlands Regional Action Plan 2020 cited the Galway MedTech hub as an 'excellent exemplar' of a world leading med-tech region. In the last few decades, Ireland has cemented its reputation as a hub for MedTech innovation. This evolution is due to the abundance of talent, proactive government support, a thriving education ecosystem, and the increasing presence of global MedTech giants. Today, Ireland is widely regarded as one of the top 5 MedTech hubs in the world (IBEC 2023). The greater Galway area contains one-third of Ireland's MedTech workforce. Not only has it attracted strong foreign direct investment sector with many large MNCs (i.e. Boston Scientific and Medtronic), but it also has a strong indigenous med-tech and sub-supply sector (Creganna, Tympany). The sector is closely aligned with the major education hubs of ATU and UoG. Start-up and scale-up enterprises have access to several innovation, incubation and co-working spaces in Galway city and surrounding area, as well as campus incubation centres at ATU - Innovation Hub (iHub), at UoG - Ignite Business Innovation Centre, and Bioinnovate Ireland. Indeed, a number of currently successful startups have come directly from incubation centres at these universities (Luminate Medical, Relevium Medical, Hidrawear). Indeed, this success did not happen overnight. As far back as 2008, reports were being commissioned to identify critical skills shortages in the MedTech sector. We can see echoes of the challenges outlined and the recommendations provided in these reports, with the reports we have reviewed related to the advanced manufacturing sector. A 2008 report conducted by Publica Consulting and McIver Consulting on behalf of the Expert Group on Future Skill Needs and Forfás (Future Skills Needs of the Irish Medical Devices Sector, 2008) stated that "The main opportunity to differentiate Ireland on the basis of skills is in the supply of high quality engineers." In order to achieve this supply of skilled workers they provided a number of recommendations.

- A Centre for Medical Device Manufacturing Excellence should be established in the higher education sector to assist industry in developing the skills required for automation, lean manufacturing and quality management.
- A call for close cooperation between the Irish Medical Devices Association, FÁS, Skillnets and other organisations.

- Higher education institutions involved in graduate studies in biomedical engineering should continue to work towards establishing a Fourth Level Graduate Education Institute, so as to prepare graduates to contribute effectively to medical devices sector innovation and to strengthen the network of relationships among future key players in Irish medical devices innovation. (Bioinnovate in UoG is an example of this)
- Entry into the new graduate programmes in medicine by engineering graduates has the potential to produce a supply of graduates qualified both in medicine and engineering. Medical and engineering schools should jointly create more opportunities for clinicians in training to undertake studies and/or research in medical technology and biomedical engineering. (Could similar crossover opportunities exist in advanced manufacturing, for example those skilled in medical data analysis could be reskilled in process data analysis)
- As technological convergence in medical devices advances, skill requirements will evolve significantly, necessitating strategic interventions. To address this, integrating courses on crucial convergence topics into undergraduate biomedical engineering programs, establishing master's programs specialising in key areas of demand, and offering specialist or cross-disciplinary undergraduate degrees tailored to industry needs are essential measures to prepare graduates for emerging skill demands.

**Irish Manufacturing Research (IMR)**

Irish Manufacturing Research (IMR) was established in 2014 as a fully fledged Research and Technology Centre. IMR's goal is to Demystify, Derisk and Deliver emerging technologies and new knowledge to enable industry to succeed at the cutting edge of advanced manufacturing. With initial funding of €15m, IMR developed a work programme including projects in IoT, Data Analytics, Chilled Water Optimisation, Knowledge Management and Schedule Optimisation.

In 2017, a new R&D lab in Mullingar was established which enabled the expansion of the research into additive manufacturing, machining, and robotics and in partnership with a cluster of Irish SMEs, a unique national facility supporting high-TRL industry focused research in a "factory" environment.

In 2024, Irish Manufacturing Research is a leading Research and Technology Organisation providing a portfolio of research, training, and consultancy services to Industry across 4 thematic pillars: Digitisation, Sustainable Manufacturing, Design for Manufacturing, Robotics and Automation.

**IBEC**

In a more general call for addressing talent shortages across Ireland, IBEC make three key recommendations in the area of what it calls 'Talent and Innovation':

- Leverage the National Training Fund to support enterprise-led skills development and boost enterprise education engagement.
- Close the €307 million funding gap in higher education to deliver a sustainable funding model to support Ireland's universities to remain at the cutting edge.
- Deliver a sustainable funding model to support an integrated apprenticeship system, and to reduce anomalies between craft and consortia-led apprenticeship in relation to off the job training costs.

## 5.2 Northern Ireland Context

Across the border in Northern Ireland, similar efforts are being made to create hubs and centres of excellence for different industries. An example of a government initiative to support the industry is the City and Growth Deals centres of excellence[38]. A City or Growth Deal is a bespoke package of funding and decision-making powers negotiated between government and local authorities. They are aimed at helping to harness additional investment, create new jobs and speed up inclusive and sustainable economic growth. Advanced manufacturing related activity spans all of the Region's City and Growth Deals (Belfast Region City Deal, Derry City & Strabane City Deal, Mid Southwest Growth Deal and the Causeway Coast & Glens Growth Deal). Centres of Excellence emerging from these deals include: AMIC (Advanced Manufacturing Innovation Centre), Cognitive Analytics & Digital Robotics Innovation Centre (CADRIC), Design Smarter Digital Twin, i4C Innovation and Cleantech Centre, Agri-Tech Food Innovation Excellence Centre and Robotics, Automation and Packaging Innovation Centre (RAPIC). These centres of innovation excellence will provide opportunities for businesses, located both in and outside Northern Ireland, improving the interface between world-leading academia and research and provide access to breakthrough technologies, helping to drive innovation in processes and product development. The City and Growth Deals centres of excellence will be best placed to understand the more detailed skills requirements, particularly in core areas such as:

- Sustainable Polymers and Composites
- Digital Factory
- Smart Design
- Nanotechnology and Photonics
- Sustainability and Net Zero

They will be able to support industry in understanding emerging technological advancements - providing an environment for shared learning which will mitigate the risks associated with initial investment costs. Close connections with Education delivery partners provides a great opportunity for meaningful collaboration. The £150 million pound City and Growth Deals initiative will act as a catalyst to innovation and scaling up of organisations leading to continued growth and whilst there is no direct allocation for skills and training, there is an opportunity to align the skills needs with funding opportunities. Economy Minister Conor Murphy has announced various funding initiatives within the Skills Agenda[39] and there is an opportunity to align skills funding with City Deal Investment.

DfE have produced an Advanced Manufacturing, Materials and Engineering Sectoral Action Plan with "People and Skills" identified as one of the Four Key Themes[40].

Makers Alliance, an independent industry-led body established in 2021 to drive the strategic development of the Advanced Manufacturing sector in Northern Ireland in their Strategic Plan[41] identified Skills and Labour as one of the six drivers for the development of a high-performing, yet sustainable manufacturing sector and through their Delivery Plan will continue to influence how stakeholders can contribute to make a difference.

38 https://www.investni.com/international-business/why-northern-ireland/city-and-growth-deals

39 https://www.economy-ni.gov.uk/ministers-speech-update-skills-agenda-02-july-2024

40 Advanced Manufacturing, Materials & Engineering Sectoral Action Plan for 2024-2027 (economy-ni.gov.uk)

41 Makers-Alliance-Strategic-Plan-August-2022.pdf (matrixni.org)

The Advanced Manufacturing Skills Assessment (Northern Ireland City and Growth Deals) report from January 2024 made 5 key recommendations:

- Develop a collaborative approach to future skills provision for the advanced manufacturing sector.
- Align and rescale existing provision to meet current and future demand reflecting industry needs.
- Colleges and Universities work to expand the range of apprenticeship and higher level apprenticeship pathways.
- Increase attractiveness and raise awareness of career potential in sector.
- Prepare for emerging skills needs associated with sustainability and Net Zero.

## 5.3 UK Context

Made in the Midlands[42], part of the Made in Group, has as its stated aim 'to challenge the erosion of British industry'. Established in 2009, it is an industry-funded network of manufacturing companies operating in the English midlands and Yorkshire. It has 600 manufacturers including SMEs and large companies including for example Portakabin, Schneider Electric, Jaguar Land Rover, Moog, Mazak, Siemens, etc. Its members commit to mutual support and networking, to building supply chains with local firms, to promoting manufacturing as an attractive career and supporting apprenticeships and export development.

**High Value Manufacturing Catapult (HVMC)**

HVMC, a strategic research and innovation hub for industry plays a significant role supporting skills and workforce planning in the sector. Through the skills value chain approach, HVMC connects workforce development with the wider innovation eco-system, leveraging the technological know-how of Centres of Innovation to build an industrial skills base for the future.

## 5.4 International Context

**It's OWL Technology Network – North Rhine-Westphalia, Germany**

https://www.its-owl.com/about-us/ 'It's OWL' - Intelligent Technical Systems OstWestfalen Lippe - is an industry-led advanced technologies cluster in the Ostwestfalen-Lippe region in Germany's state of North Rhine-Westphalia. - Established in 2012, it is an industry-led initiative, supported by Government funding, that develops the necessary infrastructure resources and supports processes and value chains. It has 200 business partners participating in collaborative advanced innovation projects with third-level and research partners and along the companies' value chains. Its impact has been in business transformation, job creation, new start-ups, new Industry 4.0 focused research centres and new education and training courses for industry needs. The It's OWL network has built a reputation as a benchmark for successful transformation through digitisation for SME companies in Europe, and for example helped firms with business collaborations and rapid business transformation projects to address issues caused by the covid-19 crisis.

42 https://madeinthemidlands.com/

The 'Digital Skills for Tomorrow, Today' report by NZTech commissioned for the purpose of identifying skills gaps across advanced digital skills in NZ, also provide recommendations which could be easily mapped to the advanced manufacturing sector given the crossover in skills[43]. They provide three groups of recommendations.

- Our Collective Response to Digital Skills Challenges needs to Mature Rapidly:
  - Have a plan - create a digital technology industry workforce plan.
  - Set targets - focus on realistic absolute numbers.
  - Understand the issues - undertake further deep dive research into specific challenges.
  - Use an Industry Standard - rapidly deploy the SFIA framework to enable alignment.
- Governments must Show Leadership
  - Install leadership - responsibility should be entrusted to a senior government position.
  - Create entry level jobs - Governments should establish a wide range of entry level digital roles.
  - Enhance the visibility of available support - maintain funding assistance for entry level roles and improve their accessibility.
  - Address underlying causes - allocate resources towards ensuring universal internet and device access for all learners.
- Industry Must Prioritise Collaboration and Abandon Rhetoric:
  - Engage in collaborative attraction efforts - work as an industry to support the attraction of learners into tech.
  - Collaborate on planning - support and improve workforce planning.
  - Collaborate on new pathways - co-design and support work integrated learning.
  - Collaborate on a platform - to make it easier to find industry courses, initiatives, and information about tech careers.

43 https://nztech.org.nz/wp-content/uploads/sites/8/2023/08/NZTech-Digital-Skills-Report_final.pdf

# 6 HOW CAN TECHNOLOGY SUPPORT?

# 6 How can Technology support?

Many challenges are outlined in this report. The solutions to many of these challenges point to the need for digital solutions which can achieve the following:

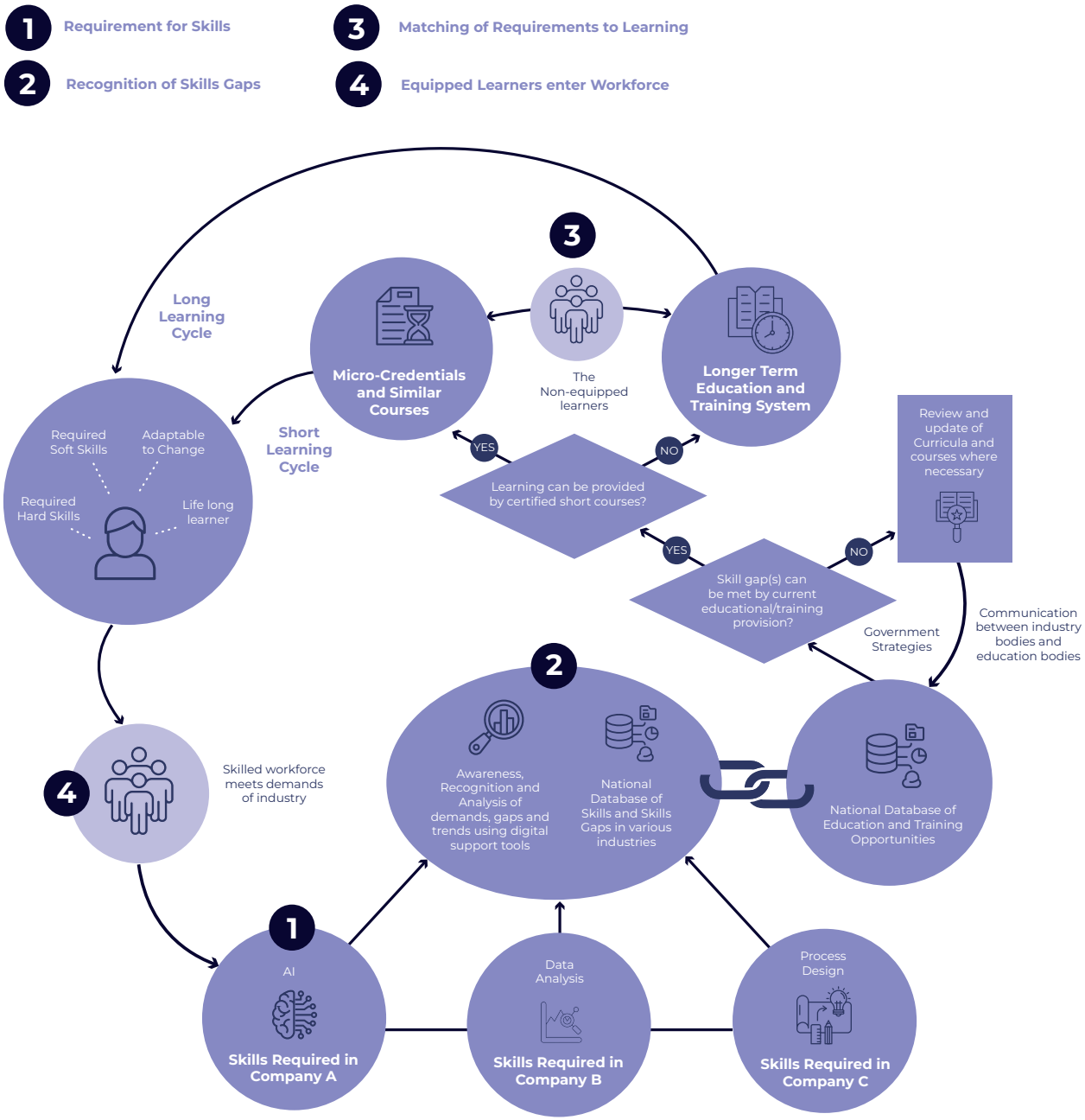
- Recognise and flag skills gap before they become apparent and impactful.
- Provide a platform for communication between education and industry, whereby the skills gaps within an industry can be related directly to education and training opportunities (and hence recognise potential gaps in the education and training offerings).
- Speed up and simplify the learner journey, leading to shorter training cycles such that skills do not go of out of date and workers do not spend long periods 'off the job.'
- Engage organisations and learners and demystify digital concepts.
- Enhance Peer-to-peer learning and collaboration.
- Create a coherent digital strategy which links stakeholders together. Not just meeting the training demands of the now' but panning for the training demands of the future.

A potential model is outlined in Figure 6. This is an extension of the original model we outlined in Figure 3 (section 2.3) which would be considered more traditional and current.

This model tries to account for the following:

1. A means for collective industry to recognise skills gaps and learning requirements among their workforce,
2. A database to monitor and anticipate skills gaps on a national level couple with an education and training database that can match learning options to the skills required. This would replace more formal research reports as the primary means to inform both industry and academia.
3. A recognition that not all learning needs to be provided by longer term education cycles. This may include a framework whereby micro credentials become the first preferences for industry, and if learning cannot be provided by micro credentials, then more formal education cycles will kick into action. There would be a review of curriculum and courses if no adequate education or training is currently available. This requires strategic level planning by governments and a close relationship between industry and education.
4. Workers can now enter or re-enter the workforce quipped with the skills they need.

***Figure 9:*** *Model that relates industry needs, learning provision and shorter learning cycles*



# 7 CONCLUSIONS

# 7 Conclusions

## 7.1 How will advanced manufacturing change in the future?

Advanced manufacturing is poised to undergo significant transformations in the future due to rapidly advancing technology, evolving economic conditions, and the shifting needs of society. In this report we referred to terms like Industry 4.0 and the 'age of acceleration'. These terms point towards a shift in how manufacturing is being carried out, with rapidly evolving technology being central to the future of manufacturing. With this need for the understanding and integration of technologies comes the need for adequate learning pathways to ensure a capable workforce within the sector. Industry must provide appropriate learning pathways to ensure that potential and current employees possess the latest knowledge and skills required to do their jobs effectively. Strategic recruitment processes must be implemented to attract skilled talent, offering cutting-edge training programs to enhance skills, and providing attractive benefits to promote employee retention. Given the evidence in this report, there is plenty of reason to be hopeful despite the challenge outlined. Numerous initiatives are underway and there is at the very least a strong recognition that change is needed and a strong appetite for change to be implemented. According to the World Economic Forum, there is an opportunity for advanced manufacturing to deliver real impact across industries and offer a path to a more innovative, inclusive, and sustainable industry transformation.

## 7.2 How will technological & operational change impact the future of manufacturing work?

The convergence of the emerging technologies outlined in this report is expected to drive unprecedented levels of innovation, efficiency, and sustainability in the advanced manufacturing industry, reshaping the way products are designed, produced, and consumed. Based on the required skillsets described in this report, it is clear that advanced manufacturing will transform with technologies related to automation, AI, and 3D printing for increased customization. Based on the emergence of collaborative robots (cobots), the workforce will need new skills for human-machine collaboration. IoT will create smart factories, enhancing supply chain management. Advanced materials and nanotechnology will revolutionize product development. AR and VR is expected to improve training, design, and maintenance. Sustainable practices related to the green transition will focus on reducing waste and adopting a circular economy. Cybersecurity will become essential for protecting intellectual property and data. Global supply chains may shift towards localised production for greater flexibility and resilience against geo-political events and other externalities.

## 7.3 How will skills needs evolve?

We can refer to back to quote from Section 2, where Deloitte's Michael Gretczko stated that "The human skills and capabilities required to build, manage, and optimise these machines and processes will have to change as well. We are on the cusp of one of the most substantial shifts in how things are made, the workforce of the factory of the future will look markedly different than it has looked since the dawn of the Industrial Revolution". Given the near exhaustive list of technological changes which have been referenced in this report, it is going to be a challenge to develop, evolve and even maintain skillsets related to these technologies. Addressing this challenge requires a multi-faceted approach involving collaboration between industry and learning providers with support from government initiatives. The relationship between industry and academia is crucial to ensuring that the right learners are produced according to skill requirements of the industry. This relationship can be supported by technology to recognise and flag skills gap before they become apparent and impactful, providing a platform for communication between education and industry. In this way, the skills gaps within an industry can be related directly to education and training opportunities. If these learning provisions are not appropriate to teach the skills necessary, then the provision will need to rapidly evolve to keep up with demand. There may be a short shelf-life for modern skills related to modern technologies, with some tech-related skills remaining relevant and required for only 3-5 years at a time.

> *"We are on the cusp of one of the most substantial shifts in how things are made, the workforce of the factory of the future will look markedly different than it has looked since the dawn of the Industrial Revolution.*
>
> **Michael Gretczko**

# 8 REFERENCES

# 8 References

Advanced Manufacturing: A New Narrative. BRIEFING PAPER OCTOBER 2023. World Economic Forum.
https://www3.weforum.org/docs/WEF_Advanced_Manufacturing_A_New_Narrative_2023.pdf

Advanced Manufacturing Skills Assessment, Northern Ireland City and Growth Deals (January 2024)
Advanced Manufacturing, Materials & Engineering Sectoral Action Plan for 2024-2027 (economy-ni.gov.uk)

Digital Skills for Tomorrow, Today DIGITALS SKILLS AOTEAROA: EDITION THREE. An updated analysis of the Digital Skills landscape of New Zealand. NZTech.
https://nztech.org.nz/wp-content/uploads/sites/8/2023/08/NZTech-Digital-Skills-Report_final.pdf

Evaluation of the Engineering Skills and Training Needs of Manufacturing and Construction Sectors in the Southeast. January 2024.
https://assets.gov.ie/284567/5bc03b69-6024-414a-9c34-0282d281eb30.pdf

Future Skill Needs in Manufacturing: A Deep Dive, Manufacturing Institute/Rockwell/PTC (2022)
https://themanufacturinginstitute.org/research/future-skill-needs-in-manufacturing-a-deep-dive/#access-the-report

Future Skills Needs of the Irish Medical Devices Sector, Publica Consulting and McIver Consulting on behalf of the Expert Group on Future Skill Needs and Forfás. (2008)
http://www.skillsireland.ie/media/egfsn080205_medical_devices.pdf

IBEC Manufacturing in Ireland 2023. Boston Scientific case study 2023.
https://www.ibec.ie/-/media/documents/ibec-campaigns/manufacturing-report/ibec-manufacturing_case-study_-boston-scientific.pdf

Industry 4.0, the Future of Work & Skills. Future Skills Centre. Building Collective Resources for the Canadian Aerospace Industry
https://fsc-ccf.ca/research/industry-4-0/

Ireland's Talent Landscape 2024, Future Skills Challenges of Irish Business: Skillnet Ireland, Behaviours and Attitudes. 2024.
https://www.skillnetireland.ie/uploads/attachments/SNI_IrelandsTalentLandscape2024.pdf

The Kootenay Advanced Manufacturing Sector Assessment, Jonnah Ronquillo, Kathleen Ayre, Melanie Fontaine, Dr. Sarah-Patricia Breen, Dr. Tracey Harvey, Selkirk College. (July 2023)
https://arcabc.ca/islandora/object/sc%3A6112/datastream/PDF/view

LMETB AMTCE FET ADVANCED MANUFACTURING PATHWAYS SCHOOLS PROJECT 2022/2023 ACADEMIC YEAR
https://amtce.ie/amtce-fet/

Manufacturing excellence, World Skill UK, BAE Systems, Learning and Work Institute. (May 2023.)
https://learningandwork.org.uk/wp-content/uploads/2023/05/Manufacturing-excellence-report_FINAL.pdf

Midlands Advanced Manufacturing Action Plan 2021-2024
https://www.midlandsireland.ie/wp-content/uploads/2022/08/Midlands-Regional-Enterprise-Plan-2024.pdf

Midlands Advanced Manufacturing Survey 2022. Midlands Regional Skills Forum – Department of Further & Higher Education, Research, Innovation and Science - 2022.
https://assets.gov.ie/250720/911c269d-0b3f-47e3-9173-f5f07049abcb.pdf

OECD Skills Strategy Ireland: Assessment and Recommendations. 2024.
https://www.oecd.org/en/publications/oecd-skills-strategy-ireland_d7b8b40b-en.html

SOLAS Difficult-to-fill vacancies survey, Recruitment Agency Survey conducted in November 2023 by the Skills and Labour Market Research Unit (SLMRU) in SOLAS.
https://www.solas.ie/f/70398/x/2702562088/solas-difficult-to-fill-vacancies.pdf

Skills for Biopharma, Researching and Forecasting the Current and Future Skills Needs of the Biopharma Sector in Ireland to 2027. EGFSN Secretariat, National Skills Council. (April 2024)
https://www.skillsireland.ie/all-publications/2024/skills-for-biopharma.pdf

The future of work in manufacturing Report by Deloitte. Paul Wellener  Ben Dollar  Heather Ashton  Luke Monck  Aijaz Hussain. 2020
https://www.deloitte.com/global/en/our-thinking/insights/industry/manufacturing-industrial-products/future-of-work-manufacturing-jobs-in-digital-era.html

The successful implementation of industry 4.0 in manufacturing: An analysis and prioritization of risks in Irish industry. Ghadimi et al. 2021
https://doi.org/10.1016/j.techfore.2021.121394

WORK READY GRADUATES: Building employability skills for a hybrid world. CMI (Chartered Management Institute). September 2021.
https://www.managers.org.uk/wp-content/uploads/2021/09/employability-skills-research_work-ready-graduates.pdf