DEVELOPING EXCELLENCE IN MEDICAL TECHNOLOGIES: SYNTHESIS REPORT

A report prepared for
Advantage West Midlands

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1. INTRODUCTION

1.1 The "Developing Excellence" study

The 'Developing Excellence in Medical Technologies project' was concerned with the role of skills supply in the promotion of the medical technologies sector in six regions:

- the West Midlands, United Kingdom
- Scotland, United Kingdom;
- Baden-Württemberg, Germany
- Bavaria, Germany
- Medicon Valley, Denmark
- Massachusetts, USA.

The selection of regions was not accidental. Baden-Württemberg is widely acknowledged as a major centre of production in medical devices, Bavaria is the location of Siemens Medical one of the largest medical device producers in the world. Medicon Valley is recognised as recognised spreading from Denmark into Sweden is recognised as a major centre of medical device, pharmaceutical, and bio-technology clustering. In the United Kingdom both the West Midlands and Scotland have recognised the medical technologies cluster as major potential source of future high-skill employment. Historically, Massachusetts has been a major centre of medical device manufacture in the USA producing good for export and for the large US domestic market.

The study is principally concerned with the role of skills as a facilitator or inhibitor to the development of a high-skill, high productivity industrial development. The choice of countries

provides a variety of institutional arrangements for the supply of skills. Both Germany and Denmark represent countries with a long tradition of structured training to young people. The dual system in Germany has, until relatively recently, been regarded as being an integral part of the success of this economy producing high value-added goods. In Denmark, the commitment to training and development enshrined in collective bargaining, allied to a relatively high level of expenditure of training within active labour market policies, has ensured a strong supply of skilled people. In contrast, the UK and USA represent countries with a much more voluntarist approach to training. In other words, it is very much up to employers to decide the type and volume of training in which they are prepared to engage. Even within the UK there are differences with the structure of education in England differing to that in Scotland.

The selection of countries and regions within them provides different industrial development trajectories supported by varying approaches to the supply of skills *(see Table 1).*

Table 1 Classification of training systems and market position

	Concentration in relatively high value-added production	Concentration in relatively low value-added production
Structured/tri-partite approach to skills supply	Germany Denmark	
Voluntarist approach to skills supply	USA	UK

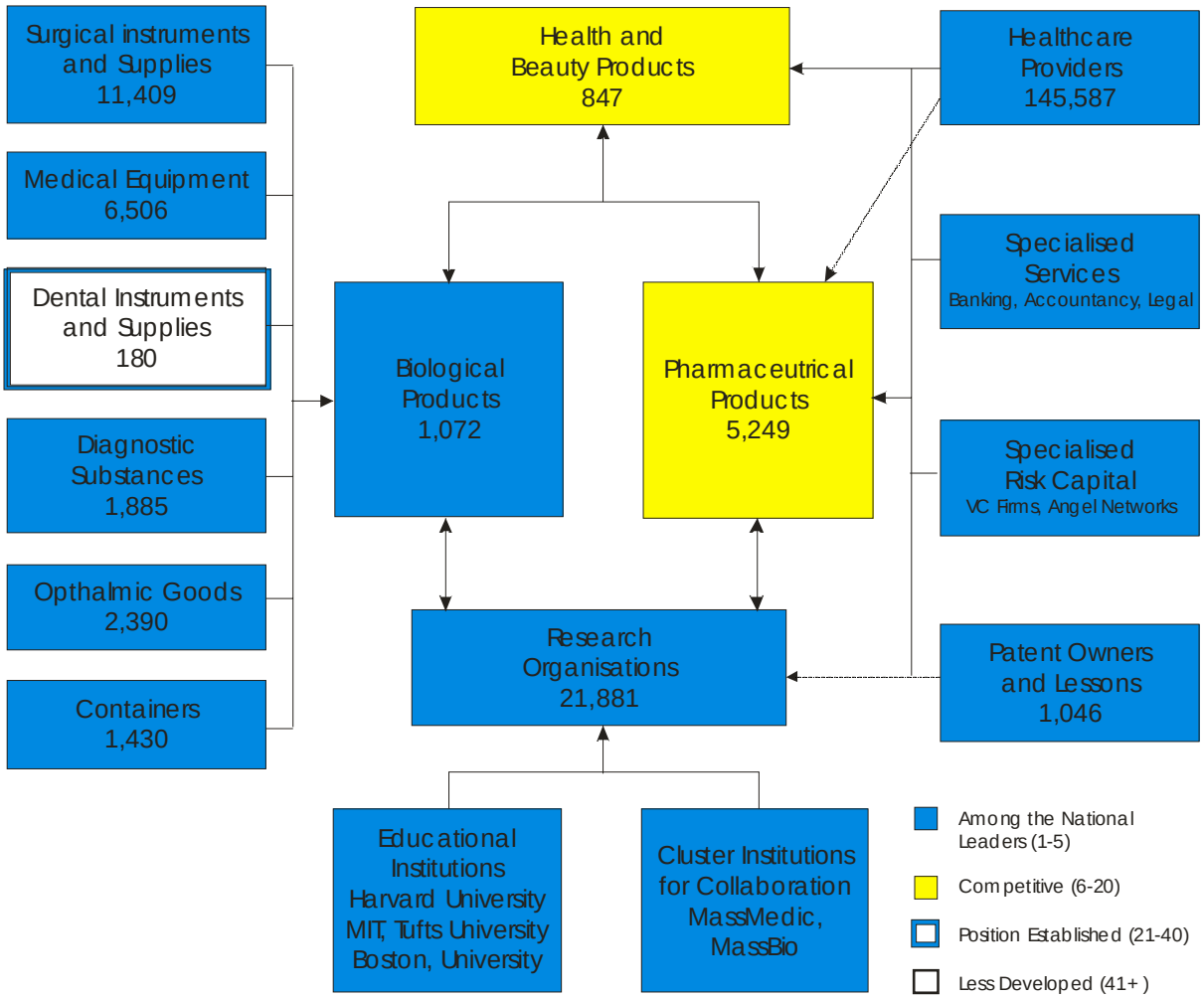
Table 1 is clearly a gross over-simplification. But at an aggregate level productivity levels are generally higher in the German, Danish, and US economies than in the UK. Research into the manufacturing sectors in countries such as Germany indicate that they tend to make much greater use of intermediate level skills – *i.e.* people trained to apprenticeship level – than in the USA and the UK where there is more emphasis on less skilled personnel on the shopfloor but with many more managers.

1.2 The unit of observation: cluster

The study is very much concerned with the medical technology 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 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 1.2)*.

Figure 1.2 Boston Life Sciences Cluster



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

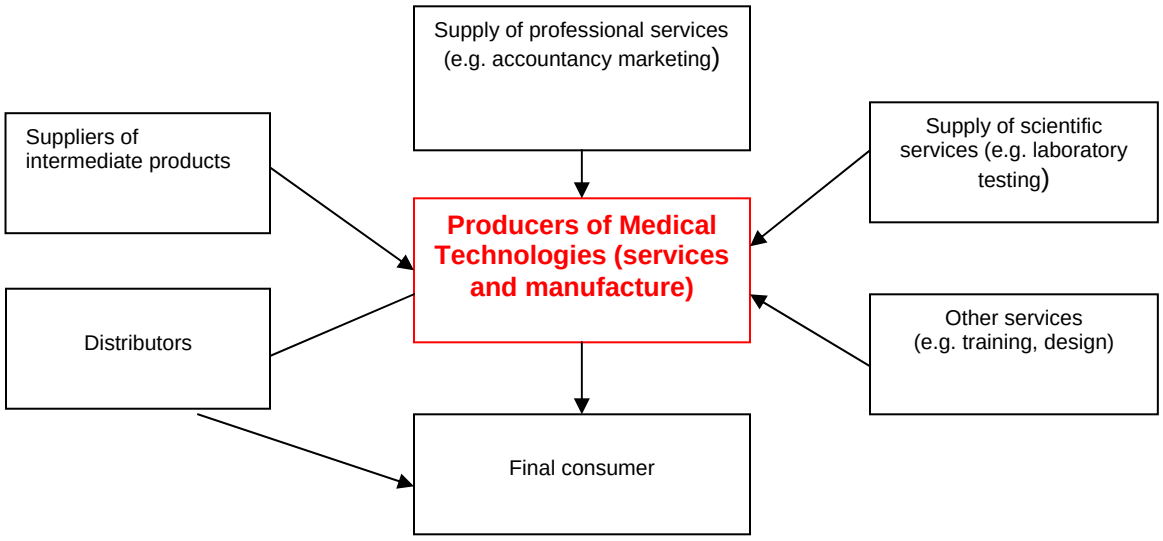
It is clear that some clusters have grown organically because the institutional, economic and social framework was conducive to their formation and success (see the earlier discussion of the approximate reverse – the low skills trajectory and equilibrium). But the picture is not all positive, particularly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

From a practical point of defining a cluster might be seen in the following terms (see Figure 1.3). This views the cluster with respect to its forward and backward linkages as well as complementarities with other sectors. This comprises:

- tions that produce medical technologies (goods and services) but where they are not the main product or service delivered (and according classified to another SIC category);
- organisations producing intermediate inputs to the medical technology sector (*e.g.* support services such as accountancy services, products used in assembly, process technologies, *etc.*).

Implicit in the typology of the cluster is that some of the companies that occupy the box at the centre of *Figure 1.3* will not be primarily producers of medical technologies but will also include companies that produce a wider range of goods and services.

Figure 1.3 Schematic outline of medical technologies cluster



1.3 The skills context

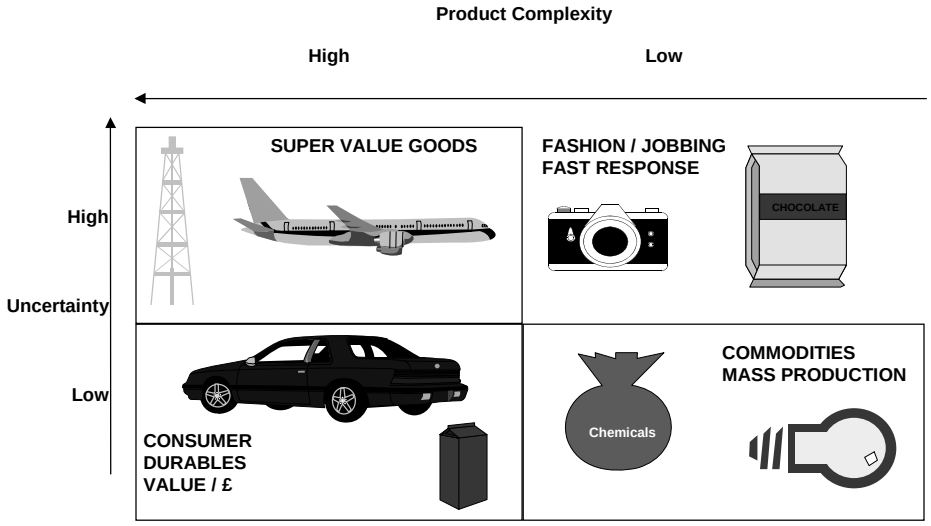
Looking at current skills supply and demand can produce a limited view of the potential skill development has for the future growth of an industry or cluster. It needs to be borne in mind that skill demand is a derived one stemming from the business plans companies have in place. Even recognising that skill demand is a derived one, for many companies the important attached to the development and training of their staff is a second or third order consideration after financial and operational management considerations (Purcell, 1998).

Recent analyses of company skill needs has concentrated upon understanding their product market strategies. In practice, product market strategy proves, in practice, difficult to define. In large organisations there are likely to be a number of dimensions relating to generic functions such as human resources, marketing, and so on, as well as specific functions that relate to the business in which the organisation operates. There are also likely to be a number of levels at which decisions are made, such as: head office, at the establishment level, or divisions/departments within the company. One of the key issues linking product market strategy to skills, as will be discussed in greater detail later, is the role of ***strategic vision***. By this is meant the capacity of an organisation to outline its future, identify market opportunities, and ensure that the human resources are in place to capture that market. Of interest is the extent to which that strategic vision is in place, if at all, and where it is taking place: at the establishment, at head office, within or outwith the UK?

The Puttick Grid, devised by the Warwick Manufacturing Group, defined product market position with respect to the complexity of the product and the level of certainty in the market *(see Figure 1.4)*.

Figure 1.4

Product classification and market position

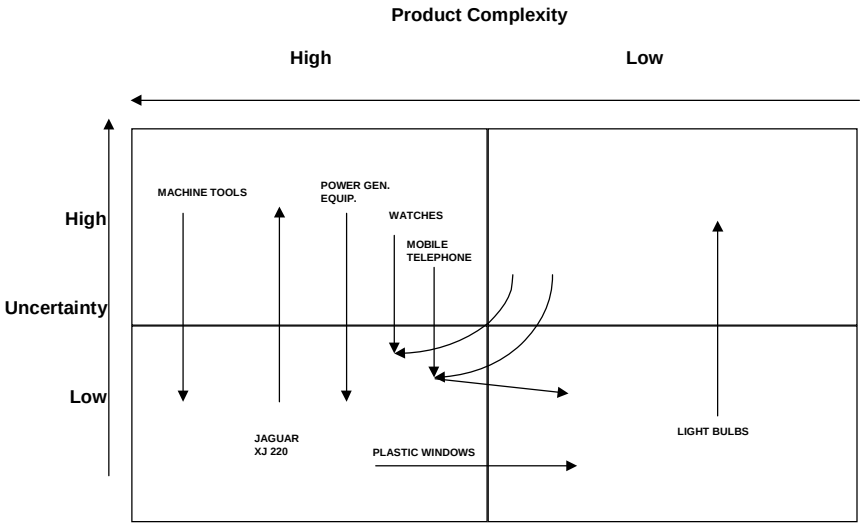


Source: Warwick Manufacturing Group

It is worth noting that products have the potential to move around the quadrants depicted in *Figure 1.4*. Mobile telephones, for example, started out as a super value-added good – the upper left quadrant – but has arguably moved towards becoming a consumer durable (the lower left quadrant). To a large extent this reflects the maturation of a product. Other product lines, in contrast, appear firmly lodged in a particular quadrant, such as aerospace. The key question for this study is to identify where the medical technologies sector or cluster sit in relation to *Figure 1.4*.

As products shift position in the Puttick Grid, production processes, volumes of production, and sales margins adjust. And because the production process and the potential market changes there are consequent changes in the skills required to meet production needs. Organisations operating in, say, the super value-added goods sector might decide to migrate with their product to a mass production, low margin position, or move on to the development of the next generation of products and services *(see Figure 1.5)*. This where the idea of strategic vision is often so important.

Figure 1.5 Examples of changing product market positions over the product life cycle

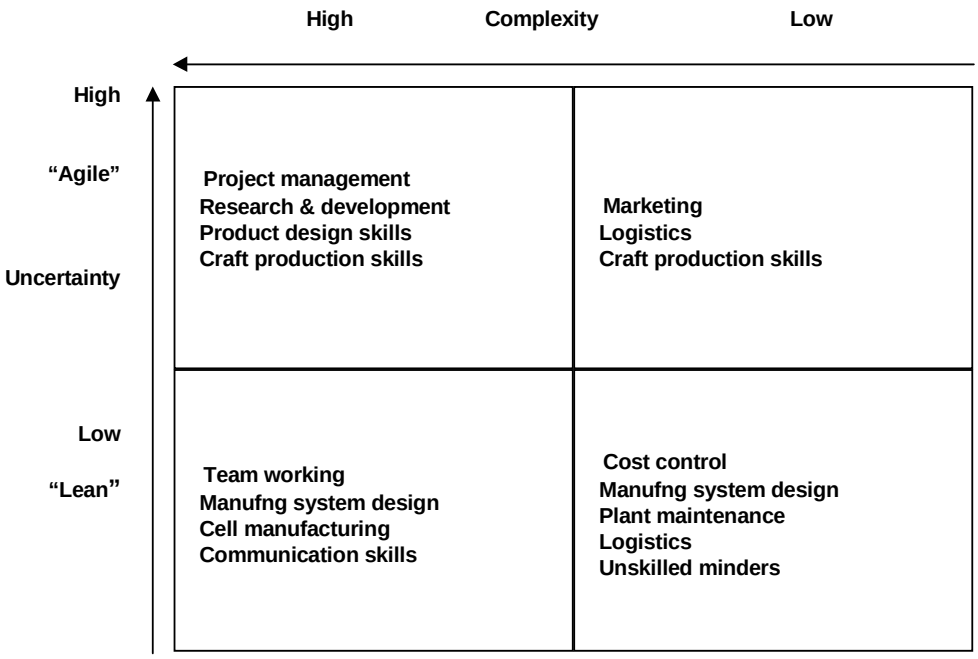


Source: Warwick Manufacturing Group

Evidence from the then Department for Education and Employment's *Extent Causes and Implications of Skill Deficiencies* study indicated that often – possibly too often - organisations were content to maintain their current product market position rather than to move, or attempt to, into relatively higher value-added sectors.

Skills can be mapped onto the Puttick Grid. Davis *et al's* analysis of the engineering and food and drink sectors completed this exercise *(see Figure 1.6)*. This is set very much in a dynamic setting insofar as the emphasis is upon the skills that will either allow maintenance of the existing product market position or to move into new ones in the face of market and product changes. This is referred to as 'agility', the capacity to go beyond flexible production and work organisation techniques, to encompass the ability to readily move into new market areas as required.

Figure 1.6 Skills and product market strategy



Source: Davis *et al* (2001)

1.4 Data sources

This synthesis report is designed to provide key findings from the multi-country study. It is based on the following documents:

- UK: Benchmark Report
- UK: West Midlands Survey and Case Study Report
- UK: Scotland Survey and Case Study Report
- Germany: Benchmark report
- Germany: Survey Report for Bavaria Baden-Württemberg
- Germany: Case Study Report for Bavaria Baden-Württemberg
- Denmark Benchmark Report
- Denmark: Medicon Valley Survey Report
- Denmark: Medicon Valley Case Study Report

- USA: Benchmark Report
- USA: Massachusetts Survey Report
- USA: Massachusetts Case Study Report

1.5 Structure of report

Chapter two provides information about the institutional infrastructures relating to the provision of health services, industrial development, and training in each of the respective countries. Chapter 3 examines evidence relating to the size and structure of the medical technologies sector or cluster in each of the respective areas studied. Chapter 4 provides data from the surveys and case studies of medical technology companies. Finally, Chapter 5 summarises the findings of the study and outlines the policy implications.

2. INSTITUTIONAL STRUCTURES FOR HEALTH CARE

2.1 Introduction

This brief section outlines the different institutional arrangements in place to provide health care. As will be seen these systems are quite distinct: from the universal of provision of health care paid for through National Insurance and general taxation in the UK, the insurance based system in Germany, to the dominance of the private sector in USA. The health care sector is the ultimate consumer of many of the technologies – although home care technologies are increasing – especially high value-added equipment. Hence the need to consider the institutional arrangements in place to provide health care.

2.2 The health care system

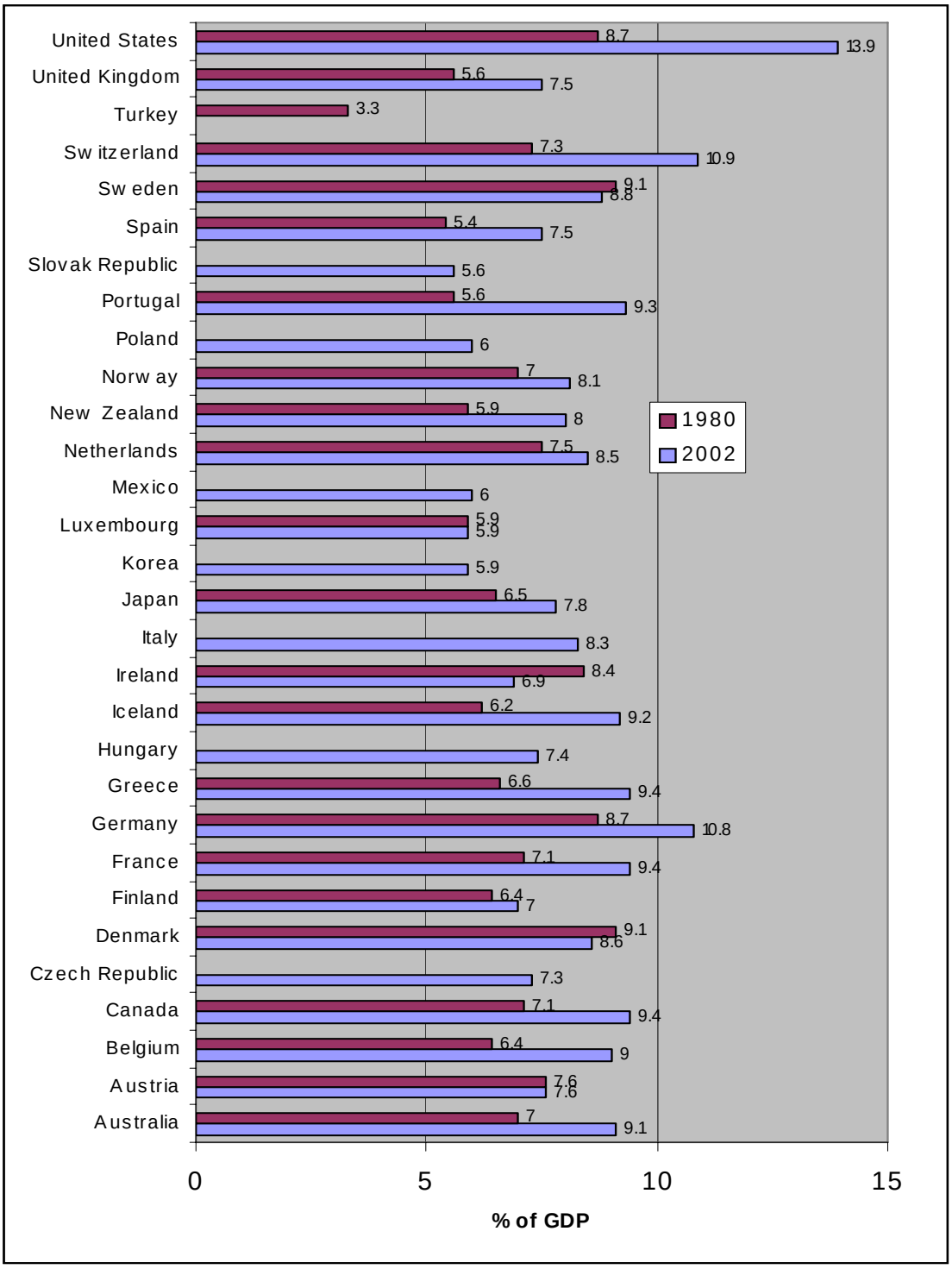
The health care system is likely to be the main consumer of medical technologies in each of the respective countries the study has addressed. For medical technology companies they may be involved in the production of an intermediate good and/or engaged in exports. Nevertheless, the organisation and funding of the health care system is likely to shape, in large part, the domestic market for medical devices.

Clearly related to this is expenditure on health care. *Figure 2.1* shows the level of expenditure as a percentage of GDP across OECD countries. The data reveal substantial differences between countries, although the trend over time is clear with an increasingly large share of GDP spent on health care. Clearly the USA has the highest expenditure on health care at nearly 14 per cent of its GDP in 2002. Although it is also apparent that Germany spends a relatively high percentage of GDP on health care.

In exploring the health care system further, there are a number of issues here that are germane to the study:

- the organisation of the health care system;
- the extent of private provision; and
- the main challenges facing the respective national health care systems.

Figure 2.1 Expenditure on health care as percentage of GDP



Source: OCED Health Statistics 2004

2.3 Organisation of health care system

The UK and Denmark have broadly similar systems for the delivery of universal health care paid for through taxation. In the UK the system is largely centralised through the National Health Service, although there has been a long-standing commitment to ensuring representation at regional and local levels. In Denmark the system is arguably more decentralised and delivered through regional authorities.

Germany operates an insurance system. Almost 90 per cent of the German population, or 73 million people, are insured with a statutory health insurance fund (SHI)[1] due to mandatory membership. There is also private health insurance fund (7.3 million people) for people who wish to opt-out of the SHI. In the SHI all members are entitled to the same level of benefits while contributions are a certain percentage of salary (principle of solidarity). At present, depending on the fund, the compulsory contribution rate is about 14.5 per cent (the estimate for 2003) of gross salary which is split equally between employee and employer.

The country which stands in marked contrast to the above is the USA. There is no organised public health care system in the United States. The field is covered by *Managed Care*, which is a combination of insurance company functions, health care delivery systems, and health outreach programmes. This has gradually replaced the former *fee for services* system, which was a free market for health services[2]. Medicaid is a programme, jointly funded by federal and state authorities, that provides health insurance to approximately 40.6 million low income women with children and disabled persons, including low income people over 65 years of age. Most of those enrolled are children and their mothers. While the elderly and disabled make up only 10 per cent and 17 per cent, respectively, of the Medicaid population, they consume almost 72 per cent of all Medicaid spending. A large proportion of expenditure goes to nursing homes. Seventeen per cent is spent on children and 11 per cent on parents[3].

2.4 Private *versus* public provision of health care

The importance of the private sector in relation to medical technologies is that the private health care system will compete with respect to the level of service it can provide. This will relate in part to the various technologies they can provide to patients. It is noticeable in the UK, for example, that efficiency in the health care system has been tackled – with mixed results – by attempting to introduce a degree of competition between health care providers within the NHS.

Figure 2.2 provides data relating to the percentage of total expenditure on health care accounted for by the public sector. Even in the USA, where provision is predominantly private, the public exchequer still meets 47 per cent of total health care costs. But in other countries the public share predominates.

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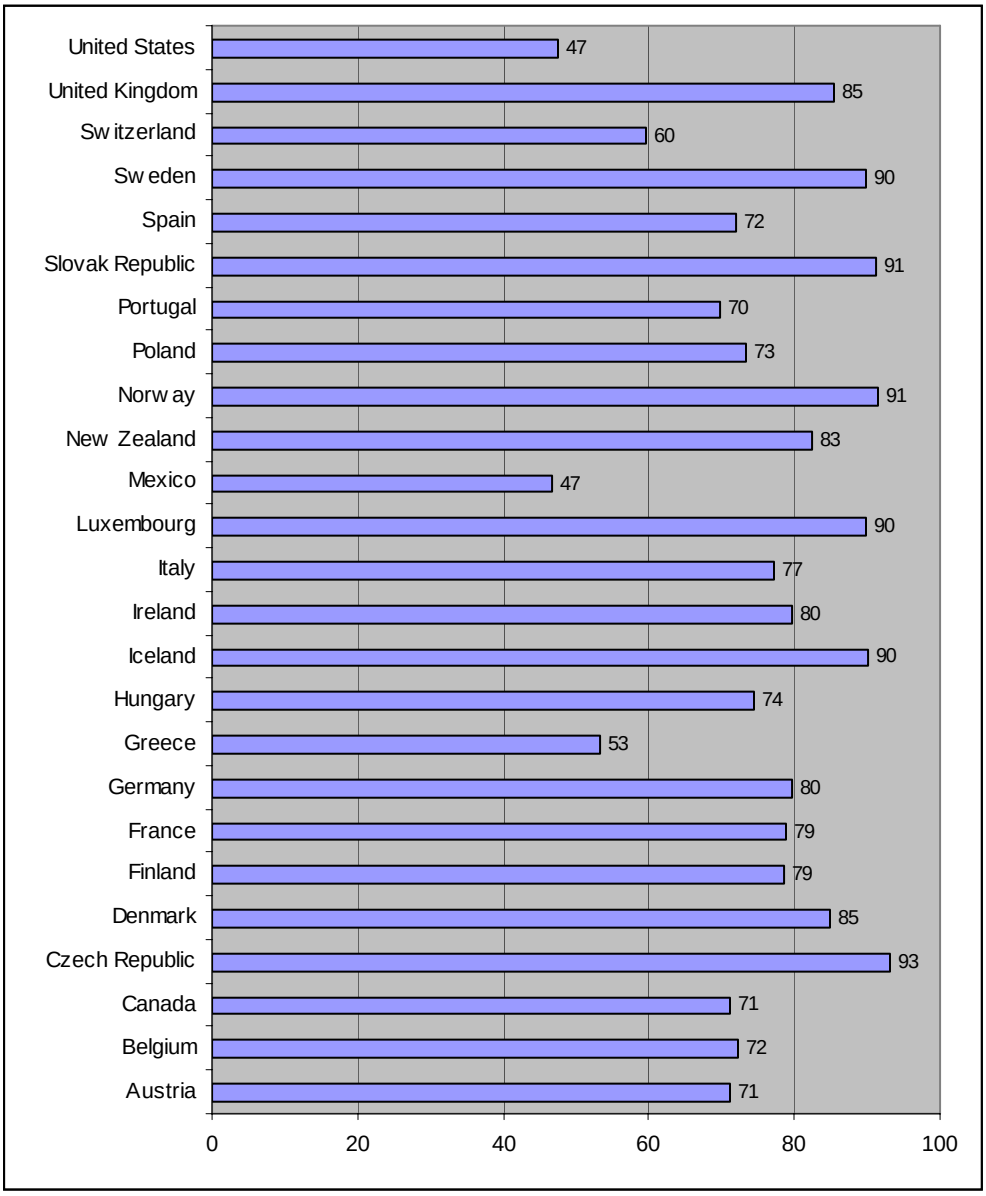
[1] The number of SHIs decreased from over 1,200 after the unification in 1990 to 356 in 2002 due to strong concentration processes. 287 of the 356 SHIs are company-based health funds, most of which opened up to the public in recent years.

[2] *AARP website and PLS Consult 1996*

[3] Kaiser Commission, 1999.

Figure 2.2 Public expenditure as percentage of total expenditure on health care, 2002



Source: OCED Health Statistics 2004; own calculations

2.5 Main challenges facing provision of health care

In the UK, the demands placed on the health care 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.

In May 2003 the German Government published its *Draft on the modernisation of the health sector* (Gesetz zur Modernisierung des Gesundheitswesens). The content of the proposed changes is as follows:

- dental prosthesis will not be part of the SHI as from 2005 and has to be covered separately by patients with mandatory insurance;
- sick-pay (Krankengeld) will not be part of the SHI as from 2006 and is likely to be covered by patients with mandatory insurance;,
- there will be new patients contributions outpatient care and higher contributions for pharmaceuticals and hospital care;
- the strengthening of patients' rights;
- the establishment of a foundation and of an institute for quality and efficiency in the medical sector;
- the mandatory training for physicians;
- general practitioners will become *gate keepers* (voluntarily);
- non SHI reimbursement for OTC drugs;
- reference (fixed) prices for pharmaceuticals even with patent protection;
- pharmaceutical industry has to give to SHI a 16 per cent rebate (instead of six per cent) in 2004 on those drugs which are not yet part of the fixed price system, totalling 1 billion Euro.

Patients can expect to pay higher contributions, while employers will be relieved in small parts from high non-wage labour costs (it is estimated that the SHI contribution rate will be reduced to 13.6 per cent in 2004 and 12.15 per cent in 2006). According to SHI calculations, patients will contribute to the savings by eight billion Euro in 2004 as only one billion Euro will come from the drug sector and no contribution will be made by other sectors. Hospitals will be only marginally affected.

With a very low population increase and the prospects of an ageing population combined with a strong political pressure to reduce taxes and the development of new more expensive technologies, the service level in the hospitals and nursing homes is under pressure. These are the main challenges to Danish health care today.

The present system of health care in the United States has been subject to many discussions since its introduction. The central question concerns a possible medicare reform that might bring the United States closer to other developed countries in providing a system of health service that was free at the point of delivery and financed from taxation. The fear is that the costs of the health care system would again start to increase beyond the former peak of 12.2 per cent of Gross Domestic Product.

A second important question concerns the incentives generated by the existing system. It is questioned whether the system actually achieves a high degree of free market cost control and, hence, more cost efficient services. It is suggested that, as a result of the widespread use of the

capitation system, the present arrangements encourage health care staff to minimize efforts rather than to increase efficiency.

There is a strong pressure to reduce health care expenditure, especially spending on salaries and wages. The pressure has resulted in an out flow of physicians from Medicare. Medicare law required a reduction of payments to physicians of 4.4 per cent in 2003 after a similar reduction in 2002. But, at the start of the year, Congress authorized CMS to revise the 2003 rates, and payments were instead increased at an average rate of 1.6 per cent. CMS is hoping that this step will slow the loss of physicians and persuade those who remain to continue serving Medicare patients.

2.5 Conclusion

The evidence provided above reveals that there are common pressures on health care systems throughout each of the countries covered by the study. But these pressures are mediated through very different health care systems. This has potential implications for the demand for 'big ticket' technologies as well as placing cost pressure on the suppliers of more mundane technologies. The key question, which is very difficult to assess, is whether the different systems are more or less likely to depress demand for medical technologies.

3. THE MEDICAL TECHNOLOGY SECTOR AND CLUSTER

3.1 Introduction

This chapter provides information about the structure of the medical technologies sector and cluster in the six case study areas. A number of themes are focussed upon:

- the problems of measurement. Even classified as an industrial sector there are problems in measuring levels of output, employment, and skills;
- the historical development of the medical cluster or sector;
- the role of the state as an agent of economic development in promoting medical technologies as a potential growth sector;
- the supporting role played by the education sector not just in supplying skills but also as a source of research and development (R&D).

Each area is considered in turn before attention is given to the common themes that support a strong medical technologies cluster.

3.2 United Kingdom

3.2.1 West Midlands

The West Midlands region is situated in the heart of England and embraces an area of some 13,000 square kilometres. The population of the region is around 5.7 million and accounts for nine per cent of the population of the United Kingdom.

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.

Economic growth in the West Midlands has broadly followed the national average in recent years and this remains the case in 2003[4]. 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[5]. 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 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)[6]. 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.

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[7]. 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[8]. In proportionate terms, these job cuts were estimated to be the largest of all the UK regions[9].

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. 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. 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.

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4 Royal Bank of Scotland, *PMI West Midlands Report*, 11 August 2003

5 Custom and Excise figures.

6 Office of National Statistics, Labour Market Statistics, August 2003: West Midlands.

7 ONS, *op cit*.

8 Royal Bank of Scotland, *op cit*.

9 Royal Bank of Scotland, *op cit*.

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.

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[10] 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.

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,

[10] 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.

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 3.1*. 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.

Table 3.1 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

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[11] 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;

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

- 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 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.

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.

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. But 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.

3.3 Germany

No wholly reliable data is available on the medical technology sector in Germany. Neither the SHI nor the Federal Health Monitoring System (Gesundheitsberichterstattung des Bundes) which is a part of the Federal Statistical Office have exact information on expenditure for medical devices, equipment or technology, owing to the complicated reimbursement system in the outpatient and hospital sectors. T

A further problem is that the medical technology sector is not represented by one association or interest group but by four, each of which focuses on a different market segment, as follows:

- German Medical Technology Association (represents about 200 members);
- Association of the Diagnostics Industry (78 members; focus on laboratory and home diagnostics);
- Association of Electro-Medical Engineering (about 100 members; focus on electric/electronic investment goods);
- German Industrial Association for Optical, Medical and Mechatronical Technologies (called *Spectaris*, about 400 members but not all involved in medical technology).

In 1996, according to the Federal Ministry of Education and Research the share of sales in different medical device sectors in Germany was the following *(see Table 3.2)*:

Table 3.2: Shares of Sales of Various Medical Devices in Germany, 1996

Medical devices	21%
Medical technology products	20%
Diagnostics	13%
Electrical medical engineering devices	12%
Dental products	12%
Ophthalmic optics	9%
Optics, lasers, laboratory	8%
Others	5%

Source: Health Research Programme of the German Federal Government 2001, p. 38.

Medical technology products and electrical medical engineering devices account for about one-third of total sales. The most vigorous increase in turnover in recent years has been achieved by the ophthalmic, laser, laboratory engineering and medical devices sector.

After the United States (72 billion Euro in 2001) and Japan (25 billion), Germany (16.5 billion) is the third largest market for medical devices and medical technology equipment in the world, according to the German Medical Technology Association[12]. In Germany the hospital sector is the most important market place. It is estimated that in the year 2000 medical devices and technologies accounted for about 6.5 billion Euro in the hospital sector. Another 5 to 5.5 billion Euro was spent on medical devices in the outpatient sector.

According to information from the Federal Statistical Office, 82,200 people were employed in the German medical technology sector in 2001. The latest data for 2002 indicate a further growth in employment by 2.8 per cent up to 84,500 people (and that increase is clearly contrary to the general trend in employment in Germany). According to the branch associations, as many as 100,000 people might be employed but that simply highlights, once again, the problem of inadequate and inconsistent information. I n 2002, the employment of manual workers grew more than non-manual employment for the first time. The share of non-manual is approximately 40 per cent and above the average in manufacturing industry, generally, where it is 35 per cent.

The health technology sector is still dominated by many small and medium companies in relation to number employed. But, in relation to the total sales volume, small and medium enterprises are not so important. Companies with fewer than 100 employees make up nearly two-thirds of companies but account for 28 per cent of total sales. Companies employing 1,000 or more people make up less than one per cent of the total but account for nearly 29 per cent of sales.

The medical technology sector in Germany is strongly export oriented and ranks number three, internationally, behind US and Japanese manufacturers. In 2000, the share of exports equalled domestic sales for the first time. Since then, the growth of exports has been stronger than the modest growth of domestic sales. In 2002, exports represented 55 per cent of total turnover and were growing at an annual rate of 10.3 per cent compared with a growth rate in domestic turnover of 2.1 percent. Export sales currently exceed sales in the domestic market sales by over one billion Euro (6.6 compared with 5.4 billion Euro).

3.3.1 The State of Bavaria

Bavaria is the largest German state in terms of geographical area with 70,548 km² and the second largest in terms of number of citizens (about 12 million people). In 2001, Bavaria produced 17.3 per cent Germany's GNP; a total of Euro 29,103 per person compared with the German average of Euro 25,056 (STMWVT 2002, page 3).

Until the 1950s, Bavaria was a rural state with a tradition in agriculture; light industries;, tourism (The Alps); and trade (Augsburg, Munich); and high unemployment (STMWVT, 2002). Heavy industries were almost solely concentrated in the Nürnberg area. Beginning in the 1960s and 1970s Bavaria started to develop as a prime location for the banking and insurance sector and light industries, such as electrical engineering and automotive industries. The next stage was the development of new technologies in the information and communication technology sector. Most recently, Bio-medical and Medical technologies have started to thrive. Developments have been supported by a number of large companies, such as HypoVereinsbank, Allianz Insurances, Munich RE, Siemens, BMW, Audi, and GlaxoSmithKline.

At the same time, however, companies of medium size, with between 100 and 5000 employees started to become the backbone of the Bavarian economy and main driving force behind research, job creation, and tax revenues. That is why the Bavarian Government continues to encourage and support companies of medium size at both the state and the national level.

[12] Bundesverband Medizintechnologie (German Medical Technology Association): Annual Report 2001/2002.

The fact that Bavaria was relatively late in its economic development has, more recently proved to be an advantage. First, following the second world, new industries, mostly in the field of electrical and mechanical engineering, had to be developed and were thus supported by the state. At the same time, old heavy industries and mining did not become a burden upon the state's economy and finances when they could no longer compete in plunging world markets, as has happened in other German states and former economic powerhouses such as Northrhine-Westfalia in the 1970s and 1980s.

Bavaria is a centre for the medical technology industry in Germany. In 1998 more than 224 companies from this sector had their headquarters in the state. This represents about 20 per cent of the German total and the companies employ 20,000 people.

Fourteen of the 50 largest (by total revenue) medical technology and pharmaceutical companies have a main branch in Bavaria. They include global organisation such as Siemens Medical Technology division; Baxter; GlaxoSmithKline; Novartis; Pharma; and Roche. In addition, a large number of companies of medium size are located in the state (STMWVT invest I): At the same time, about 60 per cent of medical technology companies in Bavaria have less than 10 million Euro in annual sales. The most important product groups in Bavaria are electro-medical devices with 67 per cent followed by orthopaedic-mechanical goods with 11 per cent (STMWVT 1997, page 21). Fifty per cent of all electro-medical devices and 30 per cent of Germany's medical-technological output comes from Bavaria (STMWVT invest I).

Two localities are central to the medical technology sector in Bavaria: Munich and Erlangen, in conjunction with Wuerzburg und Bayreuth/Regensburg.

Bavaria's Assistance for Medical Technology Industry Development

The key element in the success of the health technology sector in Bavaria is what the Bavarian Ministry for Economics, Transport and Technology (STMWVT invest I) calls a *quick transfer of technology*. It is the aim of the state to bring companies and researchers together to promote aggressive research and successful product innovations.

Exceeding the state's normal annual business development budget of 500 million Euro, the state has invested an additional four billion Euro since 1994 in education; research; technology transfer; entrepreneurship; and the specific business fields of ICT; new materials; environmental and medical technologies; and mechatronics. This occurred through two state programmes: ***Offensive Zukunft Bayern*** (starting in 1994 with a budget of about 2.8 billion Euro) and ***High-Tec Offensive*** (starting in 2000 with a budget of about 1.35 billion Euro) (STMWVT, 2002). The enormous financial support was possible through a large sale of shares of former state owned companies by the state of Bavaria in the middle of the 1990s.

First, research and information networks have been promoted. The *Forum MedizinTechnik und Pharma (http://www.forum-Medical technology-pharma.de)* was founded to act as an information node between all stakeholders in the sector: large and small companies; investors; academic researchers; and hospitals. Before the establishment of the *Forum*, a corresponding problem existed because there was a lack of connection between scientific ideas and investment capital. In addition, a *Working Group of Bavarian Research Networks (Arbeitsgemeinschaft der bayrischen Forschungsverbuende www.abayfor.de)* was founded to bring together researchers from all disciplines including medical technology and related sectors. The *Bavarian Research Foundation (Bayrische Forschungsstiftung)*, a long established organisation to finance single research projects with matching capital from the private sector, is also fully engaged in the strategy.

Secondly, four **regional competence centres** are supported by the Bavarian Government. They are as follows:

- **Erlangen/Nürnberg** is the seat of Siemens' medical technology division. It is the centre for medical technology in Bavaria, especially imaging methods and virological and pharmaceutical research. The state's engagement in this area is especially strong because the district has structural problems and relatively high unemployment. Erlangen/Nürnberg is furthermore integrated in the nation-wide *competence-network project (Kompetenznetze, www.kompetenznetze.de)* funded by the *Federal Ministry for Education and Research.*
- In **München** the universities with their attached hospitals are the centre for institutionalised research. For further technology transfer, the *Max-Planck-Research-Institutes (MPI)* for biochemistry, neurobiology, and physics that have their basess in Munich, are fully involved. The MPIs are a public-private research partnership specific to Germany. The *Research Centre for the Environment and Health (Forschungszentrum fuer Umwelt und Gesundheit, GSF)*[13], is involved as well.
- **Regensburg** and **Würzburg**, both cities with universities, cooperate closely with Erlangen/Nürnberg.

Because education falls under the responsibilities of the states, the level of education tends to differ from state to state. The more southern states tend to perform better than the northern or eastern states. Bavaria and Baden-Württemberg always perform particularly well in international comparisons, such as the PISA study, in which Bavaria ranked very high while Germany as a whole performed poorly.

In relation to higher education, Bavaria enjoys the benefit of the following:

- nine public *general universities* (Augsburg, Bamberg, Bayreuth, Erlangen-Nürnberg, Munich [Ludwig-Maximilians-University und Technical University], Passau, Regensburg und Würzburg);
- seventeen public *universities of applied sciences* (Amberg-Weiden, Ansbach, Aschaffenburg, Augsburg, Coburg, Deggendorf, Hof, Ingolstadt, Kempten, Landshut, Munich, New-Ulm, Nürnberg, Regensburg, Rosenheim, Weihenstephan, Würzburg-Schweinfurt).

Although most of these institutions do not offer a specific degree in medical technologies, they guarantee an ample supply of engineers, biologists, chemists, physicists, and doctors. Types of courses vary from university to university: some offer their students the opportunity to specialise in medical technology within their general studies (such as, electrical engineering); others offer an entire medical technologies master programme. Just recently the new *Institute of Medical Technology* was founded by Munich's Technical University. It is a graduate programme including classes, among others, in biocompatible materials; physiology; quality; management; law; biomechanics; optomechatronical measurement systems; telemedicine; macromolecular chemistry; and so on. (http://www.zimt.tum.de/). At *Munich's University of Applied Sciences* a specialism exists within the courses on microelectronics; at *Ansbach's,* there is one within the course programme for industrial engineers. In addition, Technical Schools in Regenstauf and Ansbach offer courses to become a state-approved technician for medical technologies (Staatlich gepruefter Medizintechniker).

[13] The GSF belongs to the *Helmholtz-Research-Societies* (similar the *Max-Planck-Institutes*). See also footnote 2 and 16. The GSF's goal is to "identify health risks for humans and the ecosystem, to estimate the environment's capacity for usage and to develop concepts to avoid lasting damages".

3.3.2 The State of Baden-Württemberg

Baden-Württemberg shares its eastern boarders with Bavaria and its western border with France. 10,537,000 people live in this state which covers an area of 35.751 km². Baden-Württemberg consists of various regions that were united after World War II to create today's state. In total, 4.977 million people work in the state and 4.450 million of them are employed by the state or private businesses (Argedonau, 2003). In 2001 Baden-Württemberg produced a GDP of 307 billion Euro, which is about Euro 28,920 per person compared with the German average of Euro 25,650.

The area has a long tradition in manufacturing, engineering and light industry, including cotton manufacture and clock-making, starting in the 18th century; hardware production and steam engine and motor manufacture (Benz, Daimler) in the 19th century; and then airplane and automobile manufacturing in the 20th century. The area also saw an early engagement of the state in education. In 1825, Germany's first *Technische Hochschule (Technical University)* was founded in the city of Karlsruhe and in 1850 the *Staatliche Uhrmacherschule (State-run school for clock-making)* in Furthwangen. In 1889 the state also started to support the training of apprentices. As in Bavaria, the lack of raw materials restricted the development of mining and heavy industry and encouraged light industries, instead.

Although there have also been large enterprises in Baden-Württemberg (such as Bosch, Porsche, SAP, Heidelberg Printing Systems, and what is today Daimler-Chrysler) the economic backbone of the state has always been and continues to be small and medium-sized companies. But now there are also large international companies in Baden-Württemberg, such as IBM, Hewlett-Packard, Sony, and Pfizer.

Baden-Württemberg spent 11 billion Euro in 1999 on research and development, the largest amount of any state in Germany. Over 78 per cent of the 11 billion was contributed by the R&D expenditure of the state's companies; 10.5 per cent from university research and 10.7 per cent from non-university research organisations. The private sector contribution to R&D is growing and accounts for a quarter of all private R&D expenditure in Germany.

Baden-Württemberg depends heavily on the export of its goods: A third of the state's workplaces depend on exports. The export volume of the state is Euro 8,100 per person, compare with the German average of Euro 6,800 (Japan US$ 3,000; USA about US$ 2,500). About 1.7 per cent of the world's exports come from Baden-Württemberg.

As stated above, the traditional strengths of the state lie in engineering, vehicle construction and electronic engineering. In addition, the annual rate of 112 patent registrations per 100,000 inhabitants in the state is the highest in European. With this background, the state of Baden-Württemberg is seeking to develop a strong position in microelectronic; information and communications technologies; biological technologies; and medical technologies in order to remain attractive as a location for production in the global economy.

State spending on R&D (four per cent of the GNP) is above that of the Germany average (2.3 per cent) and that of the United States or Japan. Private businesses in the state also spend more than average on R&D expenditures (about 17 per cent of their annual expenditure) and also employ more people than normal in R&D Baden-Württemberg also produced 29,1 per cent of Germany's total production in the medical technology sector in 1996 (without lab-diagnostics).

Baden-Württemberg is in a strong position as a location for the medical technology industry in Europe. Industry and research combine to produce a great variety of products. About one half Germany's manufacturers in the sector are based in the state. There are multi-national companies with a great variety of products as well as small companies, which might make only a single product. Within the state, Tuttlingen and Tuebingen-Reutlingen are the centres of the

medical technologies sector. The former accommodates about 400 companies, both suppliers and OEMs; and the later accommodates about 200. According to *bw-invest*, a state network of technology transfer centres provides the bridge between private industry and research institutes and ensures rapid access to new ideas, innovations and research findings.

Another important centre for the sector is the *Research Centre Karlsruhe* which has its own subdivision for medical technology (http://www.fzk.de/as-med/).

Almost every product group within the sector is produced in the state, including, anaesthetic products; surgical instruments; sterilisation supplies; diagnostic instruments; imaging diagnostics; implants; laboratory supplies; and radio-therapy, laser-therapy and ultrasonic-therapy.[14] But there is a growing a specialisation in minimal invasive surgery.

Currently, there is a trend towards an integrated portfolio of products and solutions among the companies in the sector. Although they still feel themselves technically superior to their global competitors, the companies are conscious of competition from lower cost production sites around the world. In order to finance relatively high labour costs they judge that they must sell services as added value to their products[15].

As in Bavaria, the state of Baden-Württemberg sees technology transfer as the key requirement for innovation and technology development. A major report by the State Ministry of Science, Research and Arts (*Strategies for the Baden-Württemberg Research Policy, 2000*) gave a clear analysis of the strengths and weaknesses of the research sector in the state and identified the most important areas for action. But there are indications that the state is not yet fully organized to cope with the weaknesses. A Roland Berger Strategy Consultants' study concluded: "*In Baden-Württemberg various enterprises or public institutions of the health branch belong to the market leaders in their sector. However, the potential for synergies that lies in an early integration of these branches remains unused. The historically grown boundaries between these branches, such as Medical Technology; Fitness; Home Care; Pharma; and wholesale, remain too strong"* (Roland Berger, page 52).

In addition to its research policy, the state is engaged in local marketing. In order to improve its marketing of industrial sites in the region, the Ministry for Economic Affairs of Baden-Württemberg founded the *Society for International Economic Cooperation Baden-Württemberg (Gesellschaft fuer internationale wirtschaftliche Zusammenarbeit Baden-Württemberg)*. Its principal aim is to generate new business development in new technology enterprises in Baden-Württemberg. In order to fulfil this aim, the Society helps foreign companies that wish to invest in the state, but also companies from the state which want to invest abroad. Its services include providing country information; finding good locations and sites for new businesses; and dedicated market research. It is financed through the state and the *State Association of Industry (Landesverband der baden-württembergischen Industrie e.V.)*. A particular member of staff has responsibility for the medical technologies sector.

A further strong resource which assists the development of the industry is the strong research environment in Baden-Württemberg. It is estimated that about eight billion Euro are annually invested in research in the state. About 20 per cent of all *Max-Planck-Research-Institutes* and 30 per cent of the *Fraunhofer-Research-Institutes*, as well as 25 per cent of the research capacity of the *Hermann von Helmholtz-Society of German Research Centres*[16] are located in

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14 A complete list can be found at www.bw-invest.de.

15 Further reading: Fraunhofer Gesellschaft ISI: www.isi.fhg.de/pi/projekte/sa_lb_bwz.htm

16 All named institutions belong to public-private research partnerships that form the third pillar of research in Germany besides all-public research in universities and all-private research in enterprises (see footnote 2).

the state. There are about 100 independent research centres in the state, outside the universities. But they are connected with them through public and private initiatives, such as the *Competence Networks (Kompetenznetze.de)*, a result of cooperation between the German Federal Government and the individual states.

In the city of Karlsruhe, 94 out of every 1,000 industrial employees are engaged in research and development. This is the highest number in Europe. Within *Competence Networks* Baden-Württemberg supports a *Research Centre (Forschunszentrum Karlsruhe)* in the city that focuses on science and engineering. A subdivision is especially dedicated to medical technologies and benefits greatly from the scope for close inter-disciplinary research involving other divisions of the Centre and the city's university.

Also under the framework of *Competence Networks,* the state is currently engaged in the two areas Tuttlingen and Tuebingen-Reutlingen, as mentioned above. These two areas have developed over the past 130 years a globally unique concentration of about 600 companies specialising in surgical instruments. Over the past 15 years those mainly middle-sized companies have started to widen their portfolio of medical technological products. At the same time they are also specialising in instruments for minimal invasive surgery, supported by working groups of the University Hospitals of Tuebingen and Stuttgart. But systematic coordination between medical, technical-scientific and industrial contributors was lacking. The *Competence Centre Minimal Invasive Medicine & Technique (Kompetenzzentrum Minimal Invasive Medizin & Technik, MITT)* was founded in 2001 to fill the gap. This non-profit organization has as its goals the advancement of medical technical sciences; further education in the field of Medical Technology; and technological transfer between universities and business enterprises in the sector. Although supported by the state, the initiative for this *Competence Centre* came from universities, companies and hospitals.

The development of the sector in Baden-Württemberg has been largely based upon historical strengths and influences combined with initiatives from universities, research institutes and private businesses. The state's role has been relatively minor, certainly compared with that of Bavaria. But that now seems to be changing.

Baden-Württemberg is the German state with the highest density of educational institutions. There are two *technical universities* in Karlsruhe and Stuttgart; and seven *general universities* in Freiburg, Heidelberg, Hohenheim, Constance, Mannheim, Tuebingen and Ulm. There are 37 *universities of applied sciences;* eight *universities of cooperative education;* three large research institutions; 14 *Max-Planck-Research-Institutes;* 14 research institutes of the *Fraunhofer Societie;* and ten institutions in cooperation with the private sector. Altogether, over 100 non-university research organisations are located in the state with plenty of links to the university sector. Figure 2 gives a geographical overview of the density of research and educational institutions in the state.

In Baden-Württemberg there is no dedicated educational course for the medical technologies sector. But there are many courses in particular disciplines where students can specialise in the field of medical technology, while still studying for a general degree in, for instance, electrical engineering. In addition, Technical Schools in Esslingen and Heidelberg offer courses to become a *state-approved technician for medical technologies (Staatlich gepruefter Medizintechniker)* .

3.4 USA

The estimated word market in medical technologies is around US$150-175m and the US has about 42 per cent of the market. Around 16,170 companies are registered as medical device

companies employing around 335,800 people. Estimated growth is around 8 per cent a year to 2005.

Surgical and medical instruments comprises is the largest part of the industry followed by electro-medical and electrotherapeutic apparatus. Polymer development and medical plastics are expected to show high growth rates in the future, along with home health care, and ready filled inhalers and syringes.

The key areas for medical devices in the USA are Silicon Valley, California, and *Route 128*, the 100 kilometer highway around Boston and Cambridge in Massachusetts, are two of the principal concentrations of new technology, not only in the United States, but also in the world. These are regions that since the second World War have been devoted to the creation of new information technology. Both regions have developed on the basis of active collaboration between high level research universities; companies that intensively make use of the knowledge developed at the universities; and a public sector which both provided active support to the development of the university resources and expertise and also fuelled the development through large scale and demanding military and airspace programmes[17].

The cluster faces many challenges and the manner in which the public and private sectors handle these challenges will determine the cluster's future economic growth. In order to remain competitive with other states, Massachusetts must continuously ensure the existence of an environment that supports research and entrepreneurship so the region can continue to pioneer biological, medical, and scientific innovations to the benefit of the region, the nation and the world[18].

Universities are important sources of IPR. The University of Massachusetts receives $200 million in research grants half of which is medical related. Licence revenues amount to $4-$5m a year. Massachusetts General Hospital carries out $250 research a year, much of this linked to laser imaging and radiology applications. Due to pressures on health care costs, the focus is now upon cost effectiveness might limit the developmental potential of the medical technologies sector.

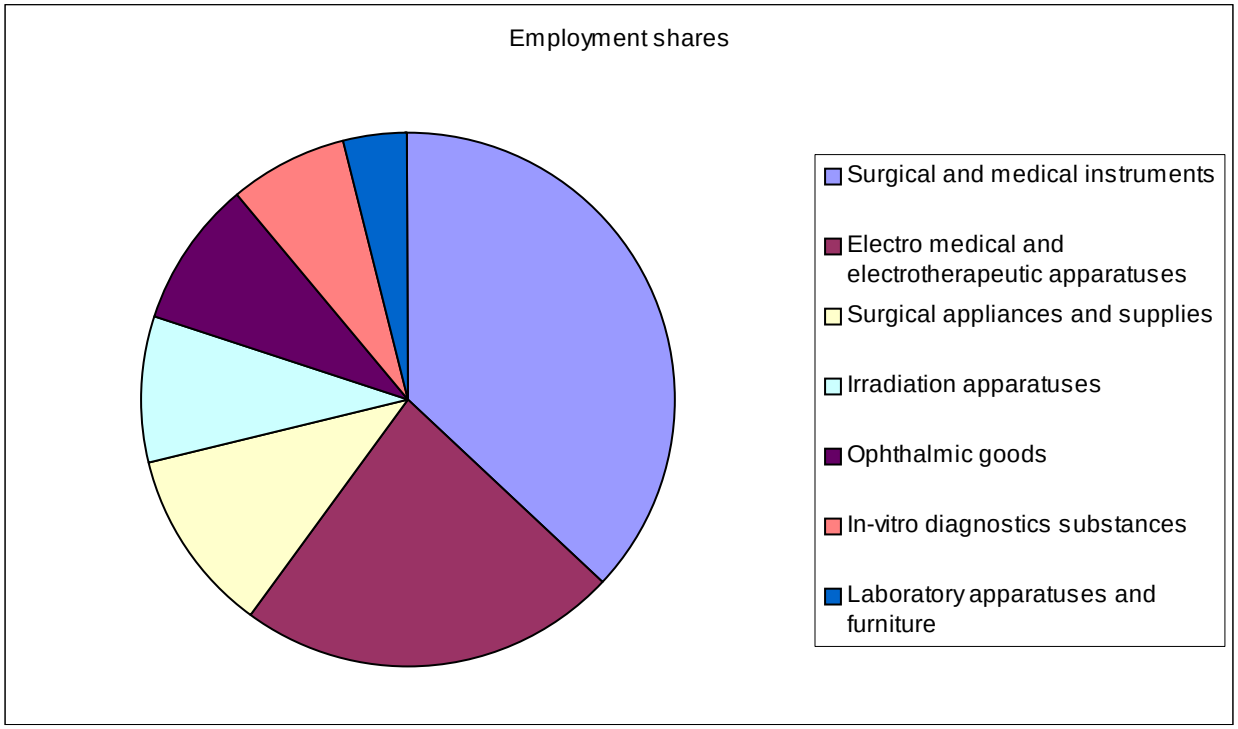
3.4.1 Massachusetts

The Massachusetts economy is currently in recession (like US generally). But medical technologies has performed relatively well compared to manufacturing. 23,000 people employed in the industry and people tend to be highly educated and consequently better paid.

In Boston there are around 600 medical companies, with annual sales or more $8.3 billion. Employment in the sector is broken down as follows *(see Figure 3.2)*.

[17] Paul Mackun, 1998
[18] Mitchell Adams, 2003

Figure 3.2 Employment in medical technologies in Massachusetts



Source: 1997 Economic Census and A. Clayton-Matthews, 2001.

Aggregate sales are dominated by a few companies, including Boston Scientific (sales of $2,919 in 2002); Haemontics ($335.1m); Polymedica Corp ($334.6m). These companies are involved in R&D, and there is a great deal of venture capital entering the industry too. Massachusetts. has a lot of patent activity and medical accounts for around a quarter of all patents.

Like other parts of the United States, Massachusetts expects to suffer from a shortage of skilled labour in the near future. The increasing demand for highly qualified and skilled people combined with the low rate of population growth and the ageing population will all contribute to this development.

There are two main ways in which the state can reduce the problem. The first is to attract more skilled people into the state; and the second upgrade the existing labour force through further education and training. In Massachusetts, both solutions are being are pursued. A relatively high inflow of immigrants consists of 60 per cent highly educated people who are attracted by the world famous universities, and 40 per cent of unskilled people. At the same time, efforts are being made to educate the existing labour force.

Teaching hospitals and research universities play an important role in the growth of the medical device sector. More research is done in these institutions than in private industry, often resulting in the licensing of technology to medical device firms and occasionally in the formation of start-up companies or joint ventures with existing companies. Massachusetts's hospitals and universities enter license agreements and form ventures with companies around the world. About 30 to 40 percent of the deals are made with partners within the state[19].

[19] Mitchell Adams, 2001

There is therefore no doubt that the supply of university level skills together with networking among university researchers, health sector specialists and private enterprise research and executive staff is of the utmost importance for the development of the medical device industry in a region like the Greater Boston area. The relatively large share of the population who have a college education further helps industries like the medical technology industries to get the educated staff they need.

3.5 Denmark

In broad terms, Medical technology is a small, but strong business area in the context of the overall Danish private sector. In conjunction with related business areas like medicine production and other private service companies in the health sector, this competence cluster contributed seven per cent of total Danish exports in 1998, while it represented only one per cent of the total private sector[20].

Danish medical device manufacturers comprise a handful of large companies and many small ones. There are about 550-800 production and sales companies in Denmark and at least 44 per cent of the facilities are located in east Zealand; 174 in the regional authority district of Copenhagen and 67 in that of Frederiksborg.

Aarhus, the second-largest regional authority district, has 79 production facilities. Ten manufacturers are either listed independently on the Copenhagen Stock Exchange or owned by listed companies[21]. In Aalborg and Odense there are smaller, but still significant competence clusters of medical technology firms, all of which have close relations with the local hospitals and universities and are very research intensive.

Danish owned companies locate a large part of their production abroad. In addition to domestic production amounting to € 1.7 billion in Denmark, the value of products manufactured abroad by Danish owned companies amounted to about € 1.1 billion.

The number of employed in the overall medical technologies sector increased by 28 per cent over the period 1992-1998. That brought the total employed within medical device manufacturing to about 15,000-18,500 people . In Sweden, about 20,000 people, spread among 1,500 different companies, are employed in medical technology. In the whole of the EU, 2003 estimates suggest that the medical technology sector involves 7,000 business entities, which employ about 350,000 people.

The Danish production generates value added for society of about € 1 billion. Danish medical device manufacturers recorded a turnover of € 1.7 billion in 2000. Seventy-nine per cent of the products were exported[22]. The production figure for Denmark is € 262 per head of population, which makes Denmark the largest producer of medical devices per head in the world. In Sweden, the production figure per head of population is about € 121 as a whole.

The growth in exports has also been substantially higher for the medical technologies industry than for the rest of the Danish exports. In the period 1991-2001 exports rose by 173 per cent compared with the average of 73 per cent over the same period. In addition, the value added per employee is about € 110.000 annually, which is 25 per cent higher than for other resource clusters in Denmark[23].

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20 Medico/Health – A Business analysis, The Danish Ministry of Economic and Business Affairs

21 Cf. http://www.medicoindustrien.dk

22 Medicoindustrien i tal – 2002 (The medico industry in numbers – 2002), The branch organisation of Medico technology, 2003

23 Bio-/sundhed (Bio-/health – A new partnership for growth), Public Task force, 2002

In general, it is possible to divide the medical technologies sector into two sub-sectors: first, the manufacture of instruments for medical diagnostics, treatment and relief of handicap, including hearing aids; and, secondly, the manufacture of disposable medical instruments and products [24].

The manufacturing of instruments for medical diagnostics, treatment and relief of handicap, including hearing aids.

As the larger of the two, this sub-sector had about twice as many employees and three times the turnover compared with the *disposable* sector (see below). However, in recent years the sub-sector did experience a relative decline of seven per cent in the number of employees and turnover compared with the overall sector. This decline was mainly due to budget cuts and efficiency projects in the public health sector. In contrast to this development, the hearing aid manufacturers experienced a substantial growth in the previous decade.

Manufacturing of disposable medical instruments and products

This sub-sector experienced strong growth in the period 1992-1998 mainly due to some of the main players such as Maersk Medical and Coloplast. The main customers were mostly municipalities, counties, and the individual end users. The demand for products has slowly been increasing. This sub-sector is characterized by substantial advantages of scale and it is becoming increasingly difficult to establish new production start ups in the sector.

The number of applications for patents is one clear measure of the results of R&D investments. However, there is a clear difference in research policy between Denmark and Sweden, which results in Swedes being substantially more motivated towards entrepreneurial activity, as already mentioned in section 2.4. Swedish academic researchers have rights to their own inventions whereas Danish researchers are subjected to sharing the rights with project participants.

Difference in patenting policies between Denmark and Sweden may explain some of the differences in the figures seen in the following tables, as may differences in the size of the sector within each country[25]. The table below shows the number of patents applied for in the medical technology sector in the years 1990-2000 *(see Table 3.3).*

Table 3.3 Patents for medical devices

	Denmark	Sweden	Finland	Bayern	LOC	CA	NC
1990	28	133	11	127	50	351	20
2000	84	234	54	180	109	1,236	59

Companies within the medical technology sector naturally collaborate with the educational sector and public research institutes as well as private companies. Many collaborators constitute other players within the health sector. Innovation typically results from interaction and cooperation between the company, customers, suppliers, competitors and other related companies. Other industries, which link with the industry of medical technology, in particular, and the bio-health industry, in general, include the following:

- The telecommunications industry (wireless communication)

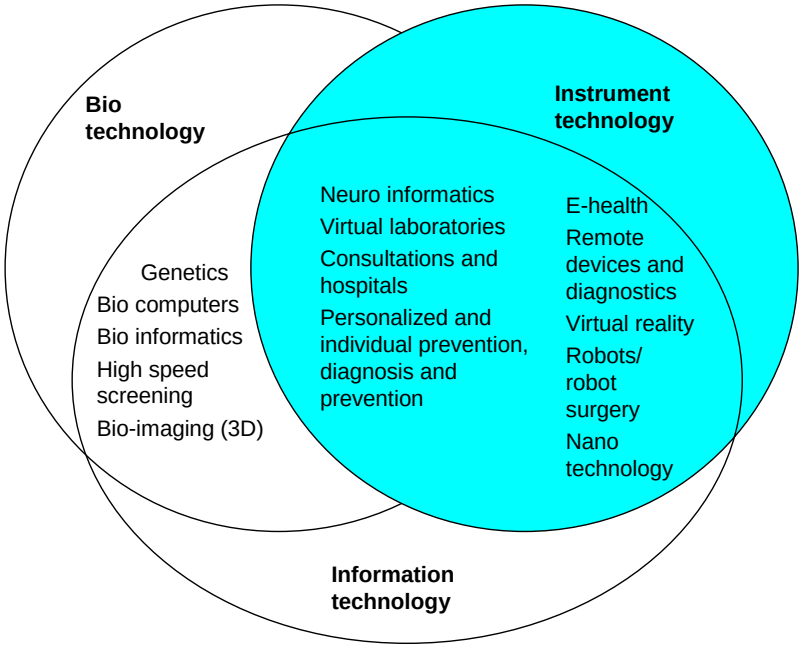
[24] Medico/Health – A Business analysis, The Danish Ministry of Business/Aston Lisbjerg

[25] The tables are adapted from ”International Benchmarking af Bio-Sundhedsområdet i Danmark”, National Agency for Enterprise and Housing, September 2002. LOC: London, Oxford, Cambridge; CA: California; NC: North Carolina

- The IT industry
- Various fields within the technology industry

The advantage of collaboration is primarily the sharing of knowledge and expertise across the boundaries of the business. The result is a technology mix. Small companies struggle to survive if they try to carry through an unsuccessful research project on their own and larger companies co-operate in order to obtain the quickest and most effective R&D. It saves them both time and money to do so. For an an illustration of the linkages between the closest industries (*see Figure 3.4)*[26].

Figure 3.4 Inter-industry linkages in medical technologies in Denmark



The Danish medical technology industry is characterised by a few major players; 75 per cent of the total industry's turnover is accounted for by just 10 companies, which constitute the key players in the industry. Some of the central companies are the following:

- Coloplast (healthcare products and services within ostomy, incontinence, wound, breast and skin care.)
- Radiometer (provider of blood gas equipment)
- Maersk Medical (catheters, surgical aids to drainage bags, wound care and infusion devices)
- Ambu International (diagnostic products, life-supporting and training equipment and solutions to hospitals and rescue services)
- B-K Medical (diagnostic ultrasound products)
- Oticon (manufacturer of hearing care solutions)[27]
- GN Resound (also known as Danavox) (digital or non-digital hearing instruments)

[26] Medico/Sundhed – en erhvervsanalyse, Erhvervsfremmestyrelsen, 2001

[27] Part of the William Demant Group

In addition to the major key players, the industry has a range of small, but innovative companies.

According to a report by Epinion[28], companies within the bio-health sector are seeking skill profiles within the following three main categories:

i. a wide range of technical and theoretical skills obtained from education, including possible research experience;
ii. subsidiary knowledge relevant to the sector, for example IT and product control;
iii. Personal and general qualifications.

The three most sought after personal qualities, which employers tended to regard as more important than technical, theoretical and IT skills, were as follows:

iv. ability to co-operate;
v. analytical skills;
vi. communication skills.

According to the report drawn up by Epinion, the bio-health sector (manufacturing of medical and surgical equipment constituted approximately five per cent of this sector in 2000[29]) is in no need of labour, generally. But particular, rapidly growing areas within the sector do experience shortages of labour. The industry of medical technology is to some extent comparable to that of biotechnology, which hired 500 new employees within the 40 largest companies in 2002. In such circumstances it becomes difficult to find not only enough but also well qualified candidates.

Peter Frank, political consultant from Medicon Valley, states that in year 2010 the medical/health sector will be lacking between 2300 and 5700 PhDs and an equivalent number of university candidates[30] especially from scientific and technical studies as well as medical science. However, the employment demand in the private sector is heavily dependent on venture capital, which is why the above-mentioned numbers are based on willingness from investors; a continuing ability to compete within companies; as well as an ability to remain in the market and possibly to control segments of it.

The expected demand for labour in the medical technology sector, specifically, is difficult to estimate according to the available information. In addition, different sources estimate the demand differently. Thus, another estimate is that the demand for researchers for the entire health sector will reach a minimum of 600 between 2002 and 2005. However, there is no doubt that the sector will be short of qualified labour. Therefore, it is critical that the whole health sector invests in research and development and remains highly innovative in order to attract newly qualified candidates and PhDs. This will prevent the industry from being subject to a brain drain by more tempting offers abroad, including pay; size of research budgets; research environments; and the availability of strong teams of researchers[31].

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28 Epinion A/S Analyse, Efterspørgslen efter arbejdskraft på biosundhedsområdet (Labour force demand in the bio-health sector) , June 2002

29 Bio-sundhedsarbejdskraft og -uddannelser: Udbud og efterspørgsel (The labour force and educations within bio-health: Supply and demand); by "Erhvervs- og Boligstyrelsen" et al, September 2002. This report includes the report by Epinion

30 Cf. http://www.biokemi.org

31 Cf. Boersen, March 22nd, 2001

The Oresund Region ranks fourth in the world for expected growth during the next decade. The value of establishing the Oresund Region has been quantified at € 5 billion, which, of course, has favourable implications for the medical technology sector.

Medicon Valley/the Oresund Region has about 2.9 million residents, which represents 22 per cent of the total population of Denmark and Sweden. Moreover, 40 per cent all employees in the health industry in Denmark and Sweden are working in Medicon Valley, which represents 35.000 employees in the biotechnology, pharmaceuticals and medical technology sector.

The forecast for the Oresund Region towards 2008 shows a significant increase in employment on the Swedish side. Employment in Skåne is expected to rise by more than eight per cent, while employment on the Danish side is expected to rise by up to 3.5 per cent[32]. As part of this development, Medicon Valley is the largest growth centre in Scandinavia within the health related sector. In addition, it has been predicted that about ten companies a year will relocate into the Medicon Valley area.

There are 12 universities in the Medicon Valley area, of which Lund University is the largest and most diverse in northern Europe. Around 135.000 students are listed at higher learning facilities and there are 10.000 scientists, of which 4.000 are researchers with advanced academic degrees[33]. In addition, the area offers 26 hospitals of which 11 are university hospitals. Medicon Valley/The Oresund Region is ranked third in Europe regarding research and development in medicine and biotechnology/life sciences (including medical technologies). The region is surpassed only by Paris and London, and is ahead of Oxford-Reading; Cambridge; Berlin; and Brussels-Antwerp[34]. The rate of growth in employment within the medical technology sector is also relative high. In the period 1997-1999, employment increased by 51 per cent while turnover in Swedish medical technology rose by 102 per cent.[35] The rates of growth rate are estimated to be similar on the Danish side.

The main historical influence behind the development of the Danish medical industry in Medicon Valley lies in the Danish health care system founded in the 1960s. The health care system in Denmark was at the time unique and advanced. The system established the basis of a general demand for health services, and, combined with the infrastructure, the higher education institutions and a number of entrepreneurial companies began the development of the industry at the local level.

Much of the current development is now attributed the following three influences:[36] [37]

i. The relative maturity of the sector (mature R&D pipeline with product focused companies and access to funding and academic knowledge and expertise);
ii. The presence of four fully integrated pharmaceutical companies (Novo Nordisk, AstraZeneca, H. Lundbeck and LEO Pharma), which provide funding and attract highly qualified employees to the region. In addition they branch out to other related areas and thereby ultimately support other sectors, including the medical technology sector;
iii. The overall national approach and focus in Denmark and Sweden supporting the Oresund Region and the dynamics of the cooperation across the borders.

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32 Business and opportunities in the Oresund region, Oresund Chamber of Commerce and Industry, 2003

33 http:/www.medicovalley.com

34 http://www.oresundnetwork.com

35 The Swedish biotechnology innovation system, VINNOVA, 2001

36 Bio-/sundhed (Bio-/health – A new partnership for growth), Public Task force, 2002

37 Commercial Attractiveness of biomedical R&D in Medicon Valley, The Boston Consulting Group, 2002

Medicon Valley is generally seen as having particular competitive strengths in four major business areas; diabetes research; inflammatory research; neuroscience; and cancer[38]. These areas are in several cases integrated in business ventures within the medical technology sector. Within R&D, there are strong links across the Oresund but various reports have found evidence that the integration between the Swedish and Danish sides of Medicon Valley could be improved[39].

The main bottleneck in Medicon Valley is thus the limited supply of skilled PhDs. In addition, there are also signs indicating bottlenecks in relation to the overall supply of skilled labour.[40] A general decline in the number of young people is expected to affect the supply of highly skilled labour in the period 2005 to 2010.[41]

The future shortage of skilled employees can be limited by an increase in the numbers produced by the various universities and other education institutions. Furthermore, it will be important to attract skilled labour from other countries in order to minimize the shortages. But the forecasts still suggest that there will be a shortage, especially at the PhD level which, in turn, could inhibit the growth of the medical technology sector in Medicon Valley.

3.6 Conclusion

The country and local area studies illustrate a number of findings in relation to the West Midlands:

- the medical technologies sector/cluster is well established in all of the case study areas outside the UK;
- there are strong links between sectors in these areas to bring about market advantages, and there are strong overlaps with the biosciences and biotechnology;
- there is a relatively large volume of R&D and patenting activity with strong linkages to the higher education sector;
- many of the sectors have a strong core established in high-value, high-tech production of medical devices typically associated with large multi-national enterprises;
- that said there is a large population of SMEs in each of the case study areas;
- there is some evidence of specialisation in each of the case study areas;
- the skills of the workforce are relatively high compared to the economies in which they are situated and a strong demand for graduates and post-graduates;
- national and regional enterprise agencies have played a leading role in establishing the clusters in their present locations and continue to do so.

The existing evidence in relation to the West Midlands is that it has not achieved the critical mass of activity and core of high-tech, high-value companies evident in the area studies outside of the UK. To some extent this is a consequence of starting much later to establish the cluster. The next section addresses this issue in greater detail through survey and case study data.

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38 Commercial Attractiveness of biomedical R&D in Medicon Valley, The Boston Consulting Group, 2002

39 Viden på tværs i Medicon Valley (Knowledge across Medicon Valley), Aston Promentor, 2002

40 Competence clusters in the capital region, Oxford Research 2002

41 Bio-/sundhed (Bio-/health – A new partnership for growth), Public Task force, 2002

4. SURVEY AND CASE STUDY EVIDENCE

4.1 Introduction

This chapter provides key findings from the survey and case studies in an international comparative context. It demonstrates how industrial structures, product market positions, and skill needs varied between the three areas. Some of the differences reported stem from differences between the sectors/clusters across the various countries and the varying institutional arrangements in place, but they will also arise from cultural differences in the way that questions relating to skill needs of the workforce are answered by respondents.

The chapter commences by comparing the characteristics of the companies in the sample, the product market strategies they have pursued, and how this relates to problems either recruiting employees from the external labour market or developing further the skills of the existing workforce. This relates very much to the overview presented in section 1 that outlined how skill needs derive from the product market strategies of companies.

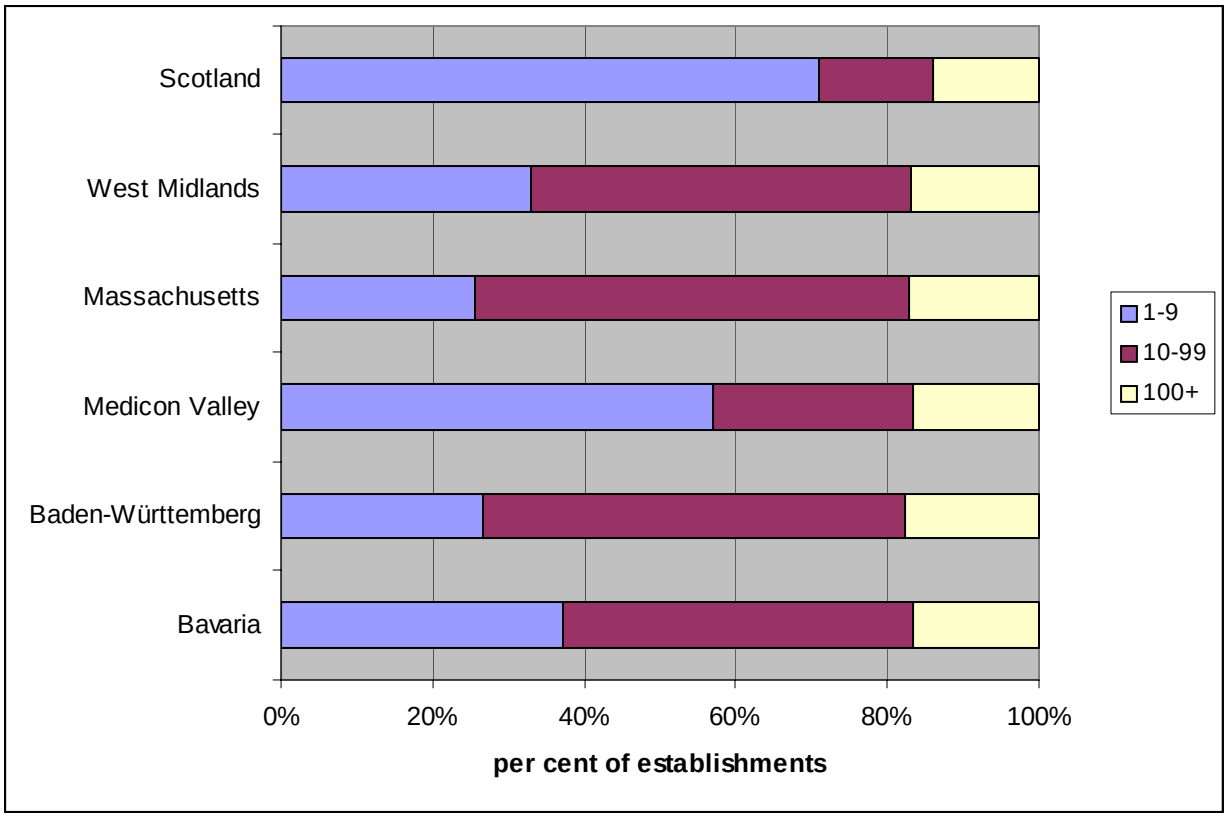
4.2. Characteristics of companies

Figure 4.1 reveals that in many instances the medical technology sector/cluster is one dominated by small and medium size enterprises. In all six areas there are relatively few large companies engaged in medical technologies. The situation seems most marked in Scotland where the sector/cluster is composed mainly of small establishments. But all areas were dependent upon a large number of small companies.

The range of activities in which medical technology companies engaged were varied within regions. Rather than a clear picture of specialisation emerging the more apparent picture was that of a wide variety of activities being common in all areas: from the production of simple bandages to the production of hi-tech equipment. This is described in greater detail below.

With respect to the more hi-tech equipment, Bavaria (in the area around Erlangen/Nurnberg) had a greater concentration of hi-tech manufacturers.

Figure 4.1 Size characteristics of medical technology companies

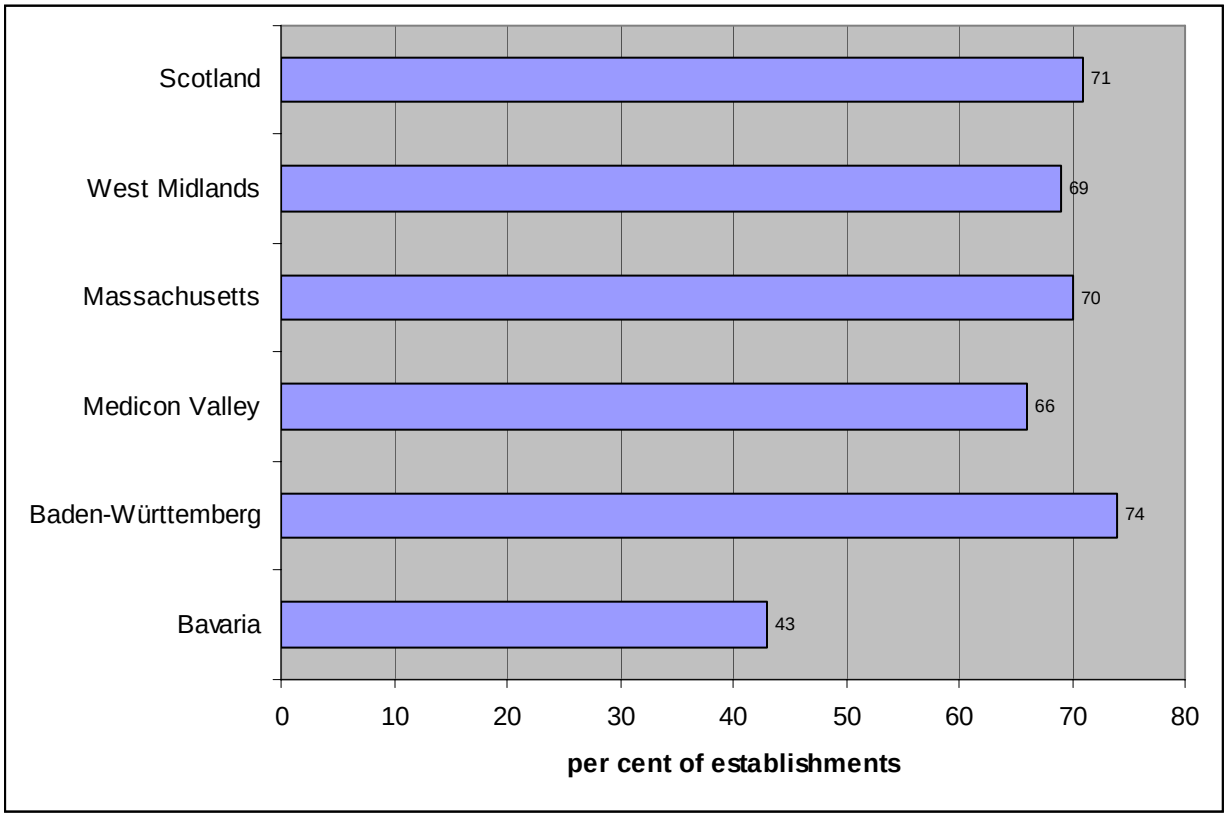


Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

The study adopted a cluster based approach - as far as possible - to ensure that companies were primarily located in sectors other than medical technologies but which produced medical devices were included in the study. *Figure 4.2* shows the percentage of establishments in each of the six areas that reported that they were exclusively engaged in the production of medical devices.

The results show a relatively high level of concentration of activity in medical technologies. It is only in Bavaria where companies were likely to be engaged in the production of a variety of good and services. More typically, around three quarters of establishments in each area operated exclusively in medical technologies. In many respects this is a consequence of the size of companies. Smaller companies are much less likely to be able to operate in a variety of production activities.

Figure 4.2 Proportion of establishments exclusively producing medical technologies



Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

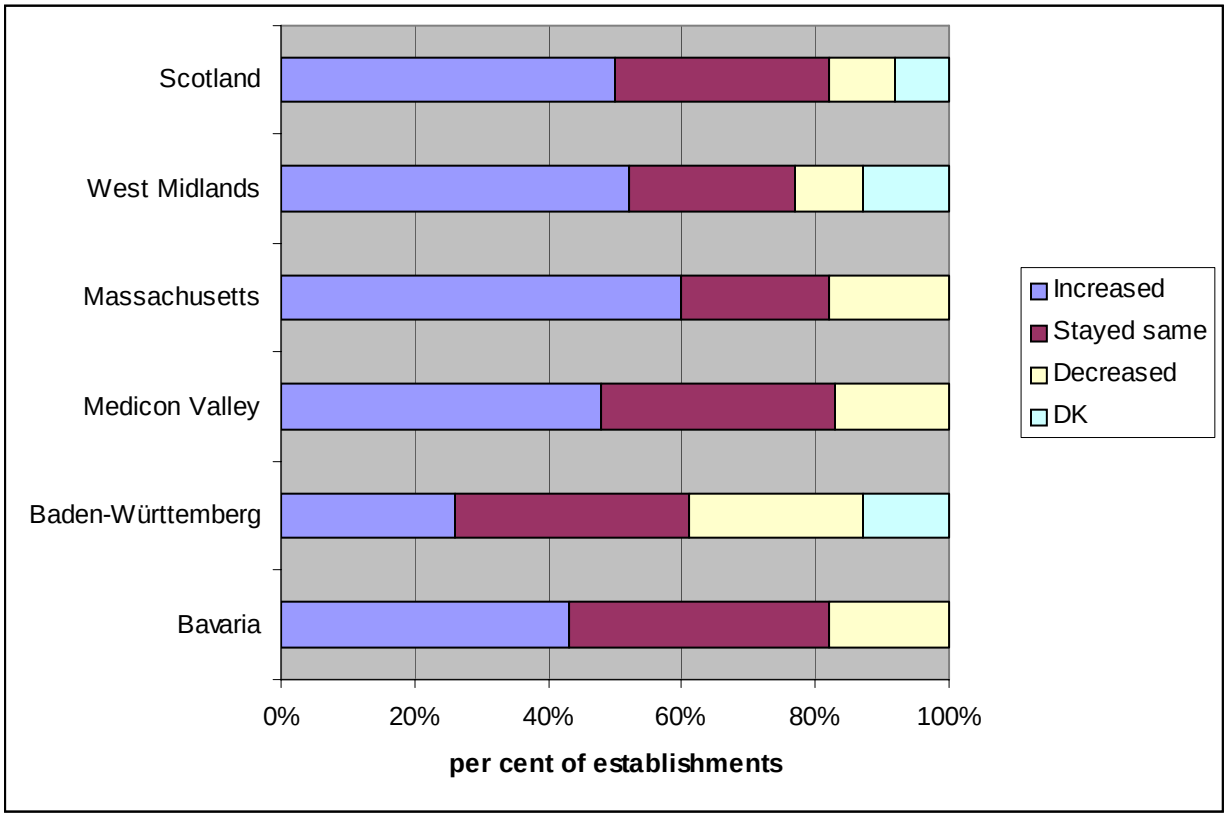
The size structure of the sector/cluster is reflected in the turnover levels reported by companies. The level of sales turnover recorded in each area: a majority were below £1m a year (at current exchange rates) with a substantial proportion recording a turnover of less than £500,000 a year.

4.3 Trading conditions

The economic environment in which the study took place varied between the six areas. Germany probably represented the least favourable trading conditions due to the slump in the German economy. Similarly, trading conditions were sluggish in the USA. Possibly the most favourable trading condition were in the UK which has experienced steady economic growth over recent years. That said, the previous chapters have indicated how expenditure – especially public expenditure – is becoming squeezed as a consequence of people living longer and the pressures on the tax system to pay for the care of increasing numbers of old people.

Other than Massachusetts, it was companies in the West Midlands and Scotland that were most likely to report real sales growth over the November 2002 – November 2003 period. Consequently, companies in these two areas were least likely to report contracting sales. Looking to the future, 52 per cent of companies in the West Midlands expected sales to either increase rapidly (21 per cent) or slowly (31 per cent) compared to 61 per cent in Medicon Valley, 48 per cent in Bavaria, and 53 per cent in Baden-Württemberg. Most companies in Massachusetts were expecting sales growth over the next two to three years.

Figure 4.3 Change in sales turnover (November 2002- November 2003)

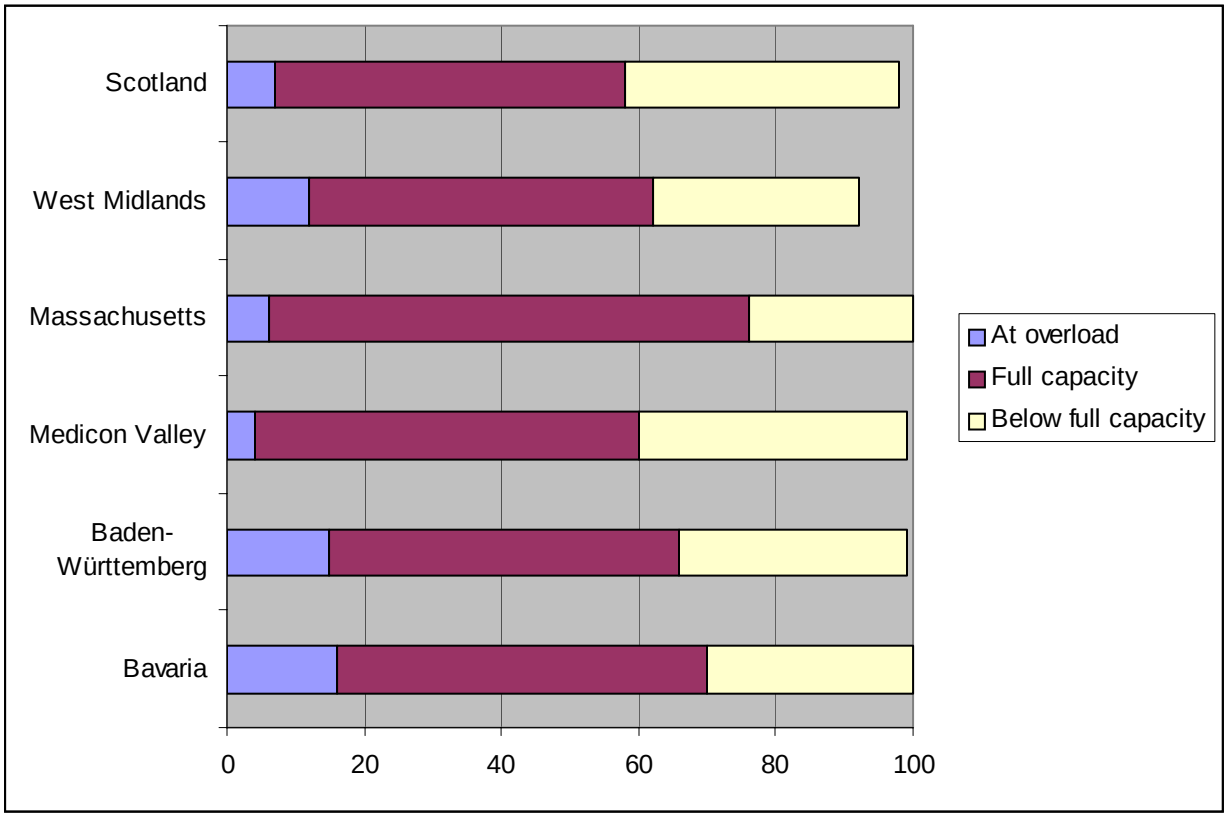


Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

Figure 4.4 reveals the extent to which companies were operating at above or below full capacity given the size of their premises, their number of staff, *etc.* The following findings are notable:

- the relatively high percentage of companies operating at below full capacity in Medicon Valley and Scotland;
- the relatively high percentage of companies in the West Midlands and in the two German regions were reported that they were working at overload.

Figure 4.4 Capacity Utilisation



Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

4.4 Customer base

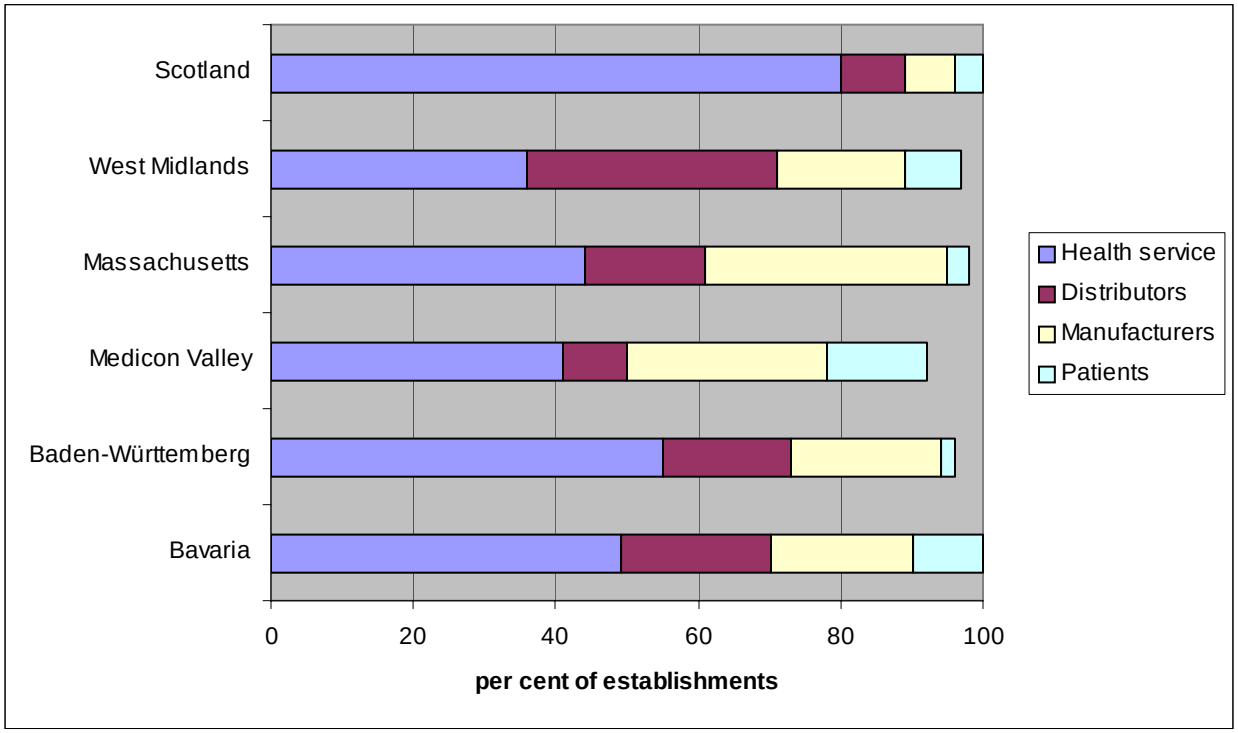
Respondents were asked to specify the main customer for the products and services according to whether they were:

- other manufacturers;
- the health service;
- patients; or
- distributors.

One has to be careful in how these data are interpreted since companies could be supplying more than one type of customer. But the subject of interest was the main customer. *Figure 4.5* shows that there was considerable variation between the six areas. To some extent this will reflect the different structures for supplying health services and patients, but will also reflect the different types of product market strategy pursued by companies.

Scotland stands out as having a large share of companies supplying the health service. The data reveals that this largely small companies supplying dentures and other relatively low-tech products directly to the NHS. The West Midlands stands out as supplying a relatively large share its output to distributors.

Figure 4.5 Main customer for medical products



Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

There was also wide variation in the export orientation of companies with those in the West Midlands and Scotland being least likely to report that they exported:

- in Germany, 48 per cent of companies in the Bavarian sample reported they exported goods, and 77 per cent in Baden-Württemberg;
- 48 per cent of companies in Medicon Valley exported;
- in Massachusetts, 66 per cent of companies reported exporting activity; and
- in the West Midlands 37 per cent of companies reported that they exported.

Where companies exported it tended to account for a sizeable proportion of their output. On average, around a fifth of exporters reported that this activity accounted for 50 per cent or more of their output.

4.5 Product market position and trajectory

Skill needs, as outlined in the introductory section to this report, will derive from the business plans that companies put in place. The relationship is undoubtedly a complex one. In order to capture a quantitative account of employers' business strategies a series of questions were asked about:

- the volume of production;
- whether the product was a complex one;
- the price elasticity of demand;
- whether the production process was technologically advanced;

- the level of automation in the production system; and
- whether a standard or premium market was being served.

Respondents were asked to classify the position of their place of work relative to what they considered to be the norm in their sector *(see panel for the actual questioning used)*.

A.) a score of one indicates that, compared to others in your industry, this establishment is a high volume producer or service provider and a score of five indicates that you provide one-off or very low volume services or products

High volume	1	2	3	4	5	DK	One-off

B) a score of one indicates that, compared to others in your industry, you provide a highly complex service or product and a score of five that you provide a simple product or service

Highly complex	1	2	3	4	5	DK	Simple

C.) a score of one indicates that, compared to others in your industry, the competitive success of your establishment's products or services does not depend at all on price and a score of five that success is wholly dependent on price

Not at all price-dependent	1	2	3	4	5	DK	Wholly price dependent

D.) a score of one indicates that, compared to others in your industry, your production systems are state of the art and a score of five that, compared to others in your industry, you are well behind recent technological developments

State of the art	1	2	3	4	5	DK	Well behind recent developments

E.) a score of one indicates that the way you produce your products or services is highly automated and a score of five that they are not automated at all

Highly automated	1	2	3	4	5	DK	Not automated at all

F) a score of one indicates that you compete in a premium quality product or service market and five that you compete in a market for a standard or basic quality product

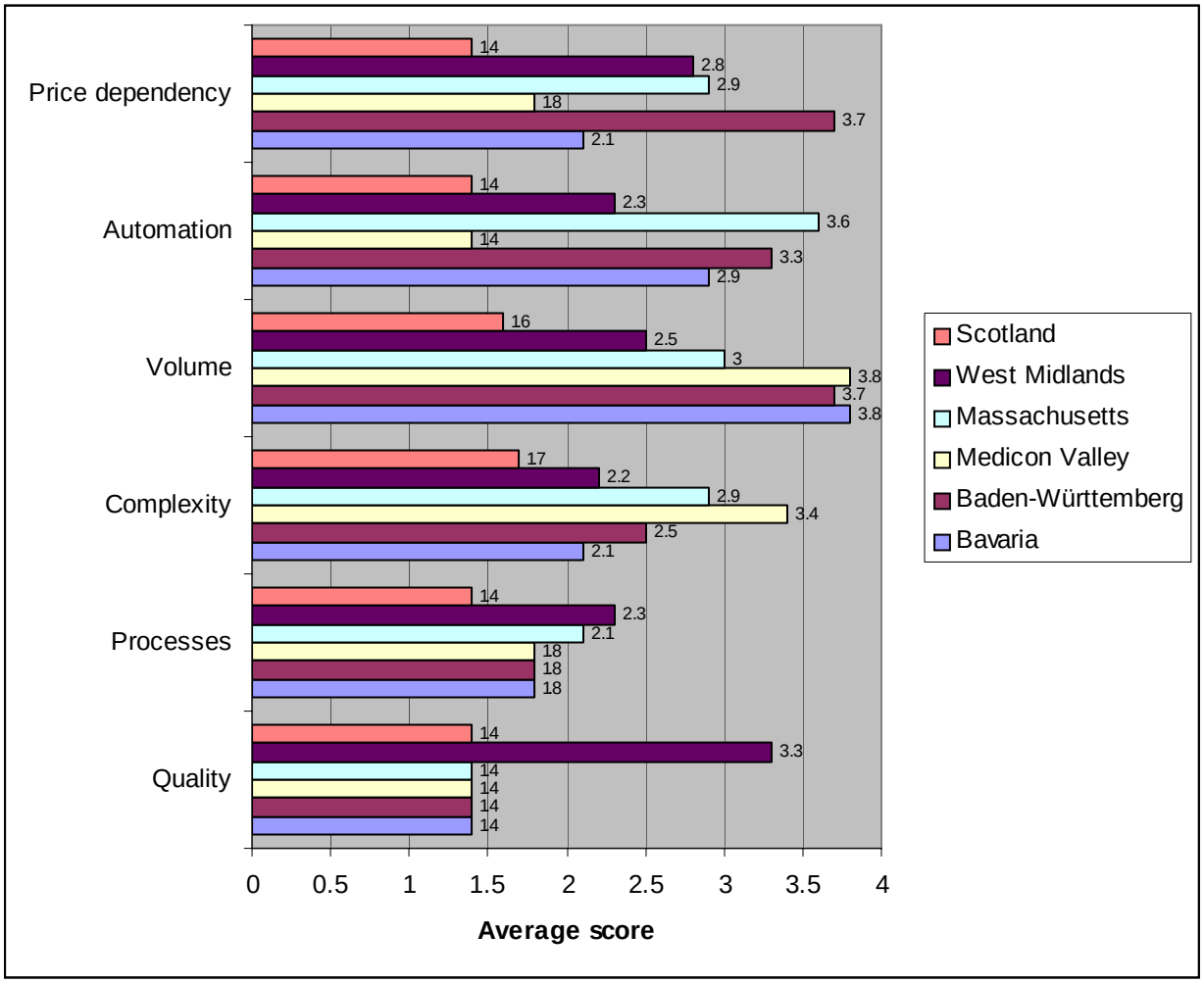
Premium	1	2	3	4	5	DK	Basic / Standard

To report the data, average score were calculated based on the scores recorded above. *Figure 4.6* shows the average scores for each of the six areas. The key findings are as follows:

- **volume**: the principal difference is between Scotland on the one hand producing in low volumes, and Baden-Württemberg producing relatively high volumes;
- **product complexity:** at one extreme there is Scotland producing what are considered to be complex products and at the other there is Medicon Valley producing comparatively simple goods;
- **price dependence**: Scotlands reports that its products are relatively price inelastic compared to Baden-Württemberg which is most dependent upon prices reflecting the high volume of production in which it engages;
- **production processes:** there is relatively little variation between areas except that the West Midlands is a little more likely to report that its production processes are not state-of-the-art;
- **automation** is more to the fore in Massachusetts and Baden-Württemberg – again reflecting the high volume of production;

- there is virtually no variation with respect to whether a **premium market** is being served with all areas reporting that they serve this type of market, except for the West Midlands where the results show that a standard market is being served.

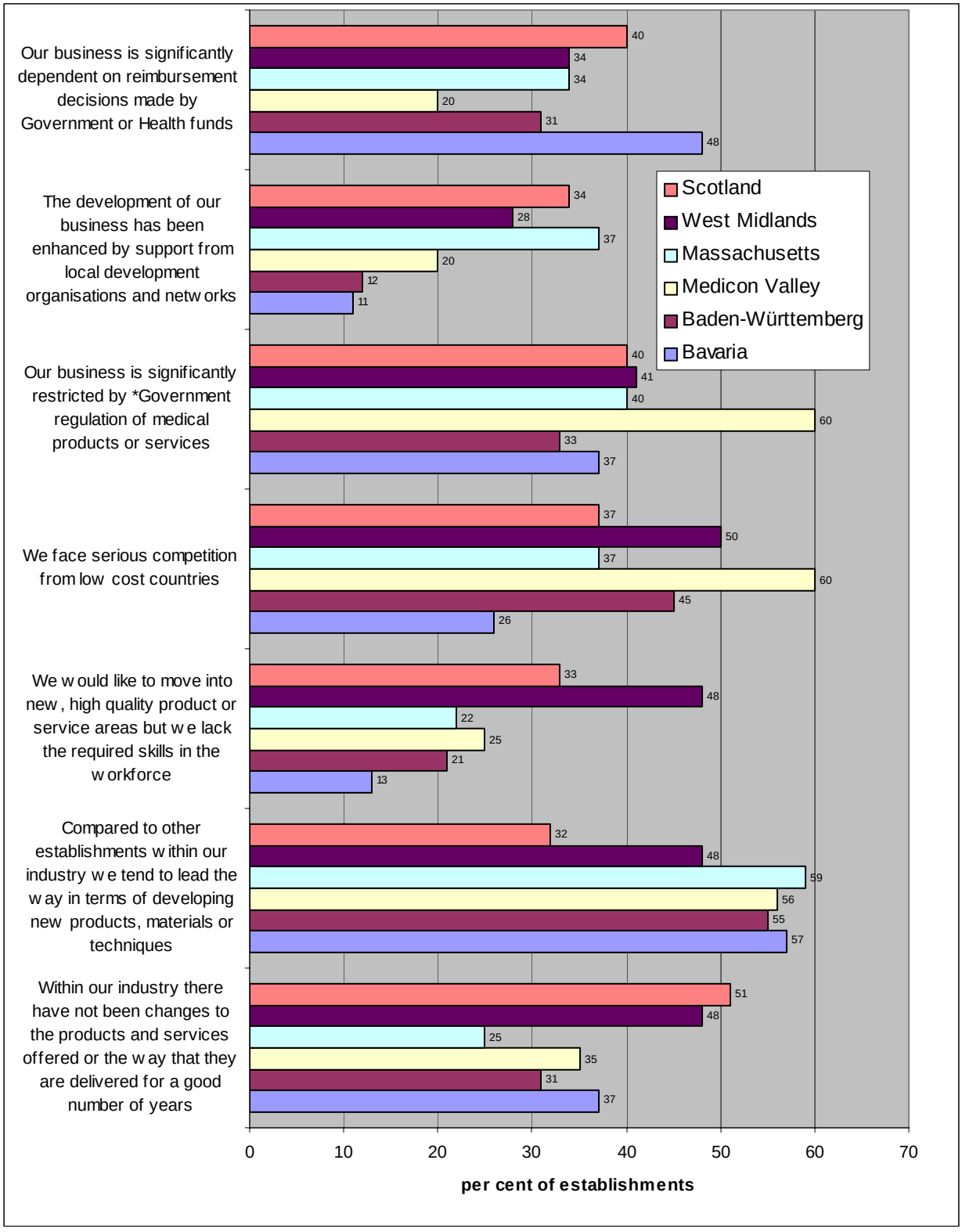
Figure 4.6 Product market position



Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

As well as addressing current product market positions, the study was also concerned with the product market trajectories companies were pursuing and the barriers they encountered in entering higher value-added markets *(see Figure 4.7)*.

Figure 4.7 Product market trajectories



Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

A number of findings are apparent from *Figure 4.7:*

- the two UK regions are most likely to agree that there have been no changes to what products and services are delivered, with Baden-Württemberg being the most likely to report changes;
- it tends to the two UK regions that are least likely to report that they lead the way in the development of new products, materials, and techniques;
- it also tends to be in the two UK areas that skills are most likely to be reported as a constraint on moving into higher value-added markets;
- Medicon Valley was the most likely to report competition from imports;
- it was also in Medicon Valley that employers were most likely to report that their business was restricted by regulations governing medical devices;
- it was the Bavarian sector/cluster that was most likely to report that it was dependent upon government reimbursement;
- the USA and the two UK regions were most likely to report that their activities had been supported by regional development agencies.

4.6 From product market strategy to skills

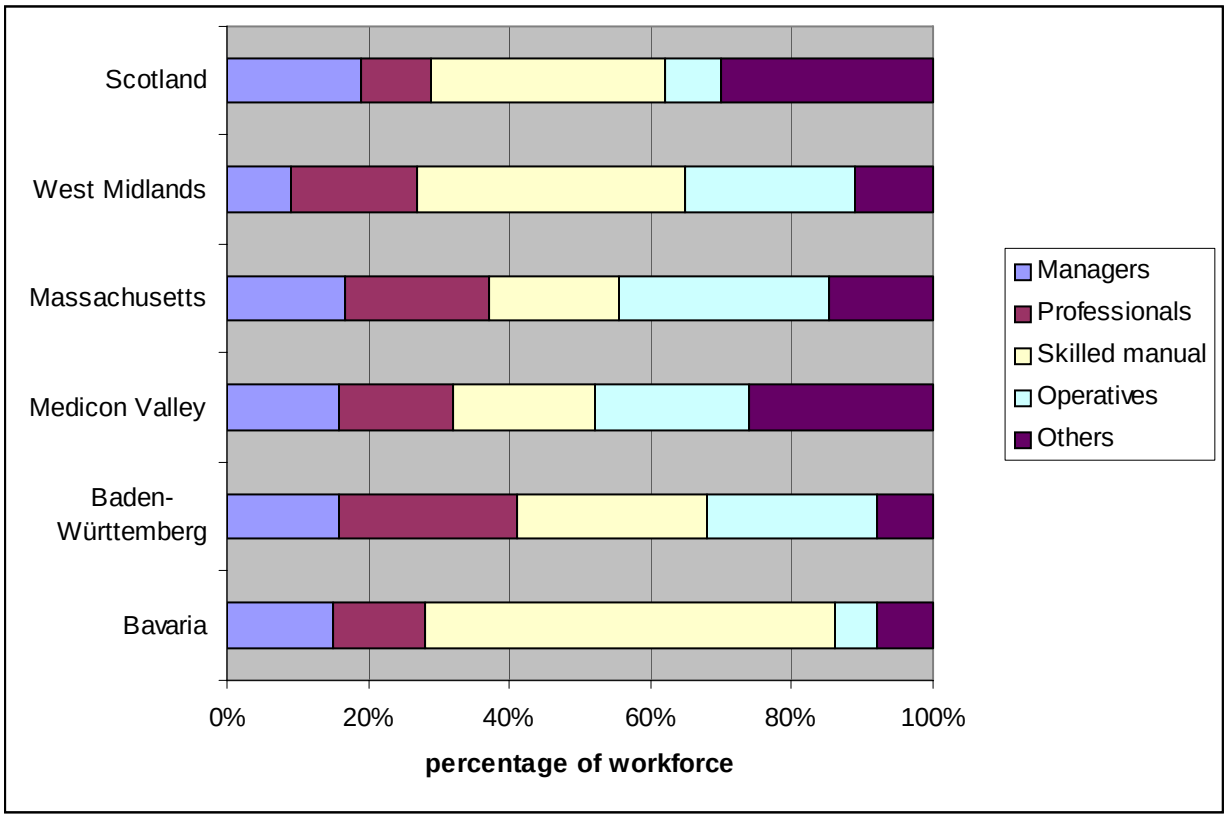
The starting point for looking at skill needs is by looking at the current structure of the workforce *(see Figure 4.7)*. Occupation provides a proxy measure of skills. The comparative data reveals considerable differences in the occupational profiles of the sector/cluster across the six areas:

- the proportion of managers in the workforce varies little across the regions;
- the share of professional scientists and engineers in the workforce is greatest in Baden-Württemberg although differences are modest between regions;
- Bavaria is most dependent upon skilled manual workers followed by Scotland and the West Midlands;
- Bavaria and Scotland stand out given the small share of semi-skilled operatives employed.

The principal differences between regions, therefore, would appear to be in the share of skilled manual workers and operatives.

Across the regions an almost constant proportion of the people are employed in research and development (R&D), at around 12-15 per cent of the workforce.

Figure 4.7 Occupational structure of the workforce



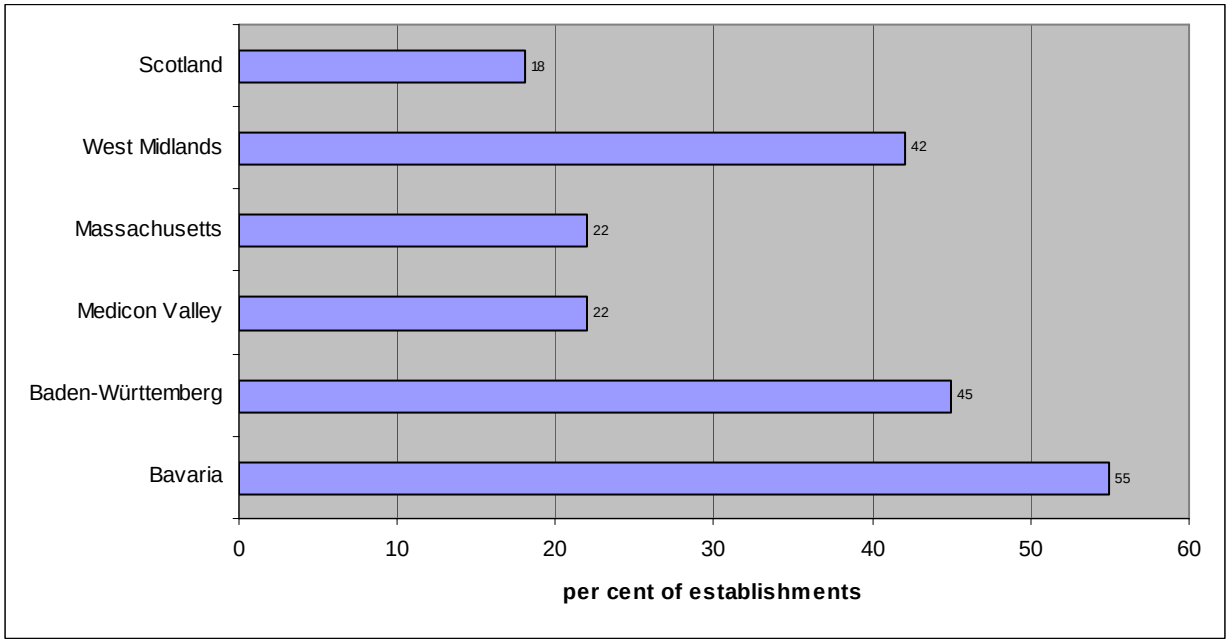
Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

Of particular interest is the extent to which skills act as a constraint on the business strategy. This is likely to arise in two ways:

- **recruitment problems:** through being unable to recruit staff from the external labour market with the skills required or the ability to acquire the skills employers seek;
- **skill gaps:** through the existing workforce being unable to provide the skills the company requires to meet its business plan.

Figure 4.8 reveals the percentage of establishments that reported recruitment problems. Bavaria, Baden-Württemberg, and the West Midlands were the most likely to report recruitment problems. In practice, the actual number of hard-to-fill vacancies was modest. In the West Midlands and Baden-Württemberg it related primarily to operatives, whereas in Bavaria it was also for skilled manual workers.

Figure 4.8 Recruitment problems



Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

Even if the volume of recruitment problems is quite modest where establishments encountered them they reported a number of harmful affects on their businesses from creating heavy workloads for existing staff (often met through increased overtime work) to delays in delivering goods and lost orders.

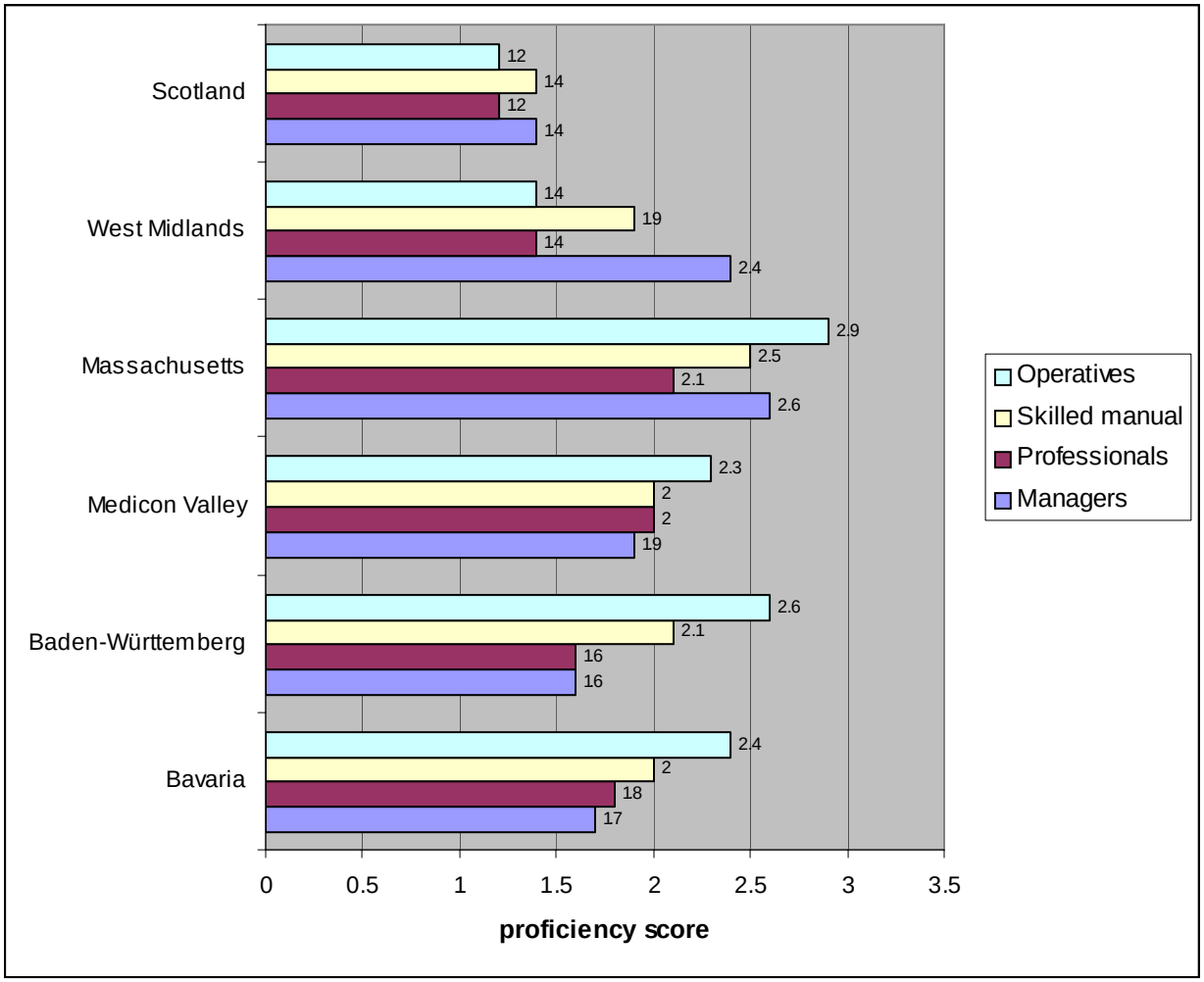
Figure 4.9 provides information about the proficiency of staff who were working in the establishments at the time of the study. Respondents were asked the following question:

> Thinking about each occupation (you employ) can you please tell me whether you regard your staff, on average, in those categories as
>
> | | |
> |---|---|
> | exceedingly proficient at their job | 1 |
> | highly proficient at their job | 2 |
> | fully proficient | 3 |
> | not quite fully proficient | 4 |
> | not proficient at their job | 5 |

An average score has been calculated for each occupation. If respondents reported, for example, that managers were *exceedingly proficient at their job* they scored 1 and if they said that managers were *not proficient at their job*, they scored 5.

Generally, it is the two UK regions that are most likely to report that their employees are fully proficient. In the West Midlands managers were considered least proficient, but much less so than in other regions.

4.9 Proficiency of current staff (skill gaps)



Source: AWM Developing Excellence in Medical Technologies (IER/WMG/Economix/PLS)

Gaps in proficiency often arose because staff lacked the mix of technical and generic skills the organisation required. In fact the emphasis was often upon the generic aspects reflecting, perhaps, that the possession of technical skills was a pre-requisite to obtaining employment in the first instance. By generic skills respondents were referring to communication skills, customer handling skills, *etc.*

Overall, establishments across all regions were confident that their staff were well equipped to meet the future needs of the business, but recognised that they would be likely to encounter problems recruiting the staff they would require in the future.

4.7 Conclusion

The description provided above is based on survey and case study responses. It is important to recognise that there are qualitative differences and similarities between the six case study areas. Baden-Württemberg , Bavaria, and Massachusetts have developed large-scale medical technology clusters –as the previous section indicates – often producing some of the most

advanced medical technologies. When addressing the skill needs of companies it is necessary to bear these qualitative differences in mind. Many of the organisations in Scotland and the West Midlands were engaged in the production of dentures and there was relatively little evidence of organisations producing, for example, technologies comparable with latest scanners. Case study evidence also suggests that IPR in the multi-national companies was often generated outside of the UK.

But the differences should not be too exaggerated. There are many aspects of the medical technology sectors in areas such as Baden-Württemberg that are comparable with that in the West Midlands. Especially the dependence upon small and medium sized enterprises. There is also the wide range of products being produced in every area to consider. This can sometimes make it difficult to discuss the medical technologies sector as a single entity since the variety it contains is so great. For many of the relative low-tech producers the skills that are required here are generic and transferable rather than specific, non-transferable technical ones.

5. CONCLUSION AND POLICY IMPLICATIONS

APPENDIX A

Medical Technologies Questionnaire
Core Questionnaire

PREAMBLE TO QUESTIONNAIRE

ASK TELEPHONIST IF NO NAME ON SAMPLE: May I speak to the most senior person here who has responsibility for human resource and personnel issues?

ASK RESPONDENT:
Good morning/afternoon my name is _____ and I am calling from [NAME OF ORGANISATION *e.g.* University of Warwick Institute for Employment Research or survey company if used]. We are conducting a survey of companies in Europe engaged in the production of medical technologies to find out about what skills are necessary for their businesses to grow and survive.

INTERVIEWER NOTE: The study has been commissioned by the Regional Development Agency for the West Midlands in the UK with aim of understanding the skill needs required for the development and growth of employment in medical technologies. A summary of findings from the survey will be made available to all participant companies.

The interview will take on average 20 minutes depending upon the answers given and all information will be treated as confidential and the anonymity of your company is guaranteed in any report. Would it be convenient to conduct the interview now or should I call you back?

INTERVIEWER NOTE: ADD IF NECESSARY:

- Co-operation will ensure that all the views expressed are representative of all employers
    - The results will be available in the New Year on http://www.warwick.ac.uk/ier
- All information will be treated in the strictest confidence. Responses will not be attributed to any individual or company. Results will be reported in the form of aggregated statistics.

Further information can be obtained from Mark Winterbottom or Zehra Koroglu at IFF Research on 020 7250 3035 or Terence Hogarth from the Institute of Employment Research on 024 765 24420.

A: DETAILS OF ORGANISATION

ASK ALL

I would like to begin by asking you some questions about this establishment or site. By establishment I mean this single location even if includes more than one building.

A1 What is the main business activity of this establishment?

_____ CODE TO 4-DIGIT ISIC

PROBE AS NECESSARY:
What is the main product or service of this establishment?
What exactly is made or done?

Can I just check that you produce some medical products or services?

Yes GO TO A2
No **TERMINATE INTERVIEW**

A2. Please describe the different types of medical product and services you produce:

	A2	A3
Medical Devices		
Surgical Devices		
Orthotics		
Prosthetics		
Rehabilitation		
Gerontology		
Wound care		
Imaging/modelling		
Innovation support and infrastructure		
Biomaterials		
Opthalmology		
E-healthcare		
Biosciences		
Pharmaceuticals		
Biotechnology		
Biological modelling		
Genomics/Proteomics		
Innovation and incubation support		
Veterinary		
Other (please specify)		

A3. And which would you say were the main medical products or services you produce?

B. EMPLOYMENT

I would now like to ask you some questions about employment at this establishment.

B1. How many people are currently employed at this establishment?

WRITE IN NUMBER AND CODE RANGE

NUMBER : _____

1 – 4	
5 – 9	
10 – 24	
25 – 49	
50 – 99	
100 – 199	
200 – 499	
500 – 999	
1000+	

B2. How many staff are employed in activities directly relating to the production of medical products or services (please include managers and support staff as well as production staff).

WRITE IN NUMBER AND CODE RANGE

NUMBER : _____ B

ALL	
1 – 4	
5 – 9	
10 – 24	
25 – 49	
50 – 99	
100 – 199	
200 – 499	
500 – 999	
1000+	

The following questions relate solely to staff employed in connection with medical products or services.

B3. Thinking back twelve months how many people were employed then in connection with the production of medical products or services?

WRITE IN NUMBER AND CODE RANGE

NUMBER : _____

	B3
NONE	
1 – 4	
5 – 9	
10 – 24	
25 – 49	
50 – 99	
100 – 199	
200 – 499	
500 – 999	
1000+	

B4. How many people involved in the production of medical products or services have left the establishment in the past 12 months?

WRITE IN NUMBER AND CODE RANGE

NUMBER : _____

	Q4
NONE	
1	
2	
3	
4	
5-9	
10-19	
20-49	
50 – 99	
100 –199	
200 or more	

IF NUMBER NOT KNOWN ACCEPT PERCENTAGE

---------- %

B5. IF EMPLOYEES HAVE LEFT: What were the main reasons for people leaving employment in this establishment?

READ OUT

Better pay elsewhere	
Lack of career development at this organisation]	
Internal promotion within company	
Dismissed	
Made redundant	
Career breaks	
Other (please specify)	

B6. [Text sub if not All at B2: Still thinking only about staff involved in the production of medical products and services,] approximately how many staff at this establishment are employed as…
Note: THIS SHOULD SUM TO B2, NOT B1 (IE. TOTAL INVOLVED IN MEDICAL PRODUCTION)

READ OUT

Managers	
Professional scientists and engineers	
Skilled trades occupations (i.e. fully apprenticed manual employees)	
Process, plant and machine operatives (*i.e.* semi-skilled production workers)	
Others	

B7. How many people [text sub if not All at B2: involved in the production of medical products and services] do you employ with...

	NUMBER	PERCENT
a degree level qualification in clinical or medical subjects		
a degree level qualification in science or engineering subjects		

ASK ALL

B8. How many people at this establishment are employed in research and development related to medical products and services?

NUMBER : _____

NONE	
1	
2	
3	
4	
59	
10 – 24	
25 – 49	
50 – 99	
100 –199	

200 or more	

B9 ASK IF NONE AT B8: So where does research and development take place in this company?
READ OUT: at another branch of the company in this region
at another branch of the company outside this region
at company head office
we don't do any research and development
don't know (DO NOT READ OUT)

ASK ALL

B10. [Text sub if not All at B2: And still thinking only about staff involved in the production of medical products and services,] Over the next two to three years do you expect employment at this establishment to:

READ OUT? *SINGLE CODE*

Increase a great deal	1
Increase a little	2
Stay the same	3
Decrease a little	4
Decrease a great deal	5
(DO NOT READ OUT) Don't Know	X

B11 In relation to your current premises and equipment would you say that this establishment was…?

READ OUT

At overload	1	
At full capacity	2	
Somewhat below full capacity	3	
Considerably below full capacity	4	

C. RECRUITMENT PROBLEMS

I would now like to ask you some questions about recruitment at this establishment over the last 12 months [IF ACTIVITIES OF COMPANY NOT ALL MEDICAL TECHNOLOGIES ADD: I only want to know about recruitment to jobs related directly to the production of medical products or services].

ASK ALL

C1 Have you recruited any staff in the last 12 months?
Yes
No

C2. Over the past 12 months how many vacancies, including any you have currently, have there been at this establishment? *PROBE FOR BEST ESTIMATE*

WRITE IN NUMBER _____
NONE

IF NONE GO TO SECTION D

C3. In which specific occupation(s) have you had vacancies at this establishment over the last 12 months?

Occupation	**Number**
Occupation 1 -	(1-9999)
Occupation 2 -	(1-9999)
Occupation 3 -	(1-9999)
Occupation 4 -	(1-9999)
Occupation 5 -	(1-9999)
Occupation 6	(1-9999)

C4. How many vacancies have you had for [EACH OCCUPATION @ C3]

C5. Were any of these vacancies [FOR EACH OCCUPATION @ C3] hard-to-fill?
IF YES ASK: and how many were hard to fill?

	Enter number of hard to fill vacancies					
	Occ 1	Occ 2	Occ 3	Occ4	Occ 5	Occ 6
Yes						
No						
DK						

C6 ASK IF MORE THAN TWO OCCUPATIONS MENTIONED AT C5 AS CONTAINING HARD TO FILL VACANCIES: Which two occupations with hard to fill vacancies do you regard as having had the most impact on your business?

ENTER 1ST OCCUPATION _____
ENTER 2ND OCCUPATION _____
Don't know

IF 'DON'T KNOW' ENTER THE TWO OCCUPATIONS WITH THE LARGEST NUMBER OF HARD TO FILL VACANCIES

C7. Which of the following skills have you found difficult to obtain from applicants for *[OCCUPATIONS @ C6] … READ OUT*
IF 'YES' FOR SKILL CONTINUE: and *w*ould you say that it has been impossible, very difficult, or quite difficult to recruit people with [SKILL MENTIONED].

SCORE DIFFICULTY AS FOLLOWS

Impossible	3
Very difficult	2
Quite difficult	1
Don't know	0

CODE ALL MENTIONED

	1st occupation		2nd occupation	
	Yes/No	Difficulty score	Yes/No	Difficulty score
General IT user skills				
IT professional skills				
Communication skills				
Customer handling skills				
Team working skills				
Foreign language skills				
Problem solving skills				
Management skills				
Numeracy skills				
Literacy skills				
Engineering skills				
Scientific skills				
Clinical/medical skills				
Other Technical and practical skills				
Skills related to product regulations				
Any other skills (WRITE IN)				
(DO NOT READ OUT) No particular skills difficulties				
(DO NOT READ OUT) Don't know				

C8. What were the main causes of having a hard to fill vacancy for *[TWO MOST IMPORTANT OCCUPATIONS WITH HARD TO FILL VACANCY]*?
DO NOT READ OUT. CODE ALL MENTIONED

	1st Occ	2nd Occ
Too much competition from other employers		
Not enough people interested in doing this type of job		
Poor terms and conditions (e.g. pay) offered for post		
Low number of applicants with the required skills		
Low number of applicants with the required attitude, motivation or personality		
Low number of applicants generally		
Lack of work experience the company demands		
Lack of qualifications the company demands		
Poor career progression / lack of prospects		
Job entails shift work/unsociable hours		
Seasonal work		
Remote location/poor public transport		
Other (WRITE IN)		
No particular reason		
Don't know		

C9. *ASK ALL WITH HARD-TO-FILL VACANCIES*
Generally speaking, were hard to fill vacancies causing this establishment to experience any of the following and how often do these effects occur (never, occasionally, often or all the time)?:

READ OUT (CODE ALL MENTIONED).

	Never	Occasionally	Often	All the time
lose of business or orders to competitors				
delay developing new products or services				
have difficulties meeting customer service objectives				
have difficulties meeting required quality standards				
face increased operating costs				
have difficulties introducing new working practices				
increase the workload for other staff				
Other difficulties (WRITE IN)				

C10. Have hard to fill vacancies caused this establishment to respond in any of the following ways, and how often (never, occasionally, often or all the time)?:.. *READ OUT?*

CODE ALL MENTIONED

	Never	Occasionally	Often	All the time
Increase salaries				
Increase the training given to your existing workforce in order to fill the vacancies				
Redefine existing jobs				
Increase advertising / recruitment spend				
Increase/expand trainee programmes				
Expand recruitment channels				
Take any other action (WRITE IN)				
(DO NOT READ OUT) None				
(DO NOT READ OUT) Don't know				

C11. ASK IF YES AT C1: Thinking about the people you have recruited over the last year, have you recruited them from any of the following?
READ OUT. CODE ALL THAT APPLY.

From parent company	1
From a company in the medical device sector in the region	2
From a company in the medical device sector outside the region	3
From another industry in the region	4
From another industry outside the region /	5
From research job in the region	6
From a research job outside the region	7
From public sector	8
From unemployment	9
Don't know (DO NOT READ OUT)	x

C12 IF YES AT C1: Have you recruited staff from any of these sectors in the last 12 months?
READ OUT. CODE ALL THAT APPLY.

automotive	1
aerospace	2
instruments / fine engineering	3
general engineering	4
commercial / service sector	5
Are there any other sectors other than medical technologies which you have recruited significant numbers from in the last 12 months? (please specify)	O
Don't know	X

ASK ALL
C13 Thinking of your recruitment needs, is your main preference to:
READ OUT OPTIONS 1 TO 3. CODE ONE ONLY

Recruit people who already have skills in medical technology	1
Recruit people and train them to your specific requirements	2

Redeploy and retrain people from elsewhere in your company	3
It depends/ mixture (DO NOT READ OUT – TRY TO GET AN ANSWER IN 1, 2 OR 3 IF POSSIBLE)	4
Don't know (DO NOT READ OUT)	X

C14 Do you, or would you consider, sourcing any skills or 'services' from outside the UK?

NO
YES Which skills or services are you referring to? (WRITE IN)

_____

(allow don't know)

D: INTERNAL SKILL GAPS

I'd now like to turn to the skills within your existing workforce. Please do not think about any external recruitment problems that you may face. [IF ACTIVITIES OF COMPANY NOT ALL MEDICAL TECHNOLOGIES ADD: I only want to know about jobs related directly to the production of medical products or services.

Earlier we spoke about specific groups of occupations:

Managers
Professional scientists and engineers
Skilled trades occupations (i.e. fully apprenticed manual employees)
Process, plant and machine operatives (*i.e.* semi-skilled production workers)

D1. Thinking about each occupation can you please tell me whether you regard your staff, on average, in those categories as

exceedingly proficient at their job	1
highly proficient at their job	2
fully proficient	3
not quite fully proficient	4
not proficient at their job	5

[ASK FOR EACH OCCUPATION MENTIONED AT B6 EXCEPT 'OTHER' CATEGORY]
Let me start with managers. Are they [READ OUT LIST]. And for professional scientists and engineers. [REPEAT FOR EACH OCCUPATION AT B6]

READ OUT

Managers	
Professional scientists and engineers	
Skilled trades occupations (i.e. fully apprenticed manual employees)	
Process, plant and machine operatives (*i.e.* semi-skilled production workers)	

D2. ASK IF ANY GRADE OF STAFF CODED 4 OR 5 AT D1: In what specific areas of your business are staff lacking full proficiency?

PROMPT IF NECESSARY
Overall management of organisation
Operations/Production management
Research and development
Sales/Marketing
Administration
Other (please specify)
None **GO TO QUESTION D8**

D3. What are the main causes of some of your staff not being fully proficient in their job… *READ OUT*?

CODE ALL MENTIONED

Failure to train and develop staff	1
Recruitment problems	2
High staff turnover	3
Rapid pace of change in industry	4
Lack of experience or their being recently recruited	5
Staff lack motivation	6
Any other cause (WRITE IN)	7
(DO NOT READ OUT) No particular causes	8
(DO NOT READ OUT) Don't Know	X

D4. And still thinking about your staff who are not fully proficient which, if any, of the following skills do you feel need improving… *READ OUT*?
CODE ALL MENTIONED.

General IT user skills	
IT professional skills	
Communication skills	
Customer handling skills	
Team working skills	
Foreign language skills	
Problem solving skills	
Management skills	
Numeracy skills	
Literacy skills	
Engineering skills	
Scientific skills	
Clinical/medical skills	
Other Technical and practical skills	
Skills related to product regulations	
Any other skills (WRITE IN)	
(DO NOT READ OUT) None	
(DO NOT READ OUT) Don't Know	

D6. Now, thinking more generally about staff at all levels within the establishment, is the fact that some of your staff are not fully proficient causing this establishment to …… *READ OUT*?
CODE ALL MENTIONED

lose business or orders to competitors	1
delay developing new products or services	2
face difficulties meeting customer service objectives	3
face difficulties meeting required quality standards	4
face increased operating costs	5
face difficulties introducing new working practices	6
(DO NOT READ OUT) No particular problems / None of the above	7
(DO NOT READ OUT) Don't know	X

D7. Which if any of the following actions are being taken at this establishment to overcome the fact that some of your staff are not fully proficient in their job … *READ OUT*?
CODE ALL MENTIONED

Increased recruitment	1
Providing further training	2
Changing working practices	3
Reallocating work within the company	4
Expand recruitment channels	5
Increase/expand trainee programmes	6
Any other action (WRITE IN)	7
(DO NOT READ OUT) No particular action being taken	8
(DO NOT READ OUT) Don't know	X

ASK ALL
D8. *IF ANY STAFF NOT FULLY PROFICIENT AT D2 ASK:* Which of the following barriers would you say may exist to your developing a more proficient team of staff in the future… READ OUT
CODE ALL THAT APPLY.
IF ALL STAFF FULLY PROFICIENT AT D2 ASK: Which of the following barriers would you say may exist to your maintaining a proficient team of staff in the future ... READ OUT
CODE ALL THAT APPLY.

Lack of funding for training	1
Lack of suitable courses in my area	2
Lack of suitable courses generally	3
Unwillingness of staff to undertake training	4
High staff turnover	5
Lack of time for training	6
Lack of cover for training	7
Other barriers (WRITE IN)	8
(DO NOT READ OUT) No barriers	9
(DO NOT READ OUT) Don't know	X

D9. Are the skills this organisation requires in good supply in the local labour market?

Yes, but depends on skill
Yes, all skills needed
No
Don't know

D10. What are your reasons for saying that [ANSWER AT Q10]?

_____
_____
_____

D11. Overall, how well prepared is your workforce to meet the product market challenges of the future?

READ OUT
Very well prepared
Quite well prepared
Not well prepared
Not at all well prepared
DO NOT READ OUT: Don't know

D12 Again, thinking about the future are there any skills that you foresee as being difficult to obtain (even if you face no such difficulty now?

No
Yes (please specify)

(allow don't know)

E. PRODUCT MARKET

I would now like to ask you some questions about the medical products and services you produce.

E1. Who are the main customers for the medical technology products and services you produce?

_____

DO NOT READ OUT
Health Service
Directly to patient
Other manufacturers
Distributors

E2. How much of the products or services you **sell** requires approval from the regulatory authority **of the respective market**? READ OUT

All
Nearly all
More than half
Some
Not many at all
None

ASK ALL

E3. I'd now like to ask you a number of questions about the main medical products or services that are provided by this establishment. First of all on a scale of 1 to 5, where would you place this establishment and the products or services that you provides if…READ FIRST STATEMENT BELOW

A.) a score of one indicates that, compared to others in your industry, this establishment is a high volume producer or service provider and a score of five indicates that you provide one-off or very low volume services or products

High volume	1	2	3	4	5	DK	One-off

B) a score of one indicates that, compared to others in your industry, you provide a highly complex service or product and a score of five that you provide a simple product or service

Highly complex	1	2	3	4	5	DK	Simple

C.) a score of one indicates that, compared to others in your industry, the competitive success of your establishment's products or services does not depend at all on price and a score of five that success is wholly dependent on price

Not at all price-dependent	1	2	3	4	5	DK	Wholly price dependent

D.) a score of one indicates that, compared to others in your industry, your production systems are state of the art and a score of five that, compared to others in your industry, you are well behind recent technological developments

State of the art	1	2	3	4	5	DK	Well behind recent developments

E.) a score of one indicates that the way you produce your products or services is highly automated and a score of five that they are not automated at all

Highly automated	1	2	3	4	5	DK	Not automated at all

F) a score of one indicates that you compete in a premium quality product or service market and five that you compete in a market for a standard or basic quality product

Premium	1	2	3	4	5	DK	Basic / Standard

ASK ALL

E4) How applicable are each of the following statements to this establishment and the industry you work in?

	Very applicable	Quite applicable	Not very applicable	Not at all applicable
Within our industry there have not been changes to the products and services offered or the way that they are delivered for a good number of years	1	2	3	4
Compared to other establishments within our industry we tend to lead the way in terms of developing new products, materials or techniques	1	2	3	4
We would like to move into new, high quality product or service areas but we lack the required skills in the workforce	1	2	3	4
We face serious competition from low cost countries	1	2	3	4
Our business is significantly restricted by *Government regulation of medical products or services	1	2	3	4
The development of our business has been enhanced by support from local development organisations and networks	1	2	3	4
Our business is significantly dependent on reimbursement decisions made by Government or Health funds				

F. YOUR ORGANISATION

Finally I would like to ask you a few questions so that we may classify your establishment.

F1. Over the last 12 months, can you tell me (approximately) the total value of sales at this establishment?

£_____

IF DON'T KNOW, PROMPT WITH RANGES BELOW

Less than £500,000	1
£500,000 - £999,999	2
£1m - £1.9m	3
£2m - £4.9m	4
£5m - £9.9m	5
£10m - £19m	6
£20m - £49m	7
£50m - £99m	8
£100m - £199m	9
£200m - £499m	0
£500m or more	V

F2. [IF NOT MEDICAL TECHNOLOGIES @ A1]. What percentage of your sales or output is in medical products or services?

WRITE IN % _____

IF DON'T KNOW, PROMPT WITH RANGES BELOW

1 – 9%	1
10 – 19%	2
20 – 29%	3
30 – 39%	4
40 – 49%	5
50 – 59%	6
60 – 69%	7
70 – 79%	8
80 – 89%	9
90 – 99%	0
100%	V

F3. Since November 2002 by what percentage would you say your total sales or output of medical products and services has increased or decreased by?

WRITE IN % INCREASED_____DECREASED_____

IF DON'T KNOW, PROMPT WITH RANGES BELOW

	Increased	Decreased
0%		
1 – 9%		
10 – 19%		
20 – 29%		
30 – 39%		
40 – 49%		
50 – 59%		
60 – 69%		
70 – 79%		
80 – 89%		
90 – 99%		
100%		

F4. Generally speaking would you say that over the next two to three years the market for the medical products or services you produce will...

grow rapidly	
grow slowly	
remain stable	
decline slowly	
decline rapidly	
Don't know (DO NOT READ OUT)	

F5. What proportion of your sales of medical products and services is exported?

WRITE IN % _____

IF DON'T KNOW, PROMPT WITH RANGES BELOW

NONE	1
1 – 9%	2
10 – 19%	3
20 – 29%	4
30 – 39%	5
40 – 49%	6
50 – 59%	7
60 – 69%	8
70 – 79%	9
80 – 89%	0
90 – 99%	V
100%	W

F6. How long has the establishment been located at its current address?

Less than 12 months	
Between 12 months and 2 years	
Between 2 years and 3 years	
Between 3 years and 5 years	
Between 5-years and 10 years	
More than 10 years	
Don't know	

F7. Has this business always been located in this region
YES
NO
Don't know

F8. [IF NO @ F7] When did the company relocate to this region? ENTER DATE_____

F9. Is this establishment part of a larger organisation
Yes
No GO TO THANK YOU AND CLOSE OF INTERVIEW

F10. Where is the headquarters of that organisation located?

ONLY READ OUT IF PROMPT REQUIRED

UK
Germany
France
Switzerland
Elsewhere in Western Europe
Eastern Europe
North America
Japan/Far East
Elsewhere (please state)

F11. What is the main business of the organisation to which this establishment belongs?

_____

F12. How many people does the organisation to which this establishment belongs employ in total?

_____

PROMPT WITH RANGES IF NECESSARY

24 or less	1	
25 – 99	2	
100 – 199	3	
200 – 499	4	
500 – 999	5	
1,000 – 1,999	6	
2,000 – 4,999	7	
5,000 – 9,999	8	
10,000 or more	9	

THANK RESPONDENT AND CLOSE INTERVIEW

APPENDIX B: CASE STUDY GUIDE