UK COMMISSION FOR EMPLOYMENT AND SKILLS

Sector Skills Insights: Advanced Manufacturing

Evidence Report 48
July 2012

Intelligence Investment Impact

Sector Skills Insights: Manufacturing

Colin Davis, Terence Hogarth and Lynn Gambin

Institute for Employment Research, University of Warwick

Zoey Breuer, Richard Garrett

UK Commission for Employment and Skills

July 2012

Foreword

The UK Commission for Employment and Skills is a social partnership, led by Commissioners from large and small employers, trade unions and the voluntary sector. Our mission is to raise skill levels to help drive enterprise, create more and better jobs and promote economic growth. Our strategic objectives are to:

- Provide outstanding labour market intelligence which helps businesses and people make the best choices for them;
- Work with businesses to develop the best market solutions which leverage greater investment in skills;
- Maximise the impact of employment and skills policies and employer behaviour to support jobs and growth and secure an internationally competitive skills base.

These strategic objectives are supported by a research programme that provides a robust evidence base for our insights and actions and which draws on good practice and the most innovative thinking. The research programme is underpinned by a number of core principles including the importance of: ensuring '**relevance'** to our most pressing strategic priorities; '**salience'** and effectively translating and sharing the key insights we find; **international benchmarking** and drawing insights from good practice abroad; **high quality** analysis which is leading edge, robust and action orientated; being **responsive** to immediate needs as well as taking a longer term perspective. We also work closely with key partners to ensure a **co-ordinated** approach to research.

This report contributes to the UK Commission's work to transform the UK's approach to investing in the skills of people as an intrinsic part of securing jobs and growth. It outlines the performance challenges faced in the **Advanced Manufacturing** sector, the 'real-life' skills solutions implemented by leading and successful businesses to overcome them, and the benefits from doing so. Similar reports are available for the following sectors: Construction; Digital and Creative; Education; Energy; Health and Social Care, Professional and Business Services; Retail; Tourism. Each report is summarised by an accompanying PowerPoint slide pack. By understanding the key performance challenges employers face and the skills solutions available to address them on a sector-by-sector basis the UK Commission can make better use of its investment funds to support economic growth.

Sharing the findings of our research and engaging with our audience is important to further develop the evidence on which we base our work. Evidence Reports are our chief means of reporting our detailed analytical work. Each Evidence Report is accompanied by an executive summary. All of our outputs can be accessed on the UK Commission's website at www.ukces.org.uk

But these outputs are only the beginning of the process and we will be continually looking for mechanisms to share our findings, debate the issues they raise and extend their reach and impact.

We hope you find this report useful and informative. If you would like to provide any feedback or comments, or have any queries please e-mail info@ukces.org.uk, quoting the report title or series number.

Lesley Giles

Deputy Director

UK Commission for Employment and Skills

Table of Contents

Charts

Tables

GLOSSARY

This report uses data from several sources and uses a definition of the sector depending upon which data sources are available.

PRINCIPAL DATA SOURCES

Employer Perspectives Survey 2010 (EPS 2010)

The UK Commission's Employer Perspectives Survey 2010 (UK Commission 2010d) gathered the views of approximately 14,500 employers on the UK's employment and skills system. The aim of the survey is to provide evidence to stakeholders operating in the system across the four UK nations to inform policy and improve service delivery.

http://www.ukces.org.uk/publications/er25-employer-perspectives-survey

The UK Commission's UK Employers Skills Survey 2011 (ESS 2011)

The UK Commission's UK Employer Skills Survey (UK Commission, 2012) provides UK-wide data on skills deficiencies and workforce development across the UK on a comparable basis. It was undertaken at the establishment level and involved over 87,500 interviews, with a follow up survey of over 11,000 employers focusing on employers' expenditures on training.

http://www.ukces.org.uk/publications/employer-skills-survey-2011

Working Futures Database

Working Futures 2010-2020 (UK Commission 2011b) is the most detailed and comprehensive set of UK labour market forecasts available. The results provide a picture of employment prospects by industry, occupation, qualification level, gender and employment status for the UK and for nations and English regions up to 2020. The database used to produce the projections is held by the University of Warwick Institute for Employment Research and Cambridge Econometrics.

http://www.ukces.org.uk/assets/ukces/docs/publications/evidence-report-41-working-futures-2010-2020.pdf

Labour Force Survey

The Labour Force Survey (LFS) is a quarterly sample survey of households living at private addresses in the United Kingdom. Its purpose is to provide information on the UK labour market that can then be used to develop, manage, evaluate and report on labour market policies. It is conducted by the Office for National Statistics. Figures quoted in this report are based on a four quarter average.

http://www.ons.gov.uk/ons/guide-method/surveys/respondents/household/labour-force-survey/index.html

SECTOR DEFINITIONS

Two definitions of the sector have been employed in this report as no single definition of advanced manufacturing is available.

Standard Industrial Classification (SIC) Based Definition

Manufacturing is traditionally defined in SIC (2007) as 10-33. The principal data sources above use this definition of manufacturing.

Sector Skills Assessment (SSA) Definition

Information from the SSA for manufacturing is also used to inform the analysis in this report. For the purposes of the SSA manufacturing is defined as SIC (2007) 10-33 and 72. The addition of SIC 72 acknowledges the importance of research and development to advanced manufacturing.

EXECUTIVE SUMMARY

The Importance of the Sector

The BIS Growth Review described advanced manufacturing as that part of the manufacturing sector which:

- is intensive in the use of capital and knowledge;
- requires long term investment decisions to develop processes and buy equipment (that can take more than a year to manufacture);
- uses high levels of technology and R&D and intangible investments (training, improvements to business process) to support innovation;
- requires a flexible workforce with strong specialist skills in the areas of science, technology, engineering and mathematics and design;
- competes in international and domestic markets.

In many respects the aim is to encourage all of manufacturing to become advanced manufacturers since it is only becoming this that business will be able to thrive and contribute to the rebalancing of the economy.

Advanced Manufacturing represents one of the best opportunities for the UK to rebalance the economy. The sector has the potential to drive up levels of value-added in the economy, and make a substantial contribution to export growth. Its global competitiveness is ultimately dependent upon the skills of its workforce.

The sector's potential is evidenced in that it accounted for over half of all UK exports in 2009, and had the fourth highest technology balance of payments of OECD countries. It accounted for 12 per cent of gross value-added (GVA) - at £130bn - and employed approximately 2.6 million people in 2010.

Several sub-sectors and major companies have global significance such as the UK aerospace sector with a 25 per cent share of the global aerospace market; its high productivity generates 20 per cent of UK manufacturing sector output from five per cent of its employment. The UK manufacturing sector as a whole contains several world leaders. JCB, for instance, is the world's third largest manufacturer of construction machines and the UK automotive sector employs approximately 156,000 people directly in vehicle

manufacturing - accounting for almost six per cent of all manufacturing employment. And the UK Johnson Matthey company is the world's largest manufacturer of catalytic converters.

Key Challenges

The principal challenge facing the sector is the rapid pace of technological development which is taking place on a global scale. The challenge for the sector is to capture and retain a leading share of the high value added segment of the global market in manufacturing. The evidence points to the high value added segment being in the research and development (R&D) of new products and processes, design for manufacture, and the manufacture of relatively complex products. But this is not the only potentially high value added segment of the sector. Even where manufacturers are engaged in high volume rather than niche production there is a need to ensure that they possess the product market strategies which will allow them to prosper in this segment of the market and make a significant contribution to overall value-added in economy.

Small and medium sized enterprises (SMEs) account for 65 per cent of total manufacturing employment compared to 74 per cent across all sectors (LFS, 2010). The challenge for SMEs is to acquire the strategic management skills which will allow them to prosper and grow. Often when SMEs, especially the smaller ones, begin to grow they need to introduce new organisational structures. For instance, whereas senior managers may need to have broad based skills when a company is small, as it grows there is often a need to have more demarcation between management roles. In other words, specialists are required to fill particular functional roles in the organisation (marketing, finance, human resources, *etc,*).

Productivity in the sector measured as GDP *per* hour worked has improved over the last decade and continues to improve in the UK compared with France, Germany, and the USA. Related to this, exports of manufactured goods having shown good growth over recent years; in 2010 the value of exported manufactured products reached nearly £230bn. There is, therefore, an opportunity to encourage all manufacturing companies, but especially those who have had little experience of exporting, to develop further skills which allow them to capture export markets.

The challenges facing the manufacturing sector should not be under-estimated. Manufacturing businesses require very different management skills to optimise business performance depending upon their product market strategies and the stage in the product market lifecycle of their principal products. These evolving business styles are a particular skills challenge for larger, let alone, smaller companies to optimise and to keep pace with market and technological change.

Skill Demand

The speed of change is increasing and forcing supply chains to become more like supply networks requiring higher levels of flexibility, agility and a broader spread of soft skills across the workforce. It is likely that in the future higher levels of employee responsibility, autonomy and managerial delegation will be required at all levels in the organisation. This is driving up skill levels in manufacturing.

A continuing drive for higher productivity, better competitiveness and higher value added is built into occupational employment projections for the sector over the next 10 years: with an 11 per cent increase in managers, directors and senior officers (although lower then that expected across all sectors at 18 per cent), a 14 per cent increase in professional and associate and technical jobs (similar to that for all sectors); counterbalanced by 16 per cent loss of skilled trade occupations (compared to a 6.5 per cent loss across all sectors), and a 23 per cent loss of process and machine operative jobs (also much higher than the loss across all sectors at 11 per cent).

The evidence overall shows that the number of people engaged in higher level occupations and who are relatively well qualified has been growing in the sector which reflects the increasingly complex nature of products and production processes. This is likely to continue over the long-term which will result in the sector becoming increasingly highly skilled. In particular, the sector has and will continue to have a strong demand for people with Science Technology Engineering and Mathematics (STEM) skills.

It is important to note that though the number of people in skill trades occupations is projected to fall over the medium-term, replacement demands for this occupation are likely to remain positive and high due to the number of people in these jobs who will exit from the sector over the coming years. Accordingly, the sector will have a continued demand for people trained to Level 3 (typically *via* Apprenticeships).

Skills Supply

The evidence points to skills supply being well supported by an extensive initial and continuing vocational education and training infrastructure with a substantial increase in the number of people being qualified each year in the subjects and skills upon which the manufacturing sector is dependent.

In the advanced manufacturing sub-sector the supply-side often has to run very fast in order to keep pace with developments on the demand side. Accordingly, employers at the cutting-edge may need to look internally to develop the skills they require.

The skills the sector needs typically embody a high level of numeracy and are in high demand in other sectors of the economy. Skills supply issues therefore need to be seen in the context of the sector's capacity to attract – and retain - people who have the skills it requires. Therefore simply increasing skill supply will not necessarily satisfy the sector's skill demands.

Skill Mismatches

Survey evidence indicates that where manufacturing employers have vacancies they are more likely to report that applicants do not possess the skills, experiences or qualifications they require than in the economy generally. As noted earlier, this relates in part to the strong demand in the economy generally for the types of skill the sector requires. More strategically, key skills deficiencies relate to professional and senior managers and their ability to adequately research the drivers of change to enable them to develop effective product market strategies.

The Government has recognised the opportunities of advanced manufacturing and is backing the development of technology and innovation clusters including high value manufacturing ones. Several related initiatives address skills deficiencies through schemes including the Growth Innovation Fund, Technology Innovation Centres / Catapult Centres, the Leadership and Management Advisory Service, and the Employer Investment Fund. Ultimately the success of any support initiative is dependent upon a recipient company being able to develop product market strategies which allow it to capture high value segments of the market and create a skills structure appropriate to its product market aspirations. That said, all of the initiatives mentioned above are designed to assist companies realise their product market aspirations.

All of the evidence points to companies being able to overcome the various skill deficits they face by engaging in training at all levels of the workforce. Several case study examples provided in the main body of the report indicate how provision of vocational training leads to improvements in company performance as well as generating a wider set of benefits relating to, for instance, the satisfaction employees derive from their employment.

Conclusion: Growth through Skills

There are significant business benefits to employers from investing in the skills of their workforce, but a better way to consider this issue in relation to advanced manufacturing is with the respect to the costs of not investing in skills development. By definition, advanced manufacturing is knowledge intensive and dependent upon a relatively high level of

innovation. The aim, in many respects, is to encourage manufacturing employers in general towards being advanced manufacturers. The rewards of doing so are substantial not least the capacity to survive in a global market where low value manufacturing is increasing outsourced to countries with lower production costs. The evidence presented in this report suggests that where advanced manufacturers have invested in skills, they obtained significant gains from doing so. It is also apparent that there is a substantial training and skills infrastructure which companies can make use of in raising the level of skills in their workplaces.

Without doubt one of the most powerful messages to employers about the benefits of training is its association with business survival: the evidence indicates that the provision of training is strongly related to business survival.

1 The Economic and Policy Climate

Increasingly, the competitiveness of advanced industrial nations is explained with reference to the capabilities of their respective labour forces. Hence, national education and training systems are seen as providing comparative economic advantages. It is notable that over the recent past education and training have taken centre stage in policies designed to foster the UK's competitiveness and lie at the heart of the current Government's plans to kick start the recovery against a backdrop of challenging global economic conditions. To understand the role skills development might play in stimulating growth within the digital and creative sector requires some consideration of the current economic situation and current skills policy.

In 2012 the UK economy, and indeed the global economy, is still coming to terms with the repercussions of the 2008/9 economic recession. By comparison with previous recessions, 2008/9 was relatively deep and it continues to cast a long shadow over the country's medium-term economic prospects (see Table 1.1). The economic climate at the time of the 2008/9 recession and in the period afterwards has been characterised by low interest rates and a depreciation of sterling against other currencies, notably the dollar and the euro. Whilst these would usually be sufficient to give a fillip to the economy by boosting demand and, given time, increasing output, the potential for export led growth has been seriously undermined by continuing weak demand conditions across the global economy, especially in the Eurozone and the USA. Also the difficulties households and businesses have had gaining access to finance as the banks have sought to increase their capital has restricted growth. Moreover, the markets' continuing disquiet over developments in the Eurozone has contributed further to the climate of uncertainty in the global economy thereby further dampening demand.

Table 1.1 Four recent periods of recession in the UK

	Start date	Date of bottom of recession	Length of period from start to bottom of recession	Total decline in GDP (%)	Time taken for GDP to recover to level at start of recession
1	1974 Q4	1975 Q3	4 Quarters	3.8	7 Quarters
2	1980 Q1	1980 Q4	4 Quarters	5.9	13 Quarters
3	1990 Q3	1992 Q2	8 Quarters	2.3	11 Quarters

4	2008 Q2	2009 Q1	6 Quarters	6.3	?

Source: Office of National Statistics Quarterly Economic Accounts, 1975, 1981, 1993, 2010

As a consequence of the above developments, the rapid acceleration in growth observed after the recessions of the early 1980s and 1990s has failed to materialise. Nevertheless the economy is expected to resume its long-run growth path over time (see Chart 1.1) but in order to do so there are specific steps the UK economy needs to take. The UK Treasury has identified a number of weaknesses which need to be addressed if a sustained recovery is to be achieved (BIS / HM Treasury 2011):

i. the level of debt funded household consumption;

ii. the share of the economy accounted for by the public sector;

iii. weak business investment;

iv. an over-dependence upon financial and business services;

v. unbalanced regional growth.

Government has identified four ambitions which need to be realised in order to restore long-term sustainable growth (BIS / HM Treasury 2011):

i. creating the most competitive tax system in the G20;

ii. making the UK one of the best places in Europe to start, finance and grow a business;

iii. encouraging investment and exports as a route to a more balanced economy;

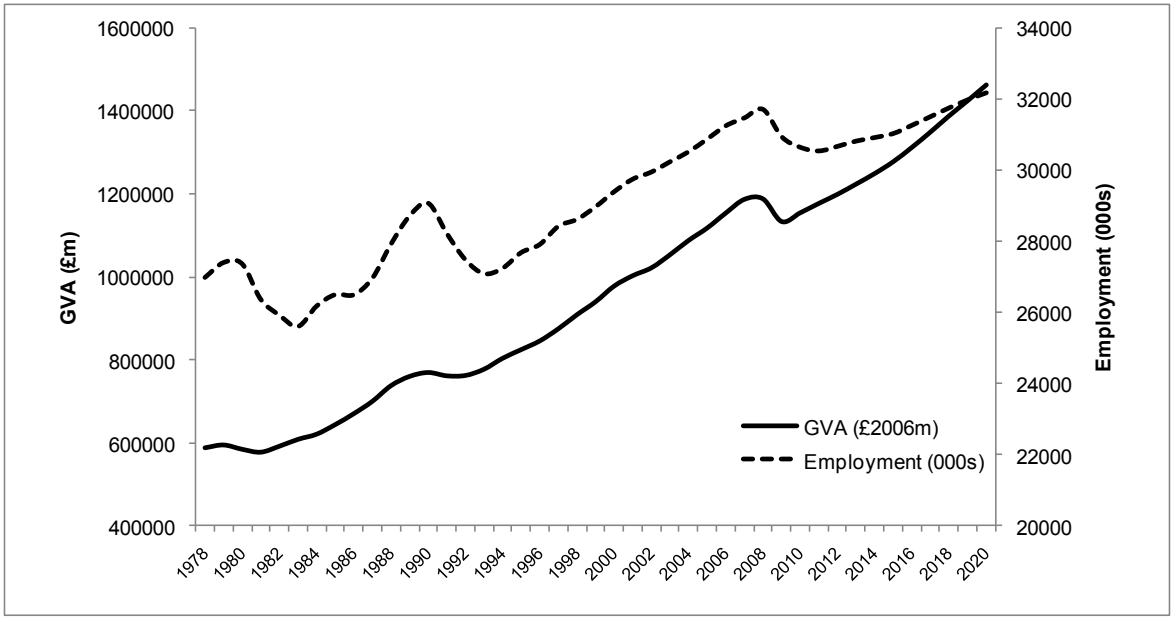
iv. creating a more educated workforce that is the most flexible in Europe.

Therefore, the role of skills in national economic policy is clearly an essential one; to bring about recovery and sustainability by creating jobs and growth.

From the employer's perspective there is a need to adapt to both global demand side conditions and the consequences which are likely to arise from policies designed to rebalance the UK economy. Depending upon the sector there are likely to be a number of skill-related performance challenges which employers will need to address as they seek to consolidate existing markets, develop new ones, and introduce technical and organisational changes to improve their competitiveness. The importance of these challenges become even more apparent if one considers the role of skills in the economic cycle. Evidence demonstrates that the recovery from previous economic recessions was hampered by skills shortages, and that these skill shortages then contributed to further

downturns in the economy (Blake *et al*., 2000). Therefore, the message is clear: a failure to invest sufficiently in skills now has the potential to dampen future growth.

Chart 1.1 Employment and Gross Value-Added 1978 - 2020



Source: Working Futures 2010-2020, **UK Commission (2011b)**

At a time when capital investments are constrained as a consequence of problems in the global banking system, investments in skills, and human resources more generally, made through programmes such as Apprenticeships and Investors in People, and funded through initiatives such as the Growth and Innovation Fund, may be the most amenable to employers.

Based on the latest evidence available, this report considers the specific situation in the Advanced Manufacturing sector to provide:

i. an overview of the size and structure of the sector and the principal drivers of change over the medium term which are likely to have some bearing upon skill demand;

ii. an outline of current and expected patterns of skill demand in the sector;

iii. a description of skills supply and how this has adapted to changing patterns of skill demand;

iv. an analysis of mismatches between the demand for, and supply of skills, and the implications of this for the sector.

In conclusion, the report identifies the performance challenges faced by the sector and highlights the skills solutions available to address them thereby delivering increased levels of growth and contributing to the recovery of the UK economy.

2 The Importance of the Sector

Advanced manufacturing is not defined with reference to industry codes rather it is that part of the manufacturing sector which, according to the Growth Review for the sector (BIS 2010a) is characterised by:

- intensive use of capital and knowledge;
- long term investment decisions to develop processes and buy equipment (that can take more than a year to manufacture);
- high levels of technology utilisation and R&D and intangible investments (training, improvements to business process) to support innovation;
- a flexible workforce with strong specialist skills in the areas of science, technology, engineering and mathematics and design; competing in international and domestic markets.

For practical purposes when presenting data the sector has been described with reference to the Standard Industrial Classification 2007:

10 Manufacture of food products
11 Manufacture of beverages
12 Manufacture of tobacco products
13 Manufacture of textiles
14 Manufacture of wearing apparel
15 Manufacture of leather and related products
16 Manufacture of wood and of products of wood and cork, except furniture
17 Manufacture of paper and paper products
18 Printing and reproduction of recorded media
19 Manufacture of coke and refined petroleum products
20 Manufacture of chemicals and chemical products
21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
22 Manufacture of rubber and plastic products
23 Manufacture of other non-metallic mineral products
24 Manufacture of basic metals
25 Manufacture of fabricated metal products, except machinery and equipment
26 Manufacture of computer, electronic and optical products
27 Manufacture of electrical equipment
28 Manufacture of machinery and equipment n.e.c.
29 Manufacture of motor vehicles, trailers and semi-trailers
30 Manufacture of other transport equipment
31 Manufacture of furniture
32 Other manufacturing
33 Repair and installation of machinery and equipment
72 Scientific research and development

Not all activities within the above categories might be advanced with reference to the Department for Business Innovation and Skills' (BIS) definition, but they all have the potential to be so given appropriate product market developments and product market strategies. Hence the statistics provided mainly refer to the manufacturing sector overall and, accordingly, the base from which the UK is developing its advanced manufacturing capacity. Wherever possible, points have been illustrated with examples of advanced manufacturers' activities.

Manufacturing is a cross cutting sector which offers major business and employment opportunities derived from a multiplicity of devices and products as intermediate outputs (i.e. inputs into the production of other goods) and as final outputs (i.e. used by the end consumer). These activities account for 12 per cent of GVA 2.6 million jobs in 2010.[1] As a major exporter it also plays a critical role in terms of the UK's balance of trade.

Differentiating the UK's capability from global competitors is paramount to the sector's success and requires harmony between a systematic approach to manufacturing, investment in advanced technologies and, perhaps most of all, a highly educated and skilled workforce at all levels to continuously improve products and processes (BIS, 2009). Advanced manufacturing is recognised in its own right for its importance in the Government's growth review as one of eight key sectors (BIS /HM Treasury, 2011). But more than that, many of the other seven sectors rely on using high levels of manufactured products for their own success, offering significant opportunities for better inter sector co-operation (UK Commission, 2010a, 2010b and 2010c).

The Government's review (BIS, 2010d) highlights areas of advanced manufacturing where there is a strong skills and research base to build upon and have the potential for 'strong competitive advantage': these include aerospace, defence, bio-pharmaceuticals, microelectronics and chemicals and low carbon vehicle technologies.

A globally successful, high value adding, advanced manufacturing business is distinguished by its ability to integrate one or more of these technologies, and more, with a business style and technological approach appropriate for the stage and development of its market place opportunity. Whilst this means that success is not limited to large companies, there are major challenges for management skills in medium sized UK

1 These estimates are derived from the Working Futures database. The Labour Force Survey reports higher levels of overall employment at nearly 3 million. The Working Futures database also reports slightly different levels of GVA compared with the ONS estimates in the SSA report for manufacturing cited in this report. The GVA figures reported here are based on the latest data recently revised in the macro-economic model which underlies the Working futures projections (*i.e.* the Cambridge Econometrics model). The data in this report are in 2006 prices which also contributes to the difference.

advanced manufacturing companies (even more for small companies) to recognise strategic trends and opportunities, to respond with appropriate business styles and technologies, and to put in place skills which have the agility to evolve integrated structures that keep pace with changing needs (UK Commission, 2010b). It also means that it is very difficult to define, at any one time, where a business sits in the spectrum of advanced manufacturing.

Measures and indices for productivity and value addition have tended to focus on monetary values to date but in a low carbon society, measures of energy and materials consumed, and mass and distance travelled are increasing in their importance. Traditional manufacturing processes and supply chain structures are being re-thought and will potentially pose a skills challenge over the next ten years at all levels from strategic and professional skills to managerial and specialist skills (SEMTA, 2010, 2012).

2.1 Overall Output and Employment Performance

Employment in the manufacturing sector in the UK represents approximately eight per cent of all manufacturing employment in the European Union (Eurostat, 2012). As a share of overall employment within the UK (at ten per cent) it is lower than in countries such as Germany where it accounts for around 20 per cent of total employment. In many respects this is the key issue. A combination of productivity growth and specialisation in relatively high value-added niche production is unlikely to generate large-scale direct employment growth, but it is likely to generate relatively strong growth in value-added with the potential to generate employment growth through supply-chains (including a wide range of business services). This then is the challenge for the advanced manufacturing sector in the UK: growth in advanced, high value-added production activities.

The net 2010 output of £130 billion for the UK manufacturing sector (see Table 2.1) perhaps belies the roller coaster ride that the sector has had through the last decade and hides the traumas of the considerable restructuring which has taken place. The output per person (for 2009) of 50,000 compares favourably to the all sector average of 37,000. However, the figures mask the wide variations in the sector from low volume high value aerospace goods, to medium complexity goods such as automotive products, and to low complexity, high volume consumer manufactures such as food products. For example, successful competitiveness in aerospace manufacture requires significant numbers of highly educated and highly skilled personnel, and with potential for high value adding.

Success in food manufacturing, in contrast, embeds high level skills in the design, manufacture and development of the automated systems (with a minimum of operators) and, consequently, results in more flexibility as to where factories can be located.

As a medium complex product and process automotive manufacturing is a particularly interesting example. Automotive manufacturing has experienced the recession of the UK market along with other sectors but the global corporations involved have taken advantage of both sterling's weakness and emerging markets such as India and China, with the result that production output and employment in the UK has held up relatively well. The UK is also home to a significant share of the global market for premium vehicles with their high value adding opportunity.

The UK aerospace sector has been and continues to be a good performer with a 25 per cent share of the global aerospace market and around 20 per cent of UK manufacturing sector output (UK Commission, 2010b). Relative productivity in UK aerospace is indicated by the level of employment which is less than five per cent of the manufacturing sector as a whole. These figures are counterbalanced by a number of low value adding, low complexity, low technology sectors which have suffered more heavily through the recession.

Table 2.1 Key Output and Employment Indicators

Manufacturing	2010 level	Growth rate: 2000-2010 (% p.a.)	Changes (absolute)	Growth: 2010-2020 (%)	Growth rate: 2010-2020 (% p.a.)	Changes (absolute)
Output (£2006m)	130,435	-1.2	-17,459	26.8	2.4	34,981
Employment	2,638,037	-4.3	-1,448,350	-6.4	-0.7	-168,988
Part time employment	196,518	-4.3	-108,560	0.0	0.0	48
Full time employment	2,239,433	-4.5	-1,294,141	-7.3	-0.8	-164,054
Self employment	202,086	-2.0	-45,649	-2.5	-0.2	-4,982
Male employment	1,988,851	-4.0	-989,125	-6.8	-0.7	-134,480
Female employment	649,186	-5.2	-459,225	-5.3	-0.5	-34,508

Source: Working Futures Database 2010-2020, UK Commission (2011b)
Base: SSA Definition

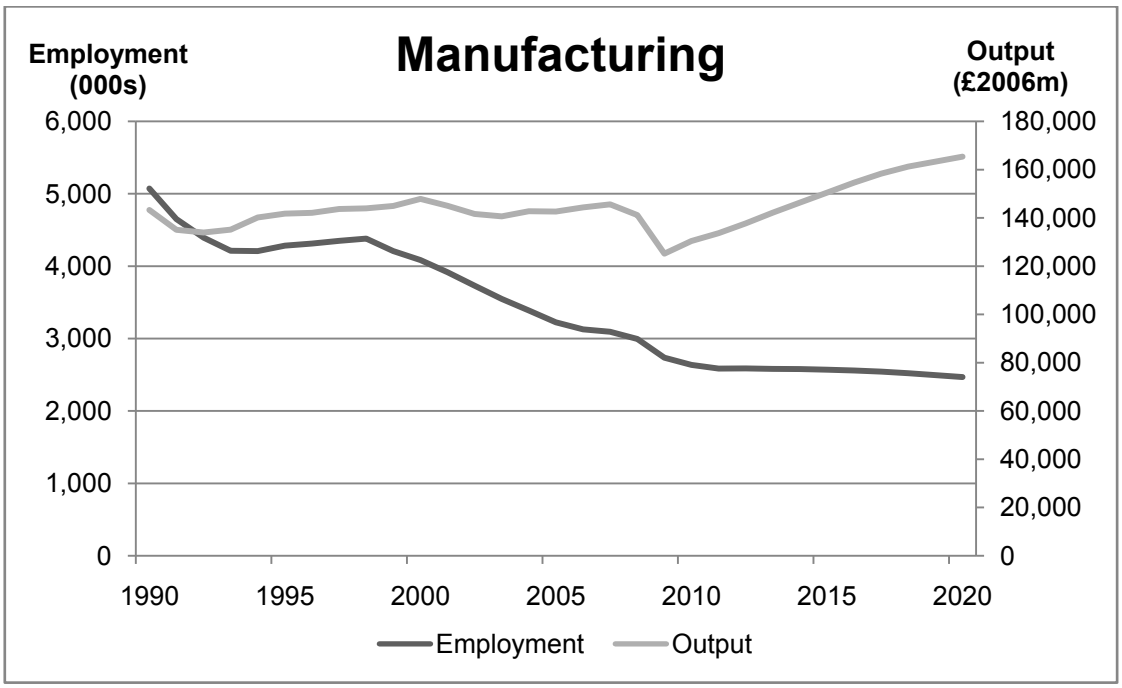
Future output growth of more than 2.4 per cent a year (in real terms) is projected to 2020 and assumes the continued strong performance from advanced manufacturers in sectors such as aerospace. As Chart 2.1 indicates, there is an expectation that the pressures to improve productivity and competitiveness will continue with a net loss of employment at a

rate of -0.7 per cent a year. Employment is predominantly male with men accounting for three quarters of all employment; male employment is also expected to fall at a slightly faster rate than that of women over the period to 2020. The share of the workforce represented by people from Black, Asian or Minority Ethnic (BAME) communities (seven per cent) is lower than the average across all sectors (nine per cent) (LFS, ONS, 2010).

Some 15 per cent of employment is currently part time or self employed. The figure overall is expected to marginally rise to 16 per cent by 2020 since self-employment will decline at a slower rate than employment in the sector overall, and part-time employment is not expected to change over period to 2020. Little change is expected in the averages across s all sectors, with part-time employment expected to rise from 28 to 29 per cent and self- employment to remain at 14 per cent.

A description is provided in Section 4 about the demand for skills (measured with respect to occupation and qualifications). It is worth noting at this point that the sector as a whole is dependent upon people working in skilled trades occupations, and people typically qualified to Level 3 (Levels 5 and 6 in the new QCF) often associated with Apprenticeship training in the sector. It is likely, however, that the 'advanced' sub-sector is relatively more dependent upon people with high level skills associated with managerial, professional, and associate professional occupations, and with HE qualifications, given the relative importance ascribed to R&D and innovation.

Chart 2.1 Trends in Employment and Output



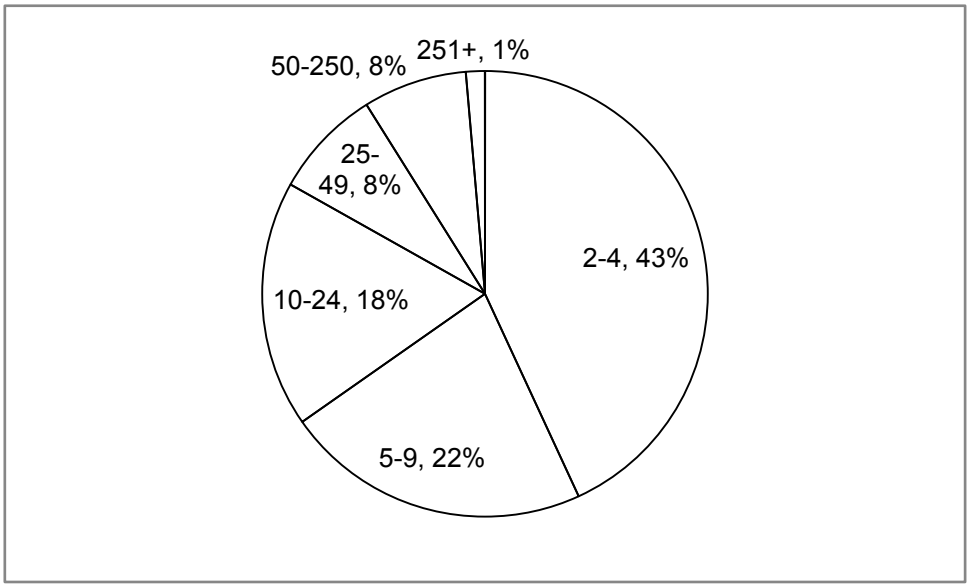
Source: Working Futures Database 2010-2020, UK Commission (2011b)
Base: SSA Definition

2.2 Employment Structure (for 2010)

Charts 2.2a and b illustrate the importance of small and medium sized enterprises (SMEs) to the manufacturing sector and how they are crucial to the UK economy (IET, 2010). Under the EU definition of an SME, with up to 249 employees, 65 per cent of employees in UK manufacturing work for SMEs compared to 74 per cent across all sectors. Successful SMEs are always at risk of being swallowed by larger organisations as a way of capturing their intellectual property and few breakthrough all the barriers to

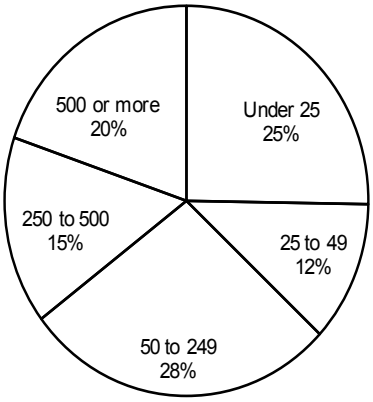
become a global player but a significant number do make it through to medium sized enterprises (MSEs). Success is a major challenge for any company and its management team requiring strategic and change management skills that few SMEs possess. These skills relate to being able to recognise when and how to change its structure to adapt, and how to remain competitive in rapidly changing market driven by technological change. The ability to evolve skills at all levels in the business rapidly becomes the critical success factor (BIS, 2010b).

Chart 2.2a Size Structure of Employment (% of establishments by employer size band)



Source: Inter-departmental Business Register (IDBR), ONS, 2010

Chart 2.2b Size Structure of Employment (% of employment by employer size band)



Source: LFS, 2010

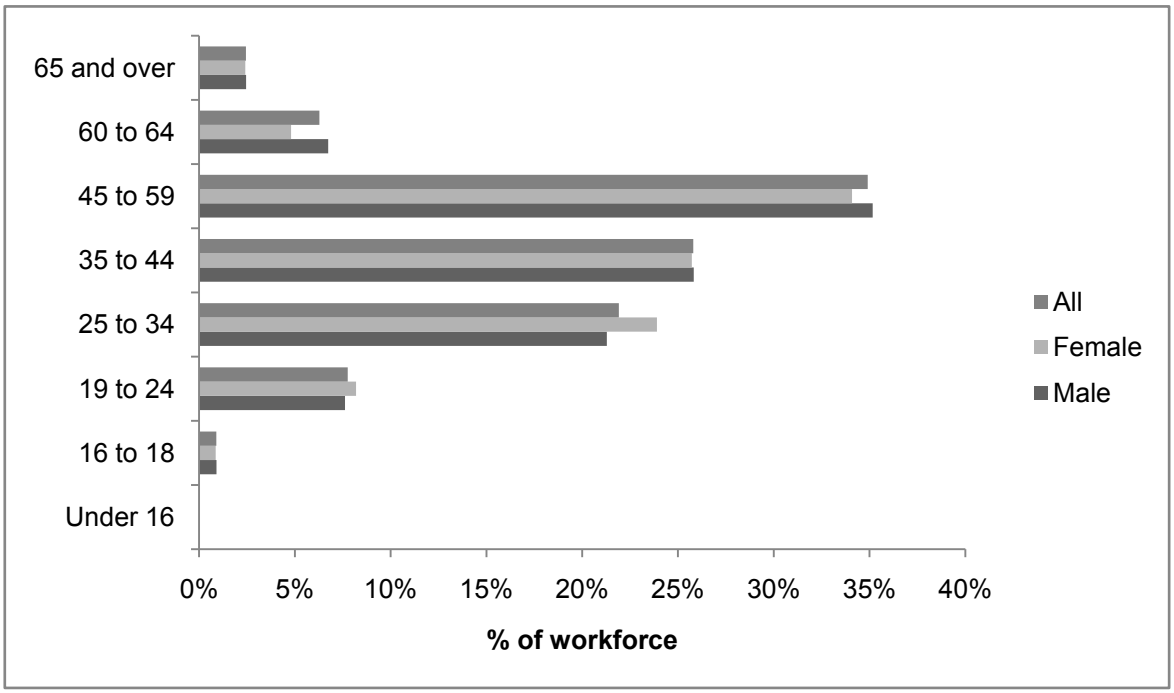
As far as the long term wealth of the UK is concerned, a key factor is where the ownership of the company's strategy is located and also the focus of the highest value adding activities or components (often found in the same place). In the UK, automotive manufacturing is a good case in point where the sector, and the employment in it, has benefitted from the overseas ownership of the large corporations involved. It remains the case that the highest value adding activities of these companies – such as the design function - are likely to be located within the companies' HQs (Davis *et al.*, 2002). SMEs and MSEs tend to have stronger local roots and present significant opportunities to retain the full benefits of intellectual property ownership, profits, growth and development in the UK.

2.3 Age structure of employment

The age profile in the UK manufacturing sector is depicted in Chart 2.3 and illustrates the slightly higher presence of female workers in the younger age ranges. What is most striking about the age structure of the sector is the concentration of people in the older age ranges: with 61 per cent of the workforce between the ages 35-59, much higher than the 46 per cent for all sectors (LFS, ONS, 2010). The presence of under 25s in the workforce is lower for manufacturing at nine per cent than the average across all sectors (13 per cent). This has implications for replacement demands and the need for the sector

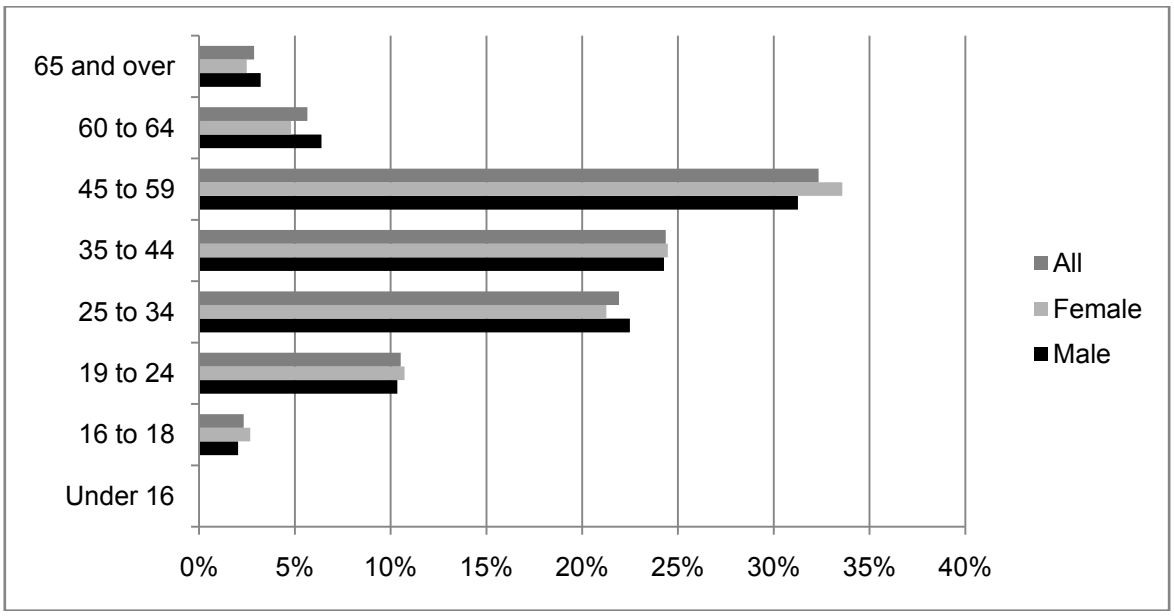
to invest in recruiting people into the sector. Given many skill needs are sector specific this will mean recruiting trainees through programmes such as Apprenticeship.

Chart 2.3a Age Structure of Workforce for Construction



Source: LFS, 2010
Base: SSA Definition

Chart 2.3b: Age Structure of UK Workforce (all sectors)

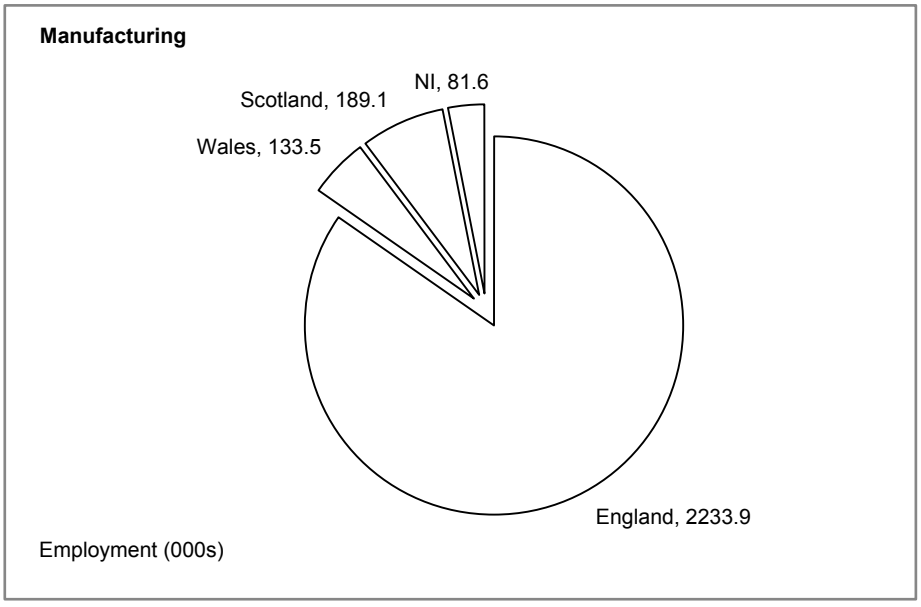


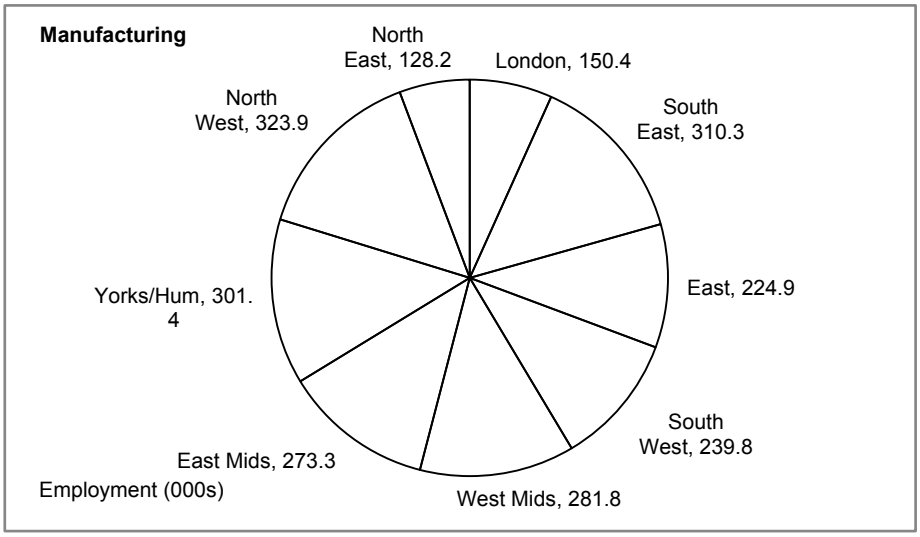
Source: LFS, 2010

2.4 Distribution of Employment by Nation and Region

The concentration of manufacturing in England can be seen in the employment Chart 2.4. There are potential opportunities in the separate nations. In Scotland, for example, renewable energy potentially provides a market for wind turbines but Scotland's capacity to take advantage of this opportunity is ultimately dependent upon its manufacturing capability. Better awareness of the skill and technology maps required – in this case in relation to renewables - could result in a much higher proportion of manufacturing skills and jobs being in the UK as a whole or in particular localities where there is high demand for a given product or technology. Some of these issues are recognised and being addressed but there is more to be done – as set out by BIS (BIS, 2010d).

Chart 2.4 Employment by Nation and Region (000s)





Source: Working Futures Database 2010-2020, UK Commission (2011b)
Base: SSA Definition

Chart 2.4 also illustrates the importance of manufacturing to all of the regions in England but care must be exercised as to where older low value adding manufacturing industries and jobs are located and where higher value adding, high technology advanced manufacturing jobs are located or likely to be located in the future. A concern must be the potential for drift of employment to the South East, with the development of emerging technologies, rather than building on and diversifying the manufacturing strengths in the other regions. That said, recent news regarding developments in the automotive sector in the Midlands (Jaguar Land Rover) and the North East (Nissan) offer a degree of regional counterbalance (EEF, 2012).

2.5 International Standing of the Sector

As noted above, the manufacturing sector in the UK accounts for eight per cent of all manufacturing employment in the EU (approximately 33.6 million), but with the share of overall employment in the sector being lower than in countries such as Germany.[2]

Manufacturing is vital to the balance of trade with the sector accounting for over half of all UK exports in 2009 (BIS, 2009). Much of this is linked to multinational corporations taking advantage of currency and other favourable trading conditions but working from UK factories. These are now much leaner and productive than they used to be with many using advanced manufacturing technologies, and delivering products which are much more competitive than hitherto in a global marketplace. The challenge is to support

2 This based on the NACE classification of industrial sectors which is analogous to the SIC derived on.

and encourage smaller companies which have world beating technologies and products, but which have neither the skills nor experience to be effective in overseas markets, nor the management capacity and leadership to develop and adapt to the demands of operating within global markets.

Whilst the UK manufacturing sector cannot expect to be a dominant player in all sub-sectors - with excellent examples of world beating companies in many sub-sectors – there is capacity for growth fuelled by the strong base in areas including aerospace, defence, bio-pharmaceuticals, microelectronics and chemicals and emerging potential in technologies such as low carbon vehicles (BIS, 2010c). In fact BIS has calculated (using OECD 2010 economic indicators based on 2008 figures) that the UK has the fourth highest technology balance of payments of all the OECD countries; *i.e.* measuring technology transfer payments for production ready technologies including licence fees, patents, purchases and royalties paid, know-how, research and technical assistance. (BIs, 2010c).

The UK aerospace industry is of global significance with around 25 per cent of the global aerospace market and is the second largest in the world behind the USA (UK Commission, 2010b). It embodies a wide array of advanced manufacturing systems in final products as well as in the supply chain companies including researching, developing and working with an array of esoteric carbon and non-carbon materials and technologies such as plastic/printed micro and silicon electronics, composites, and nanotechnology.

In vehicle manufacture JCB is the world's third largest manufacturer of construction machines and equipment with many of its global plants in the UK; many with sophisticated robotic and automated manufacturing systems and employing 9,500 people.[3] Caterpillar, Terex and Komatsu – operating in the same sector - also have UK manufacturing bases.

The UK automotive sector employs around 150,000 people directly in vehicle manufacturing accounting for almost six per cent of all manufacturing employment with as many people again providing components and services to the sector (SMMT, 2012). SMMT also suggest that in total around 730,000 jobs are dependent upon the motor industry. It also exports a large percentage of its outputs. It is in a number of the high technology components and in niche, premium and motorsport vehicle manufacturing that

3 www.jcb.com/aboutjcb/welcome.aspx

there is dominance in the UK. The UK Johnson Matthey[4] company for example is the world's largest manufacturer of catalytic converters; eight of the twelve F1 engineering racing teams in the 2010 season were located in the UK based on manufacturers of sports, premium and high technology vehicles and engines; "Motorsport Valley" in the Northampton area is estimated to employ over 38,000 people of whom 25,000 are qualified engineers (UKTI, 2007).

The UK has a positive balance of payments in small onshore wind turbines. In 2009 the UK industry was the largest exporter of small wind machines in the world (Renewable UK, 2011), exporting to over 100 countries and providing almost 1,900 UK jobs. Most of these companies are small or medium sized and are consequently faced with the problems all SMEs face as they grow and develop: managing R&D, innovation, market growth, technology development, manufacturing systems development and not least, restructuring and acquiring different skills. Ultimately it is the capacity of the sector to manage these types of challenges which will determine its capacity to capture both domestic and international markets.

2.6 Summary

Manufacturing is a cross cutting sector with high value adding skills that offers major employment opportunities for the UK and accounted for over half of all UK exports in 2009. According to OECD figures it has the fourth highest technology balance of payments; it has the third largest share of UK GVA - after professional and business services and retail - at some 12 per cent (£130bn output) and more than 2.6 million people were employed in 2010.

Advanced Manufacturing is recognised in its own right for its importance in the Government's growth review as one of eight key sectors as well as the part it plays in the success of the other seven directly and indirectly through technology diffusion. Six key manufacturing areas with high level skills have been highlighted: aerospace, plastic/printed electronics, silicon electronics, industrial biotechnology, composites and nanotechnology.

The sector has global significance in a number of sub sectors including some with high skill demands and substantial Intellectual Property (IP) generation. Aerospace is one

4 www.mathey.com/whatwedo/productsandtechnologies

sector where the UK excels. In vehicle manufacture too the country has outstanding performers, including JCB and a strong presence in Formula 1 vehicles.

The manufacturing sector is also vital to innovative business start ups, and small and medium sized companies (less than 250 employees) are vital to the sector. They are also an important contributor to UK owned IP (SEMTA, 2009).

3 Key Challenges facing the Sector over the Medium-term

3.1 Recession and Recovery

Table 2.1, in the previous section, illustrated the longer term impact in employment over the last ten years with more than 1.4m jobs lost to the sector representing around 35 per cent of the 2000 level. Employment fell by nine per cent in 2009 and a further 3.5 per cent in 2010. Much of this erosion came about through a combination of the necessity to introduce more productive systems and equipment, not least lean manufacturing, and the total loss of many companies that were unable to adapt to the pressures of the global environment (SEMTA, 2010).

The recent recession, however, has seen a much more disparate picture with wide variation between the continued failures in some sub sectors, retrenchment but resilience in many others and recession beating growth in others making the macro picture much more difficult to interpret.

Traditional manufacturing sub-sectors of wood, textiles and clothing, pottery, many of the simple metal products, and printing have suffered heavily through the recession as far as employment is concerned and do not have the presence in export markets enjoyed by aerospace and automotive employers (SEMTA, 2010). Uncertainties in the supply chain have caused some manufacturing corporations to rethink or remodel their production and organisational structures which may stretch current skills. For example, the Japanese Tsunami in 2011 and its attendant power rationing significantly disrupted component supplies to a number of UK based automotive manufacturing plants. And a recent survey of 200 UK manufacturers highlighted the risk to growth in 2012 which potentially results from global supply chains with two thirds of executives citing concerns about raw material shortages and components or elongated lead times for their supply (EEF 2012). That said, the same executives remained upbeat about prospects for 2012 and the medium term. Nevertheless, some companies are clearly concerned about their supply chains and this may result in an increased volume of inputs being sourced, where possible, more locally (see section 3.3).

Prospects over the near and medium term are likely to depend more on overseas markets than the domestic market. Continued weakness of sterling against the US dollar will help aerospace manufacturing in particular and presents excellent opportunities for potential markets in renewable energy technologies for example. Over the longer-term the sector's competitiveness will be determined more by its relative productivity rather than exchange rate fluctuations. BIS / OECD figures from 1995 to 2009 (all sectors) for relative productivity measured as GDP *per* hour worked shows the fairly steady and continuing trend of improvement of the UK compared with France, Germany and the USA moving from the order of a 25 per cent disparity towards 15 per cent (BIS, 2010c). Ultimately the future of sector within the global marketplace will depend upon its relative productivity in high value added sectors of the manufacturing market.

3.2 Investment, R&D and Innovation

The advanced manufacturing sector, by definition, is dependent upon relatively high levels of capital investment and R&D (SEMTA, 2010). The evidence suggests that the manufacturing sector is characterised by relatively high levels of capital investment and R&D expenditure (BIS, 2010c). The key facts indicate the following.

- Over 70 per cent of firms in the UK manufacturing sector are engaged in innovation activity with the highest proportion in the electrical and optical equipment industry (BIS, 2010b).
- The manufacturing sector accounts for the majority of R&D expenditure in the UK. In 2008, the total spend by UK business on R&D was £16bn of which approximately £12bn, or around 75 per cent, was accounted for by manufacturing.
- The majority of R&D is carried out in higher value industries, in particular the pharmaceuticals, aerospace, motor vehicles and electronics related industries. These industries, together, accounted for an estimated 75 per cent of total business spending on R&D in manufacturing in 2008.
- Measuring R&D as a percentage of value added, the 2006 OECD figures reveal pharmaceuticals to be the highest in the UK with 40 per cent followed by aerospace with over 30 per cent.

- Investments in intangible assets refers to investments in software, design and other aspects of product-development, brands, training and business process improvements all of which contribute to competitiveness. The manufacturing sector accounted for around half of total spending on intangible assets in 2004 (Gil and Haskel, 2008).

Despite the positive picture described above, there has been an ongoing series of reports about the current lack of capital for investment and this could prove to be one the biggest limiters to medium term growth and success of the manufacturing sector as it will potentially affect advanced manufacturing the most. The Government is backing the development of technology and innovation clusters, initially in high value manufacturing, healthcare (cell manufacturing), energy and resource efficiency (offshore renewable energy), transport systems, ICT and electronics, photonics and electrical systems. All of this will drive up the demand for high level skills related to innovation and design (IET, 2011).

3.3 Global Competition

World competitiveness has been subject to substantial change over the relatively recent past. In recent decades, the strength of manufacturing in countries including USA, Japan and Germany has been subject to pressure from countries such as Taiwan, Korea and many others. While corporations in the USA - not least in automotive manufacturing - had to sharpen up their processes and technologies to compete with the Japanese, electronic and electrical manufactures were flooding out of countries such as Taiwan and Korea. The last decade alone has seen the massive growth of manufactured goods from countries such as China with the probability that over the next decade of more competition from countries including India and Brazil.

The ‘fallout’ from the recent economic crisis has been significant turmoil caused by the uncertainties in energy and transport costs, currencies and exchange rates, inflation, resource and materials supplies causing much re-thinking about the way supply chains will need to work in the future. One method of reducing the level of risk inherent in supply chains is to ensure that no source of materials, components or expertise is more than 24 hours away from its assembly operations. Another approach has been to utilise higher levels of direct computer monitoring of the supply chain.

It is also apparent that across the entire supply chain there is increasingly an expectation that products will be of perfect quality (zero defects). This has required all countries in the supply chain to possess both the manufacturing processes and the required skills in order to satisfy the demands of the next tier up in the supply chain. Accordingly, all countries with a manufacturing capacity have been investing in both process technology and manufacturing skills at all levels.

Across the world there are different reactions to the common issues of climate change with some economies resisting the issues of mitigation and adaptation whereas others have fully embraced both. Over time there is the likelihood that products, processes and advanced manufacturing systems will all need redesign in the light of various climate change measures which will create a demand for new skills. At the moment, the evidence points to the impact on skill levels being relatively modest (Cedefop, 2010), but there is the possibility that in future countries could increasingly compete on their capacity to rely upon relatively 'green' production processes. This may then have greater implications relating to the design of products and the processes used in their production which have implications for skill needs (*e.g.* design skills).

Central to the globalisation process is the spread of supply chains across the world, with conscious decisions from manufacturers about where to locate different activities within the value chain. The main trend here has been to move relatively low value added activities offshore to take advantage of lower production costs (*e.g.* labour costs). Increasingly, however, there is evidence that more high value-added activities are being developed offshore too, such as the internationalisation of R&D. On the other hand, there is evidence that some manufacturers have been repatriating manufacturing activities related to the difficulties of operating in some countries, *e.g.* the enforcement of Intellectual Property Rights (BIS, 2010b).

3.4 The Role of Skills in Overall Competitiveness

A key driver differentiating the product capacity of national manufacturing systems is skill. Over time technological advantages might even out as countries and manufacturers are able to learn from one another. The factor which tends to ensure that one country, or one manufacturer, remains more competitive than another, is that of possessing the skills which allow new products to be developed (*e.g*. innovation skills), then brought to market

(*e.g.* R&D, design for manufacture skills, *etc.*), and then fully exploited so that they are able to capture global markets (*e.g.* marketing skills). In the technology stakes there tends to be a degree of leap-frogging with manufacturers stealing a lead on their competitors only to be eventually caught up and sometimes surpassed. There are examples of where companies have been able to stay at the forefront of technological development. Rolls Royce is an example of a UK global competitor which has been able to develop a world beating aero engine platform and maintain sufficient speed of ongoing innovation to make it difficult for competitors to overtake. This success is based on investing in skills in their own R&D capability alongside those used in integrated advanced manufacturing systems.

SMEs engaged in manufacturing generally do not have the infrastructure and could not afford the scale of innovation systems and investments in skills that their larger counterparts are able to make. There is, however, a long and successful history in the UK of SMEs developing customised and effective advanced manufacturing cells and systems. This has been made possible by their possessing the high level skills which allows them to develop product niches.

3.5 Strategic Management

A major challenge for companies of all sizes is the ability to look for and recognise the longer term trends and drivers of change that could impact upon their businesses, the implications that those trends have for them, and the expected timescales over which change of one kind or another will need to be completed. Usually, most change brings opportunities even when they may appear, in the first instance, only as a threat, but there needs to be sufficient prediction of future change so that plans can be developed which turn threats into opportunities. Companies therefore need to invest in foresight type activities in order to anticipate change and develop responses accordingly. Whilst larger companies often invest in these type of foresight activities these are sometimes head office activities which, given the dominance of multi-national corporations in the sector, does not always mean that these types of skill are extant in the UK plants. Smaller companies are much less likely to possess these types of strategic management skills (UK Commission, 2010b and 2010c; Davis *et al.*, 2002).

Climate change for example is driving an increasing level of research into the consumption of energy and materials during the manufacturing process as well as into

the subsequent use of a finished product and its recycling and the minimisation of waste in its disposal. All of these areas of change reflect potential opportunities to create, adapt or differentiate a manufacturing business, but in the first instance the senior managers in the company need the necessary strategic management skills to recognise the challenge and respond accordingly (Davis *et al.,* 2002). For instance, there is increasing recognition of the benefits of using bio-compatible and tissue based materials and processes rather than metals or plastics in the manufacture of an increasing number of medical technology devices and implants. On the other hand there are many tempting "green" product ideas that have good apparent benefits but which prove to economically non-viable. Hybrid cars are a case in point where it is not at all clear whether the promoted energy (fuel) savings during use are greater than the additional energy and materials used in the manufacture and recycling processes.

The strategic skills increasingly relate to being able to recognise market opportunities and develop cost-effective responses which allow companies to ensure that they fend off the competition and capture the profits. Within a global market place, characterised by rapid developments in technological change in products and production processes, the emergence of new materials and concerns over energy consumption, the strategic skills employers require are substantial.

Large manufacturing companies in the UK are generally well positioned as far their knowledge of trends and long term developments are concerned and with well structured strategic management input from their UK senior team or from their overseas parent company. Companies such as Rolls Royce and BAE Systems demonstrate these strategic skills on a number of fronts and the large manufacturing companies in the automotive sector are demonstrating their ability to ride recessionary times as well as anybody and better than most. The biggest challenge comes with the significant body of SMEs in the sector which do not follow this pattern and tend to be, as a consequence of their size, much more reactive to immediate market and customer demands. They have less resource to develop their strategic skills. The challenge for this group is to gain access to the professional development and training which will allow them to predict change so that they position themselves to best respond to the future needs of their markets and the very customers that are their lifeblood. Other challenges include developing financial modelling skills and good economic justification skills in a financially driven world – *n.b.* no justification for capital or revenue will succeed without the funder being confident that the company understands its drivers of change and has reasonable

prediction mechanisms for judging, and controlling, the financial returns on any investment.

SMEs exist because they have won through all the early battles for their existence and have doggedly pursued their goals – usually reflecting the personality of the owner / managing director. There is therefore considerable inbuilt resistance to change at a strategic level if, and when, that fundamental *raison d'etre* for the continuation of their existence is challenged and frequently the risks and arduous challenges of tackling more ambitious opportunities are seen to be too great to pursue. Understandably they are cost driven, wary of investment costs and often wholly controlled by their cash flow. Lack of understanding and the skills to measure more ambitious opportunities are all limiters to growth. The skills to manage or cope with these pressures are important for all companies but especially so for SMEs.

3.6 Summary - Strengths and Weaknesses

The manufacturing sector hides a wide variation of businesses within it: from traditional sub-sectors which have suffered heavy job losses during the recession, to advanced manufacturing sub sectors that have registered recession beating growth. Good performance and strength in export markets has been seen in sectors including aerospace and automotive along with some emerging technology based advanced manufacturing. All of the evidence presented in this chapter points to skills – at both strategic and in the day-to-day running of businesses – being central to turning potential market threats into opportunities.

4 Employment and Skill Demand in the Sector

4.1 The Changing Demand for Employment

Davis *et al.* (2002) revealed how the window of opportunity for a business to fully exploit and derive maximum profit from a manufacturing business project has been reducing as product life cycles shorten. Accordingly, it has become increasingly important for businesses to be agile and to be able to adapt their skills faster than ever before as their markets change. This chapter looks at the changing demand for skills in the manufacturing sector. The previous chapter has already drawn attention to the demand for strategic management skills as companies look to develop and exploit new markets. This chapter looks in a more detail at the changing demand for skills at all levels of the organisation.

4.2 Factors Affecting the Demand for Skill

There is a major opportunity for UK businesses to improve their competitiveness through optimising and developing their skills. Of course, whilst skills are a major and differentiating factor, other factors also need to be in place to drive up competitiveness including access to advanced design and manufacturing knowledge, access to market and customer knowledge, access to appropriate technologies and access to finance. The types of skills needed to drive up the competitiveness of individual businesses and business projects will depend on the style of manufacturing business and its aspirations; each style having very different characteristics. The common element is that no successful business can stand still, and doing more of the same is not a recipe for continued success.

A large domestic market can be an important factor to encourage the development of highly automated, mass market, flow process style manufacturing, such as food manufacturing. These production processes tend to rely upon high level skills to control the production process with relatively modestly skilled operatives working on the production line. Whilst many companies operate in this market, including several large multinationals, there is seen to be more scope for developing advanced manufacturing in relatively low volume highly complex, high technology sectors of the market. To drive up competitiveness in this context, there is a need to increase the skill base in high technology R&D and product innovation together with skill required in advanced

manufacturing processes (Davis *et al.,* 2002). These include relatively highly skilled engineers at graduate and intermediate levels.

Regardless of the sector in which organisations operate (*i.e.* high volume or niche manufacturing), the capacity to be able to respond in a flexible and agile fashion to market opportunities is seen as essential. Manufacture of the torch for the 2012 London Olympics is an example. UK automotive component suppliers have had to become more agile and introduce more flexible, advanced manufacturing technologies and processes to enable them to compete in the automotive sector. The same technologies and manufacturing project processes have enabled an automotive manufacturer, Premier Sheet Metal, and its supply chain, to win the contract for more than 8,000 torches for the torch bearers who will relay the flame for 70 days around the UK. This type of diversification, for the supplier as much as the Original Equipment Manufacturer (OEM), may prompt new market opportunities for both but it will require new skills to develop them into profitable and sustainable new business. In this case, it is the capacity to apply existing skills to the development of a new product in a new market.

The automotive sector is a success story in the UK, based on the major productivity improvements which have progressed through the sector, driven in the main by overseas owned OEMs introducing more effective and integrated production techniques and developing concomitant skills. This has all been supported by high levels of investment in advanced manufacturing technologies. The key issue is how to ensure that the types of lesson learnt in the automotive sector can be transferred to the sector more generally. This is addressed in more detail in Chapter 6. For now it is possible to identify factors which are affecting the demand for skills:

i. the introduction of new technologies – in products and processes - and the new skill needs these give rise to;

ii. innovation in product design and innovation and the capacity to apply existing skills in new markets;

iii. the strategic management skills required to identify and capture new markets.

Key enabling and flexible technologies, including robotics and other forms of automation and material processing devices and machines, are reducing in relative cost, increasing in capability and widening their potential application to low volume, niche and SME friendly manufacturing opportunities. The corollary is that there is a greater need than ever for skills in digital techniques, computing, numeracy, analytical thinking, man-

machine ergonomics and interface development, risk analysis and understanding methodologies (including design for manufacture, design for assembly and design for automation).

Innovation occurs most commonly at an interface, for example, between technologies and methodologies and requires skills linked to merging and adaptation of technologies. Examples in recent times have included laser technologies merged with printing techniques, rapid prototyping technologies merged with tissue scaffolding, and antiseptics manufacturing with bee husbandry. Similar problem solving skills capacity is increasingly needed through lower levels in organisations to be similarly innovative about implementing process and technique changes. All carry issues of management skills to recognise, understand and manage change.

The trend is expected to continue where supply chains are becoming more like supply networks in which personnel at all levels represent the organisation in “sideways” conversations and discussions needing more soft skills including interpersonal skills.

Work is increasingly likely to be customised and less regulated requiring greater personal responsibility. Managers need to develop more delegation skills. Manufacturing management increasingly needs to measure and monitor the process and not the production to achieve 100 per cent quality every time.

4.3 Changing Patterns of Skill Demand

The manufacturing workforce has retracted over recent years and at a faster rate than that for all sectors. The manufacturing workforce is expected is to shrink, decreasing by over six per cent (not accounting for replacement demand) while employment overall is expected to grow by five per cent. At the same time, the output for the sector is expected to continue to grow at just under the average rate across all sectors (manufacturing 27 per cent growth in output on 2010 levels, compared to 30 for all sectors).

Alongside the expected growth in output and shrinking of the workforce, the analysis above suggests an increasing reliance upon higher level skills. The analysis below shows how the skill structure of the UK sector as a whole is likely to develop over the medium term. Table 4.1 illustrates the projected effect of a number of factors highlighted in section 4.2 on occupational demand to 2020. It shows the increasing demand for people to work in relatively high skill occupations (*e.g.* managers, professionals, and

associate professionals) with an expected increase of 8.5 per cent although this is below the comparative figure across all sectors with is expected to increase by 15 per cent. It also reveals an expected contraction in the number of people employed in more modestly skilled occupations. This pattern of increased demand at one end of the spectrum, for high skill occupations, and reduced at the other reflects that of the whole economy. The exception being that although expansion demand for intermediate level jobs is expected to be much lower than that the level for all sectors, later in the following section we explore how replacement demand will mean a continuing call for intermediate level skills (particularly in skilled trades occupations) in the medium term.

The expected drive to less manual work and more automation, even on low volume work, let alone high volume process manufacturing, are seen in the figures for process, plant and machine operatives with a reduction of 23 per cent of the 2010 jobs expected to go by 2020, much more so that across all sectors which is expected to see a reduction of 10.5 per cent.

Table 4.1 Changing Pattern of Skill Demand

Manufacturing:	2010	2015	2020	2010	2015	2020	2010-2020		2010-2020
Employment Growth	Numbers (000s)			% shares			Change (000s)	Change (%)	All sectors (%)
Managers, directors and senior officials	279	299	310	10.3	11.4	11.6	31	11.0	18.0
Professional occupations	380	402	414	14.1	15.3	15.6	34	9.0	14.9
Associate professional and technical	308	319	325	11.4	12.2	12.2	17	5.5	14.0
Administrative and secretarial	205	196	184	7.6	7.5	6.9	-21	-10.4	-10.5
Skilled trades occupations	656	602	546	24.3	23.0	20.5	-109	-16.6	-6.5
Caring, leisure and other service	23	26	28	0.8	1.0	1.0	5	21.6	11.5
Sales and customer service	79	79	77	2.9	3.0	2.9	-3	-3.2	0.1
Process, plant and machine operatives	505	449	391	18.7	17.1	14.7	-114	-22.6	-10.9
Elementary occupations	203	199	195	7.5	7.6	7.3	-9	-4.2	3.2
All occupations	2638	2572	2469	97.6	98.1	92.7	-169	-6.4	5.1

Source : Working Futures Database 2010-2020, UK Commission (2011b)

Base: SSA Definition

Even the skilled trade occupations will not be immune from this drive to higher productivity and the focusing of businesses on product and process innovation and change and the use of higher technologies in their products and the advanced manufacturing techniques required to work with them. Over 16 per cent of the 2010 jobs

in skilled trades occupations are expected to go by 2020 much more so than the expected decrease across all sectors which is expected to be just over six per cent.

The positive opportunity in high value adding employment of the drive to these higher technology applications can be seen in the estimates for professional and associate professional and technical jobs which are expected to increase by 7.4 per cent in manufacturing. However, this is still at a lower level than the all sector average of 14 per cent for the same period (UK Commission, 2011b).

Potentially the biggest skills challenge in the workforce is the expected increase in managers, directors and senior officers who must be able to mastermind and have the strategic and change management skills to take charge of this evolution in a highly technical environment (UK Commission, 2010b and 2010c). An increase of 11 per cent in personnel is expected over the 10 years to 2020 but is still lower than the expected increase across all sectors which is 18 per cent but suggests manufacturing will face some competition in attracting these skills.

With respect to qualification attainment, Table 4.2 shows the percentage of people who have attained a given level of attainment based on the new QCF. It reveals that over time more people have become more highly qualified in manufacturing but few are qualified in higher level qualifications (QCF 5 – 6) than in the economy generally. More, however, are qualified at an intermediate level (QCF 3 and 4) than in the economy generally. Whereas the share of people qualified at an intermediate level has declined and is projected to decline in the economy as a whole, it is expected to continue to grow in the manufacturing sector. This reflects the sector's reliance upon skilled trades workers and the use of Apprenticeships as means of entry to employment in the sector.

Table 4.2 Changing Pattern of Skill Demand by Qualification 1990 – 2020

Manufacturing	**1990**	**2000**	**2010**	**2020**
QCF8 Doctorate	1.3	0.8	1.0	1.6
QCF7 Other higher degree	2.5	2.2	4.5	7.8
QCF6 First degree	6.6	8.3	11.9	15.1
QCF5 Foundation degree;Nursing;Teaching	3.1	2.5	2.9	3.5
QCF 5 - 8	***13.5***	***13.8***	***20.3***	***28.0***
QCF4 HE below degree level	7.0	6.0	6.9	7.8
QCF3 A level & equivalent	20.7	21.6	22.4	19.5
QCF 3 and 4	***27.7***	***27.6***	***29.3***	***27.2***
QCF2 GCSE(A-C) & equivalent	20.1	20.6	21.1	20.8
QCF1 GCSE(below grade C) & equivalent	19.3	19.5	17.9	17.3
No Qualification	19.4	18.4	11.5	6.7
Total	*100.0*	*100.0*	*100.0*	*100.0*
Whole Economy				
QCF8 Doctorate	1.1	0.7	1.1	1.8
QCF7 Other higher degree	3.6	4.0	7.5	11.8
QCF6 First degree	7.6	10.2	15.3	19.3
QCF5 Foundation degree;Nursing;Teaching	7.4	6.0	5.6	5.2
QCF 5 - 8	***19.7***	***20.9***	***29.6***	***38.1***
QCF4 HE below degree level	5.6	4.4	4.7	5.2
QCF3 A level & equivalent	19.6	19.4	19.3	16.7
QCF 3 and 4	***25.1***	***23.8***	***24.0***	***21.9***
QCF2 GCSE(A-C) & equivalent	21.4	21.5	20.8	19.5
QCF1 GCSE(below grade C) & equivalent	19.4	19.5	16.4	14.8
No Qualification	14.3	14.3	9.2	5.7
Total	*100.0*	*100.0*	*100.0*	*100.0*

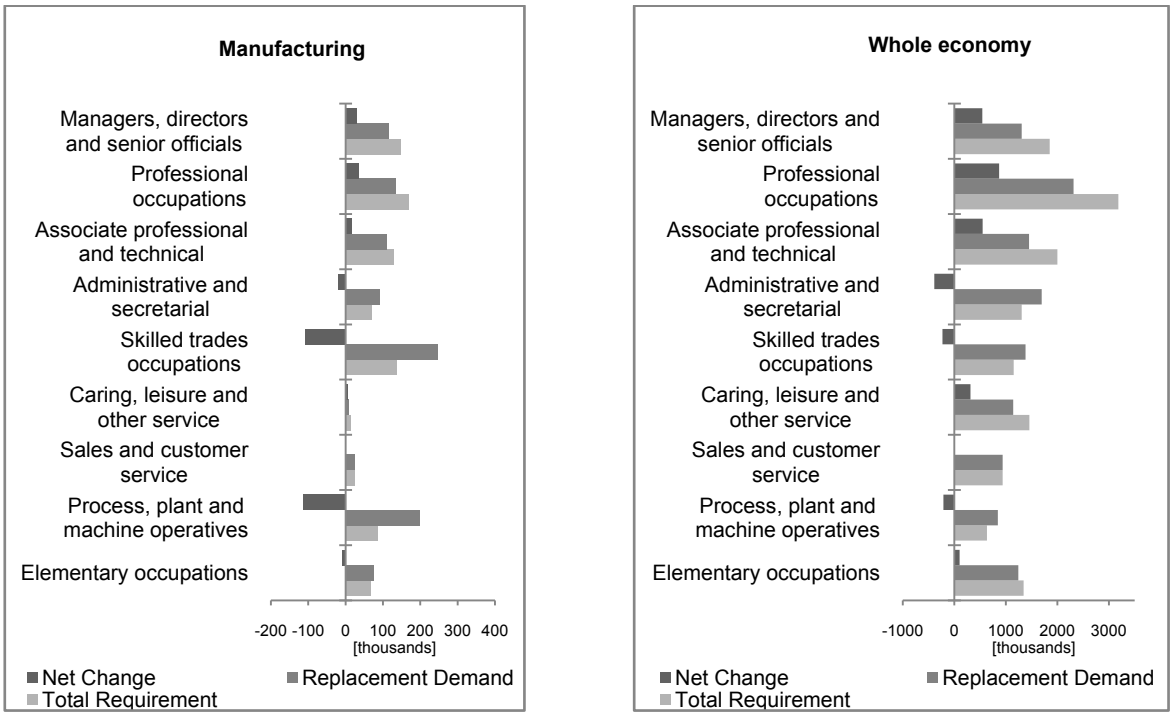
Source: Working Futures Database 2010 – 2020, UK Commission (2011b)
Base: SSA Definition

4.4 Replacement Demands

The manufacturing sector in Chart 4.2 highlights the move away from operatives and skilled trades even more so than the economy as a whole but also illustrates the scale of recruitment needed in the workforce. The principal message to emerge from Chart 4.2 is that there are occupational groups in the sector which are likely to decline in the overall numbers of people employed in them. Skilled trades workers – typically trained *via* Apprenticeships to Level 3 and sometimes beyond – are a case in point, but even here there are substantial replacement demands due to the number of people who are likely to leave their skilled trades jobs in manufacturing for whatever reason in the period to 2020. The issue then arises about how to attract people to work in a sector where the signal

being sent by the market is one of declining number of jobs, even if the story is also one of an increasing number of job openings.

Chart 4.1 Replacement Demands



Source: Working Futures Database, UK Commission (2011b)
Base: SSA Definition

There is an array of difficulties for the manufacturing sector in recruiting replacement labour. The archive images promulgated for the sector tend to be dated and all too often still reflect old technologies and manufacturing processes that do not illustrate current, let alone future, skills needs. Oily “black glove” manufacturing industries are being replaced by “white glove” clean quality systems; even more so in the new emerging technology sectors. The white glove work environment is typical of the modern, advanced manufacturing workplace, though it is not always clear that this image is readily communicated to those who might develop a career in the sector. Arguably, the messages over the last decade and beyond that manufacturing is declining, the sector is shrinking and that jobs are being shed, leaving a less than encouraging view, needs to be counterbalanced by the excitement of developing and working with the new high technology devices and systems. Certainly the estimates of replacement demand point to a large number of jobs needing to be filled over the medium-term. Moreover, the skills which will be required in order to fill those jobs are not ones which can be quickly produced with, at a minimum, Level 3 Apprenticeships taking around three to four years to complete.

Many of the new advanced manufacturing technologies are too expensive for educational establishments to invest in themselves, including universities, with the danger that educational content is lagging behind the needs in the workplace. More collaboration between industry and academia could potentially help this issue and there are some developing university technical college partnerships that are targeting this area (IET, 2011). It is interesting in this regard that the Government has invested in Technology Innovation Centres / Catapult Centres which potentially achieves this aim (see Chapter 6).

There is an increasing concern about preserving the competitive edge of the industry and limiting the leakage of knowledge of new techniques and technologies to competitors. There are a growing number of large UK companies fostering their own academies and whilst this primarily addresses the issues of customised education and training needs, it also helps to control the company's Intellectual Property (IP).

4.5 Summary

There are very different styles of manufacturing business with very different skills required to optimise business performance for different product market strategies and at different stages of product life cycle maturity. This is a challenge for large companies, which have a number of ways to keep pace with the requirements of skill set change, let alone SMEs which make up the bulk of employment in the sector. The speed of change is increasing and forcing supply chains to become more like supply networks with parallel processes rather than sequential, requiring higher levels of flexibility, agility and a broader spread of soft skills across the workforce, including inter-personal and communications. Higher levels of employee responsibility, autonomy and managerial delegation will be required at all levels in the organisation.

The expectation is that there will be a continuing drive for higher productivity, better competitiveness and higher value addition recognised in the forecasts for the next ten years which show the sector becoming increasingly highly skilled.

The latest sector skills assessment for manufacturing points to it being in a relatively healthy state but indicates a number of areas where skills supply and development will need to be include in the future (SEMTA, 2012). These include:

- enhanced of technical expertise within Associate Professional and Professional roles, in response to technical change
- improvements in leadership and management skills in order to be more cost-effective and more agile in response to market challenges and opportunities
- improvements in the market assessment skills of senior managers alongside skills associated with regulatory compliance
- increasing importance attached to supply chain management skills
- a continued demand for technically competent workers at craft and operative levels even if they will be required in lower numbers
- research and development skills and design skills are likely to be increasing in importance across companies of all sizes.

5 SKILLS SUPPLY

5.1 The Supply Infrastructure

There is a well established skills supply infrastructure which the manufacturing sector is dependent upon in satisfying its skill needs. In relation to initial vocational education Apprenticeships (at Level 2, 3, and 4/5) and higher education are the principal pathways into the sector, supported by the selected Sector Skills Councils and Skills Academies (SEMTA, 2009). And in relation to continuing vocational education and training there is: (a) a well developed private training market,[5] and (b) a number of professional bodies, such as the IEEE, which establish skill / competence standards and encourage continuing professional development and training. In combination the role of the professional institutions and their role in standard setting, alongside a well developed training infrastructure, is mutually reinforcing in driving up both the quantity and quality of skill supply.

In relation to higher education Government policy has favoured the supply of science technology, engineering, and mathematical (STEM) subjects in recognition that these are of critical importance to developing the innovative capacity of the UK. In the reforms of the higher education sector across the four nations, STEM subjects have been favoured relative to other subject areas. The critical issue for the advanced manufacturing sector is how to attract people who graduate in STEM subjects given that people with these qualifications are in high demand in other sectors, such as financial services. Furthermore, evidence suggests that 40 per cent of STEM graduates are not working in STEM roles. The supply of higher-level STEM skills broadly meets demand; where demand is unmet it is in quite specific roles and the need is for specific higher-level STEM skills (UK Commission, 2011c).

As the evidence will reveal below, the supply of people qualified in subject areas germane to the needs of the advanced manufacturing sector has been encouraging.

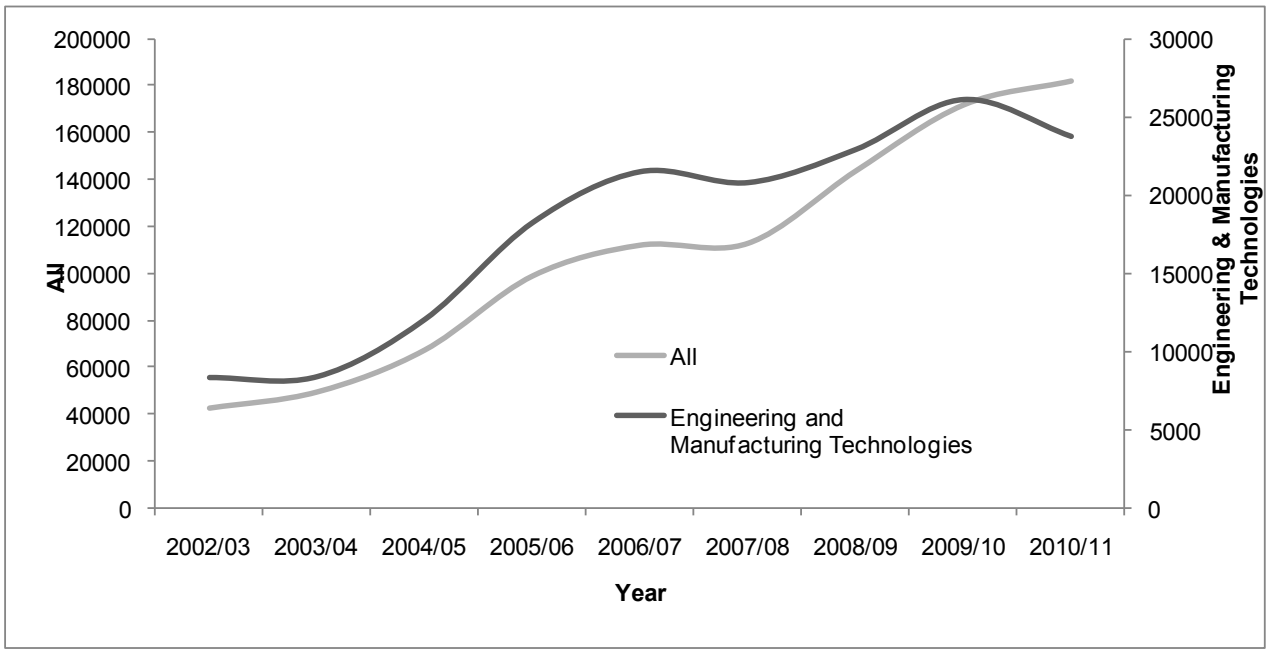
5 SSCs and Skills Academies also have an important role to play in promoting and delivering continual professional development and training.

5.2 Trends in Skill Supply: Individuals

Initial Vocational Education and Training

In relation to Apprenticeships, the number of people who have been achieving either Level 2 or 3 in engineering and manufacturing technologies has been steadily increasing over recent years, despite a recent drop-off in numbers (see Chart 5.1). As revealed elsewhere in this report, the level of replacement demand in the manufacturing sector is large which indicates that employers will need to increasingly recruit trainees if they are to avoid skill shortages in the future. In particular, there is a large replacement demand for people working in skilled trades occupations. Typically entry to this occupational group is *via* Apprenticeship.

Chart 5.1 Apprenticeship Achievements in Engineering and Manufacturing Technologies in England



Source: Data Service (2011)

Often a Level 3 engineering Apprenticeship requires applicants to possess 5 GCEs at grade C or above in English, mathematics, and a science subject. The evidence suggests that engineering firms which offer structured, three to four year apprenticeships leading to a Level 3 qualification are often inundated with suitably qualified applicants (Hasluck *et al.,* 2008). With the result that the principal constraint on increasing supply further is not so much the shortage of suitably qualified people capable of undertaking an

engineering / manufacturing apprenticeship, but the supply of Apprenticeship places by employers (House of Lords, 2007).

In relation to higher education Government policy has favoured the supply of science technology, engineering, and mathematical (STEM) subjects in recognition that these are of critical importance to developing the innovative capacity of the UK. It is also evident that STEM subjects / skills are of critical importance to the advanced manufacturing sector given its dependence upon developing new products and processes. The (HESA, 2011) evidence demonstrates that there has been an increase in the number of people obtaining STEM degrees. In 2010/11, there were around 285,000 people exiting HE with a science degree (an increase of 14 per cent since 2006/7) and over 46,000 people exiting with an engineering and technology degree (an increase of 28 per cent). The increase in graduates in engineering and technology is greater than the overall increase number of graduates (18 per cent).

The evidence also reveals that there has been a substantial increase in the number of people with Science Engineering and Technology (SET) HE qualifications in the labour force over time: from 1.7 million in 1997, to 2.1 million in 2004, to 3.7 million in 2009 (DTI, 2006). In part, the growth in the number of SET graduates has been supported by an increase in the number of school pupils studying STEM subjects at A-level. In fact, the evidence indicates that this is the principal constraint upon studying SET / STEM subjects at university.

Continuing Vocational Education and Training

Table 5.1 shows a smaller proportion of the manufacturing workforce, at 18 per cent, is in training compared with the whole economy workforce at more than 25 per cent. Training varies by occupation but the percentage of the workforce in the sector is at or below the average for all occupations. Despite higher level occupations increasing in importance in the sector training levels are especially now for managers. This is particularly concerning given the role that managers need to play in the future strategic development of the sector. However, training for skilled trades and process, plant and machine operatives is on a par with the average for all sectors, and similarly for employees under 25 years of age.

Table 5.1 Number of employees in receipt of work-related training over the past 13 weeks

	Manufacturing		Whole Economy	
Occupations (SOC Major Groups)	Number	% of workforce	Number	% of workforce
1 Managers and senior officials	108,563	18.9	1,008,425	22.6
2 Professional	95,312	27.9	1,588,563	39.5
3 Associate professional and technical	70,808	26.1	1,505,022	35.3
4 Administrative and secretarial	31,669	14.5	670,009	21.1
5 Skilled trades	94,578	15.2	476,943	15.6
6 Personal service	473	8.8	927,704	36.5
7 Sales and customer service	10,257	16.9	416,531	19.4
8 Process, plant and machine operatives	92,754	15.4	288,954	15.2
9 Elementary	30,325	11.2	470,477	14.5
All	534,739	18.0	7,352,628	25.5
Women	119,579	16.86	3,868,241	28.89
Men	415,160	18.39	3,484,387	22.56
People aged under 25	74,409	28.96	1,091,698	29.45

Source: LFS 2010

Migration

Given the high skill nature of the advanced manufacturing sector, and the global markets in which many advanced manufacturing sector is looking to recruit labour, migration is a particularly important source of skills. It is notable that the Ministerial Advisory Committee advised that restrictions on entry to the UK should be relaxed in relation to a range of engineering skills such as those in aerospace (MAC, 2011). The evidence indicates that there are manufacturing sectors which are relatively dependent upon employees who were not born in the UK. Food manufacturing, for example, had the highest share of migrants in employment in 2010 – 34 per cent - followed by the manufacture of apparel at 31 per cent (The Migration Observatory, 2010).

5.3 Employer Investment in Skills

Employer engagement in training

Employer investment in skills shows many similarities between the manufacturing sector and the economy as a whole as Table 5.2 portrays. The average training expenditure per employee in manufacturing was £1,425 in 2011 compared with £1,775 for the economy as a whole.

Table 5.2 Employer Investments in Skill

	Manufacturing	Whole economy
% of employers training	57	59
% of workforce receiving training	35	46
% average number of training days *per* trainee	7.8	8.9
Average expenditure on training *per* trainee	£3,050	£3,275
Average expenditure on training per employee	£1,425	£1,775

Source: UK Commission's ESS 2011, (UK Commission, 2012)

Note: Based on SIC 10-33 definition of sector

Base for training: All establishments,87,572 unweighted

Base for expenditure: All trainers completing the Investment in Training Survey 11,117 unweighted

European data suggests that manufacturers in the UK are more likely to have provided their employees with training than their European counterparts – 88 per cent of UK manufacturers had supplied training compared with 54 per cent in the EU-27 – but the average number of hours of training supplied, at 5 hours, was lower than the EU-27 average of 9 hours per employee (Eurostat, 2011)

Table 5.3 shows that employers in the manufacturing sector were less likely to recruit young people of any age when compared to the average for all employers.

Table 5.3 Recruitment of young people

Employers who have recruited young people	Manufacturing (per cent)	Whole economy (per cent)
16 year olds recruited to first job from school	4	8
17 or 18 year olds recruited to first job from school	5	9
17 or 18 year olds recruited to first job from FE College	5	7
Recruited to their first job from University or other Higher Education institution	5	7

Source: UK Commission's ESS 2011, (UK Commission, 2012)
Note: Based on SSA definition of sector
Base: All establishments 86,069 unweighted (not asked in Scotland)

With respect to Apprenticeships, Table 5.4 reveals that the percentage of employers who engage in this form of training, or who plan to do so in the future is higher in manufacturing than in the economy generally. As noted earlier, the sector is typically dependent upon Apprenticeships to train new entrants to skilled trades occupations. If the Semta SSC footprint is used instead of the SIC derived sector, then the results show that 15 per cent employers reported that they currently had an apprentice.[6] Where they did not they tended to report that they had no need to train or that the business was too small to take on an apprentice (32 per cent of employers without an apprentice *versus* 12 per cent across all employers) (UK Commission, 2010d).

Table 5.4 Recruitment of apprentices

	Manufacturing Employers	All Employers
Currently have staff undertaking Apprenticeships	8%	5%
Currently offer but have no staff on Apprenticeships	5%	4%
Plan to offer Apprenticeships in future	10%	8%

Source: UK Commission (2010d)
Note: Based on SIC 10-33
Base: All establishments 14,390 unweighted

A number of Local Enterprise Partnerships have picked up the challenge of the need to up-skill and the need to bring young people into the sector through training schemes and have thrown their weight behind the promotion of Apprenticeships. Efforts are being made through the Engineering Institutions and others to attract young people to Science, Technology, Engineering and Mathematics through various school linked programmes. Some large companies have fostered their own skills academies and a number of University Technical Colleges are under development including manufacturing. All these efforts and more will get the manufacturing sector to pick up the necessary speed of change (EEF, 2012).

Table 5.5 provides some further indicators of training activity. The existence of business or training plans or a training budget, are less commonly found amongst manufacturing establishments. Table 5.5 also illustrates that employers in manufacturing are less likely engage in annual reviews of their employees, less likely to engage in training of any kind,

6 SEMTA's footprint includes engineering, manufacturing and science and includes business which employ about 1.7m people.

less likely to have people training towards a formal qualification at any Level, and less likely to formally assess the training which their employees have participated in. The data also show that proportionately fewer employees in manufacturing were training towards a qualification. That said, the differences between manufacturing and the economy as a whole on all of the above indicators are not substantial in most cases.

One of the key challenges relates to supplying skills to SMEs (*c.f.* the findings on the reasons for not taking on apprentices above). Many manufacturing SMEs take the view that training promotes higher wage demands and / or leads to poaching by competitors, so there is work to be done to encourage them to recognise that they can adapt Medium Sized Enterprises's (MSE) approaches and gain similar benefits. The MSE companies tend to be the ones that have taken more advantage of schemes such as Investors in People and have come up with better approaches to the application of training in the company as well as schemes to encourage trainees to stay with the firm at least for a period of time. There is scope for Group Training Associations and the networks attached to larger employers to provide cost-effective training and knowledge transfer, respectively, to SMEs (Gospel and Clooney, 2003; Clooney and Long. 2008; Brown *et al.*, 2004).

Table 5.5 Other Indicators of Training Activity

	Manufacturing (SSA)	UK
% all establishments with business plan	**57%**	**61%**
% all establishments with training plan	**30%**	**38%**
% all establishments with training budget	**21%**	**29%**
Annual review of staff (all establishments)		
All staff reviewed	39%	47%
No staff reviewed	49%	43%
Provide training (all establishments)	**57%**	**59%**
Train towards qualification (all employers providing training)	**39%**	**43%**
Training to Level 2 qualification	13%	14%
Training to Level 3 qualification	13%	16%
Training to Level 4 qualification	8%	12%
Assess training delivered	60%	65%
% of employees trained towards a qualification in last 12 months	**10%**	**12%**

Source: UK Commission's ESS 2011, (UK Commission, 2012)
Note: Based on SSA definition of sector
Base: All Establishments 87,572 unweighted; All Establishments providing training 66,916 unweighted

Skills Utilisation

Sometimes within organisations there are untapped sources of skill supply. Employees may have a wide variety of skills which are not deployed in the workplace for one reason or another. The evidence suggests that in the economy generally around 49 per cent of establishments have employees whose qualifications and skill levels are in advance of those required to do their jobs. This compares with 43 per cent in the manufacturing sector indicating that the sector might be better able to match extant skills to tasks which need undertaking (UK Commission, 2012). On the other hand it does suggest that in both manufacturing and the economy generally that there might substantial stocks of untapped skills and knowledge – depending upon how many employees this affects and the extent to which skills are being under-utilised - which could be deployed for the benefit of the workplace. A critical issue here is how to unlock those skills for the benefit of the workplace. Investors in People (addressed in Chapter 6) is a specific programme

which looks to effectively deploy skills in the workplace, but there are a range of measures employers can take themselves to achieve this end. One such measure is having in place those processes, either formal or informal, which allow employees with high potential or particular talents to be identified and nurtured. The evidence suggests that in manufacturing 43 per cent of manufacturing employers have processes in place which allow them to do this, which is just under that for the economy generally (45 per cent). In general, where there are processes in place they tend to be informal rather than formal (UK Commission, 2012). The general finding here is that there is potential for just over half of employers in the sector to develop processes which will assist them identify the talents extant within their business. How this might be achieved is returned to in Chapter 6.

Looking more broadly at high performance working (HPW), the manufacturing sector is below average across all four indicators of HPW: identifying 'high potential' individuals, extent employees have variety in their work, task discretion and access to flexible working. One of the potential outcomes of strong delivery of HPW is strong skills utilisation another is strong strategic and operational management. Given that manufacturing scores higher than average for level of product market-strategy (vs whole economy average), using a set of indicators including customisation, pricing, new products and services and quality of products and services (UK Commission, 2012) there is clearly potential for the sector to achieve more. It would be expected that effective management and skills utilisation, and investment in skills and ways of working to strengthen this, would accompany a high product market strategy.

Employer use of, and satisfaction with, the external training infrastructure

If it is possible to ratchet up the demand for skills and training within manufacturing employers then there is a need to ensure that training suppliers are in place to meet that demand. In manufacturing there is often a need to engage with external training providers due to the fact that Apprenticeship programmes, for instance, often contain a significant amount of block or day release typically at a local college. In fact, the evidence suggests that employers in manufacturing are no more or less likely engage with external training providers than employers in general: 31 per cent of manufacturing establishments had no contact with external providers compared with 29 of all employers. The extent to which they are likely to use private training providers (58 versus 54 per cent), FE colleges (24 versus 23 per cent), or HE institutions (11 versus 13 per cent) shows little or no difference with all employers in the economy. They are less likely to

use not-for-profit / third sector organisations for training (10 per cent versus 19 per cent). There overall satisfaction with the use of FE colleges – 7.1 out of 10 where a high score indicates relative satisfaction – is not much different from the overall average of 7.4 for all employers (UK Commission, 2010d).

5.4 Strategic Skills Supply

Several reports, over the last decade, have highlighted the importance of strategic level skills and the deficiencies apparent in the manufacturing sector's senior managers and management teams, not least in the 65 per cent of manufacturing employment represented by SMEs (LFS, 2010). However the picture is much closer to that for the whole economy when looking at the BIS Population Estimates (2011) for private sector only which estimates 57 per cent of manufacturing employment as being in SMEs compared with 58 for all sectors. A basic issue for employers, especially SMEs, is awareness of the threats and opportunities facing the sector (especially to the smallest establishments) particularly that there may be major opportunities for a company to improve its effectiveness, profitability and durability by improving the way in which senior managers address strategy.

The occurrence of training for Managers, Directors and Senior Officials is well below that for the economy average: 39 per cent in manufacturing sector as opposed to 45 per cent across all sectors. Across the managerial, professional and associate professional occupations, occurrence of training is at 44 per cent for manufacturing, a full 10 percent lower than the all sector average. As it stands, for manufacturing as a whole, *more than half* of its managers and professionals do not hold qualifications at Level 4 and above.

Given the challenge of an innovation and technology driven sector and global competition it could be expected that the need for strong management skills would be paramount in the manufacturing sector. Research conducted with manufacturing firms in the UK and overseas found that better management can result in more: sales per employee, sales growth, market share growth and capital market valuation. The benefits of better management were equivalent to a 56% increase in the number of employees or a 44% increase in investment capital (McKinsey, 2010)[7].

[7] Based on interviews with 6,000 manufacturing companies in 19 countries focusing on 3 areas 1) operations management, 2) performance management and 3) talent management

Many of the training providers in the sector respond to requests from the businesses themselves, or through third party organisations, to identify training needs and then provide appropriate training. If these providers do not have sufficiently high skills themselves, along with appropriate diagnostic methods, then it is difficult for skills supply and demand to positively feed off one another. There may well be a training-the-trainer issue facing the supply of training given the pace of change in the sector.

The importance of strategic skills cannot be under-estimated. In a study on the medical technologies sector in the West Midlands, the evidence very much pointed to employers (typically SMEs) becoming locked into relatively low value markets, often opportunistically responding to demand for a given product rather than being able to strategically develop their businesses to capture high value markets. In part this stemmed from a lack of support to develop the business skills to which would allow them to achieve this end and from a lack of strategic thinking by the companies (Hogarth *et al.*, 2010).

5.5 Summary

The evidence points to skills supply being well supported by an extensive initial and continuing vocational education and training infrastructure with a substantial increase in the number of people being qualified each year in subjects / skills which the manufacturing sector is dependent upon. A number of observations can be made in relation to the challenges the supply side faces.

- In the advanced manufacturing sub-sector the pace of change is so rapid, or the skills so specific to a new technical development, that the supply-side often has to run fast in order to keep pace with developments on the demand side.
- The above point suggests that employers at the cutting-edge may need to look internally, or within their knowledge networks externally to develop the skills they require. This points to the importance of initiatives such as the Growth Investment Fund – discussed further in the next section – which provides employers with the funding capability to develop their own solutions to business challenges.
- Strategic skills development is an issue particularly germane to SMEs so that they can benefit from the opportunities potentially available to them.
- The skills which supply side provides to advanced manufacturing – essentially ones which embody a high level of numeracy – are ones which are in high demand in other sectors. Accordingly, the supply-side can be relatively strong but has less impact on

meeting demand than might be expected given the wider demand for manufacturing-friendly skills.

6 Skill Mismatches

6.1 Defining Skill Mismatches

Previous evidence has demonstrated that mismatches between the demand for, and supply of skills, can be damaging for organisational performance (Wilson and Hogarth, 2002). The (National) Employer Skill Surveys have consistently demonstrated that gaps result in, amongst other things, delays to the development of new products and services, work being turned down, difficulties meeting customer service standards, *etc.* (UK Commission, 2012). To some extent, skill mismatches will result from ongoing processes of technical and organisational changes within firms, and shifts in the pattern of demand in external markets. These will be, in part, transitional mismatches as the demand side begins to fully articulate its skill requirements and the supply side responds accordingly. But there are also likely to be structural mismatches where the demand for, and supply of, skills remain out of kilter despite the market signalling what skills are required (UK Commission, 2010b and 2010c). This chapter not only looks at the extent of skill mismatches but also looks at the effect of skill mismatch on the sector's performance and the training or training related measures taken either by Government or by employers in remedying skill deficiencies.

As there is no direct measure of mismatches between the demand for, and supply of, skills, at the sectoral level, inferences about the balance between the two are typically made through various means given that each measure provides only partial information. The common methods of gauging the level of mismatch are outlined below.

i. **Observing trends in wages** is a common method of measuring skills mismatches. This assumes that employers respond to difficulties finding the skills they need by increasing wages. In reality, not all employers respond in this way to an excess demand for skills. Regulation regarding pay, collective bargaining, and job-related risk factors will also affect wage rates, and non-wage incentives, including training, may be offered to potential employees to attract them to an organisation. There is also a more general question about the extent to which wage levels are responsive to the market. Evidence suggests that nominal wage rates are relatively more responsive in the UK than elsewhere, but this might be little more than a reflection of the demand for overtime.

ii. Estimating **the rate of return to obtaining sector related qualifications** provides a further indication of the extent to which a premium is attached to obtaining the skills deployed in a given sector. Qualifications, however, are an imperfect measure of skills and the rate of return to obtaining a given qualification, and given that the measure of return is based on wages, all of the caveats which relate to this apply as a measure of skills mismatch.

iii. **Employer reports of skill mismatches** in the form of hard-to-fill vacancies (HtFVs) and skill-shortage vacancies (SSVs) which provide an indication of the difficulties employers have in recruiting people from the external labour market with the skills and attributes they require. Surveys also capture information about problems employers experience with the skills of existing staff with respect to the extent they lack full proficiency in their jobs (*i.e.* skill gaps).

Each of these is now considered in turn with respect to the manufacturing sector.

6.2 Evidence of Relative Wage Growth

Table 6.1 provided evidence about weekly wage levels in manufacturing compared with the economy overall. The evidence reveals that the median and mean salaries of employees in manufacturing are generally higher than in the economy overall, and have been increasing more rapidly. But if one looks at particular sectors which might be considered to fall within the advanced manufacturing sub-sector – such as the manufacture other transport equipment into which aerospace falls - then the wage levels are revealed to be even higher. It is particularly noticeable that the rate of wage increase in some sub-sectors, such as manufacture of machinery and equipment in which much of ICT manufacturing and design takes places, have experienced particularly strong wage growth which may well point to difficulties in recruiting staff with the skills sought in these sectors.

Table 6.1 Weekly Wage Levels

	Annual		**Annual**	
		Percentage		**Percentage**
	Median (£)	**Change**	**Mean (£)**	**change**
UK (all employees)	403.9	0.0	491.4	0.8
MANUFACTURING	**489.0**	**2.1**	**557.7**	**2.2**
Manufacture of computer, electronic and optical products	574.9	6.5	652.5	6.1
Manufacture of machinery and equipment n.e.c.	534.3	8.1	598.7	7.4

Manufacture of motor vehicles, trailers and semi-trailers	573.5	4.3	629.7	3.4
Manufacture of other transport equipment	636.1	1.1	689.4	1.0

Source: ASHE 2011 (provisional data), 2012

The evidence further points to relatively high returns with regard to particular qualifications. At Level 2, studies indicate that relative to holding no qualification, the returns are modest in manufacturing (four per cent) compared with energy and water (13 per cent), and construction (9 per cent). (Jenkins *et al*., 2007). This may relate to the fact that the higher value-added sectors of the manufacturing sector are more dependent upon Level 3 and higher qualified people. The latest evidence suggests that the marginal wage returns at Level 3, compared with Level 2, are stronger in manufacturing (see Table 6.2) (BIS / HM Treasury, 2011).

Table 6.2 Marginal Returns to Level 3 Qualifications[8]

	Agriculture and Fishing	Energy and Water	Manufacturing	Construction	Distribution hotels and restaurants	Transport and Communication	Banking, finance and insurance	Public Admin, education and health	Other
RSA L2	-	59%	30%	5%	13%	9%	3%	17%	14%
C&G L2	4%	15%	11%	10%	8%	8%	3%	4%	1%
BTEC L2	8%	12%	3%	34%	8%	6%	3%	6%	12%
NVQ L2	-8%	1%	-1%	3%	0%	0%	-4%	-2%	4%
RSA L3	-	9%	10%	-5%	0%	21%	6%	7%	7%
C&G L3	-2%	14%	15%	12%	11%	12%	2%	5%	8%
BTEC L3	26%	21%	18%	18%	12%	17%	10%	8%	7%
NVQ L3	-2%	4%	5%	16%	7%	5%	1%	2%	11%

Source: Jenkins et al., (2007) Figure 7

Other research in relation to completing an Apprenticeship suggests relatively high returns to the employer in sectors such as engineering. McIntosh calculated the Net Present Value (NPV)[9] of apprenticeships (at any level) in five different sectors of the economy (McIntosh, 2006, 2009). The NPV was highest in construction (£156,523) and engineering (£78,351) compared with the service sector where, in retail for instance, the NPV was £31,928 (McIntosh, 2006, 2009).

[8] This Table reports some examples of negative returns. Whilst in reality it is unlikely that an individual would experience a drop in wages due to gaining qualifications Mcintosh (2009) provides an explanation of why negative returns may be observed.

9 McIntosh (2009) estimates the marginal returns to Apprenticeships. The estimated wage returns are then combined with (i) the increased likelihood of apprentices being in employment; (ii) costs of providing the Apprenticeship by employers and government; (iii) and the costs to the individual (foregone earnings). The future results are then discounted to give a net present value (McIntosh, 2009, p. 59)

The evidence suggests that there are significant business benefits from employers investing in Apprenticeships. University of Warwick Institute for Employment Research (IER) has been undertaking a series of studies on the net costs and benefits of training to employers engaged in Apprenticeship training including for engineering. The studies give an indication of the benefits which accrue to employers who invest in this form of training. The latest case study research (Hogarth et al., 2012) indicates that for engineering:

- The cost of a Level 3 (Advanced) Apprenticeship is higher than for other sectors explored but the time over which the employer recoups the cost (after completion) compares quite favourably.

- Typically the decision to recruit apprentices was driven by a need to meet future skills needs at an intermediate level.

- Employers reported that apprenticeships delivered value to the organisation in terms of providing skills immediately relevant to their needs, an opportunity to shape the work values of apprentices and introduce new skills with the potential to transfer to others

Certainly in relation to Apprenticeships more generally, employers can point to a range of business benefits relating to (Hasluck *et al*. 2008): improving the attractiveness of the company to would-be recruits, improving labour retention (especially where apprentices are new recruits), the inflow of new skills into the business and a tried and tested means of delivering the skills businesses require.

With respect to Level 4/5 qualifications, the evidence on sectoral wage rates is more difficult to identify. It is possible to look at the types of degree which the manufacturing sector requires. If one looks at the evidence from the Class of '99 – a longitudinal survey of people who entered higher education in 1999 – it reveals that graduates in engineering fared relatively well during their early period in the labour market (Purcell *et al.,* 2005):

i. they were amongst the group of graduates most likely to be employed in a job requiring a degree;

ii. their wage levels were relatively high compared with the average (though the average for people working in manufacturing for all degree was near the average);

iii. they reported relatively high levels of job quality (as reflected in their salary level, undertaking interesting and challenging work, long-term job security, and working in progressive and dynamic organisations).

Overall the evidence suggests that in certain sections of the manufacturing sector the level of wage increase, and the relatively strong marginal return to obtaining a Level 3 or Level 4/5 qualification suggests that a degree of mismatch exists between the volume of skills required and those available to employers. This is supported by evidence on skills deficiencies in the sector workforce as reported by employers.

6.3 Evidence of Employer Reported Skill Deficiencies

The 2011 UK Commission's Employers Skill Survey provides an indication of the extent to which employers experience hard-to-fill vacancies as a result of applicants for jobs not possessing the required level of experience, qualification, or skill (UK Commission, 2012). It also provides an indication of the extent to which skills extant in the workforce meet the needs of the business (see Tables 6.3a and 6.3b).

The key points reveal that in relation to recruitment:

- 13 per cent of manufacturing establishments reported at least one vacancy compared with 12 per cent in the whole economy;
- six per cent of manufacturing establishments reported at least one hard-to-fill vacancy (HTFV) compared with four per cent in the economy as a whole;
- four per cent of manufacturing establishments reported at least one skill shortage vacancy (SSV) compared with three per cent in the economy as a whole.

The above points suggest that the recruitment difficulties faced by manufacturing are not significantly different from that of the economy as a whole. But if attention is directed to the percentage of vacancies which are reported as being SSVs then this is much higher for manufacturing (24 per cent) than for the economy generally (16 per cent). This suggests that where employers have a vacancy it is likely to be more difficult to fill because of a shortage of applicants with the required skills, qualifications, or experience than is the case for employers generally.

With respect to the proficiency of the existing workforce – *i.e.* the extent to which the workforce are fully proficient in their current jobs – the evidence suggest that the situation is consistently slightly lower for manufacturing than for the economy as whole:

- 16 per cent of manufacturing employers reported skill gaps compared with 13 per cent in the economy as a whole;
- Six per cent of employees in manufacturing were regarded as not being fully proficient in their current job compared with five per cent in the economy as a whole.

Table 6.3a Incidence of Skill Deficiencies

	Manufacturing	UK
Vacancies (total)	**40,250**	**635,900**
Vacancies / 1,000 employees	15.8	23.1
% of establishments with at least one vacancy	13%	12%
HtFVs (total)	**11,850**	**143,550**
% of establishments with at least one HTFV	6%	4%
SSVs (total)	**9,700**	**103,450**
SSVs / 1,000 employees	3.8	3.8
% of establishment with at least one SSV	5%	3%
Skill gaps	**148,000**	**1,489,500**
Skill gaps / 1,000 employees	58.2	54.1
% of establishments reporting a skill gap	16%	13%

Source: UK Commission's ESS 2011
Note: Based on SSA definition of sector
Base: Vacancies as a % of employees based on all employment (N=87,571 establishments unweighted).
HTF vacancies as a % of vacancies based on all vacancies (N=17,166 establishments unweighted)
SSVs as a % of vacancies based on all vacancies (N=17,166 establishments unweighted)
Skills gaps as a % of employees based on all employment (N=87,571 establishments unweighted)
Notes: numbers rounded to nearest 50

Table 6.3b Density of Skill Deficiencies

Density	Manufacturing	UK
Vacancies as a proportion of employees	2%	2%
HTF vacancies as a % of vacancies	29%	23%
SSV as % of all vacancies	24%	16%
Skills gaps as a % of all employees	6%	5%

Source: UK Commission's ESS 2011
Note: Based on SSA definition of sector
Base: Vacancies as a % of employees based on all employment.
Hard-to-fill vacancies as a % of vacancies based on all vacancies.

SSVs as a % of vacancies based on all vacancies.
Skills gaps as a % of employees based on all employment.
Notes: numbers rounded to nearest 50

A degree of circumspection is always required with respect to the interpretation of skill gaps. This may in part reflect the capacity of a sector and provision to keep pace with the changing level of skill need.

6.4 Other Evidence on Evidence of Skill Deficiencies

The study on the engineering sector undertaken as part of the National Skills Task Force in 1999/2000 suggested that in the advanced manufacturing sector the demands made of management in ensuring that their production processes were consistent with the segment of the market in which they were operating, and that they were responsive to product lifecycles, were substantial (Davis *et al.,* 2002). In that study, many of the symptoms of skills deficiencies that were identified related to the need for senior managers to develop better business acumen; to be able to broaden their understanding of the marketplace and its constantly evolving drivers of change, and to be able to translate these scenarios into effective styles of product market strategies. In some respects, the skill deficiencies arose because of the rapid pace of change in the development of new products and processes and increased competition in the market.

The National Strategic Skills Audit for England 2010 revealed that in several manufacturing sectors relatively high shares of the workforce lacked a Level 2 or higher qualification, and relatively high shares of managers and professionals lacked a Level 4 qualification compared with sectors such as business services or financial services. This not necessarily an indication of a skills mismatch, but it suggests that there might be a qualification deficit in the sector as a whole, especially so amongst managers (UK Commission, 2010c).

6.5 Skill Mismatches: Causes and Remedies

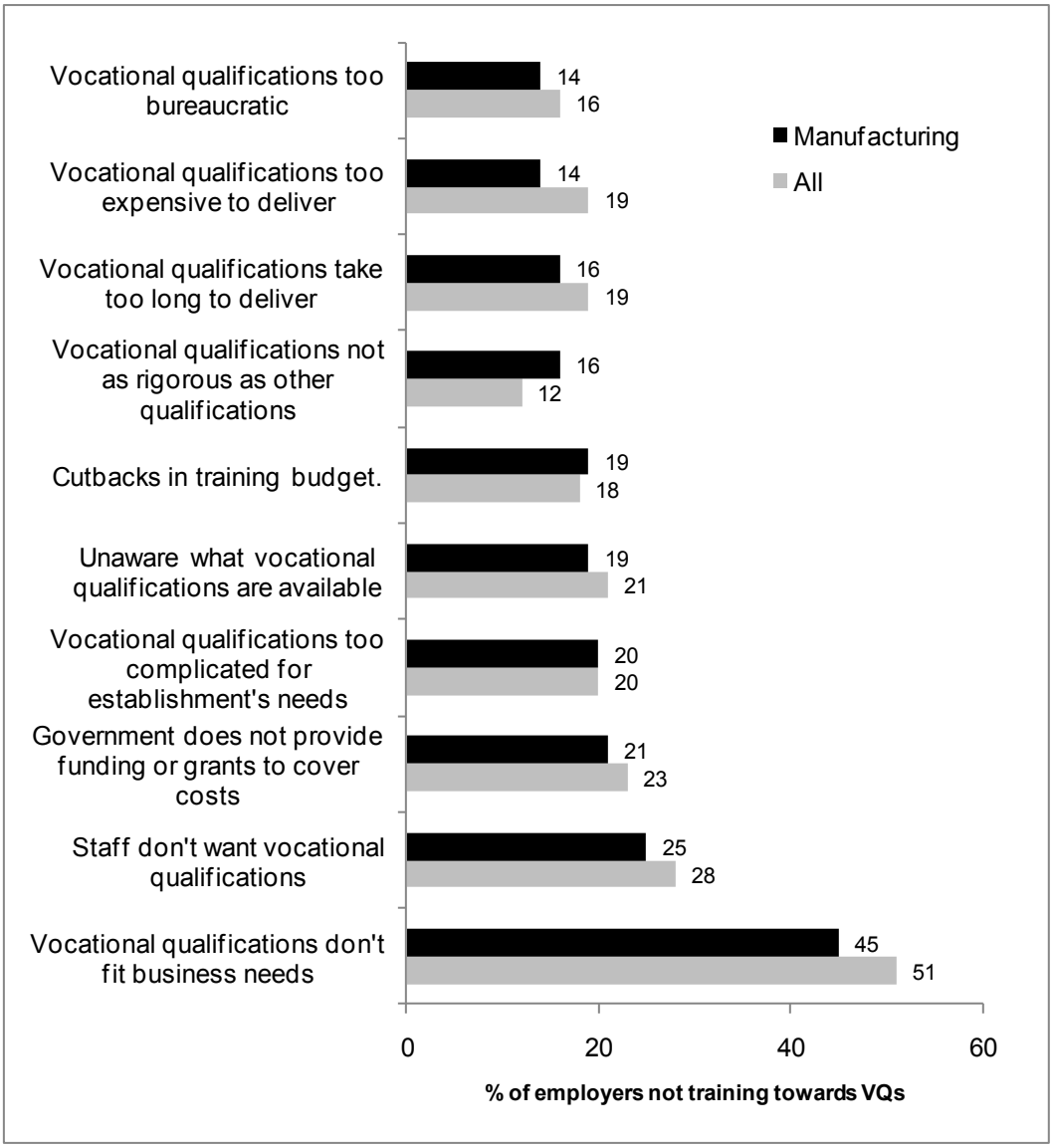
All the evidence points to skill deficiencies of one kind or another having an impact on business performance in the sector. The same proportion of manufacturing employers reported skill gaps as the economy average (15 per cent of manufacturing employers say they have a major impact upon their business, and 46 per cent a minor impact) but manufacturers were far more likely than employers overall to say it will had an impact on operating costs (61 per cent with skill gaps compared with 45 per cent of all employers).

The general impact of skill deficiencies in the workplace is to increase the workload on others and slow down developments in new products and processes. It is interesting to note that employers in manufacturing are relatively more likely to say that it might lead to more work being outsourced (20 per cent compared with 15 per cent across all sectors). This might mean that work is outsourced to other establishments in the UK, or overseas. In which case this needs to be seen in the context of the discussion elsewhere in this report about employers wanting to ensure that they have greater control over their supply chain relationships with a preference for suppliers to be increasingly local.

In relation to skill deficiencies one of the main responses from employers was to increase their provision of training. In manufacturing, for instance, 82 per cent of employers reporting skill gaps said they had consequently increased training provision (UK Commission, 2012) compared with 62 per cent for the UK as a whole. In Chapter 5 it was reported that 57 per cent of employers trained over the past 12 months. Where employers had not provided training over the past 12 months their responses were much the same as for all employers across all sectors: 68 per cent of non-trainers in manufacturing said that it was because all their staff were proficient compared with 64 per cent in the economy generally, and 11 per cent said it was due to no training being available compared with 10 per cent in the economy generally. In relation to the provision of training leading to a vocational qualification Chapter 5 reported that 39 per cent of employers had not done so over the past 12 months.

Generally where employers had not provided training leading to vocational qualification they reported a number of reasons why this was this case: the principal one being that vocational qualifications do not meet the needs of the business (reported by 51 per cent of employers in manufacturing compared with 49 per cent of all employers). The evidence also points to employees possibly being resistant to the idea of working towards a vocational qualification with 25 per cent of employers which had not provided training leading to a vocational qualification reporting this as a barrier (see Figure 6.1) (UK Commission, 2010d). Again the pattern for the manufacturing sector is similar to that for employers in general (28 per cent of which reported this as a barrier) but, again, it is slightly lower.

Chart 6.1 Reasons for Not Providing Vocational Qualifications



Source: UK Commission (2010d)
Note: Based on SSA definition of sector
Base: All establishments 14,390 unweighted

One of the key drivers of training demand will be product market strategy. As employers aim to capture higher value-added markets where the demand is for relatively

sophisticated and complex products, or seek to produce their existing range of goods with greater levels of efficiency, then this will, other things being equal, increase demand for skill levels within the organisation. Depending upon the extent to which existing staff need to raise their skills, this will increase the demand for training in general, and, potentially, training leading to the award of vocational qualifications, in particular. Moving to higher product market strategy in the firm may create skills gaps.

Manufacturing managers fear skill shortages post-recession with their potential to considerably slowdown the rate of recovery; many of them are conscious of similar problems after previous dips but suspect that there is a smaller pool of people this time with the necessary skills (EEF, 2012). A large number of initiatives have been launched to assist organisations overcome skill mismatches or skill deficiencies. Similarly, there are a wide range of company case studies which demonstrate how skill deficiencies have been avoided, and organisational performance improved, as a consequence of investing in skills. Various examples of policy initiatives and company responses are provided below.

Manufacturing Advisory Service

Many manufacturing SMEs are members of their local Chamber and that level of engagement has been tried as a mechanism to grow awareness of opportunities and change, for up skilling and training schemes. Business Links were co-located in many instances with local Chambers, also tried to roll over that engagement into more effective and "deeper" change and development for manufacturing companies. All of these structures had some beneficial effect but it is difficult to identify whether they were able to fundamentally improve the strategic skills of companies. Perhaps a more successful scheme of this type has been the Manufacturing Advisory Service (MAS) which has employed higher level skills in the delivery of the service and skills that are more focused on the manufacturing sector. The service also encompasses a higher level of customisation and closer collaboration with the client and more closely addresses their "needs" rather than their "wants".

Manufacturing Excellence Initiative

One of the skills development programmes of recent times which achieved considerable success in encouraging companies to develop their own strategic skills audit and to

encourage them to acquire better skills for their own strategic review and development was the Manufacturing Excellence Initiative. Typically it followed three phases: (i) beginning by working with the managing director personally; (ii) followed by engagement with the management team representing the leads for various functional skill groups in the business; (iii) followed by support to specific development actions by those skill group leaders – all backed up by a broad menu of education and training and qualification modules.

Growth and Innovation Fund and Employer Investment Fund

Some of these strategic change issues have been recognised as a stream of support needed within the BIS Growth and Innovation Fund (GIF) which has developed the Leadership and Management Advisory Service aimed at SMEs with the potential for high or fast growth. Other actions within GIF framework focus on the development of sub sector skills structures including life sciences and renewable technologies and the wider SME base.

The GIF and Employer Investment Fund (EIF) are co-ordinated through UK Commission. Phase 2 of EIF (launched 2011) is investing £61m alongside employer cash and in-kind investments to create a total over £100m. Almost a third of this investment at more than £32m is in the manufacturing sector, mainly in support of specific sub sector issues and SME issues generally. Support from these funds include, for example, £1m which is being invested in management and leadership capability in the motor industry and £5.7m invested in attracting new talent to fill gaps in SMEs through Apprenticeships across UK supply chain companies (see panel for details of EIF projects funded *via* SEMTA).

Employer Investment Fund

Semta: Attracting new talent to fill in the skills gaps in SMEs through Apprenticeships

- Demonstrate the return on investment for employers by recruiting an apprentice
- Improve the age and qualification profile within the Sector
- Reduce the technical skills gaps within the sector

Semta: Attracting new talent to fill in the skills gaps in SMEs through graduates

The investment will increase the number of SMEs who recruit Science, Technology, Engineering and Mathematics (STEM) graduates, through providing solutions to identified barriers and applying current 'Best Practice' from the Electronics sector across the Advanced Manufacturing and Engineering (AME) sectors including Aerospace, Automotive, Composites, Electronics, Electrical, Marine, Mechanical and Low Carbon related activity.

Semta: Transforming the skills and productivity of the supply chain companies current workforce

The investment will:

- Identify the skills and capabilities required for growth and increased productivity by supply chain Small Medium Enterprises (SMEs)
- Develop a tailored 'Capabilities and Skills for Growth Assessment' model and delivery to 2,200 supply chain companies
- Provide initial research into what financial support is required to drive SME investment in training exploring the benefits of an Enterprise Funding Model offering an 'up front' loan or National Insurance/Tax holiday or refund.

Source: http://www.ukces.org.uk/ourwork/investment/eif

Technology Innovation Centres / Catapult Centres

The Government, through its Technology Innovation Centres (TICs) / Catapult Centres, has sought to create a critical mass of business and research innovation in a technology with a potentially large global market. In this way, the collective experience of firms and research centres can be captured. One set of TICs will be in High Value Manufacturing and which should help to spur the focus on the opportunities in the high complexity and emergent technology sectors. BIS is also encouraging the take-up of apprenticeship schemes (IET, 2010), with a number of Local Enterprise Partnerships (LEP) focusing on this, and a number of companies, universities and colleges collaborating and developing different forms of academy to introduce skills which are closer to market need.

Investors in People

Investors in People is " ...the UK's leading people management standard. It's a business improvement tool designed to help all kinds of organisations develop performance

through their people."[10] Table 6.4 shows that in the advanced manufacturing sector relatively few establishments are accredited to IiP than in economy as whole. Combined with generally lower levels of investment in training this suggest one area where action could be taken.

Table 6.4 Investors in People Accreditation in IiP

Row percentages

	IIP accredited (%)	Not IIP accredited (%)	Don't know (%)	Total (%)
Advanced Manufacturing	10	78	12	100
UK	16	69	15	100

Source: UK Commission's ESS 2011, (UK Commission, 2011)

Note: Based on SSA definition of sector

Base: All Establishments 87,572 unweighted

The example below provides an indication of the benefits which employers can derive from engaging in Investors in People (IiP). The example is interesting insofar as it demonstrates that even in organisations producing relatively complex products there is a need to develop the skills of people at all levels *(see panel)*.

10 http://www.investorsinpeople.co.uk/About/Pages/default.aspx

The Company

Faraday produces low volumes of bespoke printed circuit boards and supplies larger volumes of printed circuit boards, which it commissions from partners in the Far East. The niche market low volume, quick turnaround work is produced in Washington however, and on average 600 different products per month are manufactured

While Faraday was a successful company and recognised as an Investor in People, the HR manager felt that some aspects of understanding the employee as a resource of the company could be improved. There was a real commitment to training and development, but a question as to whether the full benefits of that activity were being realised by the company. In particular, he was concerned about the skills base of the workers, and so introduced Skills for Life to Faraday.

The Results

Ten years after their first commitment to Investors in People, management are confident that the productivity improvements required to achieve their turnover targets will come from a concentration on skills and employees, both core elements of Investors in People.

The first Investors in People recognition cycle justified the desire for a more formal and professional approach to management. The skills matrices were valuable in defining where training needed to take place, and are now being further developed to fit with IT systems. Subsequent re-recognitions have reinforced quality management practices, but it was not until the most recent round in 2006 that formal measures were put in place to define required employee related improvements.

Source:

http://www.investorsinpeople.co.uk/MediaResearch/CaseStudy/Pages/CaseStudyDetails.aspx?CSID=200

Company specific approaches to skills development

Particular employers can also point a range of benefits which derive from investing in skills development. G&O Springs demonstrates the benefits which derive from investing in management skills *(see panel)*.

G & O Springs Ltd – Management Capability

Skills implications & issues

G & O Springs Ltd is a small manufacturing firm primarily supplying the Aerospace industry and employing 24 staff in the West Midlands. A skills need assessment identified that the firm's mid-level management and leadership capability needed improving and that performance gains where achievable if these skills gaps were addressed. With the help of SEMTA, the employer led Sector Skills Council, G & O implemented a tailored Team Leader Training Programme to build management and leadership capability and reduce management skills gaps. The scheme was funded entirely by G & O and served to raise the quality of training delivered to staff.

As a result of the training programme, production lead times were slashed from 45 days to an average of nine and skills gaps are down. The consequent rises in productivity and competitiveness can be passed up the supply chain to the benefit of overall sector performance.

Current & Future opportunities

Previously the company had been sceptical of the benefits of bespoke training preferring instead off-the-shelf solutions which the Managing Director admits, with hindsight, had limited benefit. This view has now changed and the company invests more heavily in better quality training for its workforce.

The sector is dependent upon intermediate skills typically supplied via Apprenticeships at Level 3. BAe Systems, an exemplar trainer of apprentices, demonstrates the benefits which flow from the provision of Apprenticeships *(see panel)*.

BAE Systems – Advanced Apprenticeships

Skills implications & issues

BAE Systems recognises that a supply of highly skilled engineers is essential to maintaining and extending its competitive advantage. Currently the company is training over 1,000 advanced engineering apprentices (equivalent to A-level standard). The training they receive is second to none and demand for the apprenticeships is high with 10 applicants for each place. BAE is therefore able to select those applicants with greatest potential. At 82 per cent the completion rate for the scheme is one of the highest in the industry.

Current & Future opportunities

The majority of apprentices go on to work for the company and many others find work in the firm's supply chain. Ultimately this serves to ensure quality in the chain, benefitting BAE Systems and driving up performance in the sector.

In addition BAE Systems is leading other employers (Airbus; Rolls Royce; Jaguar Land Rover) and working with Sector Skills Councils to develop a degree level apprenticeship for the sector to supply the high level, technical and applied skills it needs. By Sept 2011, 250 apprentices will be employed on the new scheme. This is an example of employers leading the development of qualifications to meet the needs of the sector.

Source UK Commission / BAE Systems

The example of JCB further illustrates the benefits which derive from investments in intermediate level skills *(see panel)*.

The JCB Academy – Intermediate Skills

Skills implications & issues

JCB is the world's 3rd largest manufacturer of construction equipment, with 11 of its 18 global plants in the UK. It manufactures more than 300 different products for the construction and agricultural markets and employs 9500 people. Last year the company sold more 72,000 machines with turnover of a record £2.25 bn. Based in Staffordshire close to JCB's global HQ, the Academy opened in 2010 and will deliver intermediate engineering skills and qualifications for up to 540 pupils aged 11-19. Local schools, Universities and other employers such as Network Rail are involved to deliver real-life experience of engineering problems requiring the application of multi-disciplinary skills in teams. The Academy is an example of a University Technical College where employers lead the curriculum and make vocational training more accessible.

Current & Future opportunities

The owner and Chairman of JCB says he is "...passionate about the importance of manufacturing to Britain and the JCB Academy shows [the company is] prepared to invest in creating the next generation of young engineers".

Academy graduates will have the intermediate skills needed by employers, thereby boosting sector performance and providing the launch pad for further up-skilling.

Source: http://www.jcbacademy.com/

Whilst the emphasis has been very much upon developing relatively high level skills, the example of JLR demonstrates that there are benefits to be derived from delivering skills training at a lower level as well *(see panel)*.

Jaguar Land Rover – Essential Skills for Problem Solving

Skills implications & issues

Lean manufacturing techniques have transformed the motor manufacturing industry and rely heavily on continuous improvement through staff development. Previous attempts to improve performance in the company had not been successful so with the help of the National Skills Academy for Manufacturing, the firm mapped the key functional skills needed for each stage of the production process. They identified that a lack of functional skills could be limiting workers' problem solving ability and limiting the effectiveness of training provided. A new programme that combines traditional problem solving with functional skills training was implemented. The programme leads to qualifications in Essential Skills for Problem Solving and Skills for Life in literacy and numeracy. These transferable qualifications are attractive to workers, have improved their training outcomes, and will contribute to organisational performance.

Current & Future opportunities

To remain competitive, Jaguar Land Rover needs of all its employees to be engaged in the process of problem solving and this new programme will give them the skills they need to read technical information and other data. Following success of the programme mentioned above the Skills Academy has approved the programme and will soon be rolling it out across the sector nationwide.

Source: Semta http://semta.org.uk/employers/how-we-work-with-employers/case-studies/

The example of Marshall's below provides an indication of the direct and indirect effects which training can have upon company performance but also the attitudes, confidence, and motivation of staff. The case study indicates a range of positive externalities which arise when employers' invest in training, such as the volunteering activities of employees *(see panel)*.

Marshalls Plc: Learning Culture

Established in the 1880s, Marshalls is the UK's leading manufacturer of natural stone and innovative concrete hard landscaping products supplying home improvement and landscape markets.

In 2006, a strategy called 4 Blue Boxes began at Marshalls. Now in its sixth year, Blue Box has become a driving force behind training and employee engagement at Brookfoot Works in Yorkshire.

i. At first level, the Blue Box system validates that induction has taken place and information is understood by the employee.
ii. At the second level, employees work with a qualified trainer to ensure Standard Operating Procedures are adopted and signed off by the Trainer and the operator.
iii. At the third level, employees can take an NVQ in Performing Manufacturing Operations and Team Leaders can undertake Business Improvement Techniques. There is also provision for Skills for Life courses, helping employees achieve their NVQ Level 2.
iv. At fourth level, employees take on additional responsibilities and take part in volunteering activities as part of Marshalls' CSR initiatives.

The business objectives of Blue Box are to:

- Formalise competency training
- Increase flexibility of labour skills
- Give opportunities for formal recognition through qualifications for what was an unskilled workforce
- Encourage additional responsibilities
- Improve efficiencies in key areas

The wider society benefits are:

- Establishing Marshalls' reputation through employees working as volunteers.
- Giving employees pride in representing Marshalls in their local community.
- Pride in their own abilities, with the opportunity to use skills learned at work.
- Helping charitable organisations, schools and community based projects through volunteering or enhancing landscapes using Marshalls products.

The Brookfoot Works's profitability has grown compared to budget (from 4.2 per cent in 2006 to 17.6 per cent in 2009) in spite of difficult trading conditions since mid 2008. The company feels this is evidence of how learning and understanding has increased due to training and in the pride that its people have in working for Marshalls.

"Everyone gets the opportunity to better themselves here. It's one of the benefits of working here"

Quote from a Marshall's operator interviewed as part of an IIP audit

Brookfoot's Site Support Manager has been working one day per week within National Manufacturing on Best Practice for IMS & Training to **share best practice**. The Blue Box system

at Brookfoot is now generally accepted as a **company benchmark** and has been supported at other UK sites.

In the manufacturing division the workforce had less than 10per cent with NVQ level 2 or above. Within the national manufacturing division now 90 per cent (2012) have formal qualifications, giving their families increased job security. All site managers at Brookfoot now have an NVQ L3 and across all employees the average number of training hours is 24.

Marshalls' **brand and reputation have been strengthened**, and they cherish the responsibility of being a market leader, by constantly challenging what needs to be improved.

Over the course of the training strategy, the following business improvements have been measured:

- **Return on investment**: £3,000 investment in changeover training in 2008 returned £36,300.54 of additional product in standard time.
- **Overall Equipment Efficiency (OEE) scores improved** as the percentage of operators with NVQs increased
- **Accident statistics have reduced by 62per cent**
- **Internal progression:** Brookfoot site has not been in a position to recruit in the present economic climate and has reduced its labour through natural wastage over recent years. At a site which has only 33 salaried positions, **15 have been promoted elsewhere in the business, and 19 operators have been promoted to management positions since 2006**. Only 4 people have left Brookfoot for other careers since 2006.
- The company has experienced **low absence rates** over the last four years of 2.7per cent.

As the Blue box training strategy linked business advantage skills and wider community involvement at 4th box level, Marshalls were gradually able to see the **value in respect, co-operation and self worth that was generated** when employees went into the community to enhance the business' reputation.

A survey was carried out with employees who had been involved in CSR activities over the last four years as part of their 4th blue box:

- 88 per cent said the activity increased their respect for colleagues
- 88 per cent said the activity made them feel proud to be an employee of Marshalls
- 73 per cent said the CSR activity increased their confidence in their own abilities
- 55 per cent have continued volunteering outside work
- 82 per cent of employees reported being 'delighted' or 'highly delighted' when asked to rank how they felt about their own contribution to specific CSR activities

Volunteering **increases employees' pride in their own abilities, with the opportunity to use skills learned at work.** For example, Brookfoot's Works Engineer helped judge a local Calderdale school's technology competition.

Over a four year period employees raised £15,000 for local charities through sponsorship. Often suppliers, contractors and key customers have made charitable donations to sponsored events.

"Marshalls has a great reputation within Calderdale for being a company that is open to helping out community groups, and they have not rested on their laurels but continue to strive to enhance and strengthen this further every day."

Calderdale Cares Manager Jocy Hunter

Benefits for employees through incorporating Skills For Life within Marshalls' NVQ programmes can be seen from employees quotes from the Bronze IIP audit

"It's the first qualification I've had and I can't read well. They talked me through it and I had someone to one support in private. I want to do another now"

"Who would have thought at my age I would be getting a qualification? I left school with nothing and now I have an NVQ, The kids are really proud of me."

Source: BITC case study, with updated information direct from Marshalls. Original case study can be found here - http://www.bitc.org.uk/resources/case_studies/marshalls_plc_blue.html

6.6 Summary

The degree of change in the manufacturing sector will result in ongoing transitional skill mismatches but there is evidence of more structural mismatches. Salaries of employees in manufacturing, for example, are generally higher than in the economy overall, and have been increasing more rapidly which may well point to difficulties in recruiting key skills.

An area of key skills deficiency related to professional and senior managers (particularly in SMEs) is the need to develop better business acumen; better understanding of the marketplace and its drivers of change and to then develop effective styles of product market strategies. Other challenges include financial modelling skills and good economic

justification skills together with the need to develop predictive skills to position themselves in advance for potential business opportunities.

These skill gaps and skills deficiencies are particularly likely to impact upon competitiveness, export strategies and to limit the degree to which the sector can take advantage of growth business opportunities

The Government has launched several initiatives to help focus the development of key high value adding sectors through technology and innovation centres and to address skills deficiencies through schemes including the Growth Innovation Fund, the Leadership and Management Advisory Service and the Employer Investment Fund (IET, 2011). Advanced manufacturing is a major focus for all of these elements but success for the recipient businesses will depend heavily on excellent integration of the providers and various partners. A recipient company must be able to aspire to, and evolve, a skills structure appropriate to its business style and direction of travel. Furthermore, the skill levels of the providers must be high enough to bring about change within organisations.

7 CONCLUSION

7.1 The Sector Today and Tomorrow

The Government has signalled its intention to rebalance the economy by, in part, stimulating growth in the advanced manufacturing sector. Advanced manufacturing is difficult to define. The relatively rapid decline of the UK manufacturing sector generally, arguably, was due to its reliance upon relatively low value products compared with its main competitors abroad. That said, the UK has always had a strong presence in high value, high skill sub-sectors of the market such as aerospace, and major players in more traditional sectors of the market. Accordingly, advanced manufacturing, however defined, represents one of the best opportunities for the UK to rebalance the economy and to set the country on a trajectory for a sustainable high value adding sector, generating export growth, and driving up its global competitiveness. Achieving that goal is not solely a skills issues, but without the skills to establish the appropriate product market strategies, develop new products and processes, manage global supply chains, and manufacture highly complex goods, the goal will be missed.

7.2 The Performance Challenge

The performance challenges relate to:

- ensuring that there is continued investment in fixed capital, R&D, and innovation;
- benefiting from the globalisation and the development of global value-chains;
- increasing productivity levels;
- investing in initial vocational education and training to ensure that the sector is not constrained by future skill shortages;
- investing the continuing vocational education and training of existing staff at all levels to ensure that their skills keep pace with change in the sector;
- investing in the strategic management skills of managers and professionals in the sector;
- making SMEs aware of the above points.

Despite the importance of major players in the sector the future of advanced manufacturing is also dependent, at least in part, upon the creation and growth of SMEs. SMEs represent a major challenge but also one of the largest potential growth opportunities. SMEs, as a consequence of their size, often have more limited strategic management skills which results, sometimes, in a less than ideal alignment between business opportunity, business style, and workforce skill structures.

Understanding the sector's skill needs requires some understanding of product lifecycles. Within manufacturing there is a well established pattern of products shifting over time from being small-scale batch manufactured products to mass produced commodities. The skills required at different stages in the product life cycle are not necessarily the same: from small-scale production and the emphasis upon design and design for manufacture at the beginning of the product life cycle – and associated skill requirements - to the move to mass production at the latter stages with, perhaps, production being transferred abroad leaving behind a substantial R&D and design presence. The evolving business styles associated with different stages of the product life cycle are a particular skills challenge for all businsses in the sector.

The drivers of change are bringing about other changes too. The speed of change is increasing and forcing supply chains to become more like supply networks requiring higher levels of flexibility, agility and a broader spread of soft skills across the workforce. Higher levels of personnel responsibility, autonomy and managerial delegation will be required at all levels in the organisation.

All of the above will have implications for productivity. In particular, productivity is dependent upon the employer possessing the skills which will allow them to proposer depending upon which segment of the market they are operating in.

7.3 Growth through Skills

The evidence points to the sector becoming more dependent upon people working in high level occupations. The historical data shows that the sector has becoming increasing dependent upon higher level skills and this is set to continue in the future. Employment projections reveal an expected 11 per cent increase in the number of managers, directors and senior officers (although lower then that expected across all sectors 18 per cent),

and a 14 per cent increase in professional and associate and technical jobs in the period to 2020 (similar to that for all sectors). Whilst this will be counterbalanced by 16 per cent loss of skilled trade occupations (compared to a 6.5 per cent loss across all sectors) and 23 per cent process and machine operatives, estimate of replacement demands (also much higher than the loss across all sectors at 11 per cent) suggest that there will be a strong demand for people to work in these occupations too.

The evidence points to skills supply being well supported by an extensive initial and continuing vocational education and training infrastructure with a substantial increase in the number of people being qualified each year in subjects / skills which the manufacturing sector is dependent upon. Questions arise, however, with regard to the capacity and capability of the skills supply side to meet skill demand given the fast pace of technological change.

In the advanced manufacturing sub-sector the supply-side often has to run fast in order to keep pace with developments on the demand side. Employers at the cutting-edge may need to look internally to develop the skills they require. There is also a need to recognise that the skills the sector needs which embody a high level of numeracy are also in high demand in other sectors. Altogether, the capacity of the supply-side to solve skill demand is perhaps more constrained than is the case with other sectors because of the fast pace of product development and the concomitant impact this has upon skills demand.

It is apparent that many of the leading companies in the sector invest substantially in both initial and continuing vocational education at all levels (Level 3 and above). Apprenticeships are an important source of initial vocational education and training with many of the major companies possessing well established Apprenticeship programmes which have been shaped to meet both current and future skill demand within the sector. Major companies have also made use of the Foundation degrees and graduate trainee programmes (SEMTA, 2009). In many respects, the reputation of these organisations allows them to have the pick of the best candidates, at whatever level they are being recruited, each year. The key issue is to persuade other employers, especially the SMEs, to invest in skills. Group Training Associations potentially provide one means of encouraging SMEs to engage more with training.

There are a number of initiatives designed to assist companies avoid skills deficiencies. These include the Growth Innovation Fund, the Leadership and Management Advisory

Service and the Employer Investment Fund. Potentially, these programmes provide a structure in which advanced manufacturing employers can develop solutions which address the specific needs of their businesses. This is important given the point made above about the fast pace of change in the sector which can result in the supply-side playing a constant game of catch-up.

7.4 Business Benefits

There are significant business benefits to employers from investing in the skills of their workforce, but a better way to consider this issue in relation to advanced manufacturing is with the respect to the costs of not investing in skills development. By definition, advanced manufacturing is knowledge intensive and dependent upon a relatively high level of innovation. The aim, in many respects, is to encourage all manufacturers to become advanced manufacturers. The rewards of doing so are substantial not least the capacity to survive in a global market where low value manufacturing is increasing outsourced to countries with lower production costs. The evidence presented in this report suggests that where advanced manufacturers have invested in skills they have obtained significant gains to their organisational performance.

Another way to look at the issue of business benefits is to look at the costs associated with not training. Where employers in the manufacturing sector experience skill deficiencies these are seen to have an impact on organisational performance. The survey evidence and company case study evidence provided in this report amply demonstrates this point. Moreover the type of skills the sector requires are often at a graduate or intermediate level where the lead times to train someone are relatively long. If employers rely upon the external labour market to recruit the skills they need – especially at a time when the economy is in a recovery phase – there is no guarantee that the skills will be there to be recruited unless firms are willing to pay a premium for them. As noted elsewhere in this report the skills manufacturing employers require – typically ones requiring a relatively high degree of numeracy and IT literacy - are often in high demand in other sectors of the economy. Hence the strong message in this report about the need to invest in skills at all levels of the workforce in order to avoid the types of skill deficiencies which will hamper organisational performance. The case study examples from various employers in the sector illustrate how this can be successfully be achieved, and the various programmes described indicate how businesses can be successfully assisted to obtain the skills they need to meet both current and future

demand. The pace of technological change, and the constant evolution of manufacturing processes and supply chains, further highlights the need for businesses to acquire the strategic management skills and tactical production skills in order to keep pace with change in their external environments.

The evidence presented in this report reveals that there are returns to employers and individuals from investing in skills in the manufacturing sector. Specific examples have been presented in the text, and the research by Garrett *et al.* (2010) provides further evidence of the returns from investing in skills. One of the most powerful messages to employers about the benefits of training is its association with business survival: 50 per cent of manufacturing establishments which did not provide training in 1998 had closed by 2004 compared with 20 per cent which provided training (Collier *et al.*, 2007). In other words, employers which did not train were two and half times more likely to close.

BIBLIOGRAPHY

ASHE (Annual Survey of Hours and Earnings) (2011) Provisional results (SOC 2007) Table 4 – Industry. Office for National Statistics, Newport. Available: http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-235202 [Accessed 29th June 2012].

Blake, N., J. Dods and S. Griffiths. (2000) *Employers skill survey: existing survey evidence and its use in the analysis of skill deficiencies*. Nottingham: Department for Education and Employment, 2000

Barry, Richard, Bosworth, Derek and Wilson, Rob (1997) *Engineers in Top Management*, Institute for Employment Research, Warwick

BIS (2011) *The Plan for Growth*, BIS/ HM Treasury, London

BIS (2011a) Population estimates at start of 2011 – 2011 statistical release. Available: http://www.bis.gov.uk/assets/biscore/statistics/docs/b/bpe_2011_stats_release.pdf [Accessed July 2012]

BIS / HM Treasury (2010a) *Growth Review Framework for Advanced Manufacturing*, BIS, London

BIS (2010b) *Manufacturing in the UK: an economic analysis of the sector*, BIS Economics Paper No. 10A, London

BIS (2010c) *Data Economic Growth,* BIS, London

BIS (2010d) *The path to strong, sustainable and balanced growth,* BIS / HM Treasury, LondonBIS (2009) *Advanced Manufacturing, Building Britain's Future,* BIS, London

Brown, A., Rhodes, E. and Carter, R. (2004). 'Supporting learning in advanced supply systems in the automotive and aerospace industries', in H. Rainbird, A. Fuller and A. Munro (Eds.) *Workplace Learning in Context***.** London: Routledge (pp 166 - 182)

Cedefop (2010) *Green Skills for Green Jobs – European Synthesis Report*, Commission of the European Communities, Luxembourg

Collier, W. *et al.* (2007) *Training and* Establishment *Survival*, SSDA Research Report 20

Cooney, R. and M. Long (2008). *Inter-firm Cooperation in Training*, NCVER, Adelaide

Data Service (2012) Statistical First Release Apprenticeship Supplementary Tables, March 2012, ONS. Available: http://www.thedataservice.org.uk/statistics/statisticalfirstrelease/sfr_supplementary_tables/Apprenticeship_sfr_supplementary_tables/. [Accessed 29th June 2012].

Davis, C., Buckley, T., Hogarth, T. and Shackleton, R. (2001) *The Extent, Causes and Implications of Skills Deficiencies – Engineering Sector: Case Studies*, National Skills Task Force / DfES Publications

DTI (2006) *Science, Engineering and Technology Skills in the UK*, DTI Economics Paper No.16

EEF (2012) *Executive Survey 2012, Manufacturers' views on the economy and their own prospects in 2012*, Engineering Employers Federation

Eurostat (2011) *Population, Employment, and Labour Market Conditions Database*, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Regional_labour_markets#Further_Eurostat_information

Garrett, R., M. Campbell and G. Mason, (2010) *The Value of Skills: An Evidence Review, UK Commission Evidence Report No. 22*, UK Commission for Employment and Skills, Wath-upon-Dearne

Gil, V. And Haskel, J. (2008) Industry-level Expenditure on Intangible Assets in the UK, *mimeo*

Gospel, H. and Cooney, R. (2003). *'Inter-firm cooperation in the training market: employer group training in the UK and Australia'*, mimeo, London.

Hasluck, C. *et al.* (2008) *The Net Benefits to Apprenticeships*, Ambassadors Apprenticeship Network, London

Hogarth, T. and C. Hasluck, C. Davis and G. McGivern (2006) *Medical Technologies in the West Midlands: Skills and the prospects for growing new medical technology business*, Coventry: Warwick IER and Coventry and Warwickshire LSC and the ESF

Hogarth, T. et al., (2012) BIS Research Paper 67: *Employer Investment in Apprenticeships and Workplace Learning: The Fifth net Benefits of Training to Employers Study*

HESA (Higher Education Statistical Agency) (2011) *Statistical First Release 153, Table 7. Higher Educational Statistical Agency, Cheltenham. Available:* http://www.hesa.ac.uk/index.php?option=com_content&task=view&id=1936&Itemid=161. *[Accessed 27th June 2012].*

House of Lords (2007) *Apprenticeship: a key route to skills: Volume I - Report*, House of Lords Select Committee on Economic Affairs, London, TSO

IET (2011) *The 2011 Budget & UK Manufacturing, a summary by the IET Manufacturing Policy Panel,* Institution of Engineering and Technology Briefing Paper

IET (2010) *The IET summary of the 2010 UK Comprehensive Spending Review for Manufacturing,* Institution of Engineering and Technology Briefing Paper

IET (2010) *Manufacturing Briefing,* Institution of Engineering and Technology Briefing Paper

Jenkins, A., Greenwood, C. and Vignoles, A. (2007) The Returns to Qualifications in England: Updating the Evidence Base on Level 2 and Level 3 Vocational Qualifications. *Centre for the Economics of Education Discussion Paper 89*.

MAC (2011) *Skill Shortage Sensible*, Home Office / Border Agency http://www.ukba.homeoffice.gov.uk/sitecontent/documents/aboutus/workingwithus/mac/skilled-shortage-sensible/skilled-report.pdf?view=Binary

McIntosh, S. (2006). *A Cost-Benefit Analysis of Apprenticeships and Other Vocational Qualifications*. DfES Research Report 834;

McIntosh, S. (2009). *The Economic Value of Intermediate Education and Vocational Qualifications*, UK Commission for Employment and Skills, Evidence Report 11.

McKinsey (2010) From Austerity to Prosperity: Seven Priorities for the Long Term

The Migration Observatory (2010) *Migrants in the UK Labour Market: An Overview* http://migrationobservatory.ox.ac.uk/sites/files/migobs/Migrants%20in%20the%20UK%20Labour%20Market%20v2_0.pdf

Purcell, K., P. Elias, R. Davies, and N. Wilton (2005) *Class of '99, study of the early labour market experience of recent graduates.* Department for Education and Skills, Nottingham

RenewableUK (2011) Working for a Green Britain http://www.bwea.com/pdf/publications/Working_for_Green_Britain.pdf

SEMTA (Sector Skills Council Manufacturing Consortium) (2012) *Sector Skills Assessment United Kingdom Manufacturing*, UK Commission for Employment and Skills, Wath-upon-Dearne

SEMTA (2010) *Sector Skills Assessment for Science, Engineering and Manufacturing Technologies*, SEMTA / NSA, Watford

SEMTA (2009) S*kills and the future of Advanced Manufacturing Assessment for Science, Engineering and Manufacturing Technologies*, SEMTA, Watord

SMMR (2012) *The Society of Motor Manufacturers and Traders (2012) Motor Industry Facts 2012*, SMMT, London

UK Commission (2010a) *Ambition 2020: World Class Skills and Jobs for the UK*, UK Commission for Employment and Skills, Wath-upon-Dearne

UK Commission (2010b) *Skills for Jobs: Today and Tomorrow, The National Strategic Skills Audit for England 2010, Volume 1: Key Findings*, UK Commission for Employment and Skills, Wath-upon-Dearne

UK Commission (2010c) *Skills for Jobs: Today and Tomorrow, The National Strategic Skills Audit for England 2010, Volume 2: The Evidence Report*, UK Commission for Employment and Skills, Wath-upon-Dearne

UK Commission (2010d) *Employer Perspective Survey,* UK Commission for Employment and Skills, Wath-upon-Dearne

UK Commission (2011a) *Segmenting employers by sector paper, Briefing Paper*, UK Commission for Employment and Skills, Wath-upon-Dearne

UK Commission (2011b) *Working Futures 2010 – 2020, Evidence Report 41*, UK Commission for Employment and Skills, Wath-upon-Dearne

UK Commission (2011c) *The supply of and demand for high level STEM skills, Briefing Paper,* UK Commission for Employment and Skills, Wath-upon-Dearne

UK Commission (2012) *UK Commission's Employer Skills Survey 2011:* UK Results. Evidence Report 45. UK Commission for Employment and Skills, Wath-upon-Dearne

UKTI (2007) Motorsport in the UK: An industry with a winning formula, UKTI London www.ukti.gov.uk/download/file/128529.html

Wilson and Hogarth (2002) *Skills Matter: A synthesis of the Extent Causes and Implications of Skill Deficiencies Study,* Department for Education and Skills

List of previous publications

Executive summaries and full versions of all these reports are available from

www.ukces.org.uk

Evidence Report 1

Skills for the Workplace: Employer Perspectives

Evidence Report 2

Working Futures 2007-2017

Evidence Report 3

Employee Demand for Skills: A Review of Evidence & Policy

Evidence Report 4

High Performance Working: A Synthesis of Key Literature

Evidence Report 5

High Performance Working: Developing a Survey Tool

Evidence Report 6

Review of Employer Collective Measures: A Conceptual Review from a Public Policy Perspective

Evidence Report 7

Review of Employer Collective Measures: Empirical Review

Evidence Report 8

Review of Employer Collective Measures: Policy Review

Evidence Report 9

Review of Employer Collective Measures: Policy Prioritisation

Evidence Report 10

Review of Employer Collective Measures: Final Report

Evidence Report 11

The Economic Value of Intermediate Vocational Education and Qualifications

Evidence Report 12

UK Employment and Skills Almanac 2009

Evidence Report 13

National Employer Skills Survey 2009: Key Findings

Evidence Report 14

Strategic Skills Needs in the Biomedical Sector: A Report for the National Strategic Skills Audit for England, 2010

Evidence Report 15

Strategic Skills Needs in the Financial Services Sector: A Report for the National Strategic Skills Audit for England, 2010

Evidence Report 16

Strategic Skills Needs in the Low carbon Energy generation Sector: A Report for the National Strategic Skills Audit for England, 2010

Evidence Report 17

Horizon Scanning and Scenario Building: Scenarios for Skills 2020

Evidence Report 18

High Performance Working: A Policy Review

Evidence Report 19

High Performance Working: Employer Case Studies

Evidence Report 20

A Theoretical Review of Skill Shortages and Skill Needs

Evidence Report 21

High Performance Working: Case Studies Analytical Report

Evidence Report 22

The Value of Skills: An Evidence Review

Evidence Report 23

National Employer Skills Survey for England 2009: Main Report

Evidence Report 24

Perspectives and Performance of Investors in People: A Literature Review

Evidence Report 25

UK Employer Perspectives Survey 2010

Evidence Report 26

UK Employment and Skills Almanac 2010

Evidence Report 27

Exploring Employer Behaviour in relation to Investors in People

Evidence Report 28

Investors in People - Research on the New Choices Approach

Evidence Report 29

Defining and Measuring Training Activity

Evidence Report 30

Product strategies, skills shortages and skill updating needs in England: New evidence from the National Employer Skills Survey, 2009

Evidence Report 31

Skills for Self-employment

Evidence Report 32

The impact of student and migrant employment on opportunities for low skilled people

Evidence Report 33

Rebalancing the Economy Sectorally and Spatially: An Evidence Review

Evidence Report 34

Maximising Employment and Skills in the Offshore Wind Supply Chain

Evidence Report 35

The Role of Career Adaptability in Skills Supply

Evidence Report 36

The Impact of Higher Education for Part-Time Students

Evidence Report 37

International approaches to high performance working

Evidence Report 38

The Role of Skills from Worklessness to Sustainable Employment with Progression

Evidence Report 39

Skills and Economic Performance: The Impact of Intangible Assets on UK Productivity Growth

Evidence Report 40

A Review of Occupational Regulation and its Impact

Evidence Report 41

Working Futures 2010-2020

Evidence Report 42

International Approaches to the Development of Intermediate Level Skills and Apprenticeships

Evidence Report 43

Engaging low skilled employees in workplace learning

Evidence Report 44

Developing Occupational Skills Profiles for the UK

Evidence Report 45

UK Commission's Employer Skills Survey 2011: UK Results

Evidence Report 46

UK Commission's Employer Skills Survey 2011: England Results

Evidence Report 47

Understanding Training Levies

Evidence Reports present detailed findings of the research produced by the UK Commission for Employment and Skills. The reports contribute to the accumulation of knowledge and intelligence on skills and employment issues through the review of existing evidence or through primary research. All of the outputs of the UK Commission can be accessed on our website at www.ukces.org.uk

UKCES
Renaissance House
Adwick Park
Wath-upon-Dearne
Rotherham
S63 5NB
T +44 (0)1709 774 800
F +44 (0)1709 774 801

UKCES
28-30 Grosvenor Gardens
London
SW1W 0TT
T +44 (0)20 7881 8900
F +44 (0)20 7881 8999

This document is available at www.ukces.org.uk under 'Publications'

ISBN 978-1-908418-05-0