WORKING PAPER

Future of manufacturing

‘New’ apprenticeships in the light of technological change – Ireland

Company initiatives to align apprenticeships to advanced manufacturing

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Introduction

Scope of the research

This case study report is part of the study 'Policy developments and practices of apprenticeships in selected EU Member States and world competing regions' carried out in five EU (Denmark, Germany, France, Ireland and Italy) and two non-EU countries (Australia and USA). This study is conducted in the frame of the Pilot Project 'The Future of Manufacturing' (FOME), proposed by the European Parliament and delegated to Eurofound by the European Commission (DG Internal Market, Industry, Entrepreneurship and SMEs).

One of the objectives of this study is to provide an analytical overview of apprenticeship systems in the selected countries and to review changes to the current systems following labour market shifts, changes in employment, career and mobility patterns and technological and structural change. Particular emphasis is placed on the impact of new technologies and the need for a high skilled and adaptable workforce in manufacturing and advanced manufacturing. This research is carried out in response to the increasing interest in apprenticeships among policy makers to tackle skills mismatches but also to integrate young people into the labour market. The appeal of apprenticeships is also growing particularly in a context where new technologies are transforming work organisation and production processes across all sectors, particularly manufacturing. The findings from this research will feed the policy discussions around the role of apprenticeships for the future of manufacturing and inform policy making in the context of current or planned reform of apprenticeship systems and the necessary links to be established between education/training and industrial policies.

For general information on advanced manufacturing and the apprenticeship system in Ireland, the case study report builds on the information contained in the national report on apprenticeships in the advanced manufacturing industry in Ireland that was elaborated during the first phase of the study (Eurofound, 2018).

The case at a glance

The recent Review of Apprenticeship Training in Ireland confirmed its support for apprenticeship training in general and stated that apprenticeship systems continue to offer significant benefits. It recommended that there was scope for expansion of apprenticeships into new occupations and that employer-led consortia should identify occupations that are considered suitable for apprenticeship training and put forward subsequent proposals (Department of Education and Skills, 2013).

This case study examines two of these 'new' apprenticeships - manufacturing technician and manufacturing engineer – which are in fact closely linked. Both sets of apprentices follow the same curriculum in Years 1 and 2, however the Year 3 curriculum is specific to manufacturing engineers. After successful completion of Years 1 and 2, manufacturing technicians obtain a Higher Certificate in Engineering in Manufacturing (apprenticeship), which is pitched at level 6 on the Irish National Framework of Qualifications (NFQ. EQF Level 5) and after successful completion of Year 3 manufacturing engineers obtain a Bachelor of Engineering in Manufacturing (Apprenticeship) which is pitched at level 7 on the Irish NFQ (EQF level 6). On this basis the latter may be considered a 'higher apprenticeship'.

A summary of the different defining features of the two types of apprenticeship is to be found in Appendix 1.

The report draws primarily on internal unpublished material, backed up with interviews with five key stakeholders (see list in annex).

Assessment of the case study against selection criteria

In relation to the overall FOME-study and the different forms of adaptation of apprenticeship that are addressed by the research[1], this case corresponds to a specific form of apprenticeship training adaptation – the creation of new occupations/emerging occupations, that is to say, the manufacturing technician and the manufacturing engineer.

In terms of the general selection criteria: they are examples of good practice; with links to advanced manufacturing, notably but not only in the production of sophisticated medical devices; dual training is at their core; one can be considered a 'higher apprenticeship' and the other has the potential to provide progression to a 'higher apprenticeship'; with a company-level entry point; and opportunities to interview key stakeholders.

In terms of economic criteria: it is relevant from a manufacturing perspective; based on innovative technologies; and involves different actors, primarily employers, given that apprenticeships are 'industry-led' in Ireland, but also representatives of the public authorities - SOLAS, the Irish Further Education and Skills Service, and also QQI, Quality and Qualifications Ireland, as well as a significant and well-respected training provider, the Galway-Mayo Institute of Technology.

In terms of the involvement of social partners: there is a strong role for employers and employers' associations at the national, sectoral and enterprise level, although much less so for the trade unions.

Structure of the report

The report falls in three parts: a general part with context and background information; a descriptive part that outlines the set-up and implementation process; and an evaluative part, which deals with outcomes and impact. In a final section, the initiative is viewed in a broader perspective and in relation to the continued development of apprenticeships in the advanced manufacturing sector, and relevant conclusions are drawn – in the light of subsequent developments.

[1] These are: (a) modernisation of a specific occupation; (b) creation of new occupations/emerging occupations; (c) creation of a company apprenticeship / training programme; and (d) organisation of apprenticeships/training in (regional) clusters.

1 Context factors

1.1 Sectoral-specific context factors

The number of enterprises and of persons employed in the Irish manufacturing sector has declined significantly over the period from 2008 to 2013. However, manufacturing is still considered a critical component of the Irish economy, according to Forfás, the former national policy advisory board for enterprise, trade, science, technology and innovation.[2] It provides employment, directly or indirectly, for a significant part of the workforce, across a broad range of occupations throughout the entire country. It is a major source of exports, a key driver of research, development and innovation and for economic development in Ireland (Forfás, 2013). The most important sector is pharmaceuticals, followed by food, chemical and computers. These four sectors account for 80% of turnover.[3] Over the same period (2008-2013) the number of high-tech enterprises in the manufacturing sector has declined, turnover has yo-yoed, and, the number of persons employed has declined initially and then remained more or less stable.

In order to 'lead a renaissance of the manufacturing sector', IBEC, the employers' association, presented in 2016 a vision of Ireland, based on an international reputation for manufacturing and as a world leader in manufacturing technology, operational excellence and cross sector collaboration. To drive this forward IBEC set up the Irish Manufacturers Association - drawing on its food and drink, pharmaceutic, chemical, medical technology, ICT, software, plastics and engineering sectors – 'to engage with industry and government to ensure the manufacturing sector reaches its full potential' (IBEC, 2016). The Irish Manufacturers Association called on the government to: commit to spending an additional €10 billion on infrastructure projects by 2020; provide new funding options for SME manufacturers that need capital to achieve growth and scale; and to establish a national cyber security programme with dedicated funding to prioritise cyber security research. In addition it called on the government to ensure adequate funding for upskilling in manufacturing, including lean manufacturing, and support the development of 'new' apprenticeships specifically for the sector.[4]

1.2 Relevance of dual apprenticeship

The national report on Ireland in the context of this study (Eurofound 2018) refers specifically to the recently produced *Review of Apprenticeship Training in Ireland*, which concluded that dual apprenticeship systems – the combination of on-the-job and off-the-job training - offer the following main benefits: promoting better collaboration between enterprises and education and training providers; ensuring an enterprise- led role in the design and assessment of programmes; improving the competitiveness of companies; opening up rewarding careers for a large segment of the population; ensuring that theoretical learning in an education or training institution is strongly grounded in the practical experience of undertaking a real job; supplying job-ready employees; and providing an ideal learning mode for those who learn best by doing (Department of Education and Skills, 2013).

The *Review of Apprenticeship Training in Ireland* also proposed the following:

[2] The agency was dissolved in 2014 and its policy functions were integrated into the Department of Jobs, Enterprise and Innovation.

[3] http://www.cso.ie/en/releasesandpublications/er/iips/irishindustrialproductionbysector2015/

[4] http://www.ibec.ie/IBEC/Press/PressPublicationsdoclib3.nsf/vPages/Newsroom~new-irish-manufacturers-association-launched-25-01-2016?OpenDocument

- a revision of existing apprenticeship curricula and a move away from a generic placement at Level 6 on the NFQ – this is underway - all the designated craft apprenticeships have been subject to review which has included a discussion as to their placement on the NFQ
- the expansion of the apprenticeship model into a range of new enterprise sectors - this is underway, for example, in insurance, international financial services and catering
- the development of 'new' apprenticeships, supported by a ring-fenced fund – this has led to a decision to move ahead with 23 new apprenticeships in the first instance and the continuation of the allocation to be kept within the National Training Fund
- the assessment of new proposals in terms of sustainability – this now forms part of the apprenticeship approval criteria. (Eurofound, 2018)
- recruitment to apprenticeship should continue to be the responsibility of approved employers, but there should be greater planning control of quotas for different apprenticeships – specific target registration numbers for apprenticeship programmes and apprentices up to 2020 are included in the SOLAS Action Plan to expand apprenticeship and traineeship in Ireland. (SOLAS, 2016).
- the continuation of payment to apprentices for both on- and off-the job with no reduction in earnings during periods spent in education and training institutions – this continues, even though employers with 'new' apprentices will not benefit from the previous agreement that required FÁS, and its successor SOLAS, to pay the wages of delegated craft apprentices during the period of off-the-job training (Eurofound, 2018)

These recommendations led, in part, to the definition of apprenticeship, as can be seen from box 1.

Box 1. Definition of apprenticeship

Apprenticeship is a programme of structured education and training which formally combines and alternates learning in the work place with learning in an education or training centre, (a dual system, i.e. a blended combination of on-the- job employer-based training and off-the-job training) whose completion prepares the participant for a specific occupation, and leads to a qualification nationally recognised under the National Framework of Qualifications at any level from Level 5 upwards.

Every apprentice should be employed under an approved Contract of Apprenticeship for the duration of training. Apprenticeship training should be substantial in depth and duration, and the apprentice should be employed in a real job. For a programme to be classified as an apprenticeship at entry level; it should have a duration of no less than two years. The structure of the programme should provide for more than 50% workplace based learning (Department of Education and Skills, 2013).

1.3 Needs and challenges related to manufacturing and advanced manufacturing

Following on from the publication of *Making it in Ireland: Manufacturing 2020*, Forfás and the Expert Group on Future Skills Needs produced a complementary report *Future Skills Requirements of the Manufacturing Sector to 2020*., it highlighted the fact that 'lean manufacturing techniques and increasing automation are driving upskilling requirements for both generic skills and technical skills across virtually all occupations' and that 'modern statistical

software and more complex and sometimes novel manufacturing processes are together generating opportunities to use more sophisticated data analytic techniques in support of lean manufacturing, automated manufacturing processes and manufacturing process R&D'. (Forfás and the Expert Group on Future Skills Needs, 2013).

In terms of skills requirements, concerns were expressed about the supply of technical workers at skilled trades or technician level who were capable of working on machinery that combines mechanical, electrical, electronic and IT/software technologies. For engineers, the emphasis was on the need to obtain core engineering skills. A key issue emanating from the conclusions of the report is that 'there is no clear national framework for operative level training, or for progression within operative level occupations, beyond the positioning of some courses within the National Framework of Qualifications. There is also no clear national framework for training in skilled trades not included in the apprenticeship system'. (Forfás and the Expert Group on Future Skills Needs, 2013).

IBEC, the employers' association, recommended a series of measures to improve competitiveness in the manufacturing sector – supporting R&D and encouraging innovation in SMEs, minimising regulatory burdens, protecting energy intensive industries from uncompetitive electricity costs, encouraging funding and investment, improving regional development measures and extending Ireland's global reach. In addition, it called for enhanced collaboration in the sector, and more specifically the establishment of an industry-led national manufacturing research institute, a mentoring programme for the manufacturing sector, the introduction of a competitiveness ranking for manufacturing and improving linkages between sub supply chains and industry. It also called for the greater use of lean principles and adequate funding for upskilling in manufacturing and lean manufacturing principles and approaches to problem solving specific to the manufacturing sector. In terms of 'skills for the 21st century workforce' and in response to the comment that 'there is also no clear national framework for training in skilled trades not included in the apprenticeship system' it called for adequate funding for upskilling in manufacturing and the development of new apprenticeships, specifically for the manufacturing and advanced manufacturing sector. Importantly it called also for an up-to-date future skills needs analysis for the advanced manufacturing sector (IBEC, 2016).

In addition, IBEC carried out a survey which indicated that that 88% of its members considered specified investment in technology and IT as a key priority over the following three years, because the advances in robotics and the digital marketplace make automation cost effective, flexible and offer transformational benefits in a variety of functional areas.[5]

[5] http://www.ibec.ie/IBEC/Press/PressPublicationsdoclib3.nsf/vPages/Newsroom~new-irish-manufacturers-association-launched-25-01-2016?OpenDocument

2 General information on the case

2.1 Background and reasons for initiating the practice

The mainspring for the development of the 'new' apprenticeships for manufacturing technician and manufacturing engineer was the Irish Medical Devices Association (IMDA) - subsequently known as the Irish Medtech Association. The Irish Medtech Association, a constituent part of IBEC, the national intersectoral employers' association, represents the medical devices and diagnostics sector, with 200 members, located throughout the island of Ireland. The focus of its activities is to promote and support an environment that encourages the sustainable development and profitable growth of multinational and small to medium size medical device and diagnostic companies.[6]

According to industry feedback and discussions within its Steering Committee on Skills for Operational Excellence, the formal education system and the apprenticeship system were not delivering appropriately skilled manufacturing technicians and engineers, a point that was also made strongly by one of the interviewees, the Chair of this committee. Whilst the formal education system is providing an opportunity to transfer core knowledge, knowledge itself will not necessarily make a skilled worker. Whilst the apprenticeship system is producing a number of apprentices with skills important for different parts of manufacturing, it is not producing appropriately skilled manufacturing technicians and manufacturing engineers. Although some elements of the skills required are being taught through a number of existing apprenticeships, for example for toolmakers, fitters and electricians, none offer the variety of skills provided by the 'new' manufacturing apprenticeships.

Moreover, it became clear during discussions within the Irish MedTech Associations (IMA) that the core elements for the apprenticeships were important for the MedTech sector, but also relevant to the manufacturing sector in general, and so it was decided to prepare apprenticeships which would serve the interests of the Medtech sector within a broader manufacturing environment – a development which incidentally would help to support the process of recruitment.

The IMA Apprenticeship Manager stated at the time that these apprenticeships offered candidates a unique opportunity to obtain excellent qualifications and experience with world leading companies operating in Ireland. 'Apprenticeships offer participants more than on the job skills and training; they are also a passport to a great career choice with large global companies'. The Chair of the Manufacturing Apprenticeship Consortium stated: '*As an ex-army apprentice, I immediately saw the value of this kind of programme. For innovative manufacturing industries in Ireland we needed something more like the successful German apprenticeship model where industry was a major driver*'.[7]

2.2 General and detailed objectives and expected results

The general objective of this initiative is to provide training that enables apprentices to carry out the type of tasks that are defined in the occupational profiles for manufacturing technician and manufacturing engineer:

[6] http://www.irishmedtechassoc.ie/Sectors/IMDA/IMDA.nsf/vPages/About_us~about-the-association!OpenDocument

[7] http://www.ibec.ie/IBEC/Press/PressPublicationsdoclib3.nsf/vPages/Newsroom~1,100-new-manufacturing-and-polymer-apprentices-by-2025-01-06-2017?OpenDocument

The occupational profile of the manufacturing technician is, as follows:

- The manufacturing technician provides technical support function for manufacturing operations, including troubleshooting equipment and process issues, validation and qualification activities of the manufacturing site through the creation and support of necessary validation documentation for equipment, process and product release.
- The manufacturing technician will work both autonomously and cross-functionally with Production, Operations, Engineering Support, Quality, Facilities, and Safety to ensure that the engineering activities/projects are completed as per defined project schedule.
- The manufacturing technician will also work in establishing and coordinating corrective/preventive maintenance activities for Production/Operations equipment within the manufacturing site.[8]

The occupational profile of the manufacturing engineering is, as follows:

- The manufacturing engineer facilitates efficient operations within the production area, to optimise existing processes, implement new processes and to ensure that production goals are met. Monitors performance of equipment, machines and tools and corrects equipment problems or process parameters that produce non- conforming products, low yields or product quality issues, all within a highly regulated and complex manufacturing environment.
- The manufacturing engineer analyses and solves problems from basic engineering principles, theories and initiates technical activities leading to new or improved products or process to meet strategic goals and objectives of the company.
- The manufacturing engineer applies project management methodologies and Kaizen improvement philosophy to manage production/product design and process and systems improvement respectively.[9]

2.3 Linkages to national programmes and initiatives

As already mentioned above, the development of these 'new' apprenticeships is the direct result of a national strategy to review apprenticeship training and to extend the range of apprenticeship training. In May 2013, the Minister for Education and Skills announced a review of apprenticeship training in Ireland, and the subsequent report recommended, *inter alia*, that apprenticeship modes for training and education be extended to other relevant occupations.

2.4 Scope of the programme/initiative

This initiative forms part of a broader strategy to expand apprenticeship to other occupations, and the newly established Apprenticeship Council, which was established in 2014, developed, as part of its overall responsibilities (box 2), a call for proposals for apprenticeships in areas outside the current trades. It invited proposals for 'new' apprenticeships in June 2014 and received 86

[8] http://www.apprenticeship.ie/en/apprentice/Profiles/engineering/Manufacturing%20Technician%20Occupational%20Profile.pdf
[9] http://www.apprenticeship.ie/en/apprentice/Profiles/engineering/Manufacturing%20Engineer%20Occupational%20Profile.pdf

possible schemes, a relatively high percentage of which (28%) were from the manufacturing and engineering sector. 23 proposals, 8 of which emanated from the manufacturing and engineering sector, were approved for immediate development, with another 30 placed on a list for further consideration.

Box 2. The Apprenticeship Council

The Apprenticeship Council is responsible for:

- developing a call for proposals for apprenticeships in areas outside of the current trades
- examining and analysing the proposals arising from the calls for proposals
- reporting to the Department of Education and Skills on viable new apprenticeships - having particular regard to the sustainability of the proposals received
- monitoring the development by industry and education and training partners of the successful proposals into new apprenticeships, including the curriculum development, awarding arrangements, duration and entry level.[10]

The IMDA Steering Committee submitted a proposal for two 'new' apprenticeships, for manufacturing technician and manufacturing engineer, both of which were approved by the Apprenticeship Council for development in July 2015, and, after an intense period of preparation, were finally approved, with the first round of recruitment for 2017.

[10] http://www.apprenticeship.ie/en/about/Pages/About.aspx?anchor=Council

3 Design, planning and implementation

3.1 Needs assessment and type of change implemented

In order to gauge the demand for skilled workers in this sector, the Irish MedTech Association conducted a skills needs survey of its members in April 2014. 28 enterprises responded, stating that they had 577 current vacancies immediately, with a further 563 positions available in the following 12 months. Of these, 35% were for Level 7/8 manufacturing technicians and engineers/technicians. So there was a clear demand for this type of qualified worker, with these type of skills Moreover, if these figures were extrapolated to all association member companies, the survey suggested that there would be 600 positions available on a yearly basis for manufacturing technicians in the medical devices sector alone. In addition, on successful completion of the two programmes, for manufacturing technicians and engineers/technicians, apprentices would have the skills and experience necessary to become self-employed or to build a career in one or more of the following fields:

- Manufacturing engineering
- Quality engineering
- CAD / CAM and CNC
- Lean /Six Sigma Engineering
- Production and process engineering
- Operations management, production planning and supply chain engineering
- Project management
- Maintenance and safety.

It carried out a further survey, and it was estimated that a total number of 47 technicians and 22 engineers would be required on the basis of feedback from 20 companies.

3.2 Involvement of different actors

The approach to developing the apprenticeships was inclusive, and many actors were involved in the preparation process. Following the proposal submitted by the Irish Medtech Association to the Apprenticeship Council, a consortium was formed in May 2015 to develop and deliver the accredited programmes, with cross-functional representation of Human Resource Managers and Manufacturing Operations professionals from the MedTech sector, as well as senior academics from different Institutes of Technology.

Initially the consortium included 14 different MedTech companies - Abbott Diabetes, Abbvie Ireland, Baxter Healthcare, BD Medical, Cambus Medical, DePuySynthes, Hollister, Lake Region Medical, Siemens Healthcare Diagnostics, Molex Ire, Sanmina, Teleflix Medical, Vention Medical and Vistakon.

It also included seven potential training providers - Institutes of Technology from Athlone, Cork, Dublin, Galway-Mayo, Letterkenny, Sligo and Waterford. In the end it was decided that Galway-Mayo Institute of Technology would be the coordinating training provider and also the accrediting body and on the basis of its track record in offering formal courses and strong research connections with local industries the Department of Mechanical & Industrial Engineering would provide the academic input to the development of the apprenticeship.

Trade unions are not well represented in the sector, and they were not invited to join the consortium.

3.3 Financing

Finance for the development and implementation of the apprenticeships in Ireland comes from a variety of different sources, but employers are the prime contributors.

Funding for the initial development costs for these two manufacturing apprenticeships was provided by SOLAS, to the tune of relatively modest figures of €85,000, i.e., a total of €170,000. These funds were used primarily for coordination for the IMA and curriculum development for the Galway-Mayo IOT.

Funding for the implementation of the apprenticeships comes mainly from the employers. They pay a mandatory levy of 0.7% of the gross wage bill to the National Training Fund whose aim is 'to raise the skills of those in employment, to provide training to those who wish to acquire skills for the purposes of taking up employment, or to provide information in relation to existing, or likely future, requirements for skills in the economy'(National Training Fund Act 2000[11]). These funds pay for the off-the-job apprenticeship training.

Employers are also required to pay for the remuneration of apprentices, and, as there is no sectoral wage agreement in the MedTech sector, wages are decided at the enterprise level. Employers with 'new' apprentices receive no financial incentives from the public authorities (tax exemptions, reductions in social security contributions, grants for priority occupations, grants for SMEs, grant for rural areas, bonuses for completion etc.). Whereas the wages of designated craft apprentices are paid for by SOLAS during the periods of off-the-job training, this is not the case for the 'new' apprenticeships, and so employers of manufacturing technician and manufacturing engineer apprentices pay the wages during the periods of on- and off-the-job training themselves.

In addition, all students attending Institutes of Technology (IOT) are required to pay a fee of €3,000 per year, and apprenticeships who are only in the IOTs for a part of the year, are required to pay an annual 'student contribution' of €1,500. 'New' apprentices are not entitled to existing subsidies for designated craft apprentices - travel and accommodation allowances, for example – and there is an understanding that these costs would be covered by enterprises, however.

3.4 Other forms of local, regional and or national support and expertise

Support and expertise is provided by a number of bodies:

SOLAS has overall responsibility for the promotion, planning, co-ordinating, funding and monitoring of the implementation of the Irish apprenticeship programmes. It maintains a national register of apprentices for the purpose of planning and management of overall apprenticeship numbers. It also maintains a publicly accessible national database of employers approved for apprenticeships, based on data provided by the ETB.

Quality and Qualifications Ireland is responsible for the external quality assurance of all further and higher education and training, including apprenticeship programmes. Training providers seeking access to QQI awards are required to establish quality assurance procedures in line with QQI guidelines and submit them to QQI for approval.

Galway-Mayo Institute of Technology is the coordinating training provider and also the accrediting body.

At the sectoral level the Irish MedTech Association is responsible for ensuring that the apprenticeships correspond to sectoral labour market needs and for presenting, developing and coordinating the apprenticeship programme. It is also responsible for the promotion of the

[11] http://www.irishstatutebook.ie/eli/2000/act/41/enacted/en/html

professional occupations of manufacturing technician and manufacturing engineer and the recruitment of apprentices by its members.

3.5 Implementing the programme

In terms of implementation, the apprenticeships have been built on the basis of dual education, with a clear majority of on-the-job training, as can be seen in Table 1. The manufacturing technician apprenticeship takes 2 years to complete, the manufacturing engineer apprenticeship 3 years, both of which are shorter than designated craft apprenticeships in the manufacturing sector.

Table 1: Structure of on- and off-the-job training for manufacturing technician and manufacturing engineer

Location for training	Manufacturing Technician		Manufacturing Engineer	
	weeks	weeks	Weeks	weeks
Year 1 Industry - Induction	11		11	
Year 1 Off-the job		15		15
Year 1 On-the job	37		37	
Year 2 Off-the job		15		15
Year 2 On-the job	26		37	
Year 3 Off-the job				15
Year 3 On-the job			26	
Total	74	30	111	45

Source: unpublished material

The consortium has defined the learning outcomes for the manufacturing technician and for the manufacturing engineer, as can be seen from boxes 3 and 4.

Box 3. Learning outcomes – manufacturing technician

On successful completion of the programme, the apprentice and future manufacturing technician will have the ability to:

- solve routine technical problems related to manufacturing environments through the application of fundamental engineering principles
- conduct routine analysis of components, processes, and systems through the application of engineering principles and practices
- interpret and prepare graphics and other technical documents to appropriate engineering standards
- use computer hardware and software to support automated engineering environment
- apply knowledge of processes, tools and automation to design solutions that will improve the performance of systems for the manufacture and assembly of products
- follow quality control and quality assurance procedures as required
- comply with and describe the environmental, economic, legal, safety, and ethical implications of working in a highly-regulated industry
- use and maintain documentation, inventory, and records system

- communicate effectively with the engineering community and society, and work effectively as a team member in the planning and implementation of, and reporting on a manufacturing project
- evaluate the role of a manufacturing engineering technician in the business, and the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment, assess the limitations of their own individual competence, and review their need.

Box 4. Learning outcomes – manufacturing engineering

On successful completion of the programme, the apprentice and potential manufacturing engineer will have the ability to:

- develop innovative solutions to routine technical problems related to manufacturing environments through the application of engineering principles,
- conduct routine analysis of components, processes, and systems through the application of engineering principles and practices to improve Overall Equipment Effectiveness,
- interpret and prepare graphics and other technical documents to appropriate engineering standards,
- use computer hardware and software to support an automated engineering environment,
- apply knowledge of operations management, lean engineering and six-sigma to the design, validation, optimisation and control of manufacturing processes,
- apply knowledge of processes, tools and automation to contribute to the design of components, systems and processes to improve the manufacture and assembly of products,
- develop quality control and quality assurance procedures as required,
- ensure adherence to and review the environmental, economic, legal, safety, and ethical implications of working in highly-regulated industries, for example the Medical Devices industry,
- design and maintain documentation, inventory, and records systems,
- communicate effectively on broadly-defined engineering activities with the engineering community and with society at large, and lead the planning and implementation of, and reporting on a manufacturing project,
- evaluate the role of a manufacturing engineer in the business and in society, and the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment, assess the limitations of their own individual competence, and review their need for life-long learning.

As can be seen from Table 2, the training programme covers core manufacturing modules in the off-the-job training in all Years, and the on-the-job training which is referred to as 'Industry Modules'.

In addition, if judged by the OECD definition of advanced manufacturing technology - computer-controlled or micro-electronics-based equipment used in the design, manufacture or handling of a product - aspects of advanced manufacturing are present throughout Years 1, 2 and 3, and explicit and implicit examples abound. The first learning outcome of the 'computer aided design (CAD)' module in Year 1 is the ability to use 3-dimensional solid modelling software in the design of engineering components. The module 'manufacturing automation 2' in Year 2 is designed to enable apprentices to analyse basic pneumatic/hydraulic manufacturing applications and develop

automated solutions using Programmable Logic Control technology. In module 'Manufacturing Engineering 2' in Year 2 apprentices will be required to write a Computer Numerical Control (CNC) programme for turning and milling. One of the learning outcomes of the module 'Advanced Manufacturing Processes' in Year 3 is to use computer-aided manufacturing (CAM) software for the manufacture of components on CNC machine tools. The module 'Manufacturing Design of Fixtures' in Year 3 follows on from the module 'CAD' in Year 1 and 'Metrology' in Year 2 and builds up further experience in 3-D CAD modelling and in constructing solid models of parts and assemblies.

Table 2: Details of the programme for years 1 to 3

Year 1	**Year 2**	**Year 3**
Off-the-job	**Off-the-job**	**Off-the-job**
Learning & Innovation Skills	Essential Engineering Maths 2	Six Sigma Green Belt Quality
Electrical Science	Metrology	Project Management
Essential Engineering Science	Manufacturing Automation 1 (pneumatics)	Polymer Processing Technology
Manufacturing Engineering 1	Manufacturing Automation 2	Engineering Software Systems
Essential Engineering Maths 1	Manufacturing Engineering 2	Manufacturing Process Planning
Computer aided design	Maintenance & Safety	Instrumentation & Control
Quality 1	Lean Manufacturing	Advanced Manufacturing Processes
	Manufacturing Design for Fixtures	Operations Management
	Quality 2	
On-the-job	**On-the-job**	**On-the-job**
Industry Module - Induction		
Industry Module 1	Industry Module 2	Industry Module 3

Source: unpublished material

The off-the-job training enables apprentices to gain a better understanding of concepts, tools and models that are needed by technicians and engineers. The on-the-job training, in the form of 'Industry Modules', enables apprentices to apply these concepts and models and engage in active experimentation on the basis of what they have learnt in the off-the-job training. It is expected that apprentices would be exposed or directly contribute to various operations in the enterprises and would have an opportunity to work autonomously and cross-functionally with a variety of different sections or departments to ensure that the manufacturing activities and projects are completed as per defined project schedules.

The role given to the apprentices during the on-the-job 'Industry Modules' would vary from enterprise to enterprise, depending upon its size and the type of production processes it requires. Some apprentices would work in support roles and others would be directly responsible for equipment and productivity. Given this variety of roles, it is necessary to ensure that the range of skills is as broad as possible to cater for these different environments. Clearly though, the apprentices need to work within the context of the definitions that have been made by Engineers Ireland, which for technicians and associate engineers are, as follows:

- knowledge and understanding of the technologies related to the branch of engineering
- the ability to identify, formulate and solve well-defined problems
- the ability to contribute to the design of components, systems and processes
- the ability to conduct well-defined investigations to facilitate the solution of problems
- an understanding of the need for high ethical standards in the practice of engineering
- the ability to work effectively as an individual and in teams, and undertake lifelong learning
- the ability to communicate effectively within engineering and with society at large.

3.6 Quality Assurance mechanisms

Quality Assurance is built into the development of a 'new' apprenticeship, such as manufacturing technician or manufacturing engineer, at a number of different levels – at the overall level of the system, or in a more specific targeted fashion - in terms of industry coordination, employer approval procedures, apprentice entry requirements, employer and apprentice responsibilities, and off-the-job training coordination.

Systemic quality assurance

Overall systemic quality assurance for 'new' apprenticeships is built into the implementation of apprenticeship programmes on a step-by-step basis, as can be seen from box 5.

Box 5. National apprenticeship development, critical path and implementation partners

Step 1 – apprenticeships are employer-led in Ireland, and the industry-led consortium is required to provide evidence of demand for an apprenticeship proposal on the basis of the anticipation of skills needs.

Step 2 – the Minister for Education and Skills, with support from the Apprenticeship Council, which is made up of representatives of employers' association, trade unions and training providers, is required to assess and approve the proposal for development.

Step 3 – SOLAS, the public agency responsible, inter alia, for apprenticeship training, the Higher Education Authority and the Apprenticeship Council approve the development of the project plan and allocate the funding.

Step 4 – the industry-led consortium develops the programme, which should contain the occupational profile; the programme and standards including the curriculum and assessment; quality assurance for the on- and off-the-job training; and apprenticeship programme administration – in addition the industry-led consortium is required to provide key documents, such as the professional award type descriptors, the validation policies and criteria and the quality assurance guidelines for the apprenticeship.

Step 5 – the Apprenticeship Council reviews and approves the occupational profile, ensuring that there is no overlap with existing apprenticeships.

Step 6 – Quality and Qualifications Ireland, which is responsible for the external quality assurance of further and higher education and training, approves the validation and quality assurance of the apprenticeship programme.

Step 7 – SOLAS creates the Industrial Training Order.

Step 8 – SOLAS and, where appropriate the Higher Education Authority, agree the implementation plan and budget.

Step 9 – SOLAS approves the registration for apprentices presented by the employer.
Step 10 – the industry-led consortium launches the apprenticeship.
Source: SOLAS, 2016

Targeted quality assurance

To ensure that the apprenticeships correspond to the sectoral needs of the labour market needs, an industry-led consortium takes responsibility for the presentation and development of the apprenticeship programme. It is responsible for the coordination of the programme, as well as the promotion of the professional occupations of manufacturing technician and manufacturing engineer and the recruitment of apprentices by its members. This overall task is carried out in this case by one single organisation - the Irish MedTech Association.

To ensure that employers are eligible to take on and train apprentices, SOLAS is responsible for registering potential employers and assessing their suitability on the basis of series of requirements underpinned by a site visit from an Authorised Officer. Suitability is judged by a number of factors; *inter alia*, offering the range of work specified in the on-the-job elements of the apprenticeship programme; providing the appropriate equipment; provide a qualified person to supervise the training and work of the apprentice; providing a qualified person to act as the workplace assessor/verifier; and directly employing the prospective apprentice. (For more details about the employer registration process, see Appendix 2).

To ensure that apprentices have a basic formal education and suitable numeracy and literary skills, they are required to obtain a Pass (Grade O6 or better) in five leaving certificate subjects.

To ensure that employers and apprentices know what they should expect from an apprenticeship, they are required to comply with the *Apprenticeship Code of Practice for Employers and Apprentices*[12], which explains in great detail their roles and responsibilities.

To avoid any potential for confusion over the interpretation of the different features of the delivery of the training programme in different locations, responsibility for overall training provision has been vested in one single provider – in this case, the Galway-Mayo Institute of Technology.

To ensure that there is direct link between off- and on-the-job training, it is expected that a process of coordination will be established between the in-company mentor and the academic supervisor in the IOT. Some of the activities of the on-the-job modules will be assessed together with the off-the-job training, by means of HR performance evaluation of the concrete experiences, logbooks for reflective observation, projects and process studies for active experimentation. On completion of each block of on-the-job training it is further expected that the in-company mentor will evaluate the HR performance of the apprentice. In addition, the apprentice is required to tracks his/her development as a potential manufacturing technician or manufacturing engineer using the logbook. The apprentice also compiles a project study, in the form of a short report, which describes and/or assesses one particular aspect of the enterprise's processes.

[12] http://www.apprenticeship.ie/Documents/ApprenticeshipCodeOfPractice.pdf

3.7 Skills of involved training and mentoring personnel

It is expected that apprentices would be guided and supported by an in-company mentor who is experienced and qualified in the occupation. For the manufacturing technician it is expected that the in-company mentor would have a Level 7 qualification in an appropriate discipline, or be a Level 6 qualified technician with the required depth of technical knowledge (minimum 4 years' post qualification experience). In the case of a Level 6 technician acting as an in-company mentor, the apprentice should be supervised by an engineer. For the manufacturing engineer it is expected that the in-company mentor would have a Level 7 qualification in an appropriate discipline, with 4 years' post qualification experience, and hold a position of technical responsibility in the enterprise. The in-company mentor would be required to demonstrate the use of technical skills and problem-solving at technician and engineer level, as appropriate, and ensures that the apprentice performs to the highest standard.

It has been agreed that the in-company mentors would receive the following training:

- mentoring training, organised by IBEC
- introduction to Higher Certificate/BEng Programmes and mentor responsibilities, organised by the Galway-Mayo Institute of Technology

More specifically, it is expected that this training will enable the in-company mentor to:

- understand the structure of a professional mentoring session, including how to interact with the apprentices and progress relationships appropriately
- gain expertise in the techniques of mentoring
- understand how to work with a number of mentoring tools
- gain an in-depth knowledge of the technician and engineering manufacturing programmes
- understand the 'on the job' modules the apprentice will complete while based in industry
- understand the apprentice assessment and evidence -based capturing processes
- prepare a training plan for their apprentice(s).

3.8 Difficulties and challenges during implementation

It is early days yet – at the time of writing the apprentices are in the 7th week of their first block of off-the-job training – and so there is little to go on.

The first noticeable challenge is that the apprentices come from different parts of Ireland, and the off-the-job training is taking place in the Institutes of Technology in Cork, Limerick and Galway-Mayo, with Sligo IOT starting the programme in January 2018. So, there is a concern about travelling backwards and forwards from home, in Dublin for example, to the IOT, which for some could represent a 2-3 hour drive. It could be possible to take up temporary accommodation, but, as will be seen in the next section, a considerable percentage of apprentices are over 30 and may have family commitments. This may mean that travelling is taking up a disproportionate time of the off-the-job training period.

Another possible challenge is that, as will also be seen in the next section, the entry educational attainment levels for manufacturing technician apprentices are lower than was originally proposed. Half the cohort does not have a leaving certificate, which is one of the entry

requirements. This will probably not be a problem for the on-the-job training, but the lack of math training and basic IT skills may mean that progress is slower than expected for some apprentices.

4 Outcomes, impact and lessons learned

4.1 Major outcomes and impacts on the company, region and sector

In 2017, the first manufacturing technician and manufacturing engineer apprentices were recruited and began their first off-the-job training. According to SOLAS, there were 30 recruits for the manufacturing technician apprenticeship and 12 for the manufacturing engineer apprenticeship, and so it is too early to come to any specific conclusions. At first sight the numbers appear significantly lower than expected, but, as two cohorts per year are planned, indications of mismatch, if any, will only become evident at the beginning of 2018, the time for the next cohort to begin.

In terms of gender there was 1 female manufacturing technician (out of 30), and 2 manufacturing engineers (out of 12). The level of female participation, although low, is an improvement on overall figures for female participation in apprenticeship training in Ireland, which stood at a lowly 0.25% in 2015 (Eurofound, 2018).

In terms of entry educational attainment levels 12 manufacturing technician apprentices have primary school education, 3 a junior certificate, 14 a leaving certificate, and 1 tertiary education. Only 1 manufacturing engineer apprentice has primary school education, 8 a leaving certificate, 2 an applied leaving certificate and one a craft certificate.

In terms of age there are only 2 manufacturing technician apprentices 20 years old and under, 6 between 21 and 30, 10 between 31 and 40 and 3 over 40. There is only 1 manufacturing engineer apprentice 20 years old and under, 6 between 21 and 30, 4 between 31 and 40 and one over 40. At first sight, the age profile is surprising – there are very few apprentices under 20, so this is clearly not considered as a way to enable young people to make the transition from formal education to the world of work. Indeed, on closer inspection all the apprentices are already in employment and these apprenticeships are used toupskill existing members of staff, that is to say, they are used for Continuing VET purposes and not as an Initial VET opportunity for young people. This may be explained by the fact that the initiative is in its early stages, and it has been easier to recruit quickly from an existing pool of workers. It will be interesting to see if this pattern continues, and if it does, what position the funding authorities will take

It is too early to gauge the impact on the enterprise, the region and the sector. The apprentices come from a small number of enterprises, so this initiative has clearly not yet captured the imagination of employers in the sector. One of the interviewees, the IMA Apprenticeship Manager, noted that within the sector some employers had been initially enthusiastic but chose not to participate in the initiative, as they wanted to have a clearer idea of what benefits an apprenticeship would bring. Moreover, some of the larger enterprises in the sector have their own training academies and, given the emphasis on upskilling, they do not need to enroll their staff in externally organised training initiatives. In addition, some enterprises are already involved in joint training initiatives with external training providers and so do not see the need to change these already existing arrangements.

4.2 Attractiveness and capability of apprenticeship

The two apprenticeships go some way to addressing the issue of attractiveness. They demonstrate a high level of overall systemic and targeted quality assurance, as has been seen above.

In addition, the two apprenticeships respond in part to concerns often expressed by parents that apprenticeships are an academic and professional cul-de-sac. Successful completion of the manufacturing engineer apprenticeship leads to the award of Bachelor's degree (at level 7 on the Irish NFQ equivalent to EQF Level 6), could be described as a 'higher apprenticeship' and could facilitate access to higher education and training levels. Moreover, on the successful completion

of the manufacturing technician apprenticeship (at Level 6 on the Irish NFQ equivalent to EQF Level 6), there is the possibility of gaining access to a higher education and training level, not least because the curriculum for the manufacturing technician apprenticeship is identical to the first two years of the manufacturing engineer curriculum. There is one issue to resolve however. At the moment apprentices register for the one pathway or the other. On successful completion of the manufacturing technician apprenticeship, it is possible to register for Year 3 to become a manufacturing engineer. However, Year 3 lasts only one year, and apprenticeships in Ireland are two years minimum. This means that potential manufacturing engineer apprentices would lose the status of apprentice and with it the status of employment and the accompanying wages and conditions. This would, according to some interviewees, mean in effect that there would be a very limited opportunity for progression. This serious disincentive is now under review.

4.3 Key success factors

Clearly the most significant success factor is that the Irish MedTech Association has been able to coordinate from scratch the development of two apprenticeships which address the training needs of the manufacturing sector. Two years ago, these occupations did not exist, and now there are occupational profiles, accompanying learning outcomes, a structured on- and off-the-job training programme which has been approved by Quality and Qualifications Ireland and the first cohort of apprentices. This is particularly impressive in that the MedTech sector has little or no culture of apprenticeship training.

Linked to this, if only partially demonstrated, is inclusiveness. The two apprenticeships are industry-led, by the employers' association for the sector. A training provider, with considerable experience in the sector, has been closely involved in the planning of the two apprenticeships, the preparation of the curricula and the on- and off-the-job training. One glaring absentee is the other social dialogue partner, the trade union for the sector, and one of the interviewees, the Chair of the IMA Steering Committee on Skills for Operational Excellence, expressed the view that this had been an error of judgement. However, as another interviewee, the member of the Apprenticeship Council, explained one of the trade union representatives interceded in the discussions within the Apprenticeship Council to ensure that approval of the proposal was halted until the on-the-job elements of the curriculum were included appropriately. Moreover, a formal decision has been subsequently taken within the Apprenticeship Council that each consortium must engage with the appropriate trade union in the particular sector.

5 Commentary and conclusions

5.1 Adjusting dual apprenticeship in the light of advanced manufacturing

This case study clearly demonstrates that the Irish apprenticeship system is able to respond readily to the challenges facing manufacturing and advanced manufacturing. It has created two occupations, manufacturing technician and manufacturing engineer, and two 'new' apprenticeships, in response to the needs of the labour market, as articulated by formal Irish skills anticipation bodies, Forfás and the Expert Group on Future Skills Needs, and also by employers' associations, IBEC and the Irish MedTech Association, and some of its individual members.

The curriculum provides numerous opportunities for apprentices to acquire knowledge and learn skills associated with different aspects of advanced manufacturing, such as: computer aided design (CAD) and the use of 3-dimensional solid modelling software in the design of engineering components; manufacturing automation, the analysis of basic pneumatic/hydraulic manufacturing applications and development of automated solutions using Programmable Logic Control technology; manufacturing engineering and the ability to write a Computer Numerical Control (CNC) programme for turning and milling; advanced manufacturing processes and the use of computer-aided manufacturing (CAM) software for the manufacture of components on CNC machine tools; manufacturing design of fixtures and further experience in 3-D CAD modelling and in constructing solid models of parts and assemblies.

These opportunities exist in the off-the-job training, but more research is needed to see how well they will be applied in the on-the-job training. It is quite possible that some enterprises cannot offer, and do not need, the full range of learning experiences as regards advanced manufacturing.

5.2 Policy implications and transferability

The demand for these particular apprenticeships has been clearly made by the employers' association and by certain enterprises, but there is many a slip 'twixt the cup and the lip', and, for its further development and survival, there is a need to ensure that there is a continuous supply of apprenticeship places. Interviewees, from the Irish MedTech Association and the GMIT, have pointed to the difficulty of moving employers from passive support to active participation in apprenticeship training. Moreover, if enterprises are using this opportunity solely for upskilling existing employees, there are alternative, and possibly cheaper, ways of doing this.

It is possible that supply of apprenticeship places will increase when the system demonstrates its worth. It is also possible that supply will increase now that the labour market is beginning to tighten and there is a need to start to employ young entrants to the labour market straight from school.

From a policymaking perspective there is a need to improve the connection between supply and demand. This would require a matching service, probably on-line, enabling potential apprentices to know which apprenticeship places were available and where and enabling potential employers to know who was interested in becoming an apprentice. Once this connection is made, there is a need to simplify, and/or streamline, the existing apprenticeship registration process (for details, see Appendix 3).

If the supply of apprenticeship places does decline however, this may lead to the gradual decline of this type of training and the failure of the apprenticeship system in this particular sector. Moreover, as one interviewee from GMIT made clear, if the system starts to decline and there are less and less apprentices, it will be increasingly difficult for the training providers to justify this use of resources for these particular apprenticeships. In policy terms this clearly requires, as a minimum, a vast marketing campaign, which most likely should be undertaken by the appropriate employers' association, the Irish Manufacturing Association or the Irish MedTech Association.

This campaign will need publicity material, but, more importantly, time-consuming face-to-face discussions with human resource managers and, if these apprenticeships are considered mainly within enterprises as an agent of Continuing VET, also production managers.

Linked to this is the ability of the two associations to lead this campaign, and more specifically, a point made by several interviewees, do they have the resources to undertake such a campaign? Do they have the capacity to continue to lead and coordinate this entire initiative in the medium- to long-term, once the initial funding from SOLAS for preparatory work is used up? Ireland does not have sector skills councils, or Danish-style 'trade committees' capable of shouldering this significant burden.

One policy response could be to retain a part of the moneys paid already by enterprises to the National Training Fund that are not required to support apprenticeship training and to use them to underpin the work of the coordinating associations. It has just been announced that the National Training Fund levy will be increased to 0.8% in 2018, and it is estimated that this will provide €47.5million of additional funding for the higher and further education sectors. The levy will rise to 0.9% in 2019 and 1% in 2020.[13] Unsurprisingly employers considered the increase 'unwelcome', but, according to the Minister for Finance and Public expenditure and Reform, it will 'ensure that employers have a central role in determining priorities for these sectors in 2018 and beyond'.[14] What is not clear is whether this will result in more resources for the coordinating associations and for the development of apprenticeship programmes.

[13] This is a comparatively high figure. In France employers pay an apprenticeship tax – 0.68% of the gross wage bill. In Italy they pay 0.3% of the gross wage bill into Interprofessional Funds. Moreover, employers in France and Italy can apply for a range of incentives to take on apprentices.

[14] http://www.per.gov.ie/en/budget-2018-statement-of-the-minister-for-finance-and-public-expenditure-and-reform-mr-paschal-donohoe-t-d/

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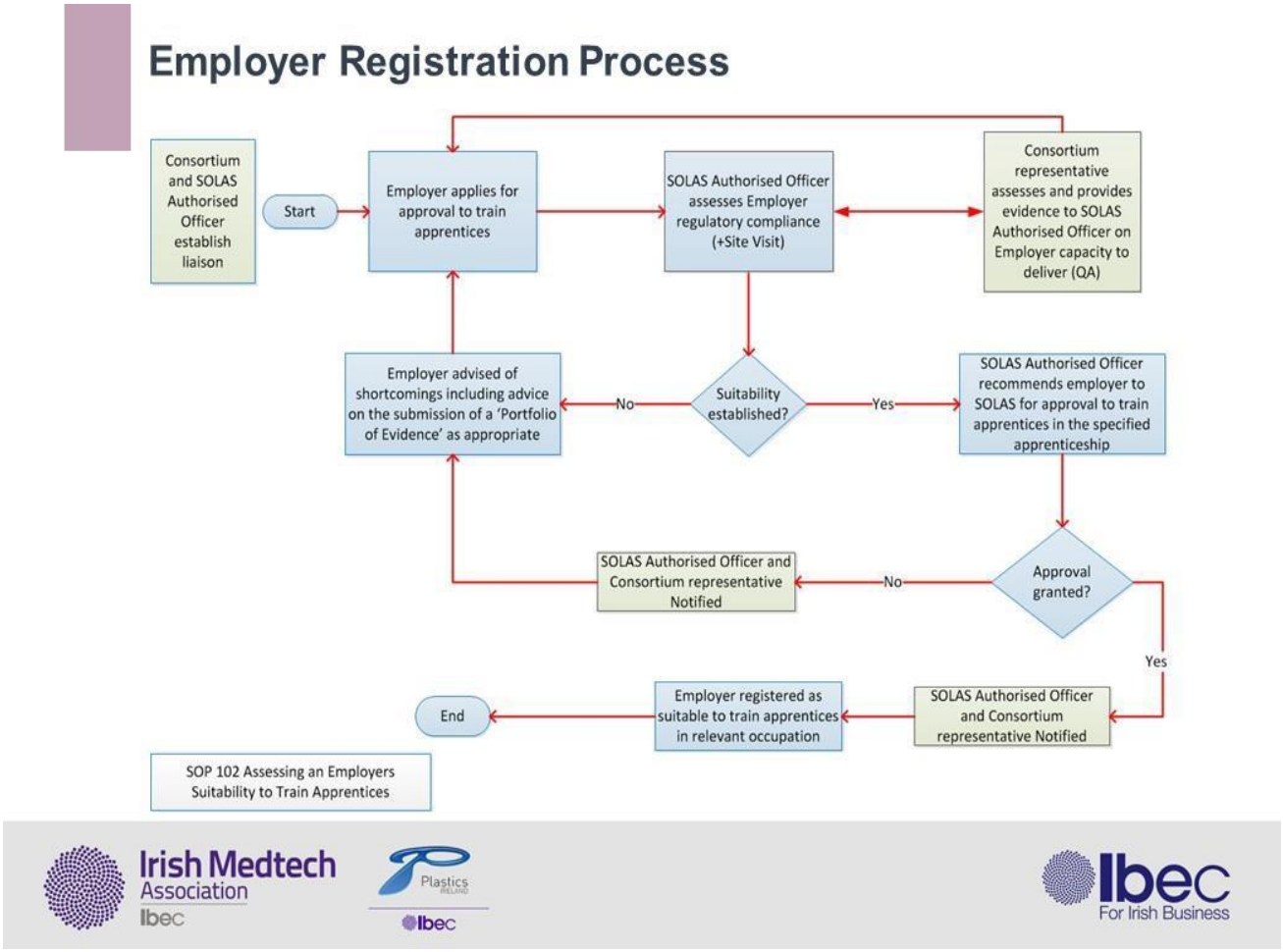
Annex

A.1: Summary of Programmes – manufacturing technician and manufacturing engineer

Title	Higher Certificate in Engineering in Manufacturing (Apprentice)	Bachelor of Engineering in Manufacturing (Apprentice)
Duration	2 years	3 years
Level	Level 6	Level 7
Off-the job training	2 x 15 weeks	3 x 15 weeks
On-the-job training	11 weeks Induction Block 37 weeks Industry Block 1 26 weeks Industry Block 2	11 weeks Induction Block 37 weeks Industry Block 1 37 weeks Industry Block 2 26 weeks Industry Block 3
Proposed commencement (Induction Block)	Jun 2017	Nov 2017
Proposed commencement (Academic Block 1)	Sep 2017	Jan 2018
Programme status	Full Time	Full Time
Proposed intake numbers	20	20
Entry requirements	Industry Interview SOLAS apprentice approval Pass (Grade O6 or better) in five leaving certificate subjects, 250 CAO points[15]	Industry Interview SOLAS apprentice approval Pass (Grade O6 or better) in five leaving certificate subjects, 250 CAO points

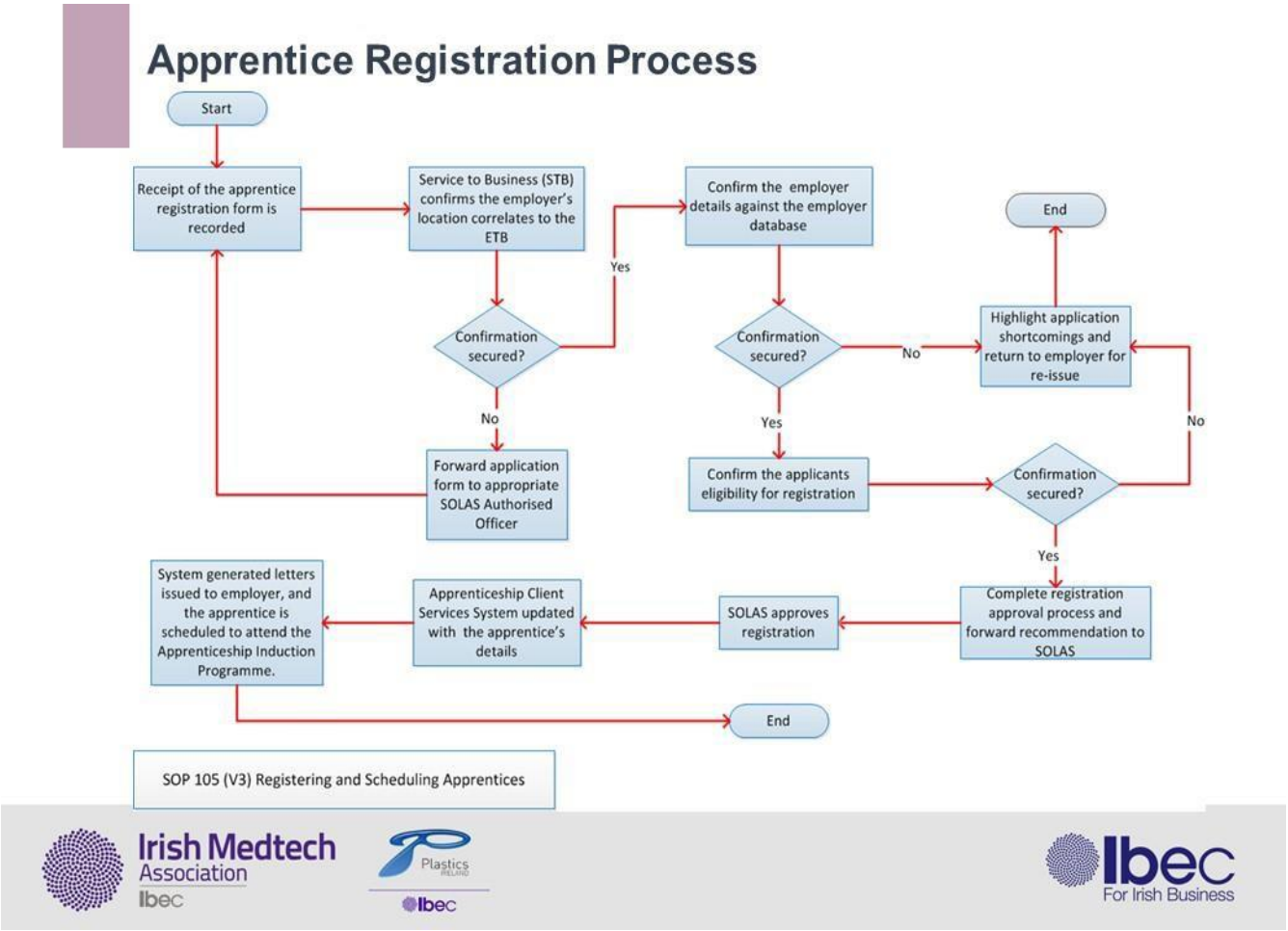
[15] The Central Applications Office (CAO) awards points to students based on their achievements in the Learning Certificate examination.

A.2: Employer Registration Process



Source: Irish Medtech Association

A.3: Apprentice Registration Process



Source: Irish Medtech Association

A.4: Glossary

Abbreviation	Original term	English translation/explanation
ETB	Education and Training Board	-
FÁS	An Foras Áiseanna Saothair	Training and Employment Authority
IBEC	Irish Business and Employers' Confederation	-
IMA	Irish MedTech Association	
IOT	Institute of Technology	-
QQI	Quality and Qualifications Ireland	-
SOLAS	An tSeirbhís Oideachais Leanúnaigh agus Scileanna	'Further Education and Skills Service'

A.5: Interviewees

Type of organisation	Name of organisation	Position/function of interviewed person
Government agency responsible for apprenticeships	Apprenticeship Council	Member of the Apprenticeship Council
Government agency responsible for apprenticeships	*An tSeirbhís Oideachais Leanúnaigh agus Scileanna*	Project Manager, Apprenticeship and Construction Services
Employer organisation	Irish Medtech Association	Apprenticeship Manager
Employer	Cambus Medical	Chair of the IMA Steering Committee on Skills for Operational Excellence
Training provider	Galway-Mayo Institute of Technology	Head of Department of Mechanical and Industrial Engineering

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