The Leicester Shire R&D Services Sector

A Report for Leicester Shire Intelligence

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EXECUTIVE SUMMARY

INTRODUCTION

This report presents the findings of a study on the research and development services sector in Leicester Shire. The R&D services sector is comprised of a number of firms and organisations involved in the provision of contract R&D services to both manufacturing and service sector clients. Leicester Shire is a sub-region covering the former county of Leicester Shire and consists of the two unitary authorities of Leicester City Council and Leicestershire County Council.

A prior study by CURS (2002) of high technology manufacturing in Leicester Shire identified the presence of a significant concentration of R&D businesses in the sub-region. Given the importance of these firms to the local economy it was felt that there was a need to better understand the history, structure and potential of the sector in order to support the development of a policy framework for sectors critical to the sub-region's economy.

This report reviews the literature on the nature and significance of the R&D services sector, provides data on R&D in general and the R&D services sector in particular in the regional and sub-regional economies, and then presents the findings of a survey of R&D service sector firms in the sub-region. The report concludes with a number of key findings and some policy considerations.

OVERVIEW

This report has identified a significant concentration of R&D service sector firms in Leicester Shire. These firms provide a range of knowledge-intense and technology-intense contract R&D services such as the provision of external R&D, product and process design, technical data services and testing to a range of sectors including pharmaceuticals, automotive and energy and utilities. Many of these firms have arisen to service the needs of the regional industrial base and their activities continue to reflect strengths in the regional economy. The development of the sector has also been driven by the presence of a substantial number of higher education institutions (HEIs) in Leicester Shire that have provided a stream of graduate employees for the sector and more recently have begun 'spinning-out' firms of this type directly. Finally, the location of a number of public sector linked Research and Technology Organisations (RTOs) in the sub-region has further supported the sector, providing a pool of highly skilled labour.

Despite the local roots of the sector it is now predominantly nationally and internationally focused with few firms relying on regional markets, and the majority of firms, despite their frequently small size, providing services to multinational businesses. This reliance on extra-regional markets and multinational clients reflects the highly specialised nature of these firms' activities. Many firms compensate for their relatively small capacities by operating within national and international collaborative firm networks of complementary specialist service providers. There is also evidence, however, of more substantial employers within the sector in the sub-region. These are often associated with foreign investment into the region, usually in the form of mergers and acquisition, in order to capitalise on the existing firm and skills base. Firms of this form have very clearly adopted international networking and market strategies.

The sector, perhaps driven by its external focus, has enjoyed employment growth in excess of that of the sub-regional, regional and national economies over the last few years, though there has been a slight downturn in recent times in line with a cooling of the national economic climate at the start of the decade. The relatively strong performance of the sector reflects the opportunities open within the global economy to firms that are able to compete on the basis of their knowledge as opposed to cost base and is indicative of a shift within the manufacturing bases of industrialised nations away from scale and cost intensive firms towards those seen as knowledge intensive. This context is perhaps reflected in a general feeling of health and optimism within the sector, a significantly different picture to that provided by the high-tech sector in 2002 (CURS, 2002). A degree of this confidence may be underpinned by strong and positive links between the firm base and the public sector support framework in place in the sub-region.

The local public policy task in relation to this sector is to ensure that conditions for its growth remain in place and that the supply of new firms through business and HEI spin-out continues. In addition, many opportunities exist to capitalise on the success of this sector within the sub-region either as a direct tool for foreign direct investment (FDI) or to promote the uptake of knowledge intense R&D activities across the firm base in the sub-region. Given its importance to the sub-regional economy and the opportunities it presents for further growth there is a strong case for the creation of a sub-regional or regional support group to oversee its development and to promote awareness of the sector. This group should also be charged with overseeing the promotion of R&D activities across the sub-regional and regional economies in general.

R&D IN THE EAST MIDLANDS

Strong Regional R&D Tradition

The East Midlands is an important location for both R&D expenditure and employment in the general economy. In 2002 over £1bn of R&D expenditure was undertaken by regional businesses and this supported 15,000 full time equivalent employees (FTEs). This placed the region as fifth largest in expenditure terms and fourth largest in employment terms amongst the UK's regions.

When compared to the relative size of each regional economy it is apparent that business R&D activity is particularly 'intense' in the East Midlands. In 2001 it accounted for 1.72% of regional GVA (fourth highest of the UK regions) whilst in 2000 business R&D related employment accounted for 0.65% of the regional workforce (third highest).

THE R&D SERVICE SECTOR

Weak Regional R&D Service Sector

The R&D services sector – a sector centred on the provision of external R&D services to other businesses – is less well developed in the East Midlands than business R&D in general (i.e. that taking place across all firms). In 2001 the R&D service sector in the region had a GVA of £162m and employed 4,194 FTEs. This placed the region sixth and eighth respectively across the UK regions.

Strong Leicester Shire Concentration

Whilst the R&D sector across the East Midlands as a whole is not especially large or intense it is apparent that the activity that does exist is predominantly located within Leicester Shire. The sector in the sub-region accounts for over 2,000 of the region's 4,000 jobs - 58.8% of regional employment - and it is estimated to generate £95.3m of the region's £162m GVA.

The effect of this level of concentration is such that the R&D sector forms an important element of the sub-region's economy providing 0.6% of total employment. This is a level of concentration well above the national rate where it accounts for only 0.42% of employment and identifies the sub-region as a significant site for R&D sector activity.

Analysis of the sector in Leicester Shire indicates that despite a recent decline in 2001, associated with the more general manufacturing recession, it has grown rapidly in employment terms since 1995. Its growth has out performed the R&D sector in the region and the UK as a whole. It has also grown at a faster rate than total employment in the sub-region, region and country.

Firm Characteristics and Performance

The sector has a high proportion of micro and small firms, but is dominated in employment terms by a small number of very large employers. This last feature distinguishes the sector in Leicester Shire from other counties in the region. It also suggests that the development of employment in the R&D sector in the sub-region is not (at least over the short term) rooted in the area's capacity to generate a profusion of small firms but in its ability to either attract or grow a small number of large firms. Employment levels in smaller firms appear to have suffered in the recent economic down turn but those of the larger employers have grown.

R&D Activities and the R&D Value-Chain

Firms are active across a range of R&D and knowledge related activities. The provision of external R&D and product and process design services are the core activities within the sector. Many firms are active in manufacturing or contracting-out the manufacture of their own designs. A sub-group of testing firms was present within the survey.

Whilst firms contributed towards the development of a range of products there was a focus on the provision of R&D services that contribute to the development of scientific instruments and metrology equipment, noise and vibration products, and energy and utilities products and services. The pharmaceuticals, automotive and energy and utilities sectors are the most important customers for firms' services.

Firm Formation

The sector is relatively young and drawn from a range of sources including HE spin-outs, business spin-outs, the public sector and traditional start-ups. The role of the HE sector in generating firms appears to have become increasingly important in the last decade. There is little evidence of greenfield foreign direct investment though there is evidence of mergers and acquisitions involving foreign corporations. Large employers frequently have public sector roots or affiliations.

Linkages and Outputs

In general, firms were focused on national and international markets with only a small minority of firms prioritising sub-regional or regional markets. The sector does not therefore appear to service the local industrial base to a great degree and is consequently more dependent on the health of the national and international economy.

Linkages and Inputs

A key input of the R&D process is knowledge. The key sources for this identified by firms were from within the firm and also from amongst clients and customers. In general firms used a wide range of knowledge sources and were highly active in accumulating knowledge.

Skills and Recruitment

Knowledge in the form of human capital is also vital and over half the firms have more than 50% of their workforce comprised of natural science graduates. In general these workers are drawn from within the local labour market. A minority of firms have experienced recruitment difficulties in the last 12 months.

Networking and Collaborative Working

Competitiveness can be enhanced through learning and competence building, processes that are promoted by networking, collaboration and co-operation between firms and other organisations. These activities were present to a high degree within the sector, as the majority of firms had co-operated for product development in the last two years. The great bulk of this activity, however, took place with extra-regional collaborators and there was limited evidence of significant networking within the region.

The Business Support Environment

Firms in the sector have benefited to a high degree from a broad range of industrial and business support initiatives – almost 40% have received grants and financial assistance. This may reflect recent public initiatives to support business formation from within the HE sector.

Issues, Challenges and Prospects

As with many small firm sectors, problems relating to access to finance, competitors and keeping cost down were most frequently mentioned. However, in general the level of concern over particular business issues was low and firms were on the whole highly optimistic with regard to their future with the great majority anticipating increases in both sales and employment.

POLICY CONSIDERATIONS

Given the significance of R&D activity for economic development it makes sense for policy-makers to support and where possible to promote its further expansion. It also makes sense for these policy-makers to take steps to ensure that the potential benefits of R&D are actually derived by the local economy.

Boosting the Supply of Firms

To sustain and boost the supply of new larger R&D firms it is important to continue the process of attracting inward investment or inward technology transfer, to target R&D firms and to continue a strong after-care service to those firms that are there. To sustain the supply of new smaller R&D firms within Leicester Shire it is also important to support the process of spinning R&D firms out from the local Universities, other public sector sources and from the private sector.

Creating Conditions for Growth

At present R&D firms are quite satisfied with the facilities available within the region and sub-region, but there obviously is a need to keep building on success. The significance of accommodation – in for example science parks – as well as the quality of the local labour supply, cannot be exaggerated in helping to generate R&D activity. Communications with firms in all size brackets can be a way of helping to match their evolving requirements.

Boosting Demand for R&D Services

To boost the value of the R&D sector to the local economy it is important to enhance the ability of local SMEs and larger firms to benefit from R&D generally, including R&D performed within the area. We know that SMEs are inhibited in their use of R&D for skill and resource reasons, and in this context it will be important to ensure that local firms of all sizes are informed of the R&D facilities that are available locally and nationally.

Creating Support Structures

These issues can be addressed together, and in dialogue with the businesses and public agencies concerned, by establishing an R&D cluster group, perhaps under the aegis of EMDA's prioritisation of innovation. This should be tied in with efforts to make regional actors aware of the presence of an R&D agglomeration, and to draw their attention to its importance for the sub-region and region.

CHAPTER 1: INTRODUCTION

BACKGROUND

The purpose of this report is to present the findings of a study of the research and development (R&D) services sector in Leicester Shire. A prior study by CURS of high technology manufacturing identified the presence of a significant cluster of R&D businesses in the sub-region (CURS, 2002). Indeed not only was Leicester Shire discovered to have a very high location quotient (2.13 in 2000) for the R&D sector, but the previous study also suggested that within more general high-tech businesses in the area (such as AstraZeneca and Sirrit) business which would not be classified as specifically R&D *firms* there is a high level of R&D *activity*. It appears, therefore, that the sub-region has over recent years developed both a significant R&D sector and a high incidence of R&D activity beyond this sector. Given the relevance of this type of cluster to the development of local economies in other areas it was felt to be important to know how this success has come about, and whether it can be extended.

The significance of knowledge for local economies has grown exponentially since the 1980s, with renewed emphasis upon higher value-added activities involving advanced skills, technology and innovation processes. This development is for instance reflected in the consolidation of a set of knowledge-intensive business services (KIBS – also known as 'strategic business services' – such as computer services, communications, management consultancy) that have a very skilled workforce. R&D services firms and represent a vital component of contemporary knowledge-driven regional and local economies because they:

- contribute to innovation;
- are associated with a variety of 'spill-overs' from firms to the wider economy, through technology transfer;
- contribute to higher productivity growth;
- help to form a relatively prosperous and highly-skilled workforce;
- contribute to strong new firm formation rates through start-ups and spin-offs;
- make areas attractive to inward investment.

A number of benefit are thought to be derived by local economies from the presence of R&D activities, as a key part of a wider knowledge intensive business services sector. Promotion of KIBS, and within this of specific sectors such as R&D services, is therefore a growing feature of many local economic and regional strategies as local agencies seek to capitalise on the innovation and growth potential of these activities. These benefits are such that if a critical mass is achieved then the local economy may be able to position itself on a strongly virtuous and sustainable trajectory of development.

OBJECTIVES

The purpose of this study is to describe the structure and development of the R&D services sector in Leicester Shire in order to identify its main characteristics, its performance, the factors that are likely to have given rise to this cluster, and the circumstances that are likely to encourage its continued development. Whilst the focus of the study is on the R&D services sector the study also addresses R&D activities in the broadest sense, and identifies secondary data for this across Leicester

Shire and its surrounding region. Secondary data is therefore assembled on indicators of comparative R&D performance of the East Midlands by region, and of Leicester Shire within the region. But the study undertakes most data assembly – and all primary data collection – from amongst firms that are specifically identified as within the R&D services sector in Leicestershire, and it addresses the following questions:

- *What types of R&D firms are present in the sub-region?* For example, how many are there, where are they located, and what is their size structure by employment and turnover?
- *What do R&D firms do?* What specific tasks are undertaken, applied research or experimental development), what types of service are provided, and at what stages do firms contribute to wider value-chains?
- *Where do R&D firms come from?* What are the origins of firms, and when were they formed? Why do certain manufacturing firms have large R&D facilities in Leicester Shire? How did small firms in the area form? Is the sector based on small indigenous firms or hived-off elements of larger firms?
- *How does R&D connect with the local economy?* What skills are used and where do they come from? With whom do firms collaborate in their activities? What is the nature of links between R&D firms and the university sector and other sectors? What markets are served?
- *What different business-models are at work?* How do firms make their money, what types of knowledge sources are utilized, and how important are Intellectual Property Rights?
- *How can this activity be grown and developed?* How is the sector faring in current circumstances? What are the factors that have encouraged the growth of the sector and general R&D activity? What are the opportunities and risk factors?
- *How can the returns from R&D activity to the local economy be enhanced?* To what degree have R&D firms benefited from business assistance of various sorts? What steps can be taken to ensure that the local economy benefits to the greatest degree from the resources available from local R&D firms and activities?

Key policy tasks here may relate to the *promotion* of R&D activities on the one hand, and the *diffusion* of R&D products within the local economy on the other. The successful promotion of R&D involves the generation of ideas and knowledge and is dependent upon (for instance) the presence of skills and facilities, and joined-up working between various governmental, educational and other institutions. The successful diffusion of R&D products into the local economy is in turn related to the way knowledge is applied locally, and firms' capacity to use and to commercialise technological advances, as well as the existence of a skilled labour force. Policy makers therefore have a number of opportunities through which to attempt to address both R&D activity and its uptake within a local economy.

METHOD

In order to address these questions the study has been designed with the following overall shape:

- *Literature review* - a brief review of the main accounts of the value of R&D to local economic growth and the main policy mechanisms through which it is supported.

- *Secondary data mapping* - a review of existing data on the R&D sector and activities in the sub-region and the region, to identify data that is already available, and contribute to the description of Leicestershire R&D cluster.
- *Firm survey* - A survey of all firms in the R&D sector. The survey used a database prepared from SIC coded information (SIC codes 73.1 and 73.2 were targeted) on firms in a number of sources, principally Dunn & Bradstreet, Companies House, Leicestershire County Council (data4business) itself, and from LATI. A total population of 67 eligible firms was identified and surveyed in a programme of telephone interviews. Some 38 firms responded. This is a response rate of 57% and suggests that the survey findings are likely to be highly representative of the characteristics and activities of the sector in the sub-region as a whole.
- *Case studies* - in depth case studies of four key R&D firms or R&D rich high tech firms, to enable key issues to be probed in greater depth, and to provide a qualitative guide for the interpretation of quantitative results.
- *Interpretation*, drawing conclusions regarding about the role of R&D activities, and the current and future implications of this for the local economy and for the policy-framework.

STRUCTURE

The report examines the literature and debates on concerning R&D in Chapter 2. Chapter 3 assembles secondary data on R&D in Leicester Shire and the East Midlands, and examines the expenditure and employment patterns here as against elsewhere in the UK. It therefore provides a preliminary diagnosis of the performance of local R&D in general and the R&D services sector in particular. Chapter 4 presents analysis of the data collected from the survey of firms, together with the four case studies. Chapter 5 presents a synthesis of these diverse findings and pulls them together into a more cohesive picture, from which policy recommendations can be identified in Chapter 6.

CHAPTER 2: R&D AND R&D OUT-SOURCING

INTRODUCTION

The expansion of research and development is part of the wider expansion of the knowledge economy and the development of knowledge intensive business services, but a part that is tied directly into the innovation process. In this chapter we examine how R&D can be defined, examine the specific characteristics of Contract R&D, and the benefits to be derived from the R&D services sector.

R&D IN THE ECONOMY

Defining R&D

Although it is hard to define in a way that will be a universally acceptable, a working definition of research and development is essential if we are to examine this activity. The standard definition of R&D, and that used as the basis for collecting data across most industrialised economies, is contained within the OECD's 'Frascati Manual' (OECD, 1994). It states that:

> "Research and experimental development comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of knowledge to devise new applications".

It therefore identifies the centrality of the creation of *new* knowledge, but also the use of *existing* knowledge to create new products and processes. The existence of social or non-technological research and development is also acknowledged.

The Frascati Manual further identifies three core activities – basic research, applied research and experimental development with R&D:

> **Basic research** is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
>
> **Applied research** is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.
>
> **Experimental development** is systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.

A crucial factor in differentiating R&D from non-R&D activities is the reasons why an activity is pursued rather than the nature of the activity itself. For instance, routine blood tests undertaken by a GP *would not* be considered as R&D, but a programme of blood tests contributing to the development of a new pharmaceutical product *would* be. Likewise, the daily recording of temperatures and atmospheric pressure is not R&D, but the investigation of new methods of measuring temperature is R&D. In this sense R&D activities are differentiated from non-R&D activities by "… the presence of an appreciable element of novelty and the resolution of scientific and/or

technological uncertainty, i.e. when the solution to a problem is not readily apparent to someone familiar with the basic stock of commonly used knowledge and techniques in the area concerned" (OECD, 1994, p.8).

Contract R&D

A distinction is drawn within the literature between 'intramural' R&D which is carried out by a firm itself, and 'extramural' R&D which the firm pays for but is carried out on its behalf by someone else. There are some complications attached to identifying the proportion of extramural R&D expenditure, including the fact that manufacturing establishments within firms may outsource their R&D to other non-manufacturing establishments within the same firm or group. However, Griffith et al produce data which shows that between 1994 and 1998 the vast majority of R&D expenditure was intramural (90%). A slightly lower proportion of R&D expenditure was retained intramurally by service establishments, but the authors conclude that "Overall, relatively little R&D is outsourced, and the use of outsourcing does not vary very much across product groups" (Griffith et al 2003, page 7). But whilst outsourced R&D appears relatively minor in proportion to the totality of R&D in the national economy, it still had a value of £2bn in 2001 and in this context represents a significant area of economic activity.

The sectors which do the most outsourcing of R&D are motor vehicles, chemicals, pharmaceuticals, oil and nuclear industries, TV and radio, and non-ferrous metals. If we examine the amount of expenditure on extramural R&D then the largest sector by far is motor vehicles, followed by chemicals and pharmaceuticals. If we examine the degree to which R&D is undertaken at the same site as production in manufacturing companies, then we discover that those sectors which are most likely to have centralised their R&D in specialist facilities are pharmaceuticals, trains, iron and steel, and non-ferrous metals.

Types of R&D

Basic or fundamental research accounts for about 5% of UK business R&D expenditure, whilst *experimental development* makes up around 62% of business expenditure on R&D (Griffith et al 2003, page 12-13). The largest proportion of R&D expenditure is on *applied* or *experimental* R&D, although this proportion varies from one sector to another. In no sector is the proportion of spend on basic R&D likely to be much higher than 14% or 15%. Those sectors which spend the largest proportion of their intramural R&D expenditure on experimental development are motor vehicles, electrical machinery and aerospace (all 8% or above). It is likely that firms will site the most applied R&D near to the production plant where products are being made. However, in pharmaceuticals, electrical machinery and TV and radio equipment, quite a high proportion of experimental development is centralised within specialist facilities. This may reflect the emphasis of R&D in these sectors upon products rather than process innovations (Griffith et al 2003, p.13).

R&D OUTSOURCING – THE R&D SERVICES SECTOR

Defining the Sector

Contract research and development has been defined as "work of an innovatory nature undertaken by one party on behalf of another under conditions laid out in a contract

agreed formally beforehand" (Ringe 1992, p.2). Recent analysis of R&D activity has argued that firms including multi-national corporations can no longer sustain an adequate level of innovation solely on the basis of in-house research. There has, therefore, been an expansion of R&D externalisation and outsourcing over recent years in developed economies. Associated with this has been a switch in the functions performed by the internal R&D process from sole generator of the firm's innovation stream to include technological scanning and contracting of external R&D. Taken together these trends have led to the expansion of a contract research market in which R&D activity is traded and in which there is now a significant cadre of specialist client and contracting firms (the latter sometimes being referred to as Contract Research and Technology Organisations (CRTO's) (Howells 1997 page 3).

One of the problems noted by Howells is that the CRT market is difficult to delimit, given the variety of different kinds of organisations it involves that undertake functions that may or may not be central to R&D, such as product testing and accreditation (which may be relatively routine but is often undertaken alongside research). R&D and the CRT market are therefore inherently fuzzy concepts, even though more precise definitions can be generated from the Standard Industrial Classification (SIC) or from Frascati.

Growth in the R&D Services Sector

The proportion of contracted out or extra-mural research in advanced economies has grown significantly since the 1970's, with a doubling of this in real terms in the UK between 1985 and 1995 (Whittington 1990). As a share of total business enterprise research and development, contracted out R&D has grown in the UK from 5.5% in 1985 to 10% in 1995 (Howells 1997, page 7). Howells points out that this phenomenon should not necessarily be regarded as entirely new, however, because at the beginning of the twentieth century it was very common for companies to look for specialists to undertake research tasks, specialists such as universities or independent research scientists, and that this practice was common even within highly scientific industries such as pharmaceuticals up to the First World War. It was in Germany and then in the United States that expansion of in-house R&D departments occurred along with the expansion of industrially based research in the inter-war and post war period. Indeed in these terms Britain tended to lag behind its main competitors and British firms were relatively slow to establish their own bespoke R&D teams.

The recent experience of R&D is not dissimilar to that of other services, which are being decentralised and outsourced as large companies narrow their focus in a manner that has been described as post-Fordist:

> "Firms accept that they need in-house capacity to adequately appraise, select and then use 'brought in' research and technical elements. They also recognise the need to retain certain core technological competences within the firm…to undertake it more effectively on a hierarchical, non contractual basis, including here reasons associated with secrecy, trust and appropriability" (Howells 1997 page 8).

The expansion of outsourced R&D is not necessarily accompanied by a contraction of in-house research and technical capacity, however, and the latter may well be expanding in a complementary manner, albeit with a different range of responsibilities (including the management of subcontractors) as the general emphasis upon innovation and knowledge grows throughout the economy.

Drivers of R&D Outsourcing

Typically, the level and outsourcing of R&D activity is conceptualised in terms of push and pull factors. Push factors towards the externalisation of R&D would include the increased complexity, cost and riskiness of the research process, and the need to spread this risk and draw upon a wider pool of talent by combining in-house with outsourced R&D activities. R&D is becoming more complex because the easier problems have been solved and at the same time, customers have become more sophisticated in their tastes. Collaboration is encouraged because in these circumstances many technologies are required for each new product, and different disciplines must be combined in problem solving (Howells 1997, page 9). In a drive to reduce the innovation cycle time in different industries, there is also a pressure to improve the interface between basic research and the developmental process that leads directly into innovation. Contract research can have a role here.

As regards 'pull' factors, specialist external research agencies provide an opportunity for firms to scan for technological challenges and opportunities in the wider economy and provide a learning opportunity for their own staff including their own R&D departments. It should be noted, however, that there are disadvantages attached to externalising R&D, including the possible sacrifice of core competences which may be necessary to a positive strategic position within the knowledge economy. It has for example been argued that the tendency for British firms in the early twentieth century to rely upon external consultants for R&D and technological solutions may have hindered innovation and made firms less receptive to design matters (Byatt 1979).

Howells suggests that the use of CRTO's is likely to be based upon the pursuit of cost reductions, and speed of delivery, as well as access to specialist expertise within large firms. Ringe in his survey of UK firms found access to specialist expertise to be the most frequently cited reason for using outsourced R&D, together with the access to specialist equipment, additional research labour, timescales and cost controls (Ringe 1992, page 28-9). Another reason given for externalising, however, maybe that large firms have sought to outsource their more routine work whilst retaining higher skilled activities in-house, although this argument probably applies to bigger firms more than smaller ones. It may be that a 'core' 'periphery' workforce is now appearing in the R&D sector, with the former working on the less routine tasks and the latter on the more routine ones, although it cannot necessarily be concluded that this division coincides with the in-house/out-sourced distinctions.

In this context, it should be noted that some activities regarded as R&D (such as screening, testing and analysing samples) can be automated and are now often undertaken by robots (as may be seen in the case of AstraZeneca). CAD and CAM have improved the interface between the designer and the manufacturer, as have Laboratory Information Management Systems (LIMS). But this kind of automation need not be associated with routinisation and a loss of skill, as in the case of 'discovery research services' provided to pharmaceutical and chemical companies by molecular designers who search for novel drugs and chemical compounds (Howells 1997, page 13).

Howells (1997) draws a distinction between three main sources of R&D subcontracting firms:

- New firms

- Spin offs
  - Spin offs from manufacturing and service firms
  - Spin offs from universities
- Government privatisations

But some UK organisations do not readily fall into these categories, particularly industrial research associations (such as PERA or Advantica) that have a significant share of the contract research market, and are gaining larger shares of turnover from overseas. These are not so much government privatisations as government-linked industry associations.

Regional Benefits From the R&D Services Sector

It is argued by some that the expansion of CRTO's can make a significant contribution to the innovation infrastructure of a nation or region by contributing to the flow of R&D into particularly SME's. But as Howells points out, there is a policy challenge here of linking SME's to the CRTO market, and question marks remain as to whether local SME's benefit from local CRTO's. SME's may lack the resources but also the expertise required to deal effectively with subcontracting R&D companies: "the simple existence of a large number of CRTO's in a national or regional economy does not imply that local small firms will be adequately provided for in relation to scientific and technical services" (Howells 1997, page 19).

CHAPTER 3: R&D IN LEICESTER SHIRE AND THE EAST MIDLANDS

In this Chapter we present data on both R&D activity in general and the R&D services sector in particular in the East Midlands and Leicester Shire. This data is taken from a series of national ONS surveys including the Annual Business Inquiry (ABI) and the survey of Business Enterprise Research and Development (BERD). It provides information on the scale, scope and structure of R&D activity and the R&D sector and also allows for inter-regional comparisons to be made.

R&D IN THE EAST MIDLANDS

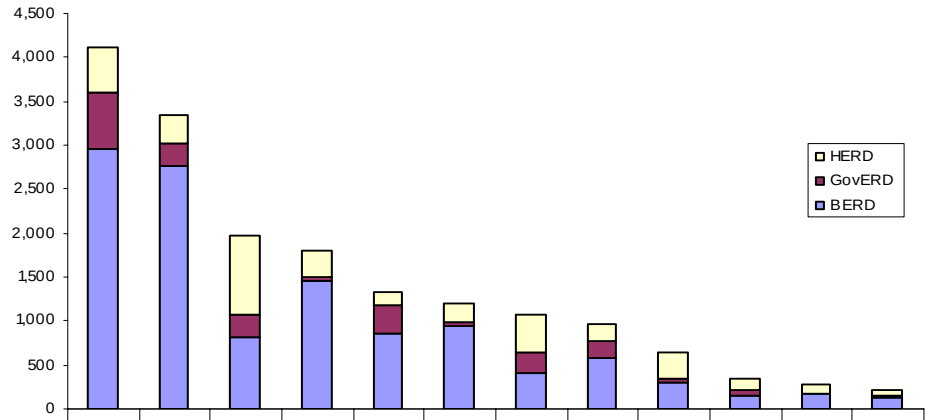
This section reviews R&D activity in general across the UK and the East Midlands. Data for this form of R&D is not available below the regional level.

Expenditure

Figure 3.1 shows a breakdown of regional shares of total R&D expenditure in the UK (whether intramurally or extramurally delivered) in 2000 broken down by sector – business (BERD), government (GovERD), and HE (HERD). The figures represent levels of R&D expenditure taking place within establishments in each sector and region. A number of features are apparent..

- The business sector is by some way the most important in the expenditure on R&D. Some £11.5bn of R&D expenditure was undertaken in this sector in the UK in 2000 compared to £2.1bn by government research bodies and £3.6bn by the HE sector.
- There is significant regional differentiation in levels of R&D performance. The South East and the Eastern regions are the most active. This is particularly the case with respect to business-funded R&D. London in contrast has a particularly high level of HE R&D.

Figure 3.1: R&D expenditure by region, 2000 (£m)



	S. East	Eastern	London	N. West	S. West	E. Mids	Scot.	W. Mids	Y&H	Wales	N. East	N.I
HERD	515	324	895	287	160	204	440	192	284	139	122	70
GovERD	635	259	258	57	307	56	238	194	48	65	2	15
BERD	2,964	2,758	810	1,451	867	933	400	576	304	144	164	139

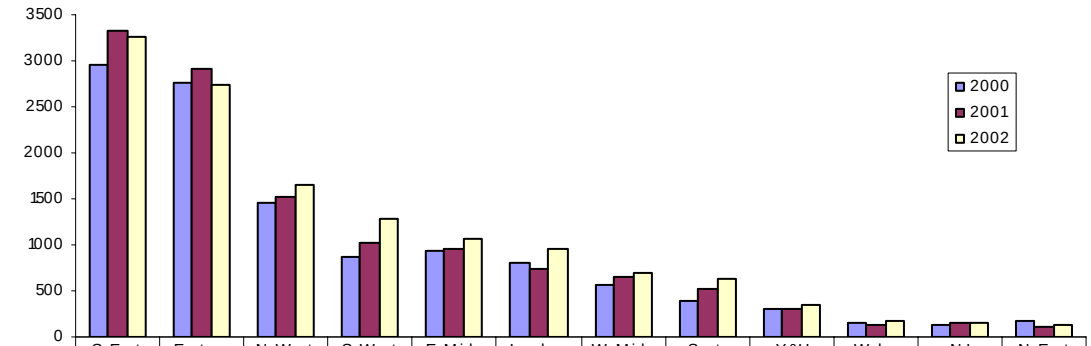
(Source: ONS, 2002a)

- The East Midlands was the sixth most active region in 2000 across these sectors. This performance was built on business R&D as HE R&D was relatively low and government-funded R&D was negligible.

Figure 3.2 provides more detail on business R&D and includes data up until 2002.

- On this measure the East Midlands is the fifth most active region. In 2000 it was the fourth but a series of sharp rises in the performance of the South West has enabled it to overtake the East Midlands in the last two years.
- Nonetheless, the East Midlands remained an important location for business R&D expenditure with over £1bn of activity by regional businesses in 2002.

Figure 3.2: Regional BERD 2000 - 2002 (£m)



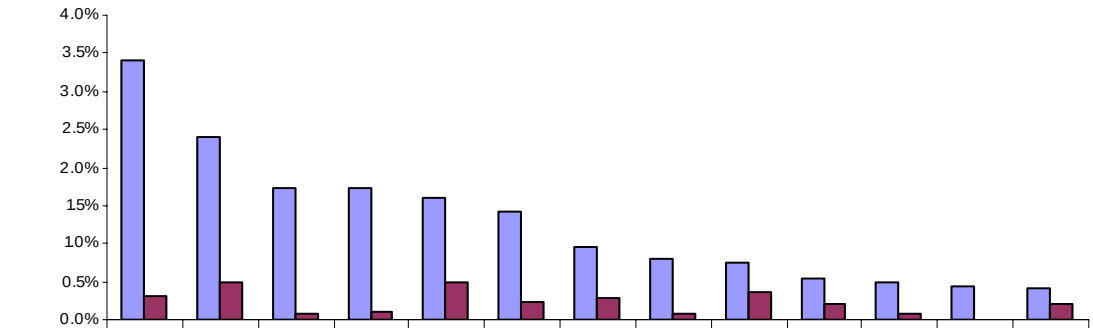
	S. East	Eastern	N. West	S. West	E. Mids	London	W. Mids	Scot.	Y&H	Wales	N.I	N. East
2000	2964	2758	1451	867	933	810	576	400	304	144	139	164
2001	3317	2916	1512	1025	951	738	662	512	298	136	150	119
2002	3268	2741	1661	1286	1063	950	695	640	357	170	149	128

(Source: ONS, 2003a)

The previous figures have given an absolute measure of R&D performance by region. Figure 3.3 relates R&D expenditure to the size of each region's economy by representing R&D as a percentage of regional GVA. This gives a measure of R&D intensity rather than merely its scale within the regional economy. The figure shows that:

- In 2001 Eastern region was the most R&D 'intense' region in the country with business R&D expenditure representing 3.4% of regional GVA.
- The East Midlands had the fourth highest level of intensity of business R&D expenditure despite the region having only the fifth largest business R&D spend in terms of sheer scale.
- R&D activity in the East Midlands therefore represents a significant proportion of regional GVA. It is above the UK average and substantially greater than that of many other regions including the West Midlands.

Figure 3.3: Regional BERD (2001) and GovERD (2000) as a percentage of regional GVA



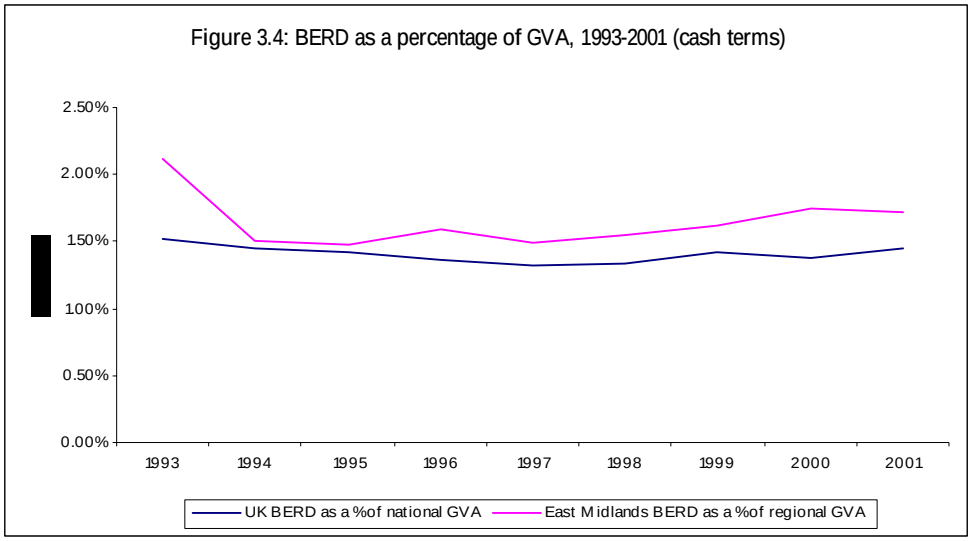
	East	South East	North West	East Mids	South West	UK	West Mids	N. I.	Scot.	London	Yorks. & Humbs.	North East	Wales
BERD	3.4%	2.4%	1.7%	1.7%	1.6%	1.4%	1.0%	0.8%	0.7%	0.5%	0.5%	0.4%	0.4%
GovERD	0.32%	0.48%	0.07%	0.10%	0.50%	0.24%	0.29%	0.08%	0.35%	0.19%	0.08%	0.01%	0.20%

(Source: ONS, 2002a; ONS 2003b)

Figure 3.4 illustrates the relationship between East Midlands and UK spend on business R&D. The figure shows the contribution of total UK BERD relative to UK GVA and East Midlands BERD relative to East Midlands GVA in cash terms year on year. It shows that:

- As a proportion of GVA, business R&D spend in the East Midlands has consistently remained above the UK average. East Midlands BERD spend as a proportion of regional GVA grew throughout the latter half of the 1990s relative to the UK following a sharp fall in 1994.

Figure 3.4: BERD as a percentage of GVA, 1993-2001 (cash terms)



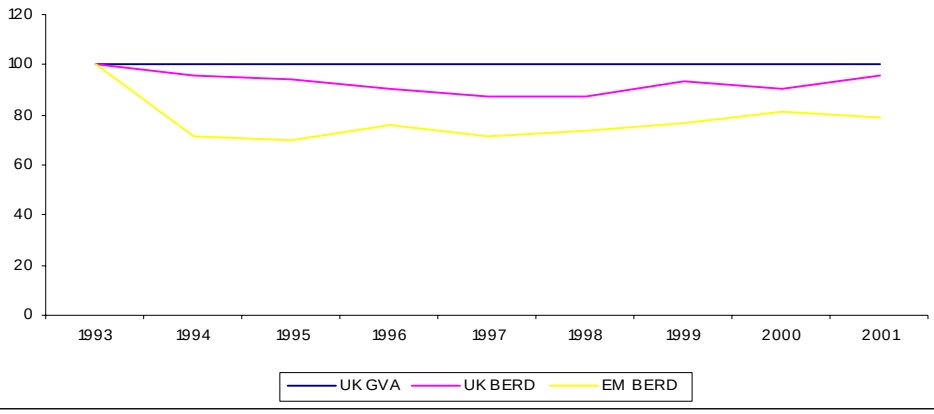
(Source: ONS 2003a; ONS 2003b)

Figure 3.5 however illustrates a more complex picture of change in BERD in the region. The indexed figure compares UK and East Midlands BERD spend to UK GVA in the period 1993-2001. It demonstrates that:

- Relative to total UK GVA the rate of spend in UK BERD fell. UK BERD is now a less significant component of national GVA than in the early 1990s.

- The performance of East Midlands BERD relative to national GVA has been even weaker. The regional rate of growth of BERD spend has failed to keep up with the national growth rate of BERD or the national growth rate in GVA.
- The relatively strong position of BERD in the region in 1993 means that despite this poor performance regional BERD, as a proportion of regional GVA in the East Midlands, remains above average (as shown in Figure 3.4).

Figure 3.5: Change in BERD in the East Midlands and the UK relative to UK GVA, 1993-2001 (UK GVA 1993=100)



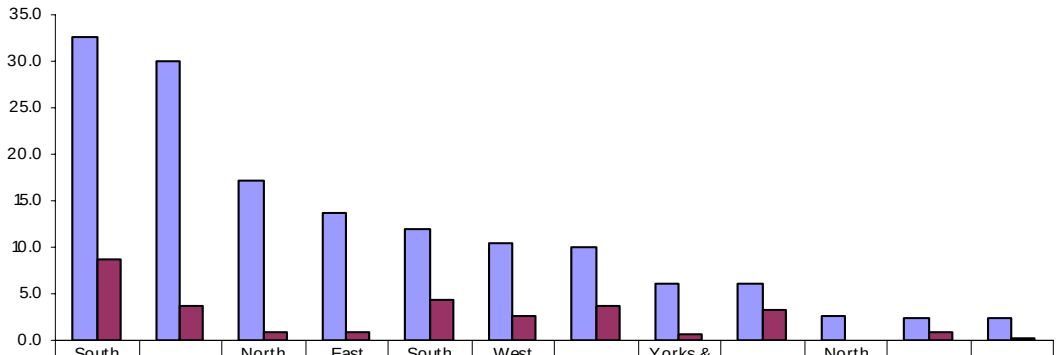
(Source: ONS 2003a; ONS 2003b)

Employment

Figure 3.6 shows levels of employment of workers *undertaking* BERD and GovERD by region in 2000. It shows that:

- The South East and Eastern regions dominate the UK regional picture with 32,700 FTEs undertaking BERD activities in the former and 30,000 in the latter.
- Some 13,700 FTEs were employed in BERD in the East Midlands in 2000. The fourth largest employment base in the UK.

Figure 3.6: Employment in BERD and GovERD by region, 2000 ('000s, FTEs)



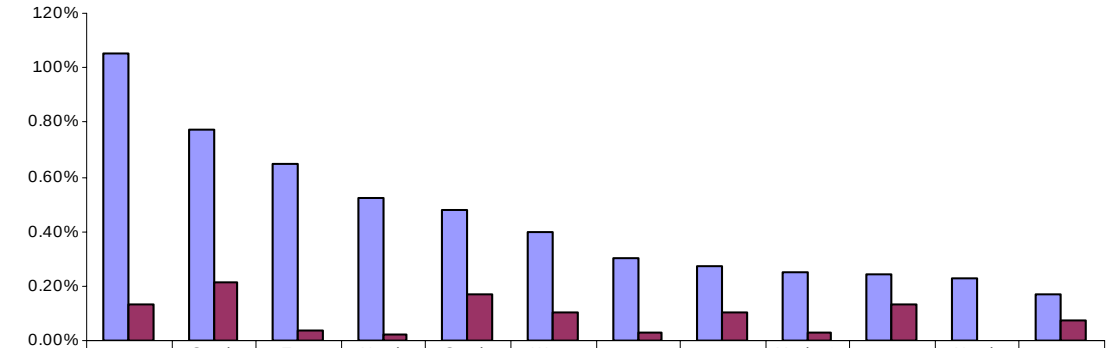
	South East	Eastern	North West	East Mids	South West	West Mids	London	Yorks & Humber	Scot.	North East	Wales	N. I.
BERD	32.7	30.0	17.2	13.7	12.0	10.5	9.9	6.1	6.0	2.7	2.3	2.3
GovERD	8.8	3.6	0.8	0.8	4.3	2.7	3.6	0.7	3.3	0.0	0.9	0.2

(Source: ONS, 2002b)

Figure 3.7 shows the concentration of BERD and GovERD employment by region in 2000, giving R&D employment as a percentage of the total regional workforce. The figure shows that:

- Eastern region has the highest concentration of BERD FTEs as a proportion of its regional labour force – 1.05%.
- The East Midlands has the third highest concentration of BERD workers – 0.65%

Figure 3.7: Pecentage of the regional labour force in BERD and GovERD, 2000



	East	South East	East Mids	North West	South West	West Mids	N. I.	London	Yorks & Humber	Scot.	North East	Wales
BERD	1.05%	0.77%	0.65%	0.52%	0.48%	0.40%	0.30%	0.27%	0.25%	0.24%	0.23%	0.17%
GERD	0.13%	0.21%	0.04%	0.02%	0.17%	0.10%	0.03%	0.10%	0.03%	0.13%	0.00%	0.07%

(Source: ONS, 2002b)

THE R&D SECTOR IN THE EAST MIDLANDS AND LEICESTER SHIRE

The previous sections provided data on R&D in general in the UK and its regions. This section moves on to focus upon one particular part of that activity – the R&D services sector. As discussed in Chapter 2 this sector involves establishments that undertake the provision of a range of R&D activities for other businesses. Whilst it is not possible to identify the amount of BERD outsourced to these businesses they are reckoned to account for the large majority of the £2bn of extramural BERD in 2001, some 15.9% of national BERD.

For the purposes of this report this sector is defined as being all firms within Standard Industrial Classification 73 (SIC 73). Within SIC 73 there are two main forms of activity.

- Research in natural sciences and engineering (SIC 73.1)
- Research in social sciences and humanities (SIC 73.2)

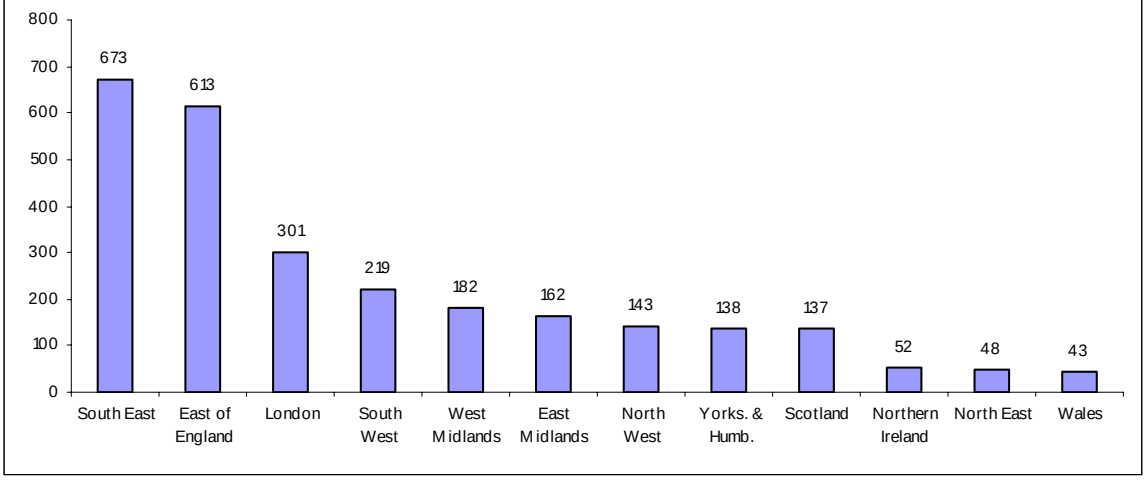
The following sections examine patterns of expenditure, employment, location and firm size in SIC 73 in the UK and East Midlands. Some data is also available with respect to Leicester Shire itself. As before, the bulk of this data is taken from a series of national ONS surveys including the Annual Business Inquiry (ABI) and the survey of Business Enterprise Research and Development (BERD).

Output

In 2001 R&D service firms in the UK generated a GVA of £2.4bn. Figure 3.8 illustrates how this breaks down regionally and shows that:

- The South East and Eastern regions have the most substantial R&D service sectors, with GVAs of £673m and £613m respectively.
- The East Midlands R&D sector had a GVA of £162m, making it the sixth largest of the UK regions in absolute terms.

Figure 3.8: Regional share of national SIC 73 GVA, 2001 (£m)

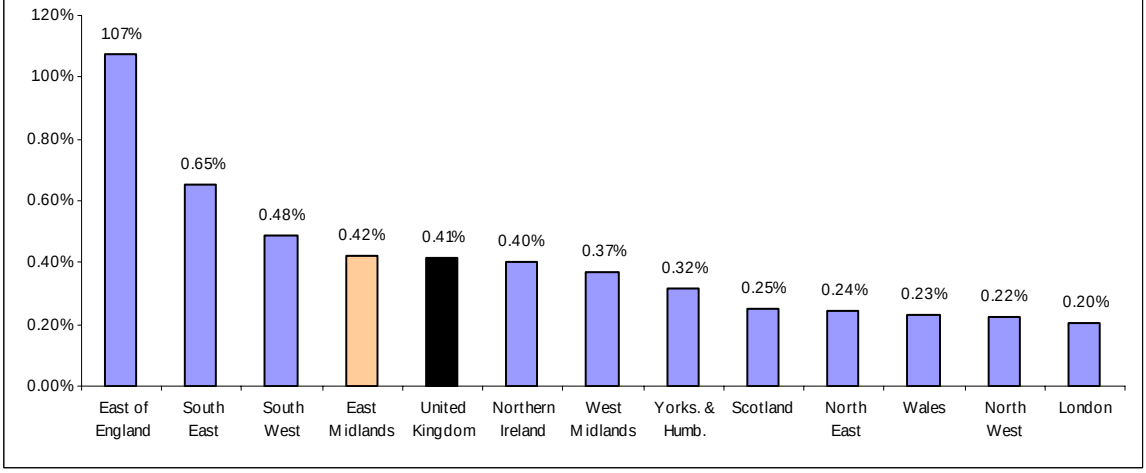


(Source: NOMIS)

Figure 3.9 shows the GVA of the regional R&D service sector as a percentage of total regional GVA – a measure of the relative importance of the R&D sector within the regional economy rather than simply its absolute size. It demonstrates that:

- The Eastern region derives the greatest percentage of its GVA from the R&D services sector – 1.07% - of all UK regions. Both in terms of BERD expenditure and SIC 73 (GVA) this region is clearly the most R&D-intense region in the UK.
- The East Midlands derives 0.42% of regional GVA from R&D services. This is above the UK average and ranks the region fourth of the UK regions by R&D intensity.

Figure 3.9: Regional SIC 73 GVA as a percentage of total regional GVA, 2001

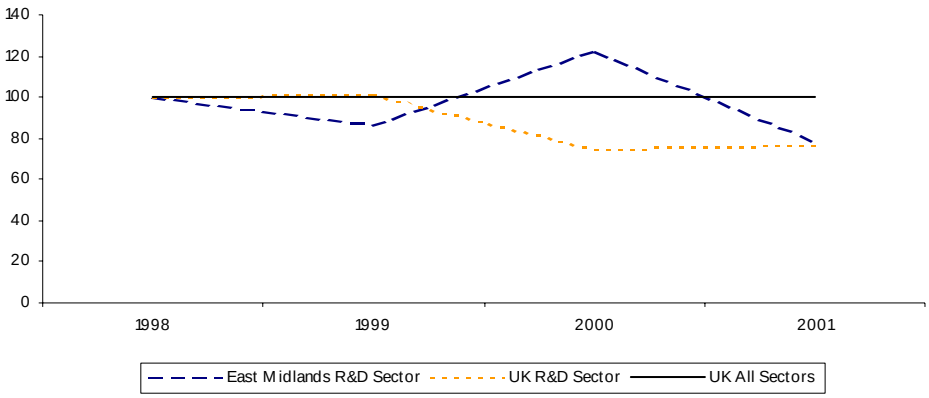


(Source: NOMIS)

Figure 3.10 shows the GVA performance of the R&D service sector relative to all sectors in the UK in the period 1995-2001. It shows that:

- The contribution of the R&D services sector across all regions to UK GVA has fallen in this period. Whilst only data from 1998 is shown here, additional data shows that the R&D sector's share of national GVA has fallen steadily from 1996, then steeply from 1999. There has however been a recovery in the sector since 2000.
- The contribution of the East Midlands' R&D sector to national GVA has fallen in the period 1998-2001. This has not been a straightforward decline, however, as there have been significant fluctuations in its level of contribution.
- Overall whilst the level of GVA generated by the R&D services sector in both the UK and the East Midlands has grown since 1998, this rate of growth has failed to match that of total UK GVA and the sector now accounts for a smaller proportion of national GVA. This is probably related to relative decline in the position of manufacturing firms, which are the main generators of R&D spending.

Figure 3.10: Change in GVA in the R&D sector compared to GVA in all sectors, 1998-2001 (UK GVA all sectors 1998=100)



(Source: NOMIS)

Table 3.1 provides a range of additional financial data for the R&D services sector in the East Midlands and the UK in 2001. It shows that:

- East Midlands R&D service firms had a total turnover of £278m in 2001 with a GVA of £162m. Employment costs were £130m.
- The R&D sector is a particularly productive sector within the regional economy as it contributes a greater proportion of regional GVA (0.42%) than its share of total regional turnover (0.24%).
- Employment costs within the sector are relatively high, an indication of the higher order activities that take place within the sector. Employment costs in the sector in the region are however below the national rate for the sector.

Table 3.1: Financial data for the East Midlands R&D services sector, 2001

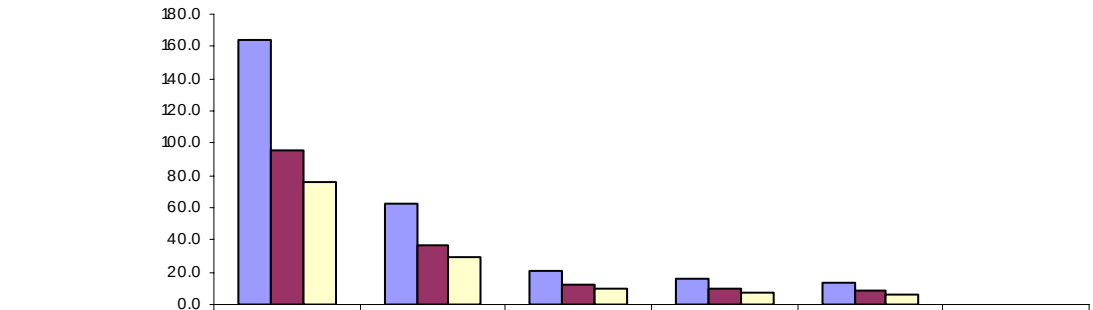
	Total turnover (£m)	Approximate gross value added at basic prices (£m)	Total employment costs (£m)
East Mids R&D services sector	278	162	130
East Mids R&D services sector as % of regional economy.	0.24%	0.42%	0.60%
UK R&D services sector	7,223	2,710	3,595
UK R&D services sector as % of UK economy	0.35%	0.41%	1.00%

(Source: NOMIS)

Figure 3.11 gives a breakdown of the East Midlands R&D services sector by county. This is a pro rata calculation based on each county's share of employment in the sector taken from the ABI. It shows that:

- Leicester Shire has the largest R&D services sector within the region by some way, with an estimated turnover of £163.5m and GVA of £95.3m.
- Nottinghamshire has the next largest R&D sector. It is however around 40% of the size of Leicester Shire's sector.

Figure 3.11: Pro-rata share of regional turnover, GVA and employment costs in the R&D sector by county, 2001 (£m)



	Leicestershire	Nottinghamshire	Northamptonshire	Lincolnshire	Derbyshire	Rutland
Total turnover	163.5	62.5	21.4	16.2	14.0	0.5
Approx. GVA	95.3	36.4	12.5	9.4	8.2	0.3
Total Employment costs	76.5	29.2	10.0	7.6	6.5	0.2

(Source: NOMIS; authors' calculations)

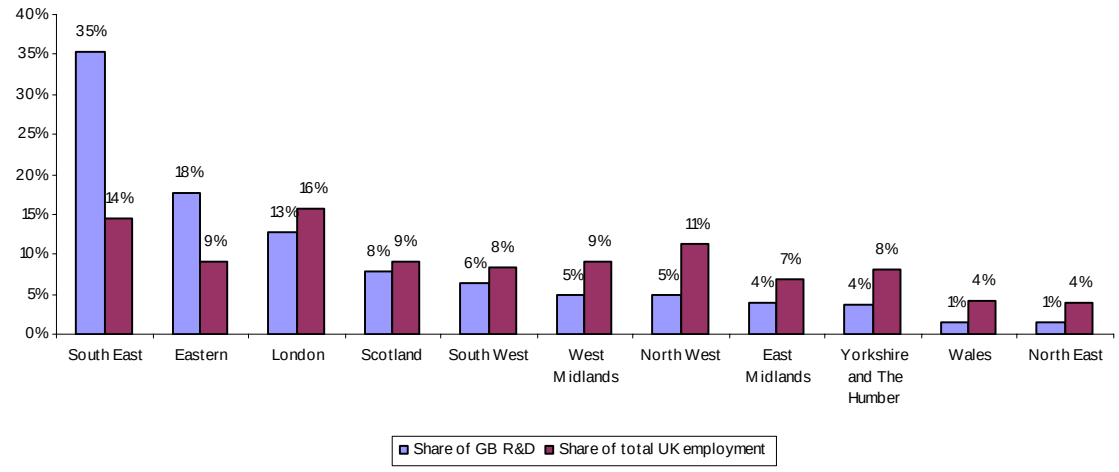
Employment

Employment levels of the R&D services sector for the UK regions are shown in Figure 3.12. The figure also shows the proportion of all UK employment located within each region, allowing for a judgment regarding the concentration of R&D employment within each region to be made. It shows that:

- The South East and Eastern regions are the most significant UK regions in terms of R&D sector employment. Respectively they account for 35% (37,841) and 18% (18,939) of the UK's total of 107,171 R&D sector jobs.

- These two regions also have the highest level of concentration R&D sector employment. In both regions their share of R&D sector employment significantly out strips that of their share of total employment. This does not occur in any other region.
- The East Midlands does not appear to have an overly large R&D sector employment base. It contains 4% (4,194) of total UK R&D sector employment, putting it is eighth place of the UK regions. Likewise R&D employment is not heavily concentrated within the East Midlands, and it contains 7% of total UK employment yet only 4% of UK R&D employment.

Figure 3.12: Share of GB R&D and total employment by region, 2001

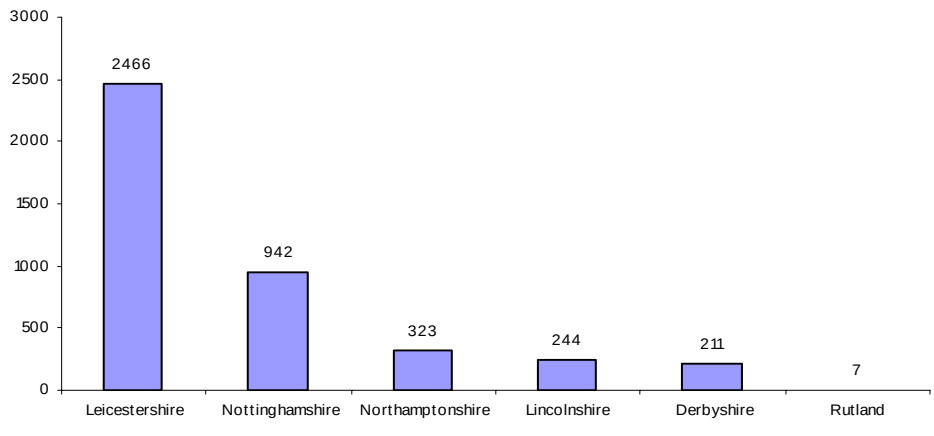


(Source: NOMIS)

A breakdown of East Midlands R&D employment by county is provided in Figure 3.13. It shows that:

- Leicester Shire dominates the sector in the region in employment terms. In 2001 2,466 workers were employed in the sector in the county, 58.8% of the regional total.

Figure 3.13: Share of regional employment by county, 2001

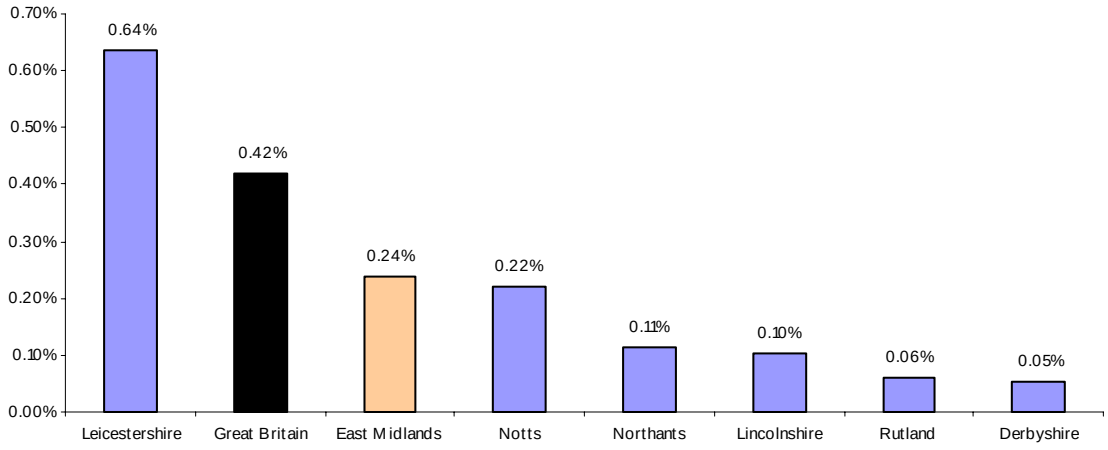


(Source: NOMIS)

Figure 3.14 provides data on the concentration of R&D sector employment within the Great Britain, the East Midlands and the region's counties. It shows that:

- In 2001 the R&D sector accounted for 0.42% of total employment in GB.
- In the same year employment levels in the East Midlands were much lower as the sector accounted for only 0.24% of total regional employment.
- But the concentration of employment was much higher in Leicester Shire. In 2001 the R&D sector represented 0.64% of total employment in the county. This is far in excess of the UK average and the East Midlands figure. None of the region's counties have concentrations of this level and all are significantly below the national rate.
- The implication of this data and the previous figures is that whilst the R&D sector in the East Midlands is not especially large, what there is of it is predominantly located within Leicester Shire. The effect of this is to give the county a very high concentration of R&D sector activity and to make the sector an important component of the county's economy.

Figure 3.14: Share of total employment in R&D, 2001



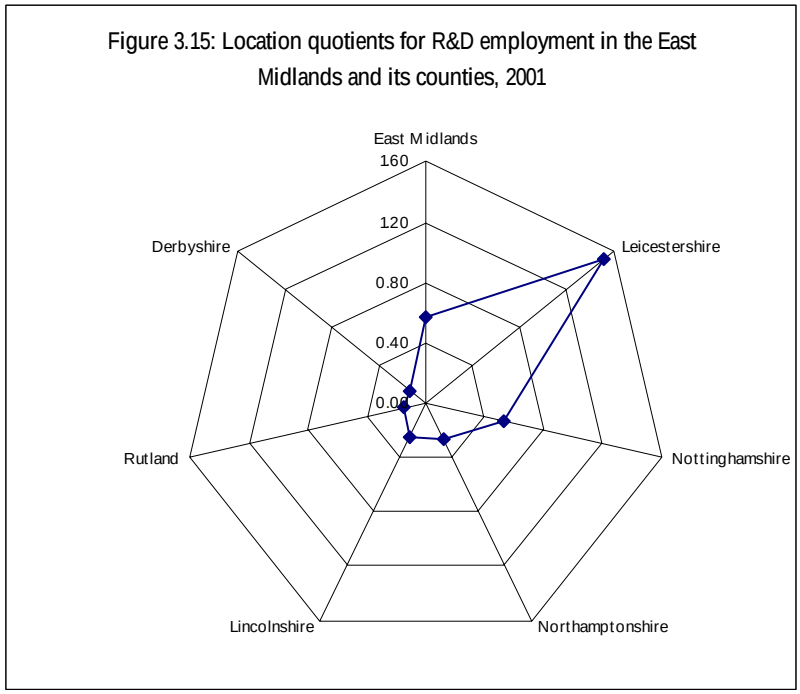
(Source: NOMIS)

The picture of a concentration of R&D sector activity within Leicester Shire is borne out in Figure 3.15. This shows the results of a location quotient (LQ) analysis of R&D sector employment in the East Midlands and its counties. LQs give a measure of employment concentration relative to Great Britain as a whole. An LQ of one represents an employment concentration equal to the national rate, whilst figures over 1.25 are regarded as representing a significant concentration of employment for that particular sector. The figure shows that:

- The East Midlands has an LQ for the R&D sector of 0.57. This suggests that R&D sector employment is significantly under-represented in the region's employment base relative to the UK.
- The R&D sector in Leicester Shire has an LQ of 1.51. This suggests that in contrast to the region as a whole employment in this sector is important to the county's employment base and that it occurs at a rate significantly above that of the country as a whole.

- Other counties in the region have low LQs for the sector. This low level of performance across the rest of the region emphasizes the distinctive nature of the concentration of R&D sector activity in Leicester Shire.

Figure 3.15: Location quotients for R&D employment in the East Midlands and its counties, 2001

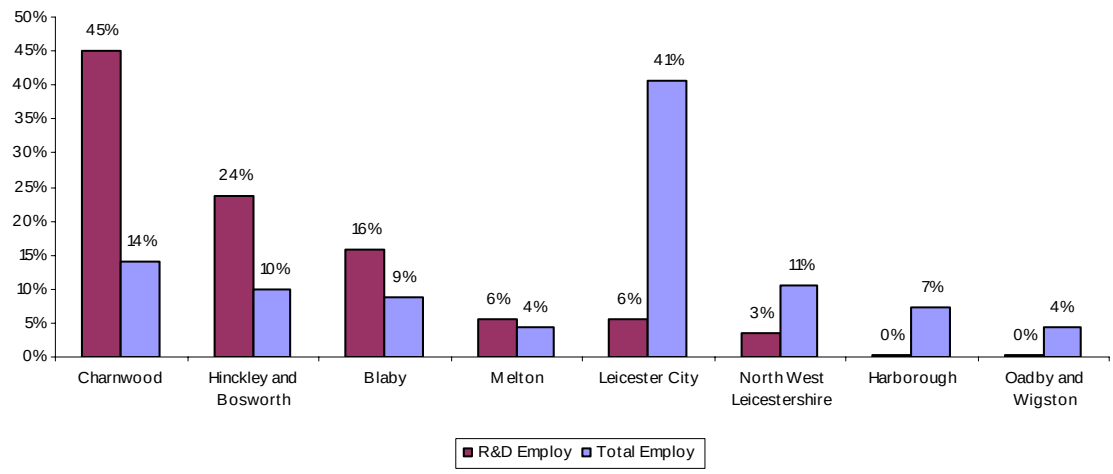


(Source: NOMIS)

Figure 3.16 provides data on the location of R&D sector employment within Leicester Shire's districts. It also shows the location of total employment across the county. It demonstrates that:

- R&D employment is concentrated in the districts of Charnwood, Hinckley and Bosworth and Blaby. These three districts account for 85% of R&D sector employment in the county.
- R&D employment occurs at a far higher rate in these districts than total employment.

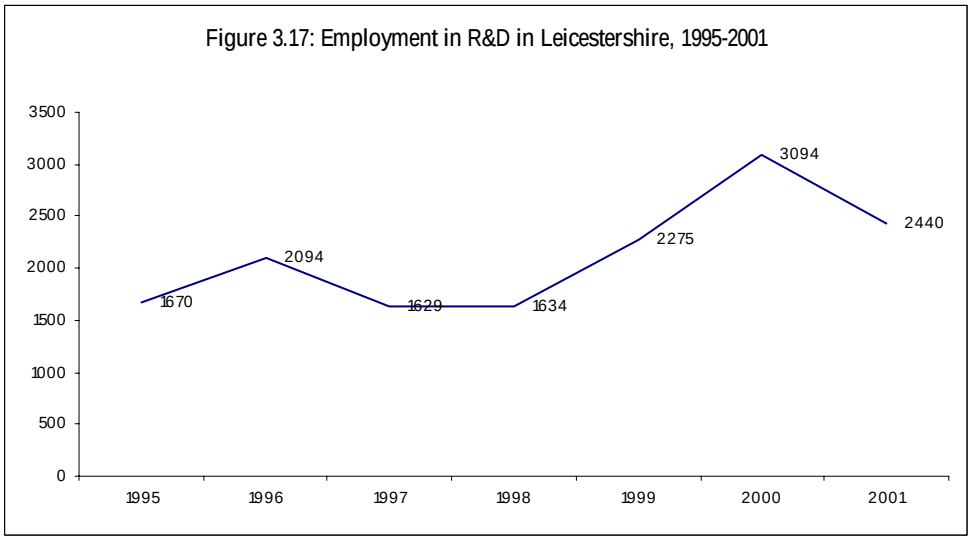
Figure 3.16: Share of Leicestershire R&D employment by local authority district, 2001



(Source: NOMIS)

The performance of the R&D sector in Leicester Shire in employment terms in shown in Figure 3.17: This figure shows that:

- Employment in the R&D sector in the county has grown in the period 1995-2001 from 1,670 to 2,440.
- There has however been a fall in employment levels since the high of 3,094 in 2000.

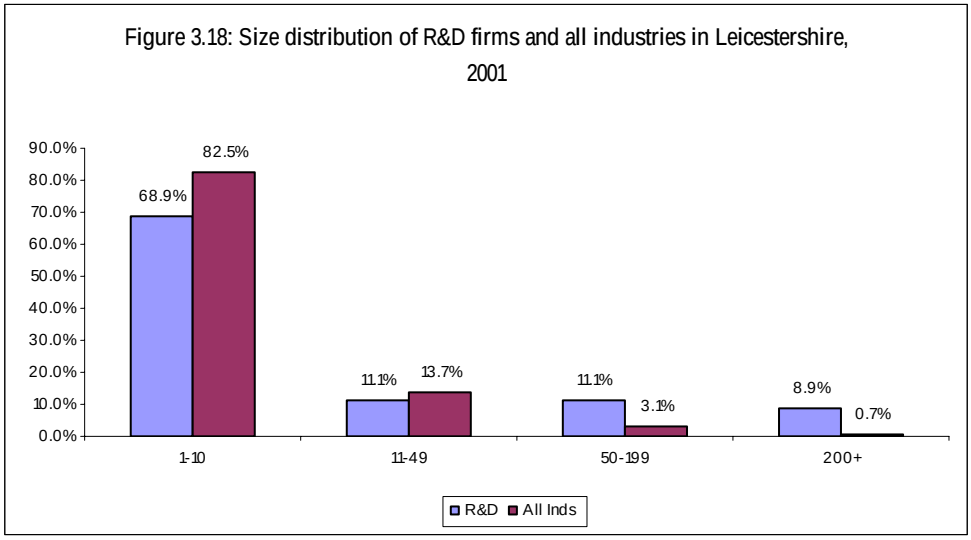


(Source: NOMIS)

Firm Size

A final set of secondary data relates to the size of R&D firms in the region. Figure 3.18 provides data on the size distribution of R&D firms and all businesses in Leicester Shire. It indicates that:

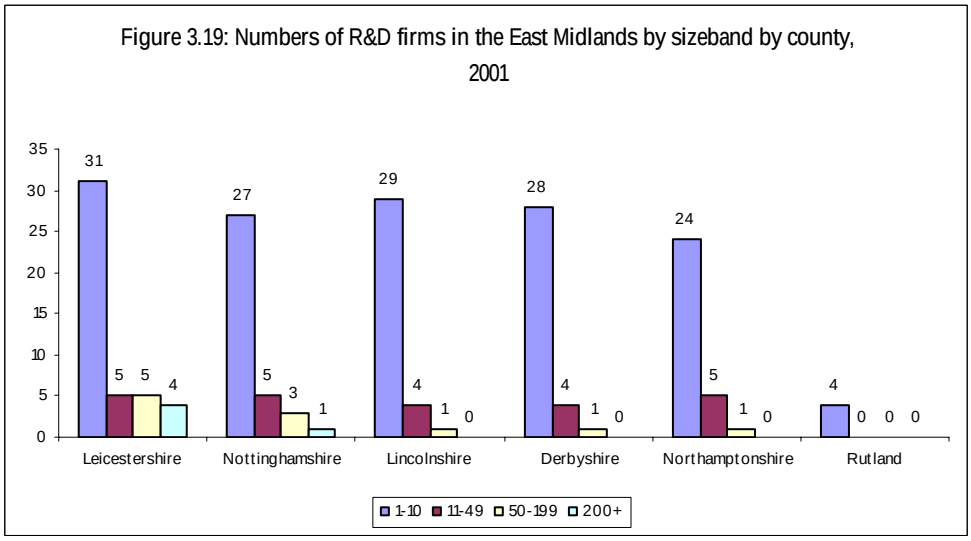
- There is a tendency for R&D firms to be slightly larger than firms in the economy in general. This is perhaps not surprising given that firms such as R&D service businesses are associated with manufacturing activities and tend to be larger than those in non-manufacturing sectors such as retail.



(Source: NOMIS)

Figure 3.19 tends to substantiate the larger size distribution profile shown in 3.18. It shows the numbers of R&D sector firms by size across the region's counties, and indicates that:

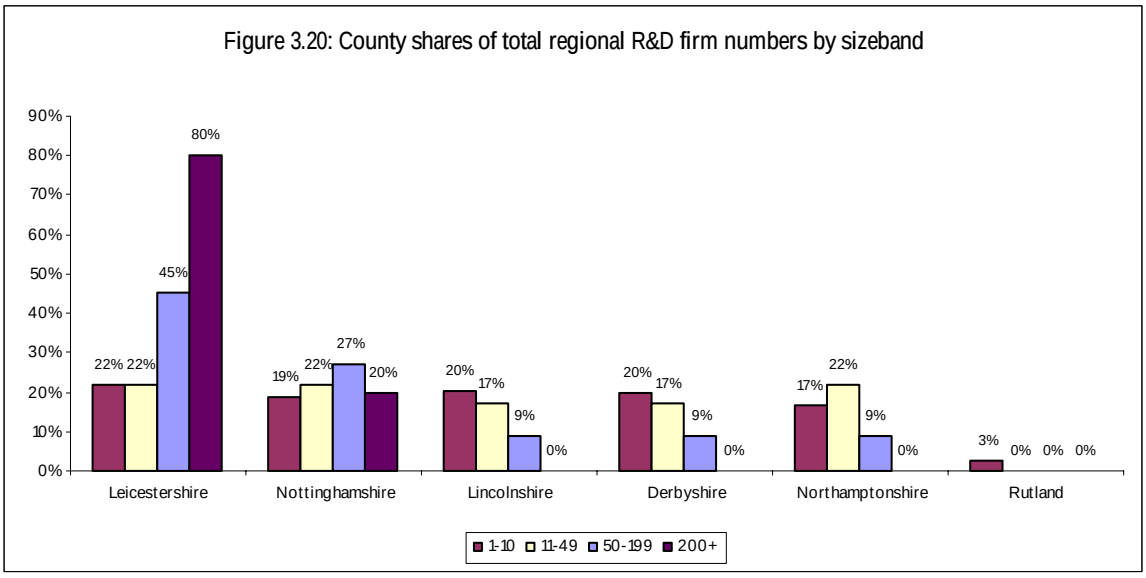
- All counties, with the exception of Rutland, share the same number of micro (1-9) and small firms (10-49) with between 24-31 of the former and 4-5 of the latter.
- The difference in structure is in medium (50-249) and large (250+) firms. It is in these categories that Leicester Shire outperforms the other counties, especially in the large firm category where it has 4 of the region's five large firms.



(Source: NOMIS)

This picture is reinforced by Figure 3.20. It demonstrates that:

- There are significant differences in counties' shares of firms by size bands. Leicester Shire, for instance, has 45% of firms employing 50-199 workers and 80% employing 200 or more.
- The sector in the county could therefore be seen as a highly concentrated one based around a small number of firms rather than one focused around a large network of small firms.



(Source: NOMIS)

CHAPTER 4: THE R&D SERVICES SECTOR IN LEICESTER SHIRE

INTRODUCTION

Chapter 3 provided a profile of both R&D in general in the UK and the East Midlands and the R&D service sector in particular. It also examined the scale and structure of the R&D sector in Leicester Shire. It showed that whilst the R&D sector in the region is not particularly strong in the national context, what there is is concentrated within the Leicester Shire economy to such an extent as to make it of significance to the wider economy and to warrant further examination.

This chapter presents the findings of a survey of R&D service sector firms in the sub-region. It provides a detailed profile of the sector exploring the its structure, activities, markets, use of knowledge, co-operation arrangements and interaction with the sub-region's business support infrastructure.

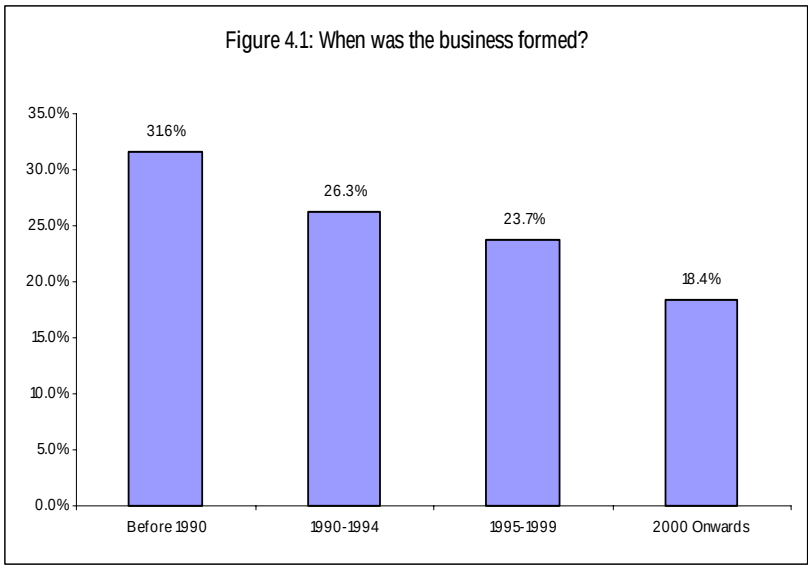
FIRM PROFILE

The first concern of this survey was to identify the basic characteristics of the research and development sector in Leicester Shire, in terms of the age, origins, size, employment trends and locations of firms.

Age of Firms

Data regarding the age of firms is presented in Figure 4.1, and this shows that the sector is relatively young.

- Nearly 70% of firms have been formed since 1990, and over 40% since 1995. This contrasts sharply with the picture gathered for a sample of High Tech firms in an earlier survey in which 72% of respondents were established before 1990 (CURS, 2002), and identifies the R&D sector in the sub-region as a dynamic one characterised by recent start-ups as opposed to mature firms.

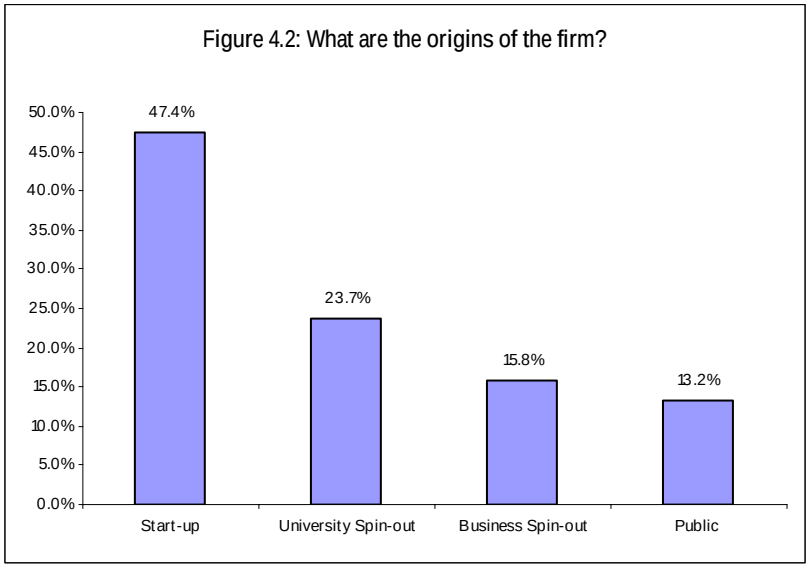


- Whilst a number of younger firms will undoubtedly fold in the short term, there is likely to be potential for expansion amongst some of these businesses given their youth. It also suggests that there may be a culture of new firm formation within the sub-region, at least within this type of sector, which may continue if nurtured.
- With regard to the macro-economic circumstances that have fuelled the recent growth in R&D activities, we can speculate that these either have to do with the growth in the knowledge economy, or the growth of subcontracting and outsourcing, or some combination of both.

Firm Formation

The previous finding also suggests that we need to understand the specific micro-economic pathways through which these ventures originated in the sub-region, to see whether these are secure and require further support. The data presented here show that firms in the Leicester Shire R&D sector have their origins in a variety of different formation processes, a situation that perhaps contrasts with manufacturing or other service firms. In particular, Figure 4.2 shows that:

- Nearly 50% of firms in the survey were 'traditional' start-ups by independent individuals or partners.
- Some 23.7% of firms were spun-out of universities and 15.8% from other businesses. The proportion of higher education spin-outs is particularly impressive, and indicates the capacity in local universities to generate viable business ideas.
- A further 13.2% had public sector roots either being privatised institutions or being private companies belonging to public institutions.

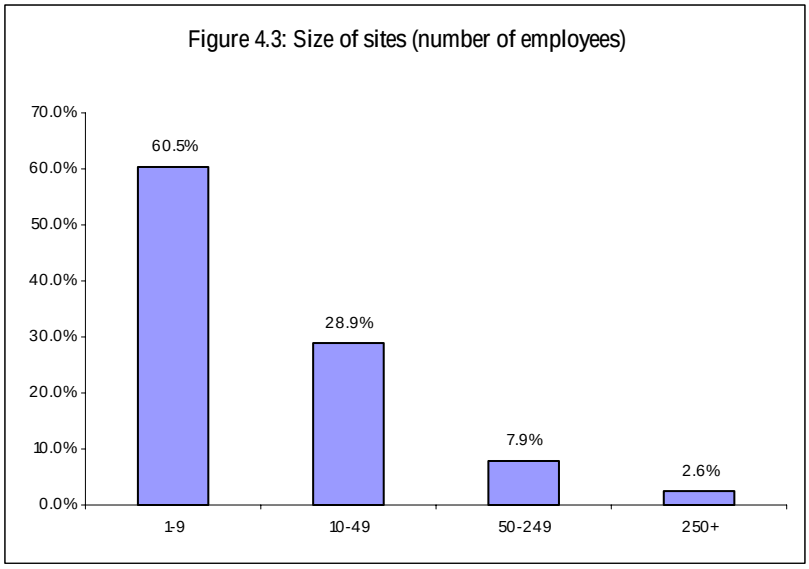


- There is some evidence from the cross-tabulation of this variable with firm age that the proportion of higher education and business spin-outs increased during the 1990s, whilst the proportion of public sector-related firms declined. So whilst firms formed before 1990 generally originated as traditional start-ups or from within the public sector, firms formed after 1995 came most frequently from HE (7 ventures) or business spin-outs (4) rather than traditional starts ups and the public sector (4 and 1 respectively). So whilst the 1980s may have been the high-point of privatisation, the late 1990s were a period in which the emphasis of government policy switched towards encouraging higher education involvement in the generation of businesses.
- Indeed the data in Figure 4.2, based on respondent self-classification, perhaps under-represents the importance of particular processes. For whilst 23.7% of firms classified themselves as 'HE spin-outs', it is clear from 'soft' data in the survey that a further 7.9% are closely associated with the sub-region's HE institutions, in that their founders' were employed in these organisations directly prior to forming these firms, and depending on one's definition of a 'spin-out' could in fact be categorised as such. This suggests, that in fact 31.6% of firms are HE-related and also that the start-up figure is correspondingly lower.
- The processes underlying the creation of many start-ups are also not fully revealed by the data in Figure 4.2. Additional soft data from the survey sheds light on these processes and emphasises the links between start-ups and existing local firms. Of the 18 firms classified as start-ups it was possible to re-classify three of these as HE-related (see above). Within the remaining 15 one could then identify three core processes behind their establishment. Firstly, a significant number of start-ups (5) were established by individuals previously working in local firms who in the course of their work identified business opportunities and established their own firms. Secondly, there were also a number of firms (3) established by individuals who had also been employed locally but were made redundant. This in turn spurred them to establish their own firms. Finally, business start-ups were also driven by management buy-outs of parts of existing local businesses (two firms).

Site Size

Another important attribute is the size of respondents by employment level, as shown in Figure 4.3. The size profile of respondents is broadly similar to that generated for the Sub-region from the ABI and set out in Chapter 3. It shows that:

- The large majority of sites (60.5%) are 'micro' (1-9 employees) whilst over a quarter (28.9%) are 'small' (10-49 employees).
- This finding adds support to the earlier conclusion that R&D is a relatively young sector with the potential for growth, and contrasts strongly with the picture reached in the context of high-tech firms (where many more medium and large firms were found).

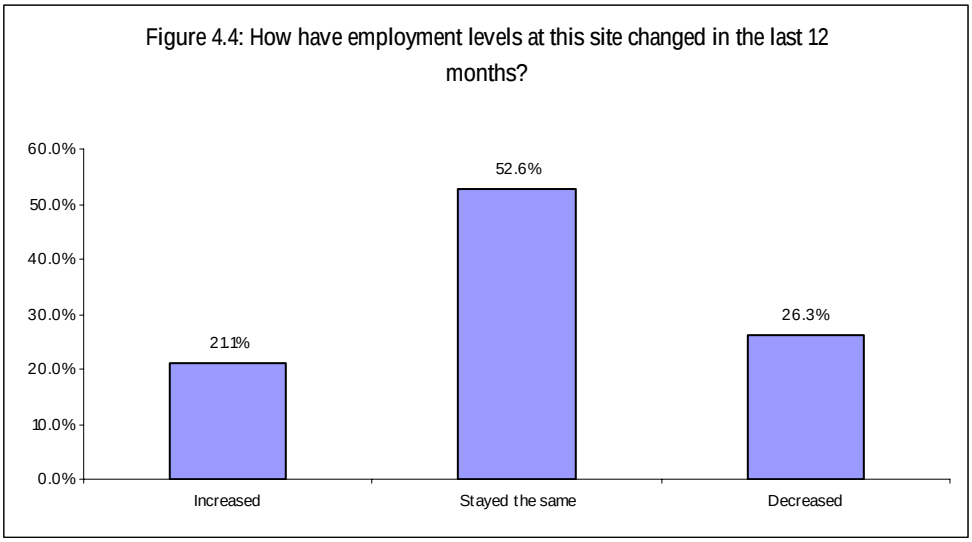


- However, when one compares the survey findings with the national ABI data for site size for the R&D sector it appears that there is a tendency for firms in the survey to be larger than the national rate. For instance, some 74.8% of national firms are micro firms and 14.9% are small firms, in contrast to the findings from the survey of 60.5% and 28.9% respectively. This suggests that the national profile for the sector is heavily skewed towards micro firms, perhaps reflecting the out-sourcing business model at the heart of the sector. It also raises questions about the ability of firms to grow further. Despite the relative youth of the sector in the sub-region it appears that firms there may have already over-performed in employment terms.

Employment Trends

In assessing the circumstances of the sector it is also important to identify major employment trends. Figure 4.4 shows that:

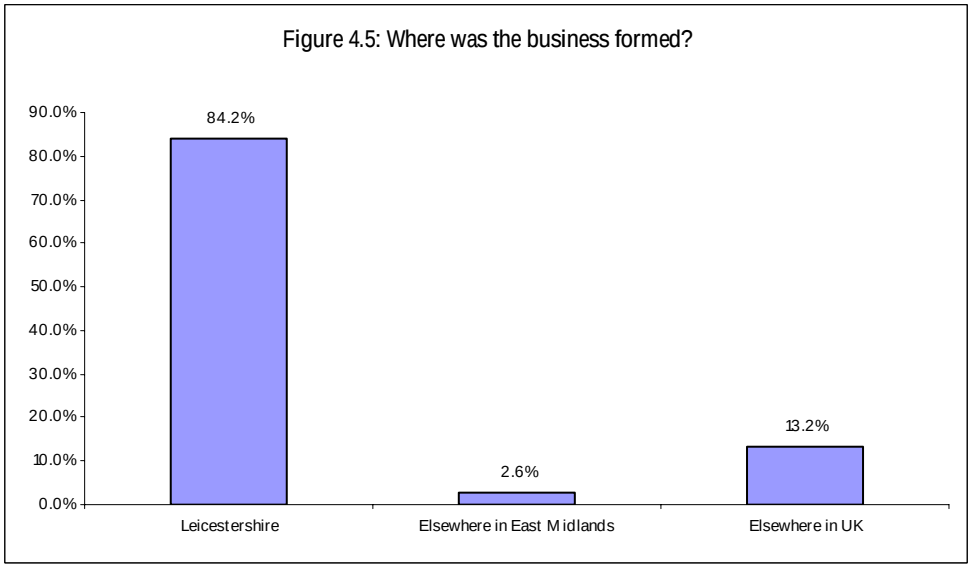
- The majority of respondents (52.6%) have experienced no change in employment levels in the last 12 months.
- But a greater percentage of firms have experienced falling (26.3%) employment rates in the last 12 months than increases (21.1%).
- This may perhaps be viewed as a response to the cyclical downturn experienced by manufacturing firms – the source of much R&D activity – in the region during 2001-2003. A review of the cross-tabulation with site size shows that there have been more job losses amongst smaller respondents than larger ones, who were in fact more likely to have increased employment than decreased. This tends to confirm the feeling that job-losses reflect reduced sub-contracting (which micro-firms undertake) as a result of the downturn in manufacturing activity.



Location

To shed further light on the origins of firms they were asked where they started and, whether or not they moved into Leicester Shire, why they are located here. It was found (as set out in Figure 4.5) that:

- The sector is primarily local in origin. Some 84% of responding businesses were first established in the sub-region. A very small number have moved into the area from within the region, although some 13% – still a relatively small number compared to other sectors – had moved to Leicester Shire from the rest of the UK.
- However, if we examine the size of these firms then we find that there is a tendency for larger firms to have moved into the sub-region. About 50% of firms employing over 50 workers have moved in from elsewhere in the UK.

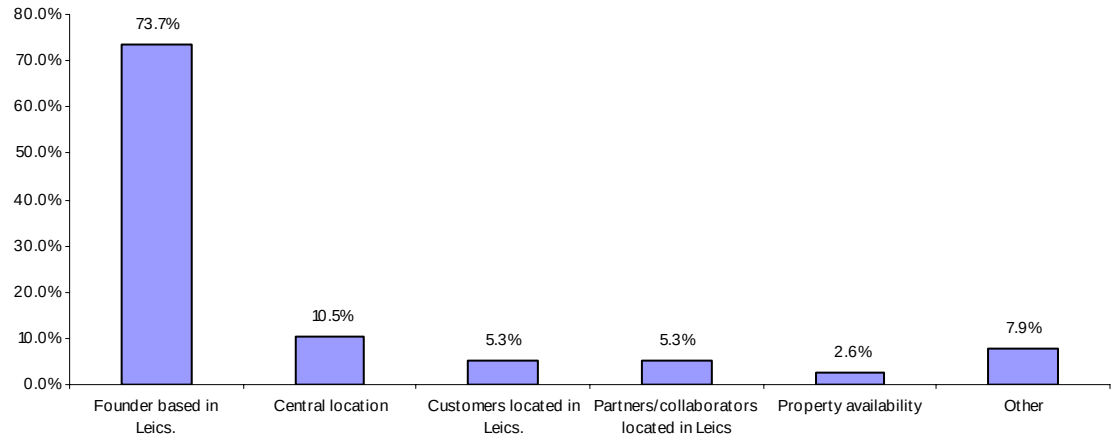


- Therefore, whilst in terms of firm numbers the sector is predominantly locally based, in terms of employment incoming firms have played a very significant role in the development of the sector. These incoming firms have however tended to be UK-based rather than foreign direct investor, and despite the presence outside of the sample survey of some well-known examples of inward investment (such as AstraZeneca), in general there is limited evidence of FDI into the Leicester Shire R&D sector.

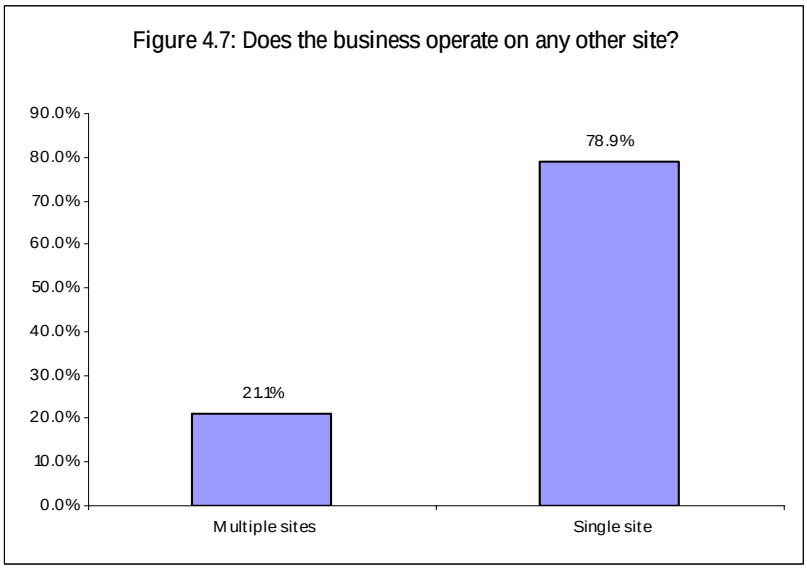
The local roots of the sector are reflected in Figure 4.6, which shows the reasons behind firms' decisions to locate in Leicester Shire. Clearly for the large majority of firms their Leicester Shire location is related to their founding individual or organisation being originally based in the sub-region.

- It should however be noted that few respondents cited the location of either customers or of partners and collaborators as reasons for being based in the locality (5% in each case). Incoming firms may have cited a range of reasons for their location in the sub-region, but the location of their customers or their partners were not as significant amongst these as a central location in the country.
- Firms employing over 50 workers, and institutions linked to the public sector, were most likely to cite the sub-region's central location as a factor behind their location.

Figure 4.6: Why was business located at current site? (Multiple answers possible)



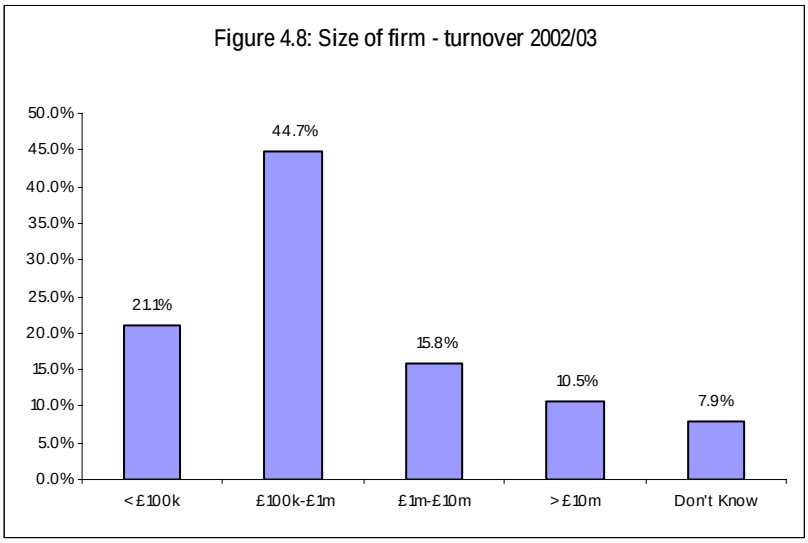
- The small size and independent character of the business in this sector is also reflected in the relative scarcity of multi-plant firms. Figure 4.7 shows that only 21.1% of firms operate on multiple sites. This amounted to eight firms, and of these only two were headquartered outside of the sub-region. Both of these had only small sites in the sub-region employing between 10 and 49 workers.



Turnover and Profitability

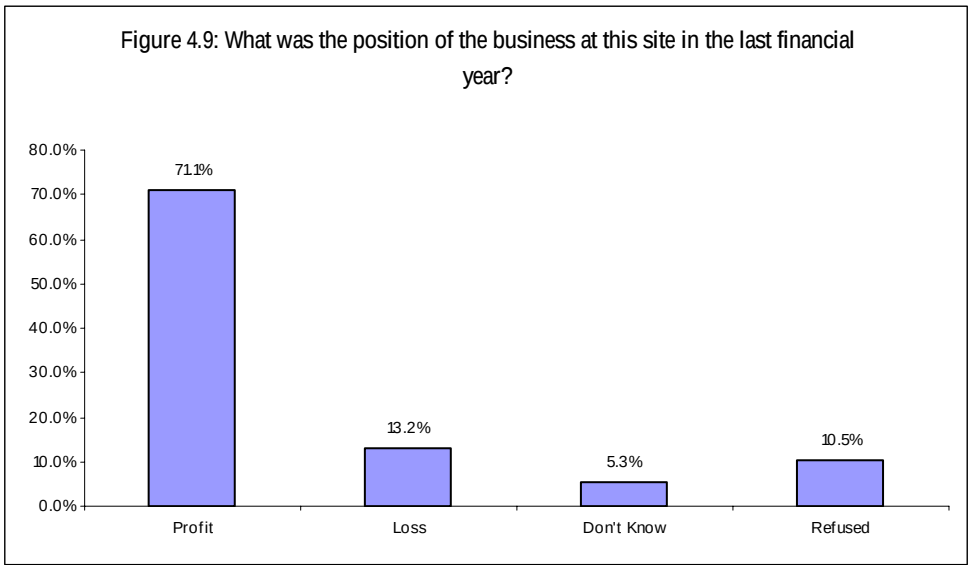
Another way of taking stock of the Leicester Shire R&D sector is by measuring the size of company turnover. Figure 4.8 summarises the answers from respondents regarding firm size by turnover. It shows that:

- The majority of respondents were relatively small, with 65.8% of firms turning over less than £1m in the financial year 2002/03.
- Only about 42% of respondents had turnover in excess of £1m that year, and only 10.5% of respondents had turnover in excess of £10m.
- The average turnover figures here are much smaller than those for the cohort of high tech firms that were studied in the previous report, a cohort that comprised a range of manufacturing firms.



To gauge the standing and performance of this sector, respondents were asked to indicate the profitability or otherwise of their firms at the end of the 2002/03 financial year, as set out in Figure 4.9.

- The great majority of businesses (71.1%) stated that they were in profit during 2002/3. Only a minority of 13% said they had made a loss.
- This result is quite encouraging given the youth of the firms, their small size and greater vulnerability, and the recent manufacturing recession which (as noted above) was probably responsible for the recent loss of employment in some local R&D firms.



PRODUCTS AND PROCESSES

This section provides data on the types of activities being undertaken by R&D firms, telling us something about the role of these firms in general whilst also shedding light upon the specific characteristics of the sector in the area.

Firm Activities

Chapter 3 showed that there are two main forms of activity within the R&D service sector. These are:

- Research in natural sciences and engineering (SIC 73.1)
- Research in social sciences and humanities (SIC 73.2)

The survey included both these categories. Some 8% of respondents were involved in the latter research area whilst 92% were involved in science and engineering based activities. These correspond closely to the ABI survey figures of 11% and 89% respectively for the sub-region.

Table 4.1 provides details of the types of R&D related services provided by respondents. It also shows the types of products and outputs whose production these services contribute to. Finally, it shows the sectors of customers for these services. A number of points are apparent from the table. These include the fact that:

- A large range of R&D related activities are undertaken by firms in the sub-region. These run from traditional R&D activities, through testing, to the provision of various R&D management activities such as the recruitment of R&D staff.

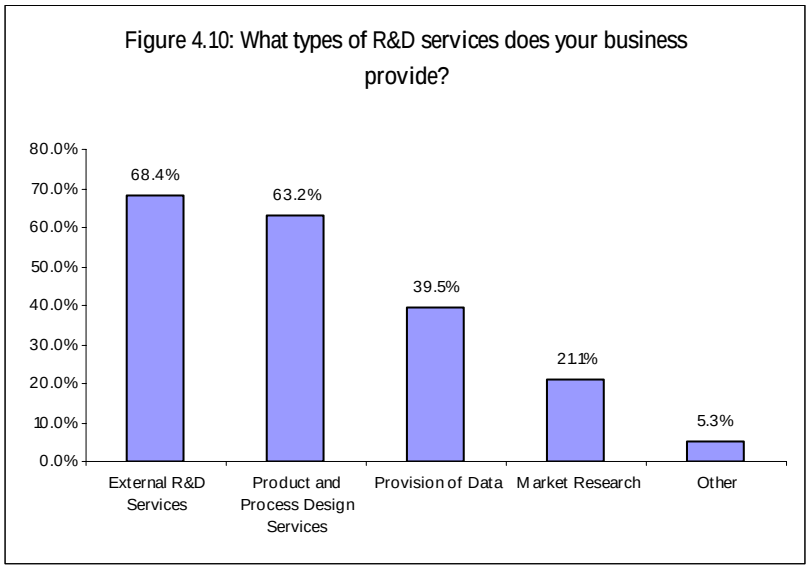
Table 4.1: Respondents' activities by service, product and customer type

Services Provided	Product Focus	Customer Focus
R&D	Scientific instruments and metrology and testing equip.	Automotive
Design	Electronic products	Marine
Testing	Noise and vibration products and research	Pharmaceuticals
Manufacturing	Materials development	Medical technologies
Equip. maintenance	Energy and utilities products and research	Energy and utilities
Consultancy	Software	Engineering
Data provision	IT products	Construction
Training (for R&D)	Medical technologies	Electronics
Training (for R&D management)	Pharmaceuticals	IT
Education	Sports equip.	Software
R&D management services	Government projects	Telecommunications
		Aerospace
		Chemicals
		Food
		Government

- Almost all firms have 'core' R&D activities at their heart such as sub-contracted R&D itself, design services or data provision (in the sense that they contribute to the creation of new knowledge) but many provide what could be considered 'non-core' activities in addition. The sector therefore needs to be seen as more broadly based than simply the provision of sub-contract R&D.
- The services provided by these firms are associated with a broad range of products and other outputs. The product areas most frequently addressed by respondent firms include scientific instruments and metrology equipment, noise and vibration products, and research for energy and utility activities.
- Respondents cited customers from a broad range sectors. The pharmaceutical and medical, automotive and energy and utilities sectors were most frequently identified. However, it was clear that many firms provide services across a broad spectrum of industrial sectors or to groups of inter-linked sectors such as software, IT and telecommunications or automotive, aerospace and shipbuilding.

Table 4.1 was generated from open questions on firms' activities and provides data on the range of these, rather than their frequency or relative importance within the sector. Figure 4.10 attempts to quantify these activities. Using data from a closed question it illustrates the importance of the three core R&D activities within the respondent group. It also shows the prevalence of other non-core activities. It employs the three standard categories used in official statistics to describe the different types of products or services R&D firms provide, and shows that:

- The majority (68.4%) of firms are involved in the provision of *external R&D services* to other firms that are outsourcing this activity.
- Many firms (63.2%) are also involved in the provision of *product and process design services* for external clients.
- Many firms were also involved in the provision of *scientific, technical and marketing information* to their client base, with 39.5% providing *technical data* and 21.1% undertaking *marketing research*.



The R&D Value Chain

We know that R&D service firms do not generally participate in basic research to a significant degree, as this tends to be done by organisations in the public sector (Readman and Hales, 2000). R&D service firms tend rather to focus upon experimental development, which involves the use of existing knowledge to create new or improve existing products, materials and processes. Figure 4.11, which covers SIC 73.1 firms only, explores these activities further. It demonstrates that:

- Most if not all R&D firms were involved at several stages of the R&D value-chain, and that their activities do not therefore respect the neat categories that are sometimes produced by analysts. Indeed, the mean number of stages in which respondents participated was 3.4 and the modal number was 5.
- The stages of this value chain which these (scientific) R&D firms mentioned most as describing their own contributions were the 'designing' and 'testing' of products (83% of respondents each).
- Firms are also deeply involved in what might be called 'product conceptualization', with some 60% involved in devising products, and 73% also undertake prototyping activities.
- Despite the focus on R&D activities within the sector, many firms are also involved in manufacturing activities themselves (40%).
- There was a discrete sub-group amongst the responding firms that focused solely on testing activities. Whilst this is regarded by some authorities as outside of R&D proper (as it does not involve the creation of new knowledge) these firms form an important element within the R&D supply chain and are therefore included within the SIC defined R&D services sector.

Figure 4.11: Firms contributing to various stages of the production process (SIC 73.1 firms only)

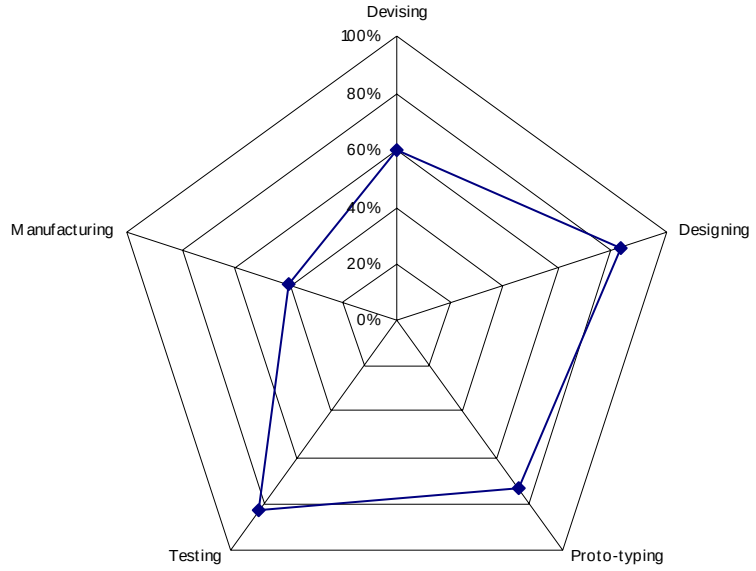
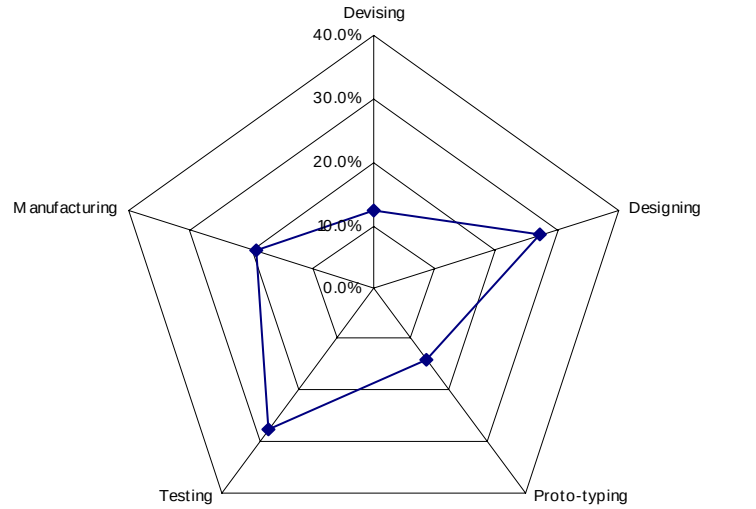


Figure 4.12 shows the average amount of time spent within firms on different aspects of the innovation and production process. This gives a measure of the relative importance of each aspect, and shows that:

- Once again, the greatest proportion of firm time is devoted to designing (27%) and testing (27.6%) products and processes, with devising and prototyping these coming fairly closely behind (12% and 14% respectively).

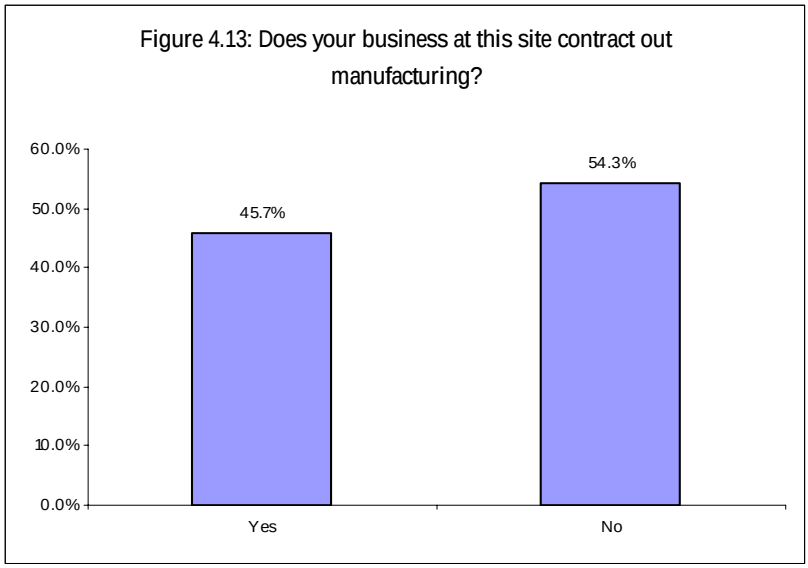
Figure 4.12: Average amount of time spent on different aspects of the production process (SIC 73.1 only)



- The chart also shows that a significant proportion of firm time is spent manufacturing, indicating (as noted earlier) that R&D and manufacturing (although regarded as different stages in the value chain) may not necessarily be divorced from one another at a corporate level.

Figure 4.13 explores further the manufacturing activities of the scientific R&D firms. It shows that:

- Some 45.7% of respondents contract out manufacturing activity.



- Taken together with those firms that undertake their own manufacturing activities, it appears that 54.2% of respondents pursue the manufacturing of their own products either directly themselves or through the contracting out process.
- Once again, this suggests that these firms should not be regarded as wholly passive, simply supporting the innovation processes of clients, and so confined to one small part of the value-chain. Rather, they are involved across a series of links in the value-chain, and appear to be more proactive in converting their research activities into their own products as well as providing R&D services to external clients.

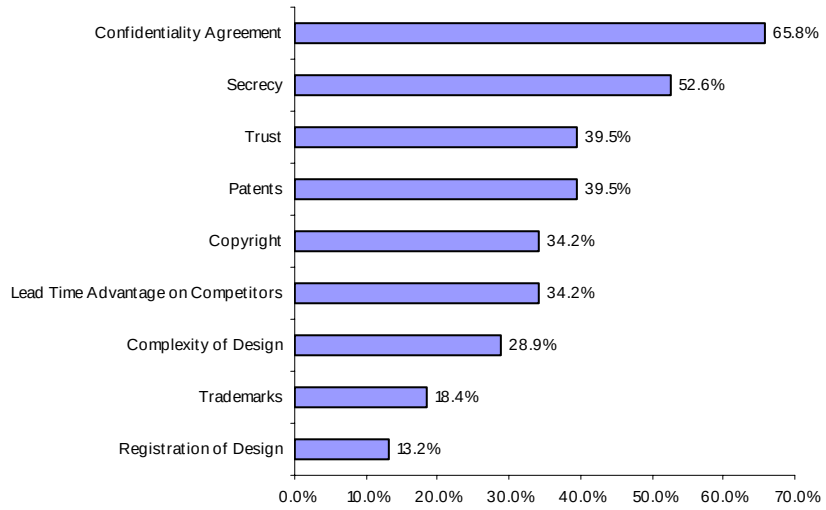
Intellectual Property

A further, vital aspect of firm activity in this sector relates to the protection of intellectual property rights (IPR). The knowledge base of these firms is the key source of competitive advantage and must therefore be protected. Figure 4.14 below illustrates the various mechanisms that firms employ to ensure that, for instance, their designs are not copied or their data resold. It shows that:

- Most firms were giving attention to the protection of their intellectual property rights through one mechanism or another.
- Confidentiality Agreements, which are specific to the parties and their relationships, are seen as the most important tool to protect IPR, with 65.8% of respondents identifying their importance as high.

- Other specific or 'relational' techniques are also important, including secrecy (52.6%) and trust (39.5%).
- More cumbersome non-specific and formal techniques – such as patents, copyrights, trademarks and registration – are also used quite frequently.
- Lead time advantage over competitors, together with the complexity of design, are recognised as sources of protection for knowledge assets.

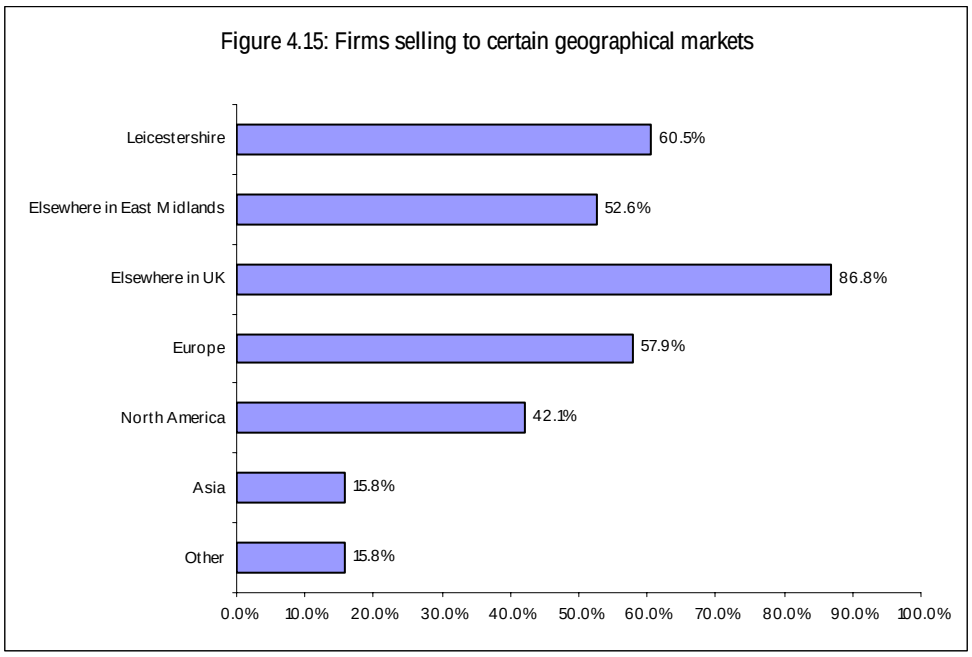
Figure 4.14: Firms citing the importance of certain IPR methods as "high"



MARKETS

The linkages through which R&D firms operate can be examined via the destination of their outputs, and via the characteristics and origins of their inputs. A number of questions were asked to identify the types of customers served by the firms interviewed. When asked about the locations of their customers (Figure 4.15), it was apparent that there is no simple inverse relationship between distance and sales:

- A significant majority of firms (61%) make some sales locally, within Leicester Shire. This proportion was considerably higher that the equivalent percentage for high tech firms (which were manufacturing businesses) in the earlier study.
- The largest proportion of firms (87%) make sales of some magnitude to clients outside the East Midlands but within the UK. However this proportion was lower than that found for the high tech sector.
- But a higher proportion of firms make sales to Europe beyond the UK than to the East Midlands. This was however also lower than that found for high tech firms.
- A large minority of firms have customers in North America (42%). This figure was higher than high tech firms.
- A significant minority have customers in Asia (16%).

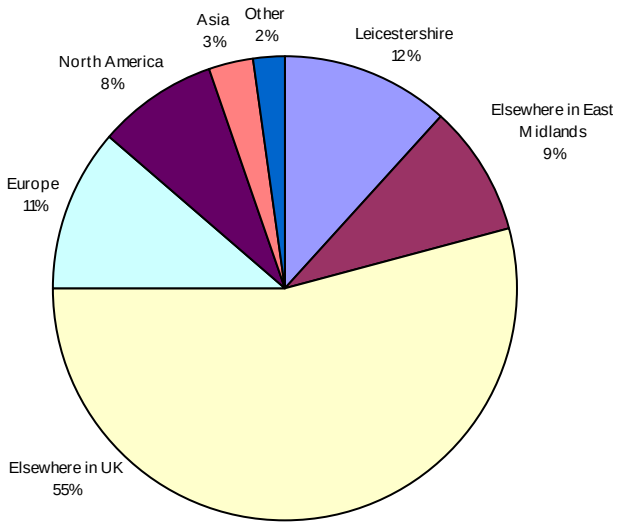


The emphasis amongst R&D firms was therefore upon selling to the UK market as a whole rather than the regional market, but with a majority also selling their services locally within Leicester Shire. But compared with high tech manufacturing firms, these R&D service businesses were significantly more local and less national, more US and less European in orientation.

The markets served by firms can also be examined by considering the proportion of their sales turnover generated from different geographical markets. Average figures are presented in Figure 4.16, and they show a similar pattern to the above:

- A significant minority of this turnover derives from the local (Leicester Shire) and European markets (12% and 11% respectively). The proportion for high-technology firms (in the context of a measure of turnover rather than number of firms making some sales) was however slightly higher.
- A majority of sales earnings for the sample (55%) are generated from the national market. The figure for high-technology firms was in this case slightly lower.
- A smaller minority of sales turnover for R&D firms derives from the East Midlands' and from North American markets (9% and 8%), with residual proportions coming from Asia and elsewhere. Here the figures for high tech firms were about the same.

Figure 4.16: Average sales by geographical market (% of total sales)



If we consider the sales emphasis of R&D firms via sales turnover, we get a rather different picture from that described above regarding Figure 4.16. The previous figure showed that the emphasis amongst R&D firms was upon selling to the UK market as a whole rather than the regional market, with a majority also selling their services locally within Leicester Shire. It also showed, however, that compared with high tech (i.e. manufacturing) firms, these R&D service businesses were more local and less national, more US less European, in orientation.

The evidence of sales turnover shows once again that these R&D firms are orientated primarily towards the national market, but with some significant involvement in selling locally within Leicester Shire (and Europe). But in this case the comparison with high-tech firms strengthens the original impression, showing R&D firms to be less locally orientated (and less European in orientation) and more nationally orientated than manufacturing firms. In either case we do not see a sector which, because it provides services rather than tradeable goods, is strongly local or regional – rather than national or international – in its emphasis.

More detail on the geographical links as evinced by their markets is provided in Table 4.2. This breaks firms into three size categories based on their annual turnover and illustrates the distribution of their sales income by geographical market. It clearly shows that a progression in turnover size is strongly associated with lower levels of sub-region and regional sales, lower levels of UK sales, and ultimately, higher levels of exports.

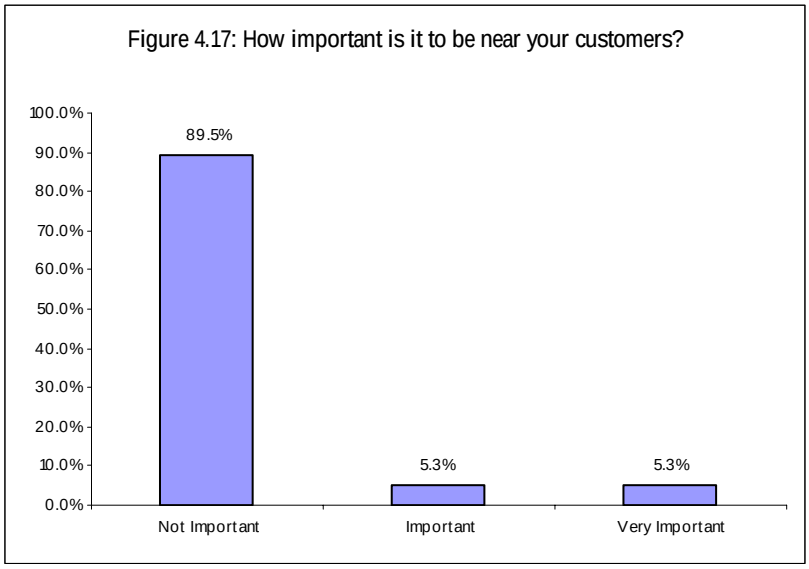
Table 4.2: Average sales by markets by firm turnover

Turnover	Leics.	E Mids	UK	Europe	N. America.	Asia	Other
<£100k	11.3%	14.0%	62.3%	9.3%	2.9%	0.4%	0.0%
£100k-£1m	14.9%	8.5%	52.8%	10.7%	6.5%	4.6%	1.9%
>£1m	6.0%	5.5%	42.5%	17.5%	19.4%	3.1%	6.0%

Light can be shed upon trading relationships, and indeed upon the clustering of similar activities, by examining the significance of physical proximity and face-to-

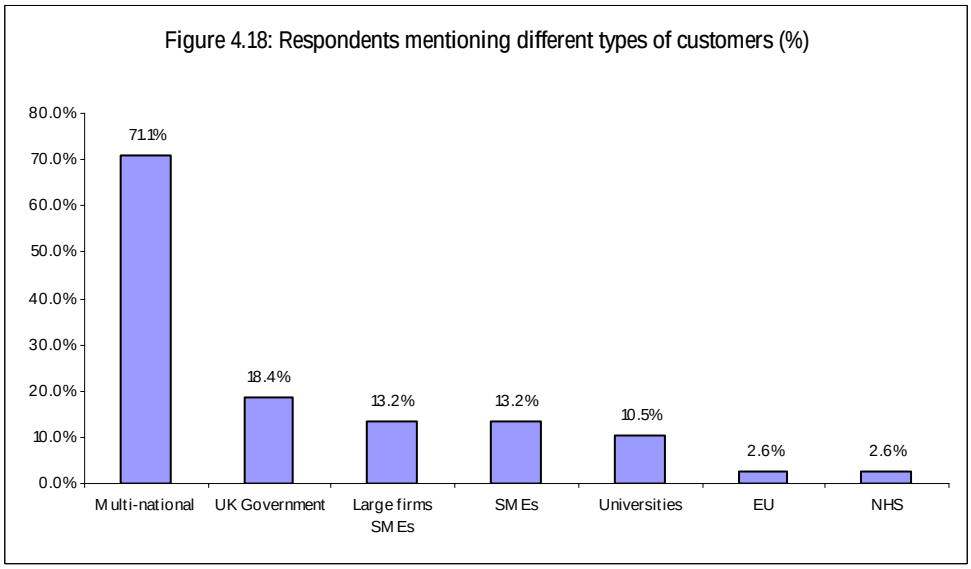
face contact (Figure 4.17). When asked how important it is to be near to customers, however:

- The vast majority of respondents stated that it was not important (90%), whilst only a small minority felt it to be important or very important (5.3% in each case).



Firms were also asked to identify the types of businesses that purchased their services. Figure 4.18 shows that:

- Respondents were most likely to identify multi-national firms as customers (71.1%)
- The state sector in its various forms was also a key source of revenue for a large number of firms.



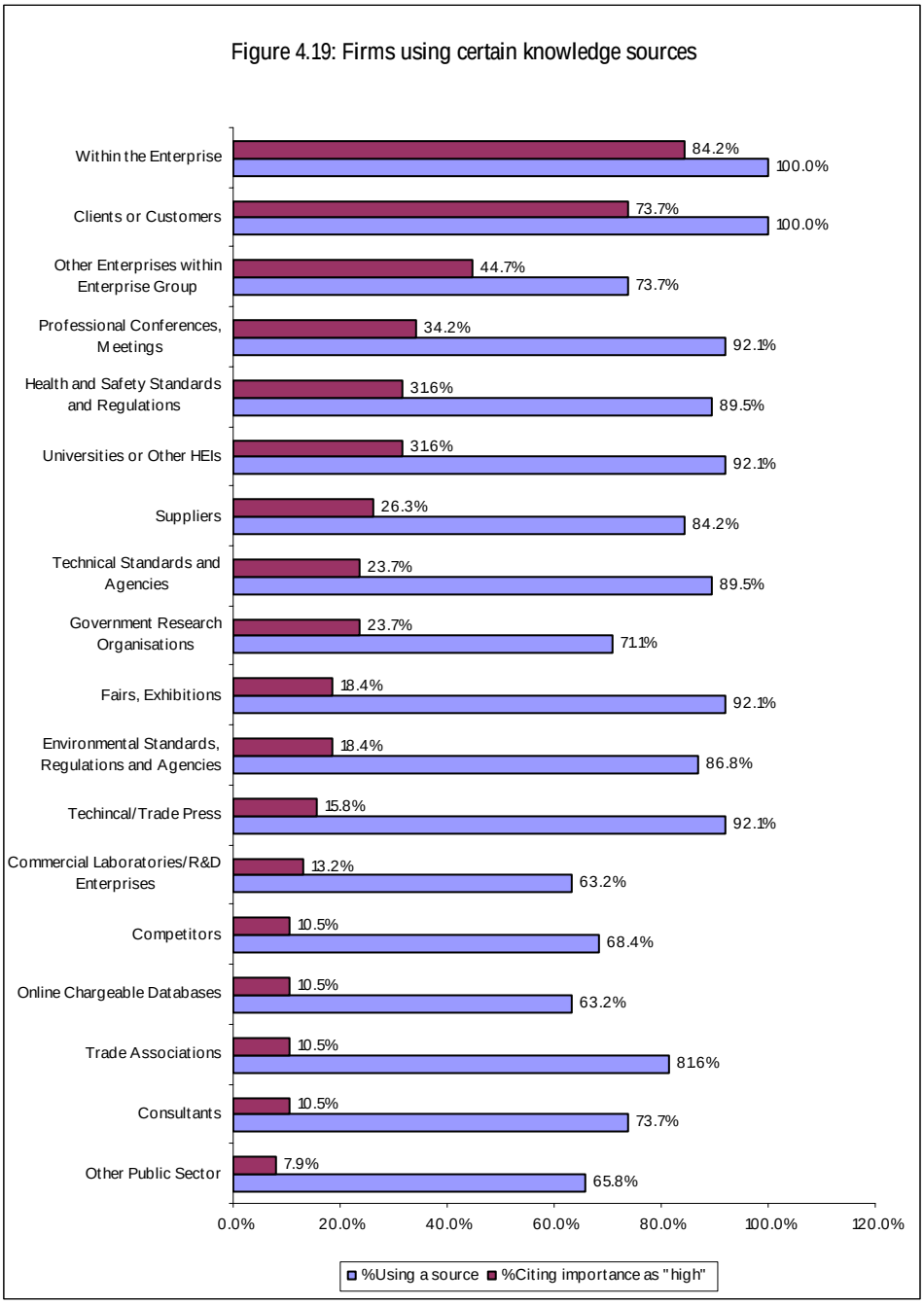
INPUTS

Knowledge Sources

The linkages through which firms operate can also be examined via the inputs into production or service provision, including skills and support services. But in the context of R&D activities a particularly important input is the knowledge or information used, especially in the development and provision of products. Respondents were therefore asked to identify the organisational sources from which this knowledge or information is drawn (see Figure 4.19):

- The two sources cited most frequently were from within the enterprise itself, and from amongst clients and customers.

Figure 4.19: Firms using certain knowledge sources



- These were also the two sources that were viewed as of 'high' importance for the business, with 84% of respondents viewing internally generated knowledge as of 'high importance'.
- Other sources that were cited very frequently as sources of knowledge included Professional Conferences and Meetings, Universities and other Higher Education Institutions, Fairs and Exhibitions, Technical and Trade Press.
- But these and others items were only cited by a minority of respondents as of 'high' importance, and the only other sources that were often seen as 'highly important' were other Enterprises within the Group, and Professional Conferences and Meetings.
- Clients and customers were clearly prioritised by R&D firms over suppliers as sources of knowledge, despite the emphasis that is frequently placed upon the latter in literature on the subject of clustering and knowledge.
- Of least importance as sources of knowledge and information to these R&D businesses were Consultants, Trade Associations, Online Chargeable databases, and (perhaps surprisingly) Competitors.

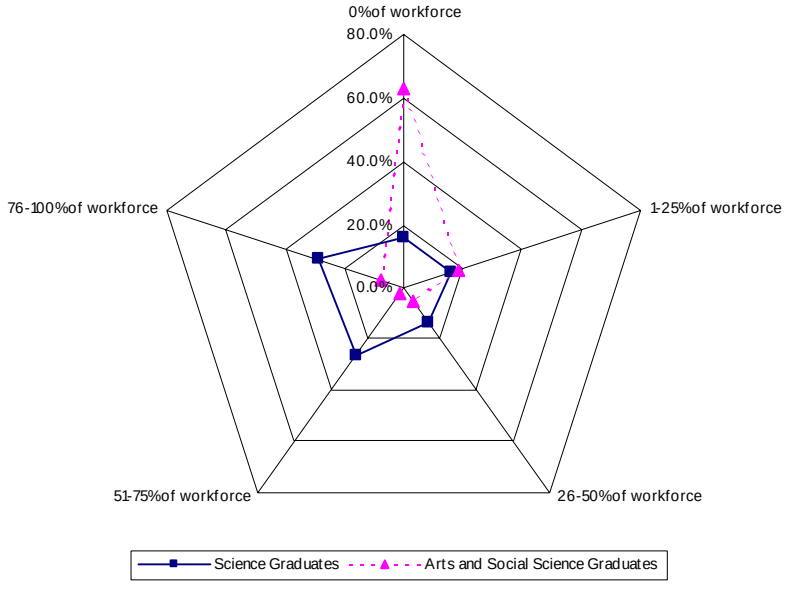
SKILLS AND TRAINING

Skills

Skills can also be expected to be an important input into the production and delivery of services amongst R&D businesses, given their dependence upon accessing high-order expertise and bodies of knowledge. The survey examined the proportion of the workforce that are graduates of different sorts, and found (see Figure 4.20) that:

- Well over half of respondents (55 %) had over 50% of their workforce made up of science graduates. Some 29% had in excess of 75% of their employees with degrees in natural science.
- Only a tiny minority of businesses had a majority of their workforce with Arts and Social Science degrees.

Figure 4.20: Proportion of graduates in workforce (%)



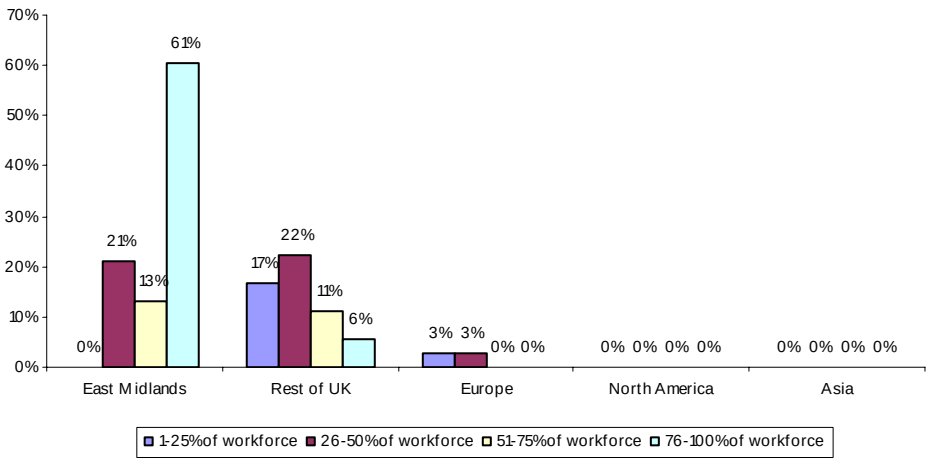
This balance reflects the predominantly natural sciences and engineering (SIC 73.1), rather than social science and humanities (SIC 73.2), orientation of the R&D services of firms sampled.

Graduate Employment

Another question examined the proportion of the workforce recruited from different locations, and found (see Figure 4.21) that there is a strong focus upon local or regional recruitment, and limited recruitment from beyond the region:

- Over 60% of respondents recruited most (over 75%) of their workforce from *within* the East Midlands region.
- Only 5% of respondents hired fewer than 25% of their staff from the East Midlands region.

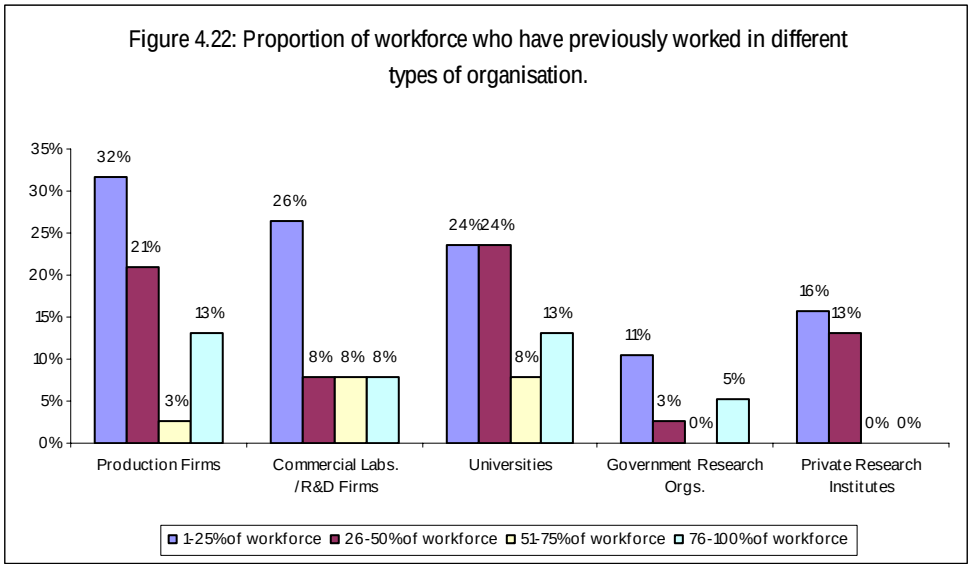
Figure 4.21: Proportion of firms' workforces recruited from the following areas.



Recruitment Patterns

Also examined was the employment background of staff in terms of their 'sectoral origins', and it was found that (see Figure 4.22):

- Nearly half of respondents (45%) recruited over 25% of their staffs from universities, whilst a large minority (37%) recruited over 25% of their staffs from production firms.
- A significant minority (21%) of respondents recruited over half of their staff from universities, and significant minorities had recruited over half of their staff from production firms, or from commercial laboratories/R&D firms (16% in each case).
- Few businesses interviewed had recruited a significant proportion of their staffs from government research organisations, and none from private research institutes. This may reflect the relative scarcity of these as against the other categories.

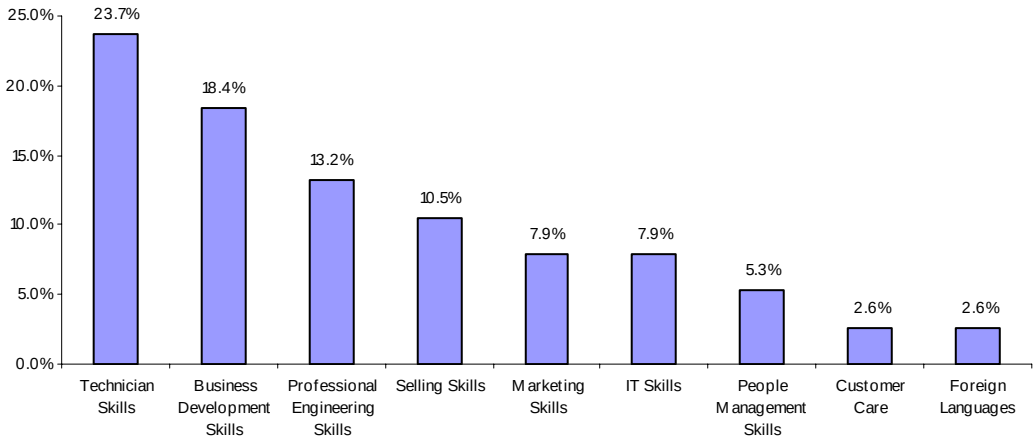


Recruitment Difficulties

The ability of firms in different sectors to find the skills they need locally is an important issue for local economic development. The survey therefore examined the degree to which R&D firms were experiencing recruitment difficulties, and it was found that most firms (63%) were experiencing no recruitment difficulties at all (see Figure 4.23). This is an encouraging picture, although one that needs to be tempered by the recognition that these firms have recently shed labour, and are emerging from a recent recession amongst their manufacturing clients. However, as regards specific skill issues:

- Almost a quarter of respondents (24%) had difficulties finding technicians.
- Recruitment difficulties were experienced in reference to the broad set of marketing skills (selling, marketing and customer care) by 21% of firms.
- Difficulties were also experienced by some firms (18% and 13% respectively) in recruiting people with business development skills and professional engineering skills.
- IT skills were found to be difficult to recruit in only 8% of businesses.
- Perhaps the clearest finding from this figure, however, is the fact that the large majority of firms (63.2%) are currently experiencing no recruitment difficulties.
- Analysis of the data suggests that recruitment difficulties across the sector are linked to the current employment performance of individual firms. Firms that have decreased their workforces in the last 12 months are less likely to report skills shortages across the board than those with stable or growing work forces. Those firms that have increased their labour forces are most likely to cite recruitment problems.

Figure 4.23: firms experiencing problems recruiting different skills sets.

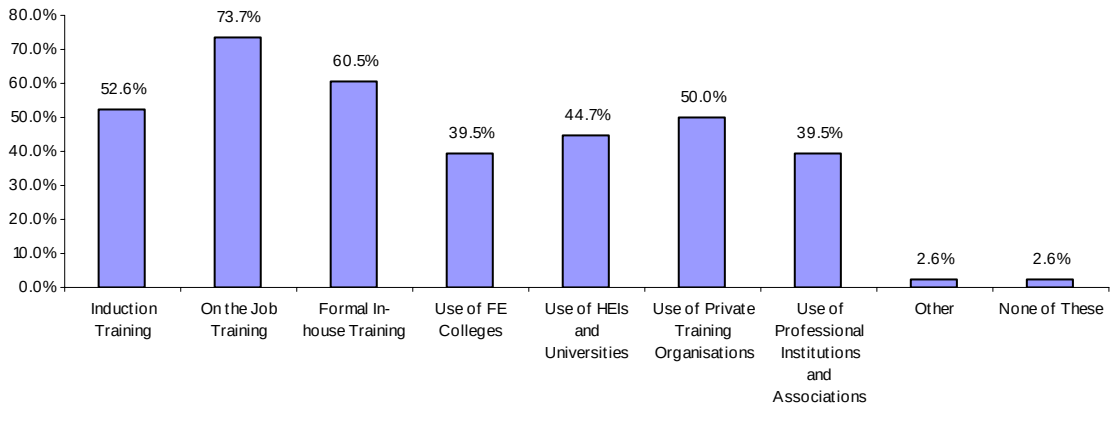


Training Provision

The contribution of firms to local skills and the development of human capital is also an important issue to be considered in the case of R&D as in other sectors. The survey therefore asked businesses about their training activities. Most firms offer training to staff in several forms (see Figure 4.24). It was for example found that most offered some kind of on-the-job training. In addition:

- Firms in this sector make considerable use of formal in-house training, which was provided by a majority (61%) of respondents.
- A significant minority (45%) also made use of higher education institutions or universities for out-of-house training, a higher proportion than used FE colleges.
- Private training organisations were used by half of respondents, and professional institutes were used by 40%.

Figure 4.24: Proportion of firms offering different types of training (% of respondents)



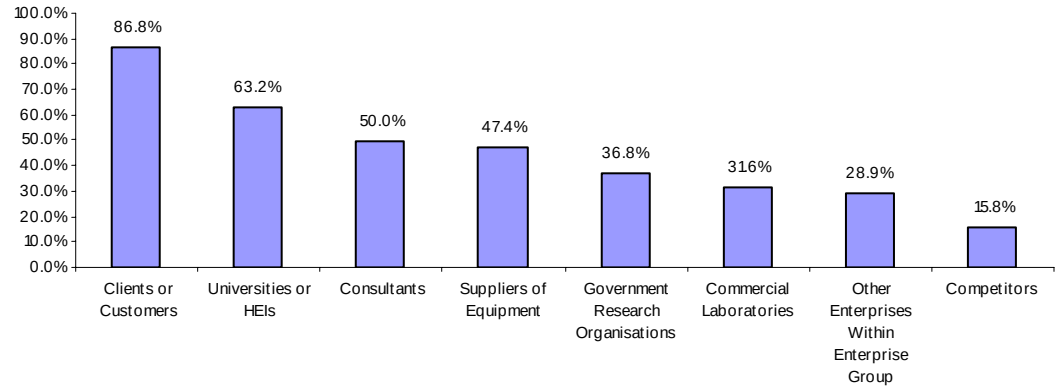
CO-OPERATION WITHIN AND BEYOND THE REGION

Collaboration for Innovation

A further dimension of the linkages in which R&D firms participate is the degree to which they collaborate with other businesses in their core functions of design development. The issue of co-operation can be examined in general, without reference to geography (as set out in Figure 4.25), and it can be examined for relations within the locality or region (see Figure 4.26). As regards cooperation in general, irrespective of the location of the partner, it was found that:

- The vast majority of businesses have in the last two years co-operated with clients or customers in the design or development of new products or services.
- A significant majority has also have also co-operated with Universities (63%), and half have co-operated with consultants.
- Collaborative linkages were also frequently sustained with suppliers, government research establishments, and commercial laboratories.
- Over a quarter of respondents (29%) cooperated with other firms in the enterprise group.
- A small but not insignificant proportion (16%) had cooperated with competitors in R&D or related activities.

Figure 4.25: Organisations with whom firms have co-operated for the design or development of products since 2001.



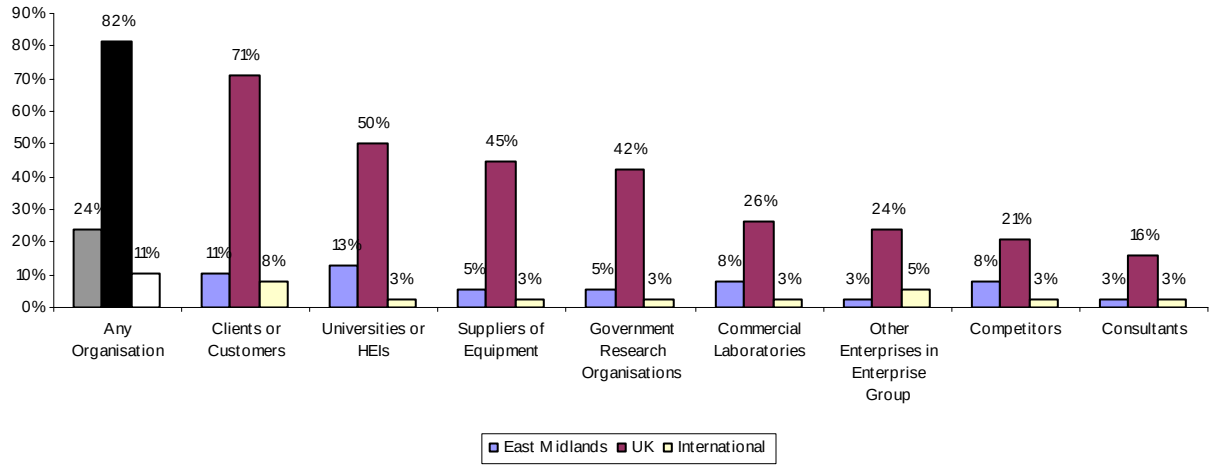
The Geography of Collaboration

Next we turn to geographical dimension of co-operation, and consider the degree to which this occurs within the region. Co-operation, rather than simple physical proximity, is often regarded as an important aspect of 'clustering', where firms in related activities with linkages supposedly like to be located near to one another. During the survey firms were asked about the location of the bodies with which they cooperate. The data here shows that:

- Firms were much more likely to collaborate with partners (of whatever sort) beyond the region than within the East Midlands.

- The universities were the organisations within the region that had the most respondents co-operating with them on core design and development issues.
- Even here, however, the proportion of firms with collaborative relationships within the region was a small (13%) proportion of the total.
- There does appear to be an emphasis upon university partners in a regional context. The proportion of firms cooperating with universities in the region exceeded that of even clients and customers (which showed the second largest proportion of 11%). At the national level cooperation links with clients and customers were by far the largest group.
- Another large group of collaborators at the national level – consultants – do not feature significantly within the region.
- Only a small minority of R&D firms in Leicester Shire (8%) co-operate with their competitors in the region.

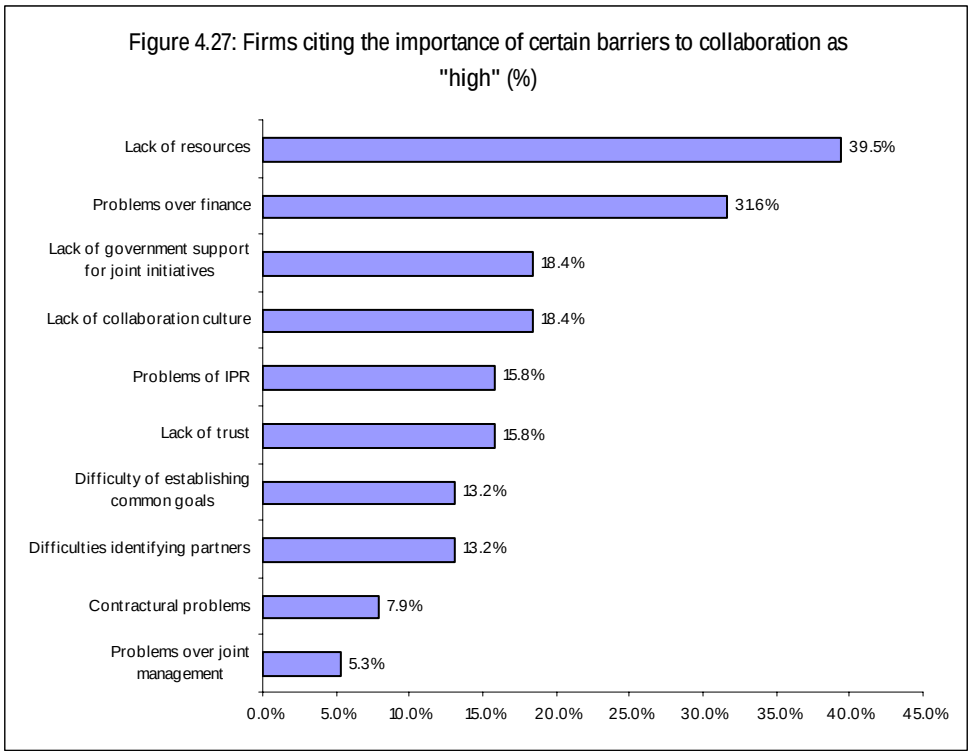
Figure 4.26: Firms co-operating with different organisations for the design or development of products or processes since 2001 by location (%)



Barriers to Collaboration

As regards the main barriers preventing collaborative working, a variety of factors were identified by firms including difficulties discovering suitable partners, and lack of trust (see Figure 3.27). However:

- The barriers that stood out and were mentioned by the highest number of firms as of 'high importance' were lack of resources (almost 40%), and problems over finance (over 30% of respondents).
- Other factors mentioned quite frequently as of high importance here was lack of government support, and lack of a collaborative culture (about 18% of firms each).
- The next most frequently mentioned factors were lack of trust, and problems over intellectual property rights (about 15% each).

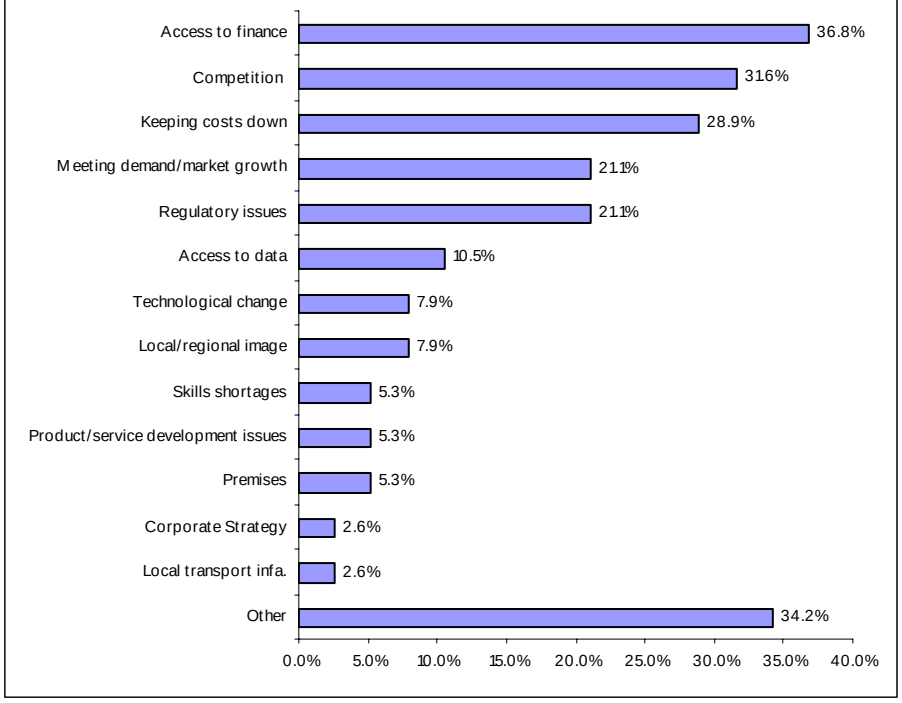


PROSPECTS AND PRESSURES

As part of the process of determining the current condition, pressures and opportunities faced and future prospects, firms were asked to identify the main 'business issues and challenges' facing them at their Leicester Shire site (see Fig 4.28):

- The challenge most frequently identified by respondents was gaining access to finance. Whilst a common issue across the sectors, this is likely to be felt most sharply by new, small firms of the sort identified within R&D.
- Likewise we could expect firms in any sector to be concerned about pressure from competition and the need to keep costs down (the second and third most frequently identified challenges) especially against a background of recent recession.
- The proportion of respondents expressing concern about responding to market growth (the fourth issues) at 21% is relatively small, suggesting that few firms are experiencing difficulties meeting expanding demand as the economic recovery takes hold. The relatively low proportion of businesses worried about skill shortages (5.3%) may reflect current relatively subdued national economic circumstances, but is also indicative of a good supply of labour in the region.
- The relatively low proportion of businesses worried about regulatory issues may reflect their role as sub-contractors of functions from others, and the relatively low involvement in direct manufacturing.
- The relative absence of concern about local or regional image, premises and local transport infrastructure (mentioned by fewer than 8.0% in each case) is good news for economic development agencies and the community more generally.

Figure 4.28: Percentage of firms identifying particular business challenges affecting their business



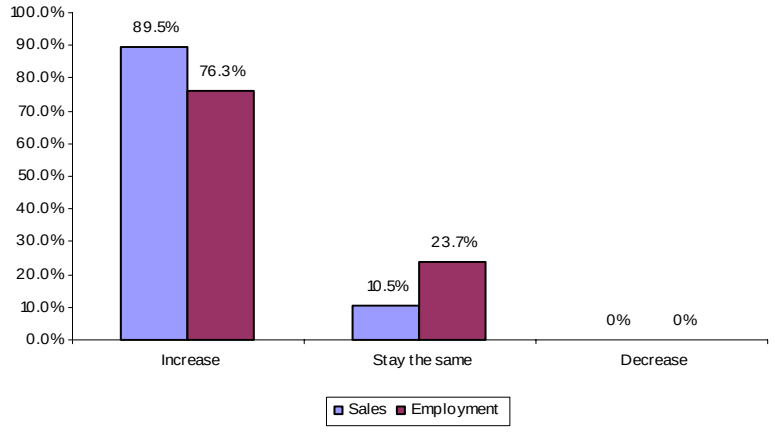
- Otherwise it appears that respondents are not intensely concerned about issues and challenges. Indeed this impression is confirmed by the observation that over 80% of high-tech firms identified keeping down cost as a concern affecting their business. It is also interesting and indicative that cost should have been the main concern for these mature manufacturing firms, whilst R&D businesses are afflicted by problems that afflict new and expanding businesses. Overall the high-tech survey revealed a higher level of concern on most of the above challenges.

Growth Prospects

Respondents were also asked to indicate their views about future expansion in sales and workforce (see Figure 4.29).

- The vast majority of respondents (90%) expected to see sales expand over the next three years, and none expected these to decrease. This is a much more optimistic picture that was found for high-tech manufacturing firms. The prognosis here is therefore strongly positive and is consistent with the current stage of the business cycle, although we should of course allow for a natural degree of optimism.
- The vast majority of respondents also expect this expansion in sales to result in employment increases, albeit at a slightly lower rate (76%), with none predicting job-losses. A further quarter of respondents (24%) expect employment levels to remain stable. Once again, this is encouraging news for policy-makers and for the locality, especially given the local emphasis of recruitment patterns.

Figure 4.29: Prospects for firms' sales and workforces over the next three years



- It should be noted, however, that the disproportionate amount of employment provided by the small number of large R&D firms means that it is the opinions and prognosis for these that is especially important for local economic development at the least in the short or medium term. Encouragingly, however, none of the larger firms employing 50 or more workers anticipated declining employment and half anticipated employment growth.

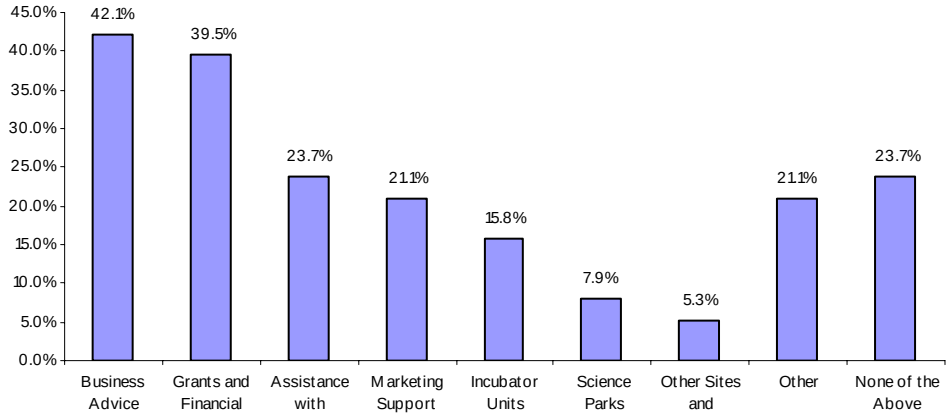
BUSINESS SUPPORT

Types of Support

An important factor in determining the degree to which the local economy is able to act as an effective 'incubator' of new businesses is the quality of the support system. A high proportion of the businesses interviewed had availed themselves of business support, ranging from business advice to sites and premises (see Figure 4.30).

- About 42% of respondents had received business advice, whilst 21% had had advice and support relating specifically to marketing.

Figure 4.30: Percentage of firms receiving different types of public support.

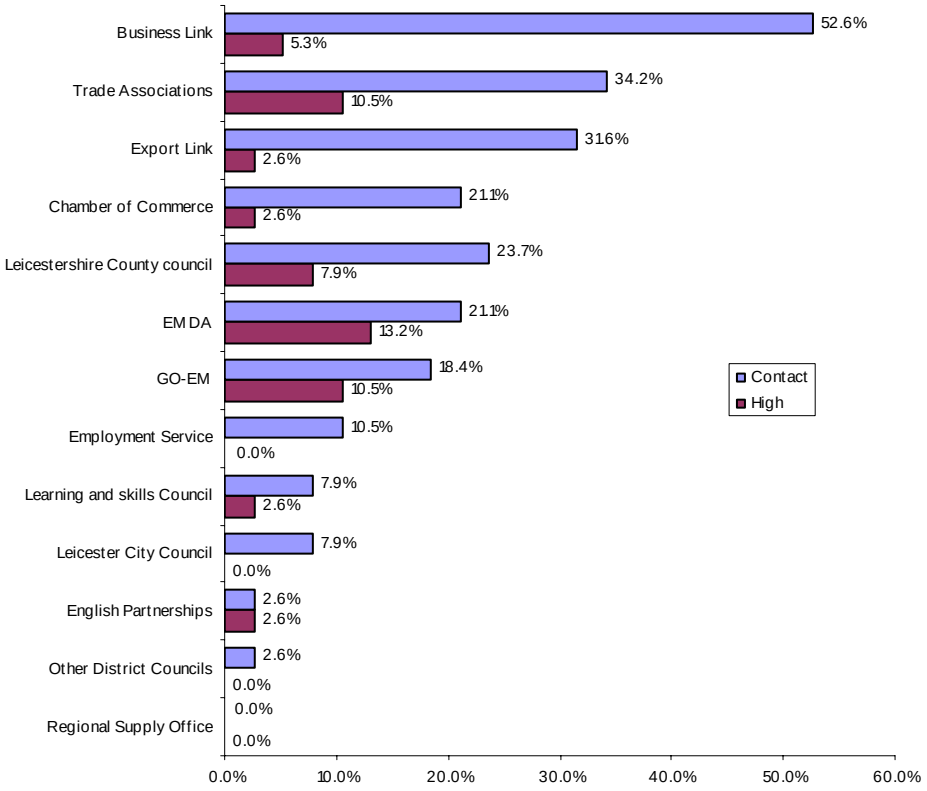


- A high proportion – almost 40% – said they had received grants and financial assistance of one sort or another. This figure does seem high, and may perhaps reflect the links that are known to exist between research and development activities and the 'public sector' in the widest sense, including universities, science parks, research associations, and public procurement.

Business Support Organisations

- A similar observation regarding the familiarity with public agencies can perhaps be made in relation to the extensive use made of specific agencies such as Business Link (53%), Export Link (32%), and Leicester Shire County Council (24%) (see Figure 4.31).
- The highest ratio of 'contact of high importance' to 'simple contact' occurred in reference to EMDA, GO-EM, Leicester Shire County Council, Trade Associations and English Partnerships(1:3 or above).

Figure 4.31: Percentage of firms receiving support from public agencies and the percentage viewing this support as being of 'high' importance



The impression is therefore of a sector that has been able to draw down a considerable amount of support – both tangible (money) and intangible – from its local environment. This situation probably reflects the relatively close and symbiotic relationship between R&D firms and the public sector, with businesses being spun out of the higher education system, or having links with publicly-funded research programmes.

CHAPTER 5: KEY FINDINGS

R&D IN LEICESTER SHIRE AND THE REGION

Strong Regional R&D Tradition

The East Midlands is an important location for both R&D expenditure and employment. In 2002 over £1bn of R&D expenditure was undertaken by regional businesses, and R&D activity supported 15,000 FTEs. This placed the region as fifth largest in expenditure terms and fourth largest in employment terms amongst the UK's regions. It is also apparent that business R&D activity is relatively 'intense' in the East Midlands. In 2001 it accounted for 1.72% of regional GVA (fourth highest of the UK regions) whilst in 2000 business R&D related employment accounted for 0.65% of the regional workforce (third highest).

THE R&D SERVICE SECTOR

Strong Leicester Shire Concentration

Whilst the R&D services sector across the East Midlands as a whole is not especially large, it is apparent that the activity that does exist is predominantly located within Leicester Shire. The sector in the sub-region accounts for over 2,000 of the region's 4,000 R&D service sector jobs - 58.8% of regional employment in this sector - and it is estimated to generate £95.3m of the region's £162m GVA. The effect of this level of concentration is such that the R&D sector forms an important element of the sub-region's economy, providing 0.6% of total employment. This is a level of concentration well above the national rate, where it accounts for only 0.42% of employment and identifies the sub-region as a significant site for R&D sector activity.

Analysis of the sector in Leicester Shire indicates that despite a recent decline in 2001 it has grown rapidly in employment terms since 1995. Its growth has out performed the R&D sector in the region and the UK as a whole. It has also grown at a faster rate than total employment in the sub-region, region and country.

Development of the Cluster

It is possible to identify a number of drivers behind the development of the sector in Leicester Shire.

- A number of firms have arisen to service the needs of local and regional industry. R&D service firms provide materials engineering, structural design and development services for the region's aerospace, vehicles, formula 1, marine and other mechanical engineering sectors. Mechanical engineering students from Loughborough, Leicester and Nottingham universities have in turn supported these firms. A similar process has occurred with the pharmaceutical sector in the region, which supports an associated R&D contract firm base, much of which is located in Leicester Shire.
- It is also possible that the R&D contract sector has been supported by the presence of a strong design sector in the sub-region. This is rooted in the sub-region's textile heritage, and in the strength of De Montfort University's School of Art and Design (Comedia, 2001).

- The sub-region has also benefited from the presence of two "applied industrial research and technology organisations" in PERA and Advantica. These public-sponsored organisations provide sector specific R&D support services and are significant employers in their own right. They have also helped establish a pool of R&D labour within the sub-region, and there are many instances where ex-employees have gone on to establish their own businesses. Likewise, the National Space Research Centre located in Leicester may also serve to support space and aerospace R&D service providers in the sub-region.
- Finally, the presence of three HEIs within the sub-region has played a significant role, not only in providing facilities and graduate recruits for these firms but also, more recently, through their ability to spin-out R&D firms.

SURVEY FINDINGS

Firm Characteristics and Performance

The sector has a high proportion of micro and small firms, but is dominated in employment terms by a small number of very large employers. This last feature distinguishes the sector in Leicester Shire from other counties in the region. It also suggests that the development of employment in the R&D sector in the sub-region is not (at least over the short term) rooted in the area's capacity to generate a profusion of small firms, but in its ability to either grow or attract a small number of large firms. Employment levels in smaller firms appear to have suffered in the recent economic down turn whilst those of the larger employers have grown.

R&D Activities and the R&D Value-Chain

R&D service firms do not participate significantly in basic research, but focus instead upon the use of existing knowledge to create new, or improve existing, products, materials and processes. Most if not all firms interviewed were involved at several stages of the R&D value-chain. The stages which were mentioned most, and which took most firm time, were the 'designing' and 'testing' of products and processes. Indeed there was a discrete sub-group amongst the responding firms that focused solely on testing activities. However, firms are also deeply involved in what might be called 'product conceptualization', with some 60% involved in devising products, and 73% also undertake prototyping activities.

The data also shows that a significant proportion of firms spend time manufacturing, indicating (as noted earlier) that R&D and manufacturing (although regarded as different stages in the value chain) are not necessarily segregated from one another at a corporate level. R&D firms should not be regarded as simply supporting the innovation processes of clients, but are involved across a series of links in the value-chain, and appear to be more proactive in converting their research activities into their own products.

Firm Formation

The survey data indicates that the sector is relatively young, with the great majority of firms having been founded since 1990. This identifies it as a dynamic sector with the potential for growth. The presence of a large number of micro firms further supports this possibility.

These firms have emerged through a variety of different formation processes, ranging from traditional start-ups to business spin-outs. Whilst most were 'traditional' start-ups by independent individuals or partners, the proportion of higher education spin-outs is particularly impressive, and indicates the capacity in local universities for generating viable business ideas. There is also some evidence that the proportion of higher education and business spin-outs increased during the 1990s, and the proportion of public sector spin-outs declined. Whilst the 1980s may have been the high-point of privatisation, the late 1990s was a period in which the emphasis of government policy switched towards encouraging higher education involvement in the generation of businesses.

In terms of firm numbers the sector is predominantly local in origin, with some 84% of responding businesses being first established in the sub-region. But in terms of employment we find that there is a tendency for this to be concentrated in larger firms that have moved into the area. Whilst incoming firms represent only 13% of all respondents, they comprise some 50% of firms employing over 50 workers, and have therefore played a very significant role in the development of the sector. It should be noted, however, that incoming firms within the sample were generally UK based rather than foreign direct investors.

Linkages and Outputs

The linkages through which R&D firms operate can be examined via the destination of their outputs, and via the characteristics and origins of their inputs, including knowledge, skills, and partners. The emphasis amongst sampled firms was upon selling to the UK market as a whole rather than to the regional market. Although a majority also sell their services locally within Leicester Shire, this generated a small percentage of firm turnover. We do not therefore see a sector which, because it provides services rather than tradeable goods, is strongly local or regional – rather than national or international – in its emphasis.

Linkages and Inputs

A vital aspect of firm activity in this sector relates to intellectual property rights (IPR). Most firms were giving attention to the protection of their intellectual property rights through one mechanism or another. The various mechanisms that firms employ to ensure that, for instance, their designs are not copied or their data resold include confidentiality agreements, secrecy and trust. The focus is generally found to be upon particularistic or 'relational' techniques as opposed to more cumbersome, impersonal or universalistic techniques – such as patents, copyrights, trademarks.

The ability of firms in different sectors to find the skills they need locally is an important issue for local economic development. The survey examined the degree to which R&D firms were experiencing recruitment difficulties, and it was found that most firms (63%) were experiencing no recruitment difficulties at all. This encouraging picture needs however to be tempered by a recognition that these firms have recently shed labour, and are emerging from a recent recession amongst their manufacturing clients.

As regards specific skill issues, almost a quarter of respondents had difficulties finding technicians, and recruitment difficulties were experienced in reference to the broad set of marketing skills (selling, marketing and customer care) by 21% of firms.

Difficulties were also experienced by some firms (18% and 13% respectively) in recruiting people with business development and professional engineering skills.

Networking and Collaborative Working

A further dimension of linkage is the degree to which firms collaborate with other businesses in their core design and development functions. As regards cooperation in general, irrespective of the location of the partner, it was found that the vast majority of businesses have in the last two years co-operated with clients or customers in the design or development of new products or services. A significant majority has also co-operated with universities, and half have co-operated with consultants. Collaborative linkages were also frequently sustained with suppliers, government research establishments, and commercial laboratories.

The degree to which co-operation occurs within the region is often regarded as an important aspect of 'clustering'. But our data shows that firms were much more likely to collaborate with partners (of whatever sort) beyond the region than within the East Midlands. Universities were the organisations within the region that had the most respondents co-operating with them on core design and development issues, and there does appear to be an emphasis upon university partners in a regional context. At the national level cooperation links with clients and customers were by far the largest group. Only a small minority of R&D firms in Leicester Shire co-operate with their competitors in the region.

The Business Support Environment

An important factor in determining the degree to which the local economy is able to act as an effective 'incubator' of new businesses is the quality of the support system. A high proportion of the businesses interviewed had availed themselves of business support, ranging from business advice to sites and premises. In particular, almost 40% said they had received grants and financial assistance of one sort or another. This figure is very high, and may perhaps reflect the links that are known to exist between research and development activities and the 'public sector' in the widest sense, including universities, science parks, research associations, and public procurement. There is also evidence of extensive use of specific agencies such as Business Link, Export Link, and Leicester Shire County Council. The impression is therefore of a sector that has been able to draw down a considerable amount of support – both tangible (money) and intangible – from its local environment.

Issues, Challenges and Prospects

In general the level of concern over particular business issues was low and firms were on the whole highly optimistic with regard to their future, with the great majority anticipating increases in both sales and employment. The vast majority of respondents expected to see sales expand over the next three years, and none expected these to decrease. The prognosis here is therefore positive and, even allowing for a natural degree of optimism, is consistent with the current stage of the business cycle. The vast majority of respondents also expect this expansion in sales to result in employment increases, with none predicting job-losses. Once again, this is encouraging news for policy-makers and for the locality, especially given the local emphasis of recruitment patterns. As with many small firm sectors, problems relating to access to finance, competitors and keeping cost down were those most frequently mentioned.

CHAPTER 6: POLICY CONSIDERATIONS

We have seen in preceding chapters that R&D sub-contracting is significant for economic development because it represents a knowledge-intensive value-added activity in its own right, and because it can contribute (in various ways) to the supply of innovation to other firms. It does therefore make sense for policy-makers to value such activity within their area, to seek to support it, and where possible to promote its further expansion. It also makes sense for these policy-makers to take steps to ensure that the potential benefits of R&D are actually derived by the local economy.

THE DEVELOPMENT OF THE R&D SERVICES SECTOR

Leicester Shire has so far been quite effective in developing its R&D sector, and it is useful for policy purposes to remind ourselves how this has come about:

1. From a *demand* angle, the growth of R&D services is linked to the more general expansion of the 'knowledge economy', which is itself an expression of the increased technical complexity of goods and services – and so of production processes – and the increased sophistication of consumers. These are circumstances that are likely to continue developing and are not easily influenced locally, even though they are reinforced by local initiatives that enhance training, boost employment, and (for example) give enhanced access to broadband.
2. From a *supply* angle, the Sub-region has a significant number of *micro-firms* that have been spun-out of two types of 'host' organisation – from Higher Education Institutions, and from larger private sector enterprises – by entrepreneurs who by virtue of their positions within these organisations were able to spot market opportunities. The survival and expansion of these firms, where it can be achieved, will make a significant contribution to the local economic climate as well as to employment.
3. Also from a *supply* angle, the Sub-region has a relatively large population of *large R&D firms*, which make a major contribution to R&D employment, and have originated through the privatisation of public services and publicly sponsored research activities, together with the de-merger of these from – and their re-merger with – multinational capital. In some – perhaps half – of these cases the firms concerned have moved into the area, and in most cases there is an involvement of non-local (national but sometimes multinational) capital.

Boosting the Supply of Firms

In order to strengthen further the local R&D services sector, steps must be taken to sustain inward investment, and to sustain the birth and expansion of small firms.

To sustain and perhaps boost the supply of new larger R&D firms within Leicester Shire it is important to:

- Continue the process of attracting inward investment or inward technology transfer, and to target R&D and related firms against a background of understanding the needs of the sector, and perhaps of identifying potential local partners.
- Continue a strong after-care service to those R&D businesses that have invested in the area, to pre-empt any issues that might lead them to consider relocation.

- Present Leicester Shire as an area that is successfully growing a strong R&D sector and provides a climate conducive to its further development.

To sustain and boost the supply of new smaller R&D firms within Leicester Shire it is also important to:

- To continue to support the process of spinning R&D firms out from the local Universities, and from private sector (and other public sector) sources.

This may involve a renewed emphasis from university managements, and enhanced links between universities and EMDA as well as the County Council and other agencies. Part of this process would involve raising the recognition and profile of the local R&D sector for each of these policy-making agencies. It would also involve opening channels of communications with larger manufacturing firms in the vicinity, informing them of the local success in generating a specialist R&D sector, and of the assistance that may be available to ventures that may be spun-out to form independent R&D businesses.

Creating Conditions for Growth

In addition to the circumstances that gave birth to firms, we also need to remember the circumstances that are sustaining the local presence of these R&D firms – whether by enabling them to survive or by encouraging them not to relocate. These circumstances seem (from the evidence of Chapter 4) to include:

- the quality of the transport infrastructure in the locality;
- the quality of local accommodation for such businesses including science parks;
- the quality and quantity of a well qualified local and regional labour supply;
- the availability of financial and other forms of business support for spin-outs;
- the conducive regional industrial structure from which R&D – or an R&D friendly environment – can be derived.

At present R&D firms are quite satisfied with the facilities available within the region and Sub-region, but *there obviously is a need to keep building on success*. The significance of accommodation – in for example science parks – as well as the quality of the local labour supply, cannot be exaggerated in helping to generate R&D activity. Communications with firms in all size brackets – for example through cluster consultation networks – can be a way of helping to match their evolving requirements.

There is some evidence to suggest that new firms spun-out from larger organisations such as HEIs are highly vulnerable over their first few years, and that even if they survive they often find it difficult to expand from having one product to having a range. There may therefore be tendency for these ventures to close after a few years, and so it is important to ensure that support measures are in place to enable these new micro-firms to survive and expand.

- In this context more research is needed to understand these processes, particularly in relation to the increasingly important area of HE spin-outs – not only in the R&D sector but across the totality of HE spin-out activity.

THE DEMAND FOR R&D SERVICES

Boosting Demand for R&D Services

To boost the value of the R&D sector to the local economy it is important to:

- Enhance the ability of local SMEs and larger firms to benefit from R&D generally, including R&D performed within the area. The expansion of outsourced R&D provides an opportunity for smaller manufacturing firms to undertake R&D when they could not afford the necessary laboratory and other facilities themselves.

It may be that initiatives along these lines are occurring already, but we know that SMEs are inhibited in their use of R&D for skill and resource reasons. In this context it will be important to:

- Ensure that local firms of all sizes are informed of the R&D facilities that are available locally and nationally. It may also help to provide training to local SMEs on R&D sub-contracting, and to open channels between these firms and major R&D firms nationally.

CONCLUSION

Recognition of the importance of the local R&D services sector to the locality and region, together with the more specific issues identified above could be addressed (in dialogue with the businesses and public agencies concerned) by:

- Establishing an R&D cluster group, perhaps under the aegis of EMDA's prioritisation of innovation

This group should address the development of both R&D in general across the regional economy, an activity in which the region has significant strengths, and also the R&D services sector in particular. This should be tied in with efforts to make regional actors aware of the presence of an R&D agglomeration, and to draw their attention to its importance for the sub-region and region.

GLOSSARY

ABI	the Office of National Statistics Annual Business Inquiry
Applied Research	is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.
Basic research	is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
BERD	Business enterprise R&D
Contract R&D	"work of an innovatory nature undertaken by one party on behalf of another under conditions laid out in a contract agreed formally beforehand" (Ringe 1992, p.2).
CRTO	contract research and technology organization, including firms that comprise the R&D service sector.
Experimental development	systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.
Extramural R&D	R&D which firms pay for but is carried out on their behalf by another organisation.
FDI	Foreign direct investment – inward investment
FTE	Full-time equivalent – the number of employees measured in these terms
GovERD	Government R&D
GVA	Value added is the balancing item in the production account for an institutional unit or sector, or establishment or industry. It measures the value created by production and may be calculated either before or after deducting the consumption of fixed capital on the fixed assets used. As stated above:

	(a) Gross value added is defined as the value of output less the value of intermediate consumption; (b) Net value added is defined as the value of output less the values of both intermediate consumption and consumption of fixed capital.
HERD	Higher education R&D
HEI	Higher education institution
Intramural R&D	R&D which a firms carries out for itself.
KIBS	knowledge intensive business services
NOMIS	National Online Manpower Information System
ONS	Office for National Statistics
R&D	**"**Research and experimental development comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of knowledge to devise new applications" ('Frascati Manual', OECD, 1994).
RTO	Research and Technology Organisation. Provider of specialist R&D services. Usually based on formerly public sector research institutes.
SIC	Standard Industrial Classification

APPENDIX A: FIRM CASE STUDIES

COMPANY A

The founder originally moved to Leicester Shire to work for PERA (the Production Engineering Research Association), but then became settled in the area. His background is in bonding materials and bonding technologies, and he is a chartered engineer. The firm is a limited company for which he is the only employee. From 1980 to 1987 he developed PERA's role in research and development, but left during a period of reorganisation and set up his own business. In the first instance he was supported in this, not by PERA top-management but by an ex-colleague there who channelled some work in his direction, and by one of the sponsors of PERA, a multinational company that needed some technical support and provided a retainer over several years.

There are no strong business linkages within the area, and the initially sponsoring multinational company was based in Croydon. He has customers who are Australian or German or American companies, but they all have a base in the UK. Most of his clients are large companies although occasionally he works for firms with fewer than 250 employees. He uses Loughborough University for some research activities, because of their specialities and facilities such as laboratories, but also Peterborough Technical College and Oxford Brookes for some chemical testing. He has some commercial collaborators in the sub-region, such as a firm which is run by someone who is an ex-colleague from PERA. There is also collaboration with a consultancy practice in Shrewsbury that used to be located in Peterborough. These links appear to have developed as a result of his presence in the area rather than being the cause for this presence. He argues that in any collaboration there will be a lead partner and therefore a contractor/sub-contractor relationship. He sub-contracts work out to colleges, and vice versa as well as to other consultants. His networks include networks of collaborators with whom there will be a contractual relationship, and a network of peers within the Institute of Mechanical Engineers' Consultants Group, which mainly provides moral support.

Sometimes his job involves developing a concept that has been conceived by somebody else, turning it into a technologically viable product, working alongside specialists from the client firm. This might involve doing the design of specific elements of the product, developing the testing methods, doing a product specification and developing a process specification for the manufacturer: "so at the end of the day I did a full report on the process, developed the process, developed the product, designed a product, defined how we were going to do it, what materials we were going to use, the range of materials that were suitable". But sometimes he is involved at the inception of the concept. An example might be the development of a method for bonding the inside of a railway train, removing all the welding and other fixing methods and applying production techniques from the aircraft industry. In this case he was involved in designing the concept, selecting the materials to be used, costing and doing the basic technical drawings. The task also involved mapping all of the technologies involved in producing a railway carriage and showing the relationships between all of these diagrammatically.

His unique contribution lies in the combination of marketing, technical and design skills which enable him to go from one end of the value chain to the other, from the inception and marketing through to production engineering and implementation issues. He generates knowledge himself during his research contracts, and learns from each project. He avoids all issues to do with intellectual property rights because of the costs of lawyers. He also feels that clients have difficult in keeping up with him technically, which enables him to defend his particular knowledge. He does become involved in commercial confidentiality agreements, but relies upon a relationship of trust with clients. Hence he has a relatively narrow client base of firms with whom he has established a relationship. He does not sell intellectual property rights or licences or patents but provides a hands-on service which involves hiring out his time. His aim is to leave the client self-sufficient, which may involve training someone there with the skills needed.

There is a problem with the physical isolation of being an R&D consultant in Melton Mowbray, where there are few others with whom one could collaborate. He says he has problems accessing information such as reference books, because it is difficult to use the university libraries. He has found collaborating with Loughborough University difficult because the institution may not be geared to helping individual consultants, and there may be a degree of competitiveness at work.

COMPANY B

The business is about twenty-two years old, and is a government supported spin-out from the Royal Aircraft Establishment at Farnborough, for which it did remote satellite sensing. Initially they had 100% government funding, but this gradually declined over a six-year period to zero, at which point it was a commercially independent firm. Although originally concerned exclusively with satellite imaging, by the mid-1990s they acquired an airborne photography side by purchasing a business in Leicester Shire, which has subsequently expanded. About four years ago the ownership of the firm was transferred to the UK arm of a giant Franco-German firm that contributes to the production of Airbus, Eurofighter, satellites and other aerospace products.

The company has 150 people based on the two sites (Leicester and Farnborough), and much of the design work is done in Farnborough whilst most production has been moved from Farnborough to Leicester because of high rent levels in the former area. They have retained their Farnborough office to be within a region that has a strong aerospace and IT base. In Farnborough they house their systems engineering group that produces the specialist software needed for handling geographic data, which involves skills that are impossible to find outside of the M3/M4 corridor. Also there they have a data processing and archiving facility which is operated on behalf of the European Space Agency. The office also has very fast internet access of 34 megabytes per second, for which the kind of cabling needed is not available in Leicester.

They are keen to identify collaborators, and will look for pieces of software they need from other firms if they can. If they want to improve upon a piece of software they will contact the supplier and ask if the latter would like to collaborate in producing an upgrade. Collaboration may also be used to enter different geographic markets, via local agents who may have their own businesses. Partnership agreements may be set up, and perhaps a consortium will be put together to deal with a big project. They have a very large number of agreements with other companies, which are there to enable them to either develop a new product or to enter a new market geographically or to pool resources in competing for work. Generally speaking the companies with whom they collaborate are so specialised that hardly any of them are in Leicester Shire. However, the respondent said that his role as technical director means that he is responsible for exploring links with universities in the region, including Nottingham and Leicester (each of which have courses that are relevant to their business). The other organisation with which they have linkages is the National Space Science Centre in Leicester, of which they are a founding sponsor, and would like to move to the high-tec science park around the Space Centre when this is completed. As regards clients in the locality, once again these do exist but represent a very small percentage of the total client base.

Generally they devise their own products, which take the form of different kinds of data, although in some cases they do sub-contracted work for organisations such as the Ordnance Survey. An example of a product would be a dataset including satellite images of particular parts of the earth. When sub-contracted to do something, such as survey a length of motorway to a high degree of accuracy, then they will send out their airborne sensors and process the data so that the client is provided with maps and other files. Another example of a product would be ‘clutter’ map, which would be a very high resolution imagine of an area in which all the objects on the ground are classified and all of the buildings measured in their height, for the purposes of a telecommunications company that wants to site a mobile phone mast. Most of what they produce is part of the R&D activity of their client companies, even if from their point of view the data products have separate design and production stages.

The biggest innovation the company is currently involved in is in geographic data hosting. This enables websites to provide maps that can be zoomed into to give high or low resolution images of particular locations, and involves having a large archive of data sitting on a computer somewhere that is organised to respond in different formats. The end product may be a DVD which is automatically despatched to the client. Here the company has developed

the entire system itself. Much of what the company does can be best described in terms of the creative industries' value chain, and they are involved throughout this value chain from inception to dissemination, archiving and training the audience. When they produce a database of UK aerial photography, say, then they will collect the data, process it, compose it into a single set, sell licences to use that data, store the data and host the system (where the data is sold as pieces), and undertake the sub-contracted work to build such systems. Most of the data is licenced to the client. Sometimes the data is somebody else's so they licence the interpretation of data that has been licenced to them by the original provider.

They supply all market sectors from agriculture through utilities to insurers and the defence industry. They have perhaps 3,000 clients at any point in time, who will be all over the world, half in the UK and half split equally between Europe and outside of Europe. Straight forward maps and data can now be produced much more cheaply in India, so they must move into more value-added activities such as products tailored to particular market niches or to very high specifications. The existence of a large parent company is a great advantage because they will provide the finance to enable the development of new products. Their parent company has very good links with the European Space Agency, which enables them to gain work for this Agency. They also get involved in helping the parent firm to produce the specifications for future satellite systems that they manufacture. The company came out of the public sector, and the public sector is still probably its biggest client. The parent company has good links to the EU and to the ESA, and the EU has also been a good source of contracts.

The products may incorporate knowledge from three or four different sources, such as geological analysis, systems engineering (writing specialist software), hardware networking, specifications for satellites, knowledge of archiving, plus they bring in consultants to work on specialist issues. The business has in particular a kind of meta-knowledge, the ability to combine all these specialist knowledges, as well as the more standard professions and disciplines that business must have such as accountancy, marketing, general management, human resources, etc. They protect their knowledge through IPR quite strongly, so that all staff sign a non-disclosure contract, and every contract with a client will have terms and conditions attached. Most often the IPR or whatever they deliver stays with them. If a firm needs the IPR in order to protect exclusivity over a particular piece of knowledge (such as an oil company over maps over a particular area), then they may sell this at a premium to the firm concerned. IPR issues are difficult though because every product is different and requires a different definition of what exactly is being protected and how.

Much of the software they use is very specialised and there are few if any training courses available so they will organise training, hiring the provider to come and deliver this. Training may also involve sending people to conferences and making sure they stay with what's happening amongst the competition. Accountancy training is being sourced locally in Loughborough. The firm likes the East Midlands, because of the M1 and East Midlands airport as well as Birmingham airport, but include the non-electrification of the Midland main line, and the absence of an adequate fast data cable provided publicly or through NTL to the region as problems with their current location. They use East Midlands airport as a base for their two aircraft and fly their data-gathering missions from there.

COMPANY C

This firm was formed in 1992 in Leicester Shire. It was a start-up founded by three local businessmen, two of whom had worked at PERA directly prior to forming the business. It now employs around 20 full time workers at its temporary site north of Leicester. The firm initially provided mainly technical consultancy services but now operates as a direct provider of science and technology R&D services. It has also switched its client focus away from DTI and EU funded programmes, key sources of funding in its early years, towards international business clients from a range of engineering-related sectors. The core business activity is the design and development of "composite" materials, principally thermo-plastic and thermo-set composites used in the transport, marine, building, energy and utilities fields.

The firm provides a range of services spanning every element of the pre-manufacturing product development process relating to the use of composites. It can provide commercial and technical feasibility studies; undertake product design, structural analysis and modelling; undertake material selection and performance; and develop prototypes. It can also identify and develop processing techniques, component manufacture and tooling methods. Finally, product evaluation studies are also provided. Testing is done through leading universities or testing bodies such as the Leyland Truck Centre. The firm does not manufacture products directly but it is associated with a number of spin-off firms with manufacturing capabilities, and with sub-contractors.

The firm generates income directly from R&D projects and also from the exploitation of the resulting IP. About 35% of the project related income is generated from national or European state funded programmes. The firm has a funding model for project payment running along a continuum from a fixed fee for a particular project through a combination of fees and IP ownership through to the receipt of no fee and but more substantial IP rights. It runs an active programme of selling licences and patents and establishing spin-off businesses. This proactive approach to IP exploitation is a key feature of the firm and it is generally unwilling to undertake R&D activities where it feels it is unlikely to generate IP for itself. To date it has spun-off five businesses based on the IP generated from its R&D projects, four of which it retains shareholdings in. The parent firm also has a joint venture with a Canadian business, has two other spin-outs in the pipeline and also owns a number of patents with a range of international utilities firms which it is currently attempting to exploit. A former employee has also established an independent company and the firm has also spun-out a non-technology business – a science and technology recruitment firm. These businesses are at the centre of the firm's networking activities, providing testing, prototyping, recruitment and other services when needed.

The firm undertakes R&D projects through three main methods. Firstly, it will undertake an entire project itself. Secondly, it will work within a network and provide some technical input. In these circumstances it will frequently project manage across the network. Finally, where it lacks specific technical knowledge, it will undertake project management tasks on behalf of a collaborative R&D network. Every project is governed by a specific collaboration agreement covering the project requirements, payment arrangements and ownership of any resulting IP. Wherever possible this is done without reference to formal legal frameworks as the firm instead favours trust as a method for overseeing projects. Network members are selected on the basis of the firm having a "track record" of some form with a particular firm or institution. Trust is built by working repeatedly across networks of the same firms and organisations. The firm does hold a number of patents but sees this method as a costly, time consuming and not wholly secure means of protecting its IP, particularly when one considers the resource implications for a firm of its size in seeking to defend patents against multinationals.

It favours the network approach within R&D projects and avoids acquiring competences in-house when this is expensive and time-consuming. Rather, it operates from a relatively small core competence base but is able to identify rapidly other organisations with the necessary competencies for particular projects and involve these in exchange for certain IP rights. This

approach gives the firm enormous flexibility that allows it, despite its size, to operate at the cutting edge of its technology field and to service major international corporations. The exchange of IP rights and the use of trading within its networks act to motivate partners and strengthen relationships. Universities such as Loughborough, and especially Nottingham and Sheffield, are at the core of these networks. Large firms and multinationals also participate within these networks. This provides the SMEs with access to facilities that otherwise would be beyond their resources whilst giving larger firms a degree of flexibility. Despite the link with local HEIs, geographical proximity is not a factor in the construction and operation of these networks, indeed many of the firm's collaborators are international. There is a focus on identifying excellence within particular fields of technology rather than simply working with partners that are local.

The core competences the firm does possess in-house are rooted in mechanical engineering with a particular emphasis on mathematical and computational skills. The firm also stresses the importance of project management and inter-personal skills, and prioritises these over pure technical ability as they serve to underpin the networking approach of the firm. The firm is also of the view that research findings are best communicated to, and exploited by, third parties, not through reports and codified outputs but through people. The firm actively places its employees within client companies in order to transfer research-based knowledge, this further emphasises the importance of inter-personal as well as technical skills. The networking philosophy of the firm implies that it does not prioritise the need to expand its knowledge base by learning new skill sets. As the technical director argued, "What we are very, very good at is networking and the reason why the gestation periods are so short is that we are not learning, we seek people out who have already learned the lessons and we integrate". It seeks to maintain and update, rather than grow, their knowledge base. This is done principally through the hands-on nature of company networks in which firm employees are constantly in contact with leading firms and institutions. It does not run significant in-house training programmes though it will on occasion receive on placement HE students or employees from other firms with particular skill sets who are then able to train existing employees. Likewise it will also send employees on placement to leading firms or organisations to develop certain skills. These types of arrangements are often secured on a 'trading' basis. The Internet is also seen as a valuable tool for supporting its knowledge base.

The firm is not a user of local business support services and is critical of the mainstream services on offer to SMEs which it feels do not operate with the necessary speed required by businesses such as itself. Local training provision standards were also felt to be low. There were three areas, however, where it felt public bodies could support its activities. Firstly, state bodies, particularly universities, have large, often under-used technical facilities that could be utilised by the science and technology SME base if they were made more accessible. Secondly, the cost of premises is seen as a major barrier to business development, and this firm is currently experiencing particular premise problems. Finally, the quality of graduates emerging from HE is not felt to be of a high enough standard. Many science graduates lack the basic fundamentals of science and mathematics. It was this concern that led the firm to establish its own recruitment agency.

COMPANY D

The firm was spun-out of School of Mechanical and Manufacturing Engineering at Loughborough University in 2001. It was established in order to commercialise a number of product ideas developed by staff members within the School in the previous years. Founded by two university staff members who continue to be employed by the university, the firm also employs a senior employee with no connection to the university. It currently employs three staff members. The securing of a DTI SMART award supported the establishment of the firm. The university provided the necessary match funding to obtain this finance.

The core business activity of the firm is the commercialisation of sports technologies concepts. It devises product concepts, develops them through a range of design processes and then constructs working prototypes. Finally, it will convert prototypes into full 3D CAD models. At this stage it will then seek to patent the product concept. On the basis of these activities, and with the protection of the patent, it then prepares presentation materials and attempts to identify an exploitation partner with whom to develop a licensing deal. Recent deals have been secured with firms such as Reebok. It then generates income through the resulting royalty stream. This model has been used for a small number of products and the firm intends to grow its revenue by replicating this approach and establish licensing deals with a larger number of firms.

Product ideas are developed from within the firm itself and also through staff members in their research activities within the university. The university therefore provides the firm with an R&D capacity and IP generating potential – research facilities and equipment, PhD students and student projects, other university staff members – that would not be available to similar non-HE affiliated SMEs. For the first two years of the firm's existence it has been involved in-house development and marketing and licensing negotiations and has only recently begun to secure licensing deals and establish a steady income stream. This period, in which cash flow has been minimal, would have been significantly more testing for the firm had it been operating outside of the university. Its relationship with the university and the tangible and intangible benefits it receives has therefore protected the firm from much of the real cost of the R&D process and have allowed it to operate for a number of years without having to secure the significant level of alternative investment that would have been required in a purely commercial context.

The firm also undertakes a limited amount of contract work whereby it will evaluate existing product concepts developed by third parties. In these situations patents are often already in place. If sufficient commercial potential exists it will develop the product and seek licensing deals along the lines of its core business model outlined above. The firm rejects approximately two thirds of third party concepts and works under non-disclosure agreements in these early screening stages. Payment for third party work of this type is in the form of a project fee or a share of the resulting royalty streams. Third parties often approach the firm as a result of the significant degree of media coverage it generates around its activities, a situation it actively cultivates. The firm tends to service a national market in this line of its business. Whilst the firm has no specific policy to grow this side of its business and views its core business as being based around its own product ideas it is nonetheless likely to maintain this activity as it is relatively low risk and the commercial returns are potentially significant.

The knowledge base of the firm is rooted in the sports science and mechanical engineering expertise of its founders. This is complemented by the commercial sports background of its non-HE employee. The firm also draws on the resources and capacities of other staff members and students in the university. It also collaborates with a London-based firm that has significant design and presentation capacities. This form of co-operation occurs in the latter stages of the development process and covers the development of final CAD based designs and presentation materials that are then used in efforts to secure a licensing deal. On the one major project where this co-operation has occurred the partner firm received a minority shareholding in the firm. Patents are a further source of knowledge used by the firm. They

help provide inspiration for design solutions and also support the firm's market research as they can be used to identify trends within particular segments of the sports technologies market and also help in the identification of competitors or preferred partners.

Whilst not directly using public business support services, the firm has benefited significantly from the public sector through its relationship with the university. Loughborough University has a strong track record in spinning-out firms and the experience of this firm has been positive. The firm has also been able to access premises on the innovation park adjoining the university. Whilst there are some obvious economic benefits including jobs and income that have accrued to both the university and the local economy, there are also a number of more subtle yet potentially equally important outcomes. These include the manner in which the firm has been able to involve its commercial industrial partners within the academic activities of the university. A number of research programmes have been funded through this mechanism as have a number of PhD places. This process therefore generates additional research funding for the university and associates global firms with the School. These are important additions to the financial and academic viability and success of the university.

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