West Midlands Regional Observatory

Regional Skills Partnership
Cross-cutting Issues 2006

Innovation: Skills as a Driver of Change

West Midlands
Regional
Observatory

Regional Skills Partnership
Cross- Cutting Issues 2006 - Innovation: Skills as a Driver of Change

Draft 3.0

19th May 2006

Document Information

Title:	Regional Skills Partnership Cross-Cutting Issues 2006 – Innovation: Skills as a Driver of Change
Creator:	Skills Research Team, West Midlands Regional Observatory, andy.phillips@wmro.org
Publisher:	West Midlands Regional Observatory, enquiries@wmro.org
Contributor:	Dr. Barbara Tilson, BCT Research Associates (BCTRA) E-mail: btilson.bctra@blueyonder.co.uk
Date created:	19th May 2006
Status:	Draft 3.0
Document Contact:	Andy Phillips, Head of Skills Research, West Midlands Regional Observatory, andy.phillips@wmro.org

(A full set of Document Information is available at the back of this document).

List of Contents

1 INTRODUCTION 7

2 KEY FINDINGS 8

3 EXECUTIVE SUMMARY 10

3.1 INNOVATION PERFORMANCE 10
3.1.1 UK performance 10
3.1.2 West Midlands performance 11
3.2 SKILLS AS A KEY DRIVER OF INNOVATION 11
3.3 INNOVATION AND SKILL NEEDS IN KEY TARGET SECTORS 12
3.3.1 Manufacturing 12
3.3.2 Automotive 13
3.3.3 Medical and healthcare technologies 13
3.3.4 Construction and the built environment 14
3.3.5 Information and communication technologies 15

4 INNOVATION PERFORMANCE: THE UK AND THE WEST MIDLANDS IN AN INTERNATIONAL CONTEXT 16

4.1 NATIONAL AND INTERNATIONAL BENCHMARKS 16
4.2 REGIONAL BENCHMARKS 19

5 INNOVATION DRIVERS AND ENABLERS 23

5.1 ENTREPRENEURSHIP 24
5.2 LEADERSHIP 25
5.3 MULTI SKILLING AND CONTINUOUS LEARNING 26
5.4 THE EXTERNAL LABOUR POOL 26
5.5 CREATIVITY 27
5.6 CREATIVITY TECHNIQUES 27
5.7 SKILLS FOR SUCCESSFUL COLLABORATION AND NETWORKING 28
5.7.1 Clusters, learning and innovation 29
5.7.2 Skills for successful technology transfer networks 30

6 INNOVATION AND SKILL NEEDS IN KEY TARGET SECTORS 31

6.1 MANUFACTURING 32
6.1.1 Size and scope of the sector 32
*6.1.2 Innovation essentials ..... **Error! Bookmark not defined.***
6.1.3 New product development 32
6.1.4 New materials and technologies 33
6.1.5 Smart materials and technologies 34
6.2 AUTOMOTIVE 34
6.2.1 Size and scope of the sector 34
6.2.2 Innovation and skills issues 35
6.2.3 The digital factory 36
6.2.4 Leadership and management 37
6.3 MEDICAL AND HEALTHCARE TECHNOLOGIES 38
6.3.1 Size and scope of the sector 38
6.3.2 Innovation and skills issues 39
6.3.3 Case study: medical device manufacturers in Coventry & Warwickshire 40
6.3.4 Case study: skill self development by a Staffordshire start up firm 41
6.3.5 Skill needs of biotechnology firms 42
6.4 CONSTRUCTION AND THE BUILT ENVIRONMENT 43
6.4.1 Scope of the sector 43
6.4.2 New materials and technologies 43
6.4.3 Skill needs for innovation 44

6.4.4 Skill needs for ICT 45
6.4.5 Skill needs for off-site manufacturing 45
6.4.6 Skill needs for building services 46
6.5 INFORMATION AND COMMUNICATION TECHNOLOGIES ..... **ERROR! BOOKMARK NOT DEFINED.**
*6.5.1 Size and scope of the sector ..... **Error! Bookmark not defined.***
*6.5.2 Innovation and skills issues ..... **Error! Bookmark not defined.***
*6.5.3 Case study: Silicon Valley: the need for generic skills. **Error! Bookmark not defined.***

1 Introduction

This report provides explores the role of skills as an important 'input factor' to innovation. Specifically, the report considers:

- The innovation performance of the UK and the West Midlands region relative to international competitors
- Skills as a driver of innovation and the role, for example, of entrepreneurship, leadership, multi-skilling, creativity and networking and collaboration
- Specific skill needs support innovation within the key target sectors identified in the Region by the Innovation Technology Council, namely:
- Manufacturing
- Automotive
- Medical and healthcare technologies
- Construction and the built environment
- Information and communication technologies

This document, which focuses specifically on the skills dimension of innovation, is underpinned by a much more detailed report, prepared by Barbara Tilson, BCT Research Associates on behalf of the West Midlands Regional Observatory. This looks at skills alongside many other factors impacting on innovation and highlights potential policy implications and priorities for further research.

2 Key Findings

Innovation can support economic competitiveness, growth and regional prosperity, acting as the 'transformational element' in the economy. Key routes to innovation are the exploitation of an invention, adaptation of a technology or idea from another sector, reconfiguration of existing products and services or a completely new business approach.

Given the concentration of manufacturing activity in the West Midlands comparatively high rates of innovation would be expected relative to the rest of the country. However:

- R&D expenditure of West Midlands businesses has lagged behind other regions in recent years
- The proportion of the working population deemed to be 'entrepreneurially active' is falling

The West Midlands also lags behind other regions in relation to other 'innovation input' factors, notably limited access to appropriate skills. Skills that underpin innovation include:

- Entrepreneurship skills: encouraging creativity, risk taking and an innovative 'ideas culture'
- Leadership skills: the motivation, inspiration and empowerment of others
- Multi-skilling: people becoming adept in a range of roles, adaptable to changing circumstances and open to new ideas
- Creativity - which is based on openness to new thinking, sharing of knowledge, an unconventional but results driven approach, the sharing of knowledge and an effective flow of information
- Skills in networking and collaboration

A range of specific skills and attributes to support innovation have been identified in the key target sectors identified in the Region by the Innovation Technology Council (see Table 1).

Table : Skill Needs in key target sectors	
Target Sector	**Skills and attributes for innovation**
Manufacturing	**New product development and introduction**: encouraging and supporting others, a curiosity to learn and try new things, balancing risk against benefits, constructively challenging the status quo **Developing 'smart' consumer products**: new horizon watch, market appraisal, competitor analysis, technology and knowledge transfer, product development expertise and leadership and management of innovation
Automotive	**Technical skills within the supply chain**: project engineering, specialist ICT including simulation software, E-business **Developing the 'digital factory'**: materials technology, micro-manufacturing, virtual engineering, simulation, advanced materials, CAD, quality assurance **Leadership and management**: strategic, programme, project and supply chain management, motivation, coaching and team building, networking, negotiation and developing customer-supplier relationships
Construction & the built environment	**ICT**: procurement and logistics, the development and use of smart technologies and robotics **Modern construction methods**: modular wiring in preassembled pods, dealing with flat pack buildings **Building services**: system design and pumping, water treatment, power flushing, energy efficiency and sustainability, photovoltaic energy sources and environmental technologies
Medical & healthcare technologies	**Among existing SMES**: marketing and market knowledge, knowledge of the NHS procurement process, business development, training and recruitment **To attract additional start up and growing companies**: business management and development, legal skills, commercial acumen, supply chain, production and project management, health and safety knowledge, knowledge of medical compliance/regulations
Information & communications technology	**Nationally**: systems design, integration, installation and ergonomics, programming, software development, business analysis, media creation, data analysis, database design **Specifically within the Region**: Java, Action Script and broadband applications

3 Executive Summary

Innovation can support economic competitiveness, growth and regional prosperity, acting as the 'transformational element' in the economy. Key routes to innovation are the exploitation of an invention, adaptation of a technology or idea from another sector, reconfiguration of existing products and services or a completely new business approach.

Innovation can be radical (denoting a step change) or incremental (via many small modifications). Innovation is produced within an organisation through four creative phases: idea generation, coalition building (where colleagues are persuaded to support the ideas), the realisation of ideas and their transfer or dissemination.

3.1 Innovation performance

3.1.1 UK performance

While the UK continues to have a world class science base, with the highest proportion of companies investing in R&D in the world outside the US and Japan, R&D investment is weak in key growth areas globally such as IT hardware and automotive and much investment is not directly linked to innovation. Innovation in the UK is constrained by:

- Significant skill deficiencies relating to the attainment of vocational qualifications and management competency
- A lack of critical mass within the UK's scientific and technical workforce: while numbers of scientists and engineers have increased steadily in recent years, numbers of key supporting staff in technical/associate professional roles such as technicians, laboratory assistants and draughtsmen have fallen significantly.

- Limited networking and collaboration among UK 'innovation-active' businesses: while they are likely to collaborate with customers or suppliers, they are less likely to be working with other businesses in their group, competitors, consultants, higher education institutions or government research organisations.

3.1.2 West Midlands performance

Comparatively high rates of innovation would be expected in the West Midlands given the concentration of manufacturing activity, which is the highest in the country. However, the R&D expenditure of West Midlands businesses has lagged behind other regions in recent years and the proportion of the working population deemed to be 'entrepreneurially active' is falling.

While this partly reflects a relatively low expenditure on R&D, the West Midlands also lags behind other regions in relation to other 'innovation input' factors, notably limited access to higher level skills.

3.2 Skills as a key driver of innovation

Key skills and aptitudes that the Region's 'innovation-active' organisations require to develop and grow include:

- Entrepreneurship skills: the development of an 'ideas culture' blending risk-taking and creativity with sound management
- Leadership skills: the motivation, inspiration and development of others
- Multi-skilling; people becoming adept in a range of roles, becoming adaptable to changing circumstances and becoming open to new ideas

Creativity, which creates the basis of innovation, can occur at a personal, team, or organisational level. Personal characteristics include openness to new thinking and experiences, being unconventional and having strong motivation. At a team level access to and the sharing of knowledge, a results driven approach and the existence of good role models are critical. At an organisational level an effective flow of information is vital in order to ensure that ideas generated can be communicated and developed. This can be encouraged by moving from hierarchical to flatter organisational structures.

Greater competition and the need for high end product strategies, complex product specifications and a diversity of competencies and disciplines, is placing more emphasis on networking, collaboration or technology transfer. Relationship building skills are critical if businesses are to make the most of their networking activities. Inter-firm relationships can be either vertical (i.e. involving companies in the same supply chain) or horizontal (whether in different sectors, or competing in the same market).

3.3 Innovation and skill needs in key target sectors

A range of specific skill needs to support innovation have been identified in the key target sectors identified in the Region by the Innovation Technology Council.

3.3.1 Manufacturing

Research has highlighted six approaches/behaviours or 'innovation essentials' for manufacturing companies looking to be innovative and achieve competitive advantage: inspirational and tenacious team leadership, collaboration on breakthrough products and processes, hard work to deliver incremental improvements, continuous performance improvement, enthusiasm for building deep relationships and empowered and committed people.

A range of approaches have been identified as important to support new product development and introduction, notably finding ways to overcome obstacles, encouraging and supporting others, a curiosity to learn and try new things, balancing risk against benefits, acting within the limits of individual authority, constructively challenging the status quo and recognising the achievements and success of others.

In order to exploit opportunities to develop 'smart' consumer products, which research has identified as a market largely unexploited and ripe for attack, manufacturers need to develop skills associated with new horizon watch, market appraisal, competitor analysis, technology and knowledge transfer, product development expertise and leadership and management of innovation. However a range of barriers to investment in the required skills and expertise, particularly among more mature manufacturers, include:

- A 'near market' view with a tendency for firms to be entrenched around core product lines
- A short term financial view, with concerns about the high costs of investment and the time taken for commercial realisation

3.3.2 Automotive

The UK supply chain is well below world class standards, notably with regard to product quality and technical innovation. If the gap in performance is to be addressed then firms need access to skills in design engineering, project engineering, specialist computer solutions for manufacturing and simulation software and E-business. More generic skills are also required relating to communication, procurement, logistics, supply chain management, international law, foreign languages and culture, marketing, people skills such as motivation, coaching and team building, problem-solving and negotiation.

Key automotive manufacturers worldwide are exploring the concept of the 'digital factory'. To turn the concept into a reality advanced and high level skills in materials technology, micro-manufacturing, virtual engineering, simulation, advanced materials, CAD and quality assurance are required.

Research has also highlighted a need to address weaknesses in leadership and management within the automotive supply chain. In particular, areas in need of improvement include programme and project management, strategic management, team working – both among the workforce and at director and senior management level, communication, networking, negotiation and developing customer-supplier relationships and motivation of staff.

3.3.3 Medical and healthcare technologies

Most West Midlands medical technology firms are SMEs and many face barriers to innovation based on limitations in their knowledge and expertise relating to:

- Market knowledge and the ability to gain access to new markets, both domestically and in key export markets in Europe, North America and the Pacific Rim.
- Marketing – time to market and the integration of technical solutions with strategic marketing are more important that manufacturing or technological advances alone
- The NHS procurement process which tends to be risk averse and cost constrained. The process is evolving, however, and medical technologies firms need to be pro-active and enter a dialogue with the NHS.
- Business development, recruitment and retention and the acquisition of appropriate workforce skills

Biotechnology firms in the West Midlands tend to be small start-ups or science park based university spin-outs. If the Region is to attract additional start up and growing biotechnology companies access to the skills required will be vital. These include:

- Scientists with business management and development skills
- Legal skills relating to negotiating intellectual property rights and patent filing
- Bringing research to commercialisation
- Dealing effectively with supply chains, including ensuring that quality standards are met
- Production management
- Project management for outsourced production
- Health and safety knowledge
- Knowledge of medical compliance/regulations

3.3.4 Construction and the built environment

The ability of West Midlands construction firms to embrace new methods and techniques is constrained by gaps in inter-personal skills in team working, customer handling, and communication. There are also critical deficiencies in technical and practical skills and management skills. These deficiencies create problems for the introduction of new working practices, as well as new product or service development. They also prevent the achievement of efficiencies which would bring down operating costs, improve performance and help meet customer targets.

The use of more sophisticated information and communication technologies, and ICT use across all functions, is leading to emerging skill needs in terms of internet-based communication methods and knowledge and data transfer, procurement and logistics, supply chain management and partnership, the development and use of smart technologies, robotics and the construction and fitting out of 'intelligent' buildings.

The take-up of modern methods of construction involving pre-fabrication such as wall systems and doors, preassembled bridges and pre-cast building foundations promises to revolutionise the construction and building services industries, certainly for new build and perhaps for a degree of repair work. Skilled trade staff will need to adapt to new working environments and practices which could include modular wiring in preassembled service and distribution pods and dealing with flat pack buildings.

Manufacturing innovation in products relevant to building services engineering has clear skill impacts for installation and maintenance. While there already emerging skill needs in relation to system design and pumping, water treatment, power flushing, building regulations, energy efficiency and sustainability. New skills will also be required that are associated with evolving technologies such as photovoltaic energy sources and environmental technologies.

3.3.5 Information and communication technologies

The role of ICT professionals is forecast to change from that of technology support to business application. ICT professionals with expertise in systems architecture and integration, networking, web design, and security will be in continued demand. However research highlights significant limitations in the supply of ICT skills:

- Nationally 40% of firms are facing recruitment problems, which are constraining their ability to develop new products and services. Workforce skill gaps are most common in relation to design and engineering and product portfolio management. Among ICT professionals there are particular deficiencies relating to systems integration, testing and design and installation. There are also issues associated with programming, software development, business analysis, media creation, data analysis, database design and systems ergonomics.

- At 9% the proportion of West Midlands firms citing skill deficiencies within their workforces is well above the national average. Some 41% of IT professionals in the Region have skill deficiencies compared with 36% nationally. There are specific issues in the Region relating to Java, Action Script and broadband applications. Staff also need to develop more generic, non-technical skills to support innovation, notably relating to customer service, communication, social skills including reliability, team working and collaboration, taking initiative, confidence and assertiveness, risk assessment and business awareness.

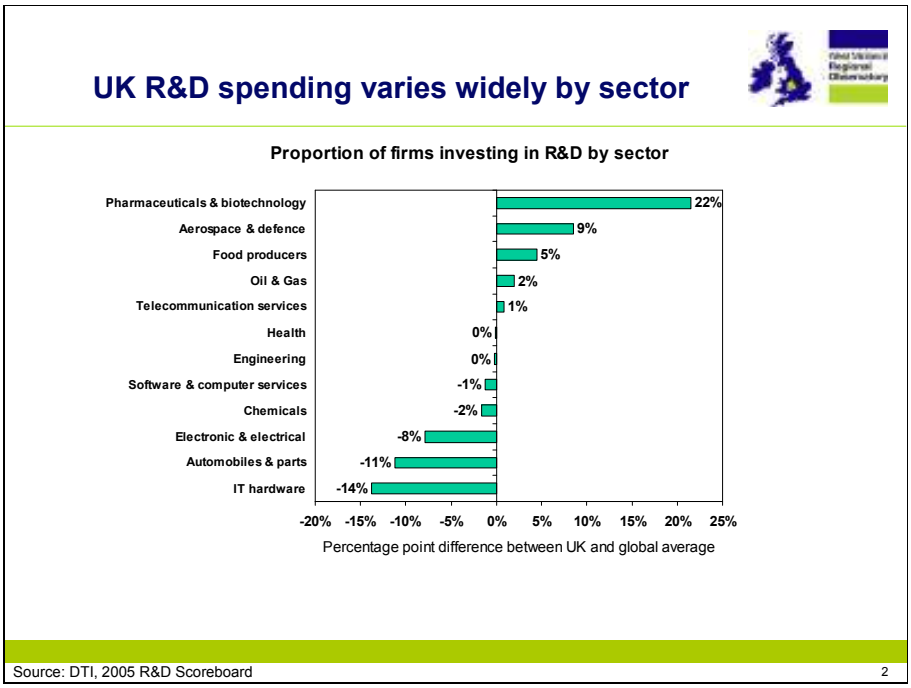
4 Innovation performance: the UK and the West Midlands in an international context

4.1 National and international benchmarks

- The UK continues to have a world class science base, with the highest proportion of companies investing in R&D in the world outside the US and Japan1. However:
- R&D expenditure is strong in pharmaceuticals and aerospace but weaker in IT hardware and automotive, where expenditure globally has grown particularly strongly in recent years
- Foreign owned companies account for a significant proportion of UK R&D expenditure. Investment by UK-owned companies is much more limited
- Much of the investment is not directly linked to innovation, which may be a key contributory factor in the significant productivity gap between the UK and the US
- Innovation in the UK is constrained by significant skill deficiencies relating to the attainment vocational qualifications and management competency2
- The UK's scientific and technical workforce lacks critical mass. While numbers of scientists and engineers have increased steadily in recent years, numbers of key supporting staff in technical/associate professional roles such as technicians, laboratory assistants and draughtsmen have fallen significantly3. The number of professionals and technicians in the UK workforce is one of the lowest in Europe4.

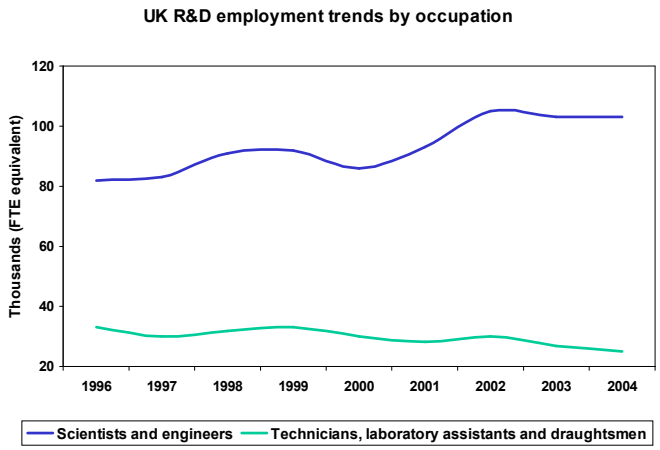
[1] DTI R&D Scoreboard 2005
[2] More detail is provided in our cross cutting issues paper on management and leadership
[3] National Statistics: Research & Development in UK Businesses 2004
[4] OECD Science, Technology and Industry Scoreboard 2005

- While the UK has a more entrepreneurial culture than many of its European competitors, it lags significantly behind the US[5]
- Those UK businesses that are innovation-active are not exploiting the potential for collaboration to its fullest extent. While they are likely to collaborate with customers or suppliers, they are less likely to be working with other businesses in their group, competitors, consultants, higher education institutions or government research organisations



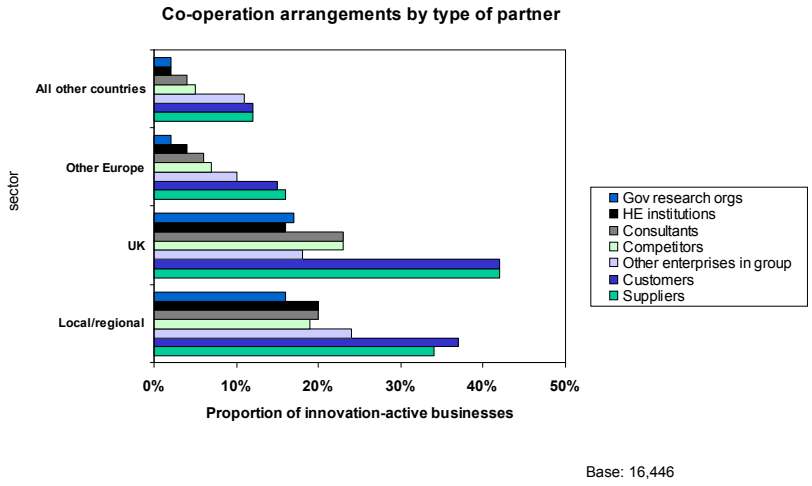
[5] DTI and HM Treasury: 2005 Productivity and Competitiveness Indicators

More scientists & technicians but numbers of support staff have fallen



Source: National Statistics 3

Innovative UK businesses are not fully exploiting the potential for collaboration



Base: 16,446

Source: Robson S and Ortmans L, First findings from the UK Innovation Survey, 2005, 4

The European Innovation Scoreboard compares the innovation performance of European regions based on seven indicators:

- Tertiary education.
- Participation in lifelong learning.
- Employment in medium-/high-tech manufacturing.
- Employment in high-tech services.

- Public R&D expenditure.
- Business R&D expenditure, and
- High-tech patents.

While northern European countries are the best performers, within the UK only the East of England (4th) and the South East (8th) come within the top 10. The West Midlands is the third best performer in the UK and the 29th best performer in Europe.

Table 1: European Innovation Index: UK regions in the top 50 rankings

Region	**Country**	**Rank**
Stockholm	Sweden	1
Uusimaa	Finland	2
Noord-Brabant	Netherlands	3
Pohhois-Suomi	Finland	4
Eastern	UK	5
Ile de France	France	6
Bayern	Germany	7
South East	UK	8
Comunidad de Madrid	Spain	9
Baden-Württemberg	Germany	10
South West	UK	14
West Midlands	**UK**	**29**
North West	UK	36
Scotland	UK	38
London	UK	41
East Midlands	UK	44

OECD, Local Governance and the Drivers of Growth, 2005

4.2 Regional benchmarks

Comparatively high rates of innovation would be expected in the West Midlands given the concentration of manufacturing activity, which is the highest in the country[6]. However, the Region lags behind in relation to a number of facets of innovation activity:

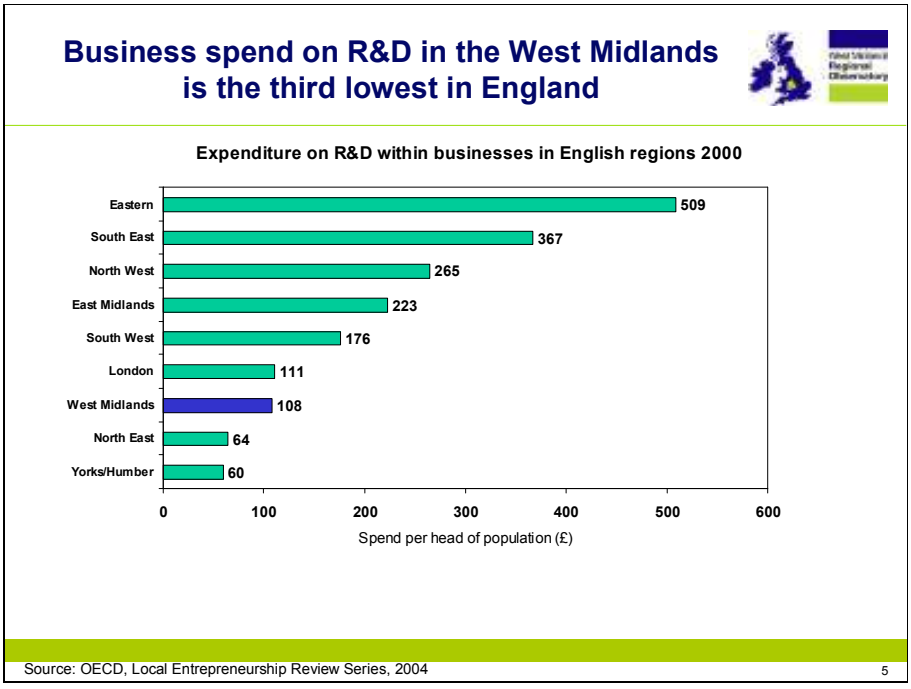
[6] OECD Local Entrepreneurship Review Series 2004

- The R&D expenditure of West Midlands businesses has lagged behind other regions in recent years. In 2000 spending was just over £100 per head of population which compares with more than £500 in the East of England and nearly £370 in the South East.

- While the proportion of businesses involved in process innovation is above the national average and one of the highest in the country, the West Midlands lags behind the East Midlands and the South East in terms of the generation of novel products.

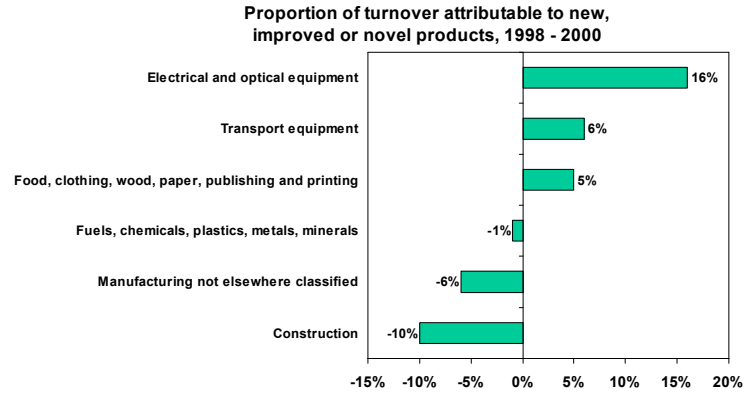
- Within the Region the incidence of innovation is greatest in certain manufacturing industries. The proportion of turnover attributable to the development of new or novel products is 16 percentage points above the national average for electrical & optical equipment and 5 percentage points above the national average for food, clothing, wood, paper, publishing and printing.

- While the amount of entrepreneurial activity[7] in the Region has historically been close to the national average, it has fallen in recent years. In 2004 5% of the Region's working age population were entrepreneurially active down from nearly 7% in 2003.



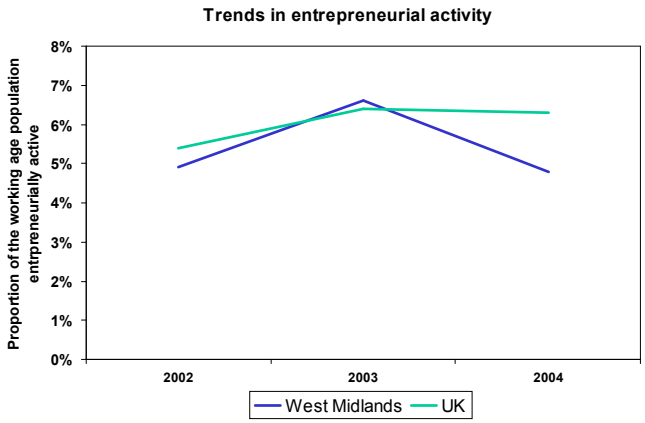
[7] defined as the proportion of the working age population actively involved in starting a business or who own or manage a business that is less than 3 and a half years old

Within the Region the incidence of innovation is greatest in some manufacturing industries



Source: Lud M, Regional Competitiveness & State of the Regions, April 2005, citing CIS3, 2001 6

Entrepreneurial activity has dipped markedly in the Region



Source: Lud M (DTI), Regional Competitiveness & State of the Regions, April 2005 7

While this partly reflects a relatively low expenditure on R&D, the West Midlands also lags behind other regions in relation to other 'innovation input' factors, notably limited access to higher level skills, which constrains the ability of firms to innovate[8]. A relatively limited supply of graduates within the regional working age population reflects both:

[8] OECD Local Entrepreneurship Review Series 2004

- A ‘drift’ of graduates from the West Midlands to other parts of the country where the knowledge economy is better developed[9]
- Issues associated with the retention of foreign students, who account for more than a quarter of doctoral enrolments and are more likely than UK students to depart once their studies are completed[10]

[9] More detailed analysis is available in our cross cutting issues paper on the knowledge economy
[10] OECD Science, Technology and Industry Scoreboard 2005

5 Innovation drivers and enablers

There has been extensive investigation of how innovation can be stimulated and supported. The EU has highlighted the following key routes to innovation:

- The exploitation of an invention.
- Adaptation of a technology or idea from another sector.
- Reconfiguration of existing products and services, or
- A new business approach

Innovation can be radical (denoting a step change) or incremental (via many small modifications). According to Kanter (1996, 1997) innovation is produced within an organisation through four creative phases:

- Idea generation.
- Coalition building (where colleagues are persuaded to support the ideas).
- The realisation of ideas, and
- Their transfer or dissemination

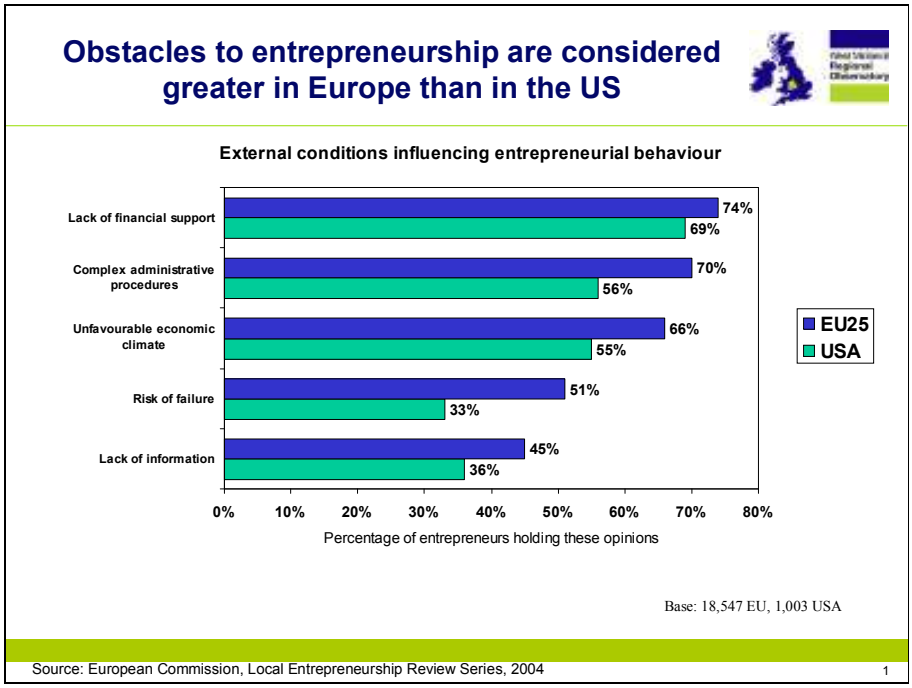
While the components of innovation are often cross-cutting, they can be grouped under three headings:

- Human resources factors - people's qualities, skills and engagement in the innovation process
- Technological factors such as research and development, horizon watch and technology transfer, also related activities such as market analysis and collaboration
- Performance factors including productivity, financial acumen and profitability, investment, and customer service

This report focuses particularly on human resources factors and the skills required to engage in the innovation process.

5.1 Entrepreneurship

Entrepreneurship skills relate to the development of an ideas culture and the tools to identify and exploit an opportunity. Entrepreneurship is defined as: 'The mind set and process needed to create and develop economic activity by blending risk-taking, creativity and/or innovation with sound management, within a new or an existing organisation.' [11] However, Evidence suggests that the kind of supportive and non-bureaucratic external environment that encourages and facilitates entrepreneurship is less evident in Europe than it is in the USA.



[11] Euractiv, The EC's February 2004 Action Plan on Entrepreneurship, summary, 31 January 2006

5.2 Leadership

'Leadership is required to create a climate where innovation thrives.'[12] The transformational/transactional leadership model of Bass and Avolio[13] sees leaders as role models; as motivating and inspiring others; encouraging innovation; attending to people's development needs; providing rewards for attaining performance targets; and taking action when things are not going to plan. The leader's role is as designer, teacher and steward, designing the learning processes so that people can deal productively with the issues they face and develop their expertise.[14] Leadership occurs at all levels of an organisation, from the boardroom to the shop floor – and accordingly leadership skills should be developed throughout.[15] However 'too often, the training of managers is either neglected or an early casualty of cost cutting, because it is seen as a cost rather than an investment.'[16]

The CRIC (2005) report for the DTI on innovation and skills notes that the 'systemic integration' all-inclusive model of innovation which involves the skills of the entire workforce has superseded the 'science push' model that suggested that innovation is produced by a small elite possessing degree and higher level science and engineering skills. The workforce is now seen as an essential repository of knowledge, expertise and ideas. Motivating and engaging their active participation in innovative activity and performance improvement is vital. The kind of human resources practices which stimulate high performance, knowledge intensive, behaviours include[17]:

- High employee involvement practices including self managed or self directed teams, cross functional teams, problem solving groups, quality circles and total quality management, continuous improvement techniques
- Human resource practices such as sophisticated recruitment practices, performance appraisals and review of staff training needs, feedback on job performance, continuous skill development programmes, training to facilitate multi-skilling, mentoring, quality assurance schemes and business excellence models
- Reward and commitment practices such as performance related pay, profit sharing, flexible working, flexible job descriptions and rewarding softer skills like good people management as well as hard financial measures

[12] Munshi et al, Advanced Institute of Management (2005)
[13] Advanced Institute of Management (2005), citing Bass and Avolio
[14] Advanced Institute of Management (2005), citing Senge
[15] Such issues were raised in a 2005 automotive survey by Tilson B, BCTRA, for Skills4Auto.
[16] Chartered Management Institute
[17] DTI & CIPD (2005), Purcell (2004), Ashton & sung (2002), Swart & Kinnie (2002)

5.3 Multi skilling and continuous learning

Job rotation and multi-skilling can contribute to improved business performance and the innovation process as people become adept in a range of operations, become adaptable to changing circumstances and open to new ideas and develop their skills and creativity. Continuous learning principally takes place in the workplace via:

- Informal learning by doing.
- Learning by interacting
- Coaching[18]

5.4 The external labour pool

The availability within the external labour market of the right skills at the right level of competence is crucial for the promotion of innovation. Talent attraction and retention is a major competitive factor for innovation and economic growth in the knowledge economy.[19]

The mobility of the labour pool can also impact on innovation through exerting skill shortages in high-demand disciplines like biotechnology, materials science, chemistry, ICT, and engineering. Typically, specialist skills which are in short supply and are likely to command a high salary may be difficult for businesses to locate and retain, particularly SMEs. In addition, skills in ancillary occupations such as venture capital operations can also be in short supply and affect the ability to manage investments in innovative enterprises in new technological fields. [20]

Innovative firms can find that the skills they need are in short supply because training courses are not yet set up to produce the new skills they require. A leading edge firm which has produced a 'new to the world' innovation may find that specific skills may not exist in the labour force at all.[21] An additional problem can arise since workers may lack any personal incentive to develop the skills required of them because of a lack of demand for those specialist skills in the wider labour market and the conclusion that those skills would not tradeable.

[18] Hepworth et al, Regional Employment and Skills in the Knowledge Economy, undated (c.2005/6)
[19] Hepworth et al, Innovation in the East Midlands Knowledge Economy, 2005, citing Florida (2002)
[20] CEC, Innovation Policy, Brussels, 2003
[21] CRIC (2005), report for the DTI

5.5 Creativity

Creativity creates the basis of innovation, which, in its development, raises difficulties that must be solved, once again, by creativity. The creative class has a central role in modern economies. Its rise underpins the importance of skills and learning as a key element in the innovation process and the competitiveness of local economies with a highly skilled and educated workforce.[22]

Creativity can occur at a personal, team, or organisational level:

- Personal characteristics of creative people include openness to new thinking and experiences, being unconventional, strong motivation, the possession of specialised knowledge and skills, and a love of their work
- At a team level access to and the sharing of knowledge is important, as well as applying knowledge and information to generate new knowledge. Creative activity can be stimulated by a results driven approach and the existence of good role models.
- At an organisational level an effective flow of information is vital in order to ensure that ideas generated can be communicated and developed.[23] This can be encouraged by organisational changes such as moving from hierarchical to flatter organisational structures to increase communication between workers and the existence of good interpersonal, influencing and relationship building skills among staff.

5.6 Creativity techniques

Everyone has the propensity to be creative via the use of proven techniques that can help them to move out of their normal problem solving mode and enable them to consider a wider range of alternatives[24]. Key techniques[25] include:

- Brainstorming.
- Story Boarding.
- Checklists.
- Mapping processes.

[22] Discussed in Hepworth et al, Innovation in the East Midlands Knowledge Economy, May 2005
[23] Sefertzi (2000); Hemlin (2002)
[24] Sefertzi (2000). INNOREGIO: dissemination of innovation and knowledge management techniques
[25] These are detailed in some depth in Sefertzi (2000), including various computer-based techniques.

- The excursion technique
- Computer techniques

Key outcomes can include:

- Innovation through the implementation of new product and process ideas
- Continuous improvement of products or services, and their higher quality
- Increased productivity and high performance
- Greater efficiency, rapidity and flexibility
- Research skills

A successful research environment is essential for the stimulation of innovation and requires[26]:

- Clear objectives
- A positive group dynamic
- Devolved leadership
- Flat and decentralised group structures
- Lively and supporting internal and external communications
- Local and international collaboration

5.7 Skills for successful collaboration and networking

The impetus of competition from producers in low wage countries is spurring British industry towards competing via high-end product strategies involving complex product specifications. A greater diversity of competences and disciplines is now needed for product and process innovation than a single enterprise, or even a single locality, can possess. This is spurring businesses to open up their knowledge creation processes and share intellectual property rights. Information and communication chains – and therefore innovation networks - are increasingly global and virtual.[27] This places added emphasis on the ability to collaborate and network successfully. Networking and collaboration can stimulate innovation between businesses because:

- Businesses learn from and do business with each other.

[26] Hemlin (2002)
[27] Welsh Economy Research Unit, 2005

- They are more likely to collaborate on strategic projects.
- This helps to build critical mass to better exploit commercialisation opportunities.[28]

Research confirms that businesses' objectives in networking are primarily to acquire new skills or knowledge.[29] This promotes and enables workforce learning and in that way contributes to their performance improvement. Other reasons include business development, accessing guidance and support, or developing business credibility. A major conclusion is that the possession of *relationship skills* is crucial if businesses are to make the most of their networking activities, whether undertaken with suppliers, customers, general social contacts, sector organisations, business or personal member organisations.

5.7.1 Clusters, learning and innovation

A cluster is a pool of interdependent and complementary competences associated with related manufacturing and service activities.[30] The production chain can include a number of manufacturing and service activities and all tend to be characterised by high degrees of mobility of people between different firms and other organisations. Successful clusters can act as a magnet for skilled and qualified people and create an environment which encourages innovative and entrepreneurial behaviour

In particular they are an important source of knowledge generation and diffusion through inter-firm 'knowledge spill overs'. Inter-firm relationships that occur in clustering can be both vertical (i.e. involving companies in the same supply chain) or horizontal (whether in different sectors, or competing in the same market). Successful clusters can develop their own 'communities of interest to deliver, develop and modify training and skills development activity involving:

- Public sector agencies
- Larger firms within the cluster
- Higher education institutions
- Support organisations such as venture capital and intellectual property specialists

[28] HM Treasury, Lisbon Strategy for Jobs and Growth, October 2005, citing RDAs
[29] Turner et al, report for the DTI, 2006
[30] Welsh Economy Research Unit, Challenging Clusters, 2005

5.7.2 Skills for successful technology transfer networks

A range of skills and attributes are required to run a successful technology transfer network, relating to[31]:

- Membership: the successful identification of suitable network members, achieving cohesion and mutual trust and exploiting shared interests
- Working towards targets: identification of objectives, needs and ways forward, instilling a sense of purpose, the ability to allocate tasks and devolve responsibility, respect for individual business backgrounds and expertise and a willingness to accept the network's working culture.
- Communication and know-how: the ability to be supportive in giving advice, sharing know-how and ensuring knowledge dissemination, interpersonal skills, reliability and leadership

[31] EU SPRINT programme

6 Innovation and skill needs in key target sectors

This section considers innovation activity and the associated implications for skill needs in a range of sectors highlighted as a priority in the Region by the Innovation Technology Council:

- New and advanced materials in manufacturing
- Transport technologies
- Medical and Healthcare Technologies

Key skills issues for the construction and built environment sector, which is also the focus for considerable innovation activity, are also considered.

6.1 New and advanced materials in manufacturing

6.1.1 Size and scope of the sector

Despite its decreasing size, the West Midlands remains the greatest concentration of manufacturing among the English regions, with 415,799 people working in a wide spectrum of industries in 2003, representing just under 15% of the total manufacturing workforce across England[32]. Key industries include:

- Food and drink
- Paper, pulp, printing and publishing
- Basic metals
- Fabricated metal products
- Rubber and plastic products
- Other non-metallic products (including ceramics)
- Transport equipment
- Electrical and optical equipment
- Mechanical engineering

6.1.2 New product development

Research within the plastics industry highlights the approach companies have taken to support the effective development and introduction of new products. As well as investment in R&D and targeting niche or emerging markets, companies have prioritised[33]:

The acquisition of specialist expertise in leading edge techniques Developing close relationships with customers Exploitation of ICT for design, simulation, prototyping and testing

A range of softer skills have been identified as important to support new product development and introduction, notably communication, leadership, thinking

[32] For more detailed analysis of the size, scope and recent performance of the sector see the WMRO Manufacturing Skills Profile, 2006
[33] Mason G, Enterprise Product Strategies, July 2005

strategically, networking, problem solving, team building, motivation and creative thinking. Associated with this is a range of behaviours including[34]:

- Finding ways to overcome obstacles.
- Encouraging and supporting others to make the best use of their abilities
- Making time available to support them
- A curiosity to learn and try new things
- Balancing risk against the benefits that may arise
- Acting within the limits of individual authority
- Constructively challenging the status quo
- Recognising the achievements and success of others

6.1.3 New materials and technologies

In order to ensure a globally competitive position at the forefront of change it is vital that manufacturing firms continually develop and exploit innovation in advanced materials, technologies and manufacturing processes[35]. Exploiting 'next generation' technologies requires a focus on:

- Advanced materials and resource-efficient manufacturing processes
- Biotechnology for industrial and healthcare applications
- Environmental and clean energy technologies

In the West Midlands, research and technology organisations at the leading edge of technological research and innovation include Qinetiq, RAPRA (polymers), MIRA (engineering), Ceram Research and universities including Warwick, Birmingham, Aston, Keele and Coventry.

Critically, firms require access to the skills required to manage these technologies, remain at the leading edge of R&D and to diffuse their knowledge and expertise into the wider industrial base.[36]

[34] Skills4Business
[35] DTI, Technology Strategy, Annual Report 2005
[36] DTI, Technology Strategy, Annual Report 2005

6.1.4 Smart materials and technologies

The concept of the 'intelligent' home or workplace is an IT-intensive, wired up environment where internet connectivity is used for the remote control of equipment. However, research indicates that there has been little action in developing appropriate 'smart' consumer products, with a market largely unexploited and ripe for attack, notably in areas such as speciality polymers, coatings, adhesives, composites, inorganic materials, metals, biotechnologies and materials and nanotechnology.[37] In order to exploit these opportunities manufacturers need to develop skills associated with:

- New horizon watch
- Market appraisal
- Competitor analysis
- Technology and knowledge transfer
- Product development expertise
- Leadership and management of innovation

A range of barriers to investment in the required skills and expertise, particularly among more mature manufacturers, include:

- A 'near market' view with a tendency for firms to be entrenched around core product lines
- A short term financial view, with concerns about the high costs of investment and the time taken for commercial realisation

6.2 Transport technologies

6.2.1 Size and scope of the sector

The West Midlands is a key national centre for the automotive sector and had a 33% share of the UK's vehicle output in 2004. Prior to the collapse of MG Rover and the announcement of the Peugeot closure there were at least 1,500 automotive suppliers in the Region, including 17 first tiers.

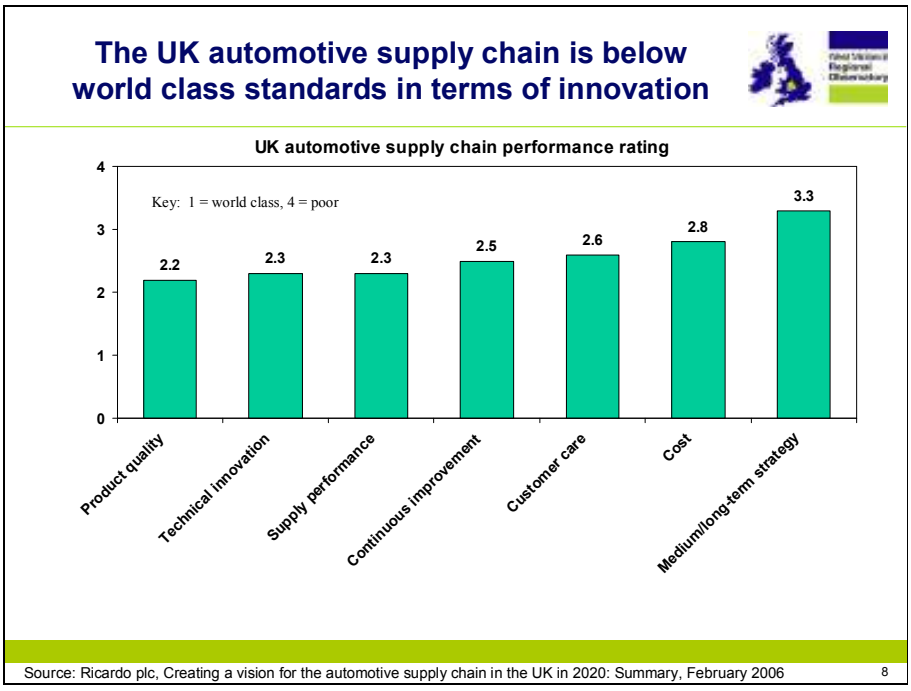
However:

- The UK retains a number of important automotive design, engineering and materials research centres, as well as industrial R&D and technical centres of some vehicle manufacturers and first tiers (most notably Ford).
- The UK motor sport sector is at the forefront of technological advances[38] and has a significant presence in the Midlands.[39]
- Regional strengths also include:
- Ford's Premier Automotive Group (Jaguar, Land Rover and Aston Martin, and the Whitley product engineering centre)
- Significant R&D activity within first tier suppliers such as Dana, GKN, and Denso[40]
- Advanced research institutes including RAPRA and MIRA
- Warwick University's Warwick Manufacturing Group, which has established a Premium Automotive Research and Development Programme with close links with Ford companies

6.2.2 Innovation and skills issues

While the industry is considered to be ahead of other manufacturing sectors in implementing continuous improvement techniques the UK supply chain is well below world class standards, notably with regard to product quality and technical innovation. A key contributory factor is the high degree of foreign ownership, notably at first tier level and a substantial slice of leading edge research and technical development occurs outside the UK.[41]

[37] Materials Foresight Report, Smart Materials for the 21st Century
[38] EEMS: Energy Efficient Motorsport (2005)
[39] AWM, Interim Automotive Strategy 2005 – 2008, April 2005
[40] AWM, Automotive Cluster Business Plan 2005 - 2008
[41] Tilson B, BCT Research Associates, Automotive industry market and sector context, 2002



If the UK automotive sector is to become more competitive and innovative firms need to acquire the technical skills and know how associated with new products, materials and processes and advances in electronics and information technology. [42] These include design engineering, project engineering. specialist computer solutions for manufacturing and simulation software. Skills in E-business are also critical, which is increasingly being used for materials resource planning, documentation for the traceability of products and materials and for the transfer of designs and other development materials within the supply chain. [43]

6.2.3 The digital factory

US firms like Ford, the large French automotive manufacturers along with key UK companies such as Jaguar and Land Rover are exploring the concept of the 'digital factory' characterised by the integration, through the use of ICT, of existing or planned products and production, the recording, storage and use of ensuing data, as well as their digital planning and form. The first step is modern tools that solve tasks such as material flow simulation or workplace design. A range of critical skills are required to turn this concept into a reality, including[44]:

[42] Tilson (2002); Deloitte & Touche and BCT Research Associates, The West Midlands Automotive Supply Chain Study, report for the Accelerate Partnership, 2001
[43] Tilson (2003)
[44] Fraunhofer Institut, Integrated training opportunities in knowledge transfer and skill creation in Advanced Industrial Engineering, undated. Supplied by Industry Forum, March 2006

- Production, engineering and technical skills in materials technology, micro-manufacturing, virtual engineering, simulation, advanced materials, product development, CAD, quality assurance in production, specific techniques including kanban, kaizen, and Just in Time
- Management skills relating to business management, production management, human resource management, management practices and psychology, flexible use of personnel, business process design
- Wider, more generic skills relating to inter-cultural communication, success-oriented procurement strategies, modern payment systems in logistics, supply chain management, international law, foreign languages and culture, marketing
- People skills, such as motivation, coaching, profiling, potential analysis, problem-solving, negotiation skills, team building and co-operation and life-long learning. Leadership and management

6.2.4 Leadership and management

Research has also highlighted a need to address weaknesses in leadership and management within the automotive supply chain. In particular, areas in need of improvement include:

- Programme and project management with UK organisations over estimating their competencies and under estimating the task[45]
- An ability among team leaders to handle routine maintenance and technical problems, leaving the qualified engineers to focus their energies on project management[46]
- Technical prowess, innovative thinking and strategic management
- Team working – both among the workforce and at director and senior management level
- 'Soft' skills in negotiation, developing customer-supplier relationships, communication, networking and motivation of staff

[45] Ricardo (2005)
[46] AIGT (2002)

6.3 Medical and healthcare technologies

6.3.1 Size and scope of the sector

Firms in medical and healthcare technologies are engaged in:

- Orthotics and prosthetics
- Rehabilitation and mobility
- Pharmaceuticals and biotechnology
- Opthalmic goods
- Dental and orthodontic devices
- Electromedical equipment
- Surgical and medical instruments
- Medical disposables[47]

The nature of medical and healthcare technologies is cross-sectoral, with links to disciplines such as plant science and agriculture, environmental technologies, the retail food sector (e.g. for lifestyle and nutrition) and sports science.

An estimated 400 – 500 West Midlands companies have some or all of their turnover derived from medical technologies, and frequently operate in one or more other sectors such as automotive, engineering and plastics processing. A 2005 study indicates that another 500 – 600 have expressed an interest in the medical sector and could consider diversifying into it, either fully or in part. [48]

Key medical school and hospital developments place the West Midlands potentially at the forefront of medical technologies research and development:

- Birmingham is a particularly strong focus, due in large degree to the University of Birmingham Medical School (including its joint venture with military medics to form the Centre for Defence Medicine) and Aston University's bio-product innovation centre and academy of life sciences.
- The University of Warwick Science Park has a small biotechnology cluster and the university's focus also includes health technologies and medical devices.

[47] Burfitt and Gibney (2003)
[48] Lewis (2005)

- Staffordshire's research focus is at Staffordshire University (including on bioengineering), and the University of Keele and its science park (e.g on orthopaedics).

In addition ICT, plastics and textiles clusters in the West Midlands have existing expertise and potential synergies with the Region's medical technology cluster:

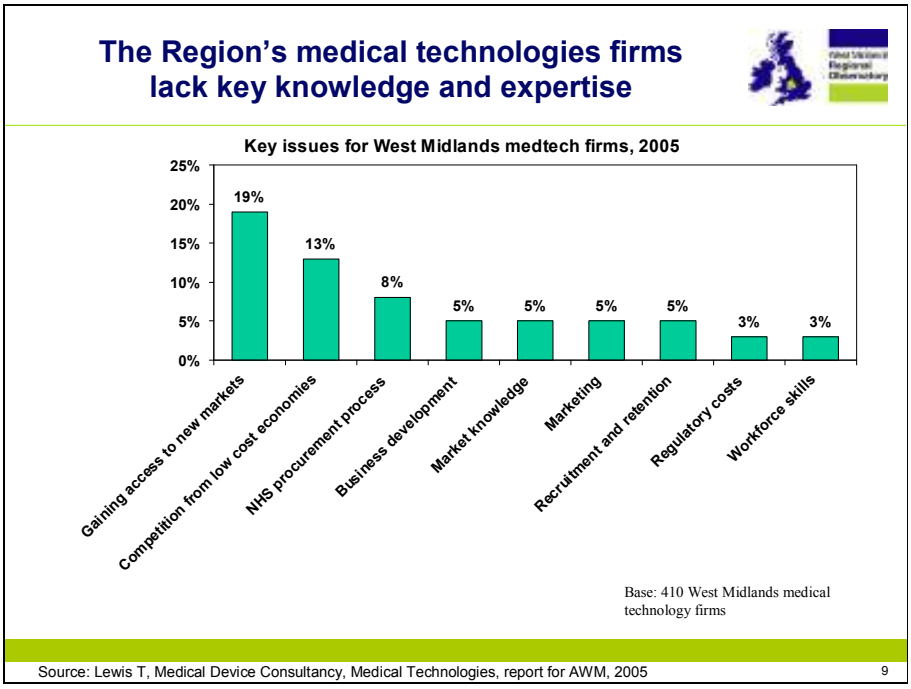
- ICT: notably around the Warwick and Aston Science Parks. Around 50 firms exist in the Warwick area alone with an interest in medical technologies.
- Plastics: there are more than 50 companies in the Region with a registered interest in medical technologies, particularly in the Telford area.
- Textiles: This is not a field of proven value for medical technologies in the West Midlands, but is considered worthy of further study, e.g. for wearable devices and personalised healthcare.[49]

6.3.2 Innovation and skills issues

Most West Midlands medical technology firms are SMEs. Two thirds of firms have developed their own products or services and further product development and the penetration of new markets are key objectives for the next five years. However, many face barriers to innovation based on limitations in their knowledge and expertise relating to[50]:

- Market knowledge and the ability to gain access to new markets, both domestically and in key export markets in Europe, North America and the Pacific Rim.
- Marketing – time to market and the integration of technical solutions with strategic marketing are more important that manufacturing or technological advances alone[51]
- The NHS procurement process which tends to be risk averse and cost constrained. The process is evolving, however, and medical technologies firms need to be pro-active and enter a dialogue with the NHS.[52]
- Business development, recruitment and retention and the acquisition of appropriate workforce skills

[49] Lewis (2005)
[50] Lewis T, Medical Device Consultancy, Medical Technologies report for Advantage West Midlands, 2005
[51] AD Little, UK Sector Competitiveness, May 2005
[52] Lewis (2005)



6.3.3 Case study: medical device manufacturers in Coventry & Warwickshire

A study of the skill needs of Coventry and Warwickshire medical device manufacturers has highlighted a focus on technological expertise as well as the need to respond to customers changing requirements in relation to new product development. Key needs relate to[53]:

- Quality planning and statistical process control
- The ability to use sophisticated electronic equipment, including CNC
- A knowledge of new laser products, and the acquisition of skills to make laser-powered surgical products
- Knowledge of polymer processing
- Multi-skilling on the shop floor, to achieve a more flexible workforce
- Medical knowledge among engineers
- Design skills to enable collaboration with the customer on product development and adaptation
- IT skills including software systems development

[53] Tilson B, BCT Research Associates, The Medical Technologies Research Project, 2002

- Legal knowledge, e.g. of patenting
- Knowledge of medical compliance/regulations
- Management, team working and other people skills including motivation and customer liaison
- Distribution and logistics skills
- Knowledge of exporting

Manufacturers also raised concerns relating to the effective sourcing of these skills, for example:

- Skill shortages relating to niche medical products, some scientific disciplines, chemists, pharmacy graduates, product design skills, technical ceramic/engineering skills, specialist engineering and tool making and people with multi-disciplinary skills.
- A lack of interest in the sector, and manufacturing and engineering generally as a career
- Limitations in the availability of specialist training in the Region and across the Midlands as a whole relating to certain biotechnology and pharmaceutical specialisms and dental technicians. This is coupled with a lack of expertise and knowledge among private training providers, a lack of information about training providers and what they do and in the availability of apprenticeships.
- The high cost and lack of grants or subsidies for workforce training

6.3.4 Case study: skill self development by a Staffordshire start up firm

In the face of skill shortages a Staffordshire implants manufacturer (Biocomposites) decided to develop the skills required internally. The skills they developed included[54]:

- How to research
- How to manufacture
- How to identify and communicate with their market
- Understanding procurement decision-making
- How to communicate and manage outsourced and long-distance operations

[54] Bratt (2006)

- How to differentiate themselves in the market
- How to reinvent what they do, continually
- Foresight skills
- Collaboration skills, as it is vital to work with partners and role models and also to use these as mentors and advisors
- Regulatory knowledge.
- How to get from research to commercialisation, and how to sustain it
- Locating funding

6.3.5 Skill needs of biotechnology firms

Biotechnology firms in the West Midlands tend to be small start-ups or science park based university spin-outs. If the Region is to attract additional start up and growing biotechnology companies access to the skills required will be vital. These include:[55]

- Scientists with business management and development skills
- Legal skills relating to negotiating intellectual property rights and patent filing
- Bringing research to commercialisation
- Dealing effectively with supply chains, including ensuring that quality standards are met
- Production management
- Project management for outsourced production
- Health and safety knowledge
- Knowledge of medical compliance/regulations

[55] Tilson B, BCT Research Associates, The Medical Technologies Research Project, 2002

6.4 Construction and the built environment

6.4.1 Scope of the sector

The construction sector includes not only building but also infrastructural and structural engineering as well as architectural consultancy, building services such as electrical wiring, plumbing, and heating and air conditioning, and gas services. It also encompasses the production and manufacture of materials for the building industry, including polymers and timber.[56]

6.4.2 New materials and technologies

Modern methods of construction such as off site manufacture and new and alternative materials are inherent in the concept of sustainability. Modern construction methods are designed to:

- Speed up the construction process significantly
- Reduce energy and water consumption during a building's construction and occupation
- Reduce waste, eliminate defects, and decrease building expenditure[57]

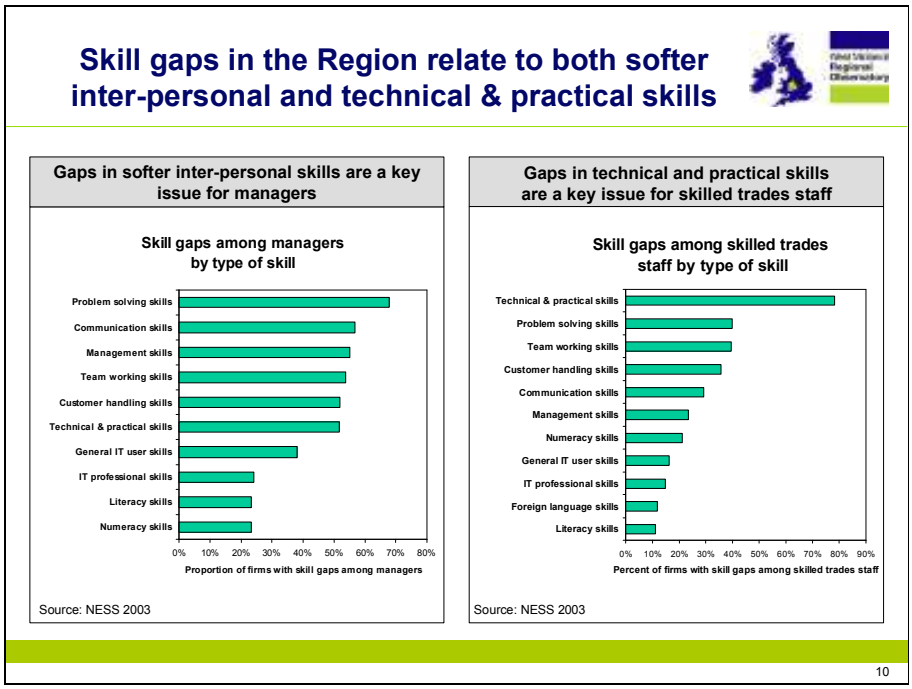
New materials for construction applications include composites and new types of concrete and joining methods. 'Smart' technologies are a major impetus for innovations including the 'intelligent home' which is digitally controlled, such as by switching appliances off or on to adjust to temperature or to suit the resident's lifestyle, as well as recording data. Fuel cells offer prospects as power sources. There is also potential for the use of nanotechnology in cement and coatings. Sensors are already in early adoption, for instance in bridges to monitor structural changes.[58]

Green concepts have much significance in construction and the built environment, not least due to concern about protecting the natural environment, ensuring that the urban setting is constructed of environmentally sound materials and building techniques that help to conserve natural resources by using alternative or regenerating sources. This has kindled interest in the use of timber and recycled materials such as waste aggregates in road construction and the re-use of reclaimed building materials.[59]

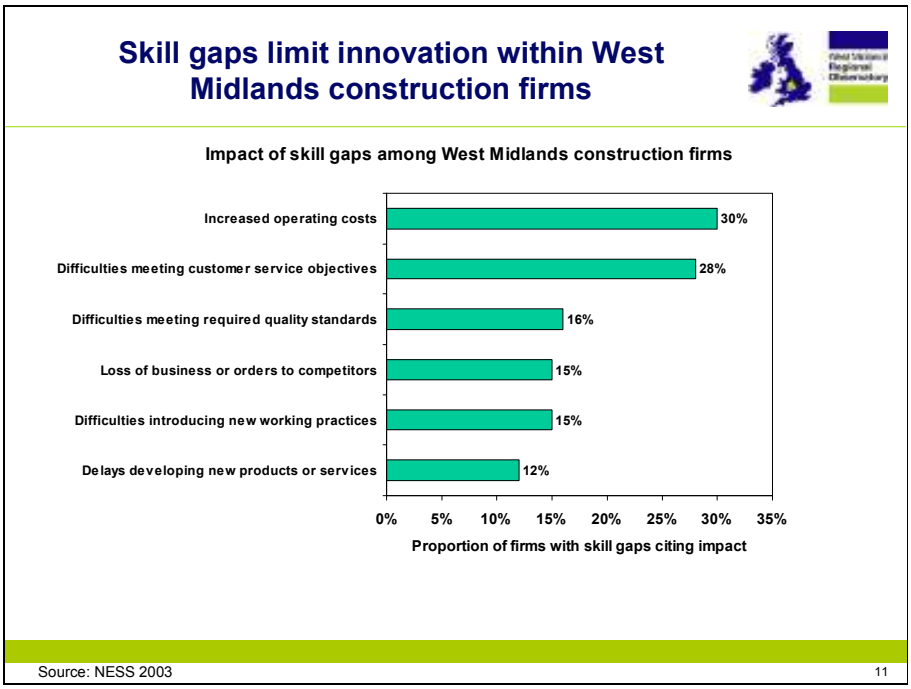
[56] Tilson, B, WMRO Construction Sector Profile, 2005
[57] Materials World, July 2005
[58] Tilson (2005); ibid (2006)
[59] Tilson (2005); ibid (2006)

6.4.3 *Skill needs for innovation*

The ability of West Midlands construction firms to embrace new methods and techniques is constrained by gaps in inter-personal skills in team working, customer handling, and communication. There are also critical deficiencies in technical and practical skills and management skills[60]. These deficiencies create problems for the introduction of new working practices, as well as new product or service development. They also prevent the achievement of efficiencies which would bring down operating costs, improve performance and help meet customer targets.



[60] Tilson, B, WMRO Construction Sector Profile, 2005



6.4.4 Skill needs for ICT

The use of more sophisticated information and communication technologies, and ICT use across all functions, is leading to emerging skill needs in terms of:

- Internet-based communication methods and knowledge and data transfer.
- Procurement and logistics.
- Supply chain management and partnership.
- The development and use of smart technologies, robotics, and
- The construction and fitting out of 'intelligent' buildings.

6.4.5 Skill needs for off-site manufacturing

The take-up of modern methods of construction involving pre-fabrication such as wall systems and doors, preassembled bridges and pre-cast building foundations[61] promises to revolutionise the construction and building services industries, certainly for new build and perhaps for a degree of repair work.

[61] Goodier C and Gibb A, Build Offsite: The value of the UK market for offsite, Loughborough University, undated (2004/5), report for DTI

Despite the fact that off-site manufacture is not expected to reach significant levels until about 2020 and even thereafter 'traditional' construction skills will still be in demand, [62] skilled trade staff will need to adapt to new working environments and practices which could include modular wiring in preassembled service and distribution pods and dealing with flat pack buildings.

6.4.6 Skill needs for building services

Manufacturing innovation in products relevant to building services engineering has clear skill impacts for installation and maintenance. While there already emerging skill needs in relation to:

- System design and pumping
- Water treatment
- Power flushing
- Building regulations
- Energy efficiency
- Sustainability

New skills will also be required that are associated with evolving technologies such as photovoltaic energy sources and environmental technologies.

[62] Tilson B, Construction skills profile, 2005

Full Document Information	
Title:	Regional Skills Partnership Cross-Cutting Issues 2006 – Innovation: Skills as a Driver for Change
Alternative title:	Cross-Cutting Issues – Innovation
Creator:	Skills Research Team, West Midlands Regional Observatory Level L1, Millennium Point, Curzon Street, Birmingham, B4 7XG Tel. 0121 202 3249 Fax. 0121 202 3240 E-mail: andy.phillips@wmro.org
Publisher:	West Midlands Regional Observatory Level L1, Millennium Point, Curzon Street, Birmingham, B4 7XG Tel. 0121 202 3250 Fax. 0121 202 3240 E-mail: enquiries@wmro.org Web: http://www.wmro.org
Addressee:	Regional Skills Partnership
Date created:	19-05-2006
Status:	D3.0 Draft for consultation
Subject category:	Mandatory
Subject keywords:	
Description:	
Coverage, Geographical:	West Midlands
Type:	Report
Format:	Text, PDF, Internet
Rights:	Copyright 2006 West Midlands Regional Observatory
Identifier:	
Document contact:	Andy Phillips, Head of Skills Research, Skills Research Team, West Midlands Regional Observatory Tel. 0121 202 3251 E-mail: andy.phillips@wmro.org

West Midlands Regional Observatory
Level L1
Millennium Point
Curzon Street
Birmingham B4 7XG

Telephone: 0121 202 3250
Fax: 0121 202 3240
E-mail: enquiries@wmro.org
www.wmro.org

EUROPEAN UNION
European Social Fund