

Future Skills Requirements of the Manufacturing Sector to 2020

February 2013



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Foreword

Manufacturing in Ireland has experienced huge changes in recent years. The sector has experienced significant employment declines over the past decade, driven by a combination of erosion in competitiveness domestically and external factors such as the global financial crisis that impact on the demand for manufactured goods. This report, requested by Government under the Action Plan for Jobs 2012, assesses the skills needs of the manufacturing sector to 2020. The report highlights that the skills and competencies needed within manufacturing are rising across virtually all occupations due to factors such as scientific and technological advances, automation, regulatory requirements, new ICTs and the drive for continuous improvement. These factors are driving demand for increased levels of skills, both for upskilling within the existing workforce and for ensuring skills supplied by mainstream education and training are sufficient and relevant to industry requirements. The need for export-led growth is generally accepted as the basis for Ireland's economic recovery and sustainability. Manufacturing is at the heart of making this happen. Manufacturing firms play critical roles as exporters, as employers, developers of new products and processes and as purchasers of goods and materials. The manufacturing sector currently employs around 200,000 people and it is estimated that each direct manufacturing job supports at least one other job in the wider economy. The employment outlook for the sector depends critically on addressing domestic competitiveness factors and a favourable international trading environment. The future employment scenarios within this report highlight an increasing demand for higher skills, with skilled operative jobs replacing elementary jobs and employment accounted for by qualified technicians and STEM professionals continuing to increase as a proportion of total employment. In tandem, the demand for higher levels of qualifications, even at basic entry roles, is rising. Importantly, from the perspective of future supply, the scenarios predict a replacement demand in the region of 4,000 to 5,000 persons per annum.



There are skills shortages currently within manufacturing, though not of significant scale. Nonetheless, many of these shortages are critical at an operational level to manufacturing firms due to the technical expertise they provide and it is therefore vital that they are addressed. The report highlights current and future shortages in areas such as toolmaking, machinists, supervisors, polymer technicians and across a number of engineering disciplines.

More broadly, the report also highlights the importance of continuous upskilling requirements across all occupations. Finally, the manufacturing sector needs to do more to promote and boost the attractiveness of manufacturing as a career choice. There are highly varied and rewarding career paths within the sector, with good potential for mobility, however, these are often not apparent to students or those working outside of the sector.

On behalf of the Expert Group, I would like to thank the wide range of companies, stakeholders and individuals who contributed to this report through consultations, workshops and who helped to shape the recommendations. As chairperson of the Steering Group for the project, I would like to thank each member of the group for their full commitment and support in overseeing the study. Finally, I would like to thank the team at Forfás for their research and analysis and leading this project to a successful conclusion.

Una Halligan
Chairperson, Expert Group on Future Skills Needs



Acknowledgements

Forfás would like to record its appreciation to the members of Steering Group who oversaw the work of the report for their commitment and contribution - membership is set out in Appendix 1. Forfás would also like to acknowledge the valuable input of the many senior executives of companies and organisations who participated in the research work for this study. Also, to those expert staff from professional and trade organisations and State Agencies who provided valuable insights at workshops and meetings. Forfás would like to acknowledge the quality of the work of Publica Consulting and Dwyer-Doyle Associates who undertook the fieldwork and the research work with companies, facilitated workshops, drafted recommendations and produced the scenarios for future employment. Thanks are due to the Skills and Labour Market Unit at FÁS which provided data and analysis on the manufacturing labour market and relevant education and training provision.



Executive Summary

E.1 Introduction

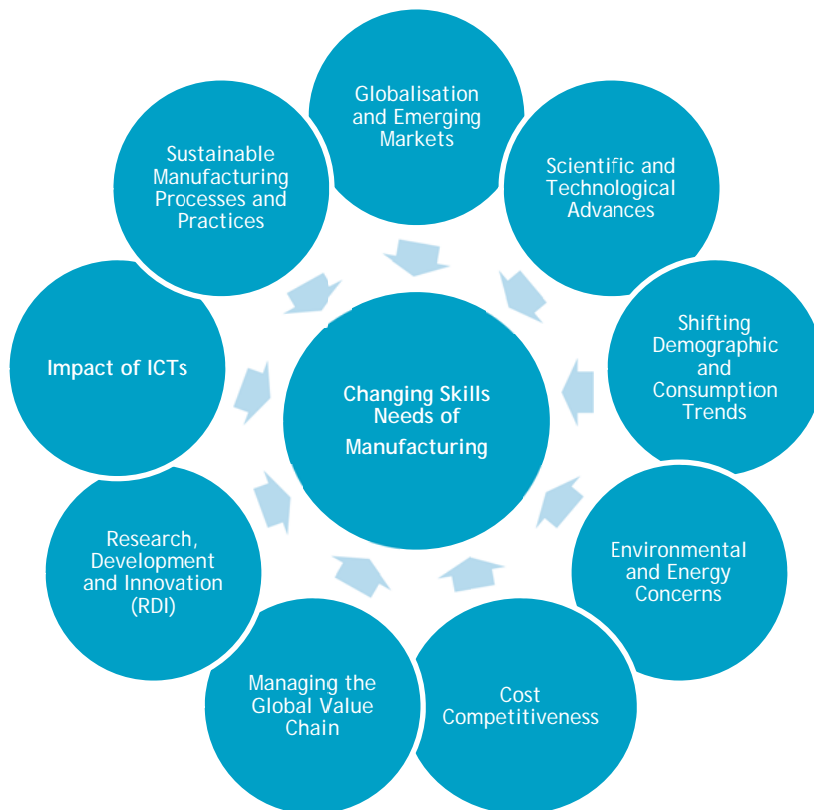
The Government's Action Plan for Jobs 2012 requested Forfás and the Expert Group on Future Skills Needs to *undertake a detailed assessment of manufacturing skills needs and use of the new structures for training and skills development to address both the immediate needs of the manufacturing sector and to anticipate longer term needs*. This study has been developed in tandem with the wider strategy for manufacturing, *Making it in Ireland*, which is being undertaken by Forfás.

The overarching objective of this study is to address the skills requirements of the manufacturing sector in Ireland over the period 2012-2020. Specifically this entails an analysis of global drivers of change; a statistical profile of skills supply and demand in the sector; a quantitative assessment of future skills needs through economic modelling; a qualitative assessment of future skills needs identified through consultations with enterprise and industry stakeholders and; recommendations to address immediate and future skills requirements.

A steering group consisting of manufacturing enterprise and education/training stakeholders was appointed to oversee the development of the report.

E.2 21st Century Manufacturing

There are numerous drivers of change impacting on the overall environment for manufacturing, which are in turn driving changing skills needs within the sector.





At a macro level, **globalisation** – the movement of capital, people, goods, services, ideas and people across borders – is accelerating and evidenced through the growth of emerging markets in terms of world trade. In 2010, developing economies were the recipients of the majority of inward foreign direct investment flows for the first time. **Scientific and technological advances** have significant implications for skills. In particular, Key Enabling Technologies (KETs) such as advanced materials, nanotechnology, biotechnology, photonics and advanced manufacturing are increasingly having a transformative effect on the manufacturing sector now and in the future. Projected world population growth of 9.3 billion by 2050 and shifting **demographics**, including ageing populations within developed economies, will have a profound impact on the future demand for manufactured goods and associated materials and commodities.

Growing middle class populations within the BRIC nations are expected to drive additional demand for manufactured goods. **Consumer preferences** are shifting in many countries with increasing emphasis on the **sustainability** of products, their carbon footprint and ‘air miles’. **Environmental** regulations and goals for **energy efficiency** mean that many manufacturing firms are developing sustainability teams to drive efficiencies from input, through production and delivery to customers.

At firm level, disaggregated **global supply chains** are driving specialisation within many manufacturing firms seeking to plug in to global networks. **Cost competitiveness** is placing increased scrutiny on all aspects of the production chain, raising the demand for continuous improvement and lean manufacturing techniques. The competitive manufacturing environment puts a particular emphasis on **research, development and innovation activities**, not only in the context of R&D for new products, but also the ability to absorb technologies and expertise developed externally which can drive innovation in manufacturing products and processes. **ICTs** are having a highly significant impact on manufacturing processes with ICT enabled processes such as increasing automation, computer integrated manufacturing (CIM), simulated manufacturing, virtual test beds and ‘digital factories’ at the cutting edge of manufacturing competitiveness. All of these drivers have significant implications for skills requirements.

E.3 Manufacturing in Ireland

Manufacturing firms play a critical role in the Irish economy – as a driver of exports, as an employer, as a source of revenue and as a key driver of growth. Manufacturing sales accounted for approximately 22 per cent of GDP in 2009¹. There are 12,790 manufacturing enterprises in Ireland.² Most of these are small in scale, with 83 per cent employing less than 10 people (micro firms) and 95 per cent employing less than 50 people. Manufacturing exports were approximately €92.9 billion in 2011, almost twice the level of manufacturing imports of €48.2 billion, giving a net export figure of €44.7 billion, thereby the primary positive contributor to the Balance of International Payments. The manufacturing sector also has significant spin off effects, such as indirect employment supported in other sectors including services, logistics, mining/quarrying, agriculture and sub-supply. Manufacturing firms source approximately €14 billion of materials and services from Irish based suppliers – although this has decreased from €17.5 billion since 2001.³ Manufacturing is a key driver of R&D activity and innovation, with 40 per cent of Business Expenditure on Research and

¹ OECD Statistics Database

² CSO Business Demography Statbank referenced Nov 2012

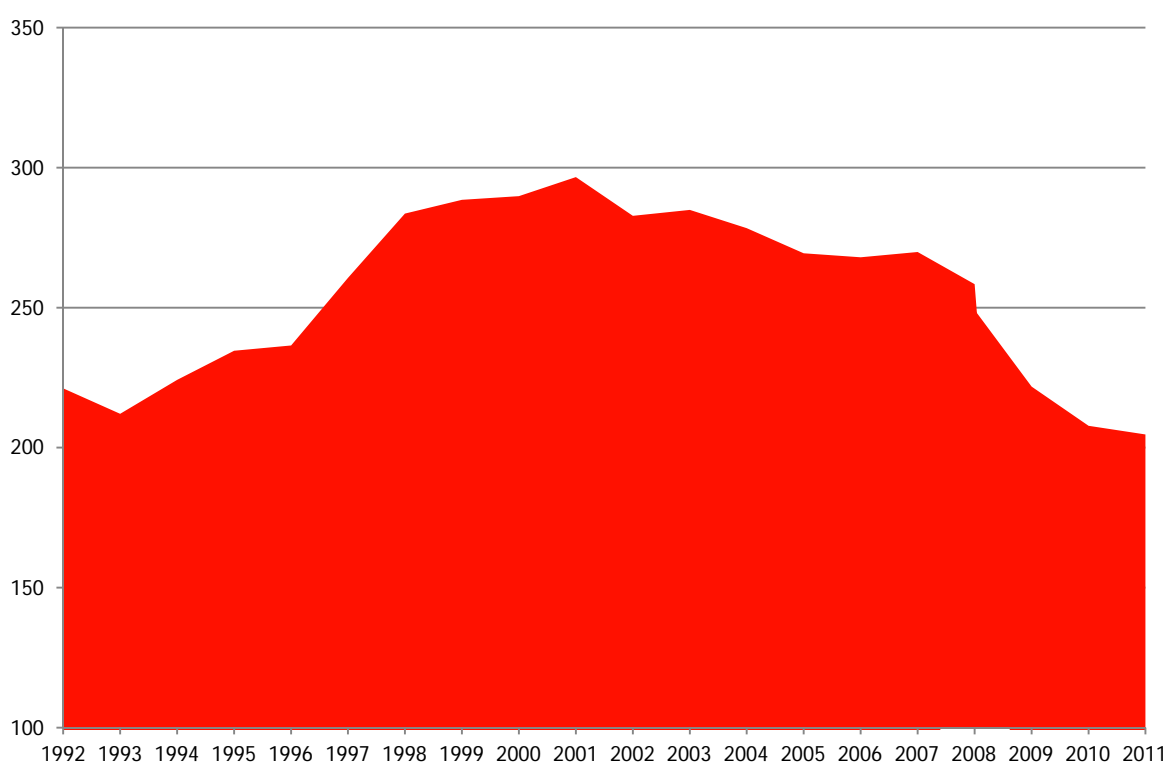
³ Forfás Annual Business Survey of Economic Impact



Development being undertaken by manufacturing firms and €740 million invested by manufacturing enterprises in R&D in 2009. The Revenue Commissioners estimate that the manufacturing sector accounted for almost 40 per cent of net corporation tax receipts in 2010⁴.

There were approximately 206,000 people employed in manufacturing in 2011⁵, accounting for 11.4 per cent of total employment. The historic long term employment contribution of manufacturing is downward, representing both cyclical (as a result of the global crisis) and structural losses (as a result of deindustrialisation/outsourcing/automation and productivity gains). However, employment has held relatively steady at 11-12 per cent of total employment from 2009 to 2011.

Figure E.1 Employment in Manufacturing in Ireland 1992-2011 ('000s)



Eurostat Annual Labour Force Statistics

Over the last decade, there have been two major shocks to the manufacturing sector in Ireland. The first occurred in 2000-2001 when, just as employment in manufacturing peaked at 296,600, the dot com bubble burst resulting in significant losses in manufacturing output worldwide, particularly within the ICT sector. The second major shock occurred in 2007-2008 when approximately 50,000 jobs were lost in manufacturing in the next 3 years. This was driven by the impacts of the global financial crisis on the one hand, which resulted in worldwide consolidation of manufacturing, major relocation of some Irish-based multinational operations abroad, merger activities and a sudden drop in demand for exports. On the other hand, demand for Irish-based manufactured goods linked to

⁴ Revenue Commissioners (2011) Statistical Report 2010
<http://www.revenue.ie/en/about/publications/statistical/2010/index.html>

⁵ CSO Quarterly National Household Survey Data



construction and consumption declined significantly in line with the downturn in those sectors. Since then Ireland has regained some competitiveness primarily as a result of falls in relative prices and favourable exchange rate movements. On a sectoral basis employment in Pharma-chemicals, Medical Devices and Food and Beverages has remained resilient throughout the recent recession. The Engineering and ICT hardware sectors have stabilised after significant shocks in 2007/2008. Consumer Goods and Other Manufacturing have continued a long term decline. Firms in these sectors that remain competitive tend to be those that have invested in technology, marketing and their strategies are focused on export potential.

Since 2007, the proportion of those employed in managerial, professional and associate professional roles has increased from 25 per cent to 32 per cent. This reflects cyclical shocks (which tend to affect those with lower skills disproportionately) and also structural change as the shift towards more knowledge intensive and higher value added activities increases skills demands across virtually all roles. The qualifications profile of the manufacturing sector is slightly below the national average with 38 per cent of employees having third level education and above (compared to 44 per cent nationally) and 16 per cent of employees with junior certificate or below (compared to 15 per cent nationally). There are substantial differences across manufacturing sectors. For example, within the food and drink, consumer products other manufacturing sectors, there are very significant proportions (20 per cent plus) of those with lower secondary education and below. At the same time, these sectors have comparatively low proportions of employees with higher level education compared to the national average. By contrast, the Pharma-chemicals and ICT hardware sectors have a very high qualifications profile, with over 60 per cent of those employed in those sectors having third level education and above.

There are also significant differences across sectors in terms of variables such as gender, age and nationality.

- For example, females account for 30 per cent of employment in manufacturing overall. However, within Pharma-chemicals and medical devices females account for around 40 per cent of employment, whereas in ICT hardware they account for just 25 per cent of employees.
- 43 per cent of employees in Consumer Products and 38 per cent of those in Other Manufacturing are over 45 years of age, whereas just 26 per cent of those employed in ICT hardware are in the same age bracket.
- 30 per cent of those employed in Food and Beverages are non-national, whereas just 7 per cent of those employed in Pharma-chemicals are non-nationals. The national average is 13 per cent.

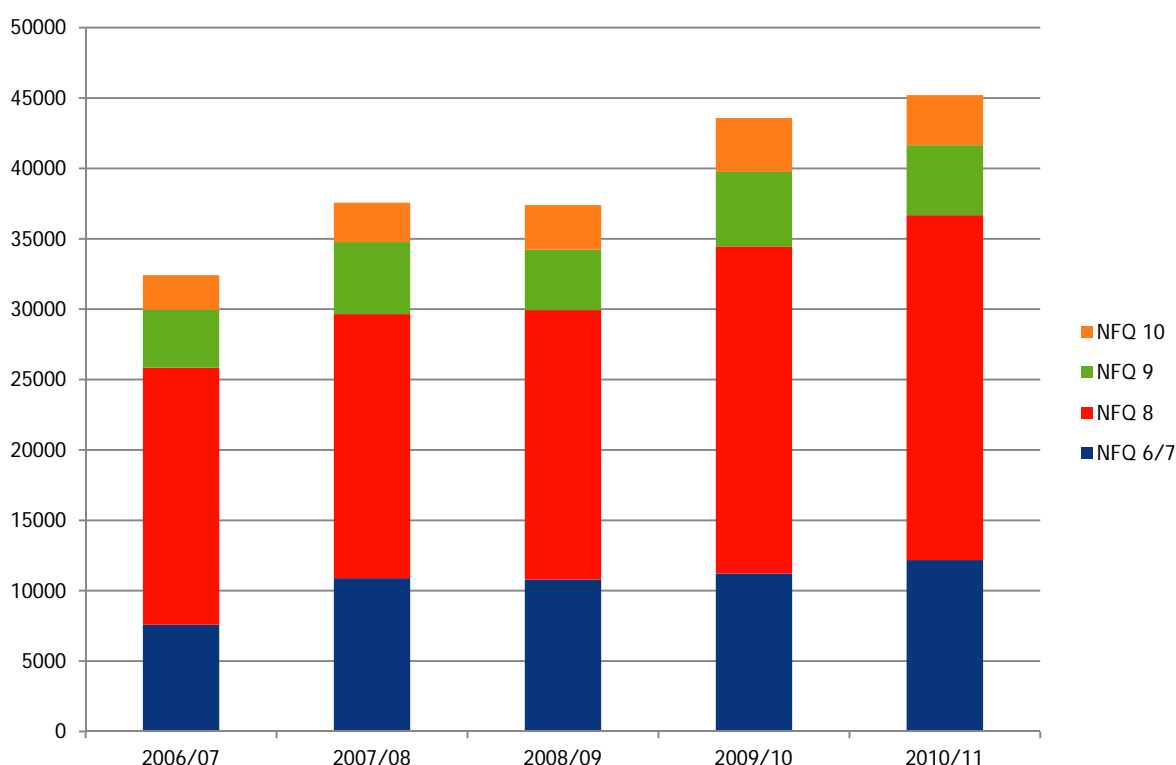
E.4 Manufacturing Skills Supply

Within higher education, there has been a significant increase in enrolments (39 per cent) from 2006/07 to 2010/11 in Science, Technology and Engineering disciplines relevant to the manufacturing sector, which is a particularly positive development given relatively stagnant levels of graduations over the same period (approx. 10,000). Therefore, an increased outflow of STEM graduates to the labour market can be expected in the coming years. Total enrolments now stand at just over 45,000. Enrolments in science/selected health programmes related to manufacturing outnumber engineering enrolments by approximately 2 to 1. Both science and engineering programmes experienced similar rates of increased enrolments. There have been strong increases at Level 6/7 enrolments, particularly in ICT related programmes, electrical engineering and



mechanical engineering. Enrolments at Level 8 and 9 mainly relate to biological/biochem/chemical sciences; computing and electronics and engineering categories. There have also been strong increases in enrolments in energy/environmental related programmes, reflecting the increasing influence of the environmental agenda. There is a challenge for manufacturing enterprises in attracting the top graduate talent in that many of these graduates are sought after for other sectors such as health, education, software and research.

Figure E.2 Enrolments (science, including selected health, and engineering/manufacturing)



Source: HEA

In addition to the enrolment data outlined above, since 2011 provision relevant to the manufacturing sector has been expanded through the introduction of the Springboard programme, which strategically targets funding of part time higher education courses for unemployed people in areas where there are identified labour market skills shortages or employment opportunities. Under the first two phases of Springboard 2011 and 2012 almost 8,000 places have been being provided on courses from NFQ Level 6 to 9 in areas relevant to the manufacturing sector: Pharma-chemicals; Food and Beverage; Green Economy; ICT and; Medical Devices. A further expansion of the Springboard initiative has been announced in Budget 2013.

A number of higher education institutes have specific expertise or centres dedicated to manufacturing, for example the BioInnovate forum; the Centre for Advanced Manufacturing and Management Systems in CIT; the Enterprise Research Centre and U Learning programme in University of Limerick; UCD-Trinity Innovation Partnership; and Sligo/Athlone Institutes of Technology/Skillnets distance learning offering in Polymer Engineering. Overall, the numbers expected to graduate from higher education are increasing, however, as outlined in Chapter 7 the



skills and competencies of these graduates to meet what will be required of the manufacturing sector is key.

Within Further Education and Training Awards, it is clear that there are a significant number of awards relevant to the manufacturing sector. In 2012, approximately 18,000 FETAC awards were made across the science, engineering, manufacturing and computing fields.⁶ Some of these awards are quite general (for example relating to IT skills), however, others are highly specific to manufacturing such as those relating to pharmaceutical processing, materials manufacturing and injection moulding. The breadth and specificity of awards highlights that there are established standards for many of the competencies required at the lower qualifications levels of manufacturing, however, these may not be apparent or clearly mapped out to all learners and employers.

There have been significant declines across most of the manufacturing Apprenticeships since 2007, coinciding with the period of decline in manufacturing employment generally. In particular, there has been a substantial relative decline in the numbers of fitters, electricians, metal fabricators, toolmakers and sheet metal workers. It is clear supply has fallen to very low levels in some apprenticeships that are critical to manufacturing (as in a recession, employers are not recruiting), giving rise to concern for the future around adequate replacement demand for qualified tradespersons within the sector.

A number of industry stakeholders as well as individual companies are involved in funding and/or provision of skills development within the manufacturing sector in Ireland, such as Enterprise Ireland, Skillnets, Engineers Ireland, Institute for the Development of Employees Advancement Services (IDEAS) and the Irish Medical Devices Association (IMDA). In-employment education and training is essential within the manufacturing sector as new technologies, regulations, processes and products continually affect skills required by existing employees.

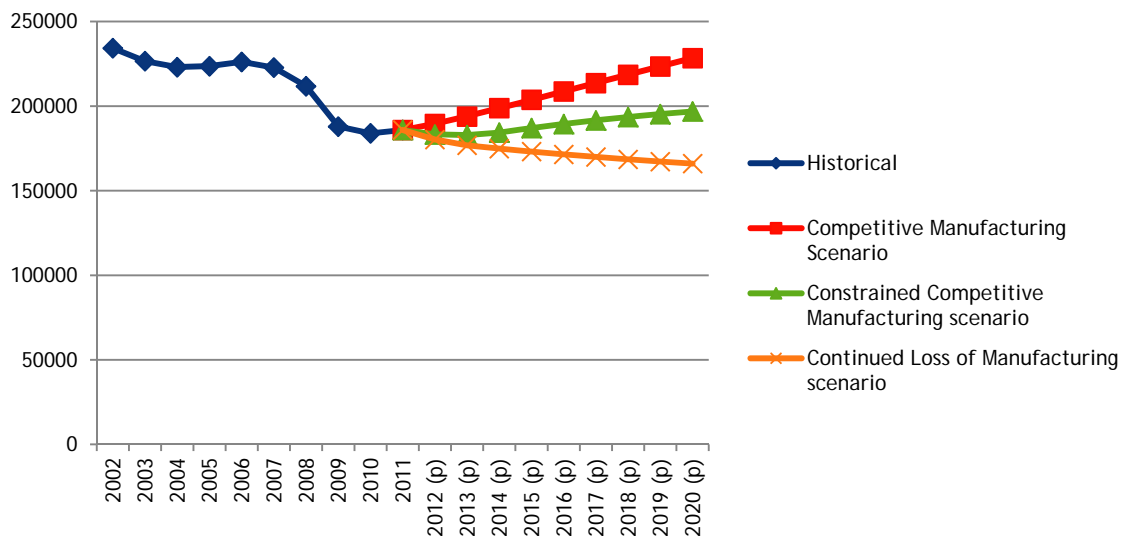
E.5 Modelling future skills demand

Future manufacturing employment has been modelled to take account of the Government's Action Plan for Jobs 2012 targets and implementation of the Forfás strategy for manufacturing - *Making it in Ireland* - report. Three scenarios for the future employment in manufacturing and skill needs are presented, based on drivers and trends described in the report, on opinions of informants in the sector and based on historic trends in employment and occupations within the subsectors of manufacturing. The scenarios are based on different assumptions about drivers of manufacturing activity in Ireland, focusing particularly on the issues of competitiveness that are likely to most influence future manufacturing employment in Ireland.

⁶ Note, the number of FETAC awards does not equate to number of graduates as many learners earn more than one FETAC award in a given year.



Figure E.3 Anticipated Total Employment* under the Three Scenarios



* Based on Forfás Employment Survey manufacturing employment data. Note that this survey does not have full coverage of the manufacturing sector. It covers circa 92% of manufacturing employment.

These scenarios are:

- **Competitive Manufacturing Scenario** - employment under this scenario rises by 22,000 to 2016 and continues incrementally to increase by 43,000 by 2020. This scenario reflects the Government's Action Plan for Jobs targets for the period to 2016, and continues these projections forward for the period 2017-2020. This scenario depends crucially on attaining reductions in labour and other business costs, productivity and innovation improvements and necessary skills supply to be realised. At the same time, the scenario also depends on a positive international environment for trade and investment and a favourable exchange rate climate with Ireland's main trading partners.
- **Constrained Competitive Manufacturing Scenario** - this scenario assumes progress within Ireland on competitiveness factors impacting on the manufacturing sector, however, potential employment growth is constrained due to a depressed international environment. Under this scenario, employment growth is limited, increasing by a net 11,000 out to 2020.
- **Continued Loss of Manufacturing Scenario** - This scenario assumes that only limited further progress is made on tackling the deficiencies in manufacturing competitiveness that accumulated over the period from around 2000 to 2008. As a consequence, the long term downward trend in manufacturing employment seen since 2001 continues. Employment falls by approximately 20,000 by 2020.

At a sectoral level across all three scenarios, Engineering, Medical Devices and Food and Beverages are expected to perform above average. ICT hardware is expected to perform around the manufacturing average. Consumer products and Other Manufacturing are expected to perform below the manufacturing average. The outlook for the Pharma-chemicals sector is that employment levels will remain stable with labour productivity and redeployment primarily driving increases in



output. There are significant shifts expected in occupational composition. The share of employment accounted for by elementary occupations falls in each subsector, as jobs at this level are replaced by operative jobs, representing an upskilling of the workforce as unskilled jobs are eliminated and replaced by skilled operative jobs. In addition, the share of employment accounted for by STEM technicians and by STEM professionals increases.

Substantial shifts in the qualifications profile of the workforce are projected, which continue trends visible in the historical data. The share of manufacturing employment accounted for by workers qualified to lower secondary level and below decreases, reflecting more demanding skills requirements at operative level. The share of manufacturing employment accounted for by workers with third level qualifications continues to increase, partly due to an increase in the share of employment accounted for by professional and associate professional level occupations, but it is mainly driven by more demanding skills requirements raising the level of qualification required within occupations, due to lower skilled manufacturing activities having moved to Eastern Europe and further afield (China, India). At the upper end, some leading manufacturing employers now require operatives to have an NFQ Level 6 or Level 7 qualification, technicians to have a Level 8 qualification and professional level occupations to have postgraduate diploma, Masters or PhD qualifications.

In summary, future employment scenarios are highly dependent on both internal and external factors, with future employment growth requiring significant improvements in domestic competitiveness coupled with a favourable international environment for trade. The model also highlights the potential for continuing loss of manufacturing employment if domestic competitiveness factors are not addressed. Across all three scenarios, there are upskilling requirements at both occupational and qualifications level. Furthermore, and importantly from the perspective of future supply, the scenarios predict a replacement demand in the region of 4,000 to 5,000 persons per annum regardless of whether employment expands or not.

E.6 Future Demand for Skills in Manufacturing

Evidence gathered through a combination of research, workshops, consultations with industry stakeholders and firm level interviews identified the following key skills issues and requirements.

Perceptions of Manufacturing Careers and Career Paths

- There is a clear consensus among stakeholders that manufacturing industry suffers from **negative perceptions** among the Irish population, and that this dissuades suitable people from seeking to make a career in manufacturing. This is an important root cause of some of the more specific skills issues. Even within manufacturing, certain sectors are perceived better than others for careers.
- **Opportunities for career progression are not clearly structured or mapped out**, particularly to prospective entrants to manufacturing and mainly at operative, trade, technician and supervisory levels. In the US and the UK the development of career paths are industry-led (for example, the Manufacturing Institute in the US, or the UK SEMTA sector skills council). In Germany, employers and the education and training infrastructure are highly integrated in the operation of apprenticeships in particular. Industry ownership and endorsement of career paths ensures that the education and training infrastructure can be mapped appropriately to provide



clarity to learners. It also provides clarity between industry and education regarding required competencies and enables gaps in learning infrastructure to be addressed where they may arise.

Skills for Manufacturing Excellence

- **Lean manufacturing techniques and increasing automation** are driving upskilling requirements for both generic skills and technical skills across virtually all occupations.
- 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. There is a strong consensus from stakeholders consulted on this that the main need is for professionals with a strong understanding of the specific manufacturing process, typically engineers or scientists (depending on the sector), to acquire **skills in data analytics**.

Trades & Technicians Skills Requirements

- A significant number of engineering firms indicated a **shortage of people with toolmaking and/or machinist skills**. Some medical devices firms also identified a shortage or potential shortage of toolmakers. A significant number of medical devices firms, and some firms in other sectors, identified a shortage or potential **shortage of polymer technicians**, qualified to around Level 7 in the National Framework of Qualifications.
- There are also more general concerns about the **supply of technical workers at skilled trades or technician level** capable of working on machinery that combines mechanical, electrical, electronic and IT/software technologies.
- The concerns in industry about the supply of **mechanical-electronic technicians and trades** appear more diffuse. These skills are important in the context of automation and computerised machinery. They can be supplied either through training and education that covers a combination of mechanical, electrical, electronic and software/IT skills, such as a Level 7 qualification in mechatronic engineering or an apprenticeship-based qualification in electrical instrumentation, or through training in a subset of these areas in the initial technician or trade qualification, followed by further training in complementary areas later.

Engineering skills

- Manufacturing firms consulted on their engineering and manufacturing management skills requirements emphasised the **need for core engineering skills** - that engineers should have the core skills associated with one or other of the main engineering disciplines, with mechanical, electrical, electronic and chemical/process engineering being the main disciplines relevant to manufacturing. So long as an engineering course develops these core skills and this is visible to prospective employers, variants such as biomedical or aeronautical engineering may also be valued. Employers will not necessarily prefer a qualification tailored to their sector over a qualification in the most closely related main engineering discipline.
- The strong consensus from workshops is that demand for **validation engineering, quality engineering, automation engineering, supply chain engineering** and other professional level engineering specialisms that support manufacturing should primarily be satisfied through



qualified and experienced engineers undertaking further study in the area to develop the specialist skills needed. Postgraduate diploma and taught Masters courses in these areas are primarily the most appropriate response to the skills.

- Engineers with a strong knowledge of **polymers** are in demand in the medical devices and plastics industries, and in parts of other sectors. Firms report a shortage of engineers with strong skills in the area.

Researcher Skills

- There is a need for **researcher skills relevant to product development**. This work requires high levels of skill and, at its more advanced levels, requires people with research degrees at Levels 9 and 10 in a relevant area, or with equivalent levels of skill. Generating these skills requires higher education research in areas relevant to the specific skills requirements. Existing moves to focus higher education research funding on industry-relevant topics, and to develop industrial PhD programmes should make a major contribution to meeting these skills needs.
- A number of manufacturing firms consulted drew attention to the high business and employment impact that a **key person with industry-leading skills** can have at firm level. They may drive improvements in business performance far out of proportion to the cost of hiring them through driving product development, commercialisation, operational performance or marketing, and through improving decision-making. They are valuable from a jobs policy perspective because they can drive activity that boosts employment.

Generic Skills

- Firms and other stakeholders consulted through interviews, workshops and stakeholder consultations emphasised that it is necessary for technical skills at all levels to be complemented with strong generic skills, particularly in terms of people skills, communication skills, problem solving skills, planning skills and project management skills appropriate to the level of the work. These skills are essential enablers for manufacturing excellence. They are also essential in other contexts, such as where contact with customers or suppliers is required, in product development, when working with regulatory bodies, or when seeking to influence investment decisions by parent companies.

E.7 Recommendations

In developing recommendations, it is clear that the skills needs of the manufacturing sector are wide and, in some instances, complex. Addressing skills needs, therefore, has a number of facets:

- Some shortages can be addressed through increasing supply, providing specific modules, accredited work placements or amending the curriculum within the mainstream education and training system. This is about ensuring both the right numbers are being produced and that graduates have relevant industry skills.
- However, many employers also address specific skills needs through upskilling and building upon existing skills base and experience within the firm - this requires flexible systems of Continuing Professional Development (CPD), online delivery, post graduate qualifications and conversion courses. In many cases, these shortages are small in scale but acutely felt by industry due to the critical nature of the roles within the firm.



- Finally, some skills requirements are for key persons with highly specific expertise that is mainly developed through experience. These are often global shortages for key persons that drive innovation and growth within the firm. The main requirements from education and training relate to ensuring access to relevant research expertise and/or collaboration on company-specific product/process development.

1. Establishing clear career paths in manufacturing

Internationally, there are clear paths in many countries for career progression from operative level up to senior roles in manufacturing, linked to their systems of training, education and qualifications. Industry takes the lead role in establishing and developing these career paths in collaboration with education and training providers. Ireland does not have a comparable resource at present. Some consequences of this include:

- School leavers and others making career choices do not have visibility of the career opportunities available in manufacturing. Employees may have difficulty identifying learning opportunities that will help in progressing their careers.
- Without clarity over career paths, providers of education and training are constrained in their ability to map their course offerings to industry needs and identify current gaps in provision that will be widely required by industry.

The most significant gap in the system is the lack of a clear framework for training at operative level, and for progressing from operative level. There are existing elements to the system which function well; there are discrete sector level initiatives for operative level training that might fit well into an overarching framework; and there are examples of very good practice on career paths within individual firms. The challenge is to build on good work that is already being done.

Key features of a career path framework for manufacturing at this range of levels would include:

- Establishing competency frameworks for the main occupations, mapped to the National Framework of Qualifications;
- Establishing learning pathways for the skills associated with each occupation, and for progression between occupations, that meet the needs of both industry and employees, and are robust in terms of learning and qualifications; and
- Facilitating both college-based and industry-based learning pathways where these meet industry and learner needs, with cross-linkages and even joint provision between the two types of pathway.

Consideration should be given to the possibility of an industry-based track to qualifications for higher level occupations, comparable to German Meister or time-served engineer.

Recommendations:

- The Manufacturing Development Forum should lead a review of manufacturing career paths. It should engage industry, employee representatives and relevant providers of education and training and the qualifications bodies including Industry Representatives, Further Education providers, FÁS/SOLAS, Skillnets and Higher Education representatives.
- The review should have reference to international experience with developing and mapping career paths, such as the US stackable credentials model, the training and progression models of various “dual system” countries in Europe and the training and progression maps of sector



1. Establishing clear career paths in manufacturing

skills councils such as SEMTA in the UK.

(Manufacturing Development Forum, Industry Associations, FÁS/SOLAS, Skillnets, Higher Education Institutes)

2. Promoting manufacturing careers

The ability of manufacturing industry to attract employees is affected adversely by lack of knowledge of the career opportunities it offers and by negative perceptions of what manufacturing work entails, among potential future employees and many of those who influence them. A programme of information and promotion targeted at all skill levels is required to ensure that the sector has a strong supply of skills, and that second level students and others are well informed about the career opportunities available to them.

There is already considerable Irish expertise with careers promotion. *Discover Science and Engineering (DSE)*, managed by Science Foundation Ireland (SFI), promotes science, engineering and technology careers, and Engineers Ireland's *STEPS* programme promotes engineering careers in conjunction with DSE. Promoting careers in manufacturing intersects significantly with the work of DSE and STEPS, as many of the key skills required in manufacturing are in engineering, science and technology at technician and professional levels.

Recommendations:

- Manufacturing companies and industry associations should participate in future Discover Science and Engineering campaigns to highlight manufacturing opportunities within the STEM sector. The initiative should draw attention to the career paths being mapped and developed under Recommendation 1 and to examples of manufacturing career success across the range of occupations, including operative, technician, supervisor and professional occupations.

(Manufacturing Companies, Industry Associations, Science Foundation Ireland, Engineers Ireland)

3. Tackling supply issues at operative, skilled trades and technician levels

Toolmakers

The shortage of toolmakers can only be addressed by an increase in the number of apprentices recruited by industry. This process could be accelerated, with the cooperation of FAS (and subsequently SOLAS when established), by firms who are FÁS-approved employers for apprenticeship training through registering skilled operatives as apprentices and submitting applications with portfolios of evidence for exemptions from phases of the apprenticeship programme for toolmaking.⁷ Feedback from employers also indicates that the toolmakers syllabus requires some updating to take account of recent advances in materials and manufacturing processes.

⁷ It should be noted that exemptions are only granted for Phases 1-5 of the Apprenticeship inclusive. All applicants are required to complete the Phase 6 examination in Theory and Practice and complete Phase 7 on the job with the FÁS approved employer to meet the criteria for the award of the FETAC Level 6 Advanced Certificate-Craft. The acceleration of the apprenticeship programme would need to be discussed with FÁS and HEA to ensure training capacity resources are available to meet the demand for Phase 2, Phase 4 and Phase 6 as a result of the exemption application process and the phases of exemptions granted.



3. Tackling supply issues at operative, skilled trades and technician levels

Polymer Technicians

The current shortages for polymer technicians are being addressed in part through a Level 7 distance learning course provided by IT Sligo on behalf of the First Polymer Skillnet. At the time of writing, the Skillnet is consulting on how many additional places might be required to meet future demand from firms for places for employees, while also continuing to provide places for the unemployed. Skill needs in this area could also, in principle, be addressed through mainstream full time provision or through initiatives such as Springboard-funded courses for job seekers.

Machinists

There is substantial demand from employers for on-going upskilling of machinists due to new technologies and/or processes. Skillnets should examine the establishment of an engineering sector Skillnet that could be responsible for in-employment training for machinists which were identified as in short supply.

More broadly, in the review of the Apprenticeship model and the range of apprenticeships, trades and traineeships, the Department of Education and Skills/FÁS should examine the potential for formal learning opportunities for machinists, particularly for CNC machining and programming, including the potential for the development of a Machinist Apprenticeship or Traineeship.

Recommendations:

Toolmakers

- Use the accelerated apprenticeship scheme to augment the number of apprentices qualifying as toolmakers every year. FAS (and subsequently SOLAS) should endeavour to ensure that at least 55-60 apprentices qualify as toolmakers each year over the period to 2016.

(Companies, FÁS/SOLAS, Higher Education Authority)

- Update the toolmaking apprenticeship syllabus to reflect recent advances in manufacturing materials and processes.

(FÁS/SOLAS)

Polymer Technicians

- Assess the potential for increasing the supply of polymer technicians, including pooling resources for the associated equipment requirements. Providers should also investigate the possibility of funding equipment costs through leasing arrangements or sponsorship by clusters of companies or equipment manufacturers.

(Skillnets, Institutes of Technology, Plastics Ireland, IMDA)

Machinists

- Target the development of an Engineering Skillnet training network (see Recommendation 7) which can address demand for in-company training and upskilling for machinists

(Skillnets in collaboration with the Manufacturing Development Forum)

- Examine the potential for formal learning opportunities for machinists, particularly for CNC machining and programming, including the potential for the development of a Machinist Traineeship or Apprenticeship.

(Department of Education and Skills, FÁS/SOLAS)

- Support places for the unemployed within these recommendations through, for example, Springboard and Momentum programmes.

(Department of Education and Skills, Higher Education Authority, FÁS/SOLAS)



3. Tackling supply issues at operative, skilled trades and technician levels

- Expedite, insofar as possible, the review of the Apprenticeship model taking into account the needs of manufacturing firms and the analysis and recommendations set out in this report. The review should consider options for provision that mitigate against shortages where they result from the cyclical nature of apprenticeship.

(Department of Education and Skills)

4. Undergraduate level skills for manufacturing

Under the medium to high growth scenarios, demand for mechanical engineers would rise significantly and feedback from employers indicates the need to increase the skills pool in this regard. This demand for mechanical engineering graduates and similar disciplines is at present driven particularly by developments in the medical devices sector.

Increasing enrolments in engineering fields should result in increased supply to the manufacturing sector in approximately 2-3 years. In the short term, the demand for mechanical engineering should be addressed through the Springboard programme.

Recommendations:

- Mechanical/Manufacturing Engineering Level 8 programmes should be targeted within the next Springboard call in the order of 250 places. They should have a particular emphasis on manufacturing skills related to automation, development and design.
- In awarding places and ensuring that the demand is appropriately addressed, a strong emphasis should be placed in tendering for programmes that demonstrate collaboration between providers and enterprises, including development of course content and provision of work placements to ensure specific industry requirements are met.
- Target jobseekers with Level 8 and below qualifications with previous work experience and engineering and related technical disciplines.

(Department of Education and Skills, Higher Education Authority, Industry Associations, Companies)

Course Content

A number of significant points with regard to courses developing professional level engineering skills for manufacturing industry emerged from the research. These refer both to Level 8 Honours Bachelor Degrees and to more recent '3 and 2' programmes that start at undergraduate level, but have the option of progressing to a Level 9 Masters degree award.

- Professional level courses in engineering that are relevant to manufacturing should all develop the core engineering skills associated with one or other of the main engineering disciplines. This should be visible to manufacturing employers, who can have difficulty in identifying what content has been covered by a graduate from a course with a non-standard title.
- Courses in mechanical engineering and other engineering disciplines connected to manufacturing engineering should all include a practical grounding in the process improvement techniques currently in use in industry, including Lean and Six Sigma.
- While it is not necessary for all graduates in mechanical engineering and closely related disciplines to have a specialised knowledge of polymers, higher education institutions should



4. Undergraduate level skills for manufacturing

recognise that many graduates in these disciplines will work in design or manufacture of polymer-based products. Therefore, it is important that mechanical engineering courses include modules or specialisations in polymer science and engineering.

- Engineering courses at this level should generally include a substantial and accredited work placement period (9-12 months) during which the student undertakes a project relevant to the employer. The 2011 Roadmap for Employment-Academic Partnerships (REAP) project on Work Placements produced good practice guidelines for work placement development.⁸
- Other widely-applicable topics that higher education institutions should address in mechanical engineering and related courses, where they do not already do so, include automation and data analytics.

Recommendations:

- Review the course content of mechanical engineering and other engineering disciplines relevant to manufacturing in the context of the findings set out above.
(Higher Education Institutes, Engineers Ireland, Higher Education Authority and Qualifications Bodies)
- Identify ways in which a structured, mentored and accredited 9-12 month work placement programme could operate more effectively to deliver to the needs of the graduate/ undergraduate and to the firm, taking into account the resource commitment required by SMEs and having regard to the good practice guidelines in the 2011 REAP report on work placements.
(Companies, in conjunction with Manufacturing Industry Associations, Higher Education Authority and Higher Education providers)

5. Postgraduate skills and Continuing Professional Development for manufacturing

From a skills perspective, some of the key functions of higher education research are to provide industry with access to researcher level skills relevant to its needs, to strengthen taught courses in higher education by improving the teaching capabilities of research academics, and to prepare Irish researchers to be effective innovators. These functions should be served well for manufacturing industry by the decision of the Government to focus research funding on 14 priority areas, most of which are relevant to Irish manufacturing industry subsectors, and two of which - Manufacturing Competitiveness and Processing Technologies and Novel Materials - are specifically targeted on the inventive underpinnings of manufacturing innovation.⁹ They should also be served well by the Irish Research Council's Employment-Based Postgraduate Programmes and Enterprise Partnership Scheme. Fourth level skills are important to drive product and process innovation in Irish manufacturing and therefore have an impact on future economic performance and employment. Continuing learning - formal and informal - for manufacturing professionals is important for all parts of the sector. The development of the employment-based postgraduate programme and industrial PhDs in the higher education sector, higher education programmes with progression

⁸ <http://reap.ie/site/wp-content/uploads/Work-Placement-Report-20111.pdf>

⁹ Report of the Research Prioritisation Steering Group, 2012



5. Postgraduate skills and Continuing Professional Development for manufacturing

opportunities developed specifically for manufacturing employees, developments in taught masters and postgraduate diploma courses, and the development of a strong CPD programme at Engineers Ireland puts in place a good institutional foundation for formal, accredited continuing learning for manufacturing professionals that builds on Level 8 and Level 9 qualifications already held.

There are, in addition, initiatives in place to develop innovation skills among higher education research students, including the UCD-Trinity Innovation Academy and BioInnovate Ireland.

Taught courses at postgraduate level have an important role to play in skills development for the manufacturing sector. There are already taught courses in place at postgraduate diploma and Masters level in mechanical engineering to develop specialised skills in some of the main areas where skills shortages at this level were identified, including taught Masters courses in materials science and engineering, supply chain management, technology management and manufacturing excellence. The key objective for the future is to leverage the existing infrastructure and develop new programmes and modules where appropriate to address continuing demand for fourth level skills.

Recommendations:

Postgraduate/Masters Programmes

- Support up to 200 places on taught postgraduate courses in disciplines relevant to manufacturing as skills priorities, particularly where key shortages have been identified through this report and annually through the EGFSN National Skills Bulletin. Address the current small scale but critical shortages in Validation engineering, Quality engineering, Polymer engineering, Automation engineering and Supply chain engineering (primarily at NFO Level 9) through upskilling employees and the unemployed (Springboard) in partnership with industry.

(Higher Education Authority, Skillnets, Industry Associations, Engineers Ireland, Higher Education Institutes)

- Focus on Manufacturing SMEs in future Irish Research Council calls for the Employment-Based Postgraduate Programme and Enterprise Partnership Scheme. Enterprise Ireland should seek to promote engagement by client companies within these programmes.

(Irish Research Council; Higher Education Authority; Higher Education Institutes; Enterprise Ireland)

6. Linking higher education provision to manufacturing industry needs

Engagement with industry is a core mission under the National Strategy for Higher Education and recommendations aimed at ensuring the system is responsive to enterprise needs are being implemented. This includes structured employer surveys and interaction and increased work placement opportunities. The Higher Education Authority has also published guidelines for the establishment of higher education institutional clusters at a regional level to support enterprise development and employment needs.

A significant theme that emerged from the research was that many of the manufacturing firms consulted spoke positively about how specific higher education institutions respond to industry skills and training needs. At the same time, there were cases where higher education institutions had put on courses in areas broadly relevant to manufacturing that were unsuccessful in terms of



6. Linking higher education provision to manufacturing industry needs

failing to attract participation from industry, or failing to place graduates within Ireland. Higher education participants in the workshops noted that it can be difficult to respond to enquiries or requests from industry given overall responsibilities and resource constraints. This issue has been examined in detail in the Roadmap for Employment-Academic Partnership (REAP) project, which provided recommendations for enhancing the interface between higher education institutes and employers.¹⁰

Recommendations:

Put in place where necessary measures for improving the interface with employers, following the National Strategy for Higher Education objectives and REAP 2011 guidelines for enhancing industry-academic engagement in the provision of skills, including:

- Clear points of contact for industry engagement;
- Communication of relevant expertise, capacity and capabilities of the HEI;
- Illustrations of the potential and benefits of engagement activities through exemplars or case studies;
- Professionalisation of the interface and service level expectations;
- Targets and metrics for engagement within the broader HEI mission.

(Higher Education Institutes)

7. Upskilling those in-employment in Manufacturing

Upskilling those with low levels of qualifications

A general issue persists at operative level in some manufacturing sectors whereby new processes and technologies are raising skills requirements at basic entry level positions in many manufacturing sectors, including demand for skills such as literacy (including technological literacy), numeracy and generic skills such as teamwork, interpersonal and communication skills. The consequence of this is that many of those employed in operative positions with low levels of educational attainment need to engage in upskilling in order to stay in employment. In particular, sectors such as Food and Drink, Consumer Products and Other Manufacturing have above average proportions of those with lower secondary education and below.

Skillnets

Skillnets is an important stakeholder in manufacturing industry training for the employed, which also provides industry-relevant training opportunities for the unemployed.

Recognising the importance highlighted amongst manufacturing companies of upskilling employees, the industry-led nature of the Skillnets model of provision, its responsiveness to manufacturing industry training needs, and the fact that Skillnets training networks collectively cover (or are available to cover) most sectors of manufacturing industry, it is recommended that Skillnets' role in continuing education and training for manufacturing industry should be developed further.

¹⁰ See the following REAP reports for further detail: <http://reap.ie/site/wp-content/uploads/Customised-Learning-Development-March-2012-2.pdf> ; <http://reap.ie/site/wp-content/uploads/work-based-learning.pdf>



7. Upskilling those in-employment in Manufacturing

Recommendations:

Operatives

- Identify progression opportunities for the low skilled and / or operatives in the sector having particular regard to the objectives of Recommendation 1.
(VECs, NALA, AONTAS)
- Develop and roll-out an operative accredited upskilling programme building on progress to date made in the Food and Beverages sector and activity under the Workplace Basic Education Fund.
(VECs, NALA, Skillnets)
- Roll out a promotion and recruitment campaign aimed at upskilling low-skilled general operatives in the manufacturing sector. It should entail clearly detailing the free career progression opportunities for employees available through the VECs Skills for Work Initiative, wider VEC basic skills provision and www.writeon.ie which also offers an RPL solution. Funding should be targeted through the EU Agenda on Adult Learning.
(NALA, VECs, Department of Education and Skills, AONTAS, Manufacturing Development Forum, Manufacturing Industry Associations and Skillnets)

Skillnets

- Examine the potential for a cost effective national manufacturing supervisory development programme, preferably leading to the award of a substantial qualification.
(Skillnets, Industry Associations)
Support specific technical manufacturing upskilling and learning for manufacturing excellence (lean), and review periodically how to maximise its impact in this area. *(Skillnets)*
- Bring together sectoral training networks in manufacturing to identify whether there are opportunities for cross-network initiatives that might benefit from the scope or scale of serving multiple manufacturing sectors.
(Skillnets)
- Target the development of an Engineering Skillnet for the sector in consultation with representatives of the engineering sector.
(Skillnets, Manufacturing Development Forum)



Chapter 1: Introduction and Objectives

1.1 Background

The manufacturing sector is a fundamental driver of the economy in Ireland. As a small, open economy, long term and sustainable growth has always relied heavily on the ability to achieve foreign earnings and success in export markets. This sector is central to this objective. However, over the past decade, the manufacturing sector has to some extent been overshadowed by growth in the domestic economy, primarily driven by consumption and construction. In the wake of the economic collapse of 2008, it is now widely accepted that Ireland's future recovery and sustainability relies primarily on the strength of our exporting sector. In this context, the manufacturing sector merits increased policy attention as a central cog in Ireland's economic potential. It is now appropriate to consider how manufacturing in Ireland can best compete into the future, drawing from its existing strengths and dynamics.

The 2012 Action Plan for Jobs (APJ) highlighted this need for a renewed focus on manufacturing.¹¹ Specifically, the APJ requested Forfás and the Expert Group on Future Skills Needs (EGFSN) "to undertake a detailed assessment of manufacturing skills needs and use the new structures for training and skills development to address both the immediate needs of the manufacturing sector and to anticipate the longer term needs of the sector". This study on the future skills needs of the manufacturing sector will support the main policy objectives of the wider long term vision and strategic plan required under the APJ. Therefore, the emphasis of this study will be on the human capital implications of the competitive needs of manufacturing to 2020, in the context of the Government's overall strategy for manufacturing *Making it in Ireland*, which is being undertaken by Forfás.

A significant proportion of the future skills needs of the manufacturing sector have already been examined in detail by the EGFSN through various sectoral reports, including: Medical Devices; Food and Beverage Manufacturing; Bio-Pharma/Pharma-chemicals and; the Green Economy. Other EGFSN studies such as that on skills for International Trade and Creativity, Design and Innovation are also relevant in this regard. Many of the recommendations in these reports are being progressed. Through recent EGFSN sectoral studies it is estimated that these sectors which have been assessed for future skills requirements account for over 50 per cent of employment and over 70 per cent of output in manufacturing. Therefore, two key objectives of this study are to update (where necessary) and reinforce the recommendations that have already been made and, within new research, there is a particular focus in the consultations on manufacturing sectors that have not been addressed in recent EGFSN sectoral studies. Broadly, this places the emphasis of research on ICT hardware, Engineering and Consumer Products.¹²

¹¹ Department of Jobs, Enterprise & Innovation (2012) Action Plan for Jobs

¹² Note, NACE manufacturing sectors have been grouped for the purposes of the report into 7 high level sectors. These groupings are provided in Appendix 2. The engineering cohort encompasses activities such as Machinery and Equipment, Materials Handling, Precision Engineering, Materials and Toolmaking, Automotive and Aerospace, Metal Fabrication and Processing. The Consumer Products section includes the manufacture of, for example, health and beauty products, cosmetics, electronic accessories, furniture; textiles; giftware; jewellery. There is a significant indigenous base of companies in this sector.



There has also been concern expressed by some stakeholders that there needs to be renewed focus on the production/process aspects of the value chain, which are perceived to have been eclipsed to a large extent from a policy perspective by other activities such as R&D, Services, Sales and Marketing. In this context, this study will have particular regard to the production/process elements of manufacturing. The competitiveness and quality of process and production functions are increasingly seen as integral to retaining, attracting and embedding higher value added activities. In addition, the views of SMEs and multinationals of various sizes and at various stages of development are sought. From a labour market perspective, potential future employment opportunities in manufacturing must also be highlighted. In particular, it is important to continue to develop and attract high level skills that will drive growth in the sector and also raise the profile of manufacturing among students as a potential career path for a diverse range of rewarding occupations.

1.2 Aim of Study

The overarching objective of the study is to assess the skills requirements of the Manufacturing sector in Ireland, over the period 2012-2020. Specifically, the project aims to:

- 1 Assess the global drivers of change impacting on the industry and the relevant consequences for future skills needs.
- 2 Provide an economic assessment and labour profile of the sector, particularly with regard to current employment and human capital characteristics.
- 3 Quantify and assess the supply of skills to the manufacturing sector from the education and training system. In addition, in-employment education and training will be reviewed.
- 4 Review best practice internationally, particularly in competitor countries, of VET and Continual Vocational Training systems and possible learnings for the Irish context.
- 5 Provide scenarios for the demand for skills in the manufacturing sector in Ireland over the period to 2020.
- 6 Develop profiles of the future skills requirements of the key occupations within manufacturing.
- 7 Based on the assessment of supply and demand, identify potential skills gaps.
- 8 Make recommendations to ensure that the skills requirements of the manufacturing sector can be addressed out to 2020. Specifically, this will propose detailed education and training interventions that may need to be introduced or expanded upon.

1.3 Methodology

Report Parameters

A number of research methodologies were employed in the research.

- The project was managed by the Forfás EGFSN secretariat working in tandem with the Forfás Enterprise Policy Department ensuring consistency with the wider Strategy for Manufacturing *Making it in Ireland*.



- A steering group consisting of industry, education, training and trade association representatives was appointed to approve the terms of reference and to validate and advise on the development of the report. A list of the steering group members is provided in Appendix 1.
- The Skills and Labour Market Research Unit, FÁS (SLMRU) provided the key statistics underpinning the profile of skills supply and demand for the sector, drawing from QNHS data and Education and Training statistics. The SLMRU also consulted and provided data underpinning the development of scenarios for the quantification of future skills requirements, with a particular focus on sectoral, occupational and skills data.
- The Forfás EGFSN secretariat undertook research on global drivers of change and international, economic and skills profiling of manufacturing.
- Research consultants Publica Consulting/Dwyer-Doyle Associates were appointed to undertake and report on interviews with over 35 manufacturing enterprises, facilitate stakeholder workshops, assess future skills needs requirements, provide scenarios for future employment and develop the report recommendations.
- Detailed consultations were undertaken by the Forfás EGFSN secretariat with 18 industry trade representatives and unions.
- 3 Workshops attended by 38 participants were held on specific themes of Operatives, technicians, crafts and supervisors, Skills for Enterprise and Innovation and Skills for Manufacturing Excellence, which framed the areas for recommendations.
- A final draft report was approved by the Expert Group on Future Skills.

1.4 Report Outline

The outline of the report is as follows:

Executive Summary

Chapter 1 - Introduction and Objectives

Chapter 2 - Global Drivers of Change in the Manufacturing Sector and Implications for Skills

Chapter 3 - Profiling Ireland's Manufacturing Sector

Chapter 4 - Description of Key Occupations and Skills Sets within the Key Enterprise Functions

Chapter 5 - Scenarios for Employment in Manufacturing to 2020

Chapter 6 - Future Demand for Skills in the Manufacturing Sector

Chapter 7 - Recommendations

Case studies, including international examples, are provided throughout the report



Chapter 2: Manufacturing - Global Drivers of Change

2.1 Introduction

There are numerous drivers of change which impact on the overall operating environment for the manufacturing sector. The purpose of this section is to gain an understanding of how these factors filter down and ultimately impact at the firm level and their implications for the future landscape of the manufacturing environment in Ireland. This assessment is undertaken by:

- Firstly, at a broad level, identifying the major global trends which are shaping the manufacturing environment; and
- Secondly, illustrating how these global trends are impacting on manufacturing firms in terms of strategies, investment and location decisions for both start-ups and expansions.

The implications of these drivers from a skills perspective are considered throughout.

2.2 Global Shifts and Trends

2.2.1 Globalisation and Emerging Markets

Globalisation, the movement of capital, products, services, ideas, and people across borders is accelerating. The pace and scale of the changes now taking place in the world economy are influenced by highly improved international transport and communications links, the liberalisation of trade and global political reforms. The process is reorienting the international division of labour and structure of both advanced and developing economies. Increasing global competition and more open markets have made a profound impact on the global spread of the manufacturing sector. Manufacturing functions are increasingly disaggregated with the emergence of global value chains, as evidenced by the growth in intra-sectoral trade and outsourcing. Through trade liberalisation, many developing countries have experienced strong economic growth in recent years and competition for foreign direct investment has broadened considerably.

According to the latest UNCTAD World Investment Report 2011, global foreign direct investment (FDI) inflows rose modestly in 2010, following the large declines of 2008 and 2009. At \$1,240 billion in 2010, they were 5 per cent higher than a year before. This moderate growth was mainly the result of higher flows to developing countries, which together with transition economies - for the first time - absorbed more than half of FDI flows. This is reflective of rising FDI in developing countries, not only for reasons of efficiency gains, but also to establish a presence closer to new and growing markets. According to UNCTAD, while world industrial production and trade are back to their pre-crisis levels, FDI flows in 2010 remained some 15 per cent below their pre-crisis average, and 37 per cent below their 2007 peak of \$1,971 billion.

Overall FDI in 2010 obscures some major sectoral differences. Data on FDI projects (both cross-border mergers and acquisitions (M&As) and greenfield investment) indicate that the value and share of manufacturing increased in line with recovering global demand post the financial crisis in 2008, accounting for almost half (48 per cent, \$554 billion) of the total global FDI compared to 37



per cent of the total in 2009. The financial crisis hit a range of manufacturing industries hard, but the shock could eventually prove to be a benefit to the sector according to UNCTAD, as many companies were forced to restructure into more productive and profitable activities - with attendant effects on FDI. In the United States, for example, UNCTAD estimates that FDI in manufacturing rose by 62 per cent in 2010 accompanied by a substantial rise in productivity.¹³

As international production and, more recently, international consumption shift to developing and transition economies, manufacturers are investing in both efficiency and market-seeking projects in these countries. In 2010, it is estimated that developing economies accounted for a greater proportion of global FDI for the first time (52 per cent compared) relative to developed economies, with Asia and South America the predominant regions for FDI among emerging economies.¹⁴

According to McKinsey, the shift in consumption growth from West to East is one of the major factors impacting on the manufacturing sector. Economic growth and associated consumer spending makes emerging markets highly attractive locations for investment. From 1995 to 2008, China's economy grew at an average rate of 9.6 per cent, India's at 6.9 per cent and Russia's at 4.7 per cent, compared to 2.9 per cent average annual growth in the United States over the same period. Furthermore, real consumer spending in China grew at an annual rate of 7.2 per cent from 1995-2008, more than double that in the US. Brazil's consumer spending, equivalent to 60 per cent of GDP, is the highest in the BRIC countries.¹⁵

Similarly, research by NAIOP estimates that growth projections for Brazil, Russia, India and China will collectively match the original G-7 share of global GDP by 2050.¹⁶ It is estimated that in 2025, India and China will account for nearly 25-40 per cent of the total world demand for goods and services, as the demand for consumer goods such as clothing, food, automobiles, phones and pharmaceuticals is driven by growing populations and a new and expanding global middle class. These consumers will have a dramatic impact on the site selection process for the manufacturing facilities and distribution centres supporting the flow of goods between global production centres and consumers. China and India's middle classes will reach 800 million people by 2020 and possess the spending capability of \$3 trillion per year. China is poised to have more impact on the world during the next 20 years than any other country. If current trends persist, by 2025 China will have the world's second largest economy and could also be the largest importer of natural resources and one of the world's biggest producers of emissions. These emerging markets have crucial implications for manufacturing firms, who need to consider their strategic importance from both a production location and as locations to target to gain new market share. From a skills perspective, it is important that there is a good understanding within enterprises of the changing nature of global markets and how it relates to their products and customer base.

¹³ UNCTAD (2011) World Investment Report 2011

¹⁴ UNCTAD (2011) World Investment Report 2011

¹⁵ McKinsey Global Institute (2010) Growth and Competitiveness in the United States

¹⁶ NAIOP Research Foundation (2010) Trends in Global Manufacturing, Goods Movement and Consumption, and their Effect on the Growth of United States Ports and Distribution



2.2.2 Scientific and Technological Advances

Scientific and technological advances potentially have 'game changing' consequences for manufacturing enterprises. Research, Development and Innovation are integral functions in modern manufacturing, however, manufacturing success is also predicated on capacity to absorb and practically build on scientific and/or technological advances made outside of the firm.

Key Enabling Technologies (KETs) will be the foundation for the developing of new products and processes. They are defined by the EU High Level Group on KETs as:

Knowledge and capital-intensive technologies associated with high research and development (R&D) intensity, rapid and integrated innovation cycles, high capital expenditure and highly-skilled employment. Their influence is pervasive, enabling process, product and service innovation throughout the economy. They are of systemic relevance, multidisciplinary and trans-sectorial, cutting across many technology areas with a trend towards convergence, technology integration and the potential to induce structural change.

At European Level 5 KETS that are fundamental for future competitiveness have been identified:

- Advanced Materials;
- Nanotechnology;
- Biotechnology;
- Photonics; and
- Advanced Manufacturing

Notably, Advanced Manufacturing is viewed as a horizontal KET in itself that is crucial for unlocking the potential of other KETS.¹⁷ KETs underpin innovation in many strategic sectors and play a key role in making new products and services affordable for the population at large. They contribute to the development of disruptive technologies across sectors such as energy (e.g. renewable energies, bio-fuel, solar energy), transport (e.g. lighter, safer and energy efficient transport vehicles), manufacturing (e.g. reduced material and process rates, energy saving), chemistry (e.g. green processing) and environment (e.g. sensors for environmental monitoring), information and communication (e.g. chips for nomadic, multimedia convergence and cloud computing), medicine (e.g. gene therapy and genetic testing) and consumer goods (e.g. mobile phones, lighting). They also contribute to the build-out of a more productive, competitive, energy and resource-efficient economy. Products with enhanced features have the potential to bear high economic value as well as ensure a more comfortable, healthy and safe life for consumers and workers in a clean environment.

¹⁷ EU HLEG (2011) Key Enabling Technologies



Advances in Materials

New materials and new processing methods have the potential to revolutionise existing industries as well as to create new ones. Developments of new applications for composites utilising materials such as carbon fibres, polymers, functional ceramics, nutraceuticals and nanotechnologies provide major opportunities to enhance the performance and competitiveness of products. They have broad applications across a wide range of sectors and products including Medical Devices, Aerospace, Maritime and Renewable Energy.

New materials usually require the introduction of new manufacturing processes as well as new skills, and new mensuration¹⁸ and quality assurance procedures etc., which themselves often require extensive investment in equipment and knowledge.

New materials also need to be understood in terms of their 'whole life' performance and environmental impact. Testing, modelling, and simulation of new materials through the range of extreme operating conditions that may be encountered in their whole life cycle is essential to ensure that relevant design models and criteria can be assured.

Discoveries such as Graphene, which has multiple possible applications from sensors to semi-conductors and novel applications as a uniquely strong material, provide radical and major longer-term opportunities for existing and new manufacturing activities.

Graphene - Ireland preparing for the future

CRANN, based at Trinity College Dublin, has announced a new collaborative research partnership with Thomas Swan & Co Ltd, a leading manufacturer of performance and speciality chemicals, based in the north east of England. The collaboration will focus on the industrial scale-up of graphene production.

Graphene is the wonder material of modern science and was the focus of the Nobel Prize in 2010. It has unique properties and is both the strongest and most conductive material known to man. There are many potential applications for graphene including next generation electronic devices, mechanically strengthened plastics and new thermoelectric materials.

www.tcd.ie/Communications/news/news.php?headerID=2400&vs_date=2012-4-1

Miniaturisation and Nano-Technologies

The history of micro-electronics is one of increasing miniaturisation of components as successive generations of chips pack more and more transistors into a given area. Such miniaturisation is also becoming increasingly relevant in other product areas e.g. for producing sensors, micro-actuators, and complete devices at miniature scale. These technologies hold the potential for generating completely new categories of device such as micro-sized medical devices (micro-diagnostic devices), microelectronic machines, and speckled computing (wireless sensor networks). This offers opportunities for the production of large volumes of integrated devices, which have sensory, communications and computing capabilities that can be distributed to provide a robust network with a wide variety of applications from medical devices to agricultural instruments for maximising yields. Smart networks of such devices hold major potential for optimising manufacturing and process plants by enabling much more effective monitoring and control of processes.

¹⁸ Collective word for measuring length, area, volume, density, wider properties of materials



Bioprocessing

Bioprocessing is becoming increasingly relevant to a range of products. It has significant potential in the development of environmentally sustainable substitutes for fossil fuels. Within the pharmaceutical sector the manufacture of more complex pharmaceutical molecules is being increasingly achieved through biological processes, rather than more traditional chemical synthesis methods. Bioprocessing will also have applications in many other areas including plastics and polymers, new materials and industrial processes.

The development of new bio-related products is also leading to changes in the business models used in particular industries. For example in pharmaceuticals, the large integrated producer businesses are moving increasingly towards a more open innovation model in which they collaborate with smaller specialist bioresearch companies specialising in developing large complex molecules with specialist properties. Within this business model, smaller companies work to develop specialised complex molecules and collaborate with the larger international companies for manufacture, marketing, and distribution.

Additive Manufacture

Manufacturing processes, especially those in engineering, have traditionally involved shaping, casting, moulding, forging, bending, cutting, or grinding materials into their approximate shape. Additive manufacture has introduced a completely new approach by building up the product layer by layer into a three dimensional form under digital control from a master design file (known as Model Based Definition). Powdered metals are melted using a laser layer-by-layer to create the final 3-D shape. As a result, products can be made that are extremely complex and without the normal stresses and defects found in traditional manufactured objects.

Today, additive manufacture is being used in relatively specialised areas such as aerospace and in small sizes and relatively small volumes. For the future, additive manufacture offers the potential for distributed manufacture in which parts can be manufactured consistently at sites on opposite sides of the world. The technology also offers the scope to customise at no incremental cost and produce fewer items at lower cost, than would be the case with assembly-line production - a significant benefit given the increasing trend toward customisation.

Although more likely a longer term proposition, additive processing is one to watch. Many specialists in the field are predicting widespread distributed manufacture of products through the use of additive approaches.

Technological change has a significant impact on skills requirements in the manufacturing base, not only higher skills requirements from the perspective of developing new products but throughout the manufacturing workforce where new technologies, new processes and automation are increasingly impacting across all skills levels.

Additive manufacturing - in practice (3T RPD Ltd, UK)

3T RPD Ltd was established in 1999 in England and has become a leading provider of plastic and metal additive manufacturing (AM) services throughout the UK and Europe. It claims to be 'unchallenged as the UK's largest plastic AM provider supplying 50 per cent of the UK market'. The company delivers to industries including Automotive, Medical, Marine, Defence and Pharmaceutical.

www.3trpd.co.uk/



2.2.3 Shifting Demographic and Consumption Trends

The United Nations projects that the world population will increase from close to 7 billion, currently, to 8 billion by 2020, and 9.3 billion by 2050.¹⁹ Projected population growth is unevenly distributed, with ageing and moderately declining populations in most European countries and low fertility rates in countries such as China, Brazil and Germany, Japan and Russia.²⁰ Intermediate fertility rates and modest population growth are projected in countries such as India, the US, Mexico and high fertility rates and large scale population increases are forecast in most sub-Saharan African countries and Pakistan.

These population shifts have strong consequences for the future development of manufacturing in the longer term. Countries with ageing populations and low fertility rates, which is projected for most European countries, will have very strong demands on health and lifestyle products and services, with ICT as a key enabler.²¹ Countries experiencing very rapid population growth will place strong demands on sectors such agricultural and food and beverage manufacturing. 'Food security' (the availability, affordability and nutritional use of food) has emerged as a key global concern for the future in both developed and developing countries.²² As industrialisation advances in emerging economies, the demand and competition for commodities, natural resources and raw materials to develop the country infrastructure and required inputs for manufactured goods will be strong.

Coupled with the projected increase in the global population and relative distribution are shifting consumer preferences. In many economies, particularly among developed countries, consumers are increasingly concerned about ethical and environmental standards employed in the manufacture of their products. Buying behaviour will be dictated by how products "align to consumer values" rather than only by price. This can include, for example, concerns around the origin of food and beverage products, whether or not they are produced through sustainable methods, whether or not they meet the Fair Trade standard, or how deep the carbon footprint is along the manufacturing value chain. Furthermore, many consumers are also becoming concerned about the distance or air miles required to transport the goods from the country of origin to their country, with an increasing emphasis on locally produced goods and services. Rules and regulations around issues such as animal testing or working conditions in the origin country can also impact on consumer preferences. From a skills perspective, companies need to anticipate these values and translate consumer preferences into product offerings.²³

In addition, consumer preferences are becoming more diverse as evidenced by the rise of manu-services (products wrapped up in services).²⁴ A survey of over 10,000 firms globally found some interesting patterns in this regard, with the United States (59 per cent); Finland (53 per cent), Singapore (49 per cent), Malaysia (46 per cent) and the Netherlands (40 per cent) having a higher

¹⁹ United Nations (2011) 2010 Revisions of World Population Prospects

²⁰ Among developed countries, only Ireland, New Zealand and Iceland have fertility rates above the replacement level of 2.1 children per woman, and are classified by the UN within the intermediate fertility group.

²¹ Expert Group on Future Skills Needs (2010) Future Skills Requirements of the Biopharma-Pharmachem Sector

²² World Health Organisation (WHO) <http://www.who.int/trade/glossary/story028/en/>

²³ Corporate Executive Board (2010) The Top 10 Drivers of Change in 2010 and beyond

²⁴ Manu-services is also termed as the 'servitisation of manufacturing' in the literature.



number of 'servicised' manufacturing firms than other countries.²⁵ The overall trend is for manu-services to be more predominant in developed countries, which is indicative of the requirement to move towards higher value added activities in more advanced economies.

Manu-services are evident in sectors such as transport manufacturing, where aeroplane or automotive products are also accompanied by a significant services component, or where parts need to be replaced.²⁶ Manu-services are also strongly evident in many technologically driven products, such as smart phones or gaming devices, where people buy both the product (which largely remains constant for its lifetime) and the services around them such as software upgrades, apps or online gaming (which are constantly evolving). The use of ICT within products as a services platform to connect people globally is one of the key drivers of change within manufacturing and is driven by consumer demand. It has been argued that manu-services have radically changed the business model for many manufacturing firms, with consumers no longer having a passive relationship with the manufacturer in the consumption of the product. Instead, consumers now 'form a contract' with the manufacturer for both products and the services, with consumers playing a highly central role in product and service innovation.²⁷ Manu-services have important consequences for skills. As consumers develop progressively complex demands from products, the variety of skills and disciplines needed to produce such products is increased.

2.2.4 Environmental and Energy Concerns

Concerns about environmental impact and energy consumption of manufacturing have grown strongly in recent years. This is not only true from a consumer or societal perspective, but also from a manufacturing firm perspective, where firms are striving for greater efficiencies in energy and waste management in the face of rising energy prices.

'Sustainable Manufacturing' is a growing theme, particularly in developed economies. Concerns about global warming, rising sea levels, natural disasters such as floods and droughts, poverty and economic recession have given support to the notion of sustainability in a pervasive way. Sustainability is about the responsible use of resources, with particular consideration of future generations, and has environmental, economic, and social dimensions, requiring both stewardship and responsible management of resource use. Manufacturing is potentially one of the most significant sources of negative environmental impact given the carbon footprint and waste arising from material and energy use, solid waste, air and water emissions that occur through production.²⁸ The pursuit for sustainable manufacturing is therefore a significant driver of change in the sector.

Energy is an ever-increasingly important factor of production for all industrial sectors. Research by Deloitte predicts that as energy becomes scarce and countries compete to attain energy security

²⁵ Neely, A.D. (2008) Exploring the financial consequences of the servitization of manufacturing

²⁶ Rolls Royce is often cited as a distinctive manu-services company in the manufacture and service of its engines. IBM is also highlighted as a company that has transitioned practically entirely from manufacturing to services.

²⁷ Neely, A.D. (2008) Exploring the financial consequences of the servitization of manufacturing

²⁸ Centre for Sustainable Manufacturing and Re-use/Recycle Technologies (SMART) UK, (2007) Environmental Impacts of Manufacturing



and independence, the cost competitiveness of energy, and particularly country specific clean and sustainable energy leadership, will be a prominent component of country manufacturing competitiveness. With increasing demand and limited supplies of traditional energy, market forces are expected to play a more formidable role in the development and diffusion of alternative forms of energy and its efficient use. Government policies, which act to increase energy efficiencies and accelerate the demand for cost-effective alternative energy, will provide the springboard whereby a country can leapfrog competing nations.²⁹ Companies that invest in energy efficiency and prepare for “supply chain ripples” will be better positioned for the future.³⁰

At EU level, the environmental agenda is relatively advanced compared to other regions, and has significant implications for manufacturing firms. These include initiatives such as the Emissions Trading Scheme, which places a cap on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. Within this cap, companies receive emission allowances which they can sell to or buy from one another as needed. The aim is that in 2020 emissions will be 21 per cent lower than in 2005.³¹ Other EU directives such as the WEEE Directive set collection, recycling and recovery targets for all types of electrical goods. The Restriction of Hazardous Substances Directive sets restrictions upon European manufacturers as to the material content of new electronic equipment placed on the market. Similarly, the REACH regulation has significant implications for chemical manufacturing and use, and places greater responsibility on industry to manage the risks from chemicals and to provide safety information on the substances.³² Finally, EU initiatives aimed at improving water quality and management also impact on many manufacturing firms.

The EU has clearly taken a pioneering role in many respects with regard to the environmental agenda and Eurobarometer surveys indicate strong public support for EU activity in this area.³³ From a manufacturing perspective, environmental-related rules and regulations can be a driver of innovation in the long term but also place significant cost and administrative burdens on the firm. A survey of manufacturing executives by Deloitte highlights that critics of the EU environment regime argue that the cost of complying with regulations makes European manufacturing uncompetitive, particularly in front of increased competition from countries such as China and India, which do not have such strict environmental rules. It has also been argued that the amount of greenhouse gas emissions businesses are allowed to produce under the EU’s Emission Trading System (EU ETS) has been set too high, leaving them little incentive to cut emissions to meet the EU’s wider targets.³⁴

²⁹ Deloitte (2010) Global Manufacturing Competitiveness Index

³⁰ Corporate Executive Board (2010) The Top 10 Drivers of Change in 2010 and beyond

³¹ http://ec.europa.eu/clima/policies/ets/index_en.htm

³² http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

³³ http://ec.europa.eu/environment/pdf/ebs_365_en.pdf

³⁴ Deloitte (2010) Global Manufacturing Competitiveness Index



2.3 Impact of Global Drivers of Change at the Firm Level

The global drivers of change as outlined above have direct consequences for manufacturing practices, investment and/or location decisions. Of course, their effects can be highly variable depending on the type of manufacturing (sector or value chain position), however, the most common recurring themes emerging from the literature are in the following areas.

2.3.1 Cost Competitiveness

The management of costs associated with manufacturing (including materials, labour, indirect costs and the tax regime) are critical in the modern global manufacturing environment. Unit costs are a reflection of all factors, direct and indirect, that contribute to the cost base of the final product. Profitability is dependent on sales relative to unit costs. There is increasing scrutiny by manufacturers of cost factors associated with all aspects of the supply chain. As mentioned previously, globalisation has led to global value chains, with the ability to locate or outsource functions of the supply chain globally, in the pursuit of the most competitive costs.

According to research by Deloitte, the overall cost of labour—including all costs of development, compliance and employee benefits along with the total cost of materials, which include logistics costs and material availability – continues to be a critical driver of manufacturing competitiveness. Manufacturing managers have actively sought efficiency in production by reducing labour and materials costs. Just-in-time production system characterises these efficiencies in terms of improved worker utilisation and reduced inventories.

Not surprisingly, the relative costs of labour and materials within a country will continue to drive its manufacturing competitiveness—at least in the short term. For example, outsourcing of production is mostly associated with low-cost manufacturing capabilities and priorities. However, companies are finding that in their relentless chasing around the globe and outsourcing of low-cost labour, they can lose longer-term leverage and internal competencies required to play the competitive game at the next level. In addition, it is worth noting that much of FDI is motivated by new market acquisition and expansion rather than solely efficiency and cost and does not necessarily impact on employment numbers in the home country. Constraints on the availability of raw materials, which can be in competition with other sectors such as construction, also influence production costs.³⁵

More widely, business environment costs, many of which are under the influence of public policy, are also critical. These include energy and utility costs and the corporate tax regime. Research by Forfás and the National Competitiveness Council (NCC) found that approximately 47 per cent of the costs of the manufacturing base are location sensitive (relevant to the cost of doing business in a given location) as opposed to 'insensitive' (prices are determined by the global supply and demand for goods and services). There are significant differences between manufacturing sectors, with 62 per cent of the medical device cost base estimated as location sensitive, compared to just 32 per cent for the chemicals sector. According to NCC case studies on costs, the contribution of labour

³⁵ Ibid



costs to total location sensitive costs in Ireland varies from 45 per cent in plastics to 56 per cent in medical devices. Transport costs are a major component of locally determined costs for plastics (18 per cent) and agri-food operations (16 per cent). Utilities are also an important cost input for the agri-food (6 per cent) and chemicals (7 per cent) sectors.³⁶

2.3.2 Managing the Global Value Chain

According to research undertaken by the European Commission, as a result of the massive fall in both costs for transport (e.g. containers) and communication (ICT) and of transaction costs and risks traditionally associated with doing business across borders, previously integrated industrial operations have been sliced up into highly complex smaller manufacturing and service packages and have to some extent been geographically redistributed across continents. As a result international production, trade and investments are increasingly organised within so-called global value chains (GVCs) where the different stages in the production process are located across different economies. Intermediate inputs like parts and components are produced in one country and then exported to other countries for further production and/or assembly in final products. The concept of GVCs is typically interpreted as broadly encompassing all activities of firms' value chains including production, distribution, sales and marketing, R&D, innovation.

Offshoring includes both international outsourcing (where activities are contracted out to independent third parties abroad) and international in-sourcing (to foreign affiliates). Decisions on which activities to source outside the firm (and potentially across borders) and which ones to keep internally (but possibly in a foreign affiliate) are determined by the existence of transaction costs and the complexity of inter-firm relationships. The OECD has pointed to research that shows that firms are more reluctant to source more complex or high-value-added activities externally, as these are often considered strategic to a firm's core business. Conversely firms often relocate high-volume production that requires low skills or standard technologies to external providers that may have cheaper or more efficient production capabilities. This would allow the firm to focus its activities on areas in which it has a comparative advantage, or allow it to engage in new, often high-value-added business activities.³⁷

The UN World Investment Report 2011 provides evidence of the fragmentation of the value chain in the growing rate of Non-Equity Modes (NEMs) of production. NEMs include, for example, contract manufacturing or services and licensing outsourcing. NEMs represent an evolving middle ground between FDI (investing overseas) and trade (producing entirely at home), whereby certain functions on the value chain are externalised to third parties and control is exercised through contracts and bargaining power. The UN Investment Report states that the use of contract manufacturing depends very much on the industry, with the use of contract manufacturing as a share of cost of goods sold varying from as high as 80 per cent in consumer electronics to as low as 20 per cent within branded pharmaceuticals.³⁸

³⁶ National Competitiveness Council (2011) The Cost of Doing Business in Ireland

³⁷ OECD (2012) International Comparative Evidence on Global Value Chains

³⁸ UNCTAD (2011) World Investment Report



The disaggregation of the supply chain is not always so fragmented with some contention more recently that, given risks associated with infringement on or loss of Intellectual Property, there may be a case for reintegration of some core competencies back to the company. Recent volatility has created urgency for some firms to re-internalise sensitive and strategic activities that were once trusted to third parties. This is particularly important for firms that compete on innovation and quality. To integrate vertically, companies assess their value network for important assets that could be at risk and internalise them.³⁹ Furthermore, the number of 'air-miles' used throughout the value-chain is a rising concern from an environmental or sustainability perspective, and consumer demand for more environmentally-friendly products may increasingly lead to 'closer to market' production activities. Excellence at all levels has become more important, and increasingly suppliers and innovation partners from different sectors, regions and with complementary competence are needed. Clusters of mutually reinforcing industries and international cooperation have gained increasing attention in market analysis.⁴⁰

2.3.3 Research, Development and Innovation (RDI)

RDI activities are often misinterpreted as the preserve of 'high tech' manufacturing firms. However, in many advanced economies, manufacturing competitiveness depends on the firm ability to embrace innovation and technology regardless of sector or product or whether developed inside or outside of the enterprise. In this context, *Manufacturing Competitiveness* has been identified as one of the key research priorities for future policy in Ireland. The focus of this priority area is on the application and development of technology and knowledge management systems to reduce costs, eliminate waste and to increase product quality. Irrespective of size, sector or ownership, manufacturing companies must constantly adapt to economic conditions and technological advances to improve their competitiveness by focusing their innovation management strategies across the four modes of innovation (product, process, marketing and organisational innovation). Success is illustrated by turning a potential disruptive factor, such as increasing energy costs, into a competitive advantage by, for example, increasing energy efficiency. The key drivers of innovation in this space include: increased pace of technological change combined with a move to technological convergence; increased energy costs; increased cost of waste disposal; and the requirement for increased product quality from a cosmetic, functional and regulation/standard perspective.⁴¹

As discussed previously, Key Enabling Technologies (KETs) and their convergence are expected to support the development of new and improved manufacturing industries and higher value-added products, together with improved production processes. The impact on industry is a blurring of the lines between formally discreet sectors and disciplines including engineering, life sciences, technological, cognitive science and social sciences. For skills requirements, this could mean, for example, chemists having an understanding of chemical engineering or vice versa. For firms, capitalising on the potential of convergence means that product development, manufacturing and

³⁹ Corporate Executive Board (2010) The Top 10 Drivers of Change in 2010 and beyond

⁴⁰ DG Enterprise & Industry (2010) EU Manufacturing Industry: Challenges and Opportunities for the Coming Years

⁴¹ Forfás (2012) Report of the Research Prioritisation Steering Group



marketing can require a range of alliances between companies from different sectors and the development of new or shared business models.

2.3.4 Impact of ICTs

According to the Australian Industry Innovation Council, digital computing, communications and the ICT revolution have had a profound impact across manufacturing industries, shifting them towards more agile, just-in-time processing, high-performance manufacturing, and accelerated introduction of new product. In addition, according to the Corporate Executive Board, in order to spark new growth streams, companies will increasingly conduct “reverse” innovation - developing products in emerging economies and “versioning” these products for sale in home markets.⁴²

Increasingly manufacturers will need to leverage the power of knowledge networks and digitised manufacturing technologies such as computer integrated manufacturing (CIM) that allow flexible manufacturing of multiple product lines and do it without necessarily increasing their manufacturing footprint. While the need is recognised, there is currently a significant gap, and hence an opportunity to develop the design and production systems to address it. Advances in CIM and the ability to move large amounts of information through broadband networks will in many cases enable manufacturing companies to operate remotely from the location of production or of markets. This potentially reduces the geographical constraints on manufacturing and allows companies to operate more effectively through global supply chains. CIM relies on a good broadband infrastructure and smart grid power.⁴³

Digital Manufacturing

Digital manufacturing is the use of an integrated, computer-based system comprised of simulation, three-dimensional (3-D) visualisation, analytics and various collaboration tools to create product and manufacturing process definitions simultaneously.

Digital manufacturing evolved from manufacturing initiatives such as design for manufacturability (DFM), computer-integrated manufacturing (CIM), flexible manufacturing, lean manufacturing and others that highlight the need for more collaborative product and process design.

ICTs used across **internal processes**, whether globally dispersed or not, through from product design and testing, production, quality control, procurement, logistics, sales and administration, facilitate greater efficiencies, cost reduction and faster time to market etc. The effective use of ICTs can have a transformative effect on organisational structures, on information management and real time decision making etc. In terms of **external supply chain and design partners**, across the world, ICTs enable procurement information, design codes etc. to be inter-changed efficiently and securely, and without loss of data integrity, facilitating effective communications, partnership management, open innovation and supply network management. Firms can connect more closely

⁴² Corporate Executive Board (2010) The Top 10 Drivers of Change in 2010 and beyond

⁴³ Future Manufacturing Industry Innovation Council (2011) Trends in Manufacturing to 2020: A Foresight Discussion Paper



with their **customers**, to build relationships, enhance customer services, garner information and facilitate a tighter feedback loop into product development and customisation.

With Computer Integrated Manufacturing, ICTs are already embedded in the production process for process control, programming robotics etc. Practices in Lean and Shingo which are being increasingly embraced by manufacturing firms are enabled by effective use of ICTs. Data collection and analytics is becoming increasingly important to enable real-time problem identification and solution, quality control and waste reduction. For some firms, the concept of *Digital Factories* is no longer a 'Factory of the Future', but is in place today. Better understanding and design of manufacturing systems are achieved by greater simulation, modelling and knowledge management from the product concept level through to manufacturing, maintenance, and disassembly/recycling leading to significantly enhanced Product Lifecycle Management (PLM). For example, testing products in virtual environments rather than on physical test beds can mean that a far more robust solution is developed, and wasted costs of physical tests are reduced.

The Digital Factory in action - insights from Siemens

Siemens' argue that many of the desirable long-term benefits from Product Lifecycle Management (PLM) cannot be achieved without a comprehensive digital manufacturing strategy. It views digital manufacturing as a key point of integration between PLM and various shop-floor applications and equipment: it enables the exchange of product-related information between design and manufacturing functions in the company. This alignment allows manufacturing companies to achieve their time-to-market and volume goals, as well as realise cost savings by reducing expensive downstream changes.

Digital manufacturing systems allow manufacturing engineers to define the complete manufacturing process in a 'virtual environment' with the following elements: tooling; assembly lines; work centres; facility layout; ergonomics and resources. Simulation of production processes is performed, with the intent to re-use existing knowledge and optimise processes before products are manufactured. Also, Siemens seeks to exploit digital manufacturing to deliver feedback from actual production operations which is then incorporated into the product design process, allowing the company to take advantage of what it terms 'shop floor realities' during the planning stage.

A wide range of skills issues are important in this field, including managing complexity, managing obsolescence, open system applications, costs of implementation, service and maintenance, integration of systems and the reliability and security of internal and external networks. The ability of systems to reconfigure, and learn, in adaptive ways is likely to become increasingly important.

2.3.5 Sustainable Manufacturing Processes and Practices

While there is no universal definition of sustainable manufacturing, the US Department of Commerce defines Sustainable Manufacturing as: *the creation of manufactured products that use processes that minimise negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound.*⁴⁴ Sustainable manufacturing processes and practices are becoming more prevalent, not only influenced by rising consumer demand for more sustainably produced processes, but also because they can have

⁴⁴ OECD (2011) Sustainable Manufacturing Toolkit



significant returns to the firm with regard to efficiency and productivity. The OECD Sustainable Manufacturing Toolkit highlights a number of case studies as follows:

- A 2010 survey of UK-based manufacturing SMEs shows that 56 per cent are already investing in low-carbon technologies and strategies. The global market for low-carbon products is already estimated to be worth over \$5 trillion and growing.
- Retailers are demanding that suppliers respond to green consumers: In 2009, Walmart, the largest retailer in the world, introduced a worldwide sustainability index. The index will be applied to over 100 000 global suppliers to give consumers a clear environmental and social rating for every product it sells.
- A green reputation drives up financial value: A study by Harvard and London Business Schools found that financial analysts rate companies with a visible reputation for environmental responsibility higher than others. Conversely, poor performance can be a serious risk. Companies with significant environmental problems, including litigation, have to pay up to 0.64 per cent more to service their debts and secure credit.
- The UK's Carbon Trust estimates that most businesses can cut their energy bills by up to 20 per cent with only a small investment - a saving that could equate to as much as a 5 per cent increase in overall profits.
- Young workers value sustainability and demand green workplaces: A 2010 survey of 5,300 respondents worldwide, carried out by Johnson Controls Global WorkPlace Solutions, shows that over 96 per cent of 18-45 year olds want their employer and workplace to be environmentally friendly or at least environmentally aware. Over 70 per cent of all respondents would like to share printers and have recycling bins in the office, while 47 per cent want to have water saving devices and solar panels installed on site.

Sustainable manufacturing processes and practices are pervasive throughout the manufacturing supply chain. Efforts by manufacturing firms to improve environmental performance have been shifting from "end-of-pipe" pollution control to a focus on product life cycles and integrated environmental strategies and management systems. Furthermore, efforts are increasingly made to create a 'closed-loop', circular production systems in which discarded products are used as new resources for production.⁴⁵ The OECD Sustainable Manufacturing Toolkit highlights how manufacturers can reduce environmental impacts, save energy and increase efficiencies across the supply chain.

- With regard to **inputs**, this can include measuring non-renewable materials intensity; restricted substances intensity; recycled/reused content.
- Within manufacturing **operations**, the main indicators are: water intensity; energy intensity; renewable proportion of energy; greenhouse gas intensity; residuals intensity; air releases intensity; water releases intensity and proportion of natural land.
- In relation to products, the indicators for measuring environmental impact are: recycled/reused content; recyclability; renewable materials content; non-renewable materials

⁴⁵ OECD (2010) Eco-Innovation in Industry



intensity; restricted substances content; energy consumption intensity and greenhouse gas emissions intensity.⁴⁶

Furthermore, the OECD also points out that many manufacturers are putting in place 'sustainability teams' to critically monitor and evaluate progress along these indicators.

2.4 Conclusions - Implications for Skills

In developed economies, the main impact on skills arising from global drivers of change is for higher skills requirements across virtually all manufacturing roles.⁴⁷ As basic processing, assembling and service functions are offshored and moved out of developed countries and/or the demand for labour is reduced through automation, the future skills focus is on productivity and more knowledge-intensive activities.⁴⁸ As a result, the relative share of 'knowledge intensity' within manufacturing in developed economies is rising across all occupation levels, bringing its own challenges for the appropriate skills mix required in to the future. Within knowledge-based manufacturing, value creation from human capital is now more likely to involve a higher level of autonomy, and rely on the judgement, insight and know-how of individuals, who draw upon their specialist knowledge. In this context, the development of both technical and soft skills is equally important. This is observable across virtually all manufacturing occupation types, and in all types of business activity. Whether in the operation of machinery and equipment, or in the provision of business services, value creation is maximised as individual workers manage complexity, not simplicity.⁴⁹ Furthermore, globalisation together with advances in ICT, and the associated increase in intra-industry trade, has increased specialisation of production. As firms become more specialised, the requirement is for a higher level of technical skill in the workforce and management.⁵⁰

Skills, in addition to costs competitiveness and the business environment, are therefore a primary driver of competitiveness in manufacturing⁵¹. The quality of skills available to the manufacturing sector depends both on the development of the existing workforce and the relevance of the graduates from the education and training sector. The Science, Technology, Engineering and Maths (STEM) pipeline from the education system to the labour market is particularly important to the manufacturing sector. Research by Deloitte has identified 'Talent Driven Innovation' (which encompasses quality availability of the labour force/quality and availability of scientists, researchers and engineers/ capacity for innovation) as the most important global driver of change for the manufacturing industry ahead of costs of labour and raw materials.

Globalisation means a sound understanding of offshoring, supply chain management and diverse workforces and strong language and inter-cultural skills will grow in importance as skills

⁴⁶ OECD (2011) Sustainable Manufacturing Toolkit

⁴⁷ CEDEFOP (2009) Future Skills Needs in Europe - Medium Term Forecast Synthesis Report

⁴⁸ DG Enterprise & Industry (2010) EU Manufacturing Industry: Challenges and Opportunities for the Coming Years

⁴⁹ Ibid

⁵⁰ Department of Industry, Tourism & Resources Australia (2007) Drivers of Change in Australian Industry

⁵¹ Cost Competitiveness and the Business Environment are two key strands that are dealt with in the *Making it in Ireland* strategy for manufacturing.



requirements. Manufacturing firms need to understand the potential of new technologies, materials and how they can not only develop new products but also new, improved and sustainable manufacturing processes. The current focus on pure financial performance will be broadened to encompass managing a broader range of stakeholders. Generalist managers are likely to have to acquire technical expertise. The increased focus on climate change and the need to cut down carbon emissions and energy consumption is generating a rising need for skills and jobs related to climate and environmental friendly solutions, technology and services.⁵² To deepen the skills challenges even further, many sectors also forecast a loss of know-how and shrinking supply of labour available due to the ageing of the manufacturing workforce, and in part due to the perception of manufacturing as a blue-collar industry compared to white-collar services professions.⁵³

The implications of changing skills needs and their implications for Ireland are discussed inter alia in detail in Chapter 7.

Case Study: 'Securing the Talent Pipeline 'in the United States

In July 2012 the President's Council of Advisors on Science and Technology outlined six objectives within their *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing* with regard to developing skills sets within the sector.

1. Correct Public Misconceptions about Manufacturing: Building enthusiasm and interest in careers in manufacturing was identified as a critical national need, and a national marketing campaign was recommended as one important step in this direction.
2. Tap the Talent Pool of Returning Veterans: Returning veterans possess many of the key skill sets required to fill the skills deficits in the manufacturing talent pipeline. Specific recommendations are made on how to connect these veterans with manufacturing employment opportunities.
3. Invest in Community College Level Education: The community college level of education was referred to as the "sweet spot" for reducing the skills gap in manufacturing. Increased investment in this sector was advocated, following the best practices of leading innovators.
4. Develop Partnerships to Provide Skills Certifications and Accreditation: Movability and modularity of the credentialing process in advanced manufacturing is critical to allow coordinated action of organisations that feed the talent pipeline. The report supports the development of stackable credentials.
5. Enhance Advanced Manufacturing University Programs: The report recommends that universities bring new focus to advanced manufacturing through the development of educational modules and courses.
6. Launch National Manufacturing Fellowships & Internships: The report supports the creation of national fellowships and internships in advanced manufacturing in order to provide required resources and national recognition to manufacturing career opportunities.

www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_amp_steering_committee_report_final_july_17_2012.pdf

⁵² Ibid

⁵³ DG Enterprise & Industry (2010) EU Manufacturing Industry: Challenges and Opportunities for the Coming Years



Chapter 3: Profile of the Manufacturing Sector in Ireland

3.1 Introduction

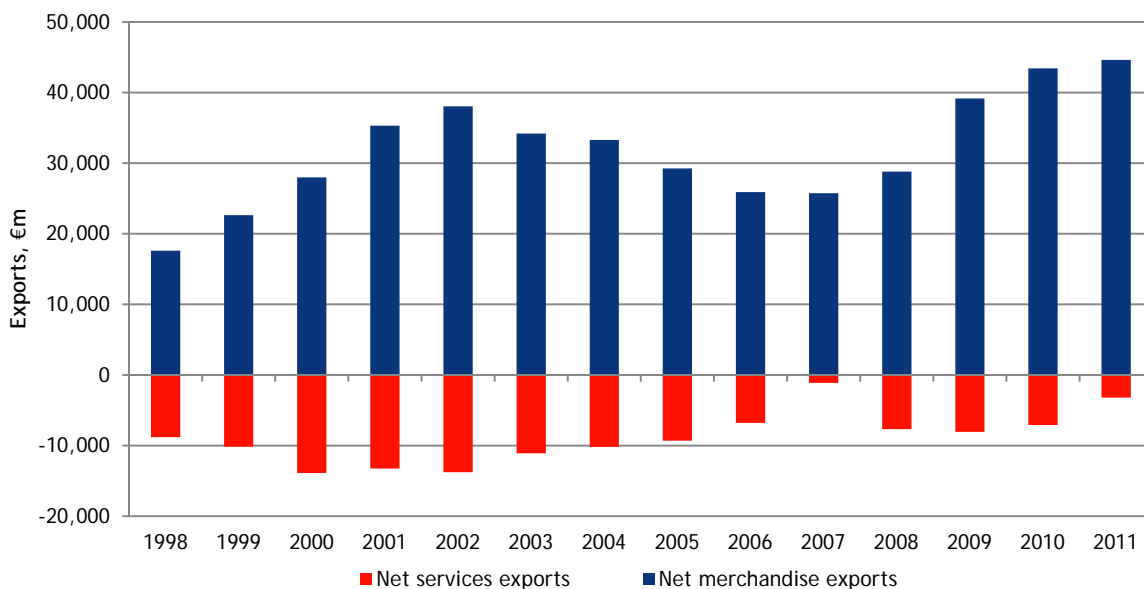
This chapter provides a statistical profile of the manufacturing sector and sub-sectoral data available, drawing from a range of sources including the CSO Quarterly National Household Survey; the Forfás Annual Business Survey of Economic Impact and the Forfás Annual Employment Survey.⁵⁴ The objective is to assemble a picture of trends in manufacturing in Ireland with a particular emphasis on changing employment and skills needs.

3.2 The Economic Contribution of Manufacturing

Manufacturing plays a critical role in the Irish economy - as a driver of exports, as an employer, as a source of revenue and as a key driver of growth:

- Manufacturing accounted for approximately 22 per cent of GDP in 2009. This represents an increase from 19 per cent in 2006, however, it is still far below its share of 31 per cent in 1999.⁵⁵
- Manufacturing exports were approximately €92.9 billion in 2011, almost twice the level of manufacturing imports of €48.2 billion, giving a net export figure of €44.7 billion, thereby the primary positive contributor to the Balance of International Payments. This is in contrast to internationally traded services, where net exports are marginally negative.

Figure 3.1 Merchandise and Services Net Export 1998-2011



Source: CSO International Balance of Payments; Goods Exports and Imports

⁵⁴ The sectoral groupings in this section are based on the amalgamation of data from various NACE codes. Please see Appendix 2 for NACE code groupings.

⁵⁵ OECD Statistics Database

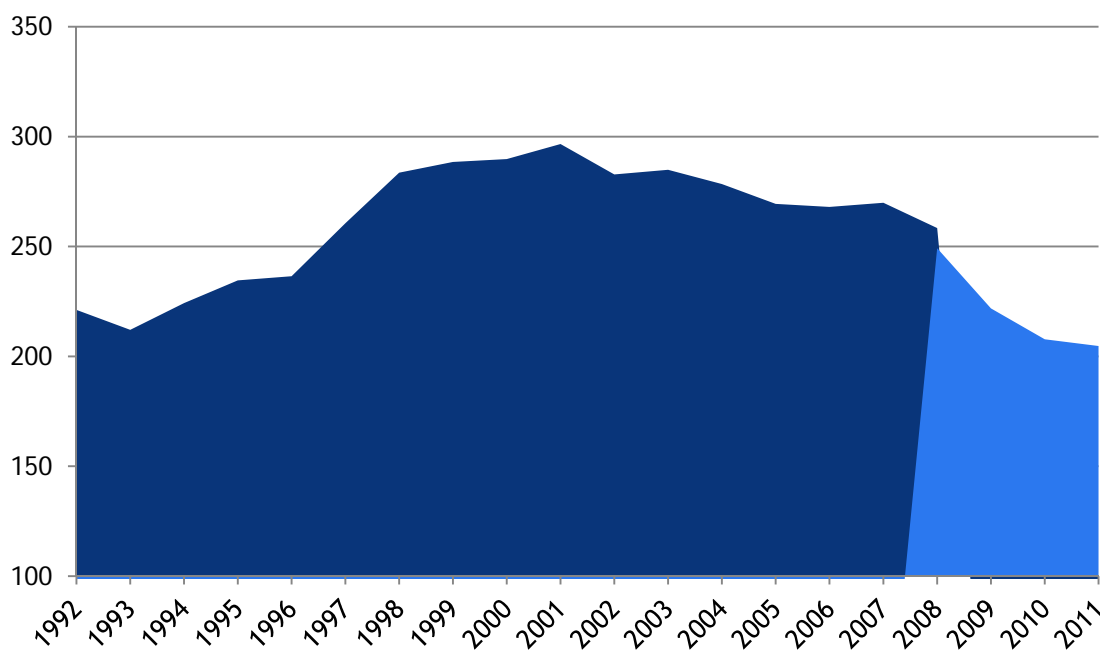


- The manufacturing sector also has significant spin off effects, such as indirect employment supported in other sectors such as services, logistics, mining/quarrying, agriculture and sub-supply. Manufacturing firms source approximately €14 billion of materials and services from Irish based suppliers - although this has decreased from €17.5 billion since 2001.
- Manufacturing is a key driver of R&D activity and innovation, with 40 per cent of BERD being undertaken by manufacturing firms. Manufacturing firms invested €740 million in R&D in 2009;
- The Revenue Commissioners estimate that the manufacturing sector accounts for almost 40 per cent of net corporation tax receipts⁵⁶.

3.3 Broad Employment Trends

There were approximately 206,000 people employed in manufacturing in 2011, accounting for 11.4 per cent of total employment. The long term employment contribution of manufacturing is downward, representing both cyclical (as a result of the global crisis) and structural losses (as a result of deindustrialisation/outsourcing/automation and productivity gains). However, employment has held relatively steady at 11-12 per cent of total employment from 2009 to 2011.

Figure 3.2 Employment in Manufacturing 1992-2011 ('000s)



Source: Eurostat Annual Labour Force Statistics⁵⁷

Over the last decade, there have been two major shocks to the manufacturing sector in Ireland. The first occurred in 2000-2001 when, just as employment in manufacturing peaked at 296,600, the dot

⁵⁶ Revenue Commissioners (2011) Statistical Report 2010
<http://www.revenue.ie/en/about/publications/statistical/2010/index.html>

⁵⁷ Note, figures are classified according to NACE 1.1 from 1992-2008 and from NACE Rev 2 from 2008-2011 due to a break in series



com bubble burst resulting in significant losses in manufacturing output worldwide, particularly within the ICT sector. Employment in manufacturing declined steadily from 2001 onwards, coinciding with rapid growth in the domestic economy, particularly within construction, public sector and consumption-related industries. This period also marked a significant decline in Ireland's cost competitiveness. During the property boom, costs in Ireland rose dramatically. According to the National Competitiveness Council (NCC) Cost of Doing Business Report, this is reflected in a 22.5 per cent loss in competitiveness recorded between January 2000 and April 2008.

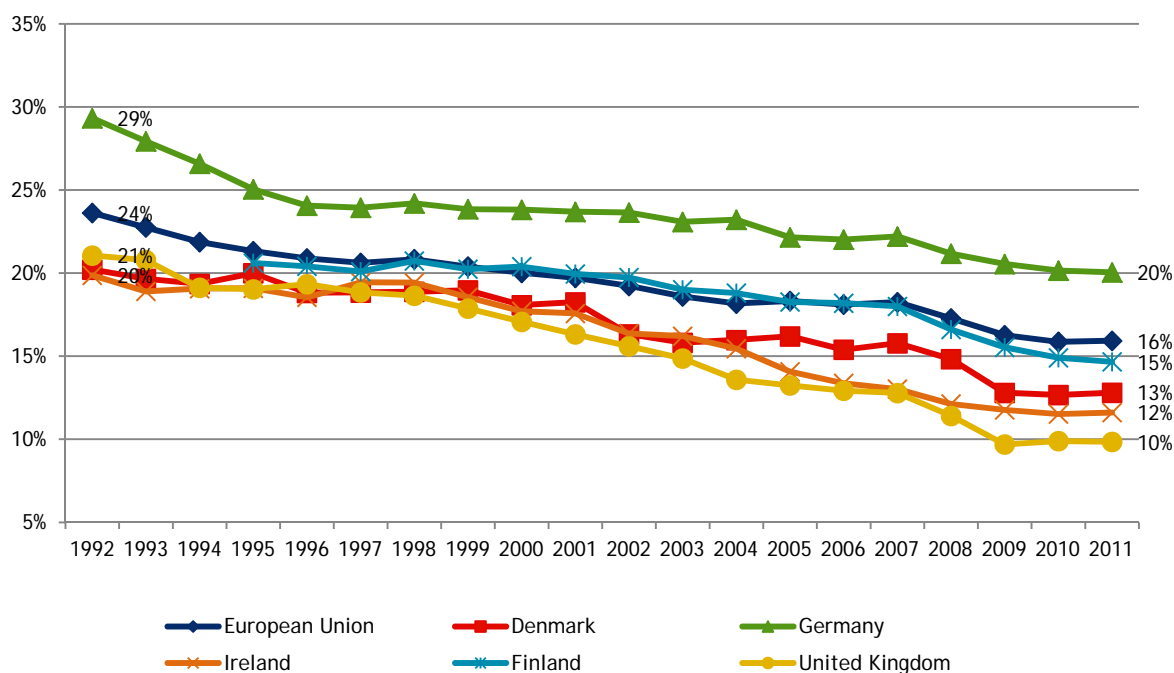
The second major shock occurred in 2007-2008 where approximately 50,000 jobs were lost in manufacturing in the next 3 years. This was driven by the impacts of the global financial crisis on the one hand, which resulted in worldwide consolidation of manufacturing, major relocation of some Irish-based multinational operations abroad, merger activities and a sudden drop in demand for exports. On the other hand, demand for Irish-based manufactured goods linked to construction and consumption declined significantly in line with the downturn in those sectors. Since then Ireland has regained some competitiveness primarily as a result of falls in relative prices and favourable exchange rate movements. From April 2008 to July 2012, Irish cost competitiveness improved by almost 19 per cent according to the real Harmonised Competitiveness Index (HCI) measure (and 10.6 per cent in nominal HCI terms). Prices have now fallen back to levels last seen in 2002.

While the claw back of some competitiveness is positive for the manufacturing sector, the NCC caution that the role played by exchange rates, both in terms of the initial deterioration in Irish cost competitiveness and the more recent competitiveness gains is important to note. Over half of the improvement in Ireland's cost competitiveness since 2008 is accounted for by favourable exchange rate movements (i.e. a weak euro, making Irish exports cheaper in non-euro markets). Therefore, a change in external conditions can have a highly significant bearing in terms of cost competitiveness in Ireland relative to other countries. At the same time, there are endogenous factors that impact on our cost competitiveness. While a significant proportion of manufacturing input costs (53 per cent) are determined in global markets, the NCC estimate 47 per cent of the manufacturing cost base is location sensitive, including costs for labour, utilities, property, transport and taxes. Therefore, there are significant external and internal risks impacting on manufacturing competitiveness in Ireland.

Many developed economies have seen a decline in manufacturing as a proportion of total employment. Compared to other competitor countries and the EU generally, the decline in employment in manufacturing in relation to total employment largely is representative of the experience in competitor developed countries. This is primarily due to a long term process of structural adjustment or 'deindustrialisation', where the contribution of services to economic growth relative to industry and agriculture has increased as a result of greater demand, both through globalisation in the form of services exports (for example financial services, software) and locally-traded services (driven by rising incomes).



Figure 3.3 Manufacturing Employment in Ireland and Europe as a % of Total Employment 1992-2011



Source: Eurostat Annual Labour Force Statistics

Since 1992 in the EU, employment in manufacturing has declined as a per cent of total employment to 16 per cent. By comparison, employment in manufacturing has declined from 20 per cent of total employment in Ireland to approximately 12 per cent in 2011. The decline in the UK has been slightly more pronounced with manufacturing now accounting for 10 per cent of total employment. Germany is one of the main outliers within developed economies, with 20 per cent of total employment in manufacturing in 2011 reflecting the very strong industrial base in Germany, however, there has also been a significant relative decline in Germany from 29 per cent of total employment in 1992.

3.4 Sectoral Profile⁵⁸

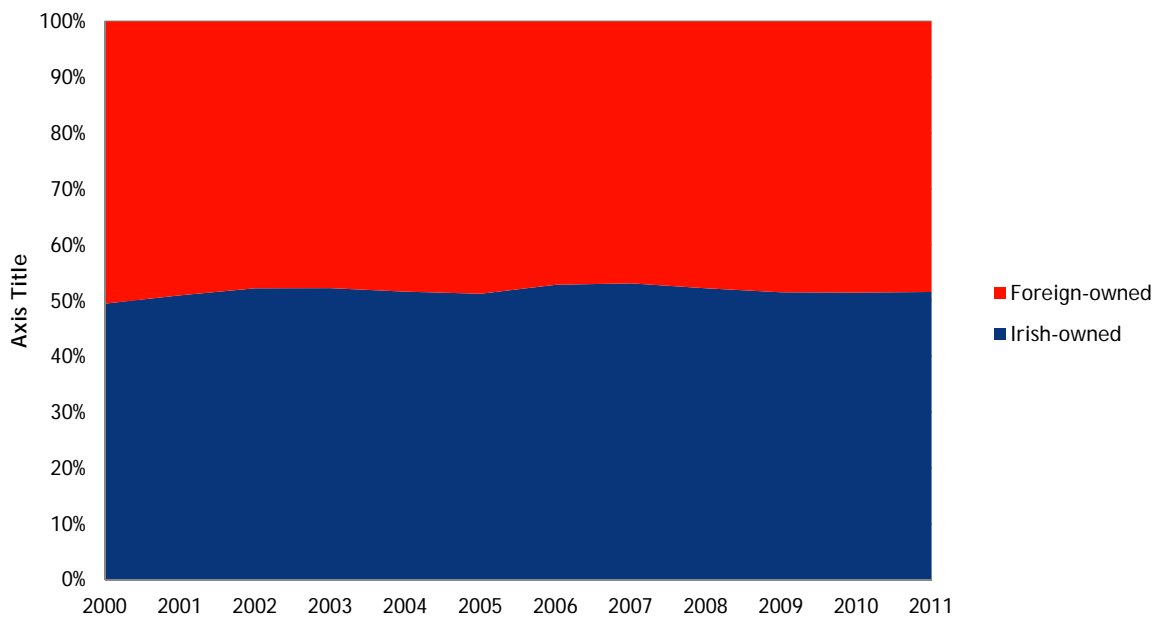
In total, there are 12,790 manufacturing enterprises in Ireland.⁵⁹ Most of these are small in scale, with 83 per cent employing less than 10 people (micro firms) and 95 per cent employing less than 50 people. In general, the larger firms are foreign owned, with the exception of a small number of firms involved in the food sector. Overall, firms assisted by IDA and Enterprise Ireland represent approximately 92 per cent of total manufacturing employment. Looking at employment in manufacturing firms by ownership, historically, it has been split virtually evenly between Irish-owned and Foreign-owned firms. The following section provides a sectoral profile of manufacturing.

⁵⁸ Note, the sectors presented in the profiling data are based on groupings of NACE codes. These groupings according to NACE codes are available in Appendix 2.

⁵⁹ CSO Business Demography Statbank referenced Nov 2012



Figure 3.4 Employment in Manufacturing in Ireland by Ownership 2000-2011 (%)

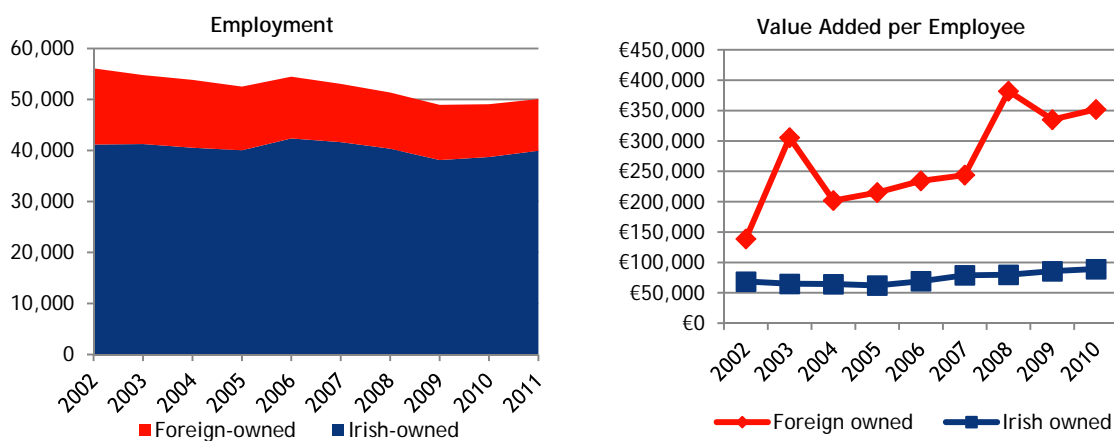


Source: Forfás Annual Employment Survey

The following section examines employment in manufacturing in further detail by sector.

3.4.1 Food and Beverages

Figure 3.5 Employment and Value Added in Food and Beverages Manufacturing



Source: Forfás Annual Employment Survey/ABSEI

The Food and Beverages sector in Ireland is highly export-oriented, with total exports of over €9.2 billion in 2010. Irish companies provide significant direct and indirect employment throughout the country. While the sector is primarily made up of small firms, a number of firms of significant scale have developed over the last decade, through organic growth and mergers/acquisitions. There are over 50,000 people directly employed in Food and Beverages, with an estimated further 85,800 in primary production, agriculture, forestry and fishing. In 2009, 85 per cent of total agricultural



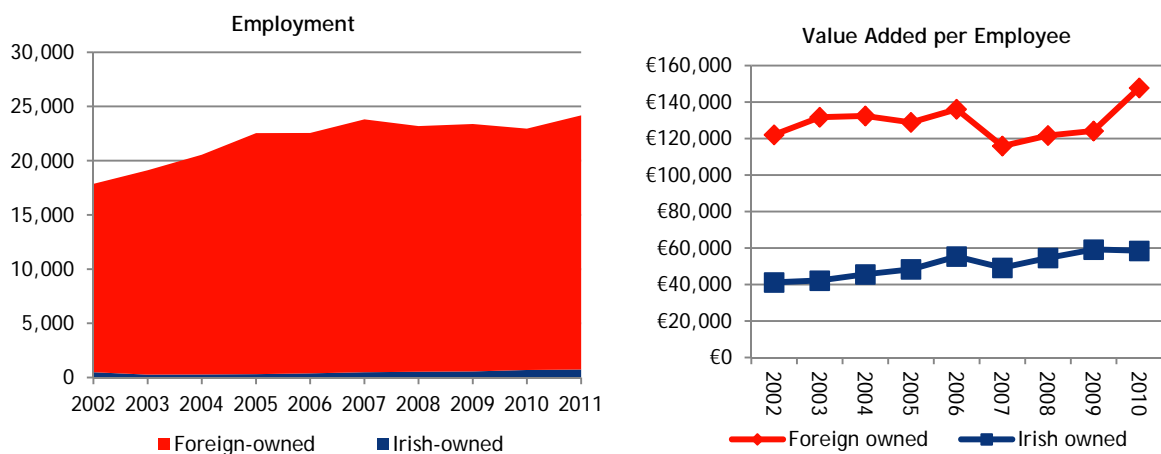
output was exported to over 160 markets worldwide. Employment in Food and Beverages manufacturing has held up relatively strongly compared to other sectors in the recent downturn, however, significant downside risks prevail given the exposure of the sector to external fluctuations.

Foreign affiliates of leading multinationals have a strong presence in Ireland, employing just over 10,000 and with Irish economy expenditure of €1.2bn. They include Cadbury, Unilever, Nestle, Northern Foods and Heinz. A number of Irish owned firms are among the world's 50 largest food and beverage multinationals, ranked by foreign assets, including Kerry Group PLC, Greencore Group PLC (*UNCTAD, 2007*). Ireland's largest food and drink export market is the UK which is dominated by four large food stores: Tesco, ASDA, Morrison's and Sainsbury's. Indigenous agri-food companies in Ireland include: the co-ops, Cuisine de France, Glanbia, Kerry Foods, Greencore, Kepak, Fyffes, Carbery, Silver Hill, C&C, Gleeson's and Cooley Distillery. The Government Harvest 2020 strategy target is to increase exports of the sector by 42 per cent by 2020, to reach €12bn building on existing and expansion into new markets.

3.4.2 Medical Devices

The medical devices sector is highly diverse. It covers thousands of products - from simple bandages and spectacles, through implantable devices, equipment for screening, to the most sophisticated diagnostic imaging and minimally invasive surgical equipment. Strong growth prospects for the industry globally are driven by ageing populations, increase in chronic ailments and increasing consumer wealth driving demand in emerging economies. High value opportunities such as remote diagnostics, combination products and eHealthcare services are being driven by advances in science and technology and convergence, particularly with ICT. The sector employed over 24,000 people in 2011 with exports of approximately €7.2 billion in 2010. Employment in the sector has been largely resilient in the face of the downturn, with employment holding steady in the last number of years and even registering a small increase in 2011.

Figure 3.6 Employment and Value Added in Medical Devices Manufacturing



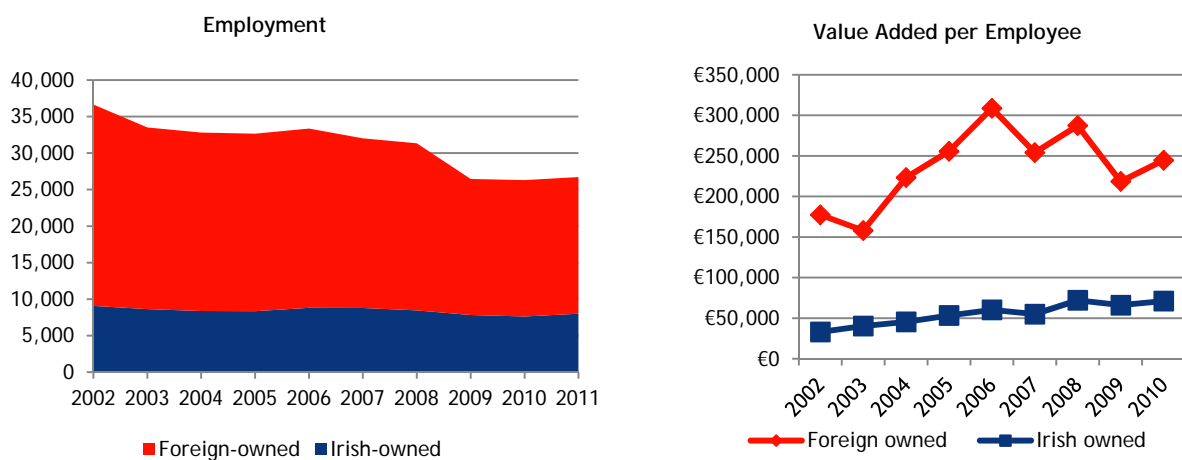
Source: Forfás Annual Employment Survey/ABSEI



There is a very strong multinational presence in the sector with 20 of the top 30 medical devices companies globally (for example, Abbott, Boston Scientific, Medtronic) with large production facilities in Ireland. There is also a small but growing indigenous base with some notable medium sized Irish owned multinationals (Creganna, Trulife) & research/technology intensive SMEs (Chiroxia, ClearStream, Vysera). The medical devices sector also links in strongly with the ICT and engineering base, for example as key partners in delivering healthcare solutions (HP, IBM, Analog, and Intel).

3.4.3 ICT Hardware

Figure 3.7 Employment and Value Added in Hardware Manufacturing



Source: Forfás Annual Employment Survey/ABSEI

ICT hardware encompasses the manufacturing of semiconductors, integrated circuits and computer hardware, peripherals and storage devices (note, it does not including consumer electronics, communications equipment, or industrial electronics). The majority of market share in these sub-markets is occupied by a few key players such as Intel and AMD in semiconductors and IBM, Dell and HP in computer hardware. In particular, the ICT⁶⁰ sector has been impacted by a number of global trends. In the first instance, Ireland benefited from substantial investment by global telecoms and computer firms during the dot.com era and lead up to Y2K. By 2000 employment peaked at 47,100. The dot.com bust resulted in global employment by these firms being almost halved. At that time, ICT employment in Ireland too experienced considerable decline - but generally fared well in the global context. Since then, the continued decline in employment in this sector has been driven primarily by location decisions of foreign firms. As computer products have become increasingly commoditised and prices have dropped, global firms will make decisions to locate operations in lower cost economies to reduce inputs costs. They also locate in high growth markets, closer to a new and expanding customer base. More recently the Dell downsizing has had an impact on a wider cohort of sectors involved in sub-supply. That said, the ICT hardware sector continues to contribute a significant proportion toward total manufacturing employment. There are approximately 27,000 people employed in the sector (agency supported firms) with exports valued at €10.3billion in 2010.

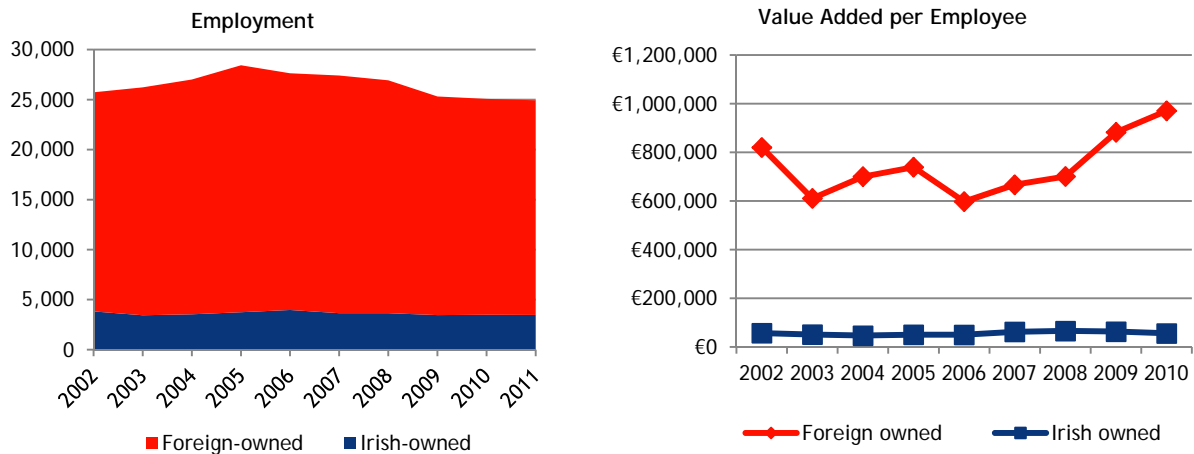
⁶⁰ NACE code : Computer, Electronic and Optical Products



Approximately 3,500 are employed in Irish-owned companies, primarily in wireless and electronic technologies. There are a number of the leading multinationals based in Ireland, notably Intel, HP, EMC, Sanmina, IBM and Dell.

3.4.4 Pharma-Chemicals

Figure 3.8 Employment and Value Added in Pharma-chemicals Manufacturing



Source: Forfás Annual Employment Survey/ABSEI

The Pharma-chemicals/biopharma sector encompasses the discovery, development, production and sale of drugs licensed by an appropriate body (e.g. Food & Drug Administration in the US) for use as medications. The sector is subject to stringent laws and regulations regarding the patenting, testing, production and marketing of drugs. In 2011, there were approximately 25,000 people employed in Pharma-chemicals, predominantly in multinational firms. It contributes in a major way to Ireland's export base with exports valued at €39.2 billion in 2010. Nine of the top ten Pharma-chemicals/bio companies globally (Pfizer, Merck, GSK) have research, manufacturing and services activities here. In addition, there is a growing indigenous base made up of medium sized Irish owned multinationals (Trulife, Chanelle, Bimeda), and research/technology intensive SMEs (Opsona, AGI Therapeutics, Eirgen Pharma). Although employment in the sector has held up relatively strongly in the downturn, there are some significant challenges facing the sector in Ireland, particularly with regard to the increasing prevalence of generic drugs and consolidation within the industry driven by mergers and acquisitions.

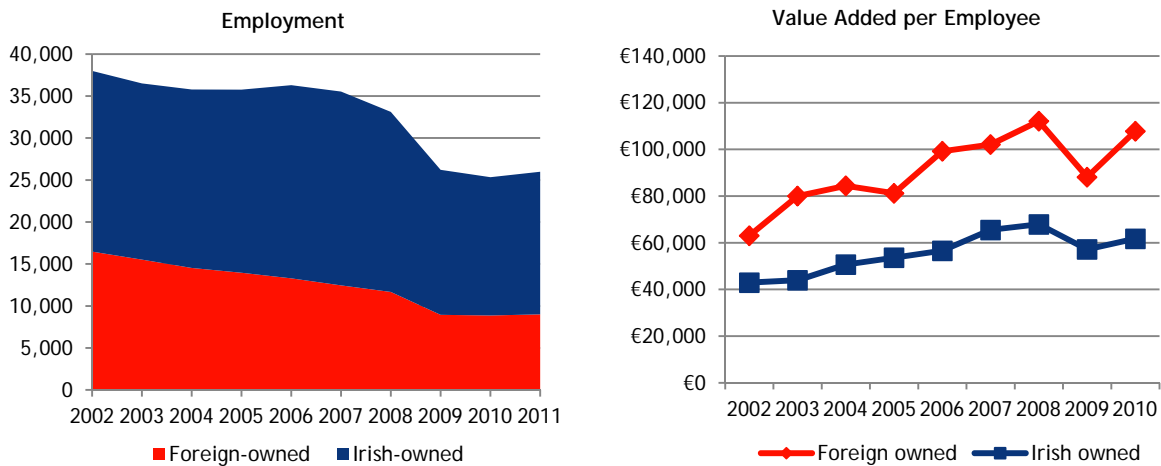
3.4.5 Engineering

The Irish Engineering sector is highly diverse. A range of engineering companies exist in terms of size, scale and product. The sector includes companies primarily concerned with metal and plastic processing and machine manufacture encompassing agricultural machinery, materials handling, precision engineering, process engineering, plastics and toolmaking and metal fabrication and processing. Many enterprises produce their own final products whereas others concentrate on sub-component manufacturing supplying in to manufacturing value chains. The majority of employment is in companies that are primarily indigenous. Employment in the broad engineering sector has decreased substantially since 2007, falling from over 35,000 to 26,000 in 2011. Much of this



employment decline is associated with the downturn in the construction sector (for example, reduced demand for machinery and materials).

Figure 3.9 Employment and Value Added in Engineering Manufacturing

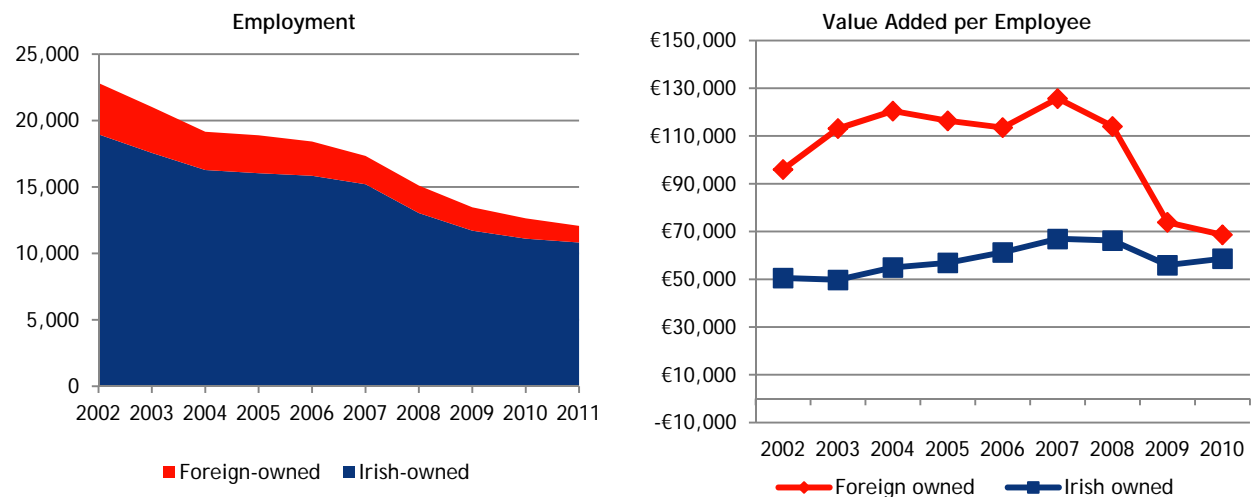


Source: Forfás Annual Employment Survey/ABSEI

However, there are some parts of the engineering sector that have significant growth potential. Enterprise Ireland has identified Agricultural Machinery, Materials Handling and Niche Precision Engineering as key growth areas in the future. Within the multinational sector, engineering ranges from companies in the automotive sector and aerospace industry to those operating in mechanical and electrical engineering, fluid components, process equipment and materials handling. Activities carried out at these operations include High Value Manufacturing, Supply Chain Management, Research and Development and Intellectual Property Management. The key players include Liebherr (construction machinery), Valeo (automotive suppliers) and Siemens (solutions engineering).

3.4.6 Consumer Goods

Figure 3.10 Employment and Value Added in Consumer Goods Manufacturing



Source: Forfás Annual Employment Survey/ABSEI

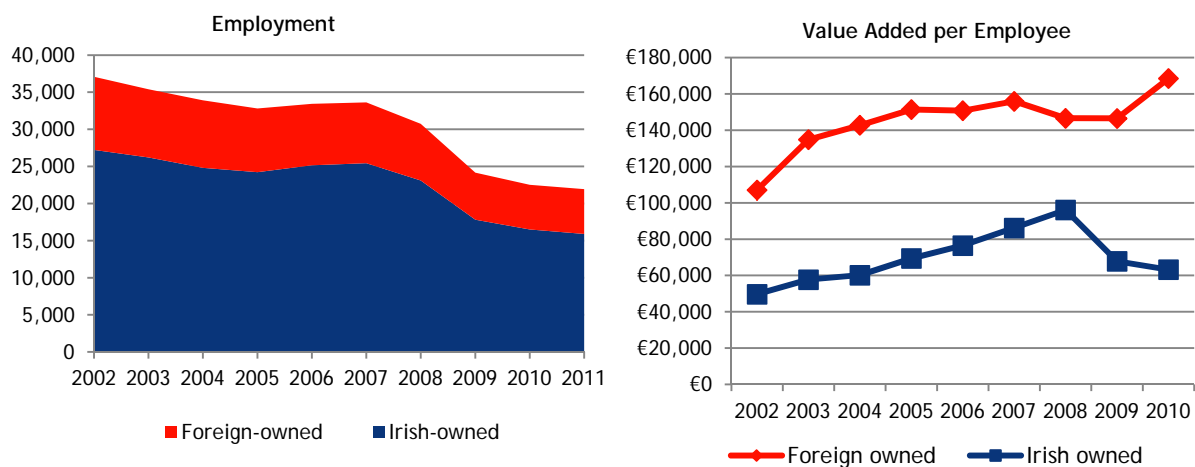


Employment in the Consumer Goods sector is almost entirely within Irish owned companies, encompassing textiles and apparel, paper print and packaging industries. Many companies in the sector are long-established, family-owned and managed. Employment within the consumer goods sector is in long term decline falling by over 10,000 since 2002 to 12,000 in 2011 reflecting the exposure of the sector to international competition, technological advances and depressed consumer demand domestically.

In an increasingly competitive environment, Enterprise Ireland highlights that there are pressures to adapt business models to become more export focused. Firms that are remaining competitive have invested in marketing, product development, design, logistics and IT. While retaining their traditional manufacturing skills they have become increasingly knowledge intensive, flexible and digitally driven. For example, the Print and Packaging industry in Ireland has undergone significant restructuring to enable it to compete in a most difficult and competitive environment. Enterprise Ireland highlights that many companies in the sector experienced significant increases in productivity. The Print and Packaging industry serves the Food, Beverage, Pharmaceutical, Healthcare, Media, Financial, Government and Industrial sectors, with these sectors accounting for over 80 per cent of turnover.

3.4.7 Other Manufacturing

Figure 3.12 Employment and Value Added within 'Other Manufacturing'



Source: Forfás Annual Employment Survey/ABSEI

'Other Manufacturing' for the purposes of this report encompasses a diverse range of industrial products such as refined petroleum products, rubber and plastics and non-metallic mineral products. Overall, employment has declined significantly in the sector since 2007 from 33,000 to just under 22,000. Many of the activities within the sector are particularly exposed to international demand for commodities, industrial products and materials in addition to having exposure to the construction downturn domestically.

However, there are some niche markets that are crucial to Ireland's wider manufacturing base. The plastics/polymer industry is particularly notable given its importance as a vital material in manufactured goods across a range of sectors, including agriculture, automotive, construction, medical devices, electrical/electronic and packaging industries. A review by InterTradeIreland of



the polymer and plastics industry in Ireland found that the sector employs approximately 11,800 people with an annual turnover of €1.98billion. In terms of processes, the main activities of plastics/polymer firms in Ireland relate to injection moulding and extrusion, with an estimated 74 per cent of firms citing the medical devices sector as the main end user of their products.⁶¹ In this context, while the polymer/plastics sector may be of relatively small scale, it plays a vital role in supporting the activities of key exporting sectors such as medical devices.⁶²

3.5 Occupational Profile

The following table shows the distribution of manufacturing occupations.

Table 3.1 Employment in Manufacturing by Detailed Occupational Group

Occupations	Number Employed	Percentage of total
Managers, Directors and Senior Officials	16,900	8.2%
Production managers and directors in manufacturing	4,400	2.1%
Functional managers and directors n.e.c.	6,300	3.1%
Other Managers, Directors and Senior Officials	6,200	3.0%
Professional Occupations	20,800	10.1%
Engineering Professionals	6,400	3.1%
Information Technology and Telecommunications Professionals	5,400	2.6%
Business, Research and Administrative Professionals	3,100	1.5%
Other Professional Occupations	5,900	2.9%
Associate Professional and Technical Occupations	29,900	14.5%
Laboratory technicians	4,400	2.1%
Other Science, Engineering and Production Technicians	5,700	2.8%
Business sales executives	5,300	2.6%
Other Sales, Marketing and Related Associate Professionals	4,900	2.4%
Other Associate Professional And Technical Occupations	9,600	4.7%
Administrative and Secretarial Occupations	15,700	7.6%
Administrative Occupations: Finance	3,200	1.6%
Other administrative occupations n.e.c.	5,400	2.6%
Secretarial and Related Occupations	3,500	1.7%
Other Administrative and Secretarial Occupations	3,600	1.7%

⁶¹ Intertrade Ireland (2009) A Simple Guide to the Polymer and Plastics Industry on the Island of Ireland

⁶² Note, not all employment in polymer/plastics is captured within this manufacturing category. Employment is also captured throughout other categories such as medical devices and engineering.



Occupations	Number Employed	Percentage of total
Skilled Trades Occupations	44,800	21.8%
Metal Forming, Welding and Related Trades	5,200	2.5%
Metal Machining, Fitting and Instrument Making Trades	10,600	5.2%
Electrical and Electronic Trades	6,400	3.1%
Construction and Building Trades	5,100	2.5%
Printing Trades	3,100	1.5%
Food Preparation and Hospitality Trades	6,500	3.2%
Other Skilled Trades Occupations	7,900	3.8%
Caring, Leisure, Travel, Sales, Customer Services and related occupations	4,000	1.9%
Process, Plant and Machine Operatives	55,100	26.8%
Food, drink and tobacco process operatives	13,600	6.6%
Chemical and related process operatives	4,400	2.1%
Other Process Operatives	3,600	1.7%
Plant and Machine Operatives	3,800	1.8%
Assemblers (electrical and electronic products)	4,400	2.1%
Routine inspectors and testers	3,300	1.6%
Other Assemblers and Routine Operatives	16,500	8.0%
Other Process, Plant and Machine Operatives	5,500	2.7%
Elementary Administration and Service Occupations	18,600	9.0%
Elementary Construction Occupations	4,800	2.3%
Packers, bottlers, canners and fillers	4,800	2.3%
Elementary Storage Occupations	4,300	2.1%
Other Elementary Administration and Service Occupations	4,700	2.3%
Total	205,800	100.0%

Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

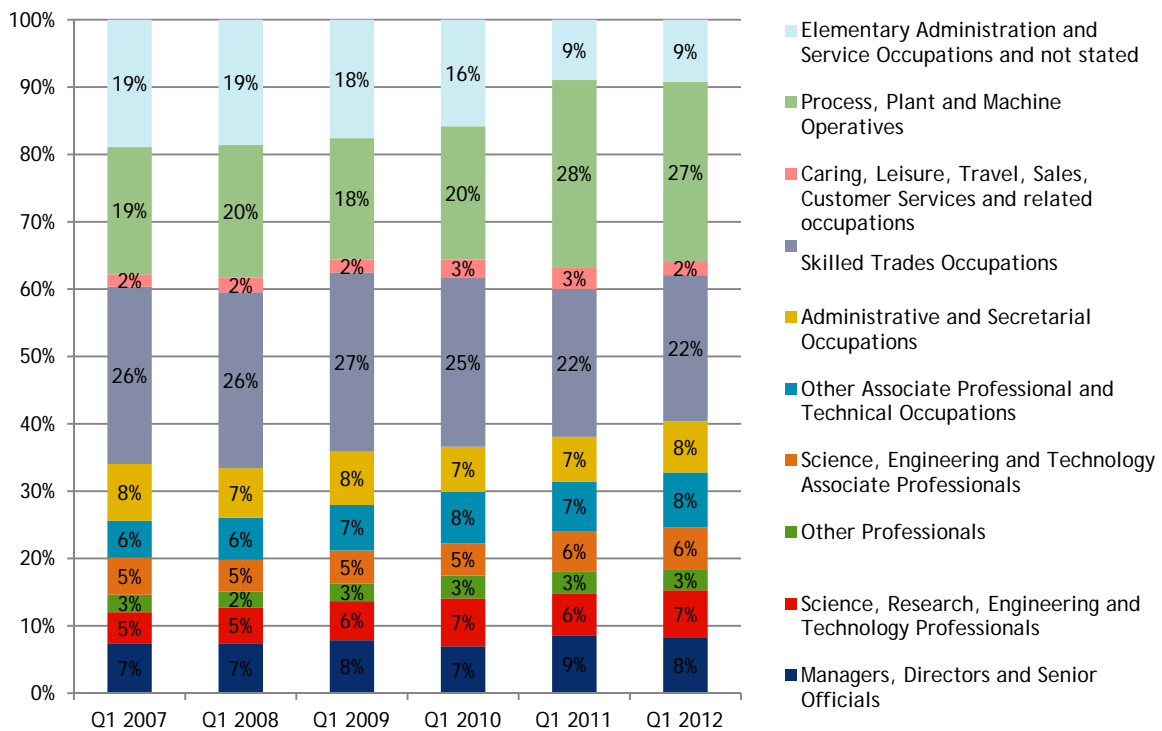
The largest occupational group within manufacturing is Process, Plant and Machine operatives, accounting for 55,100 (27 per cent) of total employment in the sector followed closely by those in skilled trade occupations (44,800, 22 per cent of total). Within this group there are significant numbers of food and drink process operatives (13,600), assemblers and routine operatives (16,500). Professional and Associate Professionals account for approximately 51,000 (25 per cent) of total employment and a further 17,000 are employed in Managerial, Director and Senior Official roles. There are significant numbers employed in specialist positions within different occupational groups:



- Within managerial occupations there is a strong presence of functional (6,300) and production managers (4,400).
- Engineering and ICT professionals make up approximately 12,000.
- Laboratory Technicians (4,400) other science/engineering production technicians (5,700) feature strongly within Associate Professionals.
- There are a variety of craft occupations prominent within skilled trades including metal forming, welding, fitting, instrument making, electrical and electronic trades, construction, printing and food trades.
- Within the operatives group, food and drink process operatives (13,600), chemical process operatives, plant and machine operatives and assembly/general operatives feature strongly.

Changes in the types of jobs performed within manufacturing are important indicators of skills demand. Looking at occupational trends within manufacturing for which data is available (2007-2012) it is clear that even within this time frame there is an increasing proportion of higher skilled jobs relative to lower skilled occupations.

Figure 3.13 Employment in Manufacturing by Occupation: Broad Sector 2007-2012



Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

From 2007-2012, the proportion of those in managerial, professional and associate professional/technical roles has increased from approximately 25 per cent of total employment to 32 per cent. This highlights that as employment levels have declined overall from 262,000 to 206,000 from 2007 to Q1 2012, those in higher skilled roles have not been impacted to as great an extent as those within production and elementary roles. This is a function of a number of factors. As



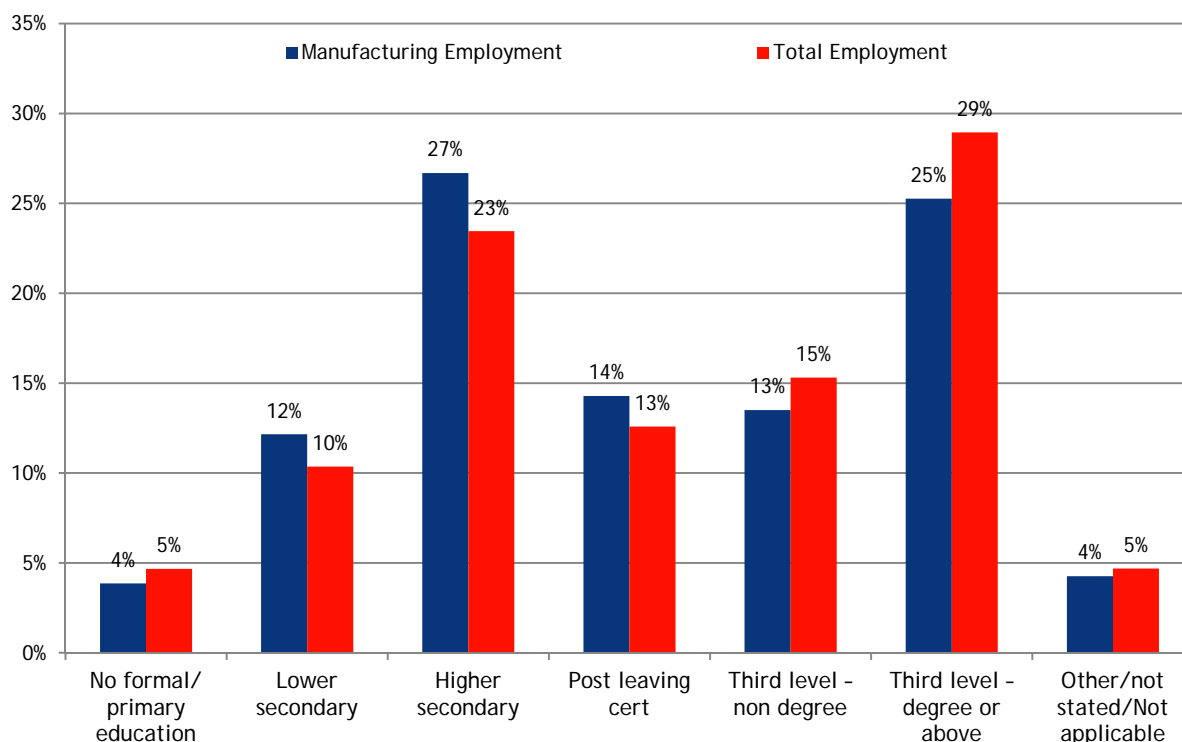
highlighted under the sectoral profile, employment declines have been primarily experienced in more traditional manufacturing industries, which tend to have greater labour requirements. In addition, the trend towards higher skills requirements is also a function of more knowledge intensive activities.

As highlighted in Chapter 2, one of the main implications of the shift to more technology intensive and higher value-added manufacturing activities, is an increasing demand for higher skills across virtually all roles. At the same time, lean manufacturing practices and greater automation further reduce the demand for labour intensive roles. It is evident that the demand for elementary/assembly type occupations as a proportion of total employment has declined from almost 20 per cent of total employment in 2007 to 9 per cent in 2012. Coupled with this decline is a relative increase in the proportion of those in operative positions relative to elementary roles, indicating an increase in the skills requirements at entry level positions.

In summary, as employment declined from 2007-2012, there has been a greater impact on lower skilled positions, driven by a combination of competitiveness, human capital and technological factors.

3.6 Qualification Profile

Figure 3.14 % Employment in Manufacturing by Educational Attainment v National Average Q1 2012



Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

The qualifications profile of those employed in the manufacturing sector overall is slightly below that of the national average. Approximately 16 per cent of those in manufacturing have lower secondary education or below compared to 15 per cent nationally. There is a greater percentage of



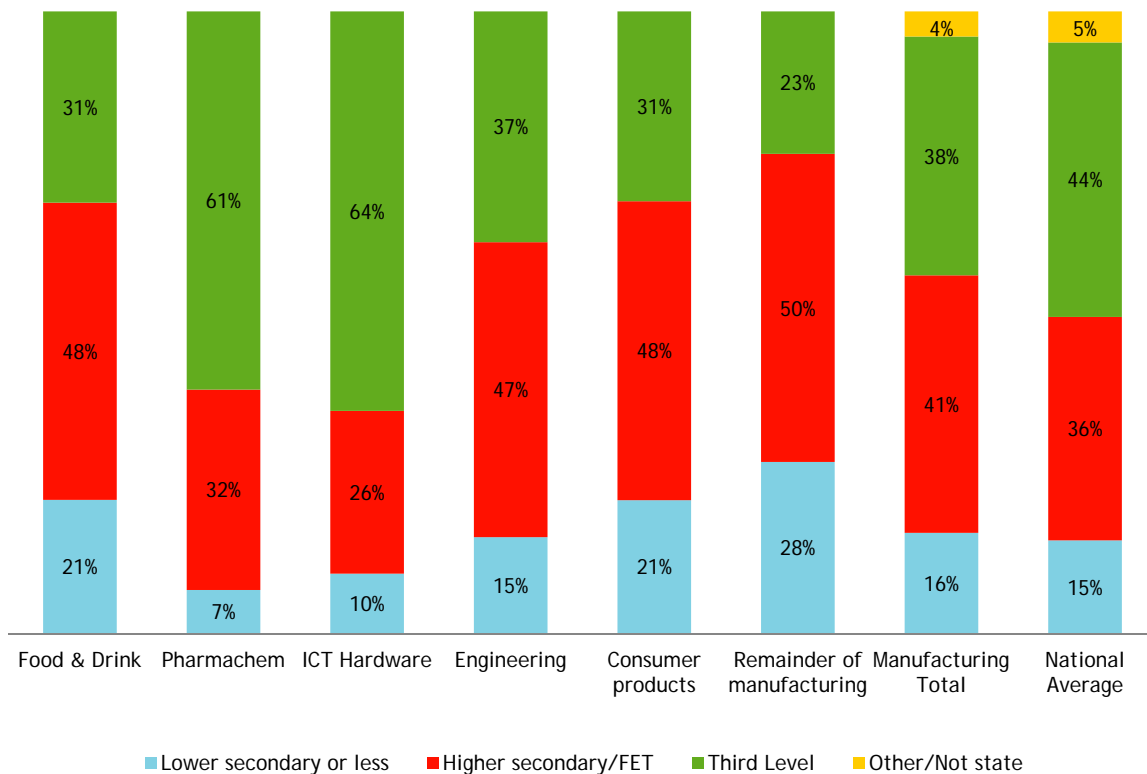
those employed with Leaving Certificate and PLC or equivalent (41 per cent) than the national average (36 per cent). Finally, 25 per cent of those employed in manufacturing have third level degrees or above and a further 13 per cent have third level non degree. However, there are quite significant differences by sub sector as demonstrated in the figure below.

Qualifications by Sector

The qualifications profile within the manufacturing sector is highly diverse depending on the sub-sector as evident in Figure 3.15. However, this should not be interpreted that a sector can be labelled as 'low skilled' as the sectoral profile does not reflect the skills profile of all firms in equal measure.

This is particularly relevant for highly diverse sectors such as engineering, food and packaging where very niche, high tech, knowledge intensive activities are not fully captured through the sectoral level statistics.

Figure 3.15 Educational Attainment in Manufacturing Sub-Sectors v Total Manufacturing and National Average Q1 2012



Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

- Within the food and drink, consumer products and remainder of manufacturing sectors, there are very significant proportions (20 per cent plus) of those with lower secondary education and below. At the same time, these sectors have comparatively low proportions of employees with higher level education compared to the national average. As documented in the EGFSN 2009 study on the Food and Beverages sector, there can be very significant and urgent upskilling



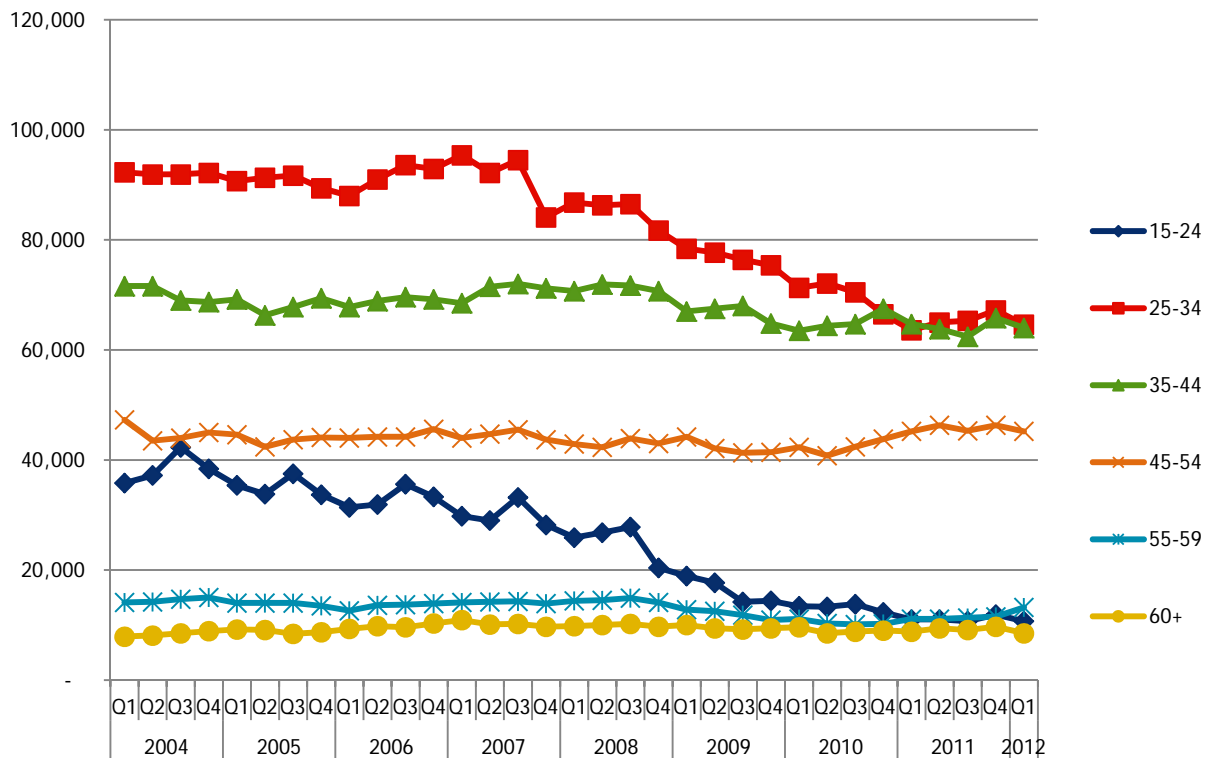
requirements for employees at these qualifications levels in order to keep abreast of technological changes and developments in the sector to retain employment.

- By contrast, the Pharma-chemicals and ICT hardware sectors have a very high qualifications profile, with over 60 per cent of those employed in those sectors having third level education and above. It should be noted, however, that much of the employment in basic assembly jobs within ICT manufacturing has been relocated out of Ireland in the last decade, which tends to enhance the qualifications profile of the employment base that remains. In addition, many firms within Pharma-chemicals and ICT have minimum requirements for entry level positions which necessitate at least third level education.
- The engineering sector is highly diverse encompassing both high tech and more traditional activities while also playing a significant role by way of sub supply to sectors such as medical devices. The engineering profile has a comparatively high proportion (47 per cent) of those with secondary education/FET or equivalent, reflecting the strong apprenticeship base, while also having a significant proportion of those with third level education and above (37 per cent).

3.7 Employment by Age

The age profile of the manufacturing sector is slightly younger than the national age profile. Approximately 36 per cent of employees are under 35 years (equivalent to the national average) a further 31 per cent are 35-44 years (compared to 26 per cent nationally), with the remaining 34 per cent over 45 years of age (compared to 38 per cent nationally).

Figure 3.16 Employment in Manufacturing by Age Cohort 2004-2012



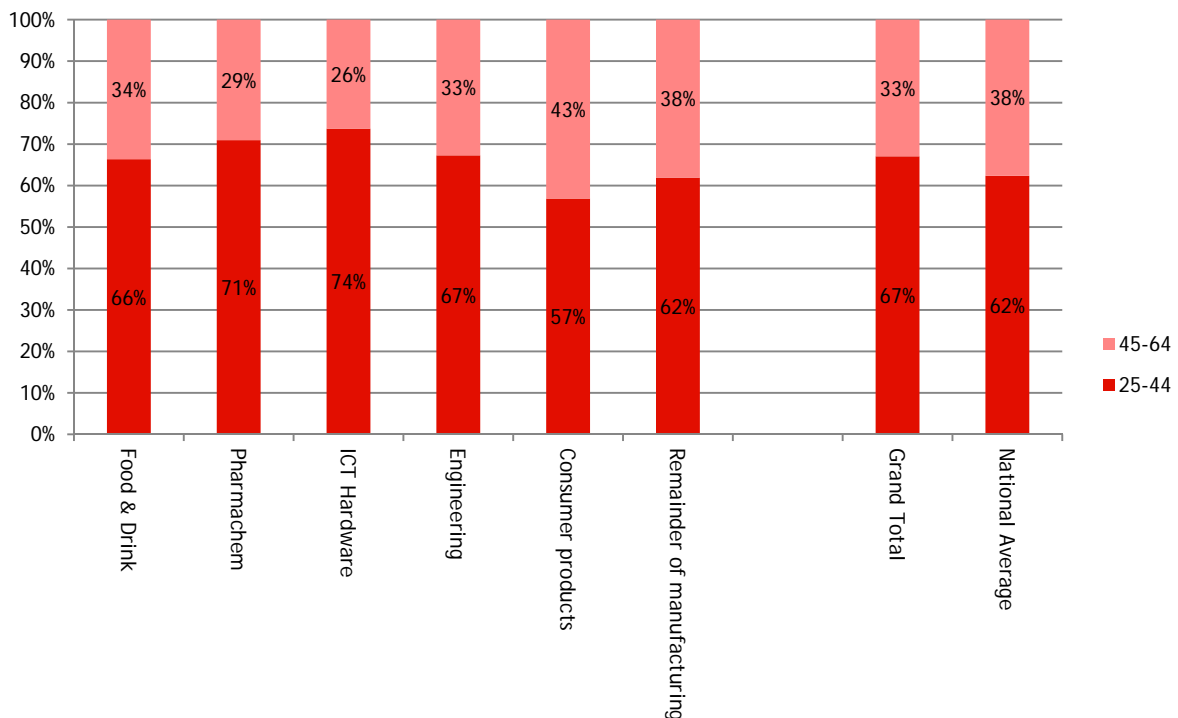
Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey



As employment has declined over the last number of years, it is clear that younger age cohorts have been affected more severely compared to older age cohorts. In particular, the number of those 15-24 year olds working in manufacturing has declined from an average of approximately 38,000 in 2007 to approximately 11,000 in 2012. Similarly, since 2007 employment declined among the 25-34 year old age cohort by 30,000 to 64,000. All other age groups have been at approximately the same levels since 2004. Coupled with the sectoral and qualification information presented earlier, this data indicates that employment declines were mainly among young people with mid-low level qualifications and primarily within manufacturing production activities.

Again, there are significant differences by sector according to age profile according to Figure 3.17.

Figure 3.17 Employment in Manufacturing by Sector and Broad Age Group 2012



Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

Note, 15-19 year olds/+65 year olds excluded due to lack of data availability at sub sectoral level.

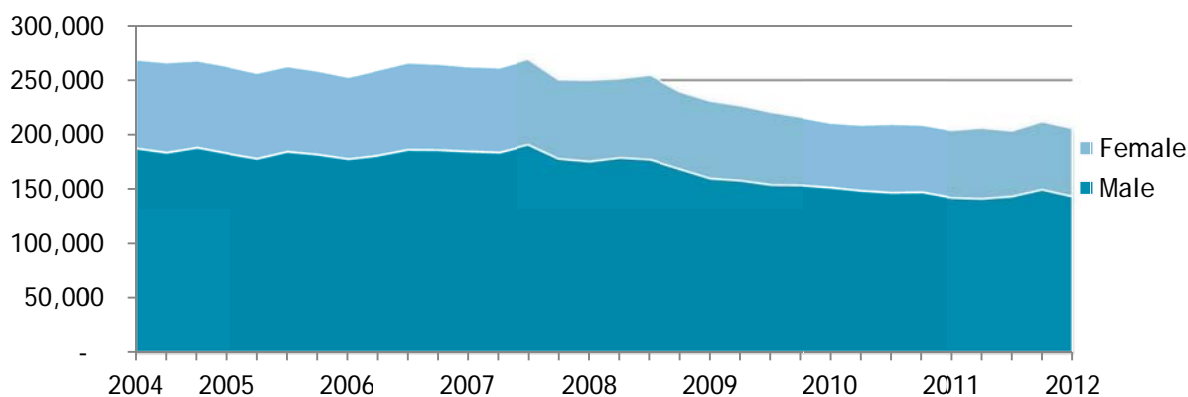
- The consumer products and 'remainder of manufacturing' sectors have comparatively older age profiles, with 43 per cent and 38 per cent respectively over 45 years of age.
- Alternatively, within Pharma-chemicals and ICT sectors, over 70 per cent of employees are under 45 years of age, which is an extremely young age profile by both manufacturing generally and the national average.
- Within engineering and food the age profile largely reflects that of manufacturing generally, however, again it is important to note significant firm level differences given the diverse nature of these sectors.



3.8 Employment by Gender

The manufacturing sector is heavily male dominated, with men accounting for 70 per cent of total employment in the sector. Notably, this ratio has remained relatively equal since 2004 for which data is available, indicating that where employment declines occurred they have been distributed quite evenly between males and females in a relative sense.

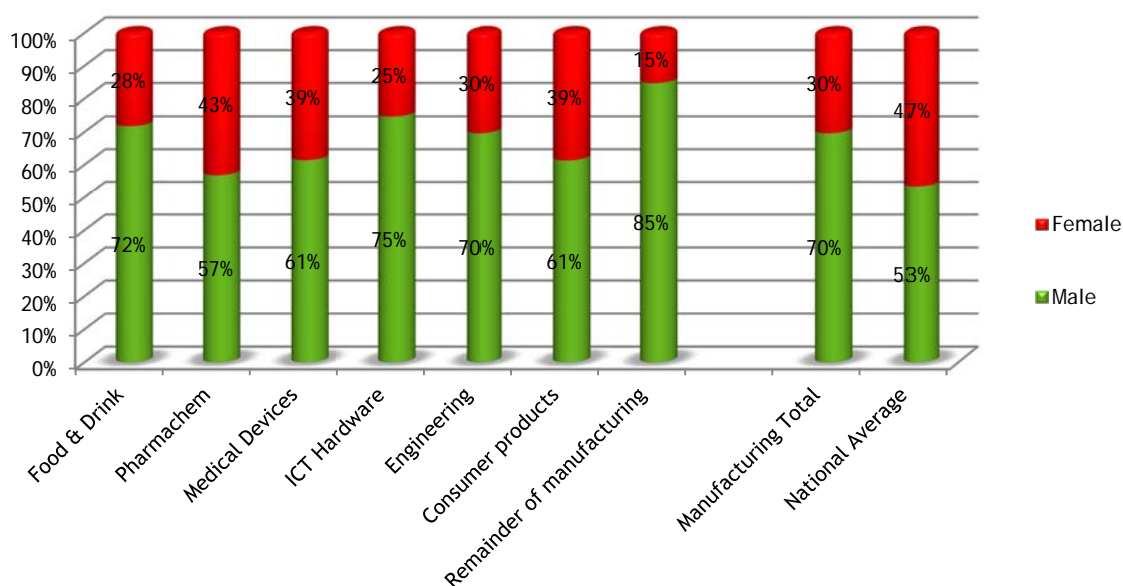
Figure 3.18 Employment Trend in Manufacturing Sector by Gender 2004-2012



Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

Males account for 53 per cent of total employment nationally, therefore, manufacturing has a relatively high gender imbalance. Manufacturing is not peculiar in this sense as males account for the great majority of employment within manufacturing, construction and agriculture, whereas employment in other sectors such as education and health is predominantly (over 75 per cent) female. The main concern with gender imbalance within manufacturing is the ability of firms to attract more females towards manufacturing careers, otherwise there is a more limited talent pool.

Figure 3.19 Manufacturing % Employment by Sector and Gender Q1 2012



Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

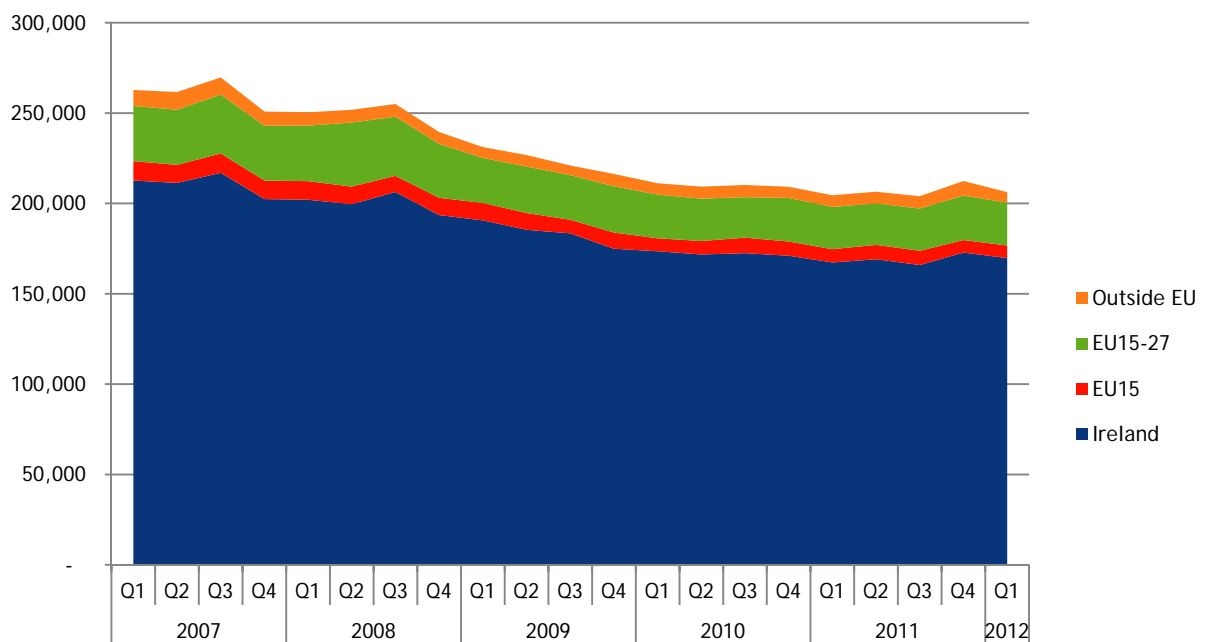


Looking at the gender profile by sector, there are quite significant differences underpinning the headline figure. Sectors such as ICT hardware, food and 'remainder of manufacturing' have higher than average male participation (over 70 per cent). On the other hand, there are a comparatively high proportion of female employees within Pharma-chemicals (43 per cent) and medical devices sectors (39 per cent). In this context, there are significant sectoral differences within manufacturing in terms of female participation.

3.9 Nationality

Foreign-nationals have played an important role in fulfilling the skills requirements of the manufacturing sector, particularly in areas of skills shortages such as engineering, science and food. Non-nationals account for approximately 18 per cent of total employment within manufacturing compared to 13 per cent nationally. In this context, the manufacturing sector is a significant employer of foreign nationals in Ireland. Within the foreign national base of 36,500 employed in the sector, 24,000 (65 per cent) are from EU 15-27 countries, a further 7,000 (19 per cent) are from EU15 countries, with the remaining 5,700 (16 per cent) from outside the EU.

Figure 3.20 Employment by Nationality 2007-2012

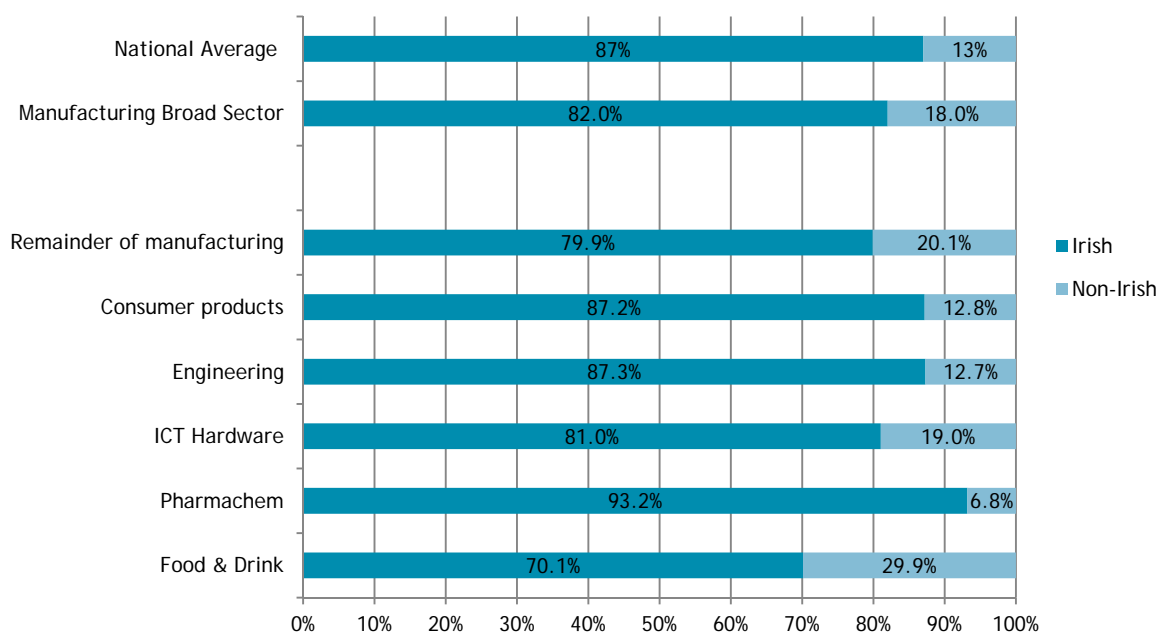


Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

On a sectoral basis, there are very significant differences in terms of the non-national manufacturing workforce. Compared to both the average for manufacturing as a whole and the national average, non-nationals represent a relatively high proportions of employment within food (30 per cent), 'Remainder of Manufacturing' (20 per cent) and ICT hardware (19 per cent). By contrast, non-nationals account for a relatively low percentage of unemployment within Pharma-chemicals (7 per cent), Consumer Products (13 per cent) and engineering (13 per cent).



Figure 3.21 Employment by Nationality Sub-sectors Q1 2012



Source: Skills and Labour Market Research Unit (FÁS)/CSO Quarterly National Household Survey

3.10 Conclusion

- The manufacturing sector is a fundamental driver of the economy. It is the primary driver of net exports, and has significant spin off effects in terms of secondary employment, corporation tax and as a purchaser of materials and services.
- The sector is facing significant challenges from international competition, industry consolidation and reduced domestic demand. Employment in manufacturing in Ireland has experienced two significant shocks in the last decade, however, there are significant differences across sectors.
- Employment in Food and Beverages manufacturing; Pharma-chemicals and Medical Devices has been largely resilient in the face of significant internal and external downside risks. Employment in ICT hardware and Engineering manufacturing has also largely remained stable in the last three years after significant downturns in 2007/2008. There are long term declines within Consumer Goods and Other Manufacturing sectors, however, there is also sustainability and competitiveness improvements within these sectors where companies have invested in product development, design and technology.
- As employment declined from 2007-2012, there has been a greater impact on lower skilled positions, driven by a combination of competitiveness, human capital and technological factors. From 2007-2012, the proportion of those in managerial, professional, STEM professionals and associate professional/technical roles has increased from approximately 25 per cent of total employment to 32 per cent. This highlights that as employment levels have declined overall from 262,000 to 206,000 from 2007 to Q1 2012, those in higher skilled roles have not been impacted to as great an extent as those within production and elementary roles.



- There are significant differences across sectors in terms of variables such as age, educational attainment, gender and nationality, highlighting the diversity of activities and skills requirements across different manufacturing markets. Therefore, from a policy perspective, it is important to consider both the commonalities and differences that exist between sectors in proposing actions and recommendations.



Chapter 4: Provision of Manufacturing-Related Education and Training in Ireland

4.1 Introduction

This chapter provides an assessment of potential skills supply to the manufacturing sector based on enrolments and graduates in STEM disciplines that are of direct relevance to the manufacturing sector. However, it is important to note that this is potential rather than actual supply and the career choices facing STEM graduates can vary widely. For example, graduates of biology or maths may pursue careers in the education/public research systems sector or business or financial services sectors. Many graduates will proceed to postgraduate learning and may diversify in disciplines different to their primary degree. Therefore, the information provided in this chapter should be interpreted as a potential pool of skills relevant to manufacturing rather than available supply.

4.2 Parameters

The following information was provided by the Skills and Labour Market Research Unit (SLMRU) in FÁS and provides important notes on interpretation of the data. Higher education enrolment and graduate data in the National Skills Database is by course title and ISCED code. However, the following issues arise in compiling the data related to the manufacturing sector:

- Some courses do not have the same ISCED code over time; comparisons overtime are therefore best done at aggregate level and the data has therefore been presented accordingly.
- Some courses have very general ISCED codes (i.e. one digit level); this does not pose a problem for the science categories, but for the engineering and manufacturing category, a substantial number of courses were included in the engineering, manufacturing and construction courses (i.e. ISCED 500); all construction related courses, where identifiable from the course title (e.g. civil engineering, construction studies etc.), were then removed manually.
- A number of courses deemed relevant to the Study were identified in the health and welfare category (e.g. biomedical science, pharmacy); these were manually selected and included in the data. Courses from the health and welfare field include:
 - Clinical measurement;
 - Optometry;
 - Med lab science;
 - Medical physics;
 - Pharmaceutical production;
 - Pharmacy;
 - Pharmacy technician; and
 - Human nutrition/dietetics.

It excludes nursing, health science, medicine, dentistry, and all rehabilitation/therapy-type courses.

- Graduate data for UCD was not returned for 2009; to compensate for this, a separate data set was used which provides numbers by ISCED code (but not course title) for Science &



engineering/manufacturing and added the total number of graduates to data extracted from the National Skills Database.

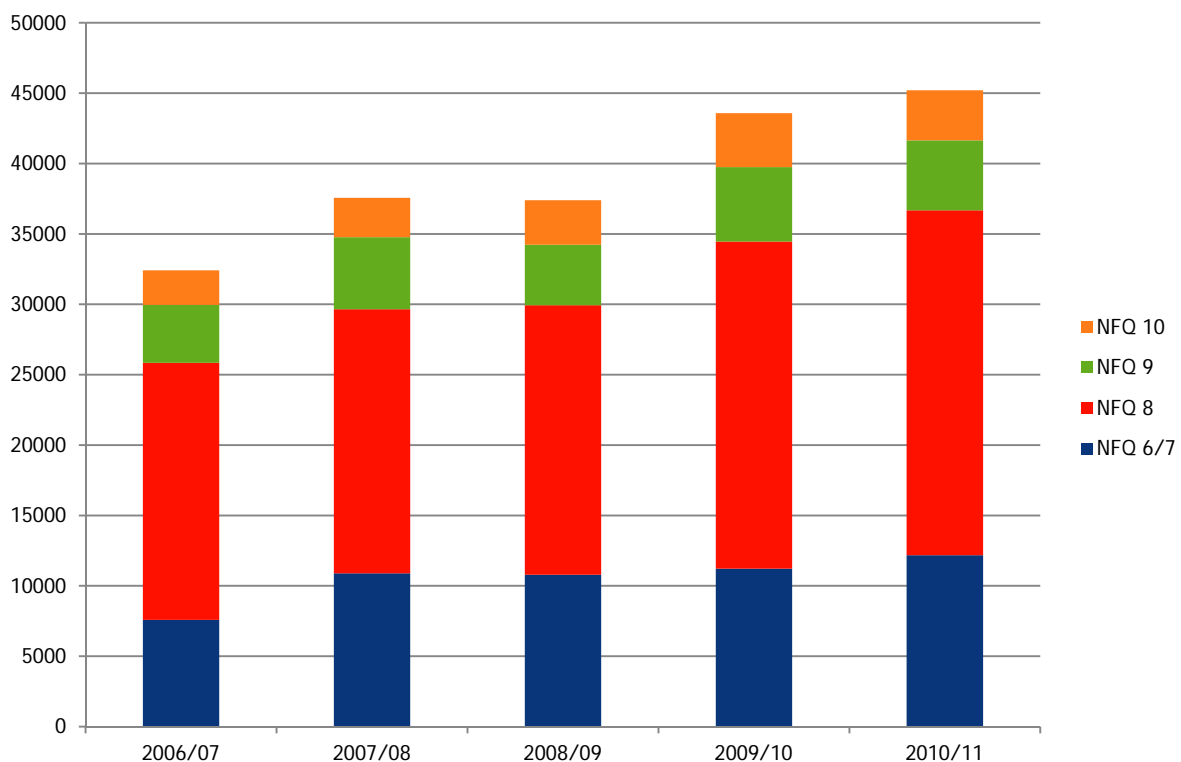
FETAC data is presented in Section 4.4. FETAC data is not available at detailed ISCED level; instead, the data is presented according to FETAC field of learning. These fields correspond broadly to the science, mathematics and computing ISCED field and the engineering and manufacturing ISCED field.

4.3 Higher Education

The following section provides an examination of the enrolment data for the supply of skills relevant to this Manufacturing Study.⁶³

Figure 4.1 below shows total enrolments in over 2,800 full and part time manufacturing-related courses. This is further broken down into science enrolments and engineering/manufacturing enrolments in Tables 4.1 and 4.2.

Figure 4.1 Higher Education Enrolments (science, including selected health, and engineering/manufacturing)



Source: Higher Education Authority

⁶³ Please note the field of learning does not refer to ISCED fields, but has been derived by the SLMRU, based on course title, to allow for the best disambiguation of fields (e.g. environmental science as distinct from other life sciences such as biochemical science). In addition, detailed field of learning data for DIT enrolment numbers was not available for all years and was therefore excluded from the analysis of the data over time (i.e. increases over the five year period were calculated excluding the DIT data).



Table 4.1 Enrolments (science, including selected health)

Science & selected health	NFQ 6/7	NFQ 8	NFQ 9	NFQ 10	Total
2006/07	4003	13207	2983	1814	22007
2007/08	5475	13280	3606	1991	24352
2008/09	5563	13953	2999	2128	24643
2009/10	5424	17133	3555	2766	28878
2010/11	5931	18196	3684	2664	30475

Source: Higher Education Authority

Table 4.2 Enrolments (engineering and manufacturing)

Engineering & manufacturing	NFQ 6/7	NFQ 8	NFQ 9	NFQ 10	Total
2006/07	3580	5057	1127	640	10404
2007/08	5413	5479	1519	806	13217
2008/09	5227	5195	1296	1037	12755
2009/10	5800	6107	1731	1064	14702
2010/11	6248	6309	1278	895	14730

Source: Higher Education Authority

The following section examines the distribution of provision in more detail by various disciplines

Enrolments (NFQ 7)

At Level 7, the number of enrolments increased by more than 4,000 over the five-year period. The increases were almost entirely within the Institutes of Technology (IoT) sector as IoTs are the main providers of programmes at this level.

- Courses in IT, computer science, and electronic engineering with computing accounted for the largest share of this increase; there were in excess of 1,500 additional enrolments over the period, bringing the total in this category in 2010/2011 to almost 3,200.
- Enrolments on courses in electrical engineering and, especially in energy engineering (e.g. renewable and electrical energy systems) also rose, by more than 800, reaching almost 1,000 in 2010/11.
- Enrolments in mechanical engineering rose by almost 700.
- Other increases were observed for biosciences/chemical, applied biology, etc.



Enrolments (NFQ 8) - excludes DIT enrolments

Total Level 8 enrolments amounted to almost 25,000 in 2010/2011, with approximately 18,000 in the university sector and 7,000 in the IoT sector. Between 2006/07 and 2010/2011, there were over 4,200 additional enrolments on Level 8 courses relevant to the manufacturing sector. Of these, more than 1,400 additional enrolments (34 per cent) were in the IoT sector; the remainder in the university sector. The largest increases were for the following:

- Enrolments in **biological/biochem/chemical sciences** increased by almost 2,000, reaching over 6,000 in 2010/2011. Courses in this category included: biological and biomedical sciences, industrial biochemistry, medical chemistry and chemical biology, microbiology, pharmaceutical science, biopharmaceutical science, genetics, biomedical engineering, chemical and biopharmaceutical engineering.
- Enrolments in **computing and electronics** amounted to approximately 5,600 in 2010/11, (spread almost evenly between the IoT and university sectors). Enrolments increased by approximately 1,000 since 2006/07; more than 600 of these additional enrolments were in the IoT sector. Typical courses in this category included electronic engineering, electronic engineering with computers, computer science, and, to a lesser extent (<100 additional enrolments) security related computing.
- The number of enrolments in **other engineering categories** grew by approximately 1,400 to reach more than 4,500 in 2010/11 with much of the increase driven by the introduction of **energy related courses** such as sustainable energy, energy systems engineering and sustainable energy technology. Energy related courses accounted for approximately 40 per cent of the overall increase in engineering (excluding electronic) over the five-year period.
- At 1,400 enrolments in 2010/11, **environmental science** courses (e.g. earth science, environment and natural resource management) grew by almost 400 over the five year period since 2006/07.
- Enrolments in other science courses increased by more than 600 to reach almost 6,000 in 2010/11. In excess of 400 of these additional enrolments were for denominated or common entry science courses, almost exclusively in the university sector.

Enrolments (NFQ 9)

Total enrolments at Level 9 stood at close to 5,000 in 2010/11; of these the highest numbers were in **computing/electronics** (almost 2,000) and **biology, biochem and chemical sciences** (more than 1,100).

- **Computing/electronic engineering**: the number of enrolments increased by approximately 600 over the five year period; of these, more than 150 additional enrolments were for courses in **computer forensics and cybercrime**.
- **Bio/bio-chem and chemical sciences** related areas grew slightly (by almost 100 additional enrolments) to reach 1,100; courses in this category include **biotechnology, biomedical science/engineering, pharmaceutical science /engineering**.
- The number of enrolments in **energy and environmental science** related courses increased to almost 500 (amounting to an additional 300 enrolments); courses in this category include: environmental protection, environmental systems, energy systems, renewable energy systems, sustainable energy.



Enrolments (NFQ 10)

At PhD level, in 2010/11, the largest numbers of enrolments were for courses in the life sciences (almost 800), including biomolecular and biomedical science, biological and environmental science, biopharma science. This was followed by physical sciences (e.g. physics, chemistry, geological sciences), also at approximately 800 enrolments. Enrolments on computing science course totalled almost 500. Within the broad engineering category of almost 900 enrolments, more than 200 enrolments were for electronics and automation courses.

All considered, there has been a very significant increase in enrolments in programmes with relevance to the manufacturing sector since 2006, which will result in a significant increased outflow to the labour market in the coming years. The balance of enrolments is almost 2-to-1 in favour of science relative to engineering, however both disciplines have experienced relatively similar rates of increase in the order of 28 per cent.

In addition to the enrolment data outlined above, since 2011 provision relevant to the manufacturing sector has been expanded through the introduction of the Springboard programme, which strategically targets funding of part time higher education courses for unemployed people in areas where there are identified labour market skills shortages or employment opportunities. Under the first two phases of Springboard 2011 and 2012 almost 8,000 places have been provided on courses from NFQ Level 6 to 9 in areas relevant to the manufacturing sector: Bio-Pharma-chemicals; Food and Beverage; Green Economy; ICT and; Medical Devices. A further expansion of the Springboard initiative has been announced in Budget 2013.

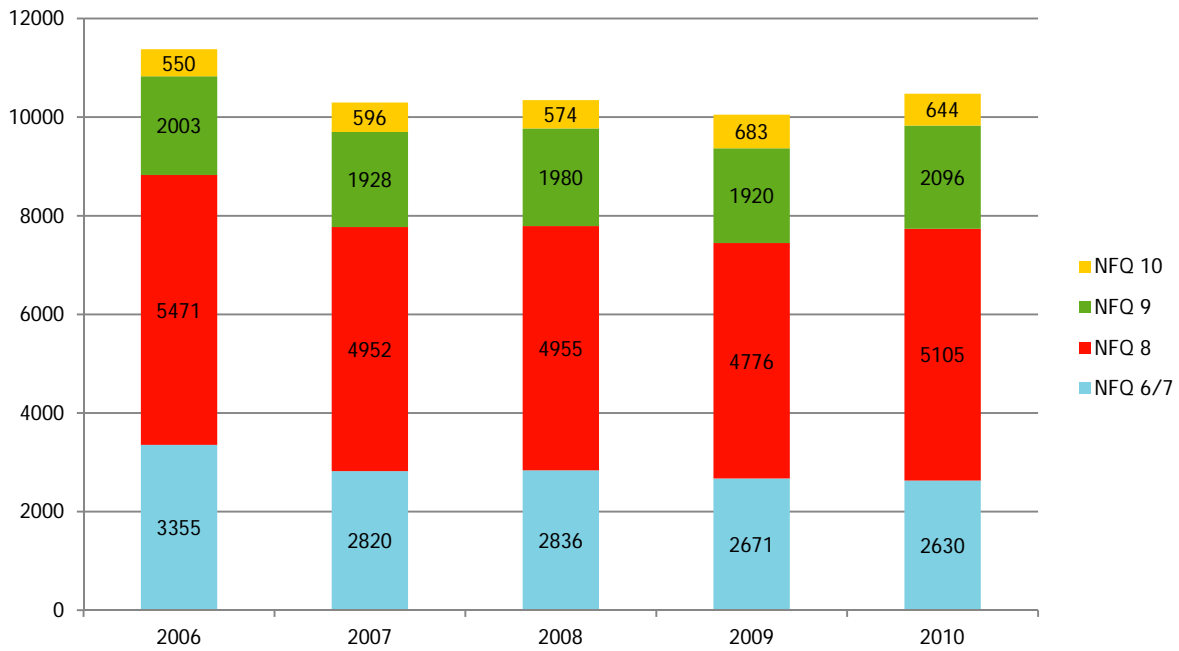
Graduate Data

Overall, graduate output from manufacturing related courses declined by 6 per cent (approximately 700 fewer graduates) between 2006 and 2010; the decline was entirely due to a fall in the number of graduates at undergraduate level, particularly at NFQ Level 6 and, to a lesser extent, NFQ Level 8. It is worth noting that total (i.e. not just manufacturing) graduate output at NFQ 6 declined considerably over the same period, and while total graduate output at NFQ 8 increased by 5 per cent, this was largely due to the appearance of nursing graduates within the data for the first time (approx. 1,700) in the intervening years⁶⁴. In other words, were it not for the inclusion of nursing graduates in the 2010 data, the number of graduates at Level 8 (all disciplines) would have declined slightly between 2006-2010.

⁶⁴ In 2003, nursing became a four-year degree programme; the first graduates emerged in 2007.



Figure 4.2 Graduates (science, including selected health, and engineering/manufacturing)



Source: Higher Education Authority

Table 4.3 Graduates (science, including selected health)

Science (inc selected health)	NQF 6/7	NQF 8	NQF 9	NQF 10	Total
2006	1701	3795	1413	407	7316
2007	1380	3472	1472	454	6778
2008	1442	3581	1482	448	6953
2009	1376	3457	1491	505	6829
2010	1345	3634	1495	479	6953

Source: Higher Education Authority

Table 4.4 Graduates (engineering/manufacturing)

Engineering/manufacturing	NQF 6/7	NQF 8	NQF 9	NQF 10	Total
2006	1654	1676	590	143	4063
2007	1440	1480	456	142	3518
2008	1394	1374	498	126	3392
2009	1295	1319	429	178	3221
2010	1285	1471	601	165	3522

Source: Higher Education Authority



Table 4.5 Graduates 2010 by broad field

% Graduates 2010 by broad field	NFQ 6/7	NFQ 8	NFQ 9	NFQ 10	Total
Bio/biochem/chemistry	17%	29%	19%	28%	24%
Biomedical science/engineering	0%	6%	6%	-	4%
Computing & electronics	36%	21%	41%	10%	28%
Electrical engineering	8%	4%	5%	-	5%
Environment related	2%	6%	7%	5%	5%
Food science/engineering	2%	1%	3%	2%	2%
Manufacturing engineering	4%	1%	1%	-	2%
Mechanical engineering	17%	7%	2%	-	8%
Other science & engineering	14%	25%	15%	55%	22%

Source: Higher Education Authority

Level 6

More than 95 per cent of Level 6 awards made in 2010 for manufacturing related fields were in the institute of technology sector.

There were approximately 700 Level 6 awards in 2010, less than half the number made in 2006.

There were declines across almost all subjects areas at Level 6, with the largest declines observed in the areas with the highest number of graduates. The highest number of graduates at this level was for:

- Computing/electronics engineering which, at approximately 250 graduates in 2010 were almost half of the 2006 level (almost 500).
- Biology, chemistry and pharmaceutical sciences which, with over 100 graduates were also approximately half of the 2006 level (almost 250).

Level 7

Approximately 95 per cent of Level 7 awards made in 2010 for manufacturing related fields were in the institute of technology sector.

There were approximately 2,000 Level 7 graduates in manufacturing (selected health, science and engineering) related subjects in 2010. The largest numbers of graduates were in computing/electronics (almost 700), mechanical engineering (over 300) and bio/bio chemical and chemical science/engineering (more than 300). There was no change in the overall number of Level 7 graduates from courses relevant to manufacturing between 2006 and 2010. However, this masks some small changes which occurred in some of the subfields over the period 2006-2010. The most notable increases were found in:



- Mechanical engineering: there were an additional 80 graduates over the period 2006-2010, bringing the total to over 300 graduates in 2010 (includes electro mechanical engineering).
- Electrical/energy engineering: the number of graduates increased to approximately 160 in 2010, 90 more than in 2006; typical courses in this category included electrical services engineering and renewable & electrical energy systems.

On the other hand, there were declines in:

- Computing/electronic engineering, where the number declined by approximately 100, going from 800 to 700 between 2006 and 2010; the declines were mostly in general computing and electronic engineering areas (most graduates were in these areas), but there were small increases (between 10 and 40 additional graduates) in computing with multimedia, software development, networking, and games development.
- Manufacturing engineering (-80), which went from over 160 to almost 80.
- Bio/chemical science and engineering (-60 - mostly for pharmaceutical and chemistry related courses).

Level 8

Approximately 3,500 of the manufacturing related graduates in 2010 were in the university sector, with the remaining 2,000 in the institute of technology sector.

In the university sector, the most prominent disciplines included:

- Approximately 1,000 graduates in biology/biochemistry, chemistry or pharmacy related fields;
- 500 in computing/electronics and automation;
- 200 in environmental or earth science;
- 200 in maths or physics;
- Much of the remainder were categorised within broader discipline groups such as physical sciences or broad science or engineering.

In the institute of technology sector, the most prominent disciplines included approximately:

- 600 computing/electronics graduates;
- 300 biology/biochemistry, chemistry and pharmacy graduates;
- 200 electricity/energy graduates; and
- 100 graduates in environmental science.

Changes over time

There were approximately 200 fewer graduates at Level 8 when compared to 2006. While there were significant increases in several specific subfields (e.g. bio/chemical sciences/engineering), these were insufficient to counteract the declines in the number of graduates in other areas, especially in computing (down almost 500 to approximately 1,000 in 2010), and some general science (-400 graduates to approximately 300 in 2010) and engineering programmes (particularly in mechanical and manufacturing engineering which fell from almost 600 to 400 over the period 2006-2010).



Increases were observed in the following areas:

- At almost 1,800 graduates in 2010, the highest number of graduates at Level 8 was for **bio/chemical science and engineering related courses**. Furthermore, the number of graduates on these courses increased by almost 400 over the period 2006-2010.
 - There were approximately 200 graduates on biomedical science or engineering courses - with 65 additional graduates when compared to 2006.
 - Other biology (including biological science, microbiology, applied biology) and biotechnology (including industrial, pharmaceutical biotechnology) related courses accounted for almost 300 graduates, up from almost 200 in 2006.
 - Pharmaceutical related areas (including pharmacy, pharmaceutical science, biopharma engineering) grew by almost 200 since 2006, bringing the total number of graduates in 2010 to over 450.
- **Environment** related courses accounted for almost 300 graduates in 2010, up from over 160 in 2006. Typical courses in this category include earth and ocean sciences, forensic and environmental analysis, and environmental biology.
- There were over 200 graduates in **electrical/energy engineering**, with most of the 100+ increase stemming from the introduction of energy and sustainable energy related courses.

CAO data shows that since the recession (2008) there have been steady increases in the overall numbers accepting places on Level 8 courses in higher education in engineering (excluding construction), computing and science (as detailed in the EGFSN's annual Monitoring Ireland's Skills Supply Reports). These increases in acceptance data can be expected to be reflected in graduate output in the medium term.

Level 9

Approximately 80 per cent (1,700) of Level 9 graduates were from the university sector. The number of graduates increased slightly at Level 9, going from just over 2,000 to almost 2,100 between 2006 and 2010.

Almost 900 were in computing/electronic engineering, 400 were in bio/chem science related areas, almost 250 were in other science, over 150 in environmental science, and over 100 each in biomedical science/engineering and energy engineering.

While there was little change in the overall graduate numbers at this level, there was a shift towards higher numbers in bio/chem science, energy, biomedical and environmental science related areas which each saw increases of approximately 100 graduates. In contrast there were declines in manufacturing engineering, and maths/statistics.

Level 10

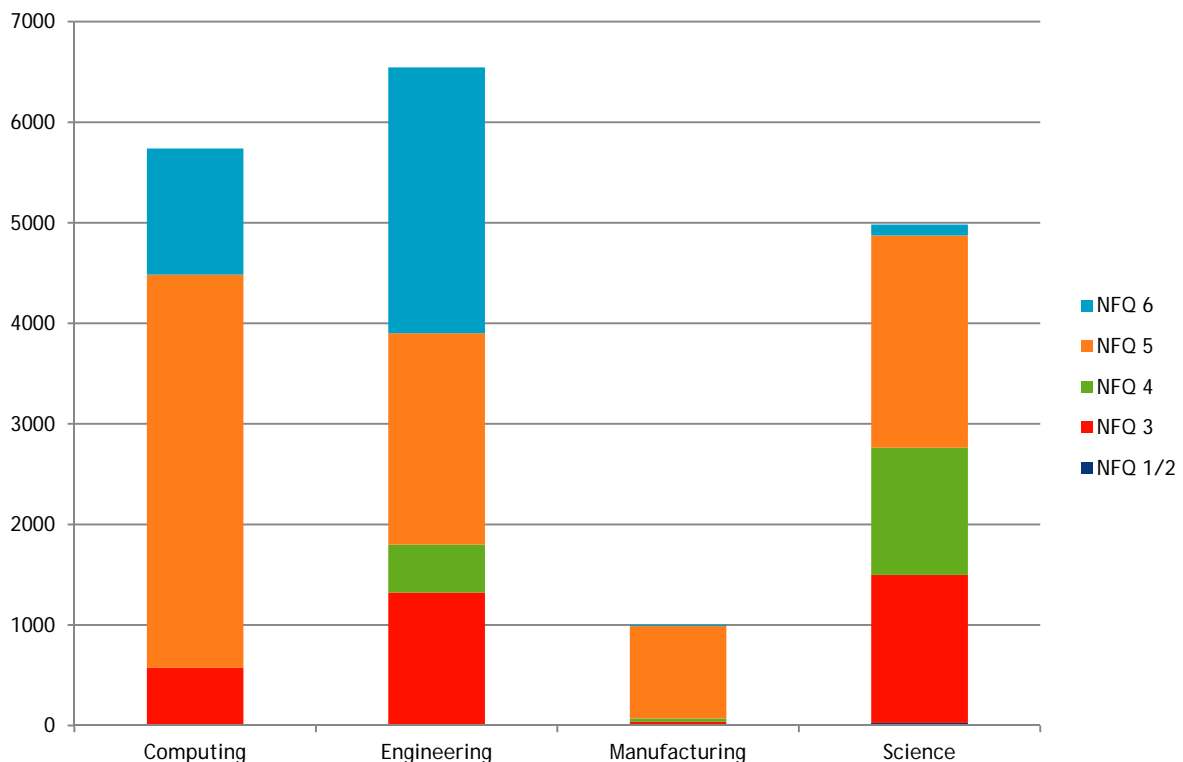
More than 90 per cent of Level 10 graduates were from the university sector. Of the 650 Level 10 graduates in 2010, almost 200 were in the bio/biochemical and chemical sciences; almost a further 200 were in unspecified science fields and an additional 100 in unspecified engineering fields. The largest increases over the periods 2006-2010 were observed in bio/biochemical and chemical which grew by more than 100, followed by unspecified engineering and environment-related fields, and computing/electronics which rose by between 20 and 40 additional graduates.



4.4 Further Education and Training (FETAC awards)

There are a significant variety of awards relevant to the manufacturing sector delivered by further education and training providers including, FÁS, VECs, Skillnets and private providers. In 2011, within the broad FETAC defined fields of Computing, Engineering, Manufacturing and Science, there were over 18,000 awards in total. The vast majority of awards are at Levels 5 and 6 (72 per cent), with a further 28 per cent at Levels 3 and 4. There are relatively few (25 in total relating to Life Science) at NFQ Levels 1/2 in these fields.

Figure 4.3 Distribution of FETAC manufacturing-related awards by NFQ Level 2011 (all award types)



Source: FETAC

Computing and Engineering account for 67 per cent of total awards, with Science accounting for a further 27 per cent. Awards specifically in the Manufacturing fields account for 5 per cent of total awards and are almost entirely at NFQ Level 5. In total, the number of Science and Computing awards has more than doubled since 2007, increasing from over 5,000 to over 10,500. Engineering and Manufacturing awards increased by over 3,000 to 8,900 in 2008, however, they have declined to 7,800 in 2009.



Table 4.6 FETAC major awards by subfield and NFQ level 2011

2011 Awards	NFQ 4	NFQ 5	NFQ 6	Total
Computing		696	202	898
Engineering	11	283	2035	2329
Manufacturing		5		5
Science		186		186
Grand Total	11	1170	2237	3418

Source: FETAC

- Laboratory techniques (143) is the most prominent major award within the science domain with Food Science (26) and Applied Ecology (17) also featuring.
- Within Computing, the most prominent awards are for Information Technology Level 5 (202) and IT Specialist Support Level 5 (398) and Computer Network Installation (62). There were 106 major awards in Networks and Software Level 6 and 55 awards in Computer Network Technology Level 6.
- In the Engineering/Manufacturing domain the majority of awards are at Level 6, reflecting the strong presence of Apprenticeships within this domain. There were a significant number of awards in Craft-Electrical (1,068) and Craft-Motor Mechanics (244). More specific to the manufacturing sector, there were also Craft awards in Fitting (127); Metal Fabrication (78); Electrical Instrumentation (44); Sheet Metal Working (18); Toolmaking (18) and Industrial Automation (16).
- Within engineering/manufacturing at Level 5, there were some highly specific major awards in Engineering Technology (95) Pharmaceutical Processing (31) Machine Tool Operation (19); Butchering (3); Extrusion (1); Plastic Injection Moulding (1).

Table 4.7 FETAC minor awards by subfield and NFQ level 2011

2011 Awards	NFQ 1/2	NFQ 3	NFQ 4	NFQ 5	NFQ 6	Total
Computing		573		3215	1052	4840
Engineering		1322	466	1691	510	3989
Manufacturing		36	34	413	12	495
Science	25	1473	1265	1925	108	4796
Grand Total	25	3404	1765	7244	1682	14120

Source: FETAC



Minor awards account for the majority of total awards in manufacturing related FETAC awards;

- Within the Science domain, the most prominent awards were for Food and Nutrition Level 3 (1,453); Mathematics Level 4 (957) and Level 5 (178).
- Within the Computing field, 2,624 relate to web/internet awards (predominantly at Levels 3 and 5); 1,108 relate to computer systems (Levels 5 & 6); 445 relate to software and 389 to programming (Levels 5 and 6).
- In the Engineering field, there are a significant number of awards within Engineering Processes (1,724), including Manual Metal Arc Welding Level 3 (785) and Oxy-Acetylene Welding Level 3 (260).
- On a sectoral level within Engineering/Manufacturing domains, there were 236 Level 5 minor awards in Fundamental Pharmaceutical Skills. 145 minor awards related to Food Processing. There were also 216 awards at Level 5 within Materials Manufacturing, including 88 Injection Moulding-Mould Setting Level 5 Awards. There are also some highly specific manufacturing awards such as Lean Manufacturing Tools Level 5 (46), Basic Electronic Assembly Level 3 (25), Engineering Workshop Processes Level 3 (186), and Statistical Process Control Level 5 (16).

Table 4.8 FETAC special purpose awards by domain and NFQ level 2011

2011 Awards	NFQ 5	NFQ 6	Total
<i>Special purpose awards</i>			
Engineering	129	99	228
Manufacturing	501		501
Grand Total	630	99	729

Source: FETAC

- There are a limited number of special purpose awards in the engineering and manufacturing fields. Most relate to waste management and environmental fields. Some specific to manufacturing production include Mounting of Abrasive Wheels (Level 5, 476 awards). There were relatively low numbers of awards in Instrumentation and Process Control (Level 6); Drug and Device Manufacturing (Level 5); Finished Pharmaceutical Production (Level 5) and Medical and Allied Devices Production (Level 5).
- The supplemental awards at Level 6 relate mainly to construction, including solar, biomass and heat pump installation.

4.5 Manufacturing Apprenticeships

The manufacturing sector has a strong tradition in Apprenticeships. As highlighted in Chapter 3, Skilled Trade occupations account for approximately 22 per cent of all manufacturing employment. Table 4.9 shows some of the key apprenticeships associated with manufacturing. Note, the data refers to the year of the award, not total numbers on Apprenticeship programmes which are spread over 4 years.



Table 4.9 Manufacturing Apprenticeship Awards

	2007	2008	2009	2010	2011
Craft - Electrical	1355	1324	1243	928	1068
Craft - Electrical Instrumentation	27	41	33	29	44
Craft - Fitting	172	108	118	122	127
Craft - Instrumentation	8	9	8	15	11
Craft - Metal Fabrication	149	120	116	74	78
Craft - Printing	14	7	7		1
Craft - Sheet Metal Working	46	31	29	15	18
Craft - Toolmaking	26	24	22	12	18
Craft - Welding		1			
Craft - Wood Machinery	13	7	8	6	1
Year on Year Change	2007	2008	2009	2010	2011
Craft - Electrical	-	-31	-81	-315	140
Craft - Electrical Instrumentation	-	14	-8	-4	15
Craft - Fitting	-	-64	10	4	5
Craft - Instrumentation	-	1	-1	7	-4
Craft - Metal Fabrication	-	-29	-4	-42	4
Craft - Printing	-	-7	0	-7	1
Craft - Sheet Metal Working	-	-15	-2	-14	3
Craft - Toolmaking	-	-2	-2	-10	6
Craft - Welding	-	1	-1	0	0
Craft - Wood Machinery	-	-6	1	-2	-5

Source: FETAC Award Statistics

There have been significant declines across most of the Apprenticeship awards since 2007, coinciding with the period of significant decline in manufacturing employment generally. In particular, there have been significant relative declines in the numbers of fitters, electricians, metal fabricators, toolmakers and sheet metal workers, while there have been virtually no awards made in the areas of printing or welding from 2007 to 2011. It is clear supply has fallen to very low levels in some apprenticeships that can be critical to manufacturing in addition to concern around adequate replacement demand for qualified tradespersons within the sector. This is considered further in Chapters 6-7. A review of the Apprenticeship system is due to be completed by the



Department of Education and Skills/SOLAS in 2013 which will review the model, including costs, duration and demand with a view to providing an updated model of training and ensures an appropriate balance between supply and demand.

4.6 Profile of In-Company Education and Training/Upskilling Activity

A range of programmes have been developed by higher education institutes to support the upskilling of employees. In addition, a number of industry stakeholders as well as individual companies are involved in the provision of company development programmes for the manufacturing sector in Ireland, such as Enterprise Ireland, IDA Ireland, Skillnets, Engineers Ireland, Institute for the Development of Employees Advancement Services (IDEAS) and the Irish Medical Devices Association (IMDA). The objective of this section is to provide a picture of the range of in-company training options and activity available to the manufacturing sector in Ireland.

4.6.1 Higher Education Provision of In-Company Education and Training (examples)⁶⁵

The Centre for Advanced Manufacturing and Management Systems (CAMMS) in CIT is attached to the Manufacturing, Biomedical, & Facilities Engineering department and Mechanical Engineering department in CIT. The centre uses the design, build, test and validate expertise of these departments in solving problems for industry and in delivering up to date training and education. The centre provides both cross-skilling programmes and entry level feeder programmes (such as the Certified Manufacturing Technician). In addition, CAMMS specialises in niche courses, including suites of programmes in Manufacturing/Quality, Process Control & Automation, Project Management, and Sustainable Energy. The centre is currently developing a suite of project management and sustainability offerings and six sigma black belt and lean expert programmes with the aim of offering minor and special purpose awards.

University of Limerick Enterprise Research Centre partners with companies to deliver professional education at NFQ Levels 7-10 in areas such as Supply Chain Management, Quality Management, Lean Sigma Systems and Technology Management. Progression pathways are available to Industry PhD level. The course delivery is through a hybrid of traditional distance education, online learning and face-to-face contact. Students attend laboratory, tutorial or seminar session during the programme and are assessed by a combination of continuous assessment: assignments, group work, online activity, practical work and an end of semester exams. The project element of each course requires the participant to apply the learning from the taught modules to their own organisations and deliver a report on their findings and results. Students are supported by experienced academic and industry subject matter experts and tutors both during the face-to-face sessions, online and by a professional team of support staff.

⁶⁵ Note, these are examples of good practice of in-employment manufacturing programmes delivered by HEI's referenced in consultations with industry stakeholders. It is a sample of the wide range of provision available from HEIs



Sligo/Athlone Institutes of Technology in collaboration with First Polymer Skillnet and Plastics Ireland provide a distance learning BEng in Polymer Processing (Level 7), primarily aimed at upskilling those working within Medical Devices, Polymer and Pharmaceutical industries. Students completing the BEng in Polymer Processing meet the requirements of a Six Sigma Green Belt award. The programme is targeted at those with NFO Level 6, Apprentices or experienced employees assessed for entry through RPL.

UCC provides a range of undergraduate and postgraduate programmes in **Supply Chain Management** that aim to blend academic and practical expertise, create an interactive learning environment including workplace and classroom learning, and enhance individual and company capability. Programmes include: Lean Green Belt distance learning program in Supply Chain Management at Level 7 and a Postgraduate Diploma / Masters in Supply Chain Management (Lean SCM Black Belt) tailored to meet the needs of companies.

BiInnovate Ireland is an intensive innovation training programme focused on the medical devices sector. It is modelled on the Stanford BioDesign programme, which was highlighted by EGFSN as a possible model for innovation training in its 2008 Future Skills Needs of the Medical Devices Sector report. BiInnovate Ireland is funded jointly by industry and Enterprise Ireland. It is run as a collaboration between four universities - NUIG, UCC, UL and DCU. Under the programme, eight fellowships are awarded each year to establish two teams of four highly qualified and experienced Fellows, with each team including people from a mix of different backgrounds necessary for medical device innovation. In the programme's first year, 2011, the teams were based in Galway and Dublin. The 2012 teams are based in Galway and Limerick. The teams benefit from extensive mentoring.⁶⁶

4.6.1 Enterprise Ireland

Enterprise Ireland has a number of supports relevant to skills development within manufacturing at managerial and employee level.

*Enterprise Ireland Lean Business Offer*⁶⁷

The lean business category comprises three levels of support which are open to EI clients that have been trading within manufacturing or international traded services for a minimum of 5 years.

- **LeanStart:** A basic introduction to the tools and techniques which can aid a company in its cost reduction targets, as well as establishing foundations for future lean or productivity improvement projects. Grant applications towards the cost of hiring a consultant are accepted. LeanStart costs are covered up to €5,000 by EI, with a maximum of seven consultancy days covered (maximum €900 p/d). The client company is required to pay €1,300.

⁶⁶ In the course of the year, each team of Fellows identifies medical challenges that could potentially be addressed with a new medical technology, evaluates their feasibility and market potential, chooses from among them, and invents and implements a technology to address the need.

The Fellows also (along with Academics, Clinicians and Industry Experts) mentor postgraduate students taking part in a less intensive team-based BiInnovate Ireland training process in medical device innovation, equivalent to up to 15 ECTS credits in a structured PhD programme. As a consequence, in addition to benefiting its Fellows, their current and future employers, and prospects for entrepreneurship, BiInnovate Ireland greatly strengthens the entrepreneurial development process available to research students in relevant disciplines at participating institutions.

⁶⁷ <http://www.enterprise-ireland.com/en/Productivity/Lean-Business-Offer/>.



- **LeanPlus:** This programme allows companies to engage in medium-term lean projects (approximately 6 months) by means of a Business Process Improvement Grant. This process allows the company to develop and utilise lean techniques and related methods and aims to advance staff capabilities and business competitiveness. The Business Improvement Grant is used in support of the LeanPlus Assignment where it can cover external trainer/consultancy costs and internal project champions for the duration of the project. A grant of up to 50 per cent is awarded for eligible costs incurred to a maximum grant of €35,000. With the aid of external consultants/trainers, a company can target areas which are lacking in efficiency such as inventory, production/overproduction as well as time deviation between production stages and market evaluation.
- **LeanTransform** is designed for large companies to deliver company-wide transformation in culture and productivity performance. It aims to improve competitiveness and upgrading of the company internally and across its supply chain. A grant of up to 50 per cent of eligible costs can be issued with the level of financial support reviewed by the Enterprise Ireland Investment Committee. The grant/cost framework covers fees for an external Lean consultant/trainer as well as employee training costs and associated training costs: maximum eligible employee training costs €1,000 p/w.

Benchmarking, Leadership and Mentoring

Enterprise Ireland offer a number of programmes to client companies targeted at the owner/manager.

Company Health Check

The Company Health Check service involves benchmarking company metrics against international SME databases. It identifies company competitiveness across a range of business functions and metrics including profitability, marketing, operations, innovation, productivity and human resources. It is helpful to companies that are embarking on a Lean Business initiative and need some assistance in identifying what parts of the business need to be worked on first and to develop an action plan. Companies that are embarking on a review of their strategic plan (or starting one) and want an independent review of the company's strengths and weaknesses can also benefit.

Enterprise Ireland Leadership 4 Growth⁶⁸

Leadership for growth is devised for CEOs and senior management of companies to solve company issues and reach strategic goals both internally and within global markets. The programme is partnered with Switzerland's IMD Business school which manages the delivery and content, and the Irish Management Institute who provide advice and coaching. The programme contains four key concepts within its framework; Inspire, Educate, Coach and Execute. These concepts allow the CEOs engage in peer learning while studying entrepreneurial leadership theory and take core concepts and apply them to the management and leadership of their own company. Each participant is assigned a Business Advisory Coach who will assist and mentor for the duration of the course. Three

⁶⁸ Management 4 Growth, <http://www.enterprise-ireland.com/en/Management/Leadership-and-Management-Development/Leadership-4-Growth-Programme-Food.shortcut.html>



themes/modules are highlighted within the programme; Dynamic Business Strategy, High Performance Leadership and Sustainable Growth - Making it happen. The cost of the Leadership 4 Growth programme is €53,333. For Small to Medium Enterprises the cost ratio is 70 per cent (€37,333) of the total is funded by EI and 30 per cent (€16,000) by the participating company. For larger organisations the funding ratio is 50:50.

Enterprise Ireland Mentor Network

Enterprise Ireland's Mentor Network was devised to assist companies experiencing difficulty overcoming issues which can stunt their national and international growth potential. The client company receive a catalogue of approved mentors (CEOs and senior executives from various sectors), from which they will choose one (more than one mentor can be chosen if multiple in-company issues are in need of improvement such as both production and market assessment). Mentor services include those relating to:

- Marketing;
- Strategic development;
- Organisation development;
- Research and Development;
- Funding and first-time exporting across the software, services, life sciences, environment and food and consumer products sectors.

The mentoring programme involves ten consultations with a mentor over a twelve month period. The programme allows for the client to liaise with the mentor and identify key issues within the organisation. Funding includes grant support towards the cost of the mentor for up to ten sessions: Maximum cost of €175 per session or €1,750 total (immediate costs are made payable to the mentor by the client with EI reimbursing the company following the completion of the programme).

4.6.2 Skillnets

Skillnets funds and facilitates training through networks of private sector companies, in a range of sectors and regions. Each network delivers training that is driven by specific industry and member company needs. There are a number of Skillnets that support skills development within the manufacturing sector. Some Skillnets are organised on a regional basis whereas others have a sectoral focus. The following section describes some of the key Skillnets that provide support for development of skills relevant to the manufacturing sector, including:

- First Polymer Training Skillnet;
- Design, Print and Packaging Skillnet;
- Innovation and Lean Sigma Skillnet;
- Life Sciences Skillnet;
- ULearning;
- Taste 4 Success;
- Pharmachem Skillnet;
- Rural Food Skillnet.



Note, not all Skillnets associated with the manufacturing sector are covered in this section. For example, many regional Skillnets are also active in co-ordinating training relevant to manufacturing. The focus here is on specific in-company technical training relevant to manufacturers.

First Polymer Training Skillnet

First Polymer Training (FPT) Skillnet operates as a training network for the Irish Plastics Industry and is funded under the government's Skillnets initiative. The aim of FPT Skillnet is to deliver training that is focused on the specific needs of the plastics industry and includes certification and development. Initiated by the IBEC business association Plastics Ireland, FPT Skillnet's objective is to provide technical training to polymer processors, at its training centre and in-company as required. Courses are provided in the areas of blow moulding, design, extrusion, injection moulding, lean/six sigma, leadership, personal development, maintenance, medical devices/ Pharma-chemicals, materials, processing, risk, thermoforming and validation. Notably, First Polymer Training Skillnet and a number of companies in the polymer industry initiated the development of a B Eng. Polymer Engineering Level 7 in collaboration with Sligo IT and Athlone IT. The BEng in Polymer Processing was designed in 2009 in collaboration with First Polymer Training Skillnet to address a shortage of skills in the polymer (plastics) area. The degree was designed after a series of meetings with the networks steering group, industry groups and selected member companies, as well as a comprehensive survey of the skills needs of the industry which determined that there was an urgent need to address a skills shortage. FTP is also active in conversion programmes for engineers which incorporate FETAC certified plastics materials, processing, part and mould design and injection moulding modules over ten days. On successful completion of assessments, candidates achieve three component certificates. The programme also includes a suitable post course work placement. Job Bridge interns are also eligible.

Design, Print and Packaging Skillnet

The Design, Print and Packaging Skillnet works with companies in the design and print and packaging sectors to deliver training solutions which will improve business performance. The focus is to provide print training, design courses and packaging courses which will assist members to reduce costs and increase competitiveness through enhanced skills and expertise. All of the training provided is in response to the expressed needs of companies in industry.

The Design, Print and Packaging Skillnet offers a range of courses within the areas from one-day technical courses to Masters programmes. The Diploma in Packaging Technology is a yearlong programme run by Dublin Institute of Technology which provides technical knowledge and operational skills necessary for packaging technology. A Supervisory Management Programme is also offered within the Design, Print and Packaging Skillnet focusing on conflict resolution, people management and action plan development⁶⁹. An MA in Professional Design Practice delivered by DIT is focused on developing the management and leadership abilities of the participants aimed at building the capacity of Irish firms to compete nationally and globally.

⁶⁹ Design, Print and Packaging Skillnet, < <http://www.Skillnets.ie/network/design-print-packaging-Skillnet> >



Innovation and Lean Sigma Skillnet

The Innovation and Lean Sigma Skillnets aims to promote the fundamental ideas of innovation and lean/sigma strategy and support the implementation of a sustainable Lean/Sigma culture in member organisations to increase efficiencies and competitive advantage. It also promotes collaboration among Innovation/Lean Sigma practitioners to encourage skill development and knowledge transfer through the organisation of network fora, conferences, development of implementation frameworks and best practice site visits. Some examples of training programmes, workshops and events organised by the Skillnet include:

- University of Kentucky/Toyota Motors 8-Step Problem Solving;
- Shingo Principles of Operational Excellence at Rolls-Royce;
- Effective Maintenance Systems: Toyota Lean Management Centre, UK;
- University of Kentucky/Toyota Motors Lean Systems Certification Programme;
- Leadership Development Programme Lean Manufacturing;
- Training Within Industry (TWI)⁷⁰.

Life Sciences Skillnet

The Life Sciences Skillnet provides training to Medtech, Pharmaceutical, Biologics, Biopharma, Food and Drink manufacturers. It is a not for profit network with IBEC as its contracting organisation. The Life Sciences Skillnet operates in conjunction with the Irish Medical Devices Association (IMDA). The network has received over €1.3 million of government funding over the past 5 years and trained over 3,000 people. The network offers programmes in compliance, leadership, management, technical, lean and computer training. It provides opportunities to assist with some company specific training events e.g. machine specific or process specific training⁷¹.

One of the core activities of the Life Sciences Skillnet is its Continuous Improvement (Lean and Six Sigma) programme, which builds on fundamental skills within the Medical Devices and Diagnostics sector such as quality, production communications, health and safety and environment, progressing to continuous improvement modules such as Value Stream, 5S and the Visual Factory, Control Variances and Equipment Effectiveness and Performance⁷². Client companies can pick and choose from the modules depending on company specific needs, however individual employees must complete all ten of the modules within the core and continuous categories in order to achieve the FETAC Level 5 National Skills Certificate.

The Life Sciences Skillnet also runs a conversion programme for engineers to convert to the Life Sciences sector. The course is specifically designed to enable engineers and technicians from traditional disciplines (such as civil, mechanical, electrical) to be qualified to take up immediate employment in the Pharmaceutical, the Bio-Pharmaceutical and the Medical Devices sectors of the economy. The training is delivered by DIT and there is a company placement and mentor ensuring the training is structured.

⁷⁰ Innovation - Services, < <http://www.Skillnets.ie/courses/innovation-services>>

⁷¹ Lifesciences Skillnet Training Needs Analysis 2013

⁷² IMDA Life Sciences Skillnet, http://www.lifesciencesSkillnet.ie/Sectors/IMDA/SKILLNET.nsf/vPages/Training_Courses-course-overview?OpenDocument



ULearning Skillnet

The objective of ULearning is to bring industry experts and academics together to establish what are the key skills and competencies for employability. The network focuses on the need to integrate industry and education in order to ensure courses at Level 7, 8 and 9 are meeting the needs of industry in the areas of Science, Engineering and Technology. ULearning Skillnet offers a number of these courses to industry and provides unemployed individuals an opportunity also to take part on courses. The network provides subventions to on average over 200 individuals yearly to take part in educational programmes and includes approximately 70 member companies. The ULearning Network also hosts a number of events with speakers from multinationals and SMEs to discuss the importance of upskilling. ULearning sources and co-ordinates many of its offerings through Sligo IT. Examples of programmes available include:

- Specialist Diploma in Lean Systems/Specialist Diploma in Technology Commercialisation;
- MSc Technology Management/MSc Strategic Quality Management - Lean Sigma Systems;
- Specialist Diploma in Supply Chain Management;
- BEng in Mechatronics;
- BSc in Manufacturing Management;
- B ENG (HONS) In Mechatronics;
- B ENG. In Polymer Processing;
- Certificate in Automation and Instrumentation;
- Specialist Diploma in Medical Device Science.

Taste 4 Success Skillnet

The Taste 4 Success Skillnet members are across a number of specific food and beverage sub-sectors, such as production, processing, artisan and services. Companies in each of the respective sectors range from micro food, sea and beverage producers, suppliers and those involved in food service. The Skillnet organises and sources a range of programmes for members, including technical, finance, management development and soft skills training. Examples of programmes include:

- Certificate in Food Industry Skills - IMPROVE IPO L5 (European Qualification);
- Certificate in Food Manufacturing Excellence - IMPROVE IPO L5 (European Qualification);
- Award in Food Manufacturing Excellence - IMPROVE IPO L6 (European Qualification);
- Diploma in Seafood Innovation - L7, UCC Accredited;
- Diploma in Food Science - L7, UCC Accredited;
- Diploma In Brewing - IBD UK Qualification;
- Lean Six Sigma Green Belt - Industry Certificate - Level 7;
- Lean Manufacturing - FETAC L6.

Of particular note is the Taste 4 Success response to the EGFSN 2009 report Future Skills Requirements of the Food and Beverage Sector, where the Skillnet has developed a strategy relating to training operatives and supervisors. Taste 4 Success is in the process of piloting the new UK IMPROVE programmes for supervisors and operatives, which operate in the UK and are mapped to the European Qualifications Framework. The intention is to expand the pilot and in conjunction with key industry stakeholders, FETAC and National Adult Literacy Agency and others to ascertain how a



similar/improved version of IMPROVE could be developed and delivered as a major FETAC award at Levels 4, Level 5 and/or Level 6.

Pharmachem Skillnet

The Pharmachem Skillnet offers Pharmaceutical training courses as well as Chemical and Medical Device training in the Munster and Leinster regions. The network aims to foster a climate of whole company development in the provision of industry specific technical training and soft skills in companies large and small nationally, consistent with the goals of member companies. Specifically, the role of the network is to increase management effectiveness; to promote best practice and facilitate benchmarking; to foster mentoring/coaching between large and small companies; to avoid duplication in training efforts; to facilitate networking and ensure best in class training. Some examples of courses include:

- Frontline Supervisory - FETAC Level 6;
- Bio-Pharma Operators Programme;
- 2 Day Internal Quality Management Systems Auditor;
- Computer Systems Validation;
- Excel Level 1 (Ms 2007) Introduction;
- Technical Writing;
- GXP - The fundamentals for working in a regulatory environment;
- Conversion to the Pharmaceutical and Medical Device Industry;
- Sterilisation & Depyrogenation;
- Pharmaceutical Wholesaler and Warehousing Induction Course;
- Six Sigma Green Belt.

Rural Food Skillnet

Rural Food Skillnet is a training network serving the food sector throughout the Republic of Ireland. The Rural Food Skillnet is funded by member companies and the Training Networks Programme, an initiative of Skillnets funded under the National Training Fund through the Department of Education and Skills. The network is promoted by the Rural Food Training Network Ltd. and managed by North & East Kerry Development. Examples of some of the courses organised by the Rural Food Skillnet include Food Safety and FETAC Level 5 (4 Days) and the Farmhouse Cheese Production Certificate in Food Science & Technology (1 Year). Some courses are organised and sourced through UCC and IT Tralee.

4.6.3 Other CPD Examples - Engineers Ireland, IMDA, IDEAS Institute

Engineers Ireland

In addition to their role in accrediting higher education engineering programmes and promoting the engineering profession, Engineers Ireland is active in the provision of upskilling those employed within the manufacturing sector through Continuing Professional Development offerings, many of which can be delivered in-company. CPD provision is available across a wide skills spectrum



including project management, communication/commercial and interpersonal skills, technical/legal programmes such as procurement and expert witness training, and strategic management.

The Engineers Ireland Future Professionals Programme is of particular note as it provides a clear pathway for the professional development towards meeting the defined competences of a Chartered Engineer. The programme begins after the graduate enters employment and participates on a Graduate Transition Programme, which is a structured approach to improved learning and development within the workplace. Participants engage in six core classroom based modules (essential skills, time management, communication/presentation skills, problem solving/analytical skills, technical report writing, and innovation in Excel) with the support of on-line resources and their employer. After approximately 3+ years further experience within industry, engineers can move on to the Professional Progression programme, which is a two year programme based on a partnership between Engineers Ireland, the employer and the learner. The learner fulfils a Learning Contract and appropriate mentoring is put in place. A CPD Log is developed over two years covering content such as project management, statistical analysis, lean principles, contracts, finance, and risk management. E-learning modules provide resources. All participants engage in 35 hours of formal project management education which is necessary for Project Management Professional (PMP) status.

Case Study: In-company Upskilling and Career Paths - Lake Region Medical

Lake Region Medical is an Original Development Manufacturer of minimally invasive devices and components with clinically-focused product innovations with facilities in Wexford and Galway. In 2012, Lake Region Medical became the first company in the Republic of Ireland—and the first medical device manufacturer in Europe—to be awarded a global standard in Operational Excellence—the prestigious Shingo Accreditation Bronze Medallion.

Lake Region has developed a system to select production operators who had the potential and drive to become maintenance fitters and put them through a national apprenticeship program. Lake Region views the main benefits from this initiative as:

- Internal candidates (because they have worked for a number of years in production) bring a culture of flexibility & accountability to their new position. They also bring a thorough understanding of Lake Region Medical equipment, systems & processes.
- Once the apprentice is fully qualified it creates an opportunity to train and promote an experienced fitter to an engineering role as vacancies arise, therefore creating a pipeline of talent right from operations up through engineering and potentially to management one day.
- Turnover within the maintenance department has effectively ceased since 2007, which Lake Region consider remarkable given the number of blue chip medical device companies operating within the catchment area.

Lake Region decided on this approach in response to the early Celtic Tiger days when tradesmen became highly sought after. The option of recruiting newly qualified Technicians straight from college was also trialled for a period but proved to be unsatisfactory as unfortunately most lacked the mechanical aptitude necessary to carry out the work effectively. The role of all maintenance employees has evolved in line with Lake Region Medical's goal to achieve operational excellence. All maintenance personnel have been trained in Scientific Problem Solving and spend 25 per cent of their time either driving or supporting the continuous improvement project.

Source: Lake Region Medical



Irish Medical Devices Association (IMDA)

In addition to their role in supporting/co-ordinating the activities of the Life sciences Skillnet, the IMDA has a strong focus on manufacturing workforce development through its Operational Excellence Taskforce, which is comprised of IMDA members and promotes and strengthens the importance of best in class manufacturing operations in Ireland as part of overall economic development strategy. This forum also identifies and promotes the appropriate processes, toolsets, structures, policies and supports required to facilitate manufacturing and operational excellence. In 2012, the Taskforce engaged with a number of higher education providers to discuss improving offerings in Lean Manufacturing at Masters/Postgraduate level. Notably, the Taskforce has developed the MÓR™ Benchmark Model for use as a Best in Class model for companies to measure themselves in areas of Lean Manufacturing to help give competitive advantage and progress on the lean journey. The model is not sector-specific. The IMDA also plays an active role in management and leadership development. In 2012, IMDA and the Life sciences Skillnet in conjunction with Cardiff University developed an 8-day Lean Leadership Programme, designed by the Operational Excellence Taskforce and accredited by Cardiff University.

IDEAS Institute

The Institute for the Development of Employee Advancement Services (IDEAS) is an independent trust established by SIPTU that provides commercial and certified training as well as developing specific courses and programmes for employees and their companies. The courses on offer include health and safety training, computer literacy training, Train the Trainer, Personal Effectiveness in the Workplace training, as well as team working and problem solving. The training also involves a strong focus on facilitation of change initiatives to better enable unions and employers to jointly identify and respond positively to challenges and opportunities facing the organisation. The Institute also offers developmental interventions such as surveys, workshops and diagnostic audits of organisations to ascertain a company's existing performance and establish objectives for improvement, which help define the required training. The Institute is currently involved in several EU research projects.⁷³

4.7 Conclusion

- There has been a significant increase in enrolments (28 per cent) from 2006/07 to 2010/11 in programmes relevant to the manufacturing sector, which is a particularly positive development given relatively stagnant levels of graduations over the same period. Therefore, an increased outflow of STEM graduates to the labour market can be expected in the coming years. Total enrolments now stand at just over 45,000. Enrolments in science/selected health programmes outnumber engineering enrolments by approximately 2 to 1. Both science and engineering programmes experienced similar rates of increased participation. There have been strong increases at Level 6/7 enrolments, particularly in ICT related programmes, electrical engineering and mechanical engineering. The main enrolments at Level 8 and 9 relate to biological/biochem/chemical sciences; computing and electronics and engineering categories. There have also been strong increases in enrolments in energy/environmental related

⁷³ IDEAS Institute, <http://www.ideasinstitute.ie/development.html>



programmes, reflecting the increasing influence of the environmental agenda. There is a challenge for manufacturing enterprises as many of these graduates are sought after in other sectors such as health, education, software and research.

- Within Further Education and Training Awards, it is clear that there are a significant number of awards relevant to the manufacturing sector. In 2012, approximately 18,000 FETAC awards were made across the science, engineering, manufacturing and computing fields. Some of these awards are quite general (for example relating to IT skills), however, others are highly specific to manufacturing such as those relating to pharmaceutical processing, materials manufacturing and injection moulding. The breadth and specificity of awards highlights that there are established standards and therefore potential upskilling opportunities available to those with low formal levels of qualifications or those in low-skilled positions.
- There have been significant declines across most of the Apprenticeships since 2007, coinciding with the period of significant decline in manufacturing employment generally. In particular, there has been a significant relative decline in the numbers of fitters, electricians, metal fabricators, toolmakers and sheet metal workers. It is clear supply has fallen to very low levels in some apprenticeships that can be critical to manufacturing in addition to concern around adequate replacement demand for qualified tradespersons within the sector.
- A number of industry stakeholders, higher education providers, as well as individual companies are involved in the provision of skills development within the manufacturing sector in Ireland, such as Enterprise Ireland/IDA, Skillnets, Engineers Ireland, Institute for the Development of Employees Advancement Services (IDEAS) and the Irish Medical Devices Association (IMDA). In-employment education and training is essential within the manufacturing sector as new technologies, regulations, processes and products continually affect skills required by employees.



Chapter 5: Anticipated Level of Skills Demand

5.1 Introduction

Three future scenarios for the future of skills demand for the manufacturing sector are presented, based on drivers and trends described in the report, and on opinions of informants in the sector and based on historic trends in employment and occupations within the subsectors of manufacturing. The scenarios are based on different assumptions about drivers of manufacturing activity in Ireland, focusing particularly on the issues of competitiveness that are likely to most influence future manufacturing employment in Ireland. The scenarios are:

1 *Competitive Manufacturing scenario*

This scenario is based on rapid improvement in the Irish manufacturing sector's competitiveness. Key components of the improvement include the following:

- Continued improvement in the sector's labour cost competitiveness, as measured by nominal labour costs⁷⁴, relative to the rest of the Eurozone;
- Significantly greater reductions in non-labour business costs than have been evident to date, to complement the improvements in labour cost competitiveness;
- A sufficient supply of high quality and relevant skills at all occupational levels, and continuing upskilling in manufacturing industry occupations so as to meet firms' operational and strategic needs;
- Strong progress on innovation and productivity improvement, enabled by skills;
- Stable or weakening euro exchange rates that preserve or improve upon the major gains in competitiveness relative to non-European locations important as trading partners and competitors, along with rising costs in major emerging economy competitors;
- Significant improvement in economic conditions, in Europe and globally, with more buoyant demand in export markets, and stronger demand in the Irish domestic market;
- A significant focus by the enterprise development agencies on assisting firms potentially at risk of closure/downsizing to substantially raise their business performance;
- A wider business and policy environment that is supportive of manufacturing industry in terms of factors such as, public funding of industry-relevant research, industrial relations and enterprise supports.

For the period to 2016, details of this scenario assume that the objectives for job creation in the Action Plan for Jobs 2012 are met. These objectives are ambitious regarding gross job creation and job losses, and strong gains in competitiveness are required to achieve this outcome. For the period from 2017 to 2020, the scenario continues the projection to 2016 forward.

⁷⁴ Unit labour cost improvements have tended to exaggerate improvements in competitiveness in recent years because they have been influenced by major shifts in sectoral composition (particularly by loss of low productivity construction jobs), and by Ireland's strong positioning in sectors in which rapid improvements in labour productivity are normal and do not necessarily reflect gains in competitiveness.



2 *Constrained Competitive Manufacturing scenario*

This scenario assumes that the components of competitiveness improvement (cost and non-cost) under the *Competitive Manufacturing* scenario that are within the control of Irish policy and Irish manufacturing operations are attained, but that the gain in business performance is constrained by factors external to Ireland.⁷⁵ The international business environment remains depressed, constraining market growth. The rate of increase in costs in key emerging economies engaged in manufacturing slows. Low inflation elsewhere in Europe constrains the rate of improvement in Irish cost competitiveness. Perhaps the euro strengthens relative to major international currencies, eroding the gains in price competitiveness that came when it weakened in recent years.

The details of this scenario are based on gross job gains 7.5 per cent below those assumed under the *Competitive Manufacturing* scenario, and job losses averaging 5.75 per cent of previous year's employment across all manufacturing sectors.

3 *Continued Loss of Manufacturing scenario*

This scenario assumes that only limited further progress is made on tackling the deficiencies in manufacturing competitiveness that accumulated over the period from around 2000 to 2008. As a consequence, the long term downward trend in manufacturing employment seen since 2001 continues.

This scenario recognises that there has already been some improvement in labour cost competitiveness, and the supply of skills available to manufacturing industry is already improving if only because competition for people from other sectors is weak. However, under this scenario the stabilisation in manufacturing employment seen in 2011 is a temporary reprieve after the most immediately vulnerable firms were lost between 2007 and 2010, underpinned by the weak euro and the gains in cost competitiveness achieved to date. Under this scenario, gains in labour cost competitiveness slow down. The wider business environment fails to improve in terms of costs and other factors. The skills response is weak. Perhaps the euro strengthens versus major international currencies. This scenario underlines the importance of a coherent policy response to the manufacturing sector and the implications of inaction on the competitiveness factors that can be influenced domestically.

The details of this scenario are based on gross job gains 15 per cent below those assumed under the *Competitive Manufacturing Scenario*, and job losses averaging 7.5 per cent of previous year's employment across all manufacturing sectors. Historically, a year in which 7.5 per cent of jobs were lost would be around the average for non-recession years. While loss of employment continues under this scenario, the rate of loss is less than the average over the last 10 years, reflecting the improvements in competitiveness that have occurred to date.

⁷⁵ See Department of Finance (November 2012) Fiscal Statement for further information of downside risks

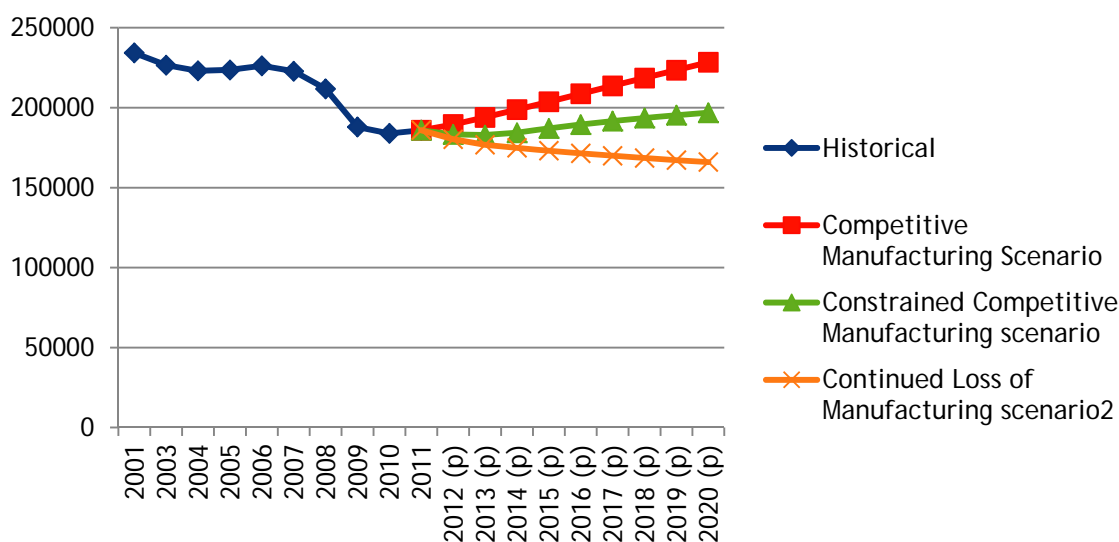


5.2 Employment under the Three Scenarios

Figure 5.1 shows how employment develops under each of the scenarios. Under the *Competitive Manufacturing* scenario, employment increases by 43,000 between 2011 and 2020. Under the *Constrained Competitive Manufacturing* scenario, it increases by 11,000 over the same period. Under the *Continued Loss of Manufacturing* scenario, it falls by 20,000.

While the quantitative scenarios are shown as smooth curves, they are intended to be representative of a wider range of possible outcomes that have more variation from year to year. A dip in employment in 2012/13 could be consistent with eventually achieving the main thrust of the *Competitive Manufacturing* scenario⁷⁶, and a rise in employment in 2012/13 could be consistent with eventually suffering the thrust of the *Continued Loss of Manufacturing* scenario.

Figure 5.1 Anticipated Total Employment* under the Three Scenarios



* Based on Forfás Employment Survey manufacturing employment data. Note that this survey does not have full coverage of the manufacturing sector. It covers circa 92% of manufacturing employment.

Internally, the model used to construct the projections disaggregates the manufacturing sector into the seven subsectors used earlier to present statistics. Employment in each of these is projected separately, based on projections of gross job gains and job losses each year.

Disaggregating the model by subsector served two main purposes:

- It made it possible to ensure that each scenario is coherent when the manufacturing sector is considered as the sum of its component parts.
- It allowed the model to reflect the significant differences in occupational profile between manufacturing subsectors. Changes in the subsectoral composition of Irish manufacturing may contribute significantly to patterns of demand for skills, and representing subsectors within the model make it possible to reflect this in the scenarios.

⁷⁶ The scenarios do not explicitly take account of data past 2011. At the time of writing, the most current QNHS shows a fall of 7,400 in employment in Industry (most of which is manufacturing) between Q4 2011 and Q2 2012.



Some of the key factors behind the subsector level projections are as follows.

Engineering

- Most firms interviewed anticipate either no change in employment or a modest increase in employment based on increasing sales volumes.
- Some firms producing specialist equipment for use in specific industries project significant employment gains.
- There was a sharp fall in engineering employment between 2007 and 2009, but a large part of this seems to be associated with a collapse in demand from the domestic construction sector, so it does not necessarily point towards a general subsector-wide weakness.
- With a combination of manufacturers of finished products and sub supply manufacturers, this is a key area of relative strength for indigenous industry.
- Based on the above points, it is assumed that the future employment outcome in the subsector will be better than the manufacturing sector average.

Food & Drink

- There is significant optimism about future activity in food, reflected in the Department of Agriculture, Food and the Marine's Horizon 2020 strategy.
- The companies interviewed for the EGFSN study are seeking more business and contracts, which would boost future employment if they are successful. However, there are firm plans to recruit currently for a small number of mid to high level quality-related jobs.
- Food and drink industry employment has been increasing since 2009, at a time when labour productivity has also been improving, pointing towards gains in competitiveness.
- Jobs announcements by indigenous firms in 2012 give cause for optimism for increased employment in higher skilled areas.
- Based on the above points, it is assumed that the future employment outcome in this subsector will be better than the manufacturing sector average.

Pharma-chemicals

- Companies interviewed either see some possibility of a modest increase in employment from bringing in new products, or employment stabilising. Expectations in the subsector are that employment in the subsector as a whole will remain at around its current level over the next few years.
- While output should increase in many operations, the impact on employment will typically be offset by increasing labour productivity and internal redeployment.
- There are some significant challenges facing the sector in Ireland, particularly with regard to expiration of patents, the increasing prevalence of generic drugs and consolidation within the industry driven by mergers and acquisitions. Whether this has a significant impact on employment will depend mainly on the nature and scale of future FDI, including winning mandates for investment in development and manufacture of new drugs coming through



established parent company pipelines. Biopharmaceutical manufacturing (in particular sterile fill finish) is expected to be a main driver of investment.

- Based on the above points, it is assumed that the future employment outcome in the subsector will be somewhat below the manufacturing sector average.

ICT Hardware

- Some of the companies interviewed expect no employment growth; some expect incremental growth through bringing new products to Ireland.
- Labour intensive activities in ICT hardware have mostly already left Ireland, making the remaining operations more sustainable.
- Employment in the subsector is dominated by a small number of large employers, making it sensitive to decisions by a small number of businesses.
- The ICT hardware sector's competitiveness is reinforced by significant clustering effects (with software and IT services) and by public investment in R&D relevant to the sector.
- Based on the above points, it is assumed that the future employment outcome in the subsector will be around the manufacturing sector average.

Medical Devices

- After remaining fairly constant between 2005 and 2010, employment in the medical devices subsector increased in 2011. There are a number of inward investment projects in the pipeline, and many firms are recruiting. Foreign-owned firms seem to be responding to recent cost (including exchange rate) competitiveness improvements.
- The subsector's competitiveness is reinforced by strong and deep clustering effects, with Ireland being an internationally important centre of manufacturing expertise and of product R&D.
- Much of the subsector's lower value component manufacturing activities have already been moved to countries with lower labour costs, making remaining activities more secure.
- Based on the above points, it is assumed that the future employment outcome in the subsector will be better than the manufacturing sector average.

Consumer products

- The consumer products subsector has a long term trend of employment loss, arising from overseas competition and increasing unit labour productivity.
- Some of the companies interviewed were seeking more business/contracts, which would boost employment if they are successful.
- The domestic market, which is important to much of the sector (especially print), is very weak.
- Prospects are for continued employment loss, but with some relief if demand in the domestic economy improves.
- Based on the above points, it is assumed that the future employment outcome in the subsector will be worse than the manufacturing sector average.



Other Manufacturing

- The subsector suffers from a long term decline in employment, arising from overseas competition in the domestic market, reduced sub-supply opportunities in some areas, and improvements in labour productivity.
- Employment in the subsector benefitted from the construction boom, but reverted to its long term downward trend with the construction collapse.
- Prospects are that employment will continue to fall.
- Based on the above points, it is assumed that the future employment outcome in the subsector will be worse than the manufacturing sector average.

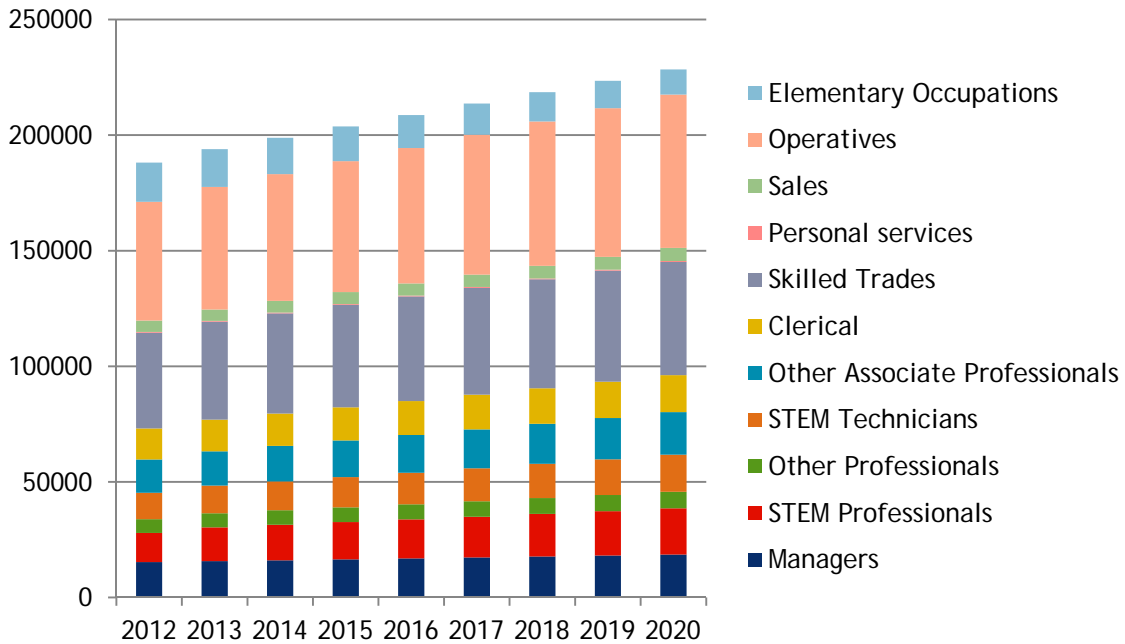
Within the model, employment projections in each subsector are disaggregated between major groupings of occupations for each scenario. Figure 5.2 summarises the projections for the *Competitive Manufacturing* scenario across the whole manufacturing sector, and Figures 5.3 and 5.4 do the same for the *Constrained Competitive Manufacturing* scenario and the *Continued Loss of Manufacturing* scenario respectively.

The main shifts in occupational composition projected under the three scenarios are as follows.

- The share of employment accounted for by elementary occupations falls in each subsector, as jobs at this level are replaced by operative jobs. This continues a strong existing trend in the occupational statistics. It represents an upskilling of the workforce, as unskilled jobs are eliminated and replaced by skilled operative jobs. It is likely that in many cases this shift will occur through upskilling workers in elementary occupations rather than by necessarily replacing them with higher skilled workers.
- The share of employment accounted for by STEM technicians and by STEM professionals increases by amounts that vary between subsectors. The shift is not projected to be very large - but it contributes to a much more substantial increase in employment of higher education graduates described later.

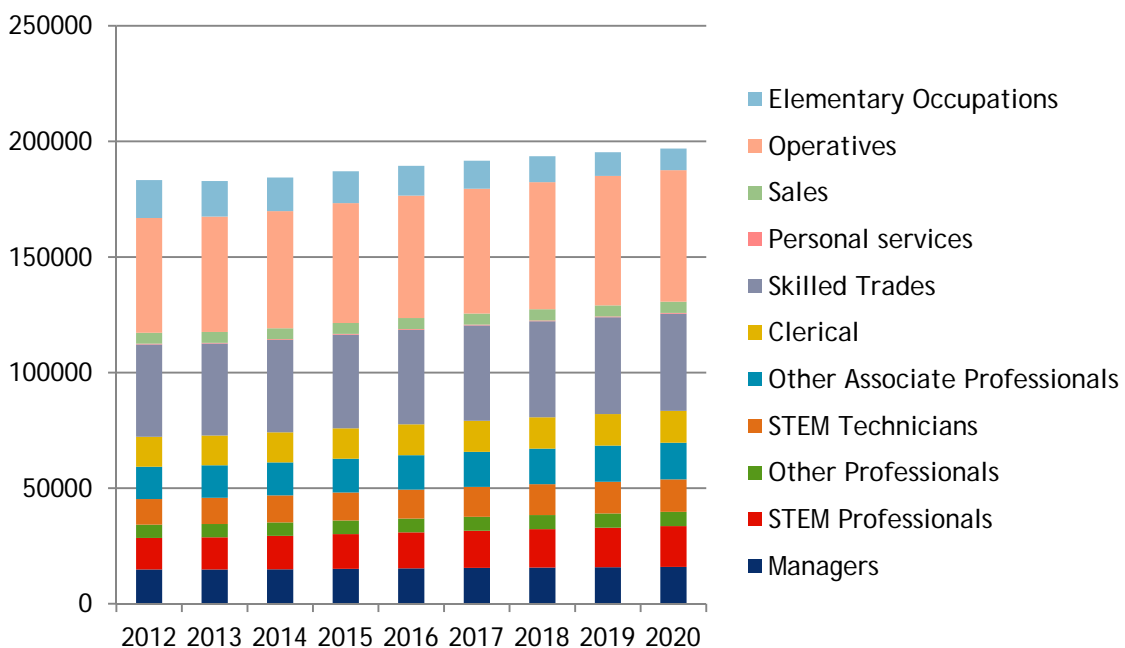


Figure 5.2 Occupational Composition of Employment under Competitive Manufacturing Scenario



Source: Model developed for study

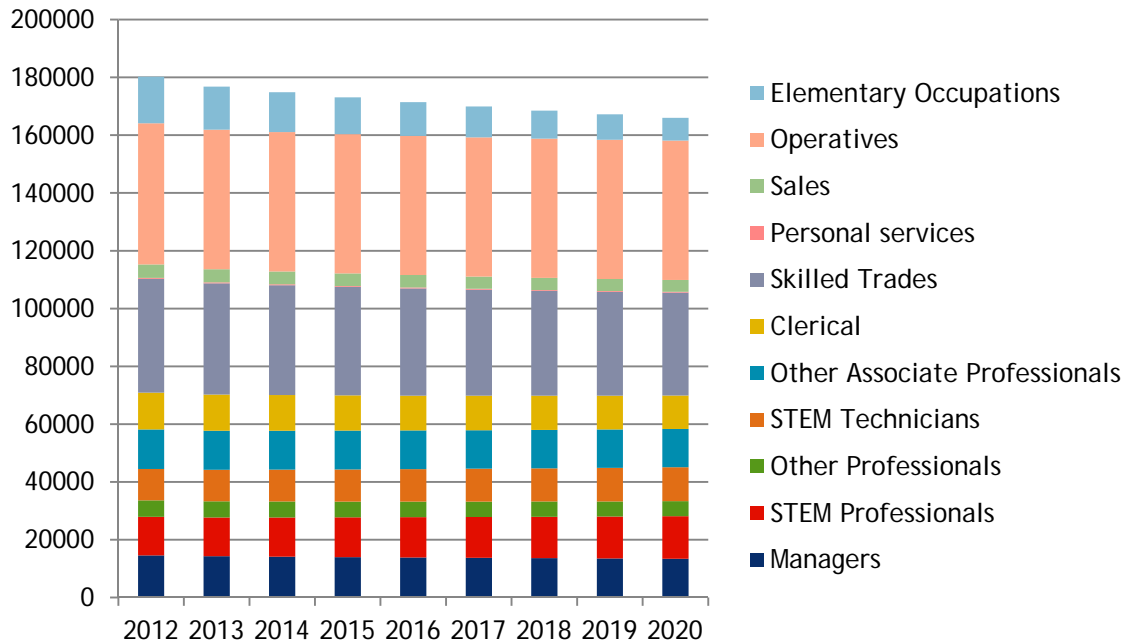
Figure 5.3 Occupational Composition of Employment under *Constrained Competitive Manufacturing Scenario*



Source: Model developed for study



Figure 5.4 Occupational Composition of Employment under *Continued Loss of Manufacturing Scenario*



Source: Model developed for study

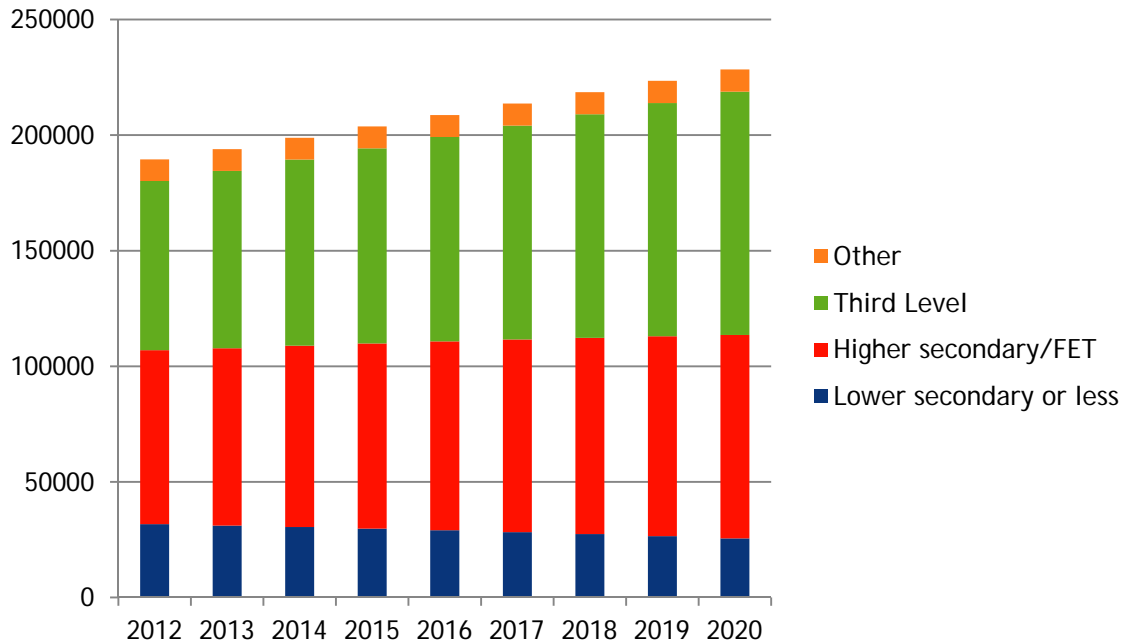
Within the model, employment projections in each subsector are also disaggregated between qualification levels for each scenario, at subsector level. Figure 5.5 to 5.7 summarise the projections for the three scenarios.

Substantial shifts in the qualifications profile of the workforce are projected, which continue trends visible in the historical data.

- The share of manufacturing employment accounted for by workers qualified to lower secondary level and below decreases as more employers see completion of second level as their minimum entry level of qualification, reflecting more demanding skills requirements at operative level.
- The share of manufacturing employment accounted for by workers with third level qualifications continues to increase. This is driven partly by an increase in the share of employment accounted for by professional and associate professional level occupations, but it is mainly driven by more demanding skills requirements raising the level of qualification required within occupations. It is primarily a reflection of the level of skill required and the trend is present across Irish manufacturing industry. At the upper end, some leading manufacturing employers now require a Level 6 or Level 7 qualification for operatives, a Level 8 qualification for technicians, and a Masters or PhD for professional level occupations.

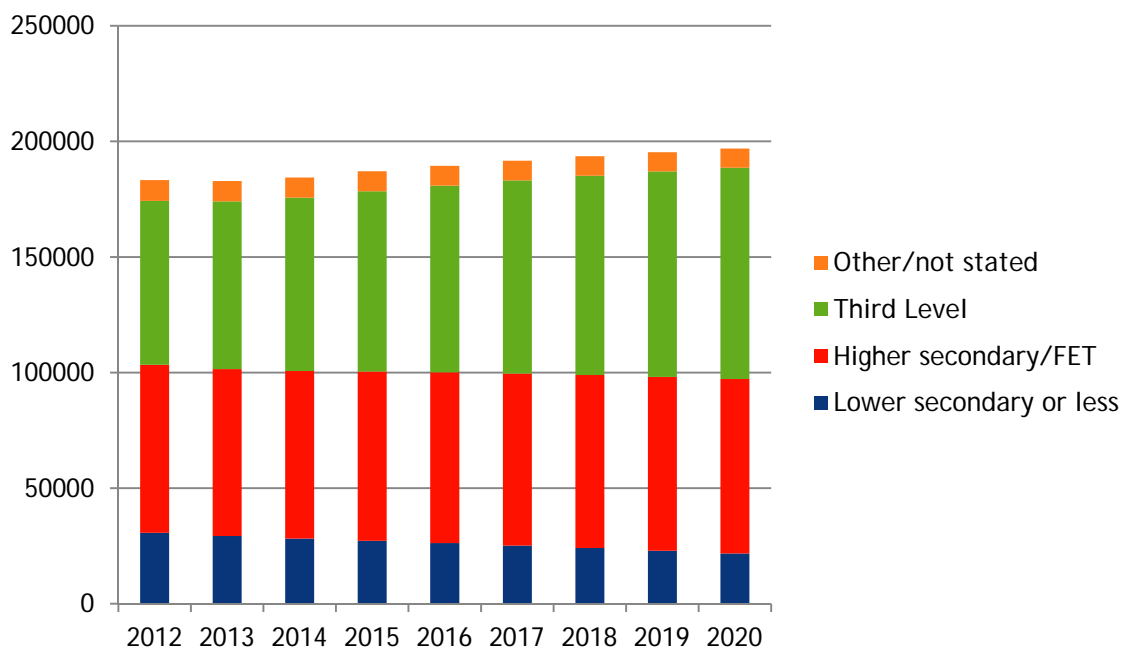


Figure 5.5 Composition of Employment by Level of Qualification under *Competitive Manufacturing Scenario*



Source: Model developed for study

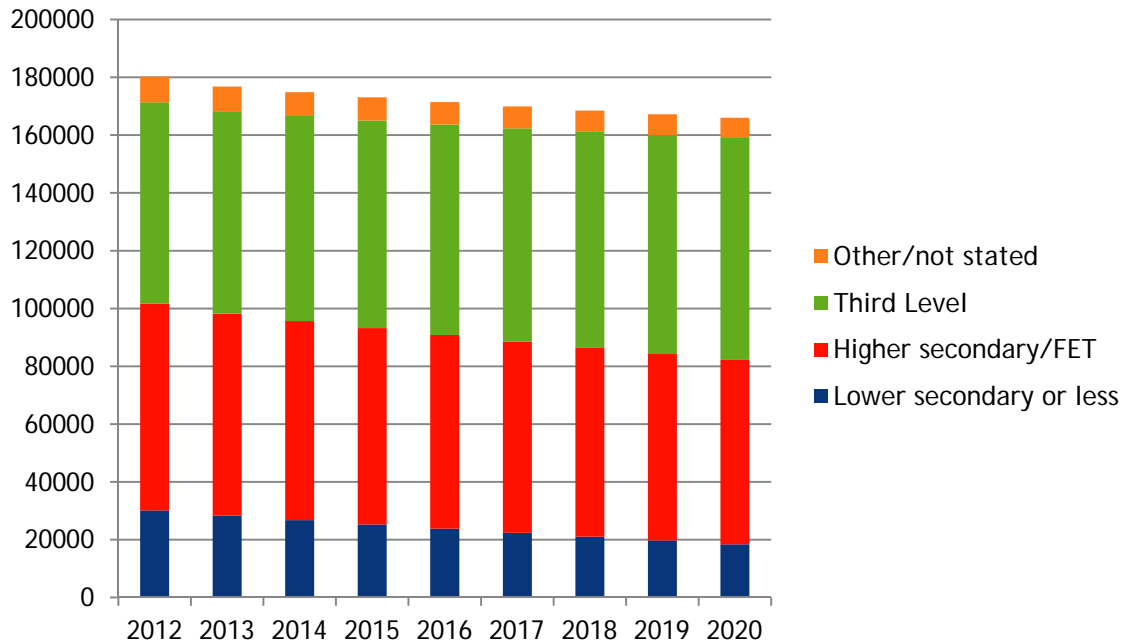
Figure 5.6 Composition of Employment by Level of Qualification under *Constrained Competitive Manufacturing Scenario*



Source: Model developed for study



Figure 5.7 Composition of Employment by Level of Qualification under *Continued Loss of Manufacturing Scenario*



Source: Model developed for study

5.3 Conclusions about Future Skills Demand under the Three Scenarios

Under the two competitive scenarios presented in the report, manufacturing employment has the potential to grow on average by approximately 0.8 per cent and 2.3 per cent per annum from 2012 to 2020, or between 11,000 and 43,000. This depends highly on both significant improvements in domestic competitive factors, including skills, and a favourable global demand for Irish exports. The continuing loss of competitiveness scenario highlights the implications of inaction on competitiveness factors within domestic control, with the potential for a continual erosion of the manufacturing base out to 2020 with a decline in the region of 20,000 in the numbers employed.

Demand for skills is of two types - expansion demand for skilled people to allow the sector to increase employment levels, and replacement demand for people to replace those who leave the sector. Note that mobility between firms within the sector does not contribute to replacement demand, as those moving remain employed in the sector.

Replacement demand is calculated as a percentage of the previous year's employment over the period to 2020 for each combination of occupational group and subsector. The percentages assumed vary between 2.1 per cent and 3.4 per cent per annum.

This reflects a compromise between three main factors, for modelling purposes.

- 1 Employment of over-55s is significant in certain sectors so loss of employees to retirement is significant (raising replacement demand).
- 2 With relatively scarce employment opportunities elsewhere, few of those employed in manufacturing industry are currently leaving their current employer, much less leaving the manufacturing sector.

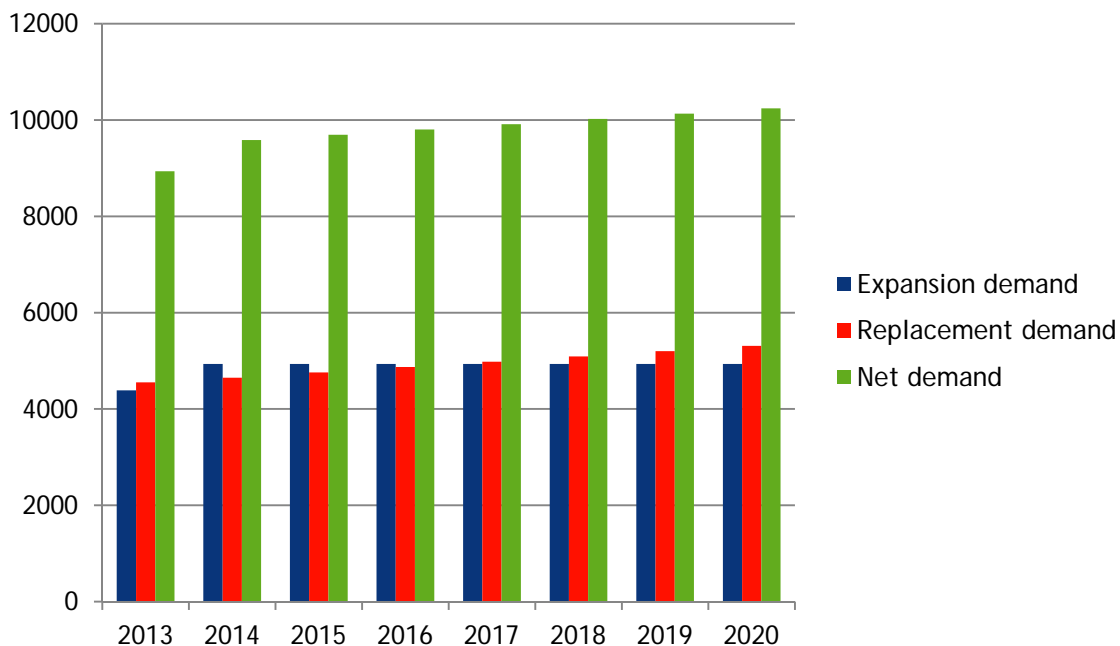


- 3 Even in better times, people working in manufacturing tend to make a career in the sector, rather than moving to other sectors (lowering replacement demand).

The specific replacement rates applied are informed by the rates used by the US Bureau of Labor Statistics in its occupational employment forecasts.

Figures 5.8 to 5.10 summarise expansion demand, replacement demand and net demand for the manufacturing sector as a whole under the three scenarios. Net demand is substantially higher under the *Competitive Manufacturing* scenario than under the *Constrained Competitive Manufacturing* scenario, which is in turn considerably higher than under the *Continued Loss of Manufacturing* scenario. The main reason for this is that employment growth means substantial expansion demand under the *Competitive Manufacturing Scenario*, and less substantial demand under the *Constrained Competitive Manufacturing Scenario*, while loss of employment means that expansion demand is negative under the *Continued Loss of Manufacturing* scenario.

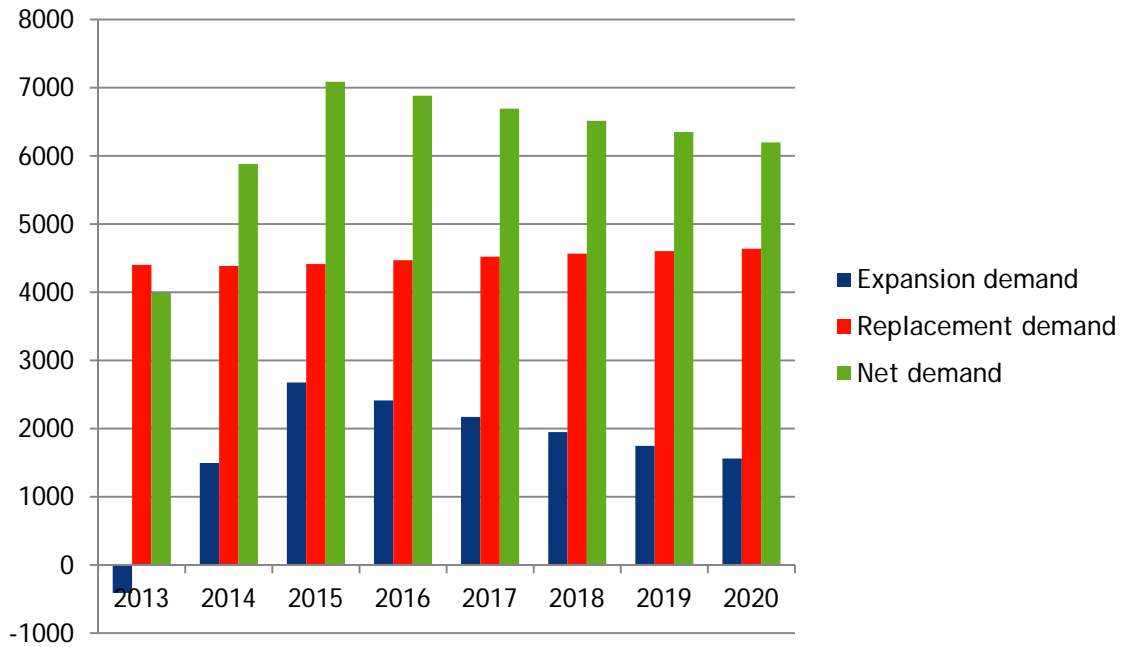
Figure 5.8 Expansion and Replacement Demand under *Competitive Manufacturing Scenario*



Source: Model developed for study

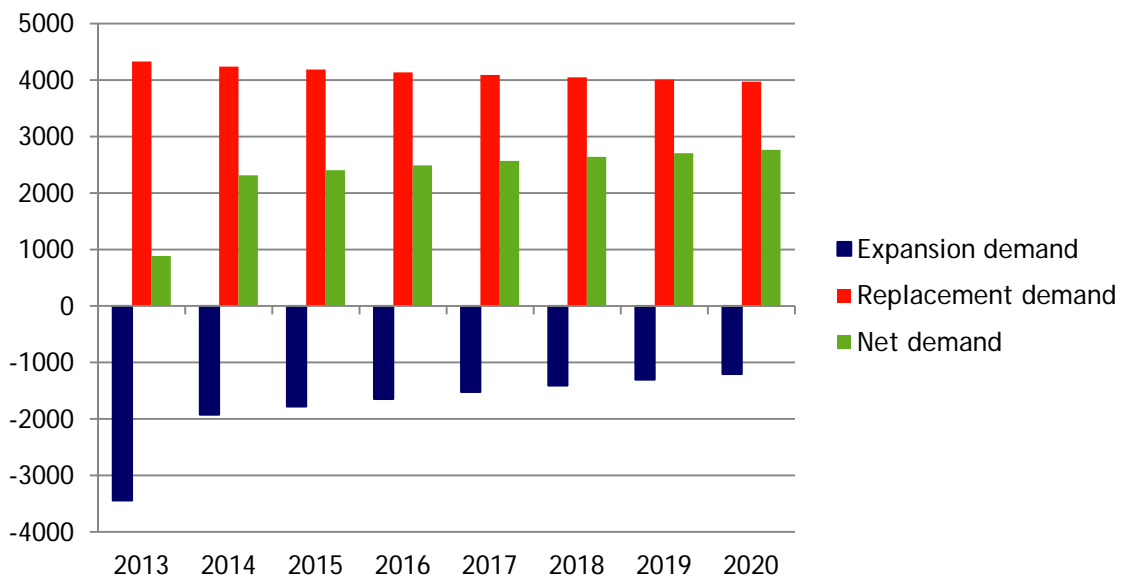


Figure 5.9 Expansion and Replacement Demand under *Constrained Competitive Manufacturing Scenario*



Source: Model developed for study

Figure 5.10 Expansion and Replacement Demand under *Continued Loss of Manufacturing Scenario*



Source: Model developed for study

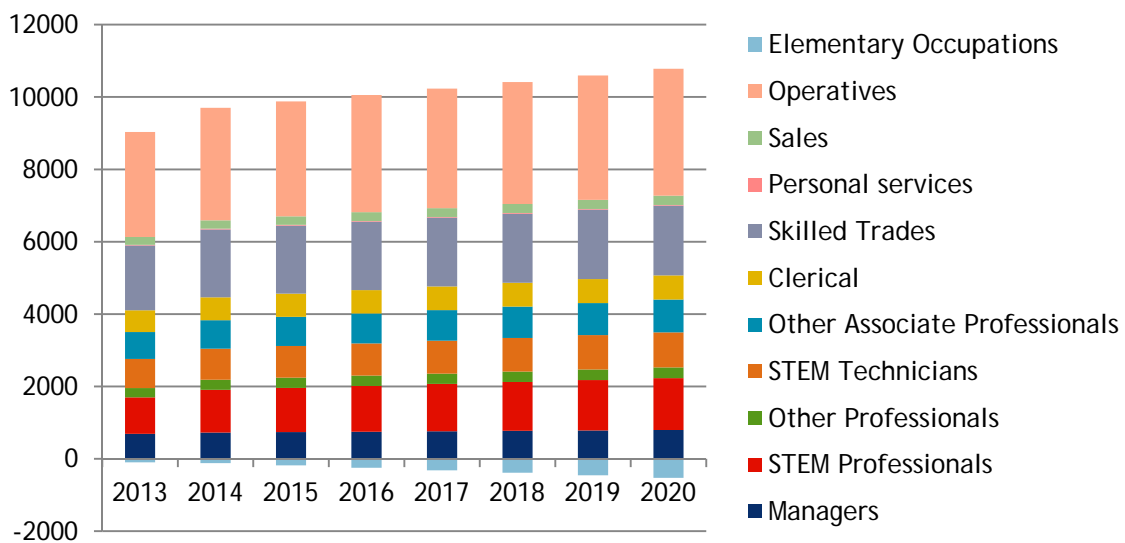
Figures 5.11 to 5.13 disaggregate the net demand for skills by major occupational grouping for each scenario. Net demand in elementary occupations is negative under all three scenarios, as many of the jobs in these occupations are replaced by operative level jobs. As noted earlier, this will



frequently be a matter of upskilling existing workers to undertake higher skilled work rather than replacing them.

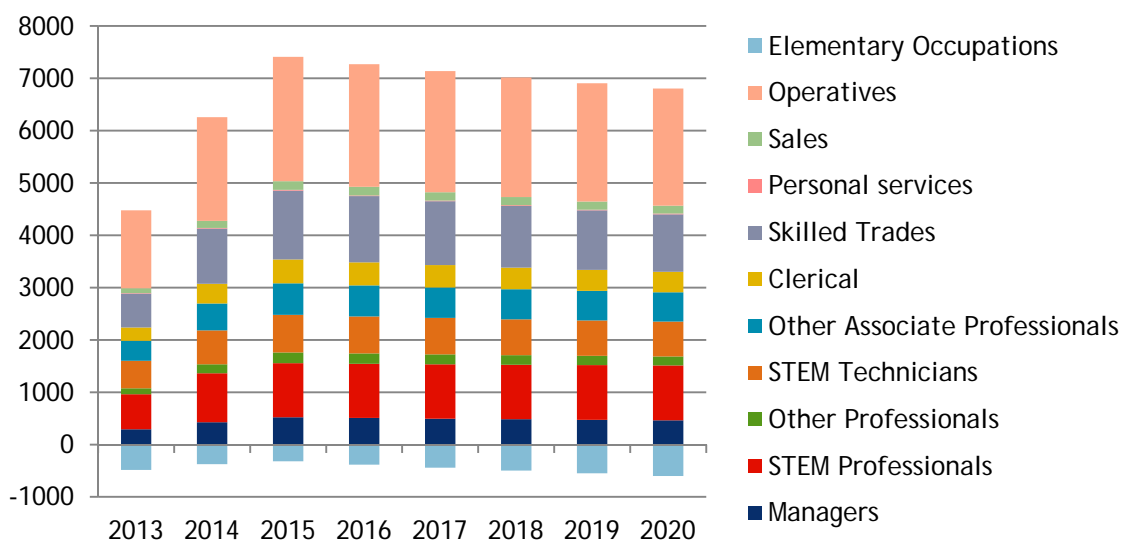
A point to note in interpreting the projections is that the Skilled Trades grouping does not just include trades that require an apprenticeship, but also occupations (such as machinist occupations) with other training mechanisms.

Figure 5.11 Occupational Composition of Net Demand under *Competitive Manufacturing Scenario*



Source: Model developed for study

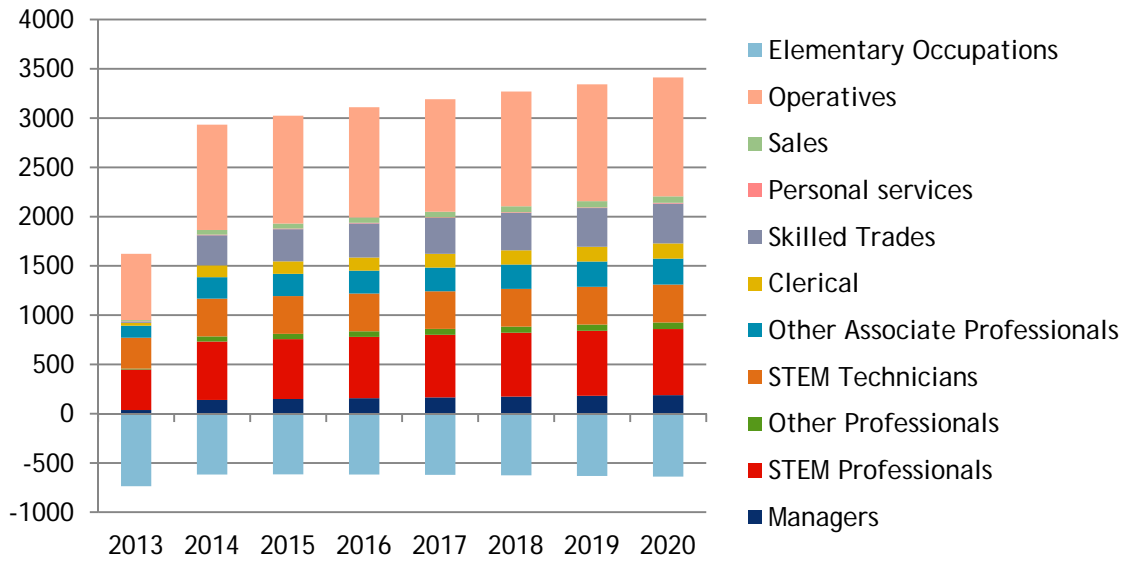
Figure 5.12 Occupational Composition of Net Demand under *Constrained Competitive Manufacturing Scenario*



Source: Model developed for study



Figure 5.13 Occupational Composition of Net Demand under *Continued Loss of Manufacturing Scenario*



Source: Model developed for study



Chapter 6: Future Demand for Skills in the Manufacturing Sector

6.1 Introduction

This chapter describes the research carried out on future skills requirements in the manufacturing sector.

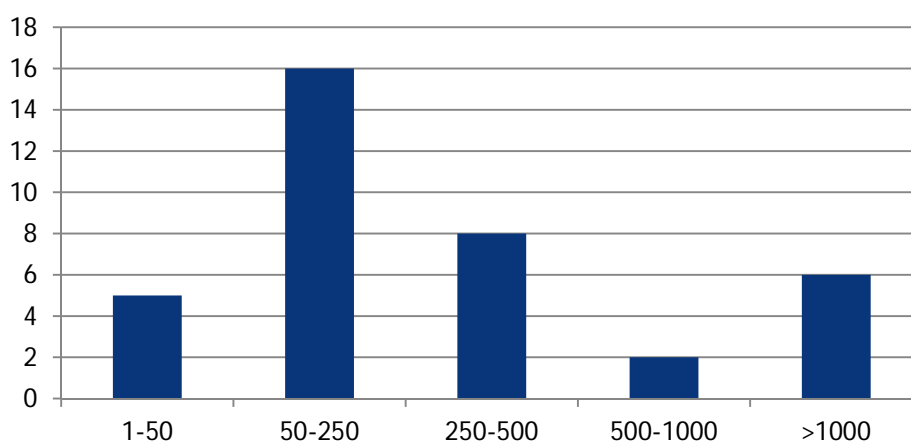
The research approach comprised four elements:

- Structured interviews were conducted at senior company representative level with over 35 selected foreign affiliate and indigenous companies from different sectors. They included small and large companies (see Figure 6.1) at various stages of maturity.
- Consultations were held with 18 different industry and union stakeholders. A list is provided in Appendix 3.
- Three workshops were held, two in Dublin and one in Cork, on the three themes of Operatives, technicians, crafts and supervisors, Skills for Enterprise and Innovation and Skills for Manufacturing Excellence. 38 companies and stakeholders participated to review and discuss the findings of the initial research work and to incorporate additional valuable knowledge and information into the research.

Since research had been conducted relatively recently by the Expert Group in three of the sectors - medical devices, pharmaceutical and food & beverages - the interview survey component of the research was weighted towards the following manufacturing sectors: ICT Hardware, Engineering and Consumer Products. This research provided information on the actual and projected skills gaps being experienced or anticipated over the period to 2020 in manufacturing companies together with the detail and complexity surrounding those requirements.

The consultations with manufacturing sector stakeholders, including representative bodies, education institutions and professional bodies provided an overview of sector requirements. They identified issues associated with matching provision to requirements, along with interventions currently being put in place by providers and actions by professional bodies.

Figure 6.1 Size of Manufacturing Companies Interviewed by Number of Employees





6.2 Manufacturing Cross-sectoral Themes

6.2.1 Engaging with manufacturing

Ireland's current endowment of manufacturing skills and experience has developed over decades. With changes in technology, consumer patterns and the availability of low cost manufacturing in emerging economies, manufacturing is ever-changing. Manufacturing leaders and professionals, together with a skilled workforce, are the essential ingredients in responding to change and sustaining a viable and healthy manufacturing sector.

In order to acquire the necessary skills, manufacturing must have a pool of educated, talented people. Throughout the research phases of the project there was a strong feeling from contributors that the manufacturing sector needs to do more to attract the required talent. It must educate young people, parents and schools about the types of careers in manufacturing, to dispel perceptions of less attractive working conditions, to describe the internal training and development opportunities associated with changes in manufacturing and to highlight the satisfying contribution made by employees across all levels of an organisation, not just in contributing to producing tangible products, but also in terms of the problem solving, continuous improvement, quality assurance, record keeping and other higher order activities required to produce excellent products to customers at a competitive cost. The trend in manufacturing towards lean six-sigma, the rise in highly regulated sectors such as medical devices and suppliers to medical devices, and the increasing automation and sophistication of technology in many instances mean that people working in manufacturing typically have varied, rewarding and challenging jobs.



Case Study: EU Attract Project

The Attract project was initiated in 2010 and has examined the recruitment strategies of students to engineering sciences and how the retention of students can be improved at an international European level. A sub-group of universities managed the project over 34 months, including Trinity College. Comparisons were made between the education systems of the participating countries in order to evaluate the context of engineering education in different countries. The project activities were carried out within the following four work packages:

1. **Perceptions:** This strand finds that engineering is generally viewed as a respected and well paid job, however, it is perceived as highly difficult and academically challenging. A key action point is to highlight skills shortages within engineering, earnings potential and also to illustrate the potential social and cultural benefits of engineering professions.
2. **Barriers:** Limiting student choices early on in the school system curtails the potential engineering pool. Delaying specialisation until the latter stages of the school system would boost eligible numbers. Higher education institutes should target greater female participation and students from lower socio-economic backgrounds.
3. **Attraction** to engineering careers is helped through a combination of approaches: the promotion of STEM courses among young people, support for teachers training and development in Science and Technology, enhancement of female participation and roles; promotion of engineers as role models and increased general public awareness about the importance of Science and Technology.
4. **Retention:** Engineering programmes tend to have higher dropout rates across the different countries and students often take longer to reach graduation. Improving communications, providing support and feedback between students and the higher education institutes can help identify specific solutions to improving retention rates.

<http://attractproject.org/sites/default/files/document/Attract%20Project%20-%20Full%20Report%20-%202012.pdf>

The need for manufacturing companies to engage with the wider population is a major concern for manufacturing stakeholders, and was voiced many times throughout the research process. When individual manufacturing practitioners were asked why they thought there was a shortage of skills in manufacturing one of the reasons given, especially by the ICT hardware sector, was that manufacturing was not seen as attractive. Concerns about the negative impact of perceptions of manufacturing on students choosing courses at third level were evident in industry sector consultations and at workshops. The perceptions of a poor working environment in manufacturing, that manufacturing is dying or that jobs in industry tend to be predominantly routine, need to be challenged and awareness made of the real experience of working in manufacturing today.



There is an opportunity to achieve a higher female participation rate in manufacturing in order to broaden the talent pool available to the sector. At present 30 per cent of those engaged in overall manufacturing are female. The female share of employment varies between manufacturing subsectors, and in the case of the companies interviewed was 50-65 per cent in the Pharma-chemicals, food and consumer sectors, but only 10 per cent in the engineering sector, with ICT hardware and medical device sectors ranging in between.

While there are programmes to promote STEM subjects and others such as Discover Science and Engineering, Smart Futures and the STEPS programme to attract students into careers in technical areas such as engineering. Firms consulted argue that there is an urgent need to educate and engage the general Irish population with manufacturing as it is in Ireland today.

Case Study: Talent 2030 - UK

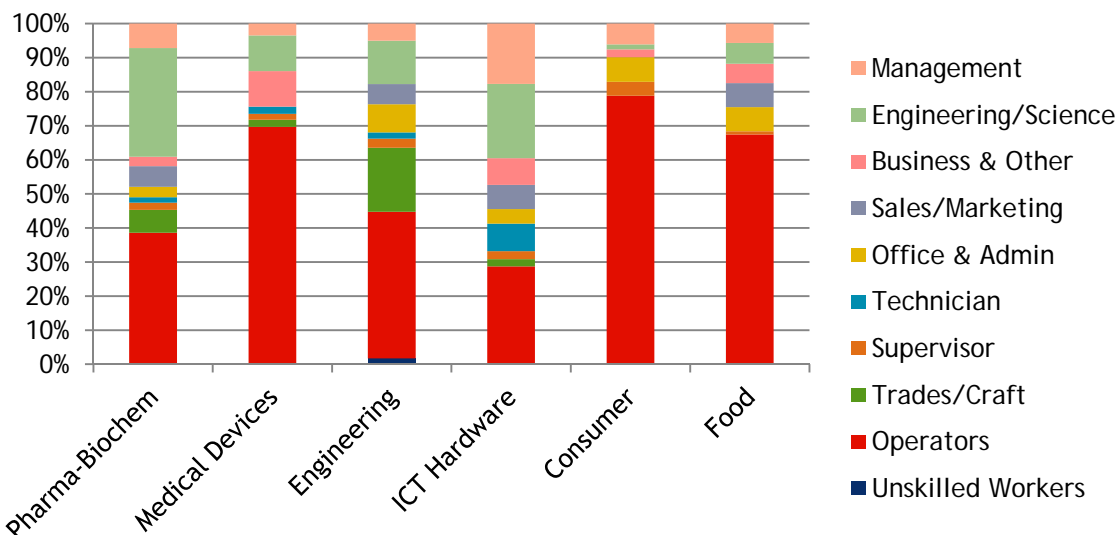
Talent 2030 is a campaign led by manufacturing industry representatives and Higher Education authorities in an attempt to rebrand and revolutionise perceptions of manufacturing and engineering careers. The project is marketed towards primary and secondary students with a focus on niche STEM and manufacturing disciplines. A number of organisations are involved with the campaign with organisations contributing via programmes, grants, awards, scholarships, workshops and training courses. The first wave of the campaign will focus on attracting more girls, to consider careers in engineering and manufacturing when making their subject choices. Fewer than one in ten engineering professionals are women and this is the lowest proportion across the EU. Talent 2030 cautions that so few women in these industries means that that the UK is at risk of letting half its talent pool go to waste.

Talent 2030: <http://www.talent2030.org/>

6.2.2 Manufacturing Career Paths

Manufacturing occupations have been analysed earlier under eight different classifications: managers, professionals, associate professionals, clerks, sales, trades, operatives and unskilled occupations. The percentage of people in each occupation varies between sectors. The actual percentages for companies interviewed are shown in Figure 6.2. Entry to manufacturing could take place at any of these eight levels, and progression between these levels can occur in a variety of ways. Career paths in manufacturing tend to be less structured and more organic than in many other sectors.

Figure 6.2 Occupational Profile of Manufacturing Companies Interviewed





On entering manufacturing at operator level, often there is no clear path for progression or recognition of skills gained unless there has been formal training. A young person can enter manufacturing as an operator either before or after Leaving Certificate frequently with no clear picture of how their career might progress in manufacturing. Equally a Higher Certificate or Ordinary Bachelor Degree graduate from an Institute of Technology may not see a clear progression path for themselves in manufacturing. It can also be confusing as they may be 'entry-level' in some organisations and technician level in others.

Consultations with industry and other stakeholders showed a clear need for more structured career paths in manufacturing, both in order to make career opportunities in the sector more visible and attractive, and in order to improve human resources and training practices. A clearly structured career path which recognises both formal and on-the-job training could provide progression paths from operative level up, linked to the National Framework of Qualifications. Consultations indicated that this would serve both individuals and firms well in terms of recognition of skills acquired, flexibility and succession planning. It would also ensure that young people contemplating a career in manufacturing either through direct entry as an operator or via an apprenticeship or through a higher education qualification will have an informed view of the available career paths to consider.

Case Study: US Stackable Credentials National Association of Manufacturers Skills Certification System

The National Association of Manufacturers has developed a system of Stackable Credentials whereby students can layer their academic and work environment achievements in the pursuit of higher education or career advancement. The Credentials contain 9 potential stages ranging from; High School Diploma; Certificate for career readiness (Industry Issued); Certificate for Precision Machining; Associate of Applied Science Degree; Certificate for Production Technician (Industry Issued); Associate Degree with Speciality; Bachelor's Degree in Engineering; Certificate for Manufacturing Engineer (Industry Issued); and finally a Master's Degree in Engineering. The partnership between colleges and industry has led to a blended model of higher education where manufacturing industry sets the standards for competency based education. Harper College in Illinois launched a program in June 2012 allowing students to earn industry-certified credentials in manufacturing while 54 companies agreed to hire students from the college as part of a paid internship scheme following the completion of the first certificate. The college also introduced more specialised certificates in four disciplines; mechatronics/automation, precision machining, metal fabrication and supply chain management. The stackable credentials are designed to emulate curricula within colleges with Phoenix State announcing a bachelor degree track known as the Bachelor of Science in Management with a focus in the manufacturing division which encompasses proficiencies from the industry's credential system. To date over 115 institutions have adopted the stacking credentials system as part of their training policy.

http://www.themanufacturinginstitute.org/~media/8FF9BD4F9136436EABE0CD814D94D5D4/Stackable_Credentials.pdf

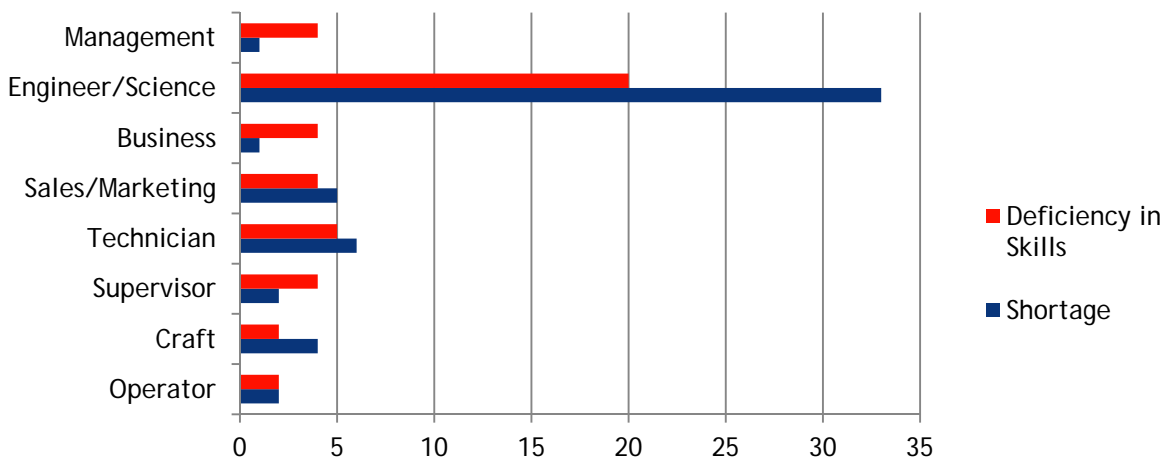


6.2.3 Current Skills Gaps

In interviews with manufacturing firms, 73 per cent of companies across all sectors reported a current skills gap. These do not necessarily imply a headcount shortage but can indicate a shortage of relevant skills externally that they expect would affect them if they had to recruit and/or a deficiency of skills within the workforce. In a minority of cases, they represent hard-to-fill vacancies. The skills gap is of significant concern for manufacturing and, as will be seen later, was listed as one of the challenges organisations said that they face.

Professional engineering and scientist occupations were the most frequently mentioned in both skills shortages and deficiencies in skills. Technicians were the next most frequent skills shortage mentioned, closely followed by sales and marketing occupations.

Figure 6.3 Current Skills Gaps by Occupation identified by Manufacturing Companies Surveyed*



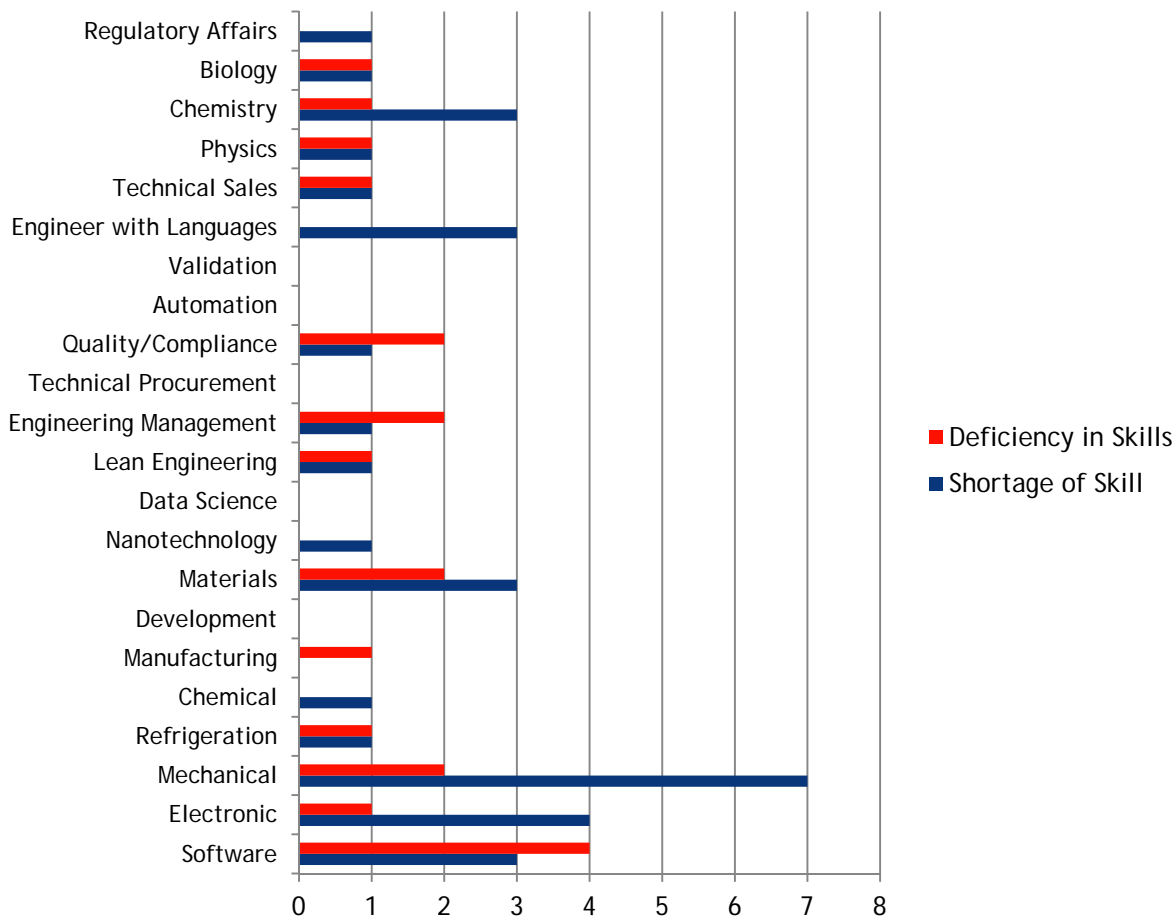
* Number of mentions of each of these gaps in interviews. Some firms mentioned more than one area of skills gap within an occupational area.

Professional engineering and science skills gaps are disaggregated into 22 specific skill areas in Figure 6.4. The skills shortages mentioned most frequently are mechanical engineers, electronic engineers, software, materials specialists (including polymers), chemistry graduates and engineers with languages.

The workshops provided corroborating evidence on shortages of skills in the main shortage areas highlighted by the survey. However, taking interview and workshop evidence together, it seems that some shortages relate specifically to experienced engineers rather than recent graduates, or specifically to recent graduates with high grades rather than to all recent graduates in a discipline. They do not all point to shortages that could be resolved just by admitting more students into relevant courses at Levels 8 and 9. Therefore, many of the skills shortages primarily relate to key persons with experience.



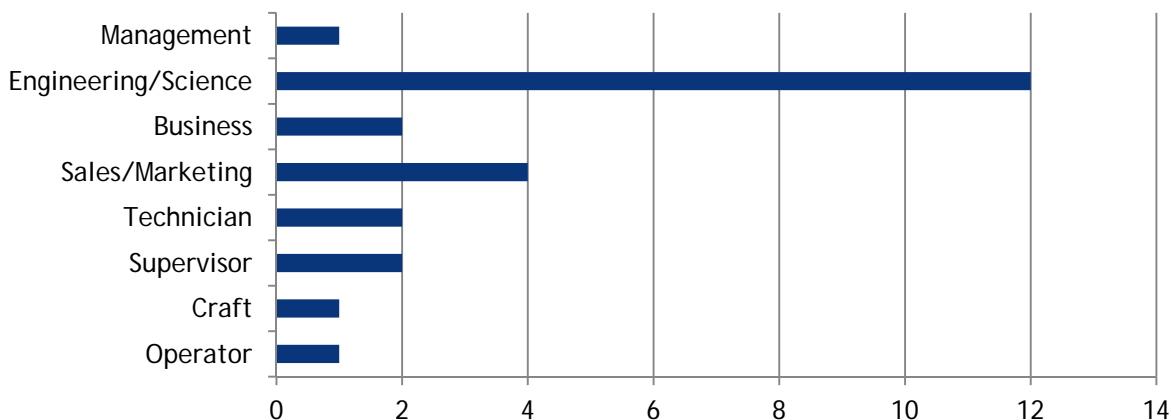
Figure 6.4 Current Skills Gaps for Engineering and Science Professionals*



* Number of mentions of each of these gaps in interviews.

While the interview survey identified only a small number of hard-to-fill vacancies, some firms indicated that they would seek to recruit skills if they were available. The majority of skill areas mentioned were in engineering/scientist occupation, as shown in Figure 6.5.

Figure 6.5 Other Skills which would be Employed if Available*



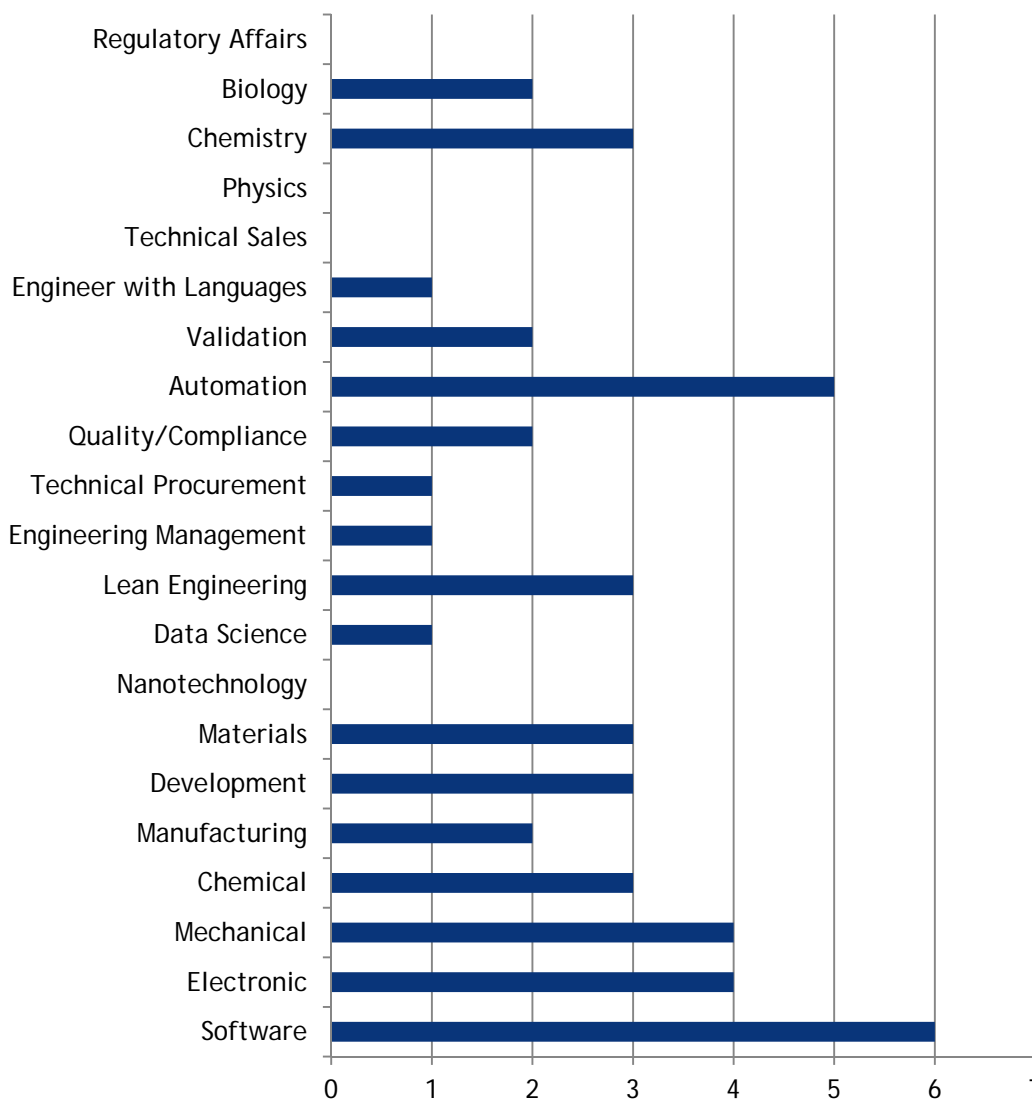
* Number of mentions of each of these skills associated with these occupations in interviews.



Firms surveyed were asked about the occupational areas where pursuing opportunities or strategic objectives are most likely to impact on employment numbers or on skills requirements. All of the main occupational categories were mentioned, but most mentions were for engineering or scientist occupations as may be seen in Figure 6.6. This suggests that, if firms succeed in pursuing these opportunities and objectives, the share of employment accounted for by engineering and science occupations will rise.

Figure 6.6 disaggregates the engineering and science occupational groups by skill area. They are distributed across a significant number of areas, with software, automation, mechanical engineering and electronic engineering appearing most frequently, but with a number of other engineering and scientific disciplines featuring significantly.

Figure 6.6 Engineering and Science Professional Occupational Areas where Pursuing Opportunities or Strategic Objectives is Most Anticipated to Impact on Numbers Employed or on Skills Requirements*

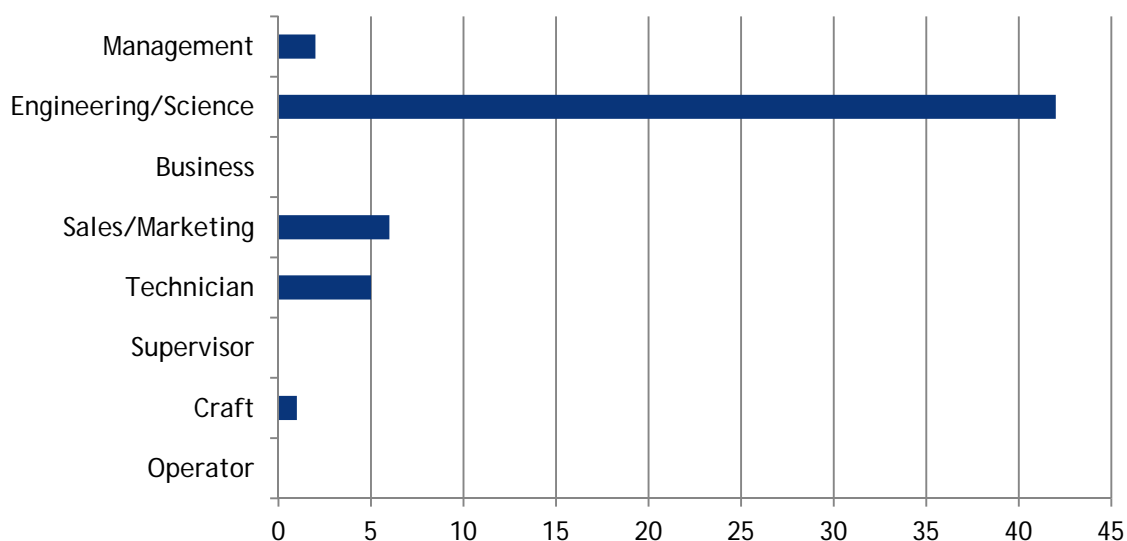


* Number of mentions of each of these skill areas in interviews.



When firms were asked about what their most important occupations will be in 2020, most mentions were of engineering and science occupations, with technicians and sales/marketing occupations also featuring significantly.

Figure 6.7 Most Important Occupations in 2020



* Number of firms interviewed that mentioned occupations in each of these categories when asked what their most important occupations would be in 2020.

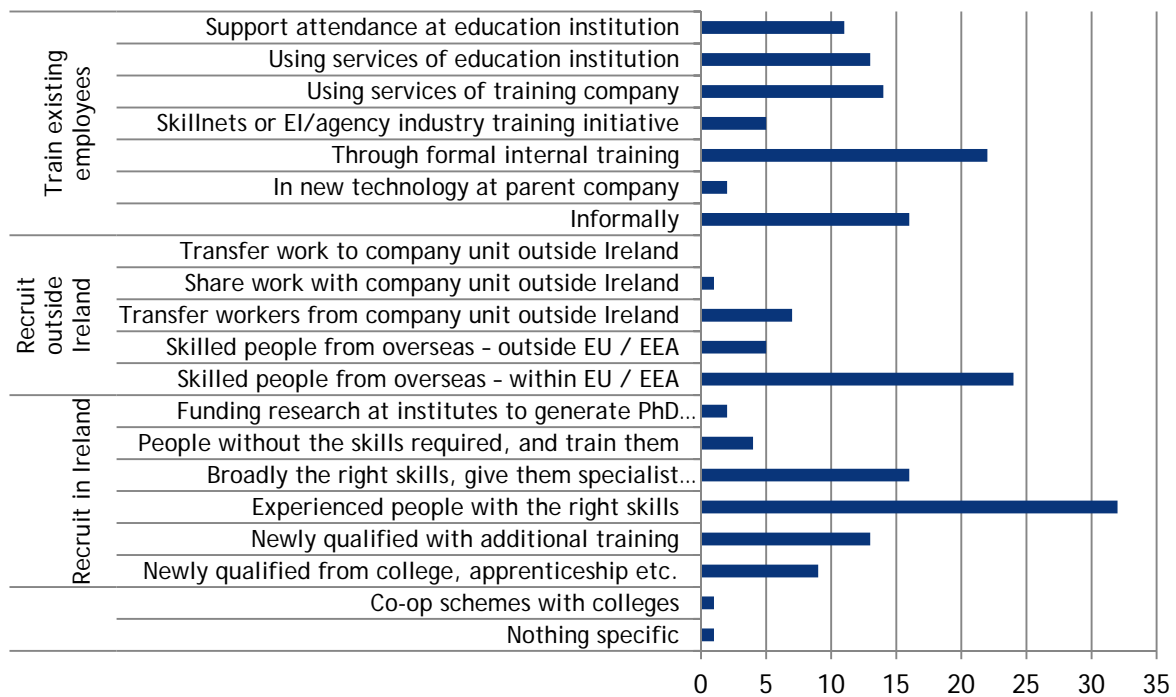
Firms use a variety of strategies to address skills gaps. The interview survey asked about what they do in three broad areas: recruiting in Ireland; recruiting overseas, and training existing employees. The results are summarised in Figure 6.8.

Key messages are as follows.

- All three types of solution are used extensively.
- Firms use a variety of methods to train employees in order to bridge skills gaps, with formal and informal internal training being the two most common among firms surveyed, complemented by significant use of education institutions and training providers.
- When recruiting from within Ireland to bridge skills gaps, firms are most likely to look for experienced people with the right skill, or for people with broadly the right skills who they can equip for the job with specialist training. Recruitment of newly qualified people to bridge skills gaps also features, but is mentioned by much fewer of the firms interviewed.
- Recruiting from overseas is a strikingly common approach to bridging skills gaps. Recruiting from within the EU/EEA is particularly prevalent, but some recruitment also goes outside the EEA. Transfers of people from company units outside Ireland also feature.



Figure 6.8 Approaches to bridging skills gaps*



* Number of firms interviewed in which each of these approaches was mentioned.

The main barriers to closing skills gap mentioned by individual companies were, finding the 'right fit' for the organisation, the length of time it took to 'grow your own' skills, budgetary constraints on training costs, the time which needed to be taken out of production for training and, the effect of location on attracting new skills.

6.2.4 Software

Software skills were mentioned as a skills gap by two sectors in particular, medical devices and ICT hardware.

The software skills needed in medical devices were for software quality assurance (i.e. software quality assurance for validation of software systems supporting the production process); software skills to manage the interface of IT systems with factory systems, software engineers for writing control software for automation equipment, and software engineers for product development.

In the ICT hardware sector software skills were required for operating system design and development, user interface development and developing hardware products with greater functionality.

6.2.5 Polymers/plastics

Polymer expertise appeared as a specific skill shortage across a number of sectors. The demand is at both technician and at engineer level. Materials science and engineering skills needs in Figures 6.4 and 6.7 include polymer/plastics skills gaps. Apart from companies wholly involved in plastics and polymer processing, there is considerable overlap with engineering, medical devices and consumer sectors.



Polymer technicians and engineers were mentioned as a skills gap in individual company interviews, at the workshops and in consultations with representative bodies. At present, First Polymer Skillnets provides a range of industry focused training with mostly Level 5 and some Level 6 courses. IT Sligo provides an online and distance learning course at Level 7 (B.Eng. in Polymer Processing) in collaboration with First Polymer Skillnet and Athlone IT. There was previously a full time Level 8 course at Athlone Institute of Technology.

Case Study: Northern Ireland Polymer Technician Apprenticeship Programme

The polymer technician apprenticeship incorporates in-company training with class room based learning for the full duration of the programme. It was designed as part of a partnership between the Northern Ireland Polymers Association and Cogent. Students who enter the programme must hold 4 GCSEs at grade C or above to include Maths and English. Employees must have experience of operating at Setter/Technician level; however, previous qualifications may exempt an employee from the NVQ Level 2 module of the programme. The programme is 3 years in duration where the candidate attends SERC for BTEC National Level 3 Diploma in manufacturing one day per week with the rest of the week spent with the employer in pursuit of NVQ2 Polymer Processing. The second year is identical to the first in structure however the apprentice works towards achieving a NVQ Level 3 Polymer Processing qualification. The final year involves full time work with the employer and completion of the NVQ Level 3 Polymer Processing qualification.

Northern Ireland Polymers Association: <http://www.polymersni.com/business-support/education-and-training>

6.2.6 Toolmaking

Toolmakers machine and assemble high precision moulding tools for the manufacture of plastic materials. Toolmakers also work with tools to produce metals and other materials. A shortage of toolmakers was reported during individual interviews, stakeholder consultations and in workshops. The shortages were related to mould manufacture for polymer/plastics moulding and were resolved in the short term in one instance through recruitment overseas. Toolmakers can also be in demand for CNC precision machining.

Training in toolmaking is apprenticeship based, and recruitment into training depends on decisions by employers to recruit apprentices. This makes it sensitive to fluctuations in the economy. There is a time-lag between increases in demand for skills triggering increases in the number of apprentices recruited, and the consequential increase in the number of qualified craftspeople produced. The number of new toolmaker apprentices recruited was over 100 per annum up to 2001 but fell to 19 in 2009. This number has increased again with 40 toolmaker apprentices recruited in 2011 but the numbers completing their apprenticeship reflect the low recruitment in 2009-10. The apprenticeship system is currently being reviewed by the Department of Education and Skills.

6.2.7 Automation

Automation is becoming increasingly important in manufacturing in Ireland. Since Ireland's cost base is high compared to many competitor countries, automation is needed to increase volume without increasing employment.

Automation skills discussed by individual companies focused on control theory and programming, robotics and vision system applications in relation to medical devices, ICT hardware and engineering



sectors. The actual employment profile suggests that the lowest percentage of operators and highest percentage of professional engineering and science skills were in the ICT hardware sector which may be related to the level of automation in this sector (Figure 6.2). When asked to rate their company relative to where they needed to be on automation the majority of the companies rated themselves at 3 or better; this was on a 1-4 scale where 1 represented the early stages of the journey and 4 represented 'very good' (Table 6.1).

Increasing levels of automation can make validation requirements more complex also.

Automation skills are required at technician level and at engineer level. These tend to be filled either through technicians and engineers in disciplines such as mechanical or software engineering undertaking additional learning to specialise in the area, or through specialist qualifications such as Level 7 and Level 8 degrees in Mechatronics from a number of IoTs. UCC offers a Masters in Mechanical Engineering - Manufacturing, Process and Automation Systems.

Table 6.1 Operations strategies - company self-ratings*

	1	1-2	2	2-3	3	3-4	4
Lean manufacturing**	3	2	6	7	6	3	2
Automation			1	4	11	2	5
Supply Chain Management	4	4	2	2	11	3	2
Regulatory Affairs & Compliance	1				10	8	11
Computer Integrated Manufacturing		1	4	4	5		4
Lean manufacturing**	1	2	2	1	9		1
Automation			1	1	2		

* Number of firms interviewed that gave themselves each of these ratings.

** The term "lean manufacturing" is used here to encompass the main process improvement approaches used in manufacturing, and includes six sigma, lean six sigma, world class manufacturing and others. Another 5 companies indicated they were just starting on lean manufacturing. Scoring on this by companies is inconsistent - some of the firms that have made most progress score themselves harshly, recognising how much scope there is for even better performance, while other companies score themselves highly even though relatively new to lean manufacturing. Nevertheless this gives us some indication of the importance of lean activity.



6.2.8 Lean manufacturing

Lean manufacturing, and similar types of process improvement programmes, are successfully permeating Irish manufacturing. Over 90 per cent of companies interviewed are engaged with lean manufacturing or similar programmes, some starting out and some with 10 or more years experience. For many smaller companies, Enterprise Ireland has been important in providing lean-six sigma initiation and training with its Lean Start, Lean Plus and Lean Transform programmes.

As the lean movement grows in Ireland a need to standardise the approach taken was suggested in some industry consultations. The need for benchmarking was also suggested by company interviews. When asked to rate themselves in terms of progress along their lean 'journey' where 1 represented the early stages and 4 represented have reached the place they needed to be, the majority of companies rated themselves in the 2 to 3 zone (Table 6.1). There was some inconsistency in how they rated themselves along the lean journey. Some of those toughest on themselves were those who were very experienced in applying lean principles and who compared themselves to Toyota, while some relatively new entrants felt they were quite a distance along the journey. This suggests that there is a need to continue to build an understanding of lean at all levels of the organisation. Building skills in lean is currently constrained by time and cost in a number of companies.

6.2.9 PhD skills

While there is considerable emphasis on PhD level requirements for pre-manufacturing research, technology and development, there is also a need for PhD level skills in manufacturing. Changes in technology, introduction of new manufacturing processes, new materials, more complex regulatory requirements, R&D on production processes to improve yield or reduce cost and key people to lead a team and drive innovation require small numbers of highly skilled scientists and engineers at PhD level in some firms.

There is a need for high level chemistry skills in the biopharma-Pharma-chemicals sector to scale up production processes efficiently, and in some cases to develop continuous processing as an alternative to batch processing for manufacture of APIs (active pharmaceutical ingredients) and associated requirement for in-process analytical techniques and compliance with regulatory requirements. High level biotechnology skills are in demand for new bioprocessing techniques and new ranges of biological products.

PhD level technologists were mentioned as a skills gap in the ICT hardware sector where specialist technologies and process improvements can improve competitiveness.

This should be compatible with one of the research prioritisation areas identified in the Report on Research Prioritisation Steering Group 2012, '*Manufacturing Competitiveness*'.

6.2.10 Data Analysis

There is an increasing amount of data produced in manufacturing from process controllers, shop floor data capture and quality systems. The skills to analyse and interpret this data are only beginning to emerge as a future skills need in some sectors of manufacturing. In the biopharma-Pharma-chemicals sector bioanalytics is identified as a skills requirement. Data analysis is becoming more important as a skill area useful to engineers and scientists working in manufacturing.

Data analytics has been identified as a one of the 14 priority research areas for Ireland.



6.3 Enterprise Skills

6.3.1 Managing Change

With new technology, new products and new operations strategies there are many changes in manufacturing. The ability to deliver change includes the ability to project manage change and to engage and motivate people to embrace and work with the change. Two skills gaps were identified in this area: project management skills and change management skills. The new Graduate Transition and Professional Progression programmes for CPD accreditation from Engineers Ireland address some of these enterprise and soft skills gaps for professional engineers.

A good example of a significant change initiative using an external training company came to light in the course of the research, which has been undertaken by one organisation to develop these skills.

6.3.2 Technical Sales

Technical sales skills combine technical product knowledge with commercial ability and people skills to go out to customers, understand their needs, propose solutions for them and build relationships with them. Many Irish engineers do not see a sales role as a positive career development, whereas in other countries many of the best engineers move into sales and other commercial roles. Having a European language, such as German, can be especially useful in this role when operating within Europe. A third of the engineering companies interviewed say they have a skills gap in this area critical to building their business for the future.

6.4 Closing Skills Gaps

Based on the evidence from interviews, workshops and stakeholder consultation, a number of approaches are proving successful in closing skills gaps through training and education provision. Skillnets was cited by many manufacturing companies as a vehicle for providing customised training in an accessible format. For example, conversion programmes facilitated by FÁS or through Skillnets training networks were noted as being valuable in bioprocessing, polymer training and in supplying validation engineers. Distance learning programmes making heavy use of online technologies, such as those provided by IT Sligo are accessible to learners even when overseas on assignment so that training is not interrupted.

However, one of the difficulties in addressing skills gaps mentioned by manufacturing firms has been the weak alignment between manufacturing and higher education institutions. Many SMEs, in particular, say that they find it difficult to engage with third level institutions, but that Institutes of Technology tend to engage more proactively than universities.

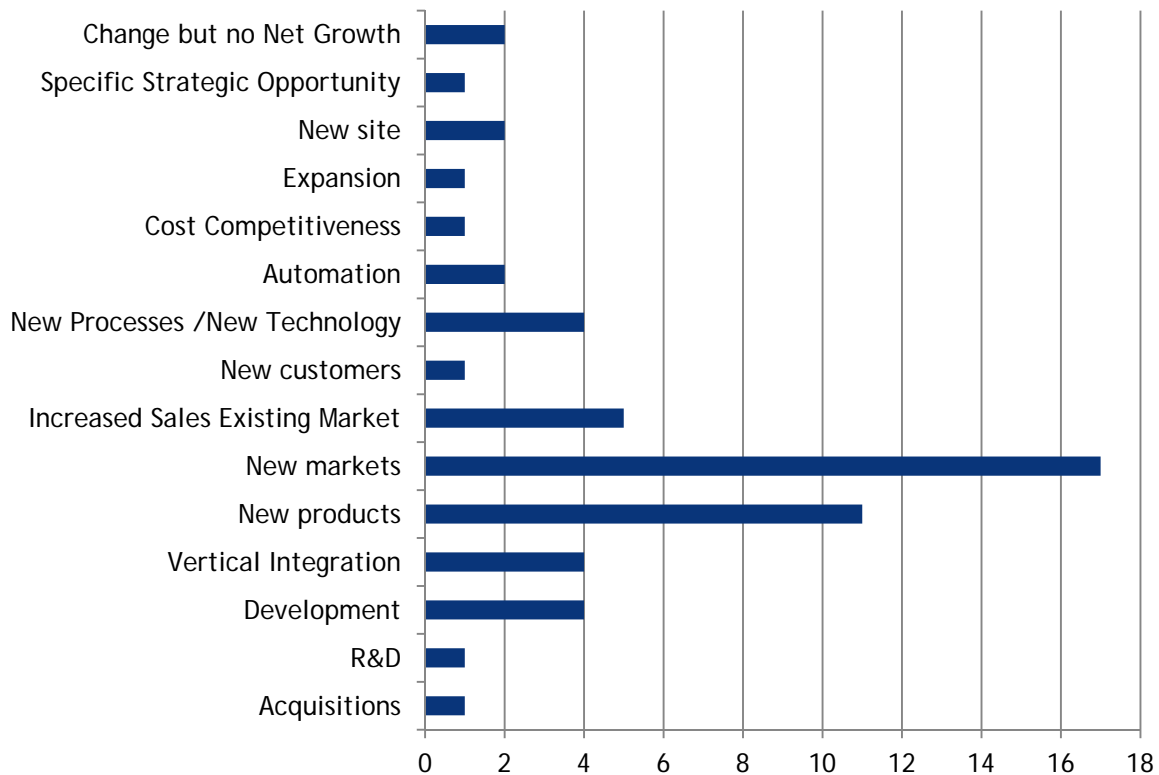
Several firms proposed that the relationship between education providers and industry should be much closer. The rate of technology change has accelerated and any 'time lag' by education providers will be exacerbated in the future. While there are many examples of positive links between HEIs and manufacturing industry, the quality of the relationship appears to vary by institution and companies expressed their concern that this is not consistent or well structured.



6.5 Future Opportunities for Manufacturing

Future opportunities for manufacturing are predominantly seen as revolving around the development of new markets and new products, as can be seen in Figure 6.9. For the firms interviewed that mostly sell within Ireland (consumer sector and some areas of engineering), the UK was the market most frequently identified for growth. For companies already involved in exporting, new markets tended to include Europe and/or eastern Asia. Introduction of new products is a strategic objective for many manufacturing companies that are leaders in their field, or which frequently change their product to differentiate it. Increasing sales in existing markets was particularly seen by food and consumer sector firms interviewed as an opportunity for growth.

Figure 6.9 Future Opportunities for Manufacturing Companies Surveyed



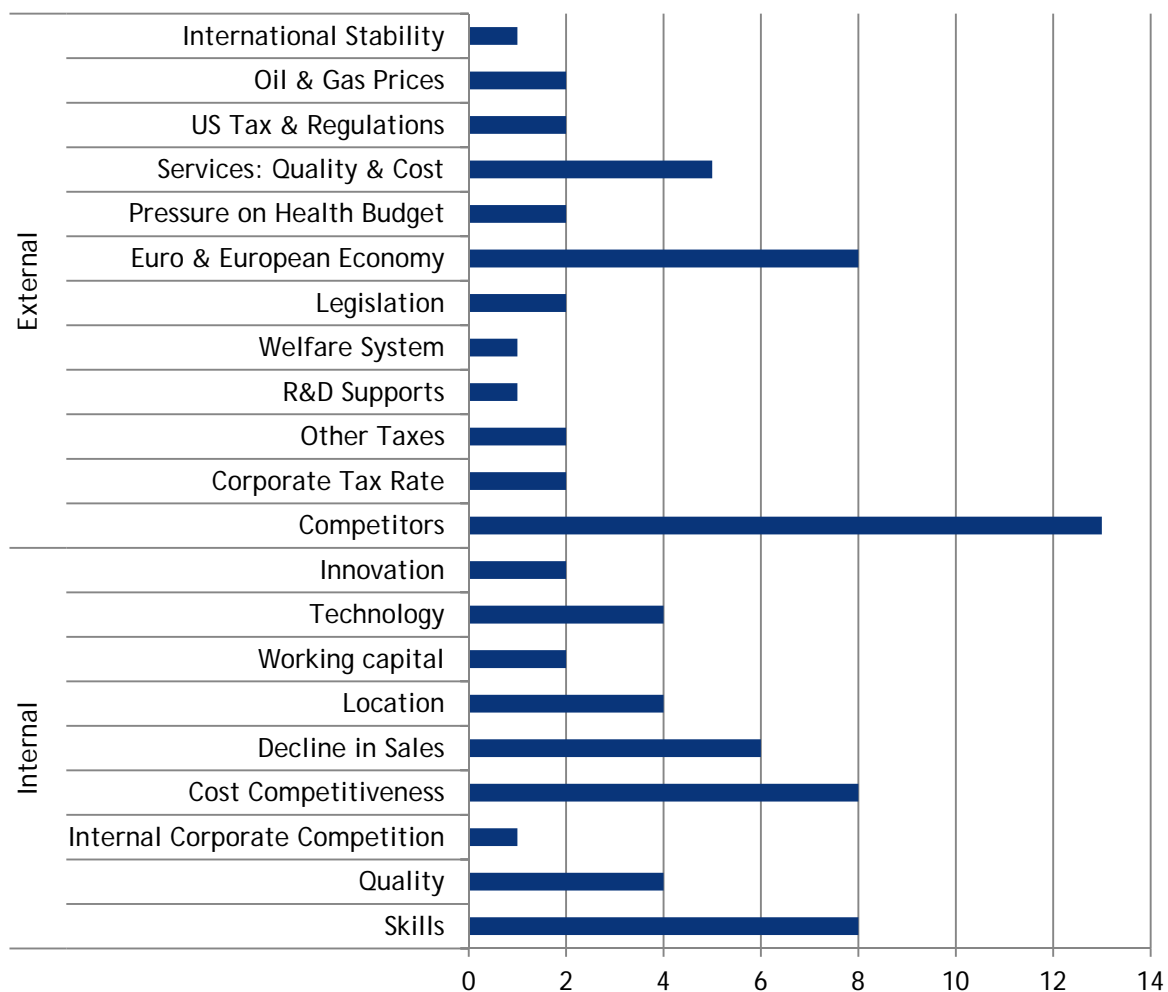
* Number of firms interviewed in which each of these opportunities was mentioned.



6.6 Strategic Threats and Challenges for Manufacturing

Manufacturing is operating in a challenging and difficult environment with both internal and external threats. The threat most commonly identified by firms interviewed was external competitors, as can be seen in Figure 6.10. The next most commonly identified external threats for manufacturing were issues relating to the euro currency and the stability of the European economy. The two leading internal challenges were skills needs and achieving sustainable costs to be competitive.

Figure 6.10 Strategic Threats and Challenges for Manufacturing Companies Surveyed*



* Number of firms interviewed in which each of these threats and challenges were mentioned.

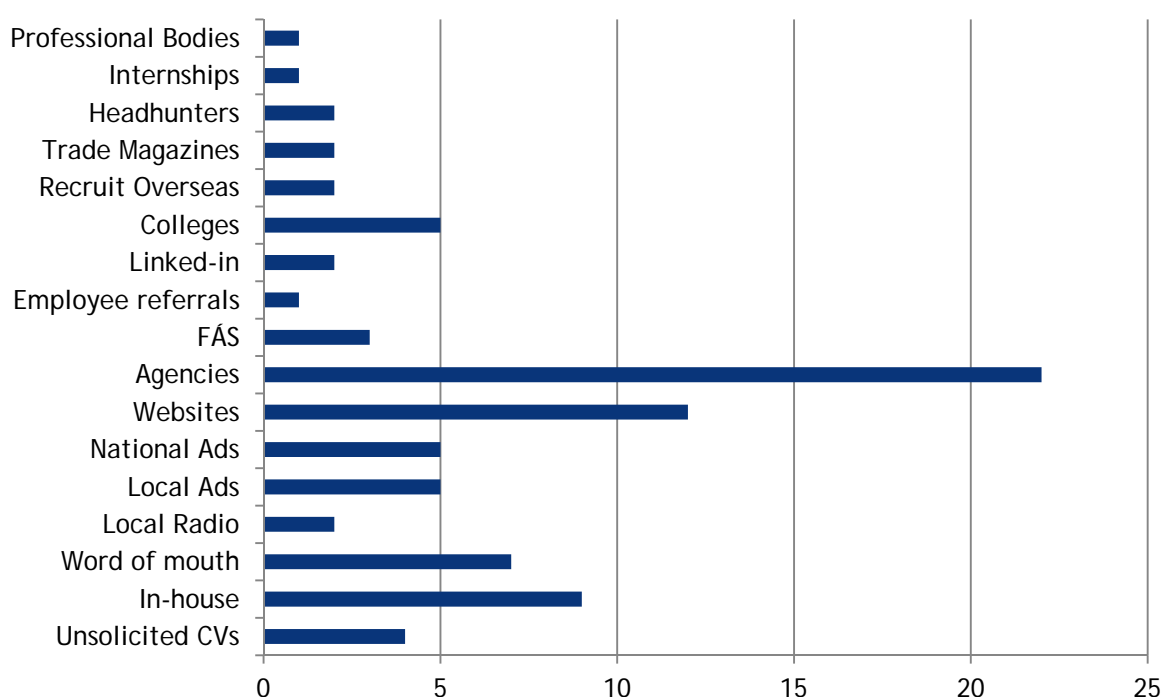
Taken as a whole, the views summarised in Figure 6.10 convey a strong message that Irish manufacturing industry sees itself being exposed heavily to international competition, with both cost and non-cost factors being important to its ability to compete, and that skills have an important impact on competitiveness.



6.7 Recruitment Challenges

Manufacturing companies employ a range of methods to meet their skills needs. For smaller companies with less dedicated resources, the research indicates that recruitment is seen as difficult and time-consuming, with considerable risk if a person recruited turns out not to be suitable. The time and money invested are wasted, and there is also an important gap in the company skills base. The method of recruitment mentioned most frequently was the use of agencies, as can be seen in Figure 6.11. The next most frequent methods were via websites, in-house recruitment, and 'word of mouth'.

Figure 6.11 Recruitment Methods used by Manufacturing Companies Interviewed*



* Number of firms interviewed in which each of these recruitment methods was mentioned.

6.8 Sector Specific Skills Gaps

6.8.1 Food and Beverages

Interviews were conducted with three food companies, all of which came from subsectors expected to grow as outlined in the 2009 EGFSN Report on Future Skills Requirements of the Food and Beverages Sector, where 30 companies were interviewed. Two of the companies interviewed were indigenous companies in niche markets and the third company was foreign owned. Each of the businesses hoped to grow volume in the next 2-3 years with some additional headcount in management, quality control and sales and marketing.

All firms interviewed mentioned current skills gaps in production and/or supervisory management, and two highlighted difficulties in filling vacancies in the area. The business impact is on production



efficiency and constraints in production capacity. There is a matching theme of action on skills in this area, particularly in terms upskilling operative and supervisory level staff by putting them through external courses (including degree level), and by mentoring and/or internal courses. This same issue is evident in the EGFSN report on Future Skills Requirements of the Food and Beverages sector and there has been some progress to addressing this through the Taste 4 Success Skillnet initiatives for operatives and supervisors. There were also skills issues in sales & marketing and languages for developing new business in the UK, Europe and the Far East. The 2009 EGFSN report also highlighted difficulties for some firms in developing in-house quality control specialism.

6.8.2 ICT Hardware

The ICT Hardware firms interviewed ranged from small indigenous companies to large foreign owned firms. Smaller firms tended to have a greater need for technical sales and marketing skills while larger ones had more of a process improvement or R&D focus. Eleven firms were interviewed in total.

Automation was seen as a way to increase cost competitiveness in ICT hardware manufacture and in associated high volume manufacturing. Skills in control theory, robotics and vision system applications were required at both engineer and technician level to support automation.

Some larger firms indicated a requirement for PhD level technologists for R&D and process improvement. Process improvement helps to raise the profile of manufacturing companies based in Ireland especially when the company is part of a multinational organisation where there is internal competition for work and new projects.

Qualifications requirements are rising in at least some firms. ICT technician roles which might previously have required the equivalent of a Level 6 higher certificate may now require a Level 7 ordinary bachelor degree and some technician roles now require a Level 8 honours bachelor degree. These are needed for ICT manufacture for technical duties including trouble-shooting and leading a shift.

Other specialised engineering skills mentioned by firms include electronic engineers with materials and test experience; radio frequency (RF) engineers, possibly electronics engineers with a Masters in RF for R&D; and specialised engineering skills, such as wet etch skills for semiconductor manufacture.

Data analytics is a skill area which will be needed to analyse and interpret large volumes of data. Workshop discussions highlighted the potential for data analytics in using the large amount of data being generated by process control and shop floor data capture systems. Manufacturing process applications of data science are likely to mainly require process experts (such as production engineers) who also have data analytic skills.

Engineers with languages for sales to expand business were also identified as a skills gap by some ICT hardware companies. These tended to be smaller indigenous companies that need to go out into the market and win business globally. The foreign language mentioned most frequently for use within Europe was German.



6.8.3 Pharma-chemicals

The global transformation which the Pharma-chemicals sector has been undergoing in response to challenges in terms of cost pressures, patent expiration, competition from generic drugs as drugs go out of patent and a shrinking research pipeline has implications for the types of skills needed. A recent in-depth study of this sector by the Expert Group identified these skills from interviews with companies and stakeholders and workshops with the sector. The current study endeavoured to corroborate continuing and future needs for those skills and any additional skills gaps emerging. Three pharmaceutical companies were interviewed, one small indigenous and two medium-sized foreign owned companies.

Chemistry skills required include analytical chemistry, organic chemistry, crystallisation and formulation and also pharmacology. Advanced, in-process, analytical techniques are required for continuous processing. The need for formulation skills was emphasised by one of the pharmaceutical firms interviewed, which mentioned the Pharmaceutical Technologist qualification available in the UK. Masters and PhD level chemistry skills are in demand for some of the above areas, and skills to take product from laboratory concept through scale-up to manufacturing process.

Biotechnology skills are required for bioprocessing with a focus on formulation, cell culture, stem cell research and vaccine development. Bioanalytics and bioinformatics are also important.

Compliance and regulatory affairs are becoming increasingly more complex and require dedicated skills.

6.8.4 Medical Devices

Three medical device companies were interviewed for this study together with industry stakeholder consultations and workshop discussions. This was to validate and update the findings from the EGFSN *Future Skills Needs of the Irish Medical Devices Sector 2005* report. The skills strategy for the medical devices sector has been to build operational excellence to support cost competitiveness and to drive product and technology innovation.

The skills required to drive operational excellence include skills in managing technology, change, strategy, cost control and leadership. Business unit leaders need to have supervisory soft skills, especially people engagement skill. Change management skills are also important so that the skills exist to drive through change with the best outcome in terms of 'buy in' and commitment from the team involved.

Technician level qualifications are increasingly required for machine operator roles at 'entry level' by companies in this sector. As technology of machine interfaces and diagnostics becomes more sophisticated, the role of the person assigned to the machine is one of 'minding and servicing' the technology which in turn operates the machine.

Product assurance skills required include software and validation skills for Software Quality Assurance including validation of software, change approval, risk assessment and failure mode analysis. Process validation skills are also required for new product introduction. Quality engineers are required in the medical devices industry for quality assurance, interaction with internal corporate quality auditors and regulatory affairs. The medical devices sector employs significant numbers of validation engineers to validate the compliance of production processes with the specifications that have been approved by, or notified to regulators.



Software engineers are required in development of ICT enabled medical devices; the addition of intelligent systems to medical devices has led to a demand for software design skills on product development teams in convergence of technologies.

Polymer technicians and engineers are required for design and production of plastic components, which account of a substantial part of all medical device production in Ireland, both in subcontracting and in many of the main medical device firms. A shortage of polymer technicians and engineers hinders product innovation in terms of mould design for product development, prototype runs, troubleshooting and validating new processes. The level at which these skills are required are at Level 7 and Level 8.

There is a particular demand for mechanical engineers with high honours Bachelor degrees. Engineering courses should cover the core engineering skills associated with a main engineering discipline. Additional skills can be developed through postgraduate courses; part time postgraduate courses can be used to provide experienced people with specialist skills.

Automation engineering skills with a particular focus on robotics and machine vision are required to support increased automation in medical device manufacturing.

Some firms require sales skills with languages. The languages mentioned by medical devices firms as being most in demand were German, followed by French, Spanish and Polish.

6.8.5 Engineering

Skills gaps identified by engineering companies were largely technical in nature ranging from operative to professional engineering level. Engineering companies have been affected by performance in other sectors, as many are suppliers of hardware, components or equipment to other sectors, notably construction, medical devices, food and Pharma-chemicals sectors.

In addition to stakeholder consultations, thirteen companies were consulted on their future skills needs. The companies interviewed were mostly small and medium (30-250 people) indigenous companies engaged in a broad range of engineering activities.

Several of the firms interviewed identified gaps in the supply of skills for CNC machining for precision engineering work in machining moulds and highly toleranced components, and this was corroborated in workshops. CNC programming for mould making and product machining was also identified as a skills gap. As one contributor from these companies said, 'we're not just pushing buttons to run these machines'; i.e. they need highly skilled machinists who have an understanding of high tolerances and finishes and the metrology methods required to measure them. Programming and metrology skills are also required to program CMM (Co-ordinate Measuring Machines) for product validation. Currently, one career path for a CNC programmer could be from a toolmaker background as they would have an appreciation of precision tolerances and highly specified finishes. CNC skills are critical to the manufacture of highly specified metal products which in turn can be used to produce plastic components for sectors such as medical devices.

Several of the firms interviewed reported a shortage of qualified toolmakers. There had been a fall-off in the number of tool making apprentices from a high of well over 100 in 2001 to a low of 19 in 2009. This trend has now been reversed with an intake of 40 toolmaker apprentices in 2011. The need for toolmakers was echoed at the workshops and in stakeholder consultations in the plastics and the engineering sectors. The Medical Devices sector requires a high number of plastic moulded



products and toolmakers are required to manufacture the moulds which are used to produce those products.

Another issue for engineering companies has been the initial training of operators to work in an engineering environment. Training covers topics such as reading an engineering drawing, basic machining skills such as loading and unloading product, basic product checks, completing product and materials documentation for traceability and an appreciation of quality and regulatory requirements. This training represents a high level of investment in an individual.

Other specialised technical skills included: engineers with materials expertise for new product design and testing in metals area; automation skills in robotics to increase throughput without corresponding increases in employment; and polymer technicians and engineers for plastics manufacturers.

There is a need for technical procurement skills, for example an engineer with commercial knowledge who has the ability to work with suppliers on technical matters, but also has the skills to negotiate the terms of a supply agreement.

There is also a need for technical sales people who can go out to customer, understand their technical and business needs and build a relationship with them. Associated with this, there is a need for engineers with European languages for technical selling, and for other customer-facing commercial and engineering roles.

6.8.6 Consumer Goods

Firms in the consumer manufacturing sector operate in a very competitive environment whether as a foreign owned entity or as an indigenous company. The current skills gaps identified in interviews tended to be commercial and related to people skills compared to other sectors where technical skills were needed. In some instances this was due to a recent or on-going contraction of the company in response to commercial pressures and the resulting excess of production related skills. However, firms identified some future technical skills needs in the context of future opportunities and strategies.

Three companies were interviewed in this sector, two of which were established over 50 years ago. One company felt it had no current skills gaps. The other two companies mentioned supervisory skills, production planning, Material Requirements Planning (MRP), supply chain management, sales and marketing skills and R&D skills, required to continue to differentiate their product by adding new product features and to secure new businesses and increase volumes. Future skills gaps identified included design and manufacturing engineers to improve component design for manufacture and to deliver flexible automation solutions. While further automation was needed to continue to drive down unit costs, flexibility and speed of response needed to be maintained; one of the major reasons for having a plant located in Europe was for speed of response to a specific demand or local product variation.



6.9 Conclusions

Manufacturing needs an engaged pool of people who are aware of the interesting and exciting opportunities offered by manufacturing; a lively working environment, fair pay and conditions, modern work practices and development opportunities. Introducing structured career paths for operative, technician, craft and supervisor levels could play an important role in attracting talented people into these roles.

A number of cross-sectoral skills gaps have been identified in manufacturing; polymer expertise, toolmakers, automation skills, benchmarking lean manufacturing, technical sales and project management and change management skills.

Approaches to closing these skills gaps include continued use of industry-led upskilling programmes through Skillnets, flexible training options and a more formal relationship for alignment of needs between HEIs and manufacturing either directly or through a third-party.



Chapter 7: Conclusions and Recommendations

7.1 Introduction

This chapter synthesises the key findings and conclusions of the research, and makes recommendations based on these.

The future development of the sector will be influenced strongly by its competitiveness in international markets. Alongside cost competitiveness, skills will be one of the key factors driving future competitiveness and future levels of employment. Skills have a central role in pursuing the manufacturing excellence agenda common to almost all firms in the sector.

A key issue in providing skills for the future will be improved perceptions of career opportunities in the sector. While this is partly a matter of better communicating the reality of working in the sector to possible future employees, there is also a need for action to better map and develop career pathways.

This chapter summarises the findings on skills needs, focusing on skills at all levels, from operative skills to researcher skills and “key person” skills, and focusing in particular on skilled trades, technicians and engineers.

Recommendations are made under the following headings:

- 1 Tackling supply issues at operative, skilled trades and technician levels;
- 2 Professional level skills for manufacturing;
- 3 Fourth level skills for manufacturing;
- 4 Improving higher education linkages to manufacturing skills needs;
- 5 Upskilling those in-employment in manufacturing;
- 6 Establishing clear career paths in manufacturing;
- 7 Promoting manufacturing careers.

7.2 Key Findings and Conclusions

7.2.1 Skills, Productivity and Competitiveness

Despite substantial loss of employment over the last ten years, there is potential for employment in Irish manufacturing to stabilise and grow in the future. Under the two competitive scenarios presented in Chapter 5, manufacturing employment has the potential to grow on average by approximately 0.8 per cent and 2.3 per cent per annum from 2012 to 2020, or between 11,000 and 43,000. This depends highly on both significant improvements in domestic competitive factors, including skills, and favourable global conditions for Irish exports. The continuing loss of competitiveness scenario highlights the implications of inaction on competitiveness factors within domestic control, with the potential for a continual erosion of the manufacturing base out to 2020 with a decline in the region of 20,000 in the numbers employed.

The future path of employment in the sector will be sensitive to developments in the competitiveness of manufacturing operations in the sector - how effectively they can compete in terms of both cost and non-cost factors. Inter-firm competition in international markets, intra-firm competition between business units in different locations enhanced mandates and international



competition between locations for new mobile investment all impact significantly on Irish manufacturing employment.

Progress on many elements of competitiveness can be influenced by Irish stakeholders, including government, the social partners, education and training institutions and manufacturing industry itself. Progress on other aspects of competitiveness, notably euro exchange rates and developments in competitor countries, is substantially outside our control.

Of the elements of manufacturing competitiveness that are within Irish control, the supply and quality of skills, and the capability to upgrade skills as required, are among the most significant.

Ireland is a relatively high cost location. Even with vigorous policy action to improve cost competitiveness, costs will still be high relative to central European locations within the EU, and relative to many emerging economies in other parts of the world. The degree of competitiveness required to sustain and grow employment can therefore only be achieved through labour productivity that is both high in absolute terms (to cover high labour and business costs) and higher than can be achieved in locations with lower costs (so that Ireland is competitive as a location). High labour productivity is a function of skills, technology and a high quality business environment. Many manufacturing technologies are easily transferrable between locations, but skills are less easily duplicated, making them centrally important to any strategy based on achieving levels of productivity higher than can be achieved at lower cost locations.

7.2.2 Manufacturing Careers

Negative Perceptions about Manufacturing

Based on the interview, workshop and stakeholder consultation evidence, there is a clear consensus among stakeholders that manufacturing industry suffers from negative perceptions among the Irish population, and that this dissuades suitable people from seeking to make a career in manufacturing. This is an important root cause of some of the more specific skills issues highlighted later, and it is anticipated that it will become a bigger issue as employment in the sector stabilises or grows.

Key issues of perception include the following.

- There is a widespread misunderstanding that manufacturing industry is dying in Ireland, and that this means career opportunities are poor. However, as seen earlier, there is a good prospect that manufacturing employment will stabilise or even grow as competitiveness improves, which will generate demand for skilled workers to meet needs arising from employment growth in the stronger parts of the sector, and which will generate a need for new workers to replace those who retire or leave the sector for other reasons, and to contribute to upskilling across the sector as a whole.
- Even if the major job losses of the last ten years were to continue, manufacturing industry would still be a major presence in Ireland for several decades into the future. The more sustainable parts of the sector would continue to offer very good career opportunities, and even firms in declining parts of the sector would continue to hire in order to replace staff who leave and in order to upskill.
- There is a widespread belief that manufacturing involves low skilled work in unpleasant and even dirty surroundings. However, the reality is that skills requirements are rising because Irish manufacturing has to focus on sophisticated activities in order to be competitive, and mostly



cannot afford to pay people to work at a level far below their potential. Most manufacturing is in modern buildings with modern equipment.

- There is a widespread perception that manufacturing does not offer good opportunities for career progression. This perception is not accurate, but it has more truth to it than the other perceptual issues. The reality is that, while there are opportunities for career progression in the manufacturing sector, they are not well structured and mapped, and probably do not work well in many cases. This is particularly an issue for those entering employment in the sector below the level of professional engineer or scientist, or typically below Level 8 in the National Framework of Qualifications.

These perceptions can be addressed in part by initiatives to better inform school students, other potential employees and the wider public, and the recommendations that follow include practical proposals for this. However, tackling the career progression issue requires action on both perceptions and reality.

Career Progression and Qualifications in Irish Manufacturing

The main cross-cutting issue at the operative, skilled trades, technician and supervisor range of occupational levels that emerged from the research is that opportunities for career progression at and from this range of levels are not well structured or well mapped out, particularly to prospective entrants to manufacturing. This emerged as the principal issue of broad concern to stakeholders from the workshop that focused on these occupations, and was echoed in interviews and in the workshop on manufacturing excellence. It also emerged from comparisons between Irish training systems and training systems in other countries such as Germany (as a representative of the many dual-system vocational training systems), the US (the home to many firms with Irish manufacturing operations, with vocational training systems that contrast with those of dual-system countries) and the UK (as Ireland's nearest neighbour).

Key features include the following.

- Career paths at these levels in Germany are well defined and well understood by all stakeholders, and are linked to a highly structured vocational training system structured around apprenticeships and apprenticeship-like traineeships. A significant feature is that journeymen qualified in the skilled trades have a progression route available within their trade - to Meister level.
- The UK has a somewhat complex set of education and training systems at these levels, made up of a combination of industry-led apprenticeship-like provision and college-led full time and part time provision. These are intended to provide well defined career development pathways from operative level up, and the UK's Sectoral Skills Councils provide guidance to map out how the progression systems are intended to work⁷⁷.
- In the US, there is considerable regional variation, but community colleges typically provide a ladder of vocational qualifications relevant to local employers, ranging as high as two year associate degrees, both college-led (full time and part time) and providing training to meet

⁷⁷ See, for example <http://semta.org.uk/individuals/progression-routes/>. SEMTA is the Sector Skills Council for Science, Engineering and Manufacturing Technologies.



employer needs. Depending on the occupation and the location, there may also be an apprenticeship route available. The recent *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing* by the President's Council of Advisors on Science and Technology has emphasised the importance of community college level education in reducing skills gaps, and the development of "stackable credentials" to "feed the talent pipeline"⁷⁸.

- In the US and the UK the development of career paths are industry-led (for example, the Manufacturing Institute in the US, or the UK SEMTA sector skills council). In Germany, employers and the education and training infrastructure are highly integrated in the operation of apprenticeships. In order for the education and training system to align appropriately, it is important that industry takes the lead in establishing the career paths. Industry ownership and endorsement of career paths ensures that the education and training infrastructure can be mapped appropriately to provide clarity to learners. It also provides clarity between industry and education regarding required competencies and enables gaps in learning infrastructure to be addressed where they may arise.

Ideally, people entering employment in the Irish manufacturing sector should be able to see what skills they would acquire, and what the opportunities to acquire additional skills and to progress to higher level occupations would be. Ideally, there should be well understood paths for progression, supported by the training and education systems, and recognised through qualifications positioned in the National Framework of Qualifications.

Some components of a system such as this are in place. There is a long-established industry-based apprenticeship system for many of the skilled trades. The Institutes of Technology are well established as providers of technician level education and training, both full-time for school leavers, and part time and through distance education for people in employment. Currently, the Institutes are also providing technician training to the unemployed under the Springboard programme. FÁS provides training programmes aimed at preparing people who are unemployed to work as operatives at a variety of levels of skill and qualification. There are industry-wide initiatives in some sectors to provide operative training at specific levels - for example Level 5 programmes, under Skillnets, for operatives in medical devices and bio-pharma.

Many manufacturing companies offer good training and career progression opportunities internally from operative level upwards, and some offer well-structured pathways for progression internally, confirming that this is relevant in the Irish context as well as internationally.

However, key issues are as follows:

- 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

⁷⁸ "9. Invest in Community College Level Education: The community college level of education is the "sweet spot" for reducing the skills gap in manufacturing. Increased investment in this sector is recommended, following the best practices of leading innovators.

10. Develop Partnerships to Provide Skills Certifications and Accreditation: Portability and modularity of the credentialing process in advanced manufacturing is critical to allow coordinated action of organisations that feed the talent pipeline. The AMP Steering Committee supports the establishment of stackable credentials."



trades not included within the apprenticeship framework. This contrasts with a wide range of other countries that have structured systems such as formal operative level traineeships organised similarly to apprenticeships (for example, an operative traineeship of 2-years duration in the case of Germany), local education providers with ladders of qualifications targeted at this level (community colleges in the case of the US) or formal apprenticeships for skilled trades not covered by apprenticeships in Ireland (for example, machinists in Germany and parts of the US).

- While there is scope for firms to put operatives through apprenticeships for skilled trades, to support their participation in technician training at an Institute of Technology, or to put them through a structured supervisory development programme, these possibilities are not well mapped out nationally for prospective operative recruits.

7.2.3 Skills and Manufacturing Excellence

Almost all of the manufacturing operations consulted through interviews and through participation in workshops are deeply engaged in change and improvement processes designed to achieve excellence in manufacturing. Manufacturing excellence programmes are designed to achieve high levels of productivity through increased output per worker, improved quality and increased flexibility. Stakeholder consultations with employer organisations and trade unions corroborate the interview evidence, and many of the stakeholder organisations consulted actively assist their members in this area through providing or facilitating access to training, through providing advice, or through promoting collaboration between or within firms.

Assistance for this sort of change is one of the main pillars of Enterprise Ireland's supports for indigenous industry, through its three-tier Lean Business Offer. Consultations with IDA Ireland indicate that it sees the manufacturing excellence agenda as being centrally important to competitiveness, with larger foreign-owned firms mainly having the resources to be able to drive it forward on their own initiative, but with many smaller foreign-owned operations limited in their progress by resource constraints - a form of market failure - similar to those that affect indigenous SMEs.

The principal types of manufacturing excellence activity described by firms are in the areas of process improvement and automation. The need for process improvement is universal. The firms that have made most progress say that their success has just revealed more opportunities to improve. The need for automation is very widespread, but some firms interviewed indicate that short production run lengths make it uneconomic under their specific circumstances. Aside from process improvement and automation, some firms consulted indicate that they invest in formal manufacturing process R&D. Other firms indicate that they are interested in doing this, or that they would at least like to have access to manufacturing process R&D capabilities at third level colleges or at some form of centre of excellence.

Lean Manufacturing and Skills

Formal process improvement approaches go under a variety of names, but the term used most commonly is "Lean". Other terms include Six Sigma (or Lean Six Sigma), Operational Excellence, Total Quality Management, Process Change and World Class Manufacturing. The precise terminology used is not an accurate guide to the precise content of a process improvement approach, as there is



a significant degree of variation in the processes and tools applied under programmes with the same title. At the same time, even process improvement programmes with different titles typically have a considerable amount in common, so it is reasonable to refer collectively to all of these approaches, when applied to manufacturing, as *Lean Manufacturing*.

Lean manufacturing approaches have been in operation in Irish manufacturing since the early to mid-1990s, and have been a focus of skills policy concern since that time⁷⁹. What has changed since then is that lean manufacturing approaches have become mainstream.

Successful implementation of lean manufacturing approaches has major implications for skills at all levels of a manufacturing operation. As pursuit of lean manufacturing has become the norm, these skills requirements have become common to most or all Irish manufacturing operations.

Based on interview and workshop evidence, the major skills implications of lean manufacturing are detailed below.

Implications for occupations

Strong **people skills and generic skills** have become very important across all manufacturing occupations, driven by the requirements of lean manufacturing.

- In addition to meeting technical skills requirements, **operatives** in a lean manufacturing environment need the skills to undertake basic problem solving, coordination, documentation and process management responsibilities. As lean manufacturing typically involves working in a team environment, skills in collaboration, communication and leadership are essential.
- **Technicians and skilled tradespeople** working in a lean manufacturing environment also typically work in team environments, with responsibilities in problem solving, coordination, documentation and process management. In many cases, their role includes both technical responsibilities and a formal leadership role (for example, shift supervisor), demanding a higher level of people skills than is necessary for operatives.
- **Supervisory management** has always required significant people and generic skills, but the team based, collaborative and measurement-focused approaches to work organisation that are usual in lean manufacturing place greater demands on skills in these areas than in the past.
- **Engineers and scientists** working directly in manufacturing have historically often had significant non-technical responsibilities, making people and generic skills relevant to their work. Progression into manufacturing management has always been a common career track, making these skills important to career development. Lean manufacturing has raised the requirement for skills in these areas, as management structures have become flatter, as team-based working has become more common, and as activities requiring non-technical skills, including team-based improvement projects, have become more important. Roles inherently requiring significant people and generic skills, such as quality engineering, validation engineering, supply chain engineering and customer site engineering, have become much more common. There is particularly rapid growth in these areas in regulated

⁷⁹ See, the FÁS Manpower and Training Studies of the Clothing, Textiles, Print & Paper, Chemicals, Food and Drink and Engineering sectors dated 1991 to 1994.



sectors such as medical devices. Engineers and scientists are often among the key people to lead lean manufacturing projects, or to be included in lean manufacturing project teams; they need strong people and generic skills, including strong leadership skills, for these roles.

- As with other occupations, lean manufacturing has increased the leadership demands on managers in manufacturing. A key message from interviews and workshops is that strong commitment from senior management down is necessary for success, and that this has to be communicated effectively through words and action throughout the manufacturing organisation.

Implications for Education and Training

- Employees involved in lean manufacturing improvement projects require training in the tools and techniques required. Many firms use training from the Six Sigma approach to process improvement to prepare employees to work on improvement projects. Six Sigma identifies several types of role: Executive Leadership and Champions from top and senior management; Black Belts and Master Black Belts who work as full time specialists in process improvement; Green Belts who work on process improvement projects alongside other job responsibilities; and Yellow Belts who also work on projects but with less training. Training to contribute to process improvement linked to these levels is available from several of the Institutes of Technology, Universities, from some Skillnets and through private training providers. Some companies in the sector have also made use of a UK Masters level course for senior manufacturing managers.
- Participants in the workshops undertaken for the study argue that the need for skills and knowledge in lean manufacturing is now so common in manufacturing industry that Level 8 engineering students who expect to work in manufacturing should cover principles of lean manufacturing in their course, and should get practical experience in undertaking lean projects through their work placements or through project work. It was suggested that they should cover the territory at a level equivalent to Green Belt.

Automation and Skills

Automated manufacturing processes have a major impact on skills requirements. Key impacts highlighted in interviews and workshops are as follows.

Automation typically eliminates the most routine manual work at **operative level** that can be undertaken by workers with limited skills. This tends to reduce the share of operatives in the workforce. It also tends to reshape operative work, requiring higher levels of skill. Firms cannot afford to allow avoidable operator error to damage costly automated equipment, to waste significant volumes of raw materials, to disrupt tightly planned production schedules, or to breach regulatory requirements⁸⁰. More important, it increases the number of manufacturing jobs that require significant technical skills and skilled trades such as industrial electrician, toolmaker or fitter. Work in areas such as overseeing automated machinery, operating complex automated

⁸⁰ Regulatory issues are particularly important for Irish manufacturing because of the relatively large share of activity accounted for by the highly regulated medical devices, food & drink and pharmaceutical sectors.



machinery (such as CNC^{B1} machines), record keeping, documentation, routine maintenance and quality control requires significant skills and knowledge.

As technicians, skilled tradespeople and engineers are required to design automated systems, to programme and re-programme them, to troubleshoot, to undertake maintenance, and to manage and improve their performance, the share of these occupations in the workforce tends to increase. Technicians, skilled tradespeople and engineers need a combination of mechanical, electrical, electronic and IT/programming skills.

Manufacturing Process R&D and Skills

Some manufacturing firms operating in Ireland are increasingly undertaking R&D into manufacturing processes, with an emphasis on Development.

Two broad types of R&D are relevant.

1. Engineering and operations management R&D into optimising manufacturing production processes.
2. Chemical and biological science-based R&D into scaling up and optimising process industry manufacturing processes, in industries such as pharmaceuticals, chemicals, food, beverages and semiconductors.

This work requires very high levels of skill, and at its more advanced levels requires people with research degrees at Levels 9 and 10 in a relevant area, or with equivalent levels of skill. Generating these skills requires higher education research in areas relevant to the specific skills requirements. Existing moves to focus higher education research funding on industry-relevant topics, and to develop industrial PhD programmes should make a major contribution to meeting these skills needs. Industrial PhD programmes are aimed at highly skilled people in employment, who can undertake their PhD research in their workplace.

Data Analytics

The need for skills in data analytics identified in the EGFSN report on *Key Skills to Trade Internationally* is also relevant to manufacturing. Indeed, manufacturing industry has a long history of applying statistical techniques to manage manufacturing processes for high quality. Statistical Process Control has been a core part of the quality management and process improvement toolkit for several decades. 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.

There was a strong consensus from stakeholders consulted on this that the main need is for professionals with a strong understanding of the specific manufacturing process, typically engineers or scientists (depending on the sector), to acquire skills in data analytics. The consensus was that this deep understanding is so important that manufacturing firms would generally recruit employees with general skills in data analytics - the combination of the manufacturing and statistical expertise is the demand.

^{B1} Computer Numerical Control



7.2.4 Toolmaking, Machinist Skills, Polymer Technician, Mechanical-Electronic Technicians and Trades

A significant number of engineering firms indicated a shortage of people with toolmaking and/or machinist skills. Some medical devices firms also identified a shortage or potential shortage of toolmakers.

A significant number of medical devices firms, and some firms in other sectors, identified a shortage or potential shortage of polymer technicians, qualified to around Level 7 in the National Framework of Qualifications.

There were also more general concerns about the supply of technical workers at skilled trades or technician level capable of working on machinery that combines mechanical, electrical, and electronic and IT/software technologies. This general concern intersects with the more specific concerns about toolmakers, machinists and polymer technicians, as all of these occupations involve skilled work with modern machinery.

Toolmaking skills are normally developed through apprenticeships. The role has evolved over time. Toolmakers in Ireland frequently require a good knowledge of polymers, and may be more heavily involved in tool design, tool maintenance and optimising tool usage than in tool manufacture. Many toolmakers develop skills in machine programming and automation after acquiring the core skills associated with the occupation. The number of toolmaking apprentices taken on by industry decreased through the 2000s, and fell sharply with the economic crisis in 2008/9. It has recovered partially since then. A number of firms consulted noted that many of their toolmakers are over the age of 50, and that retirements may contribute to future shortages.

There is no fixed approach to training **machinists**. The skillset is not fixed in any case, because different types of machine, and machines made by different manufacturers, can have significantly different specific skills requirements. FÁS provides some machinist training for the unemployed. Many companies provide training to new recruits themselves, and provide additional training over time to raise their skill level or to multiskill across a number of different machines. Firms with a strong training programme that have been able to recruit in recent years appear to be able to meet their own needs. The difficulty seems to arise chiefly for firms that do not have a recent history of recruiting operatives at entry level and training them as machinists. When these lose staff or increase sales they need to recruit experienced machinists, and have difficulty in finding them within Ireland.

Polymer technicians are in short supply, but there is already an initiative in place that goes some way towards bridging the gap. The First Polymer Skillnet works with IT Sligo to provide a distance learning Level 7 course in Polymer Engineering. Member firms of the Skillnet typically put existing employees with good potential through this course, and some places are reserved for training for the unemployed. Industry feedback on the course is good, and a number of the firms consulted commented on how well the distance learning approach used for the course meets their needs and the needs of their employees. However, as some firms indicated they would like to put more of their employees through the courses, and as demand for polymer technicians is not restricted to firms participating in the Skillnet, it is not clear that the numbers produced by the course are sufficient for manufacturing industry as a whole at current levels of activity. If significant growth in the medical devices subsector continues, there is a prospect of significant shortages.

The concerns in industry about the supply of **mechanical-electronic technicians and trades** appear more diffuse. These skills are important in the context of automation and computerised machinery.



They can be supplied either through training and education that covers a combination of mechanical, electrical, electronic and software/IT skills, such as a Level 7 qualification in mechatronic engineering or an apprenticeship-based qualification in electrical instrumentation, or through training in a subset of these areas in the initial technician or trade qualification, followed by further training in complementary areas later.

However, the routes through which people train as technicians and skilled tradespeople have become less stable, as engineering graduates at Levels 6 and 7 increasingly progress to Level 8 before entering the workforce and as recruitment of apprentices by employers into the relevant skilled trades has fallen or become volatile. At present, this is being offset by technician level education for unemployed undertaken under Springboard. There is concern about how adequate the supply of suitably skilled people will be into the future, particularly if employment in manufacturing stabilises (requiring on-going replacement demand) or returns to growth.

7.2.5 Quantity and Quality of High Level Skills

In looking at the demand for professional level skills, the research focused particularly on engineers, and within engineering focused particularly on mechanical engineering and closely related disciplines such as manufacturing engineering and biomedical engineering, also paying some attention to electronic, electrical and chemical engineering⁸².

Engineers are important to manufacturing firms in most subsectors, working as manufacturing engineers and manufacturing managers. Many firms also have engineers working in product R&D.

In manufacturing settings, a number of different engineering disciplines may be relevant, but in most cases the greatest need is for mechanical engineers and related engineering disciplines. Depending on the subsector, there may also be a need for electrical, electronic, chemical or food process engineering skills in manufacturing. Process industries (Pharma-chemicals and parts of food processing and electronics hardware) differ from others in that they generally employ scientists - chemical, biological and/or food scientists depending on the sector - in some cases scientists outnumbering engineers. Where scientists are involved in manufacturing, they typically also fill many of the manufacturing management roles.

The engineering and science disciplines needed in product R&D differ between sectors, depending on the technologies used. Mechanical engineering and closely related disciplines are important for product development primarily in the engineering and medical devices subsectors.

Manufacturing firms consulted on their engineering and manufacturing management skills requirements emphasised the need for core engineering skills - that engineers should have the core skills associated with one or other of the main engineering disciplines, with mechanical, electrical,

⁸² By design, the research did not focus on computing and software engineering. This was to limit overlap with other Expert Group research. Skills in this area were addressed in the 2012 report *Addressing High-Level ICT Skills Recruitment Needs: Research Findings* and further research into quantifying future demand is underway. However, although it was not a focus of the research, firms and other stakeholder consulted made it clear that they are experiencing shortages in the area. Informants from the medical devices sector emphasised that the convergence between mechanical and information technologies flagged in the Expert Group's 2008 report on the Future Skills Needs of the Irish Medical Devices Sector is occurring, and that this and automation are driving significant demand for skills in computing and software engineering from a sector that has not traditionally recruited them in large numbers.

The research provides only a partial view on demand for electronic engineers, partly because they are covered by the 2012 High-Level ICT Skills report, and will be covered again by the future research that is planned. While much of the important Microelectronics Design sector (a key recruiter of electronic engineers) sits within manufacturing companies, it was not feasible to do justice to its skills needs in a very broadly focused piece of research such as this.



electronic and chemical/process engineering being the main disciplines relevant to manufacturing. So long as an engineering course develops these core skills and this is visible to prospective employers, variants such as biomedical or aeronautical engineering may also be valued. Employers will not necessarily prefer a qualification tailored to their sector over a qualification in the most closely related main engineering discipline.

As well as core engineering skills, employers emphasised the importance of graduates being reasonably ready for work, both in terms of being able to apply what they have learned, and in terms of the course content reflecting the workplace as it is now.

- Employers indicated that substantial work placements (9-12 months) are important in a Level 8 or 9 engineering course, giving students much-needed real life experience in applying what they learn in a real business environment. A long work placement allows students engage in substantial projects. Employers indicated that they see work placements as forming an important part of their recruitment process. Some major employers in the sector use work placements systematically to identify which members of a graduating class they will wish to offer jobs on graduation.
- Workshop participants highlighted the value of problem-based learning as a strategy for ensuring that engineering students learn to apply theoretical knowledge effectively, but also noted that it is resource-intensive, which makes it difficult to implement under current resource constraints in higher education.
- Employers indicated that manufacturing excellence strategies such as lean manufacturing have become so universally important to industry that all courses supplying engineering graduates likely to work in manufacturing should include at least a module on the topic, which should ideally include some practical experience. It was suggested that the module could be designed to train students to “green belt” level.

The duration and content of engineering degree courses is going through a period of change at present. The standard was a four year period of study leading to the award of a Level 8 Honours Bachelor Degree. Engineers Ireland is seeking a change to a five year period of study terminating in the award of a Level 9 Masters degree. Some higher education institutions are making this change. This facilitates time for a placement for students and for specialist modules in the final year leading to the Masters.

The research highlighted a number of engineering specialisms that are currently in demand, and in which firms have vacancies that they are having difficulty filling. These include:

- Validation engineering;
- Quality engineering;
- Polymer engineering;
- Automation engineering and
- Supply chain engineering.

The strong consensus from workshops was that demand for **validation engineering, quality engineering, automation engineering, supply chain engineering** and other professional level engineering specialisms that support manufacturing should be satisfied through qualified and



experienced engineers undertaking further study in the area to develop the specialist skills needed. Postgraduate diploma and taught masters courses in these areas are a more appropriate response to the skills need than undergraduate courses would be. The Medical Devices sector has a particularly acute need for validation engineers at present, and the Life Sciences Skillnet is working to meet this need with a 36 week (10 weeks in classroom plus 26 weeks internship) conversion programme for engineers in other disciplines.

In the case of **polymer engineering**, the research indicated a number of options to addressing the skills need identified. Engineers with a strong knowledge of polymers are in demand in the medical devices and plastics industries, and in parts of other sectors. Firms report a shortage of engineers with strong skills in the area. Much of this requirement could potentially be satisfied through 1) mechanical engineering degree programmes offering specialisations or optional modules in polymers, or 2) through Level 9 programmes in polymer engineering designed to provide qualified and experienced engineers with skills in the area or through 3) specialist Level 8 course in Polymer Engineering.

Significant numbers of firms responding to the industry survey identified shortages of **mechanical and electronic engineers**. This included:

- Firms who expect to have difficulty in recruiting, but did not have vacancies when they were surveyed,
- Firms who want to recruit experienced engineers, and do not perceive a shortage of new graduates, and
- Some key recruiters of new graduates who are only interested in recruiting those who are strongest academically - looking for a first class honours or in some cases a 2:1, among other criteria.

Discussions at the workshop clarified the following:

a) While firms recruiting new mechanical engineering graduates to work in product development typically look for high grades reflecting very high levels of technical ability, many of those recruiting for manufacturing engineering roles can accept a broader range of technical ability among their engineering graduate recruits.

b) Some shortages identified by companies are referring to a shortage of graduates of the quality they require. Indeed, some of the most demanding recruiters raise broader questions about the quality of Irish engineering graduates relative to those from top engineering schools internationally, and about how comparable grades currently awarded by Irish engineering schools are with each other and with international comparators.

Even taking these factors into account, there does appear to be a **clear shortage of mechanical engineers**. The position appears to be different for graduates in electronic engineering, with demand significantly exceeding supply for graduates with high grades to work in microelectronics design, but with less demand for graduates with low grades to work as electronic engineers. Some undertake conversion training to work as validation engineers.



7.2.6 Researcher Innovation Skills

The need for researcher level skills in manufacturing has been noted earlier in the context of manufacturing excellence. There is also a need for researcher skills relevant to product development. This work requires high levels of skill, and at its more advanced levels requires people with research degrees at Levels 9 and 10 in a relevant area, or with equivalent levels of skill. Generating these skills requires higher education research in areas relevant to the specific skills requirements. Existing moves to focus higher education research funding on industry-relevant topics, and to develop industrial PhD programmes should make a major contribution to meeting these skills needs.

There is a need to make better use of researcher skills to drive product and service innovation in industry, both in order to foster entrepreneurial activity driven by research and innovation, and to ensure that researchers recruited by firms make the best possible contribution to innovation. Education and training initiatives have an important contribution to make to this.

The **UCD-Trinity Innovation Academy** provides a good example of an initiative that can be undertaken, offering a project-based module in Creative Thinking and Innovation and a more extensive Graduate Certificate in Innovation and Entrepreneurship as a part of the structured PhD programme at the two universities.

BiInnovate Ireland provides an example of a more intensive innovation training programme. Focused on the medical devices sector, it is modelled on the Stanford BioDesign programme, which was highlighted by EGFSN as a possible model for innovation training in its 2008 *Future Skills Needs of the Medical Devices Sector* report. BiInnovate Ireland is funded jointly by industry and Enterprise Ireland. It is run as a collaboration between four universities - NUIG, UCC, UL and DCU. Under the programme, eight fellowships are awarded each year to establish two teams of four highly qualified and experienced Fellows, with each team including people from a mix of different backgrounds necessary for medical device innovation. In the programme's first year, 2011, the teams were based in Galway and Dublin. The 2012 teams are based in Galway and Limerick. The teams benefit from extensive mentoring.⁸³

The Irish Research Council's **Employment Based Postgraduate Programme** offers researchers the opportunity to complete a Masters or PhD degree while employed by a private company or public organisation based in the republic of Ireland. The aim of the Employment Based Postgraduate Programme is to educate researchers at Masters and PhD level with an insight into business aspects of research and innovation and to facilitate research collaboration, knowledge transfer and networking between Irish based enterprise and researchers at Irish Higher Education Institutions. Applications are accepted from researchers across all research disciplines with the support of an eligible Higher Education Institution and a company or public organisation. Successful researchers are registered as a postgraduate researcher in the Higher Education Institution but are employed by

⁸³ In the course of the year, each team of Fellows identifies medical challenges that could potentially be addressed with a new medical technology, evaluates their feasibility and market potential, chooses from among them, and invents and implements a technology to address the need.

The Fellows also (along with Academics, Clinicians and Industry Experts) mentor postgraduate students taking part in a less intensive team-based BiInnovate Ireland training process in medical device innovation, equivalent to up to 15 ECTS credits in a structured PhD programme. As a consequence, in addition to benefiting its Fellows, their current and future employers, and prospects for entrepreneurship, BiInnovate Ireland greatly strengthens the entrepreneurial development process available to research students in relevant disciplines at participating institutions.



the employment participant for the duration of the award. The programme offers researchers direct employment while completing their Masters or PhD degree.

The Irish Research Council also operates the **Enterprise Partnership Scheme**, whereby the Irish Research Council, in partnership with private enterprises and public bodies, awards co-funded postgraduate scholarships and postdoctoral fellowships. The Scheme offers researchers the opportunity to gain additional beneficial experience and insight into the commercial arena while completing their research. It provides industry with flexible access to a pool of competitively selected, high-calibre researchers and the opportunity to build links with relevant academic research groups. The Scheme facilitates the establishment of new relationships and the strengthening of existing ones between enterprise and academia while offering financial support to researchers at an early stage of their career development.

7.2.7 Key Person Skills

A number of manufacturing firms consulted drew attention to the high business and employment impact that a key person with industry-leading skills can have at firm level. They may drive improvements in business performance far out of proportion to the cost of hiring them through driving product development, commercialisation, operational performance or marketing, and through improving decision-making. They are valuable from a jobs policy perspective because they can drive activity that boosts employment.

The main policy-relevant implications are the following.

- It is important to enable manufacturing firms to invest in developing key person skills. Enterprise Ireland's Leadership 4 Growth programme is proven to be valuable in this. Innovation leadership programmes such as BioInnovate Ireland can also make a valuable contribution. Similarly, the Irish Research Council Employment-Based Postgraduate Programme and Enterprise Partnership scheme can serve to address key person skills.
- Manufacturing firms needing to recruit a person at this level from outside the EU and EEA should have an administratively straightforward immigration process available that gives them a reasonable degree of certainty in advance of making a job offer whether the candidate will be allowed to work in Ireland.

7.2.8 Generic Skills

Firms and other stakeholders consulted through interviews, workshops and stakeholder consultations emphasised that it is necessary for technical skills at all levels to be complemented with strong generic skills, particularly in terms of people skills, communication skills, problem solving skills, planning skills and project management skills appropriate to the level of the work. These skills are essential enablers for manufacturing excellence. They are also essential in other contexts, such as where contact with customers or suppliers is required, in product development, when working with regulatory bodies, or when seeking to influence investment decisions by parent companies.

While firms identified significant deficiencies in generic skills at a wide range of levels, many are optimistic for the future. They see the long term solution being in reforms to education and training systems that are in place or in progress.



Specific positive changes highlighted include the following:

- Reforms in second level education, notably the changes to Junior Cycle announced recently by the Minister for Education and Skills, seem likely to result in school leavers having significantly stronger generic skills.⁸⁴
- Existing and anticipated changes in further education and training influenced by FETAC and FÁS should result in future holders of vocational qualifications having stronger generic skills.
- Changes to engineering courses required in order to qualify for accreditation by Engineers Ireland should result in many future engineering graduates having much stronger generic skills.

7.2.9 Languages and Customer-Facing Skills

The research provided a considerable amount of evidence to corroborate the findings of the 2012 EGFSN report on *Key Skills for Enterprise to Trade Internationally*. Many of the manufacturing firms interviewed identified difficulties in hiring people with skills in European languages for customer facing roles as an important challenge. A large part of the problem is a lack of technologists with European language skills, needed to take on roles including technical selling, customer site engineering and customer support.

The problem is about both customer expectations and practical communication issues. Most Irish engineers and scientists can only communicate well in English, but customers for industrial products are accustomed to dealing with vendor representatives who can communicate well in two, three or four major European languages. To the extent that they can communicate in a continental European language, it is most often in French, where a broader range of languages would be useful, with a particular need for more people with German language skills to trade in German-speaking countries and the significant number of continental Europeans whose second language is German.

In some cases, firms need native language speakers to operate in-country or to provide service from Ireland, however, it is the combination of technical skills with foreign languages that is the key skill requirement.

A further issue with customer-facing skills that was re-confirmed by the research is that relatively few engineers or scientists see commercial roles, such as sales or marketing as attractive career options. While many manufacturing firms need technically knowledgeable people to represent them to customers, they often have difficulty in inducing their engineers and scientists to move in that direction.

The report on *Key Skills for Enterprise to Trade Internationally* has recently made recommendations on addressing these issues. It is important to the manufacturing sector that they be implemented.

⁸⁴ The six key skills targeted for development in the new junior cycle include self-direction, wellbeing, communicating, creativity, working with others and managing information.



7.3 Recommendations

In developing recommendations, it is clear that the skills needs of the manufacturing sector are wide and, in some instances, complex. Addressing skills needs, therefore, has a number of facets:

- Some shortages can be addressed through increasing supply, providing specific modules, accredited work placements or amending the curriculum within the mainstream education and training system. This is about ensuring both the right numbers are being produced and that graduates have relevant industry skills.
- However, many employers also address specific skills needs through upskilling and building upon the existing skills base and experience within the firm - this requires flexible systems of Continuing Professional Development (CPD), online delivery, post graduate qualifications and conversion courses. In many cases, these shortages are small in scale but acutely felt by industry due to the critical nature of the roles within the firm.
- Finally, some skills requirements are for key persons with highly specific expertise that is mainly developed through experience. These are often global shortages for key persons that drive innovation and growth within the firm. The main requirements from education and training relate to ensuring access to relevant research expertise and/or collaboration on company-specific product/process development.

1. Establishing clear career paths in manufacturing

Internationally, there are clear paths in many countries for career progression from operative level up to senior roles in manufacturing, linked to their systems of training, education and qualifications. Industry takes the lead role in establishing and developing these career paths in collaboration with education and training providers. Ireland does not have a comparable resource at present. Some consequences of this include:

- School leavers and others making career choices do not have visibility of the career opportunities available in manufacturing. Employees may have difficulty identifying learning opportunities that will help in progressing their careers.
- Without clarity over career paths, providers of education and training are constrained in their ability to map their course offerings to industry needs and identify current gaps in provision that will be widely required by industry.

The most significant gap in the system is the lack of a clear framework for training at operative level, and for progressing from operative level. There are existing elements to the system which function well; there are discrete sector level initiatives for operative level training that might fit well into an overarching framework; and there are examples of very good practice on career paths within individual firms. The challenge is to build on good work that is already being done.

Key features of a career path framework for manufacturing at this range of levels would include:

- Establishing competency frameworks for the main occupations, mapped to the National Framework of Qualifications;
- Establishing learning pathways for the skills associated with each occupation, and for progression between occupations, that meet the needs of both industry and employees, and are robust in terms of learning and qualifications; and



1. Establishing clear career paths in manufacturing

- Facilitating both college-based and industry-based learning pathways where these meet industry and learner needs, with cross-linkages and even joint provision between the two types of pathway.

Consideration should be given to the possibility of an industry-based track to qualifications for higher level occupations, comparable to German Meister or time-served engineer.

Recommendations:

- The Manufacturing Development Forum should lead a review of manufacturing career paths. It should engage industry, employee representatives and relevant providers of education and training and the qualifications bodies including Industry Representatives, Further Education providers, FÁS/SOLAS, Skillnets and Higher Education representatives.
- The review should have reference to international experience with developing and mapping career paths, such as the US stackable credentials model, the training and progression models of various “dual system” countries in Europe and the training and progression maps of sector skills councils such as SEMTA in the UK.

(Manufacturing Development Forum, Industry Associations, FÁS/SOLAS, Skillnets, Higher Education Institutes)

2. Promoting manufacturing careers

The ability of manufacturing industry to attract employees is affected adversely by lack of knowledge of the career opportunities it offers and by negative perceptions of what manufacturing work entails, among potential future employees and many of those who influence them. A programme of information and promotion targeted at all skill levels is required to ensure that the sector has a strong supply of skills, and that second level students and others are well informed about the career opportunities available to them.

There is already considerable Irish expertise with careers promotion. *Discover Science and Engineering (DSE)*, managed by Science Foundation Ireland (SFI), promotes science, engineering and technology careers, and Engineers Ireland’s *STEPS* programme promotes engineering careers in conjunction with DSE. Promoting careers in manufacturing intersects significantly with the work of DSE and STEPS, as many of the key skills required in manufacturing are in engineering, science and technology at technician and professional levels.

Recommendations:

- Manufacturing companies and industry associations should participate in future Discover Science and Engineering campaigns to highlight manufacturing opportunities within the STEM sector. The initiative should draw attention to the career paths being mapped and developed under Recommendation 1 and to examples of manufacturing career success across the range of occupations, including operative, technician, supervisor and professional occupations.

(Manufacturing Companies, Industry Associations, Science Foundation Ireland, Engineers Ireland)



3. Tackling supply issues at operative, skilled trades and technician levels

Toolmakers

The shortage of toolmakers can only be addressed by an increase in the number of apprentices recruited by industry. This process could be accelerated, with the cooperation of FAS (and subsequently SOLAS when established), by firms who are FÁS-approved employers for apprenticeship training through registering skilled operatives as apprentices and submitting applications with portfolios of evidence for exemptions from phases of the apprenticeship programme for toolmaking.⁸⁵ Feedback from employers also indicates that the toolmakers syllabus requires some updating to take account of recent advances in materials and manufacturing processes.

Polymer Technicians

The current shortages for polymer technicians are being addressed in part through a Level 7 distance learning course provided by IT Sligo on behalf of the First Polymer Skillnet. At the time of writing, the Skillnet is consulting on how many additional places might be required to meet future demand from firms for places for employees, while also continuing to provide places for the unemployed. Skill needs in this area could also, in principle, be addressed through mainstream full time provision or through initiatives such as Springboard-funded courses for job seekers.

Machinists

There is substantial demand from employers for on-going upskilling of machinists due to new technologies and/or processes. Skillnets should examine the establishment of an engineering sector Skillnet that could be responsible for in-employment training for machinists which were identified as in short supply.

More broadly, in the review of the Apprenticeship model and the range of apprenticeships, trades and traineeships, the Department of Education and Skills/FÁS should examine the potential for formal learning opportunities for machinists, particularly for CNC machining and programming, including the potential for the development of a Machinist Apprenticeship or Traineeship.

Recommendations:

Toolmakers

- Use the accelerated apprenticeship scheme to augment the number of apprentices qualifying as toolmakers every year. FAS (and subsequently SOLAS) should endeavour to ensure that at least 55-60 apprentices qualify as toolmakers each year over the period to 2016.

(Companies, FÁS/SOLAS, Higher Education Authority)

- Update the toolmaking apprenticeship syllabus to reflect recent advances in manufacturing materials and processes.

(FÁS/SOLAS)

Polymer Technicians

- Assess the potential for increasing the supply of polymer technicians, including pooling resources for the associated equipment requirements. Providers should also investigate the

⁸⁵ It should be noted that exemptions are only granted for Phases 1-5 of the Apprenticeship inclusive. All applicants are required to complete the Phase 6 examination in Theory and Practice and complete Phase 7 on the job with the FÁS approved employer to meet the criteria for the award of the FETAC Level 6 Advanced Certificate-Craft. The acceleration of the apprenticeship programme would need to be discussed with FÁS and HEA to ensure training capacity resources are available to meet the demand for Phase 2, Phase 4 and Phase 6 as a result of the exemption application process and the phases of exemptions granted.



3. Tackling supply issues at operative, skilled trades and technician levels

possibility of funding equipment costs through leasing arrangements or sponsorship by clusters of companies or equipment manufacturers.

(Skillnets, Institutes of Technology, Plastics Ireland, IMDA)

Machinists

- Target the development of an Engineering Skillnet training network (see Recommendation 7) which can address demand for in-company training and upskilling for machinists.

(Skillnets in collaboration with the Manufacturing Development Forum)

- Examine the potential for formal learning opportunities for machinists, particularly for CNC machining and programming, including the potential for the development of a Machinist Traineeship or Apprenticeship.

(Department of Education and Skills, FÁS/SOLAS)

- Support places for the unemployed within these recommendations through, for example, Springboard and Momentum programmes.

(Department of Education and Skills, Higher Education Authority, FÁS/SOLAS)

- Expedite, insofar as possible, the review of the Apprenticeship model taking into account the needs of manufacturing firms and the analysis and recommendations set out in this report. The review should consider options for provision that mitigate against shortages where they result from the cyclical nature of apprenticeship.

(Department of Education and Skills)

4. Undergraduate level skills for manufacturing

Under the medium to high growth scenarios, demand for mechanical engineers would rise significantly and feedback from employers indicates the need to increase the skills pool in this regard. This demand for mechanical engineering graduates and similar disciplines is at present driven particularly by developments in the medical devices sector.

Increasing enrolments in engineering fields should result in increased supply to the manufacturing sector in approximately 2-3 years. In the short term, the demand for mechanical engineering should be addressed through the Springboard programme.

Recommendations:

- Mechanical/Manufacturing Engineering Level 8 programmes should be targeted within the next Springboard call in the order of 250 places. They should have a particular emphasis on manufacturing skills related to automation, development and design.
- In awarding places and ensuring that the demand is appropriately addressed, a strong emphasis should be placed in tendering for programmes that demonstrate collaboration between providers and enterprises, including development of course content and provision of work placements to ensure specific industry requirements are met.
- Target jobseekers with Level 8 and below qualifications with previous work experience and engineering and related technical disciplines.

(Department of Education and Skills, Higher Education Authority, Industry Associations, Companies)



4. Undergraduate level skills for manufacturing

Course Content

A number of significant points with regard to courses developing professional level engineering skills for manufacturing industry emerged from the research. These refer both to Level 8 Honours Bachelor Degrees and to more recent '3 and 2' programmes that start at undergraduate level, but have the option of progressing to a Level 9 Masters degree award.

- Professional level courses in engineering that are relevant to manufacturing should all develop the core engineering skills associated with one or other of the main engineering disciplines. This should be visible to manufacturing employers, who can have difficulty in identifying what content has been covered by a graduate from a course with a non-standard title.
- Courses in mechanical engineering and other engineering disciplines connected to manufacturing engineering should all include a practical grounding in the process improvement techniques currently in use in industry, including Lean and Six Sigma.
- While it is not necessary for all graduates in mechanical engineering and closely related disciplines to have a specialised knowledge of polymers, higher education institutions should recognise that many graduates in these disciplines will work in design or manufacture of polymer-based products. Therefore, it is important that mechanical engineering courses include modules or specialisations in polymer science and engineering.
- Engineering courses at this level should generally include a substantial and accredited work placement period (9-12 months) during which the student undertakes a project relevant to the employer. The 2011 Roadmap for Employment-Academic Partnerships (REAP) project on Work Placements produced good practice guidelines for work placement development.⁸⁶
- Other widely-applicable topics that higher education institutions should address in mechanical engineering and related courses, where they do not already do so, include automation and data analytics.

Recommendations:

- Review the course content of mechanical engineering and other engineering disciplines relevant to manufacturing in the context of the findings set out above.
(Higher Education Institutes, Engineers Ireland, Higher Education Authority and Qualifications Bodies)
- Identify ways in which a structured, mentored and accredited 9-12 month work placement programme could operate more effectively to deliver to the needs of the graduate/ undergraduate and to the firm, taking into account the resource commitment required by SMEs and having regard to the good practice guidelines in the 2011 REAP report on work placements.
(Companies, in conjunction with Manufacturing Industry Associations, Higher Education Authority and Higher Education providers)

⁸⁶ <http://reap.ie/site/wp-content/uploads/Work-Placement-Report-20111.pdf>



5. Postgraduate skills and Continuing Professional Development for manufacturing

From a skills perspective, some of the key functions of higher education research are to provide industry with access to researcher level skills relevant to its needs, to strengthen taught courses in higher education by improving the teaching capabilities of research academics, and to prepare Irish researchers to be effective innovators. These functions should be served well for manufacturing industry by the decision of the Government to focus research funding on 14 priority areas, most of which are relevant to Irish manufacturing industry subsectors, and two of which - Manufacturing Competitiveness and Processing Technologies and Novel Materials - are specifically targeted on the inventive underpinnings of manufacturing innovation.⁸⁷ They should also be served well by the Irish Research Council's Employment-Based Postgraduate Programmes and Enterprise Partnership Scheme. Fourth level skills are important to drive product and process innovation in Irish manufacturing and therefore have an impact on future economic performance and employment.

Continuing learning - formal and informal - for manufacturing professionals is important for all parts of the sector. The development of the employment-based postgraduate programme and industrial PhDs in the higher education sector, higher education programmes with progression opportunities developed specifically for manufacturing employees, developments in taught masters and postgraduate diploma courses, and the development of a strong CPD programme at Engineers Ireland puts in place a good institutional foundation for formal, accredited continuing learning for manufacturing professionals that builds on Level 8 and Level 9 qualifications already held.

There are, in addition, initiatives in place to develop innovation skills among higher education research students, including the UCD-Trinity Innovation Academy and BioInnovate Ireland.

Taught courses at postgraduate level have an important role to play in skills development for the manufacturing sector. There are already taught courses in place at postgraduate diploma and Masters level in mechanical engineering to develop specialised skills in some of the main areas where skills shortages at this level were identified, including taught Masters courses in materials science and engineering, supply chain management, technology management and manufacturing excellence. The key objective for the future is to leverage the existing infrastructure and develop new programmes and modules where appropriate to address continuing demand for fourth level skills.

Recommendations:

Postgraduate/Masters Programmes

- Support up to 200 places on taught postgraduate courses in disciplines relevant to manufacturing as skills priorities, particularly where key shortages have been identified through this report and annually through the EGFSN National Skills Bulletin. Address the current small scale but critical shortages in Validation engineering, Quality engineering, Polymer engineering, Automation engineering and Supply chain engineering (primarily at NFQ Level 9) through upskilling employees and the unemployed (Springboard) in partnership with industry.

(Higher Education Authority, Skillnets, Industry Associations, Engineers Ireland, Higher Education Institutes

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⁸⁷ Report of the Research Prioritisation Steering Group, 2012



5. Postgraduate skills and Continuing Professional Development for manufacturing

- Focus on Manufacturing SMEs in future Irish Research Council calls for the Employment-Based Postgraduate Programme and Enterprise Partnership Scheme. Enterprise Ireland should seek to promote engagement by client companies within these programmes.

(Irish Research Council; Higher Education Authority; Higher Education Institutes; Enterprise Ireland)

6. Linking higher education provision to manufacturing industry needs

Engagement with industry is a core mission under the National Strategy for Higher Education and recommendations aimed at ensuring the system is responsive to enterprise needs are being implemented. This includes structured employer surveys and interaction and increased work placement opportunities. The Higher Education Authority has also published guidelines for the establishment of higher education institutional clusters at a regional level to support enterprise development and employment needs.

A significant theme that emerged from the research was that many of the manufacturing firms consulted spoke positively about how specific higher education institutions respond to industry skills and training needs. At the same time, there were cases where higher education institutions had put on courses in areas broadly relevant to manufacturing that were unsuccessful in terms of failing to attract participation from industry, or failing to place graduates within Ireland.

Higher education participants in the workshops noted that it can be difficult to respond to enquiries or requests from industry given overall responsibilities and resource constraints. This issue has been examined in detail in the Roadmap for Employment-Academic Partnership (REAP) project, which provided recommendations for enhancing the interface between higher education institutes and employers.⁸⁸

Recommendations:

Put in place where necessary measures for improving the interface with employers, following the National Strategy for Higher Education objectives and REAP 2011 guidelines for enhancing industry-academic engagement in the provision of skills, including:

- Clear points of contact for industry engagement;
- Communication of relevant expertise, capacity and capabilities of the HEI;
- Illustrations of the potential and benefits of engagement activities through exemplars or case studies;
- Professionalisation of the interface and service level expectations;
- Targets and metrics for engagement within the broader HEI mission.

(Higher Education Institutes)

⁸⁸ See the following REAP reports for further detail: <http://reap.ie/site/wp-content/uploads/Customised-Learning-Development-March-2012-2.pdf> ; <http://reap.ie/site/wp-content/uploads/work-based-learning.pdf>



7. Upskilling those in-employment in Manufacturing

Upskilling those with low levels of qualifications

A general issue persists at operative level in some manufacturing sectors whereby new processes and technologies are raising skills requirements at basic entry level positions in many manufacturing sectors, including demand for skills such as literacy (including technological literacy), numeracy and generic skills such as teamwork, interpersonal and communication skills. The consequence of this is that many of those employed in operative positions with low levels of educational attainment need to engage in upskilling in order to stay in employment. In particular, sectors such as Food and Drink, Consumer Products and Other Manufacturing have above average proportions of those with lower secondary education and below.

Skillnets

Skillnets is an important stakeholder in manufacturing industry training for the employed, which also provides industry-relevant training opportunities for the unemployed.

Recognising the importance highlighted amongst manufacturing companies of upskilling employees, the industry-led nature of the Skillnets model of provision, its responsiveness to manufacturing industry training needs, and the fact that Skillnets training networks collectively cover (or are available to cover) most sectors of manufacturing industry, it is recommended that Skillnets' role in continuing education and training for manufacturing industry should be developed further.

Recommendations:

Operatives

- Identify progression opportunities for the low skilled and / or operatives in the sector having particular regard to the objectives of Recommendation 1.
(VECs, NALA, AONTAS)
- Develop and roll-out an operative accredited upskilling programme building on progress to date made in the Food and Beverages sector and activity under the Workplace Basic Education Fund.
(VECs, NALA, Skillnets)
- Roll out a promotion and recruitment campaign aimed at upskilling low-skilled general operatives in the manufacturing sector. It should entail clearly detailing the free career progression opportunities for employees available through the VECs Skills for Work Initiative, wider VEC basic skills provision and www.writeon.ie which also offers an RPL solution. Funding should be targeted through the EU Agenda on Adult Learning.
(NALA, VECs, Department of Education and Skills, AONTAS, Manufacturing Development Forum, Manufacturing Industry Associations and Skillnets)

Skillnets

- Examine the potential for a cost effective national manufacturing supervisory development programme, preferably leading to the award of a substantial qualification.
(Skillnets, Industry Associations)

Support specific technical manufacturing upskilling and learning for manufacturing excellence (lean), and review periodically how to maximise its impact in this area. *(Skillnets)*



7. Upskilling those in-employment in Manufacturing

- Bring together sectoral training networks in manufacturing to identify whether there are opportunities for cross-network initiatives that might benefit from the scope or scale of serving multiple manufacturing sectors.
(Skillnets)
- Target the development of an Engineering Skillnet for the sector in consultation with representatives of the engineering sector.

(Skillnets, Manufacturing Development Forum)



Appendices

Appendix 1: Steering Group Members

Name	Organisation
Una Halligan	Chairperson
Brendan Cannon	Intel
Catherine Collins	First Polymer Training Skillnet
Gerry Donovan	BC Gases
William Egerton	Dromone
James Eustace/Chris Feeney	FÁS
Maria Ginnity	Forfás
Pat Howlin	IDA Ireland
Catherine Joyce-O'Caollai	IBEC Industrial Products and Services Group
Karl McDonagh	Diageo
John McGrath	Skills and Labour Market Research Unit, FÁS
Prof. Eamonn Murphy	University of Limerick
Neil O'Sullivan	Enterprise Ireland
James Phelan	PWA International Limited
Peter Rigney	ICTU
Dr. David Tormey	Sligo IT
Marie Bourke	Forfás
Andrew Colgan	Forfás



Appendix 2: NACE Classification

	NACE (EU system of industry classification)
Food & drink	10 - Food products 11 - Beverages
Pharma-chemicals	20 - Chemicals and chemical products 21 - Basic pharmaceutical products and pharmaceutical preparations
Medical devices	32 - Other manufacturing
ICT hardware	26 - Computer, electronic and optical products 27 - Electrical equipment
Engineering	24 - Basic metals 25 - Fabricated metal products, except machinery and equipment 28 - Machinery and equipment n.e.c. 29 - Motor vehicles, trailers and semi-trailers 30 - other transport equipment 33 - Repair and installation of machinery and equipment
Consumer products	13 - Textiles 14 - Wearing apparel 15 - Leather and related products 16 - Wood and of products of wood and cork, except furniture 17- Paper and paper products 18 - Printing and reproduction of recorded media 31 - Furniture
Remainder of manufacturing	19 - Coke and refined petroleum products 22 - Rubber and plastic products 23 - Other non-metallic mineral products



Appendix 3: Industry Stakeholders Consulted

Organisation
American Chamber of Commerce
Design, Print and Packaging SkillNet
Engineers Ireland
Enterprise Ireland
First Polymer Training SkillNet
Food and Drink Industry Ireland
ICT Ireland
IDA Ireland
Industrial Products and Services Group
Innovation and Lean Sigma Federation
Institute for the Development of Employees Advancement Services
Irish Medical Devices Association
Irish Small and Medium Enterprises Association
Life Sciences SkillNet
Pharmaceutical Ireland
Pharmachem SkillNet
STEPS
Taste 4 Success SkillNet



Appendix 4: Members of the Expert Group on Future Skills Needs

Una Halligan	Chairperson
Marie Bourke	Head of Secretariat and Department Manager, Education, Skills and Labour Market Policy, Forfás
Inez Bailey	Director, National Adult Literacy Agency
Peter Baldwin	Assistant Secretary, Department of Education and Skills
Ray Bowe	IDA Ireland
Liz Carroll	Training and Development Manager, ISME
Ned Costello	Chief Executive, Irish Universities Association
Margaret Cox	Managing Director, I.C.E. Group
Bill Doherty	Executive Vice President, EMEA, Cook Medical
Tony Donohoe	Head of Education, Social and Innovation Policy, IBEC
Bryan Fields	Director, Curriculum Development / Programme Innovation, FÁS
Sonia Flynn	EMEA Director for User Operations, Facebook
Anne Forde	Principal Officer, Department of Education and Skills
Joanne Gardiner	Managing Director, Ovelle Pharmaceuticals
Joe Hogan	Founder, Chief Technology Officer and Vice President Openet Labs & IP Management
John Martin	Director for Employment, Labour & Social Affairs, OECD
Frank Mulvihill	Former President of the Institute of Guidance Counsellors
Brendan Murphy	President, Cork Institute of Technology
Garrett Murray	Enterprise Ireland
Dermot Nolan	Department of Public Expenditure and Reform
Alan Nuzum	CEO, Skillnets
Muiris O'Connor	Principal Officer, Higher Education Authority
Peter Rigney	Industrial Officer, ICTU
Martin Shanagher	Assistant Secretary, Department of Jobs, Enterprise and Innovation
Martin D. Shanahan	Chief Executive, Forfás
Jacinta Stewart	Chief Executive, City of Dublin VEC



Appendix 5: Recent Publications by the Expert Group on Future Skills Needs

Report	Date of Publication
Vacancy Overview 2012	February 2013
Regional Labour Markets Bulletin 2012	January 2013
Monitoring Ireland's Skills Supply: Trends in Education and Training Outputs 2012	July 2012
National Skills Bulletin 2012	July 2012
Key Skills for Enterprise to Trade Internationally	June 2012
EGFSN Statement of Activity 2011	April 2012
Vacancy Overview 2011	February 2012
Guidance for Higher Education Providers on Current and Future Skills Needs of Enterprise <i>(Forfás report based on EGFSN identified future skills needs)</i>	February 2012
Addressing High-Level ICT Skills Recruitment Needs: Research Findings	January 2012
Monitoring Ireland's Skills Supply: Trends in Education and Training Outputs	July 2011
National Skills Bulletin 2011	July 2011
Developing Recognition of Prior Learning: The Role of RPL In the Context of the National Skills Strategy Upskilling Objectives	April 2011
Vacancy Overview 2010	March 2011
Future Skills Needs of Enterprise within the Green Economy in Ireland	November 2010
Future Skills Requirements of the Biopharma-Pharmachem Sector	November 2010
Monitoring Ireland's Skills Supply - Trends in Education and Training Outputs 2010	July 2010
National Skills Bulletin 2010	July 2010
Future Skills Needs of the Wholesale and Retail Sector	May 2010
Future Skills Requirements of the Food and Beverage Sector	November 2009
Skills in Creativity, Design and Innovation	November 2009
Monitoring Ireland's Skill Supply - Trends in Education and Training Outputs 2009	November 2009
National Skills Bulletin 2009	July 2009
A Quantitative Tool for Workforce Planning in Healthcare: Example Simulations	June 2009



A Review of the Employment and Skills Needs of the Construction Industry in Ireland	December 2008
Statement on Raising National Mathematical Achievement	December 2008
National Skills Bulletin 2008	November 2008
All-Island Skills Study	October 2008
Monitoring Ireland's Skills Supply: Trends in Education/Training Outputs 2008	July 2008
The Expert Group on Future Skills Needs Statement of Activity 2007	June 2008
Future Requirement for High-Level ICT Skills in the ICT Sector	June 2008
Future Skills Needs of the Irish Medical Devices Sector	February 2008
Survey of Selected Multi-National Employers' Perceptions of Certain Graduates from Irish Higher Education	December 2007
The Future Skills and Research Needs of the International Financial Services Industry	December 2007
National Skills Bulletin 2007	November 2007
Monitoring Ireland's Skills Supply: Trends in Educational/Training Outputs	June 2007
Tomorrow's Skills: Towards a National Skills Strategy	March 2007



Notes

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