MEDICAL TECHNOLOGIES:
WEST MIDLANDS BENCHMARK REPORT

A report prepared for
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CHAPTER 1: NATIONAL OVERVIEW

1.1. Economic Overview of the Economy

Porter and Ketels (2003) paint a broadly favourable picture of the evolution of the UK economy from the low of the 1970s to the present day. But they suggest that the UK has reached a cross-road in its development, needing to move on from "… a location competing on relatively low costs of doing business", to one "… competing on unique value and innovation" (*op cit*. p. 5). While there is no doubt that there have been some successes that have helped slow the relative decline in the UK economy, as Porter and Ketels (2003) to some extent point out, the UK's current position is not ideally placed for future competition. Indeed, some authors point to a number of trends, such as the relative decline in R&D and patenting activity as long term trends which undermine some of the successes that Porter and Ketels discuss (SIE, 2003; Bosworth, 2004). These longer-term trends are consistent with the UK being in a low skills equilibrium – with many of its institutional and other environmental features more suited to producing low specification products (Bono and Mayhew, 2001; Bosworth, 2004) – hardly the ideal starting point for the next stage of the competitive process as perceived by Porter and Ketels (2003).

The macro-economic picture broadly reflects this stabilisation of the British economy. The recent past has seen a considerable degree of macro economic uncertainty in the UK, with both the global turn-down and, in particular, the weakness in the US economy, as well as the effects of the war in Iraq. But the macroeconomic picture for the UK is forecast to settle down to a pattern of modest growth (Wilson, *et al*. 2003). After the recent brief slow down, economic output is expected to exhibit long-term growth of about 2.5 per cent a year. Only moderate rates of increase in wages and prices are anticipated, broadly consistent with the continued low rates of inflation among the major OECD countries. The value of sterling against the euro and the US dollar is also expected to be broadly stable. The budgetary position is one of modest acceleration in public expenditure growth, which is likely to be achieved without major increases in public borrowing.

Wilson, *et al*. (2003) report that a generally optimistic picture emerges with regard to developments in the UK labour market. Employment is forecast to continue to rise at just under 0.5 per cent a year, creating over 1.3 million additional jobs over the next decade. The population of working age and the labour force are both expected to grow over the next decade and, as a consequence, overall labour market participation (*i.e.* the ratio of the labour force to the population of working age) is expected to remain roughly constant at about 78 per cent. Unemployment is forecast to remain fairly stable and unemployment rates are likely to show only a very modest increase and to be low compared with the UK's experience over much of the second half of the 20th Century.

Wilson, *et al*. (2003) also provide projections of output by broad sectors for the next decade: (i) primary and utilities – primarily comprising agriculture, mining, electricity, gas and water – are all forecast to exhibit weak growth or declines in output; (ii) manufacturing - is expected to grow at an average rate of less than 2 per cent a year, but is likely to exhibit a considerable contrast between the better performance of the technology and R&D-related industries, and more traditional sectors (*i.e.* textiles, clothing and leather, metals, *etc.*), whose poorer performance is likely to reflect intense international competition; (iii) construction - is forecast to show only modest output growth, averaging less than 2 per cent a year; (iv) distribution, transport and communications, *etc.* – comprise a diverse range of sectors, with differing prospects. Transport and communications is forecast to grow at over 4 per cent a year, where the strongest growth occurs in communications - the strongest growth of any services apart from computing. Other sectors in this broad group such as distribution and retailing, and hotels and catering are forecast to grow by just over 2 per cent a year on average; (v) business and miscellaneous services is also a diverse group. Output of business services are forecast to grow at about 4 per cent a year over the decade –

bolstered by the high performing computing and related industries, but pulled back by banking and insurance, which is projected to grow closer to 2 per cent *a year*. Miscellaneous services are also expected to show slower rates of growth in output. (vi) Non-marketed services – comprise health and education services, as well as public administration and defence. While public services' output is expected to rise by about 1.5 per cent *a year*, reflecting current policy priorities, health and education services are likely to exhibit much more rapid growth of around 2.5-3.5 per cent a year.

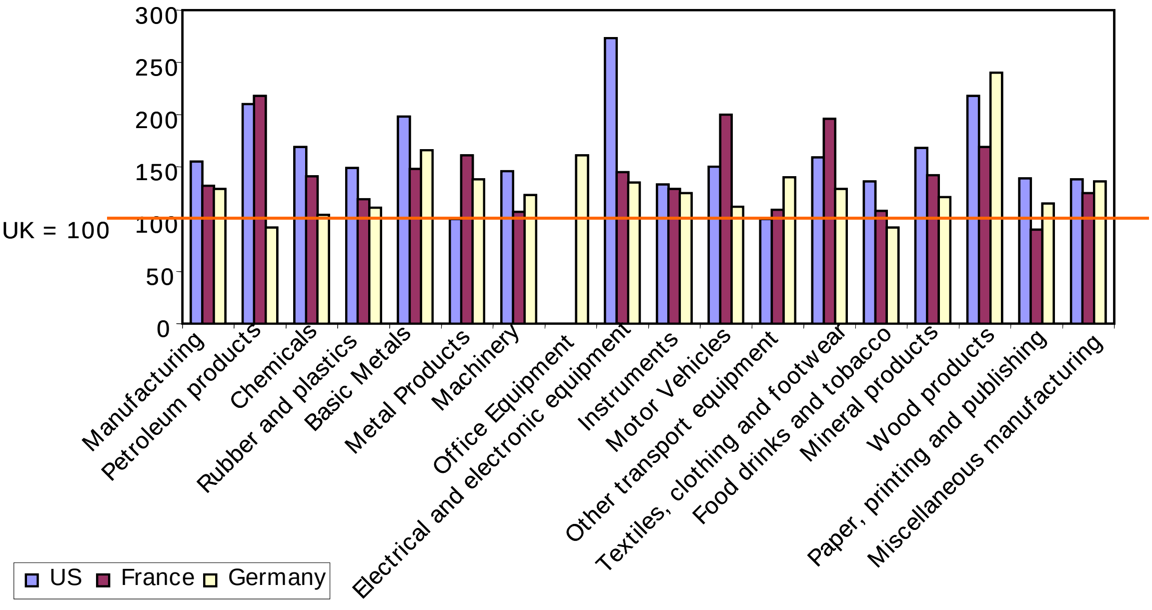
The output growth translates itself *via* differential labour productivity performance to employment prospects. The main features relevant to the present Report are that the long-term decline in manufacturing employment is expected to continue, with a further loss of just over 650 thousand jobs over the next decade. Despite the growth in output in transport and communications, employment is expected to show little change. However, employment in business and other services is forecast to rise by around 1.25 million over the decade, with the fastest growth in other business services. Finally, employment growth in non-marketed services, largely accounted for by health and education services, with public administration and defence likely to show a slight fall.

1.2 Strengths and Weaknesses of UK Sectors

Producitivity.

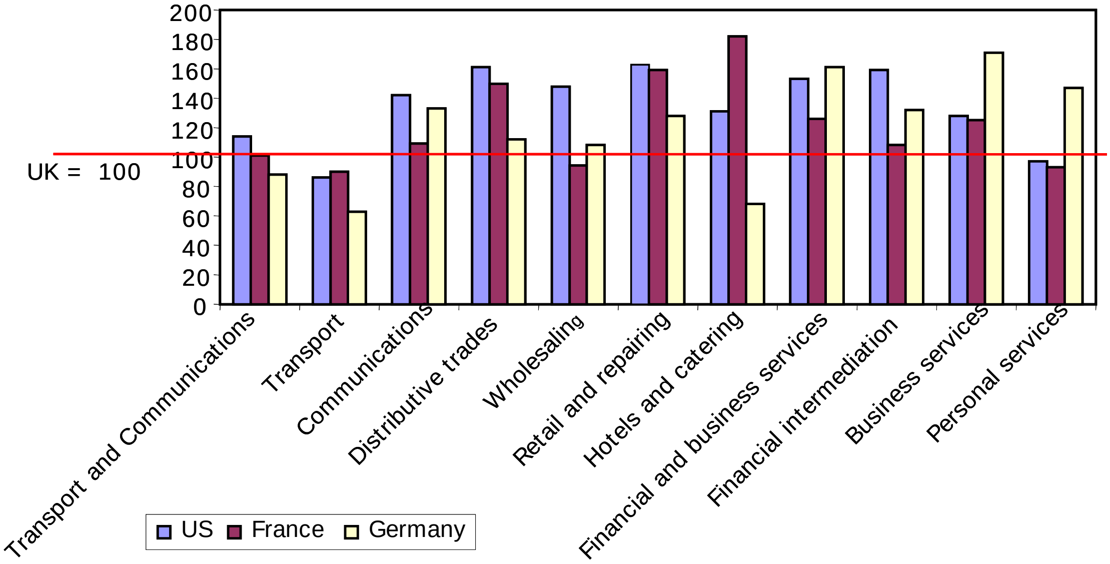
The productivity gap between the UK and its major competitors is large: US GDP *per* worker is over 30 per cent more than the UK; France exceeds the UK by just under 20 per cent; while the differential with Germany is quite small. French and German workers, however, work fewer hours than those in the UK and USA, so French and German GDP *per* hour worked are significantly higher (Metcalfe, *et al*. p. 12). What is interesting is that the productivity gap is present across most sectors of UK manufacturing and services, even in areas where the UK is considered to be relatively successful by international standards (i.e. Financial Services and Pharmaceuticals). *Figures 1.1 and 1.2* show relative labour productivity broken down by sector. The results are the productivity levels of US, French and German firms relative to that of the UK (UK=100).

Figure 1.1 International Productivity Differences Across Manufacturing Sectors



Source: Metcalfe, *et al*. (2003).

Figure 1.2 International Productivity Differences Across Service Sectors



Source: Metcalfe, *et al*. (2003).

Creativity, Innovation and Performance

These differences are linked to a wide variety of influences, including the skills base, capital intensity and innovation. Metcalfe, *et al*. (2003, p. 2) report that, "There are significant sectoral variations in innovation performance that reflect differences in the scope and conditions for innovation across sectors and the ability of firms to innovate. Regional differences in innovation performance are modest and are substantially the result of industry location effects." The link between creativity, innovation and performance can be illustrated using two ONS reports, one relating to the "Information Communication Technologies" sectors and the other to the "Creative Industries".

It is clear from the ONS data that there is a wide disparity of performance across sectors in the UK. The gross value added (GVA) for the UK ICT sector[1], for example, rose from £30.2 billion in 1992 to £59.9 billion in 2000. The overall growth of ICT far outstripped that of the economy as a whole – its average annual growth rate over this period was nearly twice as large. It is interesting that the vast majority of the growth of the sector came from ICT services: while manufactured ICT was about £7.9 billion in 1992 compared with about £22.3 billion for services, the corresponding figures for 2000 were £13.8 and £46.1 billion respectively.

A similar story emerges for the creative industries. These comprise a wide mix of sectors, including parts of textiles, software, publishing, the media, *etc*.[2]. An index of growth shows that the creative industries also increased their GVA by almost twice that of the economy as a whole over the period 1992 to 2000. The absolute contribution rose from £37.3 to £74.6 billion in total, of which, manufactured creative output increased from £9.3 to £11.7 billion, while creative service output increased from £28.0 to £62.9 billion – more than doubling in this 9 year period.

Foresight Programme

Numerous disasters resulting from previous UK governments attempting to pick and back major new product developments and product launches eventually led to a more "hands-off" approach through the Foresight Programme. Nevertheless, the aim of the Programme

1 As defined by OECD (2000). *Measuring the ICT Sector*. Paris: OECD.

2 The definition for this group is provided by DCMS (2001). *Creative Industries Mapping Document*. Department of Culture, Media and Sport. London.

remains the need to increase UK exploitation of science, although its role is mainly limited to the identification of potential opportunities from new science and technologies, or how future science and technologies could be used to address key future challenges.[3]

The Foresight Programme brings together key people, knowledge and ideas with the aim of taking a longer term view that provides sufficient lead time to enable UK companies to identify potential opportunities from new science and technologies. The initiative involves a changing, rolling programme of projects, which are chosen after wide consultation with business, the science base, government departments, etc. The activities are viewed as extremely important and each project is led at a senior level, by the Chief Scientific Officer, the Director General of the Research Councils or the Director General of DTI's Innovation Group.

The principal outputs that all Foresight projects should deliver are: (i) thorough and up-to-date information and analysis of recent developments in relevant science and technology, including an international perspective, and forecasts of what the next developments might be; (ii) visions of the future, reflecting the potential impact of science and technology, and of forecast social and economic trends, ie what success will look like; (iii) recommendations for action, by research funders, business, Government or others, to make the most of the potential of science and technology; (iv) networks of people who recognise the importance of the issues addressed by the project, and are keen to take the recommendations forward.[4] The acid test of the quality of outputs is that they inform and influence the decisions of al key policy decision makers in both the public and private sectors.

An initial scan of the Foresight projects has not revealed any direct studies of medical technologies, although cross-reference is made in a number of particular reports.[5] In addition, see the later discussion of MedLink.

1.3 Overview of Industrial Policy and Remaining Policy Questions[6]

Historical perspective

The general picture of the current macroeconomic, political, social and legal environment for business is broadly positive (Porter and Ketels, 2003, pp. 18-22). Macro policy since the early 1990s has focused on producing a more stable economic environment for business, with competition policy encouraging increased competitiveness. Social policy has also attempted to bring stability, with an increasing emphasis on social inclusion, with a view to offering opportunities to the more disadvantaged members of society. The political and legal frameworks are also well established and, in general, not viewed as a barrier to development (*op cit*. p. 19; see also Metcalfe, *et al*. 2003).

There are a number of less favourable features, however, which we can illustrate with a few examples. The UK is a long way from being an inclusive society, there are major pockets of disadvantage and income distribution in the UK is still more unequal than other European economies, and more in line with the USA). The respect with which the UK political and legal frameworks are regarded masks important issues, such as "red tape" and the degree and costs of legal protection (*i.e.* in the area of intellectual property) that appear to impact particularly on small companies. There are also issues about whether the legal and broader economic environment is conducive to both the setting up and the survival of new ventures. A final example is the failure of macroeconomic policy to generate R&D expenditures and patent activity comparable to our main competitors – it is probably too early to judge the impact of the recent introduction of tax concessions for R&D.

3 http://www.foresight.gov.uk/

4 http://www.foresight.gov.uk/

5 See, for example, Foresight (2000). *Health Care 2020*. DTI. London: HMSO.

6 An overview of industrial policy cannot be undertaken without saying something about policies with regard to factor supply, but further detailed discussion occurs in Section 1.4 below.

Low Skills Equilibrium and Trajectory

Perhaps the most damming indictment, indicative of a policy failure, is the suggestion that the UK is in a "low skills equilibrium" (LSEq) (Finegold and Soskice, 1988) or following a "low skills trajectory" (SIE, 2003; Bosworth, 2004). Finegold and Soskice (1988) argued that Britain was trapped in an LSEq, "…in which the majority of enterprises staffed by poorly trained managers and workers produce low quality goods and services" (Finegold and Soskice, 1988, p.22). An LSE is a "systems failure", associated with a self-reinforcing network of societal and state institutions which interact to stifle the demand for improvements in skill levels.[7] An LSEq is seen as a vicious circle of relatively low product/service specification/quality and workforce skills. Evidence of the lack of UK investment in new, high quality, high value added products and the existence of low specification production in the UK is beginning to emerge (Bono and Mayhew, 2001; Bosworth, 2004). Products are poor because the workforce skills to produce better ones are often lacking, and skills are poor because existing product market strategies do not demand high levels of skill and because work has been organised and jobs designed to require low levels of skill and employee participation and discretion (Bosworth, *et al*. 2003).

This outcome is not some aberration caused by irrational behaviour - individuals and firms in this system act rationally in the face of the incentives and constraints that are present and, hence, the economy as a whole ends up in a low rather than a high skills equilibrium. Despite individuals and firms acting rationally, the aggregate outcome from their decisions is not optimal, in the sense that society would prefer a high skill/high income outcome. This equilibrium is hard to shift, because it reflects a whole range of underlying factors to do with: (i) the structure of markets (especially domestic markets, which are affected by the unequal distribution of earnings and a tendency for consumers to buy on the basis of price rather than quality/specification); (ii) short-termist pressures, coupled with low management and other employee skills, that make radical changes of organisational strategy very risky; (iii) a de-regulated labour market, characterised by a reliance on the external labour market, and associate with a reliance on hiring and firing; (iv) from (iii) weak internal labour markets – encouraging low investment in worker skills, and forms of work organisation and job design that reduce skill needs; (v) a view of competitive advantage that purports to result from economies of scale, central control, cost containment, and standardisation; (vi) a tradition of voluntarism, that leaves many decisions to the goodwill of employers; (vii) weak employer groupings and weak social partners, that make collective action difficult and weakens the "union voice" for a high wage/high skill strategies; (vii) a problematic ownership structure – many large "UK" companies are multinationals, the bulk of whose activities lie outside the UK, making UK operations marginal to the well-being of the organisation or its long-term future (Bosworth, *et al*. 2003).[8]

Focus of Industry Policy

DTI industrial policies are currently under review (Metcalfe, *et al*. 2003[9]; see also Porter and Ketels, 2003). This report perceives the principal problem to be that UK productivity levels are substantially below those of other major advanced economies – a feature common across most manufacturing and service sectors. The main cause of productivity differences is argued to arise from weaknesses in UK innovation performance. This is linked to a variety

7 Systems failures offer a complex policy problem – they involve a wide range of interactions between institutional, environmental and incentive structures. Changing any one element may not, indeed, probably will not, bring the required policy outcome – it may even produce a perverse or chaotic result (Kaplin and Glass, 1995).

8 UK MNCs also tend to be concentrated in relatively mature, low-technology sectors, such as food, drink and tobacco. This affects their choice of employee relations system, and explains the weak take-up of high level work practices and the relatively low emphasis placed on skills and training.

9 This discussion is based upon the current draft of a DTI report (8th version), not currently in the public domain.

of factors, such as differences in R&D expenditure (including the low public R&D spend); capital intensity and, thereby, investment in physical capital; skills, including managements skills; the degree of encouragement and support for enterprise; and the extent two which markets are competitive.

The discussion of policy issues is structured around a small number of critical factors identified as crucial to success, which can be influenced by the Government: (i) customers - intelligent customers are required to put pressure on firms to deliver better quality goods and services; (ii) regulatory framework – needs to improve incentives for innovation and increase the extent of innovation in the economy; (iii) finance – access to finance is essential to enable investments in new products, services or processes; (iv) new knowledge – sources of knowledge, such as science base and the presence of strong design, are important in shaping innovation systems; (v) networks and collaboration – help to provide access to knowledge and to enhance the innovation process; (vi) absorptive capacity – requires human capital and appropriate (flexible) organizational structures to absorb new and existing knowledge and technology.

The analysis by Metcalfe, *et al*. (2003) suggests the following strengths and weaknesses in the UK innovation system:

i. **customers** – the main identified weakness is government procurement, which can be used to encourage greater emphasis on intelligent customer models;
ii. **regulatory framework** – including competition policy, product and labour market regulation and the IPR regime is now viewed as an area of relative strength for the UK, although: (a) changes in competition policies are likely to take time to feed through; (b) the effects of the new tax incentive for R&D is too soon to assess; (c) regulations could be made more output focused and innovation friendly; (d) there are continuing issues concerning the suitability of the framework and costs of IPRs for smaller firms;
iii. **finance** – access to finance is viewed as an area of relative strength for the UK. However, other factors may have made the demand for and access to finance more difficult: (a) the past history of macro-economic instability reduced incentives to invest and innovate; (b) the lack of skills probably affected the demand for, and success in obtaining, finance for innovation;
iv. **knowledge** – access to sources of knowledge is perceived as an area of relative strength, particularly the highly productive science base and access to expertise in design[10];
v. **networks and collaboration** – are agued to be neither a particular strength, nor a particular weakness, as innovative UK firms collaborate on innovation projects to a similar extent as firms in other large EU countries;
vi. **absorptive capacity** – is perceived to be an area of major relative weakness for the UK innovation system. This is seen as an area where poor skills – particularly intermediate skills, NCVQ 2 and 3 – hinder innovation in the UK. There are also worries about inadequate management competency and its impact on innovation.

It should be noted, however, particularly in the context of the present project, that Metcalfe, *et al*. (2003, Annex E) are, on balance, quite scathing about the efficacy of clusters – particularly the likely success of pro-active policies to develop new successful clusters. The review by Metcalfe, *et al*. (2003) suggests that the following strategic priorities for government policy, the: (i) design of public sector procurement procedures that encourage greater innovation; (ii) improvement of the skills base; (iii) introduction of more innovation friendly regulations; (iv) consolidation of the improvements in the areas of competition policy,

[10] Bosworth (2004) disputes that the science base is a particular strength, given what should be expected of one of the largest advanced countries in the world. Metcalfe *et al*. (2003) also note that the value of knowledge is limited if it cannot be efficiently exploited through innovation.

macro-economic stability and industrial relations; (v) Improvements in policy co-ordination between different levels of Government (national, regional and EU).

Spillovers, Networks and Clusters

Policy discussion has placed Increasing emphasis on the role of networks and clusters. In part this interest comes from the quite solid empirical evidence on R&D spillovers and externalities – that an individual company can benefit from the general pool of (relevant) R&D knowledge created by all companies (SIE, 2003). In addition, this literature makes it clear that "distance" is an issue, in the sense that firms that are, in some sense, closer to one another enjoy greater benefits from the common pool that they create (Griliches, 1992, pp. S43-44). While Griliches in the main refers to technological proximity, geographical closeness also has a similar effect. Networks and clusters can clearly benefit from such spillovers and externalities, but their beneficial effects may also arise from more direct relationships between firms and other organisations. One piece of evidence supporting this is the importance of the buyer-supplier chain both as a source of information and as a stimulus for the development of new products and processes (Stoneman, *et al*. 1994; REFS).

One policy solution to low skills equilibrium put forward by Finegold (1999), is the development of self-sustaining, high skill eco-systems.[11] This recognises that high skill regions or sectors, in principle, can exist within otherwise relatively low skill economies, but may also be an important source of new wealth and job creation amongst advanced countries. The focus on eco-systems as a policy response also has the advantage of moving the focus of the debate away from the concepts of high/low skills equilibria. These concepts tend to over-emphasise the approaches to skill creation and related economic decision making in the German and Japanese (high skills equilibria) economies, while under-estimating the potential of more market based systems (Bosworth, *et al* 2003). The HSE/LSE concept is also a rather static one, while the focus on eco-systems (as opposed to equilibria), places greater emphasis on evolution and trajectories (SIE, 2003; Bosworth, 2004).

Finegold's analysis is based upon the experience of successful biomedical and computer hardware and software firms clustered in Northern and Southern California. The framework identifies four requirements for the creation of self-sustaining, high skill ecosystems: (i) a catalyst or trigger that initiates their development (such as the large surge in defense funding for R&D in the case of Silicon Valley); (ii) ongoing nourishment (provided in the California by a combination of the supply of highly skilled labour from strong research based universities, coupled with the supply of venture capital and related financial and legal skills); (iii) a supportive environment, including a good basic infrastructure (especially transport and communications), a general climate attractive to knowledge based workers (both physical and in terms of support services), and a regulatory regime that supports risk taking (i.e. reducing the costs of opening and closing businesses); (iv) a high degree of interdependence between the various elements of the eco-system in terms of a common focus and a high degree of co-operation, which helps to facilitate learning (i.e. networking horizontally and vertically between firms and also amongst the individuals involved) (Bosworth, *et al*. 2003).

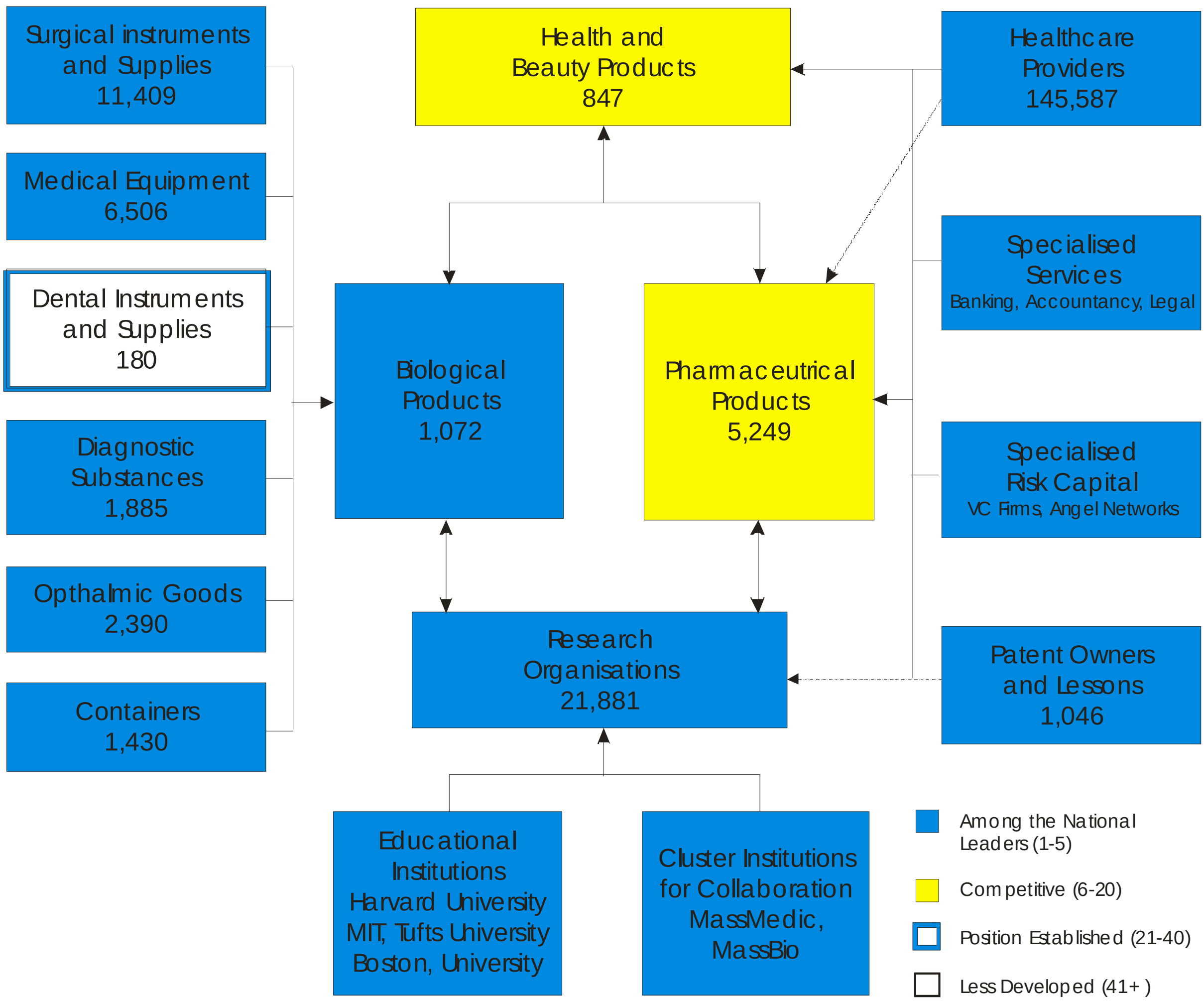
This idea of a skills eco-system is really just a manifestation of the concept of a "cluster". Clusters are normally viewed as "… geographically proximate groups of interconnected companies, suppliers, service provides, and associated institutions in a particular field, linked by commonalities and complementarities" (Porter and Ketels, 2003). While it may be possible to think of virtual clusters that are geographically dispersed, these are normally

[11] These ideas build upon earlier work by Krugman (1991) and Porter (1990), including ideas of clustering, linked to knowledge creation and diffusion processes, as well as developments in the literature on "learning regions" - see, for example, Mogan (1997) and Malmberg and Maskell (1999).

viewed more as networks – it is generally the spatial dimension that is used to define a cluster.

According to Porter and Ketels, clusters generally influence competitiveness in three main ways, they: (i) increase the *level of productivity* at which constituent firms can operate (i.e. carrying lower levels of stock due to local suppliers, reduce downtime because of access to local service providers, etc.); (ii) increase the capacity for innovation and, thereby, productivity growth (i.e. the Boston Life Sciences Cluster – see Figure 1 – includes "… world-class research universities, teaching hospitals, competing biotech companies, and cluster institutions that facilitate interaction among all these); (iii) enable new business formation, which further enhances innovation (i.e. *via* the presence of experienced researchers, access to specialized venture capital, legal services, etc. – again *see Figure 1.3)*.

Figure 1.3 Boston Life Sciences Cluster



Source: Porter and Ketels (2003, p. 28).

There is a massive interest in clusters in the literature at the present time. It is clear that some clusters have grown organically because the institutional, economic and social framework was conducive to their formation and success (see the earlier discussion of the approximate reverse – the low skills trajectory and equilibrium). However, the picture is not all positive, particularly with regard to the possibility of artificially creating the "culture" in which a cluster will develop and flourish.

Key Support for Sectors

Key sectors are supported in a whole variety of ways, through government and more local activities in the labour market (LSCs and SSCs) – *see above* for a brief discussion, and through DTI support for key sectors. The role of the DTI forms the subject of the present discussion and this, again, draws on the output of the review by Metcalfe, *et al*. (2003, Annex G), which examined programmes belonging to DTI's "innovation portfolio" or contributed to its "knowledge transfer" objective. The programmes reviewed were chosen because of their size[12], accounting for nearly £200 million (56 per cent of the Department's innovation related expenditures). Some of the main programmes are set out in Appendix 1 (*op cit*.).

The evaluations remain partial and sometimes qualitative. Many are justified, at least in part, by their wider social benefits (i.e. the better health outcomes from new medical technologies), which will often exceed the measurable private benefits to the supported firm. The main lessons gleaned by Metcalfe, *et al*. (2003) are that schemes are more likely to be successful if they: (i) have a strong rationale (particularly in identifying market or systemic failures); (ii) support the sharing of knowledge through the brokerage of partnerships or collaboration tend to result in wider economic benefits; (iii) involve SMEs insofar as they tend to exhibit greater additionality; (iv) have well-specified target beneficiaries, clarity about the innovation activities involved and well deliverables; (v) are long term and innovative in nature, but are strategically important for future core business.

The Metcalfe, *et al*. (2003) report provides a review of five main programmes and a discussion of support in two other areas *(see Appendix 1)*. The programme of most direct relevance to the present study – the MedLink Programme – is not one of the seven areas covered. MedLink is one of the UK Government's LINK programmes, aimed at promoting collaboration in pre-commercial research between industry and the research base, with a view to stimulating innovation, wealth creation and improvements in the quality of life.[13] The MedLink programme, which was announced in January 1995, focuses increasing the competitiveness of the UK medical devices industry, in order to promote "… collaborative research aimed at the development of advanced technologies with potential, ultimately, to lead on to the development of saleable new and improved medical devices".[14] The programme has three main themes: (i) diagnostics; (ii) therapeutics; (iii) rehabilitation.

Projects are required to involve collaboration between at least one science/engineering base and one industrial partner. Both NHS hospital trusts and small firms new to LINK are encouraged to put in proposals, which need to demonstrate their potential to: (i) significantly improve to medical outcomes/the process of care; (ii) provide innovative solutions to previously intractable medical problems; (iii) reduce NHS costs; (iv) raise scientific quality and originality; (v) demonstrate commercial potential, with a clear indication of the likely exploitation of the research outcomes.[15]

Again, to return to the more general conclusions of Metcalfe, *et al*. (2003) with regard to the efficacy of DTI interventions, they suggest: (i) the importance of basing interventions on a wide analytical base; (ii) the need to ensure individual funded projects contribute to productivity improvements, which means they must address a market or systemic failure; (iii) making greater use of piloting for projects where rationale is less clear; (iv) ensuring effective monitoring procedures that allow programme managers to assess the (on-going and overall) impact of interventions; (v) the need for an evaluation strategy for each project or programme, to be established prior to the start of a scheme; (vi) ensuring that projects or programmes are routinely evaluated at least every five years or so.

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12 Neither HEIF (£64m), which is a relatively new scheme, or CARAD (£21m), which is an older scheme but no full evaluation is available, are included.

13 http://www.ost.gov.uk/link/info.html

14 http://www.hop.man.ac.uk/HIR&D/natDTI.html#medlink

15 *op cit*.

1.4 National overview of approaches to local economic development (LED)

Since 1997 economic policy has developed a strong regional dimension in England than was the case in the previous thirty years.

The main departments of state for the UK (and England) of relevance to LED are:

- Department of Trade and Industry (DTI);
- Office of the Deputy Prime Minister (ODPM);
- Department for Education and Skills (DfES);
- Department for Work and Pensions (DWP).

In addition within the Cabinet Office there is the No.10 Policy Unit which acts as a think thank reporting directly to the Prime Minister. This has a roving brief and has an interest in local economic development primarily through its interest in social exclusion and PIU. It is also notable that the Treasury is taking increasing interest in regional economic development.

As the above description makes evident the responsibilities for local economic development and employment are spread across both several government departments and national executives. Within the UK the most relevant departments are: DWP, DfES; and ODPM, and the Strategy Unit within the Cabinet Office.

Department of Trade and Industry (DTI)

The primary aim of the DTI is to improve the competitiveness of national and regional economies in the UK. Most recently, DTI has been concerned with the relatively poor productivity of the national economy (compared to France, Germany, Japan, and the USA) and has issued its *White Paper on Enterprise Skills and Innovation* (2002) with its aim to improve the UK's regions through:

- equipping individuals with skills (both basic and higher level skills, especially ICT ones);
- building stronger regions and communities (through industrial development);
- investing in innovation;
- fostering enterprise and growth; and
- strengthening European and global connections

The White Paper *'Our Competitive Future: Building the Knowledge Based Economy'* (1998) made the argument for developing a cluster based approach to industrial development in the regions. DTI also has responsibility for the Regional Development Agencies who are charged with raising the economic performance in the regions.

Department for Work and Pensions (DWP)

The Department for Work and Pension has responsibility for employment benefits, state pensions, and the Welfare to Work Programme. The New Deal was designed within DWP though administered through Jobcentre Plus who have responsibility for delivering policy at a local level as well as administering unemployment benefits. DWP has recently introduced Employment Zones and Action Teams for Jobs with the aim of stimulating job growth in areas of high unemployment.

Department for Education and Skills (DfES)

The DfES is the national government department responsible for labour market and related issues. It is responsible for collecting and analysing labour market data as well as carrying out various other evaluations of specific training programmes and policy initiatives. DfES has overall responsibility for schools and post-compulsory education and training. In relation to employment it is responsible for the design and financing of training programmes such as Modern Apprenticeships. Since 2001, post-compulsory education and training, with the exception of higher education, is delivered through an executive agency, the Learning and Skills Council (LSC), funded by DfES.

Office of the Deputy Prime Minister (ODPM)

The ODPM is the main government department responsible for the local and regional governance issues and LED. The specific objectives of the ODPM are to:

- work with the full range of Government Departments and policies to raise levels of social inclusion, neighbourhood renewal, and regional prosperity;
- provide for effective devolved decision making within a framework of national targets and policies;
- deliver effective programmes to help raise the quality of life for all in urban areas and other communities.

At a local/regional level there are three main institutions:

- Government Offices for the Regions (GOs);
- Regional Development Agencies (RDAs);
- Learning and Skills Council (LSCs) and Local Learning and Skills Councils (LLSCs);
- Jobcentres.

There is a **Government Office** (GO) in each of the nine administrative regions of England which have the responsibility for co-ordinating the policies of government departments at a regional level. GOs are interdepartmental bodies co-ordinated by the Regional Co-ordination Unit (RCU) in the Cabinet Office. The GOs are funded via RCU, and staffed by representatives of the DTI, DfES, DWP, ODPM, Department for Transport, Home Office, Department for Culture Media and Sport, and the Department for the Environment Food and Rural Affairs (DEFRA).

A **Regional Development Agency (RDA)** exists for each of the nine administrative areas of England:

- London;
- North West;
- North East
- Yorkshire and Humberside;
- South West;
- West Midlands;
- East Midlands;
- South East;
- Eastern.

Each RDA has five statutory purposes, which are to:

- further economic development and regeneration
- promote business efficiency, investment and competitiveness
- promote employment

- enhance development and application of skill relevant to employment
- contribute to sustainable development

RDAs' agendas include regional regeneration, taking forward regional competitiveness, taking the lead on regional inward investment and, working with regional partners, ensuring the development of a regional skills action plan to ensure that skills training matches the needs of the labour market

Active labour and passive labour market policy is administered through **Jobcentres.** Jobcentres are where people sign the unemployment register, claim unemployment benefits, gain access to labour market programmes, and are assisted in the search for work.

The **Learning and Skills Council** is the national body charged with the delivery of education and training to the 16+ workforce. It has 47 local offices or 'arms' whose boundaries are consistent with those of the nine standard administrative regions, but there is no explicit regional tier except insofar as there partnership arrangements between LSCs (and RDAs) at the regional level.

From 2001, DfES has begun to set up Sector Skills Councils (SSCs). The role of these bodies is to articulate the skill needs of employers. In 2002, the Sector Skills Development Agency (SSDA) was established to oversee the SSCs and cover those sectors not represented by a specific SSC.

1.5 National Educational and Training System

Education is compulsory for children over the age of five years and up to the age of 16. There are two types of school – state funded and privately funded. In addition, the UK comprises two education systems, with a number of important differences (the first covers England, Wales and Northern Ireland and the second covers Scotland), although the qualifications are broadly compatible with each other. Most children start at primary school at age 5 and move to secondary school at age 11. At secondary school (both state and independent), children are prepared for GCSE (General Certificate of Secondary Education) examinations, which they sit at age 16. The pupils may leave secondary education at age 16 to begin work, but the majority stay on to take a two year course to A (Advanced) level (which may comprise taking a mix of AS (Advanced Subsidiary) and/or A level, normally sitting examinations at ages 17 (AS) and/or 18 (A and AS). Resits are possible at both GCSE and A level, which can delay the age at which the pupils move on in their subsequent study or career. Students may move on to Further or Higher Education (normally at age 18).

Higher Education is provided by around 90 Universities, which may also act as award giving bodies for other institutions. Around 43 per cent of young people (18-30 year olds) today attend university, this compares with only 6 per cent (of under 21s) in the 1960s (DfES, 2003). Attempts are being made to further increase the participation rate, in particular, by broadening access to disadvantaged students (*op cit*.). There is also considerable debate about who should fund HE and, relatedly, whether universities should be able to charge "top-up fees". While students (and their families) have carried an increasing proportion of the financial burden in the recent past, nevertheless, the private rate of return to obtaining a degree is still reported to be high, and higher in the UK than in many of the competitor economies (SIE, 2002). In addition, the UK universities are perceived to be of high quality and making an important contribution to the science base[16], although further moves are proposed to concentrate research in certain institutions, move others towards a teaching and dissemination function and ensure a greater contribution to the development of the local

[16] "The number gaining degrees has tripled in the last two decades while safeguarding quality. Completion rates for students are among the best in the world. More overseas students are studying here. Our research capacity is strong and, at best, world class. Recent years have seen a dramatic increase in the number of new companies spun out of universities' innovation." (DfES, 2003)

economies (DfES, 2003). Other authors are somewhat more sceptical of the current position, at least considering the fact that the UK economy is the fifth largest in the world (Bosworth, 2004).

While there is some degree of overlap in the qualifications that may be given in the two post-18 sets of institutions (*i.e.* universities and FE colleges), it is probably far to say that the FE colleges normally focus on a range of intermediate, more vocational qualifications, providing broad access and scope for continuing and life-long learning opportunities. The UK has a large number of Further Education Colleges, which cover most of the towns and cities in the country.[17] The numbers of students in FE are substantial, with over 1 million enrolments in November 2002, of which just under 400 thousand attended courses leading to a formal qualification (some of which, it might be argued should have been completed during the period of formal schooling).[18] There were over 2 million enrolled students in November 2002[19], of which just under 300 thousand were reported to be on workplace learning schemes (including Foundation Modern Apprenticeships (FMAs) and Advanced Modern Apprenticeships (AMAs)).

The National Council for Vocational Qualifications (NVCQ) first met in 1986. The initial work of the Council was to establish a planning group of industrialists and providers of qualifications to advise on design of the proposed new framework of National Vocational Qualifications (NVQs). The Council was not given statutory powers and faced inertia amongst the awarding bodies and professional bodies. As a consequence, progress was slow, resulting in many existing qualifications being given conditional accreditation as NVQs. Thus, the new NVQs were simply added to the existing range of qualifications, and the system became more complex and opaque than evermore transparent and navigable. The Qualifications and Curriculum Authority (QCA) was established under the 1997 Education Act[20], with statutory powers to regulate qualifications. The aims were to provide: (i) greater clarity of opportunities and pathways for progression; (ii) sharper relevance to the identified needs of employment, training and education; (iii) guarantees of quality and standards.for company and national competitiveness.[21]

Critiques of the UK system suggest it has been far from successful. Konrad (1999), for example, indicates that, in contrast to the claims made for the development of National Vocational Qualifications [S/NVQs] in the United Kingdom, the system has been dogged by "… problems of poor definition, confused conceptualisation, complex language and procedures, dilution of knowledge requirements, and a lack of a reliable and valid system of assessment." He points to an, "…unwillingness of officials to consider that the UK model might have had fundamental flaws, resulting in a significant delay in introducing reforms and improvements". He adds that this experience, "… contrasts with the success of the German 'dual system' in its various forms …". Thus, it is perhaps not surprising to find a wide range of consistent evidence of the failure of vocational training in the UK *vis a vis* our main competitors, such as Germany, particularly at the intermediate NVQ levels (*i.e*. 2 and 3) (see SIE, 2003).

The Learning and Skills Council (LSC) is responsible for funding and planning education and training for over 16-year-olds in England.[22] The Government White Paper, *Learning to Succeed* (1999) set out plans to modernise and reform the system of post-16 education and training in England. It resulted in the establishment of the Learning and Skills Council

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17 Listings can be obtained from http://bubl.ac.uk/uk/fe/ or http://www.scit.wlv.ac.uk/ukinfo/felisth.html, both of which provide access to the individual college websites.

18 http://www.dfes.gov.uk/statistics/DB/SFR/s0394/sfr13-2003v3.pdf.

19 http://www.dfes.gov.uk/statistics/DB/SFR/s0386/LSCILRSFR01r131Mar03.pdf.

20 http://www.qca.org.uk/about/99-00_annual_report.pdf

21 http://www.qca.org.uk/about/00-01_about_qca.pdf

22 http://www.lsc.gov.uk/National/default.htm

(LSC)[23], which from took over the training functions of the former Training and Enterprise Councils (TECs) in April 2001, as well as the funding responsibilities of the former Further Education Funding Council (FEFC). The LSC runs 47 local offices, known as the Local Learning and Skills Councils (local LSCs). Each local LSC comprises a council of 16 representatives from local businesses, voluntary and community sectors, local authorities and education and training organizations. Their aim is to give strategic direction to ensure the needs of local employers, individuals and communities are met (in conjunctions with Learning Partnerships and urban renewal programmes).[24]

In addition to the spatial focus of the LSC and local LSCs, the Government established the Sector Skills Development Agency (SSDA), to fund and support the activities of the new network of Sector Skills Councils (SSCs).[25] SSCs are independent, UK-wide organisations drawing upon influential employers in sectors of economic or strategic significance. While SSCs are employer-led, they seek to actively involve trade unions, professional bodies and other stakeholders. Their aim is to tackle the skills and productivity needs of their sector throughout the UK.[26] SSCs receive substantial public investment and are given access to government departments to discuss skills issues and, thereby, to influence policy. Their four priority areas are to: (i) reduce skills gaps and shortages; (ii) improve productivity performance; (iii) boost the skills and productivity levels of everyone in the sector, including action on equal opportunities; (iv) improve learning supply, including apprenticeships, higher education and national occupational standards

In the main, the prognosis for the UK is somewhat gloomy. While there is a guarded optimism about the continuing contribution of the HE system, both in terms of the science research base and the generation of highly educated workers, there is an equal measure of disquiet about the current position with regard to intermediate skills within the UK (particularly NVQ levels 2 and 3). While it is difficult to judge the most recent initiatives, those that took place in the 1980s and early 1990s have come in for considerable criticism. Nevertheless, there is some evidence that the UK has at least stabilised the position with regard to key competitors, such as Germany, and perhaps even caught up slightly (SIE, 2003). While the need for both a spatial and sectoral training dimension appears essential, it is not clear at the moment that the problems that typically characterise matrix organisational structures have been resolved (Bosworth, 2004). In addition, while there are clear attempts to join up policies between DTI, DfES, Treasury, etc. in tackling issues of joint concern, such as the role of skills in influencing productivity performance, this is not always translated to full cooperation between the various arms of government.

1.6 The Health Care System[27]

Private and Public Provision

Health care has been the subject of vigorous public debate in the UK. The National Health Service (NHS) was established in 1948 to provide free health care to the population. While, in the early years, the NHS was viewed as a considerable success, the more recent rates of increase of medical science, medical technology, and people living longer have put placed system under significant pressure and consequently it has been the focus of substantial reform. By the turn of the century, relative levels of expenditure on health care *vis a vis*

[23] http://www.lsc.gov.uk/National/default.htm.

[24] http://www.go-london.gov.uk/educationskill/london_lscs.asp; http://www.lifelonglearning.co.uk/llp/protocol.pdf.

[25] http://www.ssda.org.uk/about/about.shtml.

[26] The rationale can be found in DfES (2001). *Meeting the Sector Skills and Productivity Challenge*. London: HMSO (http://www.ssda.org.uk/pdfs/meetsschal.pdf).

[27] This section draws upon the discussion of developments in the public health system outlined in Cambridge (Econometrics 2003).

other advanced countries generally portrayed the UK in a poor light.[28] The Government White Paper *The New NHS Modern, Dependable* (Cm3987, 1997) outlined a ten-year programme to improve the NHS with the replacement of the internal market by a system of integrated care. This has also stimulated a discussion about the role of private health care relative to that of the NHS. This development in the private sector provision has parallel may changes to the public sector system, many of which have focused on efficiency improvements and involves introducing various forms of competition. For example, primary care providers now have significantly more power to choose amongst different hospitals and other service providers for the treatment of their patients. There has also been an increase in the extent of co-operation between the public and private health care sectors – in particular, the public sector is now able to buy services from the private sector.

Further freedom from government control in operational matters in the public sector is occurring with the award of Foundation status. Such status will initially be given to the best-performing hospitals, but eventually to the majority if not all hospitals. Foundation hospitals, which are central to the Government's NHS reforms, are to be "public interest companies", focusing mainly on meeting the needs of the locality. The policy, originally presented in May 2002, has proved controversial for a number of reasons: (i) Labour back-benchers see it as another step towards privatisation of the health service and the Opposition have argued that it does not go far enough; (ii) extensive negotiations have occurred between the Department of Health and the Treasury over the financial arrangements (*i.e*. that Foundation Hospitals could borrow money without Treasury agreement).[29]

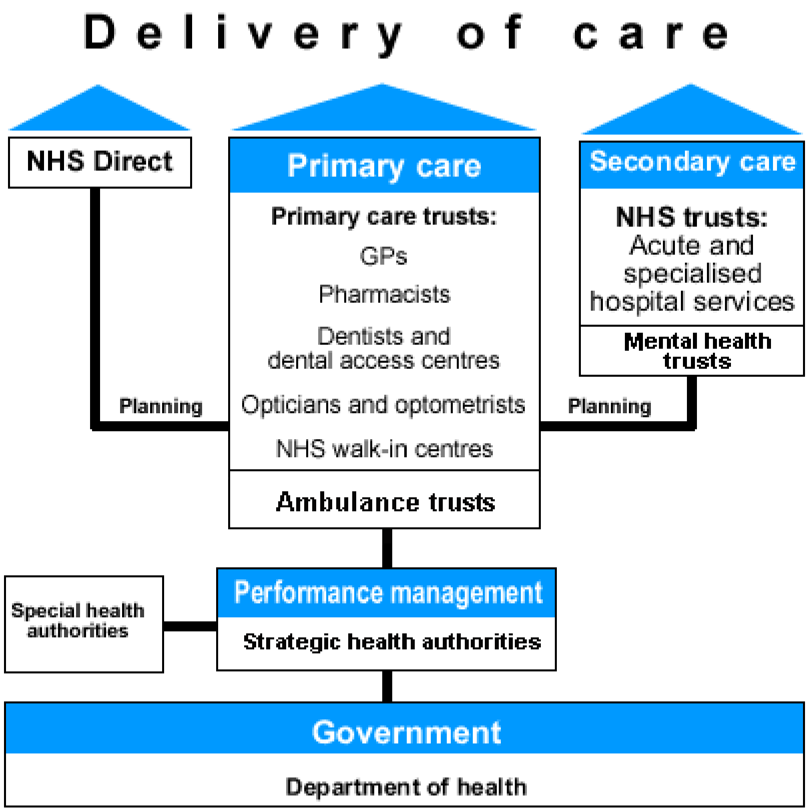
National Health Service: Organisation of Health Care

The public system of health care is provided directly through the National Health Service (NHS) which, in turn, is responsible to the Government, Department of Health (DoH). The organisational chart below illustrates how the NHS is organised in England *(see Figure.1.4)*:

28 In 2001, OECD Health Care Data reveals that the UK spent 7.6 per cent of its GDP on health care compared to the OECD average of 8.4 per cent, and 13.9 per cent in the USA. But the relative picture is improving. In 1990, the UK spent 6 per cent of its GDP on health care compared to the OECD average of 7.3 per cent. Similarly, real annual per capita growth on health care in 2001 was greater than the OECD average: 4.2 per cent compared to 3.4 per cent. Based on purchasing power parities the OECD estimates that the UK spends US$1,992 per capita on health care compared to $4,887 in the USA, $2,808 in Germany, and $2,503 in Denmark.

29 This aspect was resolved in October 2002, when it was agreed that FHs could borrow money from private sources, but the borrowing would appear in the Government accounts. Any private borrowing will result in the loss of equivalent NHS funds, in order that the total expenditure does not breach overall NHS borrowing and spending plans.

Figure 1.4 Delivery of Health Care Through the NHS



Source: www.nhs.uk/thenhsexplained/how_the_nhs_works.asp

Around one million people work for the NHS in England and it currently costs more than £50 billion a year to run, rising to £69 billion by 2005. In a typical week: 1.4 million people receive help in their home from the NHS. The NHS Plan is driving change in the organisation with its aims: (i) target the diseases which are the biggest killers, such as cancer and heart disease; (ii) pinpoint the changes that are most urgently needed to improve people's health and well-being and deliver the modern, fair and convenient services people want. The Modernisation Board is leading these changes and a number of taskforces have been created to drive forward the ideas and improvements outlined in the *NHS Plan*. Six of these are concerned with "what" services need improving and four look at "how" improvements will be made, such as investment in facilities and information technology. The Modernisation Agency helps local NHS staff and NHS organisations such as trusts and primary care trusts to improve services for patients.

The DoH's purpose is to support the Government to improve the health and well being of the population, driving forward change and modernisation in the NHS and social care, as well as improving standards of public health. DoH has embarked on a major change programme designed to improve the way the Department works by: (i) setting overall direction and leading transformation of the NHS and social care; (ii) setting national standards to enhance quality; (iii) holding the system to account; (iv) securing resources and making major investment decisions to ensure that the NHS and social care have the capacity to deliver.

There are six Executive Agencies that have responsibility for particular business areas:

i. Health Protection Agency - dedicated to protecting people's health and reducing the impact of infectious diseases, chemical hazards, poisons and radiation hazards;

ii. Medicines and Healthcare Products Regulatory Agency - safeguarding public health and the interests of patients and users by ensuring that all medicines, medical devices and equipment on the UK market meet appropriate standards of safety, quality and performance;
iii. NHS Estates - supporting the provision of high-quality NHS buildings and facilities;
iv. NHS Modernisation Agency - improving patients' experience by bringing together health care improvement and leadership development to provide top class support for clinical teams and managers across the service;
v. NHS Pensions Agency - looking after the pension needs of NHS staff;
vi. NHS Purchasing and Supply Agency - a centre of knowledge and expertise in purchasing and supply matters for the NHS.

Given the size and importance of the NHS, it is perhaps not surprising that it has been the continual focus for new government policies and changes, many of which may actually have delayed improvements to management costs and operational efficiencies that they were meant to bring about. Recent structural changes in the NHS are the merging of the former 100 health authorities into 28 new bodies and making all bodies that purchase NHS care directly into primary care trusts. Reforms are also being considered in the way that dentists are paid by the NHS - a government report on dentistry was published in August 2002.

Private Provision

The major growth in the private sector health providers can be traced over a substantial part of the last 30 years of the 20th Century. Until the 1970s, the private sector was dominated by charitable hospitals and private beds in NHS hospitals (so-called “pay beds”) until the 1970s. At this time the number of private consultants was rising and, while this induced the 1974-9 Labour Government to attempt to phase out “pay beds”, in practice, this only increased the rate of growth of private, profit-making hospitals. After a decline in “pay beds” in the late 1970s, there were roughly the same number of private beds in NHS hospitals by the mid-1990s as there were in the early 1970s (around 1500).

The number of private acute, medical and surgical beds virtually doubled over the period from 1979 (6,700 private beds) to 1998 (12,000).[30] While the number of private hospitals and clinics fell over this period from 200 to 150, many of the new facilities are larger in scale and look much more like standard NHS hospitals. By the end of the 1990s, it was reported that around 18,000 of the 23,000 NHS consultants did at least some work in private practice (*op cit.*), generating around 50 per cent of NHS consultants' income. By the mid-1990s, the UK private acute healthcare market reached a value of about £32 billion, with over 3 million people covered by various health insurance schemes. Some indication of the growth of the private sector over the last decade of the 20th Century can be gleaned from the growth in private medical insurance *(see Table 1.1)*.

[30] http://news.bbc.co.uk/1/hi/health/background_briefings/your_nhs/93714.stm

Table 1.1: Private Medical Insurance Market Sector, 2002

	1991	2001
Persons covered by PMI	6.65 million	6.66 million
Non-insured schemes		0.74 million
PMI Providers		
Company paid schemes	4.08 million	4.60 million
Personal sector schemes	2.57 million	2.05 million
Providents market share	84 per cent	50 per cent
Commercial market share	16 per cent	50 per cent
Value of UK market	£1.3 billion	£2.7 billion
Claims of UK market	£1.1 billion	£2.1 billion

Source: www.laingbuisson.co.uk/PMI.htm

Recent years have seen a greater degree of integration between the private and public health care sectors. In 2000 Labour government signed the Independent Healthcare Association (Concordat) which actively encourages private provision of healthcare services for the benefit of NHS funded patients. And in 2002 independent healthcare providers were invited to submit expressions of interest for 11 NHS Diagnostic and Treatment Centres which will provide 39,500 operations a year by 2005.

Medicines and Medical Technologies

From a medical technology perspective, two agencies are worth considering in more detail. The Medicines Healthcare Regulatory Agency protects and promotes public health and patient safety by ensuring that medicines, healthcare products and medical equipment meet appropriate standards of safety, quality, performance and effectiveness, and are used safely. The MHRA was formed from a merger of the Medicines Control Agency (MCA) and the Medical Devices Agency (MDA) on 1 April 2003. With reference to medical devices the responsibilities relate to: (i) investigating adverse incidents associated with medical devices and their use; (ii) providing advice and guidance on performance and safety aspects of medical devices, and their use; (iii) negotiating European Directives and implementing and enforcing UK regulations for medical devices; (iv) contributing to the preparation of non-statutory safety and performance standards for Medical Devices in support of the European Directives and International harmonization; (v) managing an external programme to evaluate medical devices, and provide consultancy advice, which enable device users and purchasers to select equipment suitable for their needs and which contributes to improved equipment design, safety and performance

The MDA is the oldest organisation of its kind in the world, having been established as a part of the NHS in 1948. Its accumulated experience in the field of medical device standards and evaluation gives it a unique international status. MDA's role has changes significantly over the years, because of rapid advances in medical devices technology, the development of a world market in device technology and manufacture, and the introduction of statutory regulations for the industry.

The NHS Purchasing and Supply Agency is an Executive Agency of the DoH, established on 1 April 2000. The role of the new Agency is to act as a centre of expertise, knowledge and excellence in purchasing and supply matters for the health service. As an integral part of the DoH, the NHS Purchasing and Supply Agency is in a key position to advise on policy and the strategic direction of procurement, and its impact on developing healthcare, across the NHS.

Intended to function not just as an advisory and co-ordinating body but also an active participant in the ongoing modernisation of purchasing and supply in the health service, the agency contracts on a national basis for products and services which are strategically critical to the NHS. It also acts in cases where aggregated purchasing power will yield greater economic savings than those achieved by contracting on a local or regional basis. The agency works with around 400 NHS trusts and health authorities and manages 3,000 national purchasing contracts, influencing around half of the £7 billion spent in the NHS on purchasing goods and services in the health service.

Growth in the Health Care System

There has been a sharp increase in the number of both medical and scientific and technical staff within the NHS since 1995. In addition, the 2002 Budget provided for NHS spending to rise by around 7 per cent a year in real terms over the period 2002 to 2007, against a background of increasing demand for health services. The Government aims to provide 100 new or refurbished hospitals by 2010 and, the NHS is about to make substantial investment in IT services linked to systems to provide for innovations such as electronic patient records and digital prescriptions. The increase in expenditure is also expected to support employment growth of nearly 3 per cent in 2004. The Government is planning that there should be an increase of around 80,000 staff in key roles between 2001 and 2008, comprising 15,000 additional consultants and GPs, 35,000 nurses, midwives and health visitors and 30,000 scientists. Plans have also been announced for an increase in the number of places at medical schools, as well as national initiatives to increase nurse recruitment and retention. Nevertheless, it should be born in mind that these developments take place against a background of high staff turnover in some areas of the NHS and some difficulty in recruiting both students and new employee recruits.

Main challenges facing provision of health care

Health and Social Work remain high on the list of Government social priorities. The demands placed on the system have risen significantly over time, pincered between the increasing demands arising from health care patients and an ageing population on the one hand, and the increased availability of new treatments arising from technological innovations on the other. Both prongs of the pincer movement have been associated with higher costs: increased longevity brought about by improved technologies and other social developments have the effects of raising costs and the new technologies that support such longevity are often also more expensive. These developments should also be seen against a background of historical under-investment in the health service, which provided a weak platform on which to base the new demands, coupled with constraints on funding arising from the competing demands on public spending (particularly in the light of other areas of historical under-investment, such as education and transport). The growth in spending on private sector health services reflects, in part the greater affluence of the population, but is clearly also partly a response to the problems of the public sector providers.

CHAPTER 2: THE MEDICAL TECHNOLOGIES SECTOR

2.1 Scope and Limitations

The present chapter attempts to address two main issues:

i. the first concerns what we know of the Medical Technologies (MT) sector in the UK; and
ii. the second focuses on how the information that is available might be used to address the question of how to identify the (latent) MT cluster.

The distinction is extremely important, because, as will become apparent, the current UK statistics focus on a small part of the totality of the firms that might be considered to be active in the MT *sector*, let alone the MT *cluster*. The problem is accentuated by the fact that, the MT sector is relatively small and only appears at the three-digit level as SIC 33.1 and, hence, there are few published statistics.

Broad Description of the Sector Nationally

The most relevant parts of the Standard Industrial Classification for Medical Devices and Appliances in the UK is SIC 92 Division 33, which comprises the *Manufacture of medical, precision and optical instruments, watches and clocks*. This Division comprises the following Groups: 33.1 Manufacture of medical and surgical equipment and orthopaedic appliances; 33.2 Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment; 33.3 Manufacture of industrial process control equipment; 33.4 Manufacture of optical instruments and photographic equipment; 33.5 Manufacture of watches and clocks. Of these, clearly, the Group 33.1 is central, although some of the other sectors in the two digit class 33 may also prove to be of relevance. At this stage, we simply do not know. *Table 2.1* sets out the structure of the classification by ONS.[31]

[31] http://www.statistics.gov.uk/methods_quality/sic/structure_sectiondl.asp.

Table 2.1 Classification of Industry

UK SIC 1992: SUMMARY OF STRUCTURE

Latest System Update UKSIC2003

Division	Group	Class & Subclass	Description
33			MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS, WATCHES AND CLOCKS
	33.1		Manufacture of medical and surgical equipment and orthopaedic appliances
		33.10	Manufacture of medical and surgical equipment and orthopaedic appliances
	33.2		Manufacture of instruments and appliances for measuring, checking, testing, navi and other purposes, except industrial process control equipment
		33.20	Manufacture of instruments and appliances for measuring, checking, testing, navi and other purposes, except industrial process control equipment
		33.20/1	Manufacture of electronic instruments and appliances for measuring, checking, te navigating and other purposes, except industrial process control equipment
		33.20/2	Manufacture of non-electronic instruments and appliances for measuring, checkin testing, navigating and other purposes, except industrial process control equipme
	33.3		Manufacture of industrial process control equipment
		33.30	Manufacture of industrial process control equipment
		33.30/1	Manufacture of electronic industrial process control equipment
		33.30/2	Manufacture of non-electronic industrial process control equipment
	33.4		Manufacture of optical instruments and photographic equipment
		33.40	Manufacture of optical instruments and photographic equipment
		33.40/1	Manufacture of spectacles and unmounted lenses
		33.40/2	Manufacture of optical precision instruments
		33.40/3	Manufacture of photographic and cinematographic equipment
	33.5		Manufacture of watches and clocks
		33.50	Manufacture of watches and clocks

Specialisation, Diversification and Lines of Business

Two main problems occur in UK (as opposed to US) data – they are associated with the concepts of specialisation and diversification, and arise because enterprises are allocated to sectors according to their principal products. In the case of specialisation, not all firms allocated to the MT (SIC 33.1) will be specialising entirely in the production of MT products. In other words, some part of their output is likely to fall into other product areas which may lie in SICs outside of 33.1. In the case of diversification, the mirror image of specialisation is also likely – many firms not allocated to SIC 33.1 (because their principal output lies elsewhere) may nevertheless produce MT products. In the USA, in addition to information about principal products, company data exist on their "lines of business" (LoBs), which enables researchers to trace the totality of, for example, MT-related activities, throughout the US economy.

The proportion of the industrial output of the Medical and Precision Instrument sector (industry 76 in the input-output tables for 1999) that was recorded as being the principal product of the sector was 83 per cent. The principal product of this sector as a proportion of total domestic output of the sector was 86 per cent.

While this lack of information creates a significant problem for the manufacturing sector in the UK, it is likely to be even more difficult in the services sector. In the case of software or R&D activities, for example, there appear to be no four or five digit classes that distinguish MT activities. *See Table 2.2*. [32]

Table 2.2 Detailed SIC Classes for the Computer Related and R&D Service Sectors

72			COMPUTER AND RELATED ACTIVITIES
	72.1		Hardware consultancy
		72.10	Hardware consultancy
	72.2		Software consultancy and supply
		72.20	Software consultancy and supply
	72.3		Data processing
		72.30	Data processing
	72.4		Data base activities
		72.40	Data base activities
	72.5		Maintenance and repair of office, accounting and computing machinery
		72.50	Maintenance and repair of office, accounting and computing machinery
	72.6		Other computer related activities
		72.60	Other computer related activities
73			RESEARCH AND DEVELOPMENT
	73.1		Research and experimental development on natural sciences and engineering
		73.10	Research and experimental development on natural sciences and engineering

The issues of specialisation and diversification appear unlikely to be adequately resolved until the survey and case study stages of the project, when detailed investigation can occur about LoBs.

Further Issues in the Identification of the Cluster

The initial way forward in the identification of the (latent) cluster is to explore three aspects of the linkages – limited initially to linkages with SIC 33.1: (i) explore input-output tables to see which are the main suppliers to and buyers from the MT sector; (ii) investigate technological linkages using patent and patent citation data; (iii) examine local linkages between companies and institutions. The present chapter discusses an initial trawl to look at (i) and (ii). While we discuss some of the local issues in Chapter 3, a statistical analysis will again depend on the survey and case study results. Note that, at least in the case of the West Midlands, the analysis of the *cluster* is made complicated by the fact it is a *latent* rather than

32 http://www.statistics.gov.uk/methods_quality/sic/structure_sectiondl.asp.

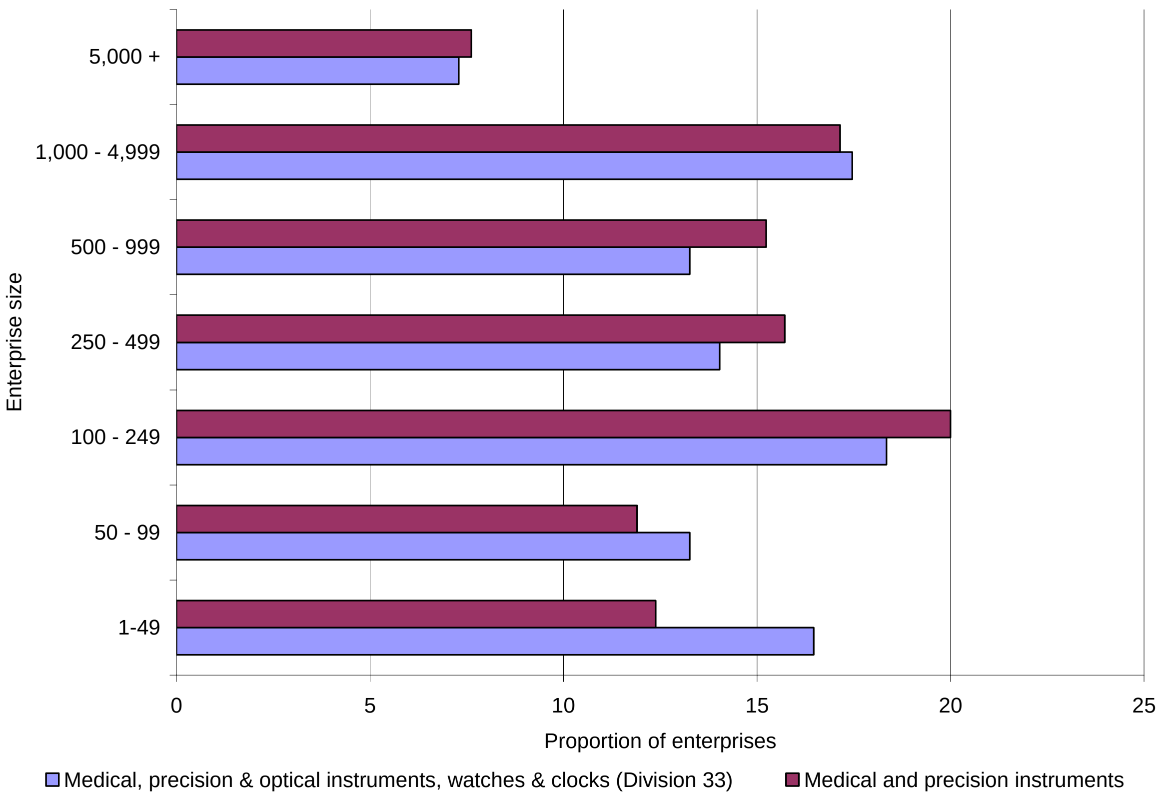
an *actual* cluster. This is where the analysis of (i)-(iii) for more established clusters in other countries will prove to be so important.

2.2 Performance of Sector (Employment/Output growth)

Number of Enterprises in the Sector

Figure 2.1 sets out the distribution of enterprises by firm size, measured by number of employees, both for the sector (33) as a whole and for Medical and Precision Instruments (33.1). The data are for 1997, the latest year available on the ONS website. Both sectors have quite a high proportion of very large enterprises and, if anything, sector 33.1 appears to be slightly more biased towards larger enterprise sizes than 33 as a whole.

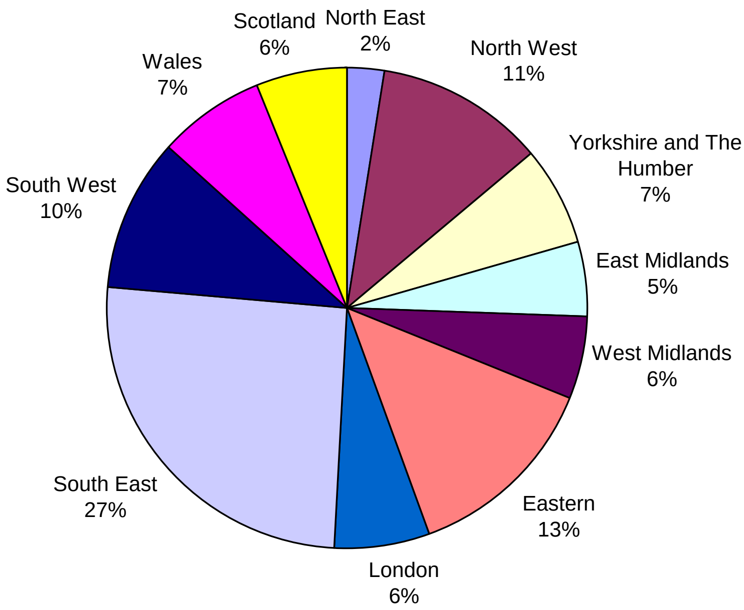
Figure 2.1 Proportion of Enterprises by Employment Size, 1997



Regional Distribution, SIC 33.1, Employment

Regional data are available from NOMIS (the latest data available are for 1998). *Figure 2.2* sets out the proportion of employees (all employees – male, female, part time and full time) broken down by region. It can be seen that the South East and London combined has by far the largest proportion of employees in this sector, while the West Midlands only have about 6 per cent of the total.

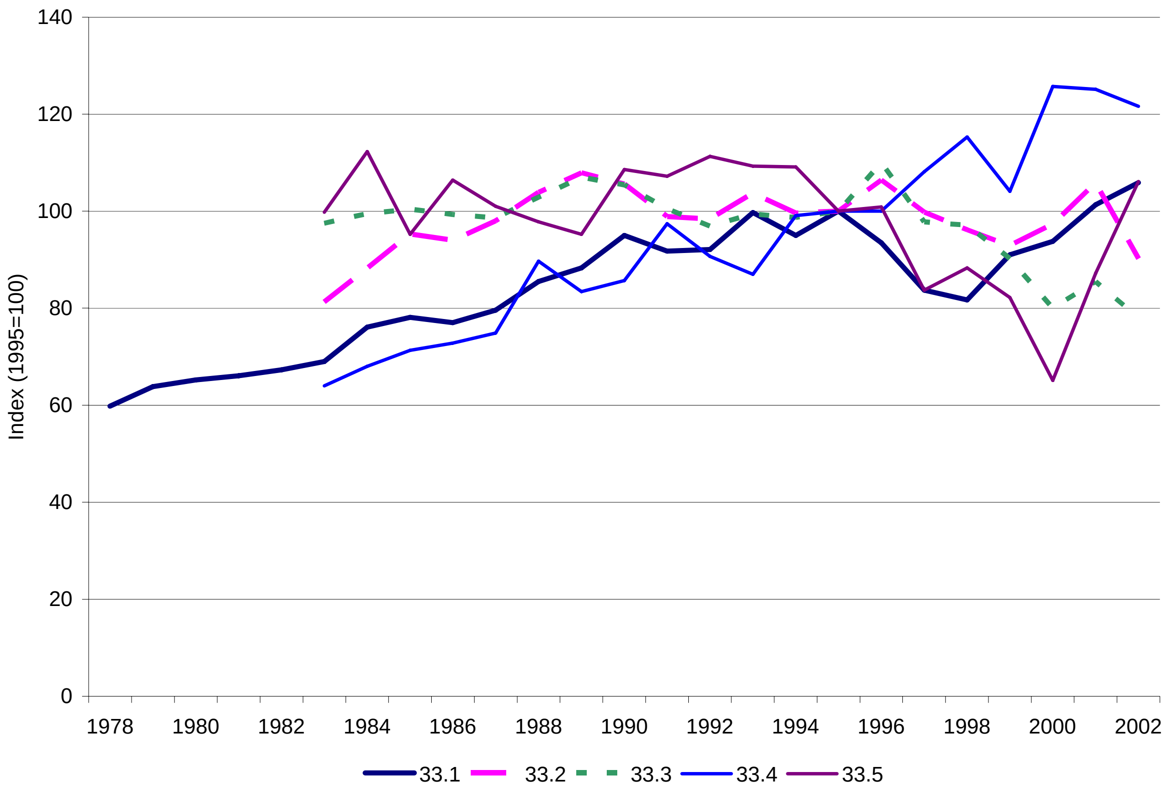
Figure 2.2 Distributiion of Employees, SIC 33.1, by Region



Sector Growth

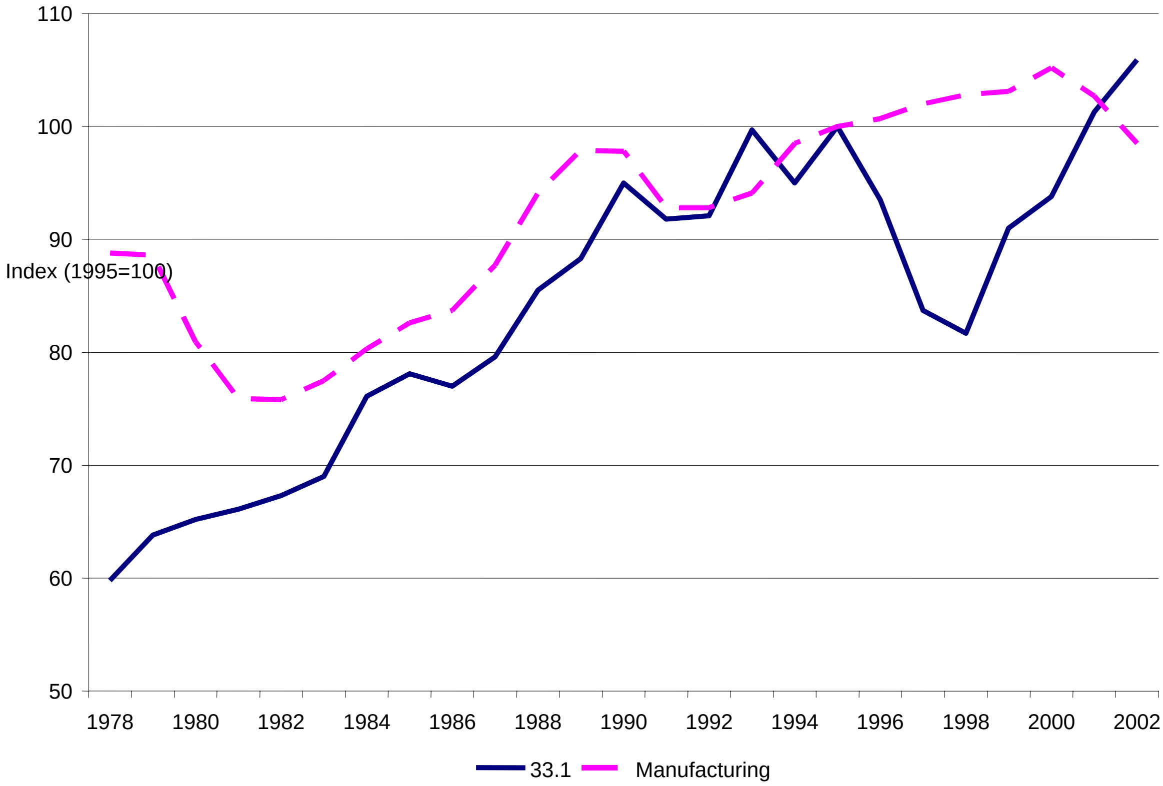
The discussion of performance outlined here focuses on SIC 33.1, and is subject to all the limitations discussed above. It can be seen that the Medical and Precision Instruments sector has grown from an index of about 60 in the late 1970s, to finish at an index of around 106 by the end of the sample period. It is also clear that the sector was severely hit by the recession of the early 1990s and only just about recovers to somewhere near the earlier trend path by 2002. In many respects, sectors 33.1 and 33.4 appear to perform more similarly and significantly better than 33.2, 33.3 and 33.5 (the other elements of SIC 33) *(see Figures 2.3 and 2.4)*.

Figure 2.3 Index of Industrial Production: Groups within SIC 33 (1995=100)



In order to put these results in context, Figure ** contrasts the performance of SIC 33.1 with manufacturing as a whole. It can be seen that SIC 33.1 outperforms manufacturing over the period as a whole, however, it suffers a major turndown *vis a vis* manufacturing in the early 1990s, which it just recovers by the end of the period. However, its recent trend looks set to outpace manufacturing as a whole by a significant amount.

Figure 2.4 Growth in the Employment of Administrative, Technical and Clerical and of Operatives



2.3 Intellectual Property Generation and the Potential Usefulness of IP Data

In terms of understanding technological linkages that might help in understanding the development of a cluster, patent data appear to be potentially very important and very exciting. For a discussion of patent data in this context, see Bosworth (2004). The broad groupings of the International Patent Classification are given in *Appendix 2*.[33] The detailed breakdown on which this is based can be found on the web[34]. It is not reported here because the detailed subclasses relating to patents in the medical technologies area covers 40 sides of information about the breakdown of IPC7 (*i.e.* the sub-groups of Class A61, medical, veterinary science, dental and hygiene).

Just to illustrate the basic data, *Table 2.3* reports on international activity in the A61 (MT) group (excluding A61K, which includes pharmaceutical preparations and related). Note, however, that the group as a whole (Class 04) also includes A62 and A63, which are not relevant to the MT area, and would need to be excluded in a more refined search. The data in *Table 2.3* relate to patent applications (rather than grants, which are available), and therefore exclude the USA (which does not report applications unless the patent is granted). The country codes used in the first row heading are provided in *Appendix 3*.

The data show the country of application (i.e. take the column relating to GB) and the countries in which UK inventors have applied for patent protection (shown by the countries appearing in the first column). It can be seen, for example, that the UK as a source is considerably less important than Germany (DE) (i.e approximately 5400 compared with 9,100 applications); and as a recipient, the UK receives 7642 compared with Germany's

33 WIPO. Industrial Property Statistics, 1997. Geneva. (CD)
34 http://l2.espacenet.com/espacenet/ecla/index/index.htm

10182. Further investigation of these data, more particularly using patent grants will be undertaken to examine the international patterns of MT technology production and technology usage.

The main aim of this initial exploration, however, is to argue that patent data are a potentially enormously important source of information for this study. It is possible to explore the range of companies that are operating in the MT area from patent application and patent grant data. It is also possible to examine linkages between companies and between technologies using these data. In particular, the inventor fields can be explored for joint invention activity, and the citation fields can be explored to show technological linkages between companies. This can be carried out in the UK and/or any of the other locations being explored in the study.

Table 2.3 International Patent Flows (Applications) in the area of Medical Technologies

Country of applicant:	XX	AT	AU	BE	CA	CH	CN	DE	DK	ES	FI	FR	GB	HU	IT	JP	KR	NL	NO	PT	RU	SE	US		TOTAL
Reporting country																								Autres	
Austria	186	0	176	28	153	164	15	658	106	53	60	332	407	5	143	251	9	118	36	2	35	260	3842	454	7493
Belgium	90	27	98	0	86	140	9	575	61	47	39	290	261	3	120	251	7	105	18	2	25	179	2738	308	5479
Denmark	188	36	176	28	150	149	15	616	0	54	59	305	407	5	140	256	10	118	37	2	37	259	3823	446	7316
Finland	158	10	82	8	68	17	6	63	50	8	0	37	152	2	24	9	3	23	21	0	17	99	1195	155	2207
France	1183	33	98	24	87	161	10	666	61	53	39	0	284	3	136	324	13	103	19	4	25	197	2921	342	6786
Germany	2771	61	180	32	157	230	15	0	106	58	67	361	430	5	157	385	19	146	41	2	42	284	4127	506	10182
Greece	4	26	97	21	85	134	9	540	60	47	38	271	252	3	120	239	7	90	18	2	25	176	2653	291	5208
Ireland	22	26	96	21	83	134	9	538	59	46	38	266	254	3	121	240	7	97	18	2	25	176	2663	281	5225
Italy	129	33	97	21	87	147	9	639	61	48	39	315	270	3	0	283	11	100	18	2	25	193	2839	317	5686
Japan	50	15	90	14	77	50	9	268	51	25	27	114	184	3	42	0	10	43	18	2	26	147	2155	231	3651
Luxembourg	11	35	176	29	149	147	15	589	105	53	59	300	398	5	135	246	9	114	35	2	36	259	3795	433	7135
Netherlands	248	30	98	24	86	145	9	606	61	48	39	284	267	3	123	273	7	0	18	2	25	193	2790	319	5698
Norway	95	11	80	9	70	23	6	103	46	13	25	50	153	2	30	11	3	29	0	2	16	94	1307	172	2350
Portugal	6	35	175	28	149	147	15	595	104	55	59	301	401	5	138	248	9	114	36	0	36	258	3766	446	7126
Spain	50	40	176	29	151	157	15	638	106	0	60	328	415	5	150	263	12	116	36	2	37	274	3900	456	7416
Sweden	267	38	176	28	151	158	15	631	106	53	60	311	411	5	144	277	10	118	35	2	36	0	3866	456	7354
Switzerland	353	44	176	29	153	0	15	687	106	55	59	340	407	5	148	260	10	125	35	3	37	268	3868	459	7642
United Kingdom	770	40	182	30	156	162	16	693	106	67	65	335	0	5	152	357	15	127	35	2	38	295	4120	521	8289
Total	6581	540	2429	403	2098	2265	212	9105	1355	783	832	4540	5353	70	2023	4173	171	1686	474	35	543	3611	56368	6593	112243

2.4 Linkages to other industries

The links between the MT sector and other parts of the economy can, bearing in mind the caveats of Section 2.1, be investigated using national input-output tables.[35] The industry we report here is 76: Medical and Precision Instruments. Total industry output in 1999 was reported to be £10.6 billion, of which about £10.2 billion was reported as being produced domestically. In addition, about £6 billion of goods were imported and a further £0.1 billion of services that were attributed to sector 76. Thus, adding on taxes and margins, total supply to the UK economy of sector 76 output was about £20.9 billion in 1999.

Consumption of Medical and Precision Instrument Output by other Sectors

The main intermediate consumption by other industries of the output of sector 76 is reported in *Table 2.4*. Note that only expenditures by other industries of over £25 million are reported in the table (more detail is provided in the original source). It can be seen that health and veterinary services are by far the largest purchaser from this sector, forming nearly 40 per cent of total purchases of medical and precision instruments. The only other buyer that purchased more than 10 per cent of the total output was public administration and defence (15 per cent).

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35 ONS (2001). *United Kingdom Input-Output Analyses*. National Statistics. 204401 Edition. HMSO: London.575

Table 2.4 Intermediate Consumption of the Output of the Medical and Precision Instrument Sector, 1999 (Values above £25 million)

Consuming sector	Value (£m)	per cent
Inorganic chemicals	32	0.38
Organic chemicals	118	1.40
Plastics, synthetics and resins	41	0.49
Pharmaceuticals	62	0.73
Structural metals	40	0.47
Metal boilers and radiators	35	0.41
Metal forging	29	0.34
Other metals	31	0.37
Office machinery and computers	207	2.45
Electric motors and generators	38	0.45
Electronic components	38	0.45
Transistors and TVs	44	0.52
Medical and precision instruments	575	6.81
Motor vehicles	330	3.91
Shipbuilding	109	1.29
Aircraft	250	2.96
Electricity production and distribution	59	0.70
Gas distribution	79	0.94
Construction	144	1.70
Motor vehicle distribution and repair	88	1.04
Wholesale distribution	75	0.89
Other transportation	40	0.47
Telecommunications	307	3.63
Computer services	147	1.74
Architectural services	84	0.99
Public administration and defence	1227	14.52
Education	62	0.73
Health and veterinary	3326	39.37
Other, nes	831	9.84
Total	8448	100.00

Consumption of Other Sectors' Goods by Medical and Precision Instruments

It can be seen from *Table 2.5* that about 10 per cent of the purchases by Sector 76 form intra-sectoral flows (i.e. they are purchases by one firm from another in the Medical and Precision Instrument sector). The main purchase, however, is of electronic components, forming 27 per cent of total expenditure from other industries. Other purchases are spread fairly evenly across the various sectors, with metal forging (6 per cent) and electrical motors and generators (8 per cent) each contribute over 5 per cent of total expenditures.

Table 2.5 Consumption of Other Sectors' Goods by Medical and Precision Instruments, 1999 (Values over £25 million)

Medical and Precision Purchases from Sector:	Value (£m)	per cent
Textile weaving	41	0.74
Other textiles	28	0.50
Paper and paperboard	64	1.15
Printing and publishing	84	1.51
Coke ovens	46	0.83
Other chemicals	55	0.99
Plastic products	327	5.88
Iron and steel	81	1.46
Non-ferrous metals	76	1.37
Metal forge and pressing	320	5.75
Electric motors and generators	403	7.25
Insulated wire	58	1.04
Electrical equipment	299	5.38
Electronic components	1516	27.26
Medical and precision instruments	575	10.34
Electricity production and distribution	77	1.38
Construction	28	0.50
Hotels and catering	31	0.56
Other land transport	72	1.29
Ancilliary transport	57	1.02
Telecommunications	59	1.06
Business and finance	166	2.99
Insurance and pensions	61	1.10
Real estate	108	1.94
Machine rentals	78	1.40
Computer services	78	1.40
Research and development	39	0.70
Accounting services	38	0.68
Market research and management consultancy	37	0.67
Architecture and technical consultancy	120	2.16
Advertising	70	1.26
Public administration and defence	121	2.18
Recreational	36	0.65
Other, nes	312	5.61
Total	5561	100.00

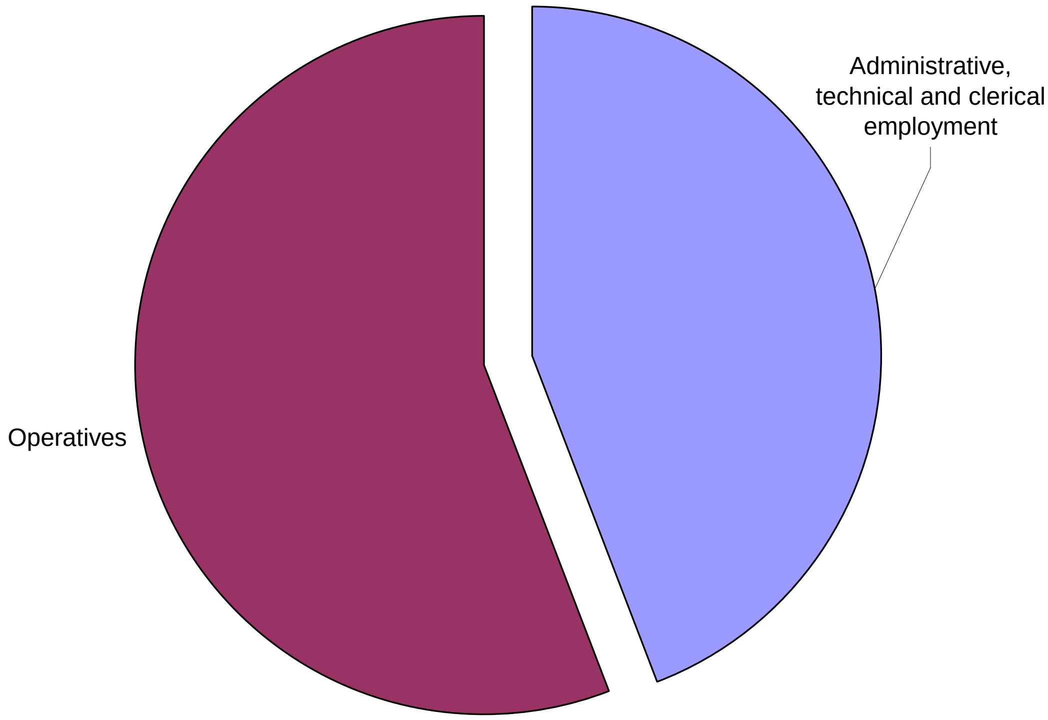
2.5 Ownership/key players in industry

The key players in SIC 33.1 can be identified using Kompass and other firm directories. Kompass, for example, produces a comprehensive listing of companies at an extremely disaggregated level (see their sub-classes of group 38). This source looks enormously useful both for patent searches of UK companies and for designing the mailing lists for the survey.

2.6 Skill Profile of Employment

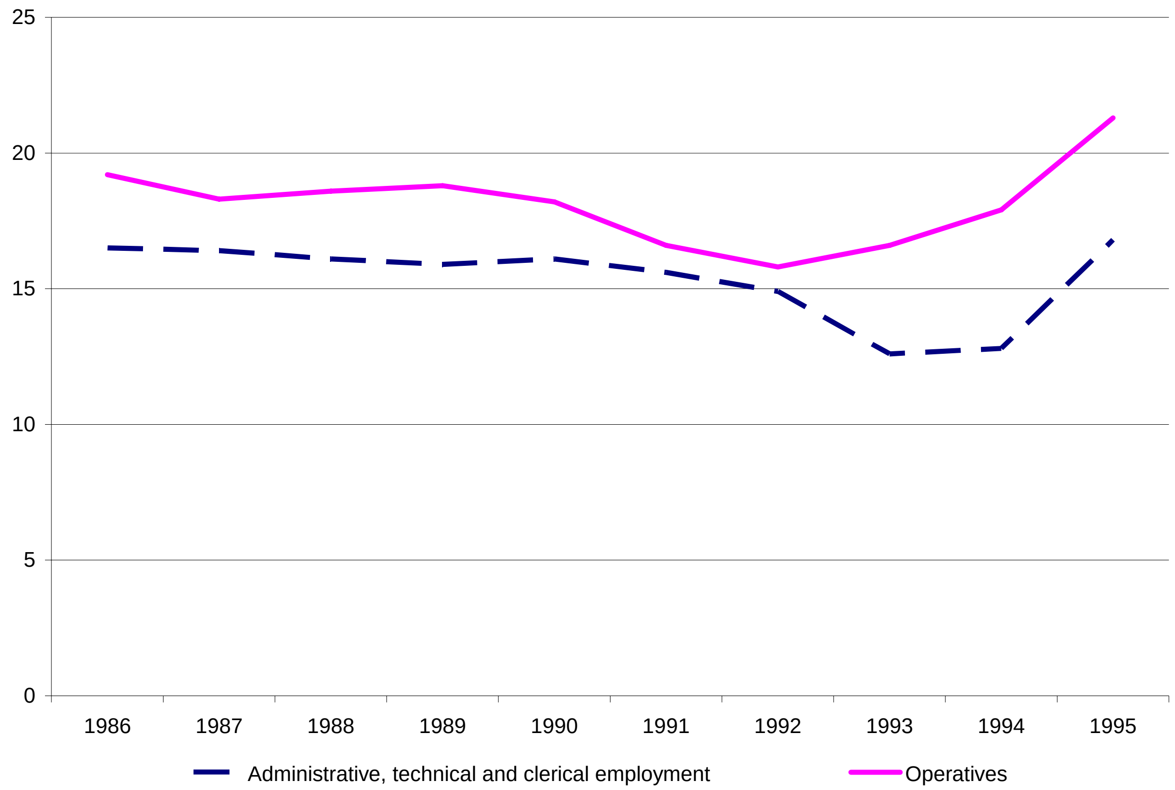
Skills data of any degree of reliability are not available at this level. The ability of the LFS to provide meaningful observations is currently under investigation. *Census of Production* data for SIC 33 as a whole provides a crude division between administrative, technical and clerical *versus* operatives. The results of this are shown in *Figures 2.5 and 2.6*.

Figure 2.5 Skills Profile of Industry



The data can also be used to produce trends over time, at least until the mid-1990s – see Figure **.

Figure 2.6 Trends in Employment of ATC and Operatives: SIC 33



2.7 Extent of unmet skill needs and reasons

No data are currently available at this level. However, it is planned to analyse the ESS to see if something useful can be said about skills and skill deficiencies.

2.8 Future of Employment in the Industry

No forecasts are available from the IER at this level of disaggregation. However, it may make some sense to report the forecasts for Instruments [to be checked] (Ind 29).

CHAPTER 3: MEDICAL TECHNOLOGY AND THE WEST MIDLAND REGIONAL ECONOMY

3.1 Introduction

The West Midlands region is situated in the heart of England and embraces an area of some 13,000 square kilometres. The region covers five counties - Staffordshire in the north, Shropshire to the northwest and Herefordshire, Worcestershire and Warwickshire in the south – together with the seven Metropolitan Districts that make up the West Midlands conurbation. The main cities and towns of the metropolitan area are Birmingham, Wolverhampton, Coventry and Walsall.

The population of the region is around 5.7 million and accounts for nine per cent of the population of the United Kingdom. This population is extremely diverse, in terms of density, ethnicity and economic activity. The population density (410 people per square kilometre) is slightly higher than the average for all English regions but this masks wide differences across the region. The City of Birmingham alone accounts for just under a million of the 2.5 million living in the conurbation and the population density is 2,000 or more per square kilometre in much of this area. The other main population centre is Stoke-on-Trent, in the north of the region, with a population of 240,000. Over 2 million people live in the rural counties outside the conurbation. Herefordshire and Shropshire are the least densely populated county areas in the region with less than 90 people per square kilometre.

While the overall age structure of the West Midlands region is similar to that of the UK as a whole, there are wide intra-regional variations. In particular, Birmingham has a ‘young’ population with an above average proportion of under-15 year-olds in their populations (22 per cent compared to just over 19 per cent) while also having the lowest proportion of population aged 60 years or above. The population is also diverse in terms of ethnic origin. According to the 2001 Census of Population, just over 11 per cent of the population of the region were of ethnic minority origin (7.7 per cent Indian, Pakistani & Bangladeshi; 2.8 per cent Black Caribbean African & Other; and 0.8 per cent Chinese & Other). This ethnic minority population tends to be concentrated within the large urban centers of the region.

The region is at the heart of the UK road and rail network. Motorways linking the North with the South East and South West converge in the Birmingham and Coventry areas while the main West Coast rail line between London, the North West of England and Scotland passes through the region. Although this is to the long-term advantage of the region, lack of rail capacity between Coventry and Birmingham, and congestion on the motorways to the north of Birmingham have created transport ‘bottleneck’ that severely restrict transport at present. The prospects for the future are somewhat brighter with a new motorway designed to reduce congestion (the Northern Relief Road) is due to open shortly while a programme of investment in rail improvements is being pursued.

International air travel is catered for by Birmingham International Airport, the UK’s fifth largest airport situated 4.5 miles to the south east of the city centre. There is also easy access to airports in the East Midlands and in Manchester. Regional business airports already exist at locations such as Coventry and additional ones have been proposed (for instance, in Wolverhampton).

3.2 Characteristics of the West Midlands economy

Economic activity

The output (Gross Value Added or GVA) of the West Midland region in 1999 was estimated to be around £63.5 billion (just over 8 per cent of UK GVA). The largest sector in the region is manufacturing that produces 29 per cent of the region’s GVA. This is substantially greater than the national average (20 per cent) and is the largest share of any region in the UK. The financial and business services sector is the next largest sector (18 per cent) although it's share is lower than the UK average (21.4 per cent). The wholesale and retail sector continues to grow and now represents 12 per cent (UK = 12.3 per cent) of the region's GVA.

Economic growth in the West Midlands has broadly followed the national average in recent years and this remains the case in 2003[36]. Nonetheless, per capita GVA in the region remains below the UK average (92 per cent of UK average in 1999) although there are considerable differences across the region. GVA per capita is above the UK average in two areas within the region (5 per cent higher in Coventry and 6 per cent higher in Warwickshire), approximately on a par with the UK average in Birmingham and Solihull and significantly below the UK average in Sandwell and Dudley (84 per cent), Wolverhampton and Walsall (82 per cent) and, lowest of all, Shropshire (78 per cent).

The West Midlands is a major exporting region, accounting for just over 8 per cent of total UK exports by value in 2002[37]. The region has also attracted a substantial volume of foreign direct investment, with nearly 2,000 overseas companies locating facilities in the region (mainly in Birmingham, Coventry and Telford).

The labour market

The number of people employed in the West Midlands during the April-June quarter is around 2.4 million (or 8.8 per cent of the UK total)[38]. The manufacturing sector accounts for 22 per cent of total employment, the second highest in the UK. Nonetheless, this share represents a considerable reduction on that of several decades ago when manufacturing employment was at its height. More than two thirds of all employment is now accounted for by the service sector and other industries which have grown rapidly in recent year with an extra 200,000 people employed in these sectors since 1995 bringing total employment to more than 1.7 million. Since March 2000, service industry employment has increased by 52,000 while employment in 'other' industries has increased by 49,000.

The region has experienced substantial job losses in the past, particularly associated with the decline of manufacturing where there has been considerable re-structuring of activities (with cuts in capacity being the predominant form of change). While not on a scale to match the job losses of the past, employment has continued to fall in many parts of the region's economy. In manufacturing employment levels have declined by 85,000 in the two years preceding March 2003[39]. Many companies in the region continue to report that employment levels are falling. At the beginning of 2003 as many as one in five businesses were reporting reductions in their workforce, although there is evidence that the rate of job shedding may have eased slightly by the middle of 2003[40]. In proportionate terms, these job cuts were estimated to be the largest of all the UK regions[41].

At the beginning of 2003, the number of unemployed people in the West Midlands (on the ILO definition) was 144,000 or 5.6 per cent of the labour force (compared to a national rate of 4.0 per cent). The number of people claiming Job Seekers Allowance has declined markedly in recent years, falling by a third since 1997. By June 2003 the number of people unemployed and claiming benefit in the region was 94,900 (or 3.6 per cent of the labour force compared to a UK average of 2.7 per cent)).

Across the region, ILO unemployment rates ranged from 11.0 per cent in Birmingham to 3.7 per cent in Worcestershire. Relatively high levels of unemployment are to be found within much of the main conurbation, in particular Birmingham (5.4 per cent), Wolverhampton (4.8 per cent) and Sandwell (4.7 per cent). The lowest rates are found within parts of the shire

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36 Royal Bank of Scotland, *PMI West Midlands Report*, 11 August 2003
37 Custom and Excise figures.
38 Office of National Statistics, *Labour Market Statistics, August 2003: West Midlands*.
39 ONS, *op cit*.
40 Royal Bank of Scotland, *op cit*.
41 Royal Bank of Scotland, *op cit*.

counties, for instance Warwick (1.6 per cent), Stratford upon Avon (1.1 per cent), North Warwickshire (1.5 per cent) and Malvern Hills (1.2 per cent).

Skills in the region

The region's heavy reliance upon manufacturing in the past meant that its workforce contained relatively large proportions of manual occupations, particularly skilled trades and semi-skilled operatives. Despite the long-term decline and re-structuring of the region's manufacturing sector, this pattern still persists. *Table 3.1* shows that in May 2003 the proportions of the region's workforce employed as managers and senior officials and in professional and associate professional & technician jobs was significantly below the national (GB) average while employment in skilled trades, process and plant & machine operatives and in elementary jobs was above the national average. The 'gap' was most marked in respect of process, plant and machine operatives (3 percentage points difference), associate professional & technical (2.4 percentage points) and skilled trades (a 1.7 percentage point difference).

Further evidence of a tendency for the region's labour force to be less skilled than the national average can be found in educational indicators for the region. Table 3.2 that on each indicator, the West midlands performs less well than Great Britain. A smaller proportion of 16-19 year olds remain in full-time education while the proportions of working age people with higher level qualifications (NVQ Levels 3 or 4 equivalent or above) is generally less than the corresponding national average figure.

Table 3.1: Broad occupational structure of West Midlands, May 2003

percentage of total employment

Occupational group (SOC 2000)	Great Britain	West Midlands
Managers & senior officials	14.8	14.0
Professional	12.1	10.4
Associate professional & technical	13.8	11.4
Administrative and secretarial	12.8	12.4
Skilled trades	11.5	13.2
Personal service	7.3	7.4
Sales and customer service	7.9	7.9
Process, plant & machine operatives	7.9	10.9
Elementary occupations	11.7	12.0

Source: Labour Force Survey

Table 3.2 Educational attainment, West Midlands, May 2003

Per cent

	Great Britain	West Midlands
16-19 year-olds in full-time education	61.8	57.6
Working age people with NVQ Level 3 or above	44.2	40.2
Working age people in employment with NVQ Lev 3 or above	49	45.1
Working age people with NVQ Level 4 or above	24.9	21
Working age people in employment with NVQ Level 4 or above	29	24.8

Source: Labour Force Survey

3.3 Medical technologies in the West Midlands

As discussed earlier in this report, the identification of businesses operating in the medical technologies sector in the West Midlands is a complex issue. In the first place there is the problem of definition (both in principle and in practice). On top of this, evidence at the regional level is sparse and potentially unreliable.

There are two main sources on information from which the medical technology cluster can be identified. First, the Office of National Statistics publishes statistics on employment, classified by establishment size, by industry and by region derived from the Annual Business Inquiry (ABI) or, before 1998, from the Annual Employment Survey (AES). The main advantage of this source is that the data is collected in a rigorous manner and coverage of establishments is high. The disadvantages of these official statistics is that they only provide information on numbers employed and can say little about the nature of the business other than the industry to which the establishment is classified. Like all data collection, the ABI and AES are subject to reporting and classification error and these problems become more important at regional and, particularly, sub-regional level.

The use of the ABI to identify the West Midlands medical technology cluster is restricted by the need to classify each establishment to an ‘industry’. Establishments are classified (using the Standard Industrial Classification, or SIC) according to their ‘main’ activity. Only one SIC classification is unambiguously concerned with medical technology (SIC 33.10: manufacture of medical and surgical equipment and orthopaedic appliances). This gives rise to two difficulties.

First, some business activities that would otherwise be classified to SIC 33.10 will in reality be classified to other industries as they take place in establishments where the main business is something other manufacturing medical, surgical and orthopaedic goods. This problem is particularly acute in situations where existing businesses are diversifying their activities into the field of medical technology. This could be especially true of a region such as the West Midlands that has a large traditional manufacturing base that may be seeking new markets for its expertise. The effect of this problem on measurement is to understate the scale of medical technology (even on the narrowest of definitions).

The second problem arising from the manner in which activities are classified in the ABI is that medical technology is a new and developing area. SIC 33.10 represents a narrow, and arguably a very traditional, view of what constitutes medical technology activity. Medical technology activity is thus likely to be found in businesses classified to other industrial activities. The difficulty is that, whatever industrial activities are included in an expanded definition of medical technology, many, perhaps the majority, will not be medical technology. In the absence of additional information about the nature of business activities, it is impossible to separate medical technology from other activities. Extending the definition of medical technology to include other SIC categories will greatly exaggerate the scale of such activities while restricting the definition to SIC 33.10 will greatly understate the scale of the cluster.

Faced with the limitations of the ABI, an alternative is to use *ad hoc* methods to identify businesses that are engaged in medical technology activities. Examination of business directories, lists of contacts compiled by organisations (such as AWM), Internet searches and similar methods have been used. The advantage of such an approach is that it is not restricted by the use of the SIC classification. Moreover, if followed up by a survey of the businesses uncovered, much additional information about the activities of businesses in the regional medical technology cluster can be gathered. Nonetheless, it is important to recognise that this approach also has limitations. It is difficult to judge the extent to which such samples of businesses are representative of the population of medical technology firms in the region. There is a risk that they are simply the most visible. Medical technology activity that may be overlooked will include micro businesses and activities that are 'hidden' within organisations whose main business is something other than medical technology.

Both types of evidence (ABI and ad hoc methods) have been used to identify the scale and form of the West Midlands medical technology cluster. For instance, Burfitt and Gibney[42] conduct a thorough analysis of the West Midlands medical technology sector using data from the 1998 AES in conjunction with a survey of such businesses while Angle Technology Ltd use ad hoc methods to identify a sample of medical technology businesses in the region. While it is unlikely that the scale and composition of the West Midland medical technology cluster can ever be know with absolute certainty, by 'triangulating' information from a variety of sources (such as those mentioned above) it may be possible to provide an approximate measure of the cluster.

Size of the medical technology cluster

A number of studies have concluded that the West Midlands has one of the smallest, if not the smallest, medical technology sectors in the UK. Burfitt and Gibney (op cit) estimated that SIC 33.10 accounted for only 0.09 per cent of all employment in the region in 1998, compared to 0.14 per cent in the UK as a whole and 0.28 per cent in the South East region.

According to the Annual Business Inquiry 2000, there were 170 establishments in the West Midlands classified as operating in SIC 33.10 (manufacture of medical and surgical equipment and orthopaedic appliances. These establishments employed a total of 1,662 employees. Three quarters of these establishments employed between 1-10 employees and a further 20 per cent employed 11-49 employees. Thus virtually all medical technology employment recorded by the ABI was in establishments employing less than 50 people.

The number of establishments and employees in SIC 33.10 recorded by the ABI appears to be roughly static. In 1998 there were 169 establishments, falling to 157 in 1999 and increasing to 170 in 2000. The small variation could be due to measurement error to which the recording of data at four-digit industry level is particularly prone. The number of employees recorded is subject to the same caveat but displays a more consistent pattern, falling from 2120 in 1998 to 1756 in 1999 and to 1662 in 2000. These figures should be regarded as indicative only but they do suggest that employment in mainstream medical technology activities has possibly been declining in recent years.

SIC 33.10 is a very narrow definition of medical technology and it is widely acknowledged that other important forms of medical technology business lie outside of that sector. A report by Angle Technology Ltd (ATL) identified 123 medical technology companies in the West Midlands employing around 3,500 employees. This is a smaller number of businesses than identified by the ABI and could be explained in three ways.

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42 Burfitt A. and J. Gibney, *On innovation in the medical devices/supplies industry: competitiveness issues for the West Midlands*, Centre for Urban and Regional Studies, University of Birmingham, June 2001.

First, the ABI records establishments (not companies) and the difference may be explicable in terms of businesses operating from more than one site in the region. Second, the ATL survey was conducted in early 2002 so the difference may reflect a further real decline in the number of medical technology businesses over the period 2000-2002. Finally, it might have been expected that ATL would identify more businesses than the ABI since ATL adopted a broader definition of medical technology. Gibney[43] cites the 1995 West Midlands Medlink Proposal as providing an estimate that in excess of 300 businesses were operating in a diverse range of medical technologies in the West Midlands. This suggests (if correct) that the ATL sample only partially covered the cluster as a whole.

Evidence from both the ABI and other sources suggests that the West Midland medical technology sector has not enjoyed significant growth. Indeed, Burfitt and Gibney (op cit) argue that the sector (narrowly defined as SIC33.10) has been in sharp decline since 1996 against a national trend of increasing numbers of manufacturing jobs. The ATL study found that firms in their sample had a rather mixed view of their prospects for business growth. A minority actually predicted substantial reductions in business activities (particularly the largest company sampled) but most projected some growth and a few projected substantial growth. Such estimates need to be treated with scepticism, as it is difficult to distinguish between 'hard' projections and wishes or intentions.

Type of medical technology activities

One advantage of the ad hoc identification of medical technology businesses is that surveys can then provide information about the characteristics of medical technology companies. The ATL survey suggested that most medical technology companies in the West Midlands were small, indigenous businesses with less than one in ten of the sample being part of a larger concern located outside the region. A large proportion of medical technology businesses were located in Staffordshire, Worcestershire and the 'Black Country' (Wolverhampton, Dudley, Walsall areas).

The activities in which the ATL sample of businesses were engaged were as shown in Table 3.3. The largest single type of activity was the manufacture of surgical appliances and supplies (26 per cent). This together with rehabilitation and mobility equipment (13 per cent) approximates SIC 33.10. The table thus serves to illustrate the point that a considerable range of activities are lie outside of that narrow definition of medical technologies. Other significant types of activity were pharmaceutical and bio-technology products, ophthalmic goods and dental and orthodontic products.

43 Gibney J., A snapshot of research and technology trends in the pharmaceutical and medical equipment devices and supplies sector, Centre for Urban and Regional Studies, University of Birmingham, March 1998.

Table 3.3 Activities within the West Midland medical technology cluster

Activity	Per cent
Surgical appliances and supplies	25.6
Rehabilitation and mobility equipment	12.8
Pharmaceutical and bio-technology products	12.8
Ophthalmic goods	10.5
Dental and orthodontic products	10.5
Surgical and medical instruments	9.8
Medical consumables	9.8
Medical software	7.5
Surgical appliances and supplies	0.8

Source: Angle Technology Ltd, 2002

3.4 Employment in medical technologies

According to data from the ABI, employment in the medical technology sector (defined as SIC 33.10) predominantly consists of full-time jobs with very little part-time working. Full-time jobs accounted for over 93 per cent of all employment in 2000. Men occupied most jobs in the sector: 73 per cent of jobs were filled by men working full-time and just 1.3 per cent of jobs by men working part-time. Women were more likely than men to be in a part-time job (5.2 per cent of total employment, but most were employed full-time (20 per cent of all employment).

There is little information about wage levels in the medical technology sector. It might, however, be expected that wages in the sector would be relatively high since the level of skills required is above average. Nonetheless, Burfitt and Gibney (op cit) note that there is evidence that the value of output per head in the medical technology sector is low in the West Midlands when contrasted with other regions. This can be expected to be reflected in pay and salary levels.

There is also little evidence relating to the skills used by the medical technology sector in the West Midlands. This is partly because of the general dearth of information about the sector but also because employment and skills issues often appear to take second place in studies of the sector to considerations of the market for medical technology, relevant technologies, innovation and physical assets such as property and premises. Yet ensuring that skill needs are met is critical to the performance of the sector.

In a relatively rare study of the skill needs of the medical technology sector in the West Midlands Byre Associates[44] seek to identify the skill needs and skills gaps in companies in the West Midlands medical technology sector and to map learning relevant provision in the region. The study identified three main areas of need for medical technology businesses. These were:

- medical engineering;
- project management;
- new product development.

The report concluded that skills gaps were of secondary importance compared to other business issues (such as short-term profitability or the impact of legislation and industry regulation). Insofar as skills development needs were identified, these needs were for supervisory and project management skills, business and commercial skills for technical managers and for Level 4 process and electronics engineering skills. The report also concluded, after mapping provision in the region, that there was adequate provision in

44 Byre Associates, Skill Needs and Provision in the West Midlands Medical Technologies Sector, Report for Advantage West Midlands, April 2001.

further and higher education institutions to meet the learning needs identified by companies in the medical technology sector.

The findings of the Byre Associates report are echoed to some extent in the findings of the ATL (op cit) survey of medical technology businesses. The ATL survey reported that employers in the medical technology sample identified a number of skills related weaknesses relating to:

- an inadequate supply of professional engineers;
- a lack of production skills in the medical diagnostics/devices area;
- a general lack of bioscience skills in the region;
- a lack of knowledge of working directives and standards required for medical technology device manufacture and production;
- a shortage of laboratory technicians;
- a lack of entrepreneurs in the medical technology field.

ATL observed that in some cases, for instance bioscience skills, the region's higher education system was producing a significant output of graduates in bioscience and biomedical sciences but the lack of a visible bioscience/biomedical industry inhibited the region's ability to retain such graduates. On the other hand, the industrial history and structure of the region meant that medical technology businesses were able to benefit from a ready supply of unskilled labour and semi-skilled labour with experience and skills in manufacturing and machining who could be trained in-house.

3.5 Drivers of medical technology development in the West Midlands

The external drivers of medical technology development in the West Midlands are similar to those drivers operating across the UK. Underlying the process is the development of a huge global market for medical devices and products. This reflects demographic change with an aging population both in the UK and elsewhere. It also reflects an increasing demand by consumers for more advanced and sophisticated treatments. Consumers are also looking for different forms of medical product, for instance those offering self-diagnosis, as well as those that incorporate new technologies involving new materials or offering portable or miniature devices. The increasing scale of healthcare in countries such as the UK has also meant that healthcare providers are seeking cost-efficient products to help reduce the financial burden of healthcare provision.

In addition to these external drivers, there are also internal drivers of medical technology-based activities in the region. The first of these is the need to diversify out of traditional manufacturing activities into new products and markets. This is the consequence of the decline in traditional manufacturing activities over much of the past four decades. Manufacturers in the region (and agencies seeking to develop the region) need to find new activities that will prevent further manufacturing decline. Some aspects of medical technology appear suited to this purpose, being a high value added activity, related to existing engineering activity and less prone to cyclical fluctuations than more traditional activities.

3.6 Industry linkages

The market for medical devices and products is a global one and for this reason most companies in the sector would be expected to operate at the national level at least, if not at international level. The ATL survey found that most companies had strong customer links outside the region, often with the National Health Service in the UK, while some had a strong international customer base. In many cases the customer base was weakest within the region.

Since the region's medical technology sector is so small, it is to be expected that most companies in the West Midlands see their main competitors as being located outside the West Midlands, often in other UK regions which have a more developed medical technology industry (London and the South East and Yorkshire, for instance). ATL observed that almost 40 per cent of companies interviewed saw no direct competition at all within the region and on the basis of this ATL concluded that intra-regional competition was negligible.

The small size of the cluster in the West Midlands may also explain why relatively few companies felt they had a strong supplier base in the region. Only a third of companies in the ATL survey felt they had even a medium strength link with West Midland suppliers and more than half indicated that they had strong links with suppliers outside the region, notably in Yorkshire, Derbyshire and Wales.

One recurring themes of research into the medical technology sector in the West Midlands is that linkages within the region, between companies and between the cluster and other parts of the regional economy (such as higher education) have been, at best, fairly weak. Burfitt and Gibney (op cit) found that 83 per cent of innovating companies had collaborated with at least one other agency or organisation and 50 per cent of innovators involved another form in the process. The reason that this collaboration does not translate into a high level of intra-regional linkage is two-fold.

First, few firms are innovating so the links are limited to a small group of companies. Second, companies that forge links with other organisations often do so with organisations outside the region. . ATL concluded that there was little evidence of inter-company collaboration within the region, with many companies having been more successful in establishing links with collaborating companies in other regions of the UK. In the case of collaboration and links with universities and hospitals, there appears to be a higher level of interaction. The Universities of Birmingham and Warwick have strong links with the medical technology sector, but so too do the Universities of Oxford, Cambridge and University College London. Even in the case of hospitals and the NHS, companies in the medical technology sector were as likely to have links with hospitals outside the region as within it.

3.7 Local skills and the development of medical technologies

The West Midlands region has eight universities, four other higher education establishments and 50 Further Education colleges. These educational institutions play an important role in facilitating the supply of people with the skills needed by the medical technology sector. Byre Associates concluded that the provision of training and learning in the region was adequate to the needs of the sector. This may be so, although it is always open to question as to whether employers are always aware of their needs and able to express that need in the form of a demand for education and training.

Further education colleges provide a broad range of low level and intermediate level courses relevant to adults employed in manufacturing companies (as operatives, supervisors, technicians or managers). Some colleges offer higher-level courses at NVQ level 4, particularly where colleges have developed 'Centres of Excellence' in particular subjects. A feature of provision in this sector is its flexibility in terms of part-time study and day-release courses.

A mapping of course provision indicates an abundance of high level course in areas such as engineering (mechanical and manufacturing), computer engineering, instrumentation and control, and computing. Far fewer colleges provide courses in areas such as manufacturing management, polymer technologies or metals technologies. Whether this pattern of provision is driven by employer demand or something else is impossible to establish.

The eight universities in the region provide a wide range of undergraduate and post-graduate education. University course cover a wide spectrum of programmes of relevance to medical technology companies. The range of degree programmes is substantial (see Byre Associates for a complete listing of first degree and post graduate studies). It is important to recognise that many students studying at West Midlands Universities do not originate from the region and many do not stay in the region once they have graduated. The issue facing medical technology companies in regard to higher education is less about whether universities offer relevant courses but whether West Midland companies can ‘capture’ highly training and skilled young people upon graduation.

In addition to undergraduate and postgraduate education, universities also provide a comprehensive range of support to business in general and medical technology companies in particular. These services include consultancy, continuing professional development programmes, contract research, technology transfer, customised training, short courses and student work placements.

3.8 Constraints on development of medical technology in the West Midlands

This section has noted on several occasions that the medical technologies sector in the West Midlands is somewhat underdeveloped, and in terms of the most easily observed element (SIC 33.10) has even been declining in recent times. What are the factors that are likely to have inhibited the development of the cluster in the past and may continue to do so in the future unless addressed in some way?

Burfitt and Gibney (op cit) suggest that the roots of the problem may lie in the industrial heritage of the region. They observe that regions that have developed the manufacture of medical devices and appliances to the greatest extent tend to be regions with a ‘new’ manufacturing sector based on light engineering and medium technology, often with links to high technology industries. Since the growth of medical technology manufacturing is based to a great extent on the adaptation of new materials and processes to medical applications, this is most easily achieved in regions where there is a close link between new manufacturing and SIC 33.10 (for instance). By contrast, the West Midlands is disadvantaged because of the high proportion of manufacturing in traditional heavy engineering where links to medical technologies may be less readily seen or achieved.

There may be other factors at work also. Even where medical technology companies do exist in the West Midlands, there is evidence that many operate at the low value added end of the market. Burfitt and Gibney (op cit) find evidence that West Midland companies in the sector are less profitable that medical technology companies in other regions. This result if, for instance, the transfer of expertise and technology from traditional West Midland manufacturing only ‘maps into’ relatively low technology, low value added products. However, studies of the sector in the region have drawn attention to the low level of innovation amongst medical technology companies. Burfitt and Gibney found that only 29 per cent of a sample of medical technology companies in the region had introduced a new product to the market in the period 1998-2000. The low level of innovation in the region may also reflect the impact of the high proportion of very small enterprises in the sector (only 15 per cent of firms employing 10 or less employees were innovators). This may reflect a lack of finances for innovation or a lack of managerial expertise. Whatever the reason, low value added per employee means that companies are likely to lack both the will and the resources to grow the business.

The effect of a failure to grow the medical technologies sector is likely to be cumulative. The smaller and less developed the sector relative to the industry in other regions, the less incentive West Midland companies have to collaborate within the region and the greater the incentive to work with companies outside the region. While such collaboration may well be beneficial to the partners, there is no guarantee that the benefits of such collaboration will inevitably flow back to benefit the region, indeed the reverse might happen.

The smaller and less visible the medical technology sector in the West Midlands, the more difficult it will be for companies in the sector to attract the skills that they require, partly because newly training young people may be unaware of the opportunities on offer with companies or may see better career prospects with companies in other regions that are performing better. The only study to map skill needs and provision in the sector concluded that employers saw few skills gaps and adequate provision. This may well be an accurate account of employer's views but it suggests a degree of complacency on the part of employers. Their demand for higher skills in areas relevant to medical technologies may not yet be fully evident because the cluster is under-developed and operating at the lower order end of the market. If companies were to seek to achieve more, either through greater innovation or commercial exploitation of existing products, then skills gaps might become more evident and it would remain to be seen to what extent the local training infrastructure could match that new demand for skills.

CHAPTER 4: CONCLUSION

This first draft has highlighted some of the key issues facing the development of the medical technologies sector from both a national and regional, West Midlands perspective. The focus is very much upon skills: the extent to which a strong skills base acts as a catalyst for the development of the industry, and the extent to which a shortage of key skills potentially acts as a constraint on development. Many of the skills required by the medical technology industry – management, scientific, and technical skills – are recruited in national rather than regional or local labour markets. This reinforces the view that the role of skills needs be seen in the wider policy context related to inward investment strategies, small firm incubation, innovation strategies *etc.*

From available evidence many of the high level skills the industry requires are ones for which shortages – as found in the national Employers Skill Surveys – are found across industry and across regions. In essence the skills mix required relates to mixes of technical skills coupled to generic skills such as management, team building/leading *etc*. Similarly, at an intermediate level the demand for technical skills appears to outstrip supply both regionally and nationally and these are exactly the type of skills required in a high-value added, high-wage sectors.

The evidence at first glance indicates that skills supply is a potential constraint on industrial development generally and especially so in high-tech, high-skill sectors. For the time being parts of the sector in the West Midlands are low-skill, low value-added sectors. The key question is to assess what will happen as firms attempt to shift their markets to higher value-added sectors as much of the industrial development policy in the UK bids companies to do. The evidence from previous research in this area suggests that substantial skill shortages and skill gaps will emerge. In many respects these will be transitional effects as labour supply adjusts to meet changing demand, but in other industries the transition has proved prolonged with, consequently, opportunities foregone.

For the future, the medical technologies sector is one that has massive potential to create high-wage, high-skill employment. But the battle to capture that market will be fought out in the global marketplace with countries and regions competing on the mix of factors, one of which will be the available skills base. In many respects the industrial heritage of the West Midlands, although identified as a weakness in some reports, may also be an advantage in that it has created a pool of skilled labour with experience in manufacturing. Ultimately it is a question of identifying national and regional comparative advantage.

In developing the benchmark report further, and that of the study more generally, the study will need to address the policies and activities in the West Midlands in a comparative context.

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APPENDIX 1 MAIN DTI PROGRAMMES PROVIDING SECTOR SUPPORT

Table A2.1 Major DTI Programmes Providing Sector Support for Innovation/Technology Transfer

Scheme	Budget (TFR 2003/4)	Purpose	New Business Support product
Smart	£27m	Funding towards the costs of R&D projects in small and medium sized firms (< 250 employees)	R&D grant
TCS	£18m	Support for graduates to work on innovative projects in firms	Knowledge transfer through people
LINK	£19.3m	Programme supporting research collaborations between firms and universities	Collaborative R&D
NMS	£75m	National Measurement System responsible for funding measurement research and its dissemination to users	NMS
Faraday Partnerships	£9.4m	Funding of networks to promote flows of people, technology and innovative business concepts between the science and engineering base and industry.	
Biotechnology	£10.2m	Public funding of a range of activities from LINK research programmes, support for exploitation (e.g. advice on IP) and support for manufacturing.	Product depends on business case and type of activity supported
Space technologies	£32.9m	Funds technology projects in support of ESA and UK space missions.	Product depends on business case and type of activity supported

Source: Metcalfe, *et al*. (2003, Annex G)

APPENDIX 2: INTERNATIONAL PATENT CLASSES AVAILABLE IN WIPO INDUSTRIAL PROPERTY STATISTICS

SECTION	*UNIT*	*SUB-SECTION TITLE*	*CLASS(ES)*
HUMAN NECESSITIES	*1*	Agriculture	A01 (except A01N)
	2	Foodstuffs; Tobacco	A21 to A24
	3	Personal or domestic articles	A41 to A47
	4	Health; amusement	A61 to A63 except A61K
	5	Preparations for medical, dental, or toilet purposes	Subclass A61K
PERFORMING OPERATIONS;	*6*	Separating; Mixing	B01 to B09
TRANSPORTING	*7*	Shaping	B21 to B23
	8	Shaping	B24 to B32 except B31
	9	Printing	B41 to B44
	10	Transporting	B60 to B64
	11	Transporting	B65 to B68
CHEMISTRY; METALLURGY	*12*	Chemistry	C01 to C05
	13	Chemistry	C07 and subclass A01N
	14	Chemistry	C08
	15	Chemistry	C09 to C11
	16	Chemistry	C12 to C14
	17	Metallurgy	C21 to C23, C25 and C30
TEXTILES; PAPER	*18*	Textiles or flexible materials not otherwise provided for	D01 to D07
	19	Paper	D21 and D31
FIXED CONSTRUCTIONS	*20*	Building	E01 to E06
	21	Earth drilling; Mining	E21
MECHANICAL ENGINEERING;	*22*	Engines or pumps	F01 to F04 and F15
LIGHTING; HEATING;	*23*	Engineering in general	F16 and F17
WEAPONS; BLASTING	*24*	Lighting; Heating	F21 to F28
	25	Weapons; Blasting	F41, F42 and C06
PHYSICS	*26*	Instruments	G01 to G03
	27	Instruments	G04 to G08
	28	Instruments	G09 to G12
	29	Nucleonics	G21
ELECTRICITY	*30*	Electricity	H01, H02 and H05
	31	Electricity	H03 and H04
OTHERS	*32*	Others	Unclassified

APPENDIX 3: WIPO COUNTRY CODES

WIPO Country Codes	
AT	Austria
AU	Australia
BE	Belgium
CA	Canada
CH	Switzerland
CN	China
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GB	UK
HU	Hungary
IT	Italy
JP	Japan
KR	Republic of Korea
NL	Netherlands
NO	Norway
PT	Portugal
RU	Russia
SE	Sweden
US	USA