



BIS | Department for Business
Innovation & Skills

Growth Review Framework for Advanced Manufacturing

DECEMBER 2010

Foreword

On 29 November, the Secretary of State for Business Innovation and Skills and the Chancellor launched the Growth Review - a fundamental assessment of what each part of Government is doing to provide the conditions for business success and address the barriers faced by industry. The Review forms a rolling programme to last the whole Parliament, with a first report by Budget 2011.

It is a reflection of the importance that this Government attaches to manufacturing that Advanced Manufacturing is among the first reviews to be taken forward.

Our goals, over the next 10 years, are to:

1. Grow manufacturing in the UK
2. Make the UK Europe's leading exporter of high value goods and related services
3. Increase the proportion of the workforce seeking, and capable of, a career in manufacturing

These are challenging ambitions that should frame our actions for the next 10 years. They reflect the capabilities of UK manufacturing, the strengths of the UK economy, and the opportunities for broad-based growth from globalisation and rising incomes, technological developments, and structural changes such as the move to a low carbon economy.

We need a relentless drive for growth that provides the best environment to achieve these ambitions. We need to examine fully the barriers to growth and set out what the Government will do to address them. The Advanced Manufacturing Growth Review will take this process forward.

This document sets out the action Government is taking to provide the right business environment, the key competitive strengths on which we can build, and examines the major future long-term growth opportunities and challenges

Are these ambitions the right ones for manufacturing?

Are these the top priorities or are there more pressing issues where we should set the goals?

We have set up an email box at BIS for you to send your ideas and evidence for the Growth Review between now and 11 February. The address is amgr@bis.gsi.gov.uk. Your comments will be considered by the review team.

Key sub sectors of manufacturing may well have growth reviews of their own in what will be a rolling programme of reviews over the next few years.

Chapter 1: What action is needed to grow advanced manufacturing?

There are many success stories in manufacturing that go unheralded. We have strengths in our research base and our business environment on which to build, but the rest of the world is not standing still. We need to continue to improve conditions for UK manufacturing companies. Wherever there are barriers to growth impeding UK companies, this Government will do all it can to remove them.

We set out in *The path to strong sustainable and balanced growth* the Government's four part commitment to the private sector which will benefit UK manufacturers, as well as other companies in the economy:

(1) we will provide the stability business needs to plan and invest

The Government has taken decisive action to reduce the deficit. This will provide business with the stability and confidence that underpins investment and helps keep long-term interest rates low. Manufacturing businesses have told us they want longer term frameworks to plan investments.

(2) we will make markets more dynamic by removing barriers to growth wherever possible;

The Government has set out a comprehensive package and industry-led measures to address these concerns around access to finance, including:

- a new bank-led £1.5 billion 'Business Growth Fund' to provide equity finance to established SMEs who need capital to secure their plans for growth;
- support for the Enterprise Finance Guarantee (EFG) over the next four years to enable lending to viable small businesses that lack collateral or track record;
- increasing the Government's share of Enterprise Capital Funds by £200 million; and,
- encouraging business angel groups and the Government's SME investment arm, Capital for Enterprise Ltd, to put together a bid to the Regional Growth Fund for a Business Angel Co-Investment Fund.

The Government is also reforming the planning system so that it supports economic growth by providing the right land in the right place for development, and ensures the timely delivery of infrastructure.

The Government is also providing incentives to help manufacturers to exploit the latest cutting edge technologies from the science base by investing more than £200 million over four years in a network of elite Technology and Innovation Centres.

(3) we will focus the Government's own activities on providing the conditions for private sector growth and investment;

The Spending Review made tough choices to prioritise resource spending that promotes growth, such as providing the largest ever financial investment in adult apprenticeships. The Government has protected science resource spending in cash terms and is incentivising universities to work more closely with business to maintain and develop the UK's strong skills base, generate new companies, and attract research and development funding from around the world.

We are also prioritising capital spending that is essential for growth. For example, in October 2010, the UK's first ever National Infrastructure Plan set out the infrastructure Britain needs and how Government will unlock £200 billion worth of public and private sector investment over the next five years to deliver it.

Greater stability in the tax regime will also give manufacturers the confidence to invest. The June Budget set a clear direction of travel, including a phased reduction in the main rate of corporation tax from 28 per cent to 24 per cent and we have just published the roadmap showing how this will be achieved. The Government has also published a document entitled 'Corporate Tax Reform: Delivering a More Competitive System'. This document shows how the Government will work with business to enhance UK tax competitiveness. It is designed to provide business with certainty over the Government's plans and give manufacturers the confidence needed to invest in the UK.

(4) we will ensure that strong growth is fairly shared and sustainable in the long term.

The Local Growth White Paper¹ set out the Government's strategy for enabling local authorities, businesses and communities to drive growth in their own area, including: shifting power to local communities and business, giving business, local authorities and other partners such as universities the responsibility for and ability to drive local economic growth, through the creation of local enterprise partnerships, 24 of which have already been cleared;

As set out in the recent Skills Strategy², the Government is expanding adult apprenticeships by up to 75,000 by 2014-15 compared to the previous government's plans. The Government will support employers to help address their skills needs through a new £50 million growth and innovation fund, with financial support to SMEs to co-fund the costs of training for lower skilled employees.

Specific measures for Advanced Manufacturing

The measures above will help manufacturing companies, as well as others in the economy. However, as we set out in '*The path to strong sustainable and balanced growth*', sectors differ in their characteristics and the way policy impacts. We therefore need to consider what are the further barriers to growth facing UK manufacturers, and the specific measures needed to do to remove these.

¹ *Local growth: realising every place's potential*, BIS, October 2010

² *Skills for Sustainable Growth*, BIS, November 2010

We are investing £50 million over three years to enhance the Manufacturing Advisory Service, which is highly valued by industry and which provides direct access to experts to solve specific manufacturing problems and achieve improvements in productivity and competitiveness.

BIS is contributing £600,000 towards a 2 year **automation and robotics programme** to be **developed** and run by the Engineering and Machinery Alliance (EAMA) and the British Automation and Robot Association (BARA) together with other trade associations. The programme will share real companies' experiences of adopting robotic systems and will help companies deliver sustainable increases in productivity, reduce waste and increase precision in their manufacturing process.

Barriers to Advanced Manufacturing growth

However it is clear that much more needs to be done. We wish to focus further on the barriers that stand in the way of advanced manufacturing sectors reaching their full potential for growth.

Our initial analysis and discussion with manufacturers suggests that these may include:

- **Innovation and knowledge transfer:** Knowledge of the latest industrial technologies and their application to manufacturing processes is often difficult to access, particularly for SMEs. Information is often contained within a particular sector, and not disseminated widely across sectors where it could also be beneficial.
- **Take up of new technologies:** The costs of demonstrating and testing the use of new technologies can be very high, particularly for SMEs, and can require access to equipment beyond the affordability of an individual company. Firms often lack knowledge about the range of technologies that are available and their potential benefits.
- **Accessing skills and training:** The costs of training and skills can be high, particularly in specialised areas of manufacturing technologies. The fast-moving nature of manufacturing, and the often cross-cutting skills needed, can make it difficult to identify suitable training and where it can be found. There is a significant skills shortage in sectors such as SET that could partly be addressed by better retention of skilled workers and tackling the gender imbalance. There were about half a million women of working age living in the UK in 2008 who were qualified in science, engineering and technology (SET), but only 185,000 of them were working in the SET occupational sectors³
- **Access to finance:** Some investment projects involving manufacturing can be hampered by difficulties obtaining appropriate and affordable finance, especially at the initial design, development and demonstrator phases of the innovation processes.

³ Briefing paper from UK Resource Centre for Women in SET

- **Exporting:** Businesses looking to export may experience difficulties gaining access to networks and contacts in overseas markets, accessing markets due to trade barriers, navigating unfamiliar business environments, handling intellectual property, and operating in different legal and regulatory frameworks
- **Regulatory issues:** Modern manufacturing often involves a complex system of operations – from production to end of life disposal – each of which is impacted by legal and regulatory frameworks, both in the UK and in other countries.
- **Energy costs and security of supply:** Many UK Advanced Manufacturing firms are within or closely related to energy intensive industries that depend on manageable energy costs and security of supply to remain globally competitive.

The Advanced Manufacturing Growth Review will take forward an intense analysis of the barriers to growth, working closely with industry, and report back with policy proposals by Budget 2011

Are we identified the right barriers for Advanced Manufacturing?

What are the top priorities?

What are the barriers that arise from Government action or inaction?

How can business and their representatives best contribute to achieving the goals

Chapter 2: Going forward

Possible areas for consideration for the Review

The Growth Review will run over the course of this Parliament, based on ongoing consultation with business. The first phase of the Review will focus on priority areas for action, including in specific sub-sectors.

Based on the analytical data and consultation with manufacturing stakeholders so far on this framework, some key areas have been highlighted as offering scope for addressing specific barriers to growth. These are listed below with some key questions we want business, and other stakeholders, to use to help frame their ideas and to provide new evidence for the review.

Supporting manufacturing productivity

Helping manufacturing to improve productivity is key to ensuring the UK manufacturing base can remain highly competitive. Improvements in productivity can be achieved, for example, through changes to working practices and processes; innovation, and improved skills.

How best can manufacturers increase productivity faster and more effectively in the UK than in other countries?

What can be done to increase the resilience and flexibility of the UK supply chain?

Helping industry export more

Official trade data shows that the value of UK manufacturing exports to emerging markets has risen in recent years. Some of the highest rates of growth in the value of exports have been in higher technology products to countries including Brazil, Mexico and the Middle East. Export opportunities to emerging markets are anticipated to increase further as a result of rising incomes in these countries.

What and where are the specific barriers to trade that restrict the access of UK manufacturers to overseas markets?

How best can we help reduce the cost and time to market for the UK's advanced manufacturing sectors, especially in key emerging markets?

Making the most of technology

In the globally competitive market-place, the ability of our manufacturers to exploit innovation and technology to create better products and processes is crucial to maintaining a competitive advantage.

The 2009 UK Innovation Survey shows that over 60% of manufacturing firms are involved in innovation activity resulting in new or improved products and processes. In the electrical and precision engineering sector, the figure is 77%.

Are there barriers that prevent manufacturers taking advantage of the new technologies, automation and new production processes that increase productivity?

How will any new investments in technology and innovation centres, and associated programmes, work best for the Advanced Manufacturing sector?

Helping manufacturing benefit from a skilled workforce

A skilled workforce is essential for UK manufacturing to compete globally. Investment in skills is amongst the most important that manufacturers can make. Modern manufacturing requires highly skilled people in both specialist and technical areas, as well as in the multi-disciplinary skills required in areas such as managing and leading complex operations.

Today, many advanced manufacturing businesses rely on highly skilled individuals, from engineers, scientists and technicians, to product designers. OECD evidence shows that almost 25% of employees in manufacturing have a first degree in science or engineering. This is lower than China (over 45%) but ahead of the United States (around 15%).

How do we ensure the sector, in particular smaller high tech companies, makes best use of the increased number of apprenticeships on offer?

How do we better enable, and assist, our world class Universities to supply the high level skills the sector needs?

What does the sector need from, and what should its contribution be to, a successful bid into the recently announced skills Growth and Innovation Fund?

Maximising market opportunities for manufacturers from Government activity

In October 2010, the UK's first ever National Infrastructure Plan set out the infrastructure Britain needs and how Government will unlock £200 billion worth of public and private sector investment over the next five years to deliver it. This is a major opportunity for UK manufacturers. The Government has already established an early dialogue with industry, including manufacturing representatives, and will continue this close relationship to ensure the country's infrastructure needs are met in a way that creates opportunities and growth for businesses in the UK. This type of approach is increasingly being used across government to ensure that the interests of manufacturing and other business sectors are taken into account as early as possible in the development of policy.

Preliminary evidence gathered as part of the 2008 Glover Review suggested that SMEs gain a small proportion of central government contracts by value. The review recommended that, to improve SME participation in public procurement, opportunities should be transparent, and the procurement process simplified as much as possible.

How should the sector, and Government, seek to benefit from the supply chain opportunities presented by the National Infrastructure Plan and wider procurement opportunities?

How can SME participation be increased?

Showcasing UK Manufacturing Excellence

There are a number of successful activities to encourage young people to take up careers in science, manufacturing and engineering, including the work of STEMNET, Engineering UK, and trade associations such as EEF. There is also a government role in ensuring that there are strong, consistent messages about the vital role of manufacturing in the UK economy, and in highlighting UK manufacturing excellence. For example, BIS will use the 2012 Olympics in London as a unique and major opportunity to showcase UK manufacturing.

The 2009/10 annual report by Engineering UK reports that only 12% of 11-16 years old claim to have some knowledge of what a career in engineering is like. Around 40% of education professionals and 31% of the general public think a first degree is the minimum educational requirement, unaware that a large proportion of technicians have vocational qualifications.

How can we scale up showcasing activities for the sector, including through digital media and in 2012 during Olympic and Paralympic games time?

What more needs to be done to improve employer engagement in our education system, and in particular, the successful delivery of the 14-19 diplomas for manufacturing and engineering?

How do we improve the quality and delivery of careers advice for the sector?

Regulation

UK manufacturing companies face a complex raft of regulations, ranging from general employment and environmental laws to product specific rules. The Government is firmly committed to reducing unnecessary burdens on business.

Well designed regulatory infrastructure and institutions that provide long-term signals to individuals and businesses and tackle inefficiencies have an important role in incentivising investment and innovation. A clear and stable regulatory framework has played an important role in promoting investment in the low carbon sector.

Which regulations are acting as a barrier to growth and how might they be reformed or removed?

How do we achieve the right level of enforcement where appropriate levels of rigour are balanced with the costs to business?

Chapter 3: What advantages can we build on for the UK?

One of the key challenges set out in the Path to Strong, Sustainable and Balanced Growth is to build on our competitive strengths, such as advanced manufacturing, to drive export growth.

Manufacturing has a key part to play in rebalancing the economy. It will create a more resilient UK economy which is less vulnerable to sector-specific shocks. Second, it will improve the UK's capability to take advantage of the new opportunities which may arise as a result of anticipated changes in global demand.

No one can predict with certainty those business activities and sectors in the UK that have the most potential to grow – but Government has a vital role in engaging with industry in those activities in which the UK has relative strengths, actual and potential, to address and reduce barriers to growth. UK manufacturing has a wide range of diverse manufacturing sectors, where the UK has real competitive advantage.

It is important to record the strengths of UK manufacturing, as the evidence is sometimes sharply different from the perception sometimes presented in the media.

Examples of successful UK Advanced Manufacturing sectors

Aerospace: On the basis of gross value added, the UK's aircraft and aerospace industry is the largest in the world behind the USA and a significant driver of regional and national economic growth and productivity. The UK based industry employs a highly skilled workforce of over 100,000 people and is a major technology innovator.

Life Sciences: The UK is a leader in life sciences in Europe. Five of the world's top 20 bestselling pharmaceuticals were developed in the UK, and all the world's leading pharmaceutical companies have R&D and/or manufacturing facilities in the UK.

Automotive: in 2008 the automotive sector was worth over £10 billion to the economy and employed around 180,000 people. 11 of the world's volume vehicle manufacturers have a UK presence, supported by 19 of the world's top 20 suppliers

Pharmaceuticals: The UK pharmaceutical sector is the leading UK sector for investment in R&D, investing £4.3bn in 2008, which represents over a quarter of all business R&D expenditure in the UK

Chemicals: The UK Chemicals sector is the seventh largest producer globally with annual sales of around £56bn, representing 12% of all UK manufacturing.

Food and drink: The Food and Drink industry is the largest UK manufacturing sector, and an important contributor to the UK economy. The sector comprises over 7000 enterprises, consisting of nearly 10,000 manufacturing sites/factories and employing over 400,000 people.

Construction Products, Materials and Systems: The UK's Construction Products and Materials sub sector's exports are worth around £5.5bn, and it employs 371,000 people in 20,000 firms.

Underpinning Sustainable Growth

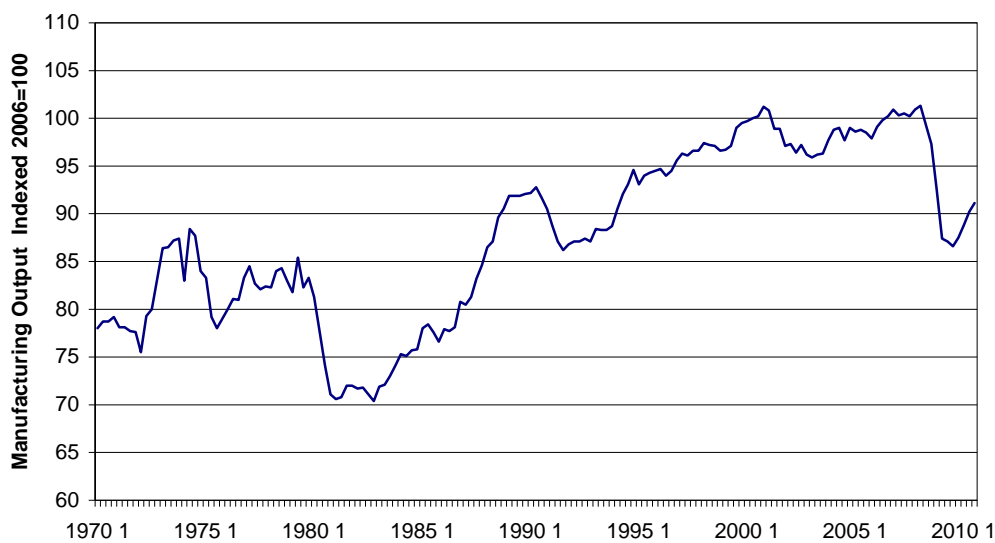
Manufacturing is the UK's third largest sector in the market economy, after business services and retail⁴ in terms of share of UK GDP. In 2009, manufacturing contributed some £140 billion in gross value added to the economy and employed some 2.6 million people⁵. The UK is the sixth largest manufacturer globally by output, and a leading exporter of technology intensive manufacturing goods⁶.

The strengths of manufacturing may be overshadowed by the fact that, in common with other industrialised countries including the US, Japan, France, and Germany, the share of manufacturing as a proportion of UK GDP has fallen. In the UK this is from just over 18% in 1990 to just over 11% in 2009. This decline as a proportion of the economy is due to a number of factors. As prosperity increases, consumers tend to spend proportionately more on services, such as healthcare and education. In addition, technological progress and stronger international competition has had the effect of driving down the cost of manufactured goods – such as cars and washing machines relative to services.

Manufacturing output has grown

However, while the share of manufacturing in the UK economy has declined, the value of goods produced in real terms has risen. Over the last three decades, manufacturing output in the UK has shown strong growth despite intensive competitive pressure. In 2007, just before the economic downturn began, the level of manufacturing output was around a third higher than in 1980.

Manufacturing industries output, Indexed 2006=100



⁴ Wholesale and retail distribution

⁵ ONS statistics, National Accounts

⁶ UNCTAD Handbook of Statistics, 2010

Characteristics of Advanced Manufacturing

With varying emphasis across companies and sectors, the characteristics of advanced manufacturing in the UK are that it:

- Is intensive in the use of capital and knowledge⁷
- Can require long term investment decisions to develop processes and buy equipment (that can take more than a year to manufacture)⁸;
- Uses high levels of technology and R&D and intangible investments (training, improvements to business process) to support innovation⁹
- Requires a flexible workforce with strong specialist skills in the areas of science, technology, engineering and mathematics and design¹⁰
- Competes in international and domestic markets¹¹

Using capital and knowledge to improve productivity

Industries such as advanced manufacturing are characterised by high levels of innovation, knowledge, skills and investment have a particularly important role to play in raising productivity, competitiveness and standards of living. New ideas, technologies, products developed in the manufacturing sector may have important uses in other sectors of the economy. Higher value industries and activities are also associated with higher levels of productivity¹² and therefore financial rewards to employees for the value they generate.

Productivity, measured on a per job filled basis, the productivity of UK manufacturing more than doubled between 1985 and 2009. As the chart below shows, the manufacturing sector has recorded greater rates of improvement in productivity performance than the services sector and the economy as a whole. The decline in productivity from 2008 Q2 reflects the impact of the recent economic downturn.

Over a ten year average the UK productivity growth rate was ahead of Germany, France, Italy and Japan. The recession affected this but it is clear that UK manufacturers are able to outperform competitors by taking advantage of new technologies, automation, and new production processes. The challenge is to do this faster and more effectively than other countries.

⁷ UK Innovation Survey 2009

⁸ BIS (2010) "Life Sciences in the UK" ; BIS Economics Paper No2

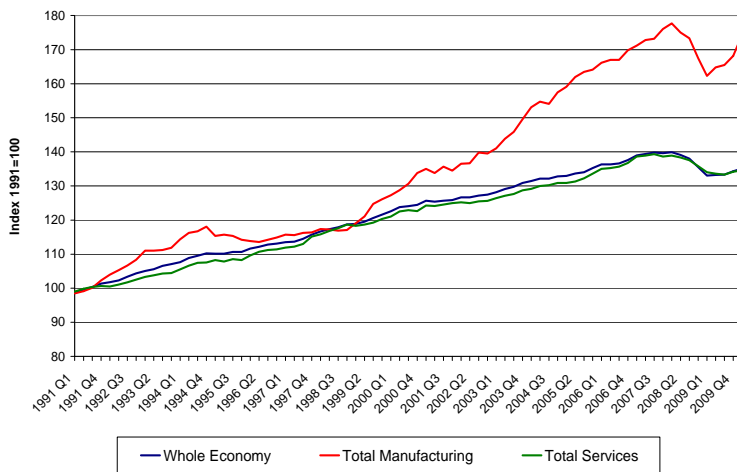
⁹ For example, initial findings from 2009 latest UK Innovation Survey found that 77% of electrical and precision engineering firms were innovative active. Source: ONS (2010) First findings from the UK Innovation Survey 2009

¹⁰ SEMTA (2009) Skills and the Future of Advanced Manufacturing.

¹¹ Many of the sectors with the highest proportion of firms which export are high-technology sectors. These include chemicals (86.5%), medical and precision instruments (80.5%), machinery and equipment (71.4%) and motor and transport equipment (65%). Source: BIS (2010) *Internationalisation of Innovative and High Growth SMEs*. BIS Economics Paper No 5

¹² Productivity is a measure of the efficiency by which firms turn inputs such as labour and capital into value added.

Productivity per filled job in the manufacturing sector relative to the services sectors and the whole economy, 1991-2009



Taking long term investment decisions

Manufacturers are rising to the productivity challenge. In a recent survey manufacturers said that over the next three years they will achieve their strategic priorities by increasing innovation and capital investment:¹³

	%
Increase innovation in the UK	76
Increase capital investment in the UK	69
Joint venture	36
Acquisition	32
Increase capital investment in other locations	25
Increase innovation in other locations	25
Other	21
Investment in sales & marketing	8

¹³ EEF/GfK NOP Shape of British Industry Survey 2010

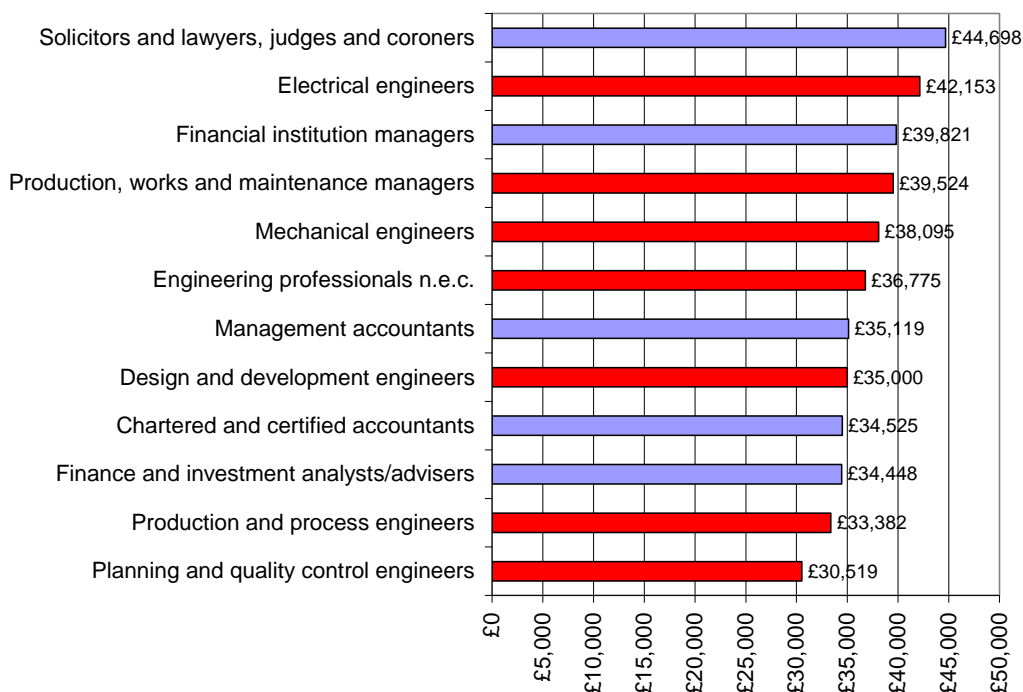
Making the most of technology

The UK's manufacturing base has transformed over recent years to develop a range of world-leading sector specific strengths - from traditional industries such as engineering and aerospace through to newer industries based around new industrial technologies. These new technologies, which have emerged from the science base, such as biotechnology and nanotechnology, are beginning to have a profound effect - creating activities that have the potential to become the manufacturing sectors of the future.

Benefiting from a skilled workforce

Like all industries there are a wide range of professions within manufacturing with the key highly qualified jobs concerning engineering. The ONS Annual Survey of Hours and Earnings (ASHE) collect data on an occupational basis as well as an industrial one. As can be seen in the chart below the median salaries in seven typical engineering occupations commonly found in the manufacturing sector are comparable if not higher than those of many financial, legal and accounting occupations with electrical engineers almost as well remunerated as lawyers and solicitors.

Median Gross Annual Salaries of selected engineering and non-engineering occupations 2009



Source: Annual Survey of Hours and Earnings, ONS

Salaries are not the only attractions of working in manufacturing. The transformation of modern manufacturing, to a range of high-value activities, has provided the opportunity for a variety of careers from designing space missions, creating flood defences and low carbon technologies, designing products from new drugs and medicines to electronic components for the next generation of mobile phones. Factories producing products depend upon engineers, scientists, technicians, graphic designers, logistics managers, product designers, sales and marketing specialists and many other roles.

In addition levels of educational achievement have increased across both the professional side and more traditional trade side of manufacturing. In 1994 only 9.7% of employees in manufacturing held a degree or equivalent compared to 17.1% in 2009 – almost double¹⁴. The figure is considerably higher among production and support service professionals, R&D development and sales & marketing workers – 31.7% of these employees held a degree in 2009¹⁵. Upskilling individuals, together with a shift in employment towards more highly skilled occupations, has resulted in a rise in educational attainment levels in manufacturing.

Designing and planning space missions

Joanna O'Rourke, Mission Systems Engineer at Astrium, is involved in the initial design and planning of space missions from the first briefing through to the preliminary design and planning.

Joanne believes her work is extremely valuable in its benefits to life of earth:

"Space missions such as the Mars Rover, investigate the fundamental physics of the universe and can help in all kinds of ways from climate observation, communications and disaster monitoring. I feel very fortunate to have a part in something so important to our future".

Skills in design

The UK design sector is renowned worldwide and we have a long standing reputation as a centre of design excellence and innovation, delivering products and services to national and international clients. A number of multi-nationals base their design centres in the UK to take advantage of the skilled design professionals here, including Nissan and Motorola. The use of design can add value to manufacturers through increased business performance and competitiveness, though design awareness is still low amongst small businesses.

¹⁴ BIS calculations based on ONS Labour Force Survey data

¹⁵ Ibid

Designing snowboards for a living

Liza Brooks is technical director at True Snowboards, UK's largest domestic Snowboard company, that she owns with two business partners. Her work is creative and hands-on – designing snowboards. Once designed, prototypes boards are manufactured and put through their paces by a professional snowboarding team. From their feedback, Liza makes the adjustments necessary to ensure the design and materials give the best ride possible, before the new range goes into production.

Becoming a leading exporter as well as a strong destination for Foreign Direct Investment

It is expected that demand is unlikely to grow as rapidly in the UK, the EU or America as in emerging economies, so manufacturing has to look to improve relative trade performance in wider global markets. There is a good foundation for this - the UK is the world's tenth largest manufacturing exporter, and developed strengths in technology intensive exports¹⁶. The UK was the seventh largest exporter of high and medium high technology manufactured goods in 2008, with exports totalling some \$260bn in value. 53% of all UK exports are of manufactured goods.¹⁷

Around 65% of total UK manufacturing exports in 2008 were high and medium-high tech manufacturing exports. In some of our key sectors, the export performance is particularly high: over 86% of firms in the UK chemicals industry and over 80% of firms in the medical and precision instruments industry are exporters.

Increasingly foreign owned businesses have seen the benefits of locating in the UK and the access this gives to domestic and export markets. Foreign owned firms have played a major part in transforming key manufacturing sectors in the UK. FDI has been making an increasingly important contribution to UK manufacturing output (between 1984 and 2005 manufacturing output by foreign firms more than doubled¹⁸. It has stimulated the application of new production technologies and processes, energised the UK's design capability and brought significant new capital flows.

Do you agree that these are the main strengths of the UK's Advanced Manufacturing?

Are there other competitive advantages on which we should build?

¹⁶ OECD STAN database

¹⁷ BIS estimates based on ONS External Trade in Goods Statistics (MQ10) and National Accounts

¹⁸ this increase in output has been driven by greater use of inputs.

Chapter 4: Where are the future long-term growth opportunities for Advanced Manufacturing?

The environment facing manufacturers has undergone and continues to face significant change. In the coming years, there are a number of long-term major challenges for the UK economy, including:

- The challenge of globalisation and new competitors in new markets;
- The challenge of climate change and its impacts;
- The challenge of increasing technological competition.

But, at the same time, these longer-term challenges offer great opportunities for our manufacturers. Advanced Manufacturing has a key role to play in providing solutions to these challenges. It is open to trading with new markets and embedded in global supply chains across the world. Advanced Manufacturing is at the forefront of developing and providing low carbon and environmental technologies, lightweight technologies, and resource efficiency and recycling materials. Advanced Manufacturing is at the centre of a global market-place where innovative products are developed with an ever-shortening development time, and with hugely increased functionality – such as smart phones.

There are key trends in the global economy with huge potential for UK manufacturing

From our initial analysis, we have identified opportunities in:

- **Growing global markets** - where consumers are increasingly looking for high tech, quality products. This is particularly the case in Brazil, Russia, India, China (BRICs), but also in other emerging geographical markets. Demographic changes and lifestyles are likely to generate new demand for more sophisticated medical devices, instrumentation and delivery of healthcare.
- **Low Carbon and Environmental Market Opportunities** – with huge opportunities in areas particularly related to low carbon, green technology, environmental and energy efficiency.
- **The use of new technologies** – with the rise of new approaches to increase productivity through for example increased use of ICT and digital in manufacturing processes and products, and the exploitation of new industrial technologies.

- **New business models** - with the rise of services as a key revenue stream for manufacturing, and the trends towards new business models based around new production processes.

Growing Global Markets

There will be millions of new consumers for high value products in the global market place – and changing demographics offering new market opportunities

It will also provide new export, supply chain and commercial opportunities for UK Advanced Manufacturing. The rapid growth of emerging economies and major changes to global income distribution will dramatically change the profile and nature of consumer demand and spending.

As disposable incomes rise, expenditure in developed economies is forecast to increase disproportionately in areas such as leisure, medical care, transport and communications¹⁹. Within these, spending is likely to shift towards luxury, high quality products and services; including areas where the UK excels – such as premium cars and high-end electronics and pharmaceuticals.

In the next five years, Asia's economy is forecast to grow by 50% and be comparable in size to the economies of the US and Europe. With India growing at around 7% a year, China at 9%, it seems likely that China will have a bigger economy than the US by 2040.

This presents huge opportunities. For example, car ownership in China has doubled in the last five years and it already has the third highest car sales in the world. Car ownership in China and India is currently a fraction of that in developed countries such as the US. Over the coming decades, as these and other emerging economies grow, a very rapid rise in car ownership is projected.

Exporting to World Markets

Brompton Bicycles, a UK manufacturer of folding bikes, won 2 Queens Awards in 2010; one for International Trade and the other for Innovation. The company's success in a market with many much lower cost competitors is attributed to investment in innovation – over 70% of the 1200 parts have been designed and made by the company. That number of parts and the fact that the bike has to be folded and unfolded frequently means that manufacturing tolerances are unusually fine. Innovation extends beyond development of cutting edge technologies to taking existing engineering techniques and applying them in new, commercially viable ways. Brompton invests heavily in training and its skilled workforce are all trained on site.

Brompton exports 70% of output to 35 countries and is very highly regarded in Asian markets, particularly Japan.

¹⁹ Cox, W.M. and Alm, R. (2007) Federal Reserve Bank of Dallas, 2007 Annual Report *Opportunity Knocks*

Demographic and lifestyle changes

Demographic changes and lifestyles are likely to generate new demand for more sophisticated medical devices, instrumentation and delivery of healthcare. New electronics and information technology will have the potential to support independent living and control costs to healthcare providers. There is also likely to be strong demand for a range of products, from vehicles to home furnishings, to be designed in a more use friendly way for older and disabled people improving the accessibility of products.

The Growing Market for Medical Devices

Renishaw is an innovator and leader in the field of precision measurement tools that are used by manufacturers across the world. They originally established their reputation in sectors such as aerospace and automotive, but have recently extended their expertise to the healthcare and dental sectors where new applications for measurement and automation are emerging.

As an example, Renishaw is now extending its activity to new applications in brain surgery, aiding surgeons to precisely implant electrodes within the brain to help treat serious Central Nervous System diseases such as Parkinson's.

Low Carbon and Environmental Market Opportunities

Low carbon technology solutions, including renewable energy, are combining to shape substantial market opportunities

One of the biggest challenges facing Europe and the rest of the world is the transition to a green economy that is energy and resource efficient. However, environmental considerations can create opportunities for sustainable growth in manufacturing.

The global Low Carbon Environmental Goods and Services sector²⁰ was worth £3.2 trillion in sales in 2008/09 and is estimated to grow by approximately 4% per year over the next five years.²¹ The sector in the UK recorded sales of £112bn in 2008/09, which represented a nominal annual increase of 4.3% from 2007/08, and exported £10.8bn, with a positive net trade position of £4.5bn (2008).

As traditional manufacturing sectors will have to transform their goods and their energy and resource use, there are also opportunities for the production of energy efficient products and services, and the production of new and innovative environmental products and solutions.

Rising incomes and greater awareness of the economic consequences of environmental issues such as climate change and waste management are likely to lead to increased demand for

²⁰ The LCEGS sector is defined by Innovas as traditional environmental services and renewable energy, as well as emerging low carbon activities, such as low carbon building technologies and carbon finance.

²¹ <http://www.bis.gov.uk/assets/biscore/corporate/docs/110-795-low-carbon-goods-analysis-update-2008-09.pdf>.

higher environmental standards such as better air quality and greener products. Recycling – in essence the process of ‘remanufacturing’ – is well established for some materials (such as metals and paper), but in its infancy for other types of waste. It draws heavily on process innovation from other industries. The UK has the opportunity to be an EU and global leader in this area.

New materials contributing to a low carbon future

New materials have a key role to play in reducing use of energy and Co2 emissions. It is estimated that just under half of total UK emissions are ascribable to buildings and use of buildings. New, lower cost and high performance fibrous composite materials are expected to become increasingly significant over the next decade: for example, as material for road and footbridges.

Light, strong materials are also vital; to help the transportation industry reduce emissions. With the upward trend in fuel prices and environmental concerns, there is a strong demand for lighter aircraft, promoting the increased use of composites in airframes and components, and more efficient engines. The UK already has developed expertise in using composites in aerospace and high- performance cars, and with the UK Composites Strategy is moving into the use of composites in other sectors such as wind turbines.

The world composites market is predicted to grow from £53bn to £74bn by 2013, driven initially by the aerospace and wind energy sectors, where demand for composite materials is expected to grow by around 15% and 13% each year respectively²². The UK composites market is currently worth £1bn annually and employs approximately 40,000 people²³. The opportunities in the UK wind turbine blade and aerospace markets alone will be worth an estimated £22bn by 2020.

Using new materials for fan blades to deliver greater efficiency

The ELF Environmental Lightweight Fan System is being developed by GKN Aerospace and Rolls-Royce to bring new engine fan blade technologies that will deliver improved performance, reduced noise and lower CO2 and NOx emissions to achieve technology goals set by ACARE in Europe for 2020.

R&D has focused on developing fan blades made of composite materials that will offer significant weight reduction compared to metals and will be the key technology driver to delivering improved propulsive efficiency. Reduced weight from the fan blades combined with their increased propulsive efficiency will reduce fuel burn and CO2 emissions. For wide-bodied jets the ELF blades will deliver 500 tonnes CO2 benefit per annum per 1% fuel burn.

The two companies are investing prior to development of the engine with support from the EU and TSB. The market opportunity is some £160bn, and has the potential to create more than 16,000 jobs during the manufacturing phase.

²² Global Composite Market 2009-2014; Materials, Markets and Technologies, Lucintel 2009.

²³ Ernst & Young (2010) UK *Composites Supply Chain Scoping Study for UKTI and BIS* – key findings (unpublished)

The application of industrial biotechnology, by the chemicals and chemistry-using sectors, can contribute to sustainable low-carbon growth through the development of new and less carbon intensive products and processes. The global industrial biotechnology market is currently worth about £35-53bn with the potential to achieve global sales of £150-360bn by 2025 in the chemical sector alone²⁴. The UK is well placed to take advantage of these future market opportunities. We are among the world's leaders of industrial biotechnology research with strengths in both business and academia (especially in biocatalysis, fermentation, plant and marine science).

New Technologies

Identifying technologies for sustained economic growth

In November 2010, the Government Office for Science published 'Technology and Innovation Futures' – a forward look at a range of developments which have the potential over the next 20 years to support sustained economic growth in the UK. The report concludes that there are strong opportunities for growth in the UK economy through the 2020s if businesses can harness scientific and industrial capabilities to take advantage of technology developments and identifies three potential areas of growth which could be transformative;

- Manufacturing – there is potential for the UK to be part of a 21st Century manufacturing revolution fuelled by new technologies and bespoke on-demand manufacturing;
- Infrastructure - including R&D and deployment of smart electric grids and increased use of sensor networks; and the Internet – there is potential for a second Internet revolution to transform the way we use data, and to open up opportunities for the creation of major new businesses.

The report identified 55 technologies which are likely to be important to the UK in the 2020s, because of the UK's comparative advantage today, its future needs, or the size of the potential market.

New enabling technologies

There are a number of new enabling technologies beginning to emerge which have potential applications in a wide-ranging number of sectors and industries - to improve or even transform production processes and boost the efficiency and quality of products:

²⁴ Arthur D Little (2009) *Quantitative modelling of industrial biotechnology and renewable chemicals* – Final report for BERR, <http://www.bis.gov.uk/files/file51252.pdf>

Technology	End-use application
Digital	<ul style="list-style-type: none"> • Consumer electronics and ICT sectors
Micro and nano-electronics	<ul style="list-style-type: none"> • Automotive • Medical instrumentation • Consumer electronics • Spacecraft • Aeronautics • Automotive • Defence • Green technologies
Nano-technology and nano-materials	<ul style="list-style-type: none"> • Aerospace • Space • Automotive • Life Sciences • Electronics and ICT • Green technologies • Food and drink
Industrial biotechnology	<ul style="list-style-type: none"> • Life Sciences • Chemicals • Green technologies
Photonics	<ul style="list-style-type: none"> • Life Sciences • Green technologies • Electronics and ICT
Advanced materials (e.g. composites)	<ul style="list-style-type: none"> • Green technologies (e.g. batteries) • Plastics (e.g. smart packaging) • Aerospace • Automotive • Transport equipment • Electronics and ICT

Source: Technology Strategy Board, Strategy documents.

These new emerging technologies will enable the development of new and better quality goods and services that meet increasingly sophisticated consumer demands for increased functionality and convenience, creating new market opportunities and new customers.

For example, Additive Manufacturing, or “rapid manufacturing”, is a recent development in manufacturing technology, which allows companies and individuals with access to 3-dimensional computer data, the ability to literally “print-out” solid objects layer-by-layer. It has recently matured to the point where it can be used to make “end-use” components, such as aerospace and automotive parts, medical implants, hearing aids, lamps shades, dental crowns, surgical aids and even furniture, to name but a few applications.

The opportunities that Additive Manufacturing presents are significant, as the technology eliminates the need for much of the capital investment associated with manufacturing, enables the manufacture of complex personalised geometries, and has the potential to reduce the carbon footprint of global manufacturing.

There are a range of new production processes technologies, including Additive Manufacturing, in which the UK has considerable capability including:

- world leading research at Loughborough and Cranfield Universities in additive manufacturing
- strengths in novel machining at Nottingham University, Warwick Manufacturing Group and the Sheffield Advanced Manufacturing Research Centre (AMRC)
- advanced laser processing at Cambridge University
- microscale and microsystems manufacturing at Heriot-Watt university in Scotland

Internet and wireless technologies are increasing the functionality and appeal of products

New technologies are being brought to market sooner than before and being adopted faster by consumers, driving innovation even faster.

There is an increasing demand for 'connectivity' in products – using electronics and mobile communications to enhance the functionality of products. The development and rapid diffusion of Information and Communications Technologies is significantly affecting the array of goods and services that people buy and the manner in which they purchase.

Putting communications at the heart of the most innovative and exciting electronics products

Imagination Technologies, based in Hertfordshire, is one of the top three electronics intellectual property (IP) companies in the world. Their technologies are used to enable graphics, video, processing, communications and connectivity and are used in home computing and in-car applications as well as mobile devices.

Their technology portfolio has won its place in some of the world's best selling and most iconic smartphones from brands such as Apple, Nokia, NTT DoCoMo, Motorola, Samsung and Sony Ericsson, as well as the new 'tablets' format based on smartphone technology. There are over 350 million people actively using its technology.

New Business Models

Companies are developing new ways of organising themselves and new business strategies to succeed in the global marketplace

The business environment for manufacturers has become increasingly complex. Improvements in global transport infrastructure, and further advances in communications technologies, in particular digital and satellite, enable information, knowledge, labour, capital, and services to travel over longer distances much more quickly than before.

As a result, manufacturers increasingly view the entire world as potential locations for 'fragmented' or separated manufacturing activities such as sourcing, assembly, research and development, logistics and distribution, marketing and sales activities. The factors behind locations decisions can include opportunities to save large margins and cost pressures, to exploit technical capabilities of a particular location, and the need to establish a strong presence to supply new markets such as India and China.

Developments in communications technologies, such as 'cloud computing' - whereby shared resources, software, and information are provided to computers and other devices on demand over the internet, offer further opportunities for manufacturers to organise and synchronise their value operations to increase revenue and cut product development cycles.

Services are forming an increasing important additional source of revenue for manufacturing

Manufacturing and services are increasingly forming part of a joint value proposition, as firms compete on a product and service basis. Companies from the aerospace, chemical and materials industries have already adopted business models based on selling a total service rather than a single product.

Much of the revenue is captured through the service element. The UK's strong service sector, together with its strengths in high-value manufacturing areas, makes it well placed to capitalise on these developments.

Engineering Support Services

Babcock International plc is a 120 year old engineering company that built up world-leading excellence in boiler-manufacture and powering ships during the mid 20th Century. In 2000 it began the transformation from an engineering company to one of the UK's leading engineering support services businesses and the leading naval support business. Key activities include refitting, refuelling and decommissioning submarines, maintaining and refitting warships, managing naval bases, providing equipment support and a broad range of training and services to Governments and industries.

Are these the major growth opportunities for UK Advanced Manufacturing?

Are there other key trends in the global economy we should explore

Are there other major demographic or societal changes they could provide growth opportunities for UK Advanced Manufacturing?

Working with devolved administrations

We will work with the Devolved Administrations in Northern Ireland, Scotland and Wales, recognising their particular and varying responsibilities. While some of the policies in this paper are specific to England, the challenges are common across the four countries of the United Kingdom. Each will consider the most appropriate arrangements in those areas for which they have devolved responsibility, to address the issues in ways that meet their own circumstances and needs.

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