Analysis of the UK Manufacturing Engineering Sector

Analysis Report for the European Project: Inter-countries Research for Manufacturing Advancement (IRMA)

March 2009

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Notes:

'Billion' in this report means one-thousand million (1×10^9).

2 Analysis of Manufacturing Engineering (ME) Sector

2.1 General Analysis of UK ME Sector

2.1.1 Economic, Political and Historic Perspective

The United Kingdom (UK) is a developed country. In 2008, it ranked fifth (second largest in Europe after Germany) by nominal Gross Domestic product (GDP), and had the sixth largest economy in the world by Purchasing Power Parity (PPP).

The UK is also a Member State of the European Union (EU), holds a permanent seat on the United Nations Security Council, and is a member of the G8, North Atlantic Treaty Organisation (NATO), Organisation for Economic Cooperation and Development (OECD), World Trade Organisation (WTO) and the Commonwealth of Nations.

According to its most recent census in 2001, UK's total population was just below 59 million, making it the third largest state in the EU [1].

The majority of the UK's energy demand is fulfilled by the North Sea oil and gas.

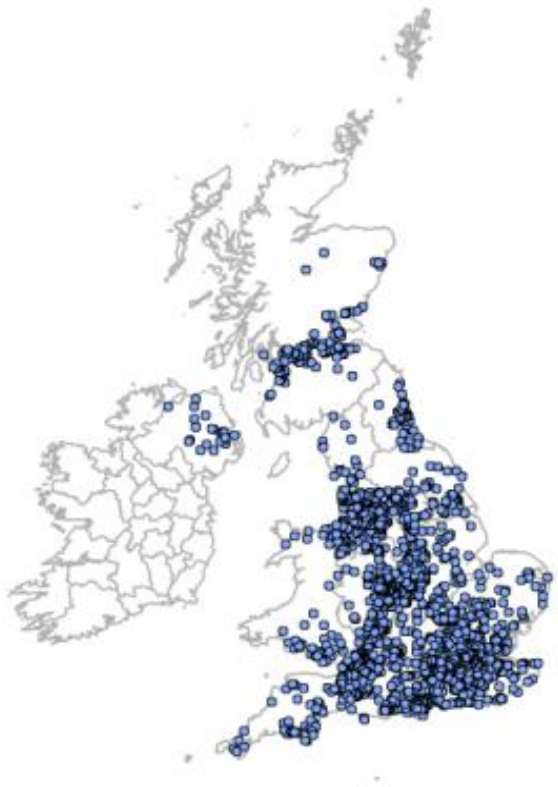
The inception of Industrial Revolution in the 18th century made UK the first industrialised country, and was a significant factor in its dominance during the 19th and early 20th centuries. The Industrial Revolution resulted in the UK's transition to a machine-based economy which was previously a worker-based cottage industry. This led to the growth of factories, mass production and concentration on heavy industries such as shipbuilding, coal mining, steel production, and textiles.

However, the economic and political cost of two world wars and the decline of its empire in the latter half of the 20th century has diminished UK's competitive advantage, particularly in the heavy industry. Nevertheless, the UK still retains a significant share of economic, cultural, military and political influence worldwide.

2.1.2 Key ME Sectors and Economic Contribution

Manufacturing remains a significant part of the UK economy (see Figure 1). Whilst it only accounted for one-sixth (~13%) of the national output in 2003 [2, 3], contributing around £150 billion per annum and half of the total exports[4].

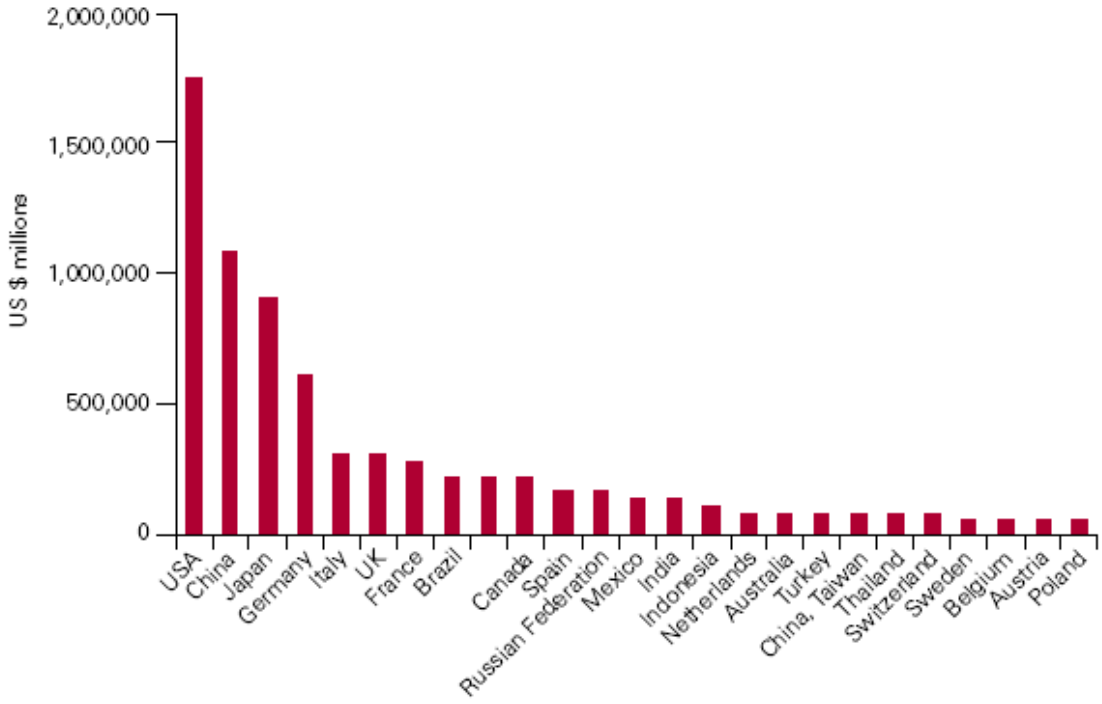
Over the last decade this trend has resulted in increased levels of foreign ownership or transfer of the UK manufacturing base [5]. Today, UK-owned companies are no longer leading the design of white goods, commercial aircraft, trains, merchant ships, power/nuclear generation equipment, machine tools, vehicles and most electronic equipment.



Source: UKTI

Figure 1: Geographical Distribution of ME (not to scale)

Nonetheless, in 2006 the UK ranked the sixth largest in the world in terms of manufacturing output or Gross Value Added (GVA). Many traditional manufacturing firms have developed and evolved into new activities, such as silicon design, Bluetooth technology, in-flight refuelling systems, fuel cells and plastic electronics. Others are now engaged in the development of cutting-edge technologies in information and communications, bio-technology and nano-technology.



Source: OECD

Figure 2: Manufacturing GVA in 2006 - Top 25

Moreover, in 2006, 25% of UK goods exports were in the high-technology category, compared to 22% in the USA, 15% in France and 11% in Germany.

The key segments making up the UK ME sector are:

- **Aerospace and Defence:** the sector comprises over 3,000 companies and employs an estimated 150,000 people directly and 350,000 people indirectly. Civil and defence aircraft production is led by the largest aerospace firm, BAE Systems, and the continental European firm EADS, the owner of Airbus. Rolls-

Royce holds a major share of the global aerospace engines market. Other notable companies in this sector include: Bombardier, Smiths, GKN Aerospace, Thales, AgustaWestland, Cobham, Finmeccanica, MBDA, Goodrich and Messier-Dowty.

- **Automotive:** The motor industry is a significant part of this sector, although it has diminished with the collapse of the MG Rover Group. Today, most of the industry is foreign owned, and the UK ranks 7th amongst the top ten car producing countries and is one of the five major automotive manufacturing countries in Europe, with over 5000 companies active in the sector. The UK automotive sector is worth over £6 billion and currently accounts for over 11% of the UK's total exports (65% of UK commercial vehicle production in 2006 was exported). The sector employs around 820,000 people with 180,000 directly in manufacturing, and produces 3 million engines and 1.8 million cars annually. Companies that have significant UK based manufacturing and assembly operations include Ford, Honda, Jaguar, Nissan and Toyota. Johnson Matthey (a British company) is the world's largest manufacturer of catalytic converters for reducing potentially harmful emissions from vehicles.
- **Construction and Engineering:** The UK construction sector is the second largest in the EU, providing annual exports over £7 billion. It contributes around 8.2 percent of GVA and employs around 2.1 million people. The sector is extremely diverse, composed of contractors, consultants, building materials and product producers. It is dominated by SMEs with a relatively small number of large companies, which include Balfour Beatty, Laing O'Rourke, Carillion, and Galliford Try.
- **Chemical and Pharmaceutical** is also a significant sector, with the world's second and sixth largest pharmaceutical firms (GlaxoSmithKline and AstraZeneca, respectively) being based in the UK. Other firms include Macfarlan Smith, Fujifilm, INEOS, Kemfine, Ciba Speciality Chemicals, Exxon, Shasun and Syngenta.

Other significant sectors engaged in manufacturing activities include:

- **Food and Drink:** This is the single largest manufacturing sector in the UK, with a turnover of £74 billion, accounting for 15% of the total manufacturing

sector and employing around 500,000 people. The 2007 export figures were around £11.5 billion.

- **Shipbuilding/Marine**: Most companies in this sector are SMEs specialising in innovative technical solutions in areas like boat building, marine electronics and software, on-board equipment and many others. The sector is export-intensive, with international trade accounting for up to 60% of turnover in some companies.
- **Microelectronics and Optoelectronics:** Whilst the UK is at the forefront of electronics design, especially low-power mixed analogue and digital designs for portable devices such as MP3 players and mobile phones, it lags behind Japan, Korea, China and the USA in industry scale and trade volume.

"Green" energy and environmentally (low carbon) sustainable production and manufacturing technologies, next-generation semiconductors, electronics, nano-technology, bio-technology and "mechatronics" are among the fledgling industries, but must be regarded as key to the UK's future competitive advantage.

2.1.3 Governmental Policies and R&D Investment

Although the ME sector contributes three-quarters (75%) of all business R&D in the economy, overall in engineering the UK is falling behind compared to the major comparator countries. In recent years, the UK government has applied increased focus on improving the attractiveness of the UK as a location for high-valued added manufacturing activities through:

- Fostering of effective innovation, investment and skills development in the UK manufacturing industry.
- Promotion of regional development via the nine Regional Development Agencies (RDAs).
- Development of virtual business networks that can connect to global supply/value chains.
- Encouraging local clusters and growth of small and medium-sized enterprises (SMEs).

2.2 Design the IRMA Model – UK ME SWOT Analysis

Manufacturing productivity (output per labour hour) is lower in the UK than in many industrial countries, including France, Germany and the US. This is providing increased incentive and impetus for adoption of lean practices (waste and re-work reduction) and operational excellence philosophy. However, recent industry figures indicate that the actual implementation of lean practices has been relatively low.

Since 1997, the UK's historic productivity gap has narrowed, showing an improvement by 50%, outstripping the rest of the economy. According to government figures, between 1997 and 2004, the average labour productivity in the UK grew by 4% more than the USA (5% more than France, and 15% more than in Germany).

The UK's manufacturing workforce has become more diverse over the last two decades, with increasing numbers of jobs in R&D, design, sales, services, after-care and supporting packages. These are in addition to the more traditional job roles in production and engineering.

The transition and transformation of the manufacturing sector has been accompanied with a significant restructuring in UK manufacturing, and inevitable job losses affecting many communities. However, it has also meant the manufacturing sector and the workforce is well placed to meet the challenges of an increasingly competitive global economy.

Moreover, according to the 'Balance of Payments' data from the UK Office of National Statistics (ONS) [1], the UK has become a significant net exporter of R&D services to the rest of the world. The balance has increased from less than £1 billion in 1997 to £2.6 billion in 2004. The figure appears to indicate a considerable competitive advantage in the generation of technological knowledge, a significant part of which can be attributed to the ME sector.

Aside from having a positive balance in R&D services, the UK also exhibits a net surplus in royalty payments received from other countries for the use of intellectual property (IP), much of which is linked to the licensing of technology (see Sections 2.3.5 and 2.4.2). This relative success appears to have been achieved through:

- New technology development that is well integrated with the rest of the world.
- Adapting to the changing business environment through increased internationalisation of R&D.
- Attracting more international investment for technological R&D than other key competitors.

It should be noted that whilst the emerging regions, especially the BRIC (Brazil, Russia, India and China) countries, may offer the UK manufacturers opportunities to relocate manufacturing operations to areas of lower labour and material costs, they present significant other logistical, commercial, political, cultural and legal challenges. The UK Trade and Investment – a unit formed by the government – is assisting UK firms understand these challenges, as well as secure export and investment opportunities worldwide.

2.2.1 SWOT Analysis

Based on the arguments of the preceding sections, Figure 3(a) and 3(b) present a SWOT assessment of key factors affecting the UK manufacturing sector.

Strengths	Weaknesses
▪ High-value added manufacturing. ▪ Advanced skills for successfully integrating and managing complex global supply chains. ▪ Ability to outsource low added value manufacturing mostly outsourced to low-labour regions of the world. ▪ Strong ability to attract foreign R&D funding. ▪ Strong financial services industry to support foreign direct investment in future manufacturing technologies. ▪ Strong traditional links between industry and higher education organisations. ▪ Modern collaborative practices for new technology and research development. ▪ Strong communications and technology infrastructure. ▪ Increasing political intent and governmental backing for nurturing the growth of ME sector. ▪ Workforce skills transformation well underway.	▪ Lower rates of productivity than most other competing economies. ▪ Slow implementation of 'lean' practices. ▪ Higher cost of living and consequential higher labour cost than emerging economies competitors. ▪ Gradual decline in existing scientific and technology skills and knowledge base. ▪ Too much emphasis and dependency on the services sector. ▪ Future generations not motivated enough to pursue engineering careers, owing to a lack of career incentives and 'dull' image of the manufacturing industry. ▪ Low rates of domestic investment in national R&D (not enough government commitment to date in providing supportive tax incentives and regulatory framework). ▪ Lack of coordination in representing the ME sector on the international stage. ▪ Declining contribution of engineering to intellectual property creation and world-class publications.

Figure 3(a): UK ME Strengths versus Weaknesses

Opportunities	Threats
▪ Manufacturing of low-carbon products presents a significant opportunity to scale-up the industry. ▪ Adoption of low-energy manufacturing methods and technologies may provide competitive advantage. ▪ Manufacturing of advanced embedded systems and electronics, optoelectronics, nano- and bio-technology present significant opportunities to build the ME sector. ▪ Mature and proven regulatory framework for supporting industry and commerce would continue to attract investors to lower-risk and dependable R&D regions. ▪ Membership of EU creates additional opportunity for synergies and investment multipliers (for example see Section 2.5 – Best Practices). ▪ Stable political and social environment provides a strong assurance for return on long-term investments. ▪ Weakness of Pound Sterling is cushioning export. ▪ The commonality of language (English) and cultural similarities continues to facilitate improved communication, understanding and trust between prospective business partners and collaborators.	▪ Slow government response in increasing investment in domestically funded R&D. ▪ Accelerated progress amongst emerging (BRIC) economies towards national manufacturing advancement. ▪ Labour and material cost disadvantage will remain despite increases in the cost-base of competing economies. ▪ Future investment in low-level R&D (particularly from SMEs) likely to gravitate towards low-cost economies. ▪ Leadership for creating new knowledge increasingly being assumed by developing countries. ▪ Weakness of currency (Pound Sterling) cannot be relied upon to create sustainable competitive advantage. ▪ Potential mid- to long-term competition also likely to emerge from Middle Eastern economies keen to develop a manufacturing base – particularly around 'green' technologies and power generation.

Figure 3(b): UK ME Opportunities versus Threats

2.3 Trends and Main Indicators

In the short term, the UK ME sector remains exposed to the global downturn. According to the industry figures, the following key short-term trends are currently affecting the industry:

- A marked reduction in manufacturing output and export orders.
- Manufacturing Purchasing Index (measuring business activity) is at a record low.
- Export orders are no longer sufficient to compensate the manufacturers for domestic weakness.
- Domestic and export prices and margins are falling.
- Increased cost of financing.
- Cash-flow problems are adversely impacting investment plans.
- Widespread job cuts, with the risk of even deeper cuts within the sector.

The above short-term trends will inevitably determine the long-term outcome and future landscape of the ME sector in the UK. Manufacturing firms in the motor vehicle and electronics segments are expected to experience the biggest slowdown.

At present, much work remains to be done both by the government and organisations within the ME sector to tackle and address the short-term challenges, and to ensure that their organisations, and the ME sector as a whole, not only survives but emerges fitter for the next cycle of economic growth.

The most important strategic trend that has been affecting the UK manufacturing sector is the growth of global value chains, as UK companies have began to increasingly source goods and services from across the globe.

This has also meant that the UK ME firms (being in the relatively higher cost economy) are increasingly competing through differentiation of their products and supporting services instead of price. Consequently, manufacturing firms are placing increased emphasis on their implementation of manufacturing technology, investment in R&D, aftermarket services, design and branding, as well as information and communications technologies (ICT), and further investment in people and skills development.

In addition, proactive action on achieving the EU and international targets for carbon reduction is creating new challenges and opportunities for the ME sector.

Hence, a number of trends are emerging along the following six axis:

- Change in Government policy;
- Integration of global supply/value chains;
- Increased information technology exploitation;
- Development of human resources and wider competencies;
- Need for renewed focus on R&D and innovation enablers;
- Transition to a 'low-carbon economy'.

2.3.1 Change in Government Policy

As more and more UK firms prepare to address the challenges and opportunities associated with globalisation of supply chains and distribution channels, the UK government has also come to the realisation that a new policy framework is required to facilitate trade, investment and national productivity, and the need to achieve balanced employment levels and trade volumes in manufacturing industry and the financial services sectors [6].

In particular, the government has identified that it may need to help businesses participate in global markets - in particular, manufacturing SMEs who continue to face barriers in accessing global value chains in high growth new emerging markets [7].

The Government has also embarked on developing a skills strategy to address the manufacturing workforce and skills development consistent with the future needs of the industry.

2.3.2 Integration of Global Supply/Value Chains

The current phase of globalisation is having a major impact on the UK ME sector. The most significant factor is the increasingly global location of the production of intermediate goods such as components and parts production. This segregation not only affects the physical component parts of products, but the accompanying knowledge intensive services, such as R&D, inventory and quality management, as well as other professional and technical activities such as aftercare and warranty. Effective

integration, smooth operation, flexibility and agility of the total supply/value chain is therefore paramount in this new operational model.

Initial data regarding the integration of manufacturing into global value chains suggests that this factor is having a positive impact on the productivity performance of UK firms [8, 9, 10].

Moreover, it appears that participation in global value chains is also helping UK manufacturers engage with international networks, for example in different product markets or sources of innovation [9, 12].

2.3.3 Increased Information Technology Exploitation

Successful exploitation of new technology for creating competitive advantage against lower wage economies is taking a fundamental role in the ME sector [10, 11, 13]. Again the new focus is to shift attention from using technology to simply automate business operations (which is still seen as being important) to fundamentally improving manufacturing processes and rapid product development. The inevitable link with the knowledge-driven economy is also being recognised in the growing role of the technology in ensuring information is efficiently collected and rapidly exchanged, enhancing order fulfilment and stock management, as well as facilitating the (digital) sharing of ideas and designs.

2.3.4 Development of Human Resources & Wider Competencies

Increased levels of price competition in the ME sector from the emerging market economies has resulted in the UK manufacturing firms' renewed focus on raising skill levels in their manufacturing workforces. Companies require a workforce with both specialist high-level technology, engineering, science and mathematics skills, and a generic set of soft skills enabling people to work across disciplines [14].

The importance of strong management and leadership in operating global value chains and utilising the skills of the workforce to deliver high value added products and services is generally well recognised by the UK firms. This is in part due to the maturity of the manufacturing and higher education base. However, the inevitable effects of downsizing of the national workforce over the last two decades and the absence of a cohesive long-term national strategy, has meant that the UK companies have been

rather slow in responding to the opportunity to re-deploy resources and transition from the traditional 'Adam Smith' style organisational structures to more flexible employment and business models.. This has limited their ability to successfully maintain the skills capability and retain the crucial engineering/scientific know-how.

2.3.5 Need for Renewed Focus on R&D and Innovation Enablers

In 2006, it was estimated that the UK provided 9% of the world's scientific research papers and a 12% share of citations, the second highest in the world after the US [15]. The UK also ranked top amongst the G8 countries in terms of number of publications per capita [16]. However, the UK has a comparatively low proportion of its total publications in engineering.

In 2003, engineering accounted for 7.1% of all UK publications. This is a similar proportion to the proportion of engineering in most western economies (e.g. 8.9% for the average of the major industrial comparator countries, and 6.4% for the average of the four small, high-tech economies, in 2003). By contrast, the emerging economies average engineering accounts for 18% of total publications [17].

The OECD data on the percentage of domestic R&D funded by the rest of the world shows the UK in a competitive position (Figure 4), with over 25 percent of commercial R&D in the UK funded by overseas donors. This compares favourably with under 5 percent for Germany, and around 10 percent for France.

Notwithstanding the above data, a different picture emerges when UK's domestic investment in R&D is analysed (Figure 5). Significant differences are notable in terms of inputs invested in R&D between the UK and its major industrial competitors. In the twenty years to 2003, the UK has invested, on average, 2% of annual GDP on R&D, which appears to be on par with the 2.6% for the US and the 2.8% for Japan. However, what is even more significant is that the UK investment as a proportion of GDP has fallen over this 20-year period, from 2.2% in 1983 to 1.9% in 2003, (c.f. USA: 2.6% in 1983 to 2.7% in 2003), while Japan has increased its investment (from 2.3% to 3.2%, over the same period).

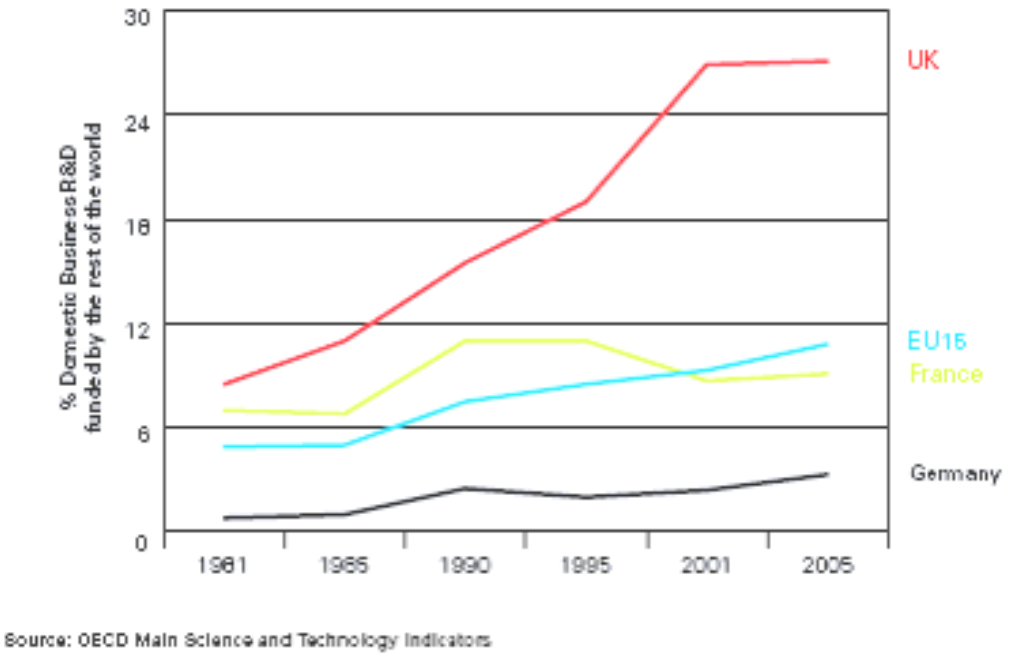


Figure 3: Externally-funded Domestic R&D

These figure appear to support the general trend that, when it comes to domestically funded R&D, the UK is falling behind its competitors and the UK's Government target of 2.5% of GDP by 2014 [18], or the European Union target of 3% by 2010. This highlights the need for the UK government to facilitate, through the right policies, an economic and regulatory environment that encourages investment in R&D – particularly manufacturing R&D, with minimal administrative burdens.

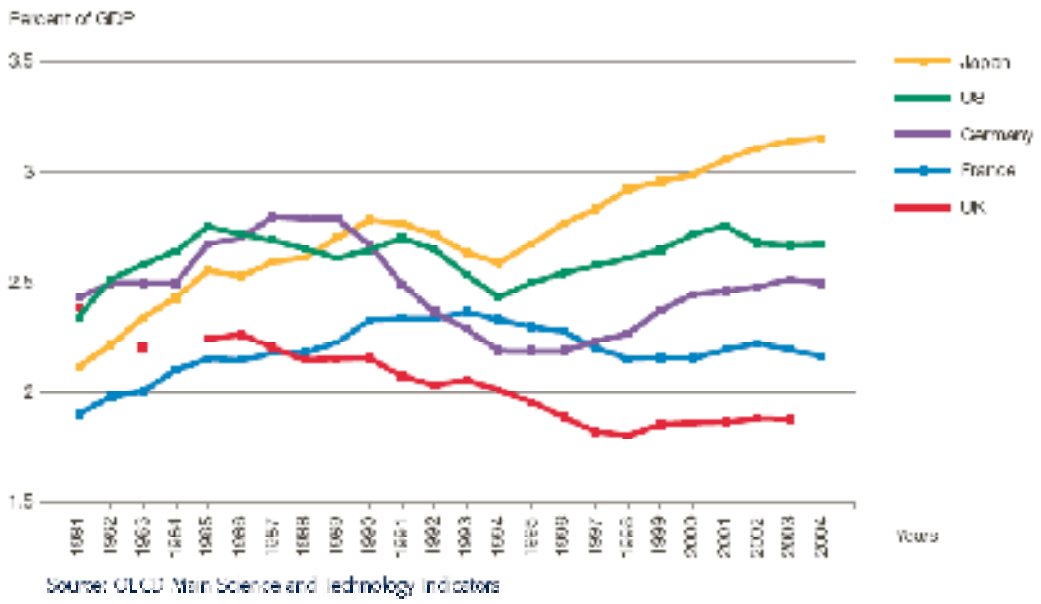


Figure 5: Gross Domestic Expenditure on R&D

2.3.6 Transition to a 'Low-Carbon Economy'

The low carbon economy (i.e. the need to tackle climate change through a broad range of coordinated economic, industrial and social actions) presents the UK manufacturers with a substantial challenge in reducing their carbon emissions. However, it is also a major opportunity to innovate new products and services to meet the demand for low carbon goods and services, which will be stimulated by the need for greater environmental efficiency across all industries and the society at large.

Although the UK ME sector has been actively involved in the definition and development of the future "green" agenda, this area is still regarded as being in early stages of what could be a promising new market in the next 5-10 years.

2.4 Connection between ME and Higher Education

2.4.1 ME Teaching, Education and Research

Manufacturing engineering has traditionally been a popular subject within the UK HEIs, with around 60 such institutions offering engineering and manufacturing courses.

The demand for degree courses has traditionally been high, increasingly from overseas students, wishing to take advantage of the UK's mature teaching methodology, international reputation and infrastructure, as well as high-quality courses, staff (many of whom are drawn directly from the industry), and traditional links with regional manufacturing firms and the business sector.

The in-flux of overseas students has also helped to compensate for the drop in demand from domestic students in the last decade. Figure 6 lists the highest ranking universities offering degree and post-graduate level courses in manufacturing engineering.

Aston	Bath	Bristol	Brunel	Buckinghamshire New
Cambridge	City	Coventry	De Montfort	Derby
Glasgow	Hertfordshire	Imperial College	Kingston	Leeds
Liverpool	Liverpool John Moores	London South Bank	Loughborough	Manchester
Manchester Metropolitan	Newcastle	Northumbria	Nottingham	Plymouth
Portsmouth	Queen Mary, London	Queen's Belfast	Salford	Sheffield
Southampton	Staffordshire	Strathclyde	Surrey	Sussex
Swansea	Ulster	UWIC, Cardiff	West of England	

Figure 6: Leading UK Universities Offering Manufacturing Engineering Courses [25]

The main ME courses on offer can be categorised into:

- Diplomas (Dip).
- Undergraduate Degrees at Bachelor Level (BSc, BEng).
- Postgraduate Level Degrees – Masters (MSc, MEng), Doctorate (PhD/DEng).

The courses vary in length with diplomas lasting up to two years; undergraduate degrees between 3 and 4 years; and full-time postgraduate masters courses typically lasting 1-2 years; with up to 4 years for a doctorate.

In addition to the above, many universities offer courses that combine industrial placements with academic studies. These are termed 'sandwich' courses, combining intermittent periods spent by the students at one or more industrial partners on real-life assignments. A number of universities also offer tailor-made courses (including MBA courses) for mid to senior management of businesses and companies. These courses combine part-time and evening tuition with on-the-job coursework. Cambridge, Oxford, Warwick, Bristol, London Business School, Manchester and The Open University have been among the pioneering universities in this area.

The fee levels vary according to the institution, the category of student (Home, EU or overseas), the social background and any sponsoring company's commitment regarding supporting the student under a trainee placement or a scheme such as Shell Step [24].

2.4.2 Impact of HEI Policy and Research on ME

The current UK policy for advanced research is viewed by many in the industry and research community as being too US-centric, with the risk that developments in the small, high-tech and upcoming countries might be missed.

According to the most recent studies and surveys of industry and academia [19, 20, 21], too much emphasis is placed in the research community on the US model of research, with numerous disciplines seeking to conform to the US norms, rather than arguing the case for a wider definition of good and rigorous research. Whilst the issue of achieving the right balance between research objectives, investment and outcomes is clearly a complex topic, the UK may be at a risk of weakening its own research base by ignoring the traditional strength of some of the European research models.

Figure 7 shows that the amount of knowledge transfer and technology exploitation by UK universities is gradually increasing. And although the UK still has a world-class science base [22], there remains a significant gap in translating the innovative ideas and research outcomes into successful mainstream commercial products or services.

Knowledge Transfer Indicator	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	% Change 2000/1 to 2005/6
No. of new patent applications filed by HEIs	896	960	1,222	1,306	1,649	1,537	**72**
No. of patents granted	250	196	377	463	711	576	**130**
No. of licensing agreements	728	615	756	2,256	2,099	2,699	**271**
Income from licensing intellectual property [£ million]	18	47	37	38	57	58	**222**
Income from business (value of consultancy contracts) – [£ million]	104	122	168	211	219	236	**127**

Figure 7: Higher Education Konwledge Transfer Indicators [23]

Through a gradual process of realisation of the importance of high-quality research and innovation that bears a high-degree of relevance to business and industry, the UK is starting to leverage its world class science and technology base. The Higher Education Innovation Fund and the Public Sector Research Exploitation fund have facilitated more focused investment in improving the capacity in universities and public laboratories to work with business and commercialise their research.

There appears to be some evidence that UK businesses are benefiting from improved interactions with universities. One aspect of this is evident in the number of licensing agreements and total intellectual property (IP) licensing income for UK universities. The figure has increased by more than 200 per cent between 2000/1 and 2005/6 (Figure 7).

Intermediaries such as the UK Research Councils are also engaged in promoting greater collaborative research with business and the Technology Strategy Board (TSB)

is also supporting companies to work with the research base through its Knowledge Transfer Partnerships (KTP) and Knowledge Transfer Networks (KTN).

Despite the positive progress being made in improving the interaction and collaboration between HEIs and the industry, there is evidence within the SMEs that many of the programmes and investment schemes are administered on a day-to-day basis by government officials or proxy organisations that do not have a full appreciation of the needs and practical constraints facing the UK SMEs. Moreover, many proxy organisations do not have a long-term commitment to the SME sector, but merely perform a care-taker or 'funding manager' role. The result is missed opportunities and reduced impact of the potential success of such schemes.

Another significant challenge facing the link between the UK HEIs and ME sector is the extent and definition of collaboration between the science base and the industrial community. To date, the dominant model of scientific research has been the linear model – i.e. that investment in science and technology is aimed at creating knowledge that can be commercialised, and hence generate economic value. Hence, the flow of knowledge from the science community to the business sector is increasingly seen as being outdated. Instead, a newer concept is emerging based on the premise that both communities interact with and inform one another; and that processes of knowledge exchange need to be explored further in order to generate a larger impact on innovation.

2.5 Best Practices

Owing to its advanced state of the ME industry, the UK has succeeded in establishing a number of world-leading schemes and collaborative partnerships that go beyond the traditional supply-chain relationships. These schemes and synergistic partnerships are beginning to yield significant benefits in terms of attracting further foreign investments and creating new ways of working and collaborating for ME firms.

The following sections profile the main highlights of the best practice approaches that have been adopted:

2.5.1 Manufacturing Research Centres

The University of Sheffield and Boeing have set up the Advanced Manufacturing Research Centre, along with over 20 other partners including Rolls Royce, Smiths, Messier Dowty – and from Japan Mori Seiki and Mitutoyo. This is a concrete example of how leading companies in the ME sector are forming international collaborative networks to share know-how, R&D and investment.

The development and prototyping costs of a new technology or production can be a significant barrier to investment in the development of new products, especially for smaller manufacturers. The Knowledge Transfer Networks (KTNs) are enabling manufacturers and their supply chains to work with academic institutions to prove concept, demonstrate and exploit new products. The centres that are leading these activities include the Advanced Manufacturing Park in Yorkshire, the Advanced Forming Research Centre near Glasgow, the National Composites Network and the Innovative Manufacturing Research Centre.

In 2010 Advantage West Midlands and the East Midlands Development Agency are planning to deliver a new addition to this network, the Manufacturing Technology Centre at Coventry, with an investment of £30 million. The MTC will focus on the development and application of high integrity joining and fabrication, expertise in tooling, automation and operational performance with industrial scale pre-production and demonstration facilities. Current estimates suggest that over 10 years the Centre could see investment of £130 million in business-led applied research and its exploitation.

2.5.2 Manufacturing Advisory Service

In 2004, the UK Government expanded the role of the Manufacturing Advisory Service (MAS) to help manufacturing businesses compete in existing and new markets. The service is available across all regions of the UK. MAS is offering free or subsidised advice on improving business and operational efficiency and effectiveness through the introduction of lean manufacturing techniques. To date, it is estimated that businesses following MAS' advice have saved over £500 million.

2.5.3 National Skills Academies

National Skills Academies that include a National Skills Academy for Manufacturing, has been established by the UK government to accelerate the skills development to match the advances in technology, trade liberalisation and the rise of emerging economies, which are enabling UK manufacturers increasingly to unbundle different stages of the production process.

Moreover, UK manufacturers are specialising, not only in the fabrication of physical components, but in accompanying knowledge intensive services, such as research and development, inventory management, quality control, and other professional and technical services.

2.5.4 Industry and SME Clusters

Clustering involves geographic concentrations of inter-connected companies, specialised suppliers and service providers and institutions such as universities that collectively support specialisation and create critical mass to attract investors and buyers.

To date, the existing clusters in various regions in the UK have demonstrated significant benefits for bringing customers and suppliers together. They have also helped create favourable conditions for producing high quality specialist support services and fostering close links with universities, resulting in industry relevant courses, research programmes and spin offs.

3 Quality and Quantity of Contact Bodies

3.1 Selection of Contact Bodies

Given the scope and timescales of the IRMA project, it was decided that a broad sample of the Contact Bodies would be drawn from the ME sector. This was to facilitate an initial engagement with the wider cross-section of organisations, from which a narrower selection could be made later, depending on the results and initial conclusions.

The following organisations were therefore approached and invited to participate in the IRMA online survey.

3.1.1 Higher Education Institutes

- Birmingham Central University
- London Metropolitan University
- Manchester University
- Southampton University
- Salford University
- University of Hertfordshire
- University of Warwick
- University of West of England

3.1.2 Manufacturing Enterprises

- Aerogistics
- Agie Charmilles
- Airinmar
- AWS Electronics
- BAE Systems x 3 BUs
- Cobra Beer
- Delcam Plc
- ETB
- Finmeccanica
- Gould Alloys
- Group Rhodes of Wakefield

- John Huddleston Engineering
- Laing O'Rourke
- Lancaster Int'l
- MB Aerospace
- Metals UK
- NIS Ltd
- Quest Vitamins
- Replica
- RFD Beaufort
- Rickard Green
- RLC Group
- Rolls Royce
- Silcoms
- Standard Aero
- Sue Steadman
- The Waterjet Group
- Trac Group

3.1.3 Intermediaries

- Heathrow City Partnership
- Lancashire County Council Policy Unit (OCE)
- Lifelong Learning Council
- London Development Agency
- Nesta
- North-West Aerospace Alliance
- Northwest Development Agency
- Royal Aeronautical Society

4 Questionnaires

Please refer to the IRMA website (http://www.irmaproject.eu/moodle/) for the three types of questionnaires utilised for each organisation category listed in Section 3.

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