

---

# ***Knowing How, Knowing Whom***

**A Study of the Links between the Knowledge  
Intensive Services Sector and The Science Base**

---

**July 2003**

## Executive Summary

### Background

Knowledge Intensive Services (KIS) are of increasing importance to the UK economy. They are dynamic economic sectors in their own right. They contribute to the economic performance of the whole economy, by providing industrial and consumer services that are required for manufacturing and other sectors to operate and reach their markets effectively.

As the name implies, these are services based heavily upon professional knowledge. This knowledge concerns very different domains across different KIS. Though, like all services, they will require a great deal of knowledge of their specific clients and markets, and of how to interface with clients and "translate" professional knowledge into something that the clients can use, there is almost always a strong base of domain-specific technical knowledge involved too. This may concern, for example, scientific and engineering subjects, the business environment, or administrative and regulatory structures. We might thus expect these to be sectors with strong links to the science base in Universities, where research and training on all of these topics is underway.

Furthermore, the received wisdom that it is primarily the manufacturing sector that is the source of innovation has been overturned in recent years. It is now widely accepted that services can be source of innovations, as well as their users - and, in the case of some KIS, agents for technology transfer to other parts of the economy. Indeed, many KIS report high levels of innovative activities in survey studies dealing with innovation. If arguments about the emerging knowledge economy are correct, KIS will be increasingly subject to competitive pressures to undertake more innovation. Links to the science base should be important to this objective.

Very little existing research has tackled the topic of KIS and the science base. Similarly, policies for fostering such links have received little attention, even while the general topic of academic-industry links has risen in prominence. More general studies of University-industry linkages do have some useful points to contribute, but the present study is exploring new territory with this specific focus.

### Survey Analysis

The report draws on several sources of information. **Survey research** proves very useful. We present secondary analyses of the data from the third Community Innovation Survey (CIS3). This survey covered a range of KIS, and some other services, as well as manufacturing industry. A number of points emerge strongly.

KIS are very diverse. There are huge differences across various subsectors, and within these, between large and small firms. (Small firms are more prevalent in most service sectors – financial services are an exception – than in manufacturing.) KIS are prone to employ much higher proportions of graduates than are other sectors. This is in itself justification for calling them "knowledge-intensive". Some KIS are focused more on Science and Engineering graduates. Some draw more on other types of graduate (including but not exclusively social scientists), as would be expected given their different knowledge bases. These links with the science base are very strikingly documented in the quantitative data. Our interview results, summarised shortly, suggest a rather more complicated picture than these simple statistics indicate.

The survey data tell us a different story when it comes to using Universities as a source of information and a collaboration partner in innovation. Universities are rarely used as information sources, and even less often collaboration partners, by most firms, whether in KIS or not. The science base lags behind private sources of knowledge.

Here, services in general, and most KIS, tend to lag behind manufacturing in general, and especially behind the more innovative, high-tech, areas of manufacturing. There is one major exception here, a set of technical services (contract R&D and testing services). These services have outstandingly closer links to the science base than do other sectors. At least, this shows that KIS can nurture and be sustained by such links! The picture is very different for other KIS, even in activities such as IT services, where the technical content is high. The structure and functioning of these "anomalous" technical services is a topic that requires further research. Unfortunately the CIS3 data can tell us little about their origins – how many are ex-public sector or spin-offs, for example.

Returning to KIS in general, there are suggestions that the issue is not simply that they lack a need for knowledge. If anything, there is a tendency for services, and KIS, to be more oriented than manufacturing firms to private sources of knowledge, and less to public sources.

Small firms are much less likely to have links with the science base than are larger ones, in all sectors. Services may be said to have a "double deficit" here, with both size and sector telling against them. There are indications from the survey analysis that those firms that do manage to engage in good linkages with Universities, as sources of information or as collaborators, are more likely to be dynamic and successful innovators. Thus there are likely to be benefits from closer linkages - even if these are not currently recognised by many managers, especially those in smaller firms.

## Interview Research

**Interview** and other qualitative research was undertaken to gain a deeper understanding of the dynamics of KIS relations with the science base. These included interviews both with KIS firms and with parties in the science base. Four KIS were studied in some detail. These included long-term insurance, business continuity, marketing and environmental services.

Graduates may be a large share of the staff of KIS, but this does not mean that most KIS firms pursue much of the way of a strategy in recruiting them. Specialist technical knowledge required for many KIS activities is simply not seen as a major function of University training, though there are exceptions here. Some sectors use Universities considerably for professional development and accreditation purposes (often in combination with professional associations) - but many do not. With a few exceptions where very specific technical skills were sought to allow a KIS to tackle a particular problem, the tendency in the sectors we studied was to treat University degrees as signifying general capability and commitment. Thus market research firms may be keen to gain social scientists and statisticians, but they showed little interest in recruiting people whose courses were more tightly specified to their business activities. (We are aware that in some other KIS sectors there may be more recruitment of people with relevant degrees, however.)

Smaller firms are less likely to recruit new graduates. They tend to seek individuals who have gained professional experience in the industry itself. Larger firms are also far more liable to have articulated strategies for graduate recruitment. They may develop strategic relationships with selected parts of the science base for this purpose, or more generally. Even in these larger firms, however, recruitment of graduates rarely involves people with skills specifically related to the domain problems of the KIS.

In line with the survey analysis, an outstanding result was that very limited use was made of Universities as sources of information and expertise. Collaborative partnerships were even less common. A few of the larger firms in other KIS sectors do engage in research-related linkages, and others scan the information outputs of academics and attend meetings that span academia and industry. Professional associations are liable to play a bridging role.

One feature of the qualitative results was that the links between KIS and the science base are two-way. It is not just a matter of knowledge flowing from Universities to industry. Some KIS firms supply inputs to teaching and curriculum design, and may be playing important roles in building up University capabilities in several emerging areas. Some are engaged in helping to guide research programmes and centres, and in formulating questions that deserve analysis. These two-way links appear to be particularly valuable ones, and it would be worthwhile to explore some cases of good practice here in future research. They do, however, only involve a minority of KIS firms (and of potentially relevant University staff).

On the "supply side", the interviews suggested that there has been little targeting of KIS as sectors with whom links need to be built, though there are a few signs that this is changing. Collaborations can be fruitful to academics in terms of providing access to industrial information and research challenges, as well as simply adding to research funds. There is again evidence that bridging institutions, and opportunities to work in research networks and centres, can make it easier for initiatives to be taken from the side of the science base.

## **Conclusions**

Industrial, technological and economic change is likely to make it more important for many KIS to forge better links with the science base. These sectors have inherited relatively poor linkages, in the main. But there are various ways in which the science base could respond to the challenges that confront KIS, and thus help to support the continued dynamism of these parts of the UK economy.

This is liable to be a matter for intermediary associations and research centres rather than of individual academics. (That said, there may be changes needed in the reward structures to individuals). Industry often prefers "one-stop shops" where a broad body of relevant expertise is concentrated (or networked). However, change is not a matter for the science base alone. Many firms are reactive in terms of innovation, and have little sense of the relevance of the science base.

They also have little awareness of programmes to foster academic-industry links. Our interviews often elicited requests for more information about such programmes and about University activities more generally. Major new schemes to foster linkages might be important. But given the very limited awareness of existing schemes at

present, it may be more of a priority to put effort into raising awareness of these, and targeting them more to KIS.

## Contents:

<b>EXECUTIVE SUMMARY .....</b>	<b>2</b>
BACKGROUND.....	2
SURVEY ANALYSIS .....	2
INTERVIEW RESEARCH.....	3
CONCLUSIONS.....	4
<b>CONTENTS:.....</b>	<b>6</b>
<b>INTRODUCTION.....</b>	<b>7</b>
<b>1 SERVICES AND INNOVATION .....</b>	<b>8</b>
<b>2 KNOWLEDGE INTENSIVE SERVICES .....</b>	<b>13</b>
3.1 KIBS.....	13
3.2 LINKS TO THE SCIENCE BASE.....	16
3.3 THE PRESENT STUDY .....	16
<b>3 SECONDARY ANALYSIS.....</b>	<b>17</b>
4.1 THE CIS3 .....	17
4.2 EMPLOYMENT OF GRADUATES.....	17
4.3 THE SCIENCE BASE AS SOURCE OF INFORMATION FOR INNOVATION.....	25
4.4 THE SCIENCE BASE AS COLLABORATOR IN INNOVATION .....	32
4.5 INNOVATION PROBLEMS .....	35
4.6 CONCLUSIONS FROM SURVEY ANALYSIS .....	36
<b>4 INTERVIEW AND QUALITATIVE RESEARCH – KIS FIRMS.....</b>	<b>37</b>
5.1 SECTORS .....	37
5.2 QUESTIONS .....	37
5.3 INTERVIEW RESULTS.....	38
5.4 CONCLUSIONS .....	56
<b>5 PERSPECTIVES FROM THE SCIENCE BASE.....</b>	<b>58</b>
6.1 UNIVERSITIES.....	58
6.2 INDIVIDUAL ACADEMICS .....	63
6.3 RESEARCH CENTRES .....	64
6.4 RESEARCH PROGRAMMES .....	65
6.5 RESEARCH COUNCILS .....	68
CONCLUSIONS.....	72
<b>6 CONCLUSIONS.....</b>	<b>73</b>
<b>REFERENCES.....</b>	<b>77</b>

## INTRODUCTION<sup>1</sup>

What are the links between the knowledge intensive services sector and the science base? How do these differ from those in other sectors of the economy? Could there be obstacles to such links that limit their contribution to these important sectors of the economy?

This report sets out the initial results and conclusions of a study of these and related topics. It has been undertaken for the Council for Science and Technology, by researchers from the newly-formed Institute of Innovation Research at the University of Manchester/UMIST.

The main objectives set for the study involved improving our understanding of:

- ◆ How knowledge-intensive services (KIS) interact with the science base to enhance their innovative performance.
- ◆ How and how far generic R&D requirements and opportunities – and similar possibilities for related activities such as standardisation – are identified; to what extent and by what means is this effected (individually, through industry mechanisms, etc.); how and how far the identified requirements are met, and opportunities pursued.
- ◆ What role research work conducted within the science base plays here; when and how it is drawn upon, what intermediaries may be involved, etc.
- ◆ What the experience and views of KIS are, concerning governmental measures for supporting links between them (and collaborations they are involved with) and the science base in support of innovation.
- ◆ Specific barriers that KIS experience in drawing on the science base for business purposes, suggestions for overcoming these.
- ◆ Perspectives from the science base on these issues.

The study proceeded through a mixture of literature review, secondary survey analysis, and interview research. The present document reports on the results of these lines of enquiry. This is intended to form a basis for discussion with the Council for Science and Technology, other policymakers, and with members of the KIS community and relevant parts of the science base.

---

<sup>1</sup> This summary report was written by Ian Miles, drawing on interview research performed by Gloria Barreto, Kieron Flanagan, Lawrence Green, Sarah Jackson, Andrew James, Khaleel Malik, Graham May and; and on secondary survey analyses by G M Peter Swann and Bruce Tether. We would like to thank the Advisory Panel on this study for very helpful comments on an earlier draft of this report.

# 1 Services and Innovation

It was long the received wisdom that services were laggards in terms of innovation. Services were unlikely to adopt new technological practices, or slow to do so. The innovations they did adopt were ones pioneered by the manufacturing sector. In the jargon of innovation studies, their innovation was “supplier driven”. Organisational innovation was perhaps more common in services. This might build on scale economies – for instance in the case of supermarkets, with their innovations around self-service and layout. In this view, services’ links with the science base would be expected to be very indirect. Manufacturers would be the ones to create or process the difficult technical knowledge. Manufacturers would create products that the service firms could use with relatively little difficulty – telephones, vehicles, typewriters, etc. The skills required to **use** such devices rarely required much technical knowledge or input from the science base.

This received wisdom has now largely been overturned.<sup>2</sup> “Services innovation” has become a very active field of study. In the process several issues have come to the fore:

- ◆ The received wisdom never applied well to such technology-intensive services as railways and telecommunications firms. Often these ran their own laboratories (for instance British Rail in Derby, BT in Martlesham). They often devised and specified innovations, acting as leaders of the cluster of smaller manufacturing firms who supplied them. They also drew upon the outputs of specialised graduates from university engineering departments. They made use of relevant government laboratories such as the National Physical Laboratory at Teddington, and participated actively in international technical fora relevant to their businesses. Some services, then, have always been both technologically innovative and connected to the science base.
- ◆ Some services have always been technology-intensive. But new specialised technology-related services have risen to prominence in recent decades. The contract R&D sector accounts for some 10% of UK business R&D; for instance. New service firms are evident, supporting the development and diffusion of new technologies such as software, biotechnology, and new materials. Technical, engineering and IT services are prominent users of new technology and agents of technology support and transfer across the economy. Many do more than just transfer knowledge, and generate their own new knowledge and innovations in the course of providing solutions to their clients.
- ◆ Services innovation has been stimulated by the availability of new Information Technology (IT). Such generic innovations as PCs, mobile telephones, websites, and so on are widely adopted in services. Indeed the lion’s share of IT investment comes from service sectors, and many graduates in activities such as telecommunications engineering have been absorbed by financial institutions in particular. The technology-intensity of many branches of services has soared with the uptake of IT, and the rapid adoption of IT-based innovations has been hard to ignore.
- ◆ It is not just a matter of being enthusiastic adopters of new IT – services have often proved to be ‘lead users’ and IT innovators in their own right. Especially when we move beyond its most basic applications IT can be complex and demanding to use, demanding some skill simply to use efficiently. Effective use requires the user to be innovative too. It is necessary to explore how business processes could be rethought so as to exploit new technical potentials. Different elements of IT systems

<sup>2</sup> See, for example, Miles (2000b) and other essays in that issue of the International Journal of Innovation Management.

have to be configured together and aligned with (new) business practices. Appropriate software and interfaces have to be selected or designed. Hardware and software have to be managed and maintained. Services have had to acquire more technical knowledge, and in the process some have become more innovative.

- ◆ Finally, we have seen a dramatic process of concentration around a few large firms in some services, despite the prevalence of small firms in most service sectors. Large-scale services, such as supermarket and financial groups, are often active innovators in their own right, even if they do not always have traditional R&D departments. (Innovations are more often managed on a project basis, with ad hoc teams put together for the purpose.) They face fierce domestic competition, are often active in international markets and also face the prospect of overseas entrants in the UK market. There is also cross-sectoral competition, often supported by technical innovations (e.g. supermarkets offering financial services, cable TV companies offering telephony).
- ◆ Additionally, such large service firms frequently have important impacts on their supply chains. They are in a position to influence manufacturers as to the sorts of equipment they require (e.g. cards and cash machines) – similar in many ways to the case of the large technology-intensive service firms discussed in the first bullet point. They can also dictate to manufacturers and other suppliers concerning the sorts of products they supply for retail (e.g. specific sorts of foodstuff and farming and manufacturing processes). These large firms may define the ecommerce and logistics systems to be used in supply chains. They may fund their own research into infrastructural issues (e.g. refrigeration and security systems). Thus their influence extends quite widely across the economy in innovation activities, as well as in more cultural and narrowly economic affairs.

For reasons such as these, the topic of services innovation has risen up the agenda for both innovation studies and for innovation policy. It has become more widely recognised that many services are innovative. This includes technological as well as organisational innovation. Evidence has been sought on services innovation, and indeed has focused on technological innovation, where survey instruments are fairly well-established. This research has progressively confirmed the basic points made above, while providing richer understandings of them.

The general picture emerging from analysis of innovation surveys and other research material confirms that some services are highly innovative. Others, however, do put less effort into innovation-related activities than comparable manufacturing firms. There tend to be differences in the organisation of innovative effort, too, with relatively less emphasis on 'R&D' in most services; and, as mentioned above, less use of standard models of R&D management.

In this report we examine data from the Community Innovation Survey (CIS) for the UK, in chapter 4. Analyses of earlier CIS data for the whole EU<sup>3</sup> have indicated that the proportion of innovators is highest amongst the technology-oriented services, such as IT services and technical services. Their reported innovation levels are comparable to high-tech manufacturing. More traditional services (such as wholesale and transport services) appear to be relatively infrequent innovators. However, there are limits to such survey studies. The measures of innovation they employ are very simple ones, and may be especially problematic for services. They do not give much scope for examination of organisational innovation or innovation through the use of technology. Definitionally, the indicators of innovation and R&D are meant to capture activities such as delivery innovations and software

<sup>3</sup> The most recent CIS survey is the third (CIS3). Cross-EU data on CIS2, which was the first attempt to cover services on this scale, are analysed by CRIC/IDSE/ISE, 2001.

development. However, case study work suggests that many service firms do not think to cite such activities when asked about technology development.<sup>4</sup> (It will be interesting to see how far the introduction of R&D tax credits leads to a reconceptualisation of these activities on the part of service firms.) There may be some underestimation of innovative activities and expenditures.

Nevertheless, some services do seem to be lagging in terms of innovation. This does not seem to be entirely a measurement problem, nor simply the result of the smaller size of most services firms. Services *are* innovative, some being among the most innovative parts of the economy – but on the whole, it appears that many services do lag behind comparable firms in most other sectors in terms of innovative effort. Part of the explanation may lie in the low-tech heritage of many service firms and sectors. As discussed above, they did not require great levels of technical expertise to be competitive, even when this required adopting technologies that were diffusing from manufacturing industry. With little need to customise these innovations, or develop them further to meet service functions, they undertook little R&D (we have already noted that service firms have rarely established organised R&D management structures - even highly innovative services firms rarely have formalised R&D departments, though there are exceptions in some firms in areas such as software - and the absence of specialised departments does not necessarily equate to the absence of the activity of 'R&D' – though it is often not thought of in those terms within the firms in question)

Another consequence of this is of considerable relevance to the current study. This is that most services remained poorly linked into technological innovation systems. The heritage is one of limited flows of knowledge about technological opportunities and good practice in innovation, into and among services firms

One instance of this comes from a study of participation in the UK Technology Foresight programme in the mid-1990s (Miles, 1999). Services in general seemed to be less active in the programme, and to come to it with fewer linkages to other players in technological innovation. Even among a set of innovative firms, the manufacturing firms sampled were typically twice as likely as the service firms to be aware of, or participating in, Foresight activities. Examining Panel activities, the more service-related Panels tended to have difficulty in accessing expertise. Traditionally technology-intensive services (like transport or telecommunications) did not find this such a problem. But other services generally emerged as poorly linked into innovation processes and networks. (For instance, we can consider the types of people enlisted in to their Delphi surveys. The service Panels had low shares of responses from industrial R&D staff and managers, with more input from marketing and other managers.<sup>5</sup>)

The implication of this line of argument is that the flows of information from innovation systems into services may be relatively underdeveloped. This may well contribute to a low pace of innovation, and a low level of innovation-related activity, in many services. It could be that this is not such a problem, of course. Perhaps the core tasks of many services are not really amenable to the application of technological innovations – the human touch remains central, or the degree of customisation is too high for automation to be readily introduced. Or, perhaps limited competition is still

---

<sup>4</sup> Cf. Coombs & Miles, (2000).

<sup>5</sup> The Health & Life Sciences Panel made an interesting exception, with unusually high numbers of academic researchers, and also a relatively high share of industrial R&D staff. This may indicate close links between leading-edge University science and the industry, which other evidence suggests is the case. It could also signify that several subdisciplines are active here, with more or less industrial and public health orientations.

experienced in some service sectors – many services are serving very local markets, for instance, and services trade, while growing, still remains at a relatively low level<sup>6</sup> - means that there is little stimulus for innovation in the first place. These arguments have some force, and contribute to explaining why services have poor linkage into innovation systems. But this does not lead to the conclusion that such poor linkages are inevitable. There are also grounds for thinking that change is in any case likely to come – and for arguing that it should be encouraged and fostered. These are:

- Even where the core activities of services are not really ready for automation, there may be a great deal that can be accomplished by the application of new technologies to surrounding elements of the service process. Interactions between supplier and client – specification and design of the service, exchange of data on client characteristics and requirements, ordering and booking, delivery and aftersales support, etc. – can often benefit from the application of new IT, in particular.
- In many sectors it is the larger firms that are making the running in such innovations, with smaller firms often finding existence far more precarious. Perhaps this is an inevitable feature of the maturation of industries. But there would seem to be considerable scope for many smaller firms to make dynamic use of new techniques (e.g. websites, mobile communications) were they to have access to technical intelligence and support, and associated organisational innovations.<sup>7</sup> Given the high levels of employment in such services, and their contribution to the health of local and regional economies, there may be a case for linking them more effectively to innovation services and systems.
- Competition, and international competition, is growing in many service sectors, and can be expected to intensify as a result of European integration and World Trade Organisation processes. Many UK firms are liable to face competition from new entrants, which will bring innovative practices into local markets and generally increase pressures for new or more efficient ways of conducting business. Others may find their innovative assets (or lack of them) affecting their leverage in forming global partnerships. Innovation is seen as a fundamental feature of the knowledge economy, and one that raises challenges for all sectors.
- Finally, services are confronted by redrawing of boundaries. Not only are service companies challenged by other services moving into their markets (as in the case of supermarkets offering financial services). Manufacturing firms are placing more emphasis on service elements of their activities and markets. Sometimes they vertically integrate services into their businesses (e.g. Sony's acquisition of music and cinema firms). Sometimes they are redefining themselves as service operators (e.g. ICL/Fujitsu offering not only business IT solutions and software, but also educational products). What is more, many services face competition from "self-service" products that aim at meeting the same consumption ends as do services – laundries and launderettes have been hard hit by washing machines, for instance. The high pace of innovation in consumer goods of various sorts means that such products may provide stronger competition for service firms – which these firms will need to respond to by innovations of their

---

<sup>6</sup> Miozzo and Miles (2003) explore some of the links between services trade and innovation. They warn that ordinary trade data should be treated with care, since much of the internationalisation of services takes place through investment, mergers, franchising, etc., due to such factors are the difficulty of transporting many services.

<sup>7</sup> For instance, there is a considerable learning curve to go up in order to effectively design and use websites, though there are some notable cases of small firms making striking use of such tools for e-business. There are also substantial organisational shifts required to maintain and integrate such facilities into business processes. Many small firms find these challenges insurmountable. But it is conceivable that support services could take much of this load off the small firms, providing locality- or niche-based tools and operations to fairly large numbers of small clients.

own. (For example, the cinema industry has had to change its offerings considerably to meet the challenges of TV, videos, DVDs, etc.)

Thus there are many reasons to think that services will find themselves under increasing pressure to innovate, and to link themselves into innovation systems. There are big questions about the capabilities both of services and the science base to respond rapidly and effectively to such pressures. This study represents an effort to examine one facet of these questions.

The discussion above has concerned services in general. Repeatedly it has drawn attention to the *variety* presented by the services sector, and *diversity* in the nature and extent of the involvement of different kinds of services, and different firms, in innovation processes and systems. Often certain Knowledge-Intensive Services have emerged as exceptions to the generalisations that have been made. This study is focusing on KIS sectors, and it is now time to consider these in more detail.

## 2 Knowledge Intensive Services

**Knowledge-Intensive Services** cover a range of industries. Statistically defining service industries is reasonably straightforward – standard industrial classifications readily identify service sectors (in addition to, and distinction from, primary extractive sectors, and secondary sectors of construction, manufacturing and utilities).<sup>8</sup> Services fall into a number of major groups, such as distributive services (transport, wholesale and retail, etc.), FIRE (financial and real estate), HORECA (hotels, restaurants and catering), public and community services, etc. It is immediately apparent that these span a huge range of activities, from caring for people to repairing goods, from providing consultancy to delivering newspapers.

Knowledge-intensity is somewhat harder to define. All economic activities are in one way or another knowledge-based, of course. But what is typically implied in discussions of the knowledge-driven economy, and similar ideas, is that there is considerable reliance on specific sorts of knowledge. These involve more than simply skill, “know how” and craft knowledge, acquired and transmitted informally or on the job. The emphasis is on more professionalised and systematically organised knowledge, much of which is produced and reproduced through Universities, professional institutions, and other elaborate institutions. One way of identifying knowledge-intensive businesses, then, is through the extent to which they rely upon skills drawn from such institutions. In chapter 4 we examine data on the proportions of employees who are graduates - this can serve as one such indicator. Knowledge production also takes place in firms, and it is common to use indicators such as the level of patenting to identify the degree of such activity. Unfortunately, patents have traditionally been inapplicable to many services innovations, so the use of this indicator is even more suspect here than it is in manufacturing.<sup>9</sup>

The analysis in chapter 4 is based on CIS3 data for the UK. It suggests that, in terms of shares of graduates among employees, certain service sectors are quite outstanding. As we would expect, some financial services are among this group, and can be justifiably seen as KIS. The other outstanding cases are a range of professional and technical services that happen to be mainly oriented to serving other businesses.<sup>10</sup> Such **Knowledge Intensive Business Services (KIBS)** have attracted a great deal of analysis in recent years.

### 3.1 KIBS

KIBS utilise high levels of highly specialised knowledge to provide support to business processes in other organisations.<sup>11</sup> Many of the traditional professional services make elaborate use of social and institutional knowledge. Other KIBS are more centred on technological and technical knowledge.

A typical purpose of **traditional professional services** is helping their clients deal with complex social systems. These include:

<sup>8</sup> This is not to say that these classifications are ideal. There are many anomalies – reflecting ambiguity about what constitutes a service as opposed to a manufacturing or production activity.

<sup>9</sup> In manufacturing there are large variations in patenting across sectors and countries that seem to have more to do with firm strategies and market conditions than with absolute levels of research effort or knowledge production.

<sup>10</sup> More accurately, they service *business processes*, since their clients often include public service and voluntary organisations, as well as private firms.

<sup>11</sup> The classic definition is in Miles et al (1995).

- 1) *institutions* especially administrative rules and regulations (e.g., legal and accountancy services);
- 2) less formally organised *social groups and interests* (e.g., marketing and issues consultancy services);
- 3) *psychological and biological systems*, (e.g., medical and veterinary services, educational and clinical psychology and psychiatry, counselling, etc.);
- 4) *elaborate artefacts of a (traditionally) low tech nature* e.g., architecture and building services).

The relationship of traditional professional services to new technology is typically that of **users of innovation**. For instance, they very often make heavy use of new IT to support their white-collar activities - e.g. to search for, organise and present data. They are less likely to be generators of innovations, especially technical ones; nor are they prominent as **agents** in the further development and diffusion of such innovations. Even here there are exceptions:

- Some professional services have considerable technical content. This applies to many members of groups 3 and 4 above. Their knowledge content may include technical knowledge about physical or biological systems, the properties of materials, and technologies applied in domains such as construction. Sometimes these firms play an important role in fostering diffusion of innovations among their clients and partners (e.g. architects specifying new materials to use, vets prompting research into animal diseases and treatments).
- There are often cases where traditional professional services firms come to specialise in supplying software and other products to users and/or to other firms in their own sectors. Examples include some producers of accountancy software, Web services for advertisers and their clients. Such services are liable to be increasingly influential shapers of new technology, as their professional experience with the technology grows.

Professional services may of course be innovative without necessarily focusing on technological innovation. There is much scope for innovation in terms of the products of many professional services – new types of auditing and consultancy product and process, for example. In such cases, there may be scope for links with social and managerial, as well as scientific and engineering, parts of the science base. Little is known about such linkages. The present study investigates them through survey research in Chapter 4, through more qualitative research in Chapters 5 and 6.

Other KIBS are more focused on **technology** from the outset. Some new services are directly based on new technology applications. For instance, Web and Internet, software and computer services help their clients to use the new technologies more effectively. Other technology-based KIBS are more involved with the production and transfer of knowledge about new technology (for instance, information and training services often play such roles). Yet others are centrally focused on technology development – many technical and engineering services, especially those engaged in contract R&D and design, and some testing services.

Services exist to support users of all types of technology. But the knowledge requirements for technology users are bound to be more challenging where new technology is involved. New technologies are often complex and demanding, until ways have been found of rendering them more user-friendly. The knowledge necessary to understand, master, and utilise the new product and process opportunities provided by new technologies will be less readily available. KIBS can thus help supply knowledge when and where it is needed. They are frequently associated with applications of generic technologies like IT, biotechnology and new

materials, and with emerging problem-driven issues (like environmental or so-called “clean” technology).

Annexe A discusses what are, and are not, KIBS in more detail. But another point about these sectors needs to be highlighted. The typical case in service sectors is that there are a small number of large firms and a very large tail of small firms. In some sectors, such as retail, there is a huge number of microbusinesses and family firms. But this is also true, if to a slightly less marked extent, in some professional services like accountancy and some consultancy and IT services.

In general, numerous surveys have suggested most small firms to be relatively noninnovative. They are also likely to be relatively low on professionally qualified staff. This picture is likely to apply to many traditional services. In KIBS, the situation is more ambiguous. Small KIBS will be professional-heavy. Often a one or two-person operation is comprised exclusively of people with professional qualifications. As the size grows, secretarial and similar capabilities are liable to be added – and these are sometimes graduates too. (Impressionistically, this becomes less likely as the firm size grows, and clerical staff are not expected to take on PA/Information Officer and similar roles: these become the domain of specialised staff.) The smaller KIBS are often not very innovative, however. Many small firms in KIBS sectors are servicing local markets, often with fairly standardised or routine products. But there are notable exceptions. Some very small KIBS operate in niches for innovative products. Sometimes they even service global markets. (For example, we know of a two-man computer security software firm with major clients in financial services round the world.) These are typically start-ups and spin-offs that are not necessarily destined to grow into large firms. While some do (for instance, what was ten years ago a two-man consultancy spun out of a University policy research group now has offices in half a dozen European countries), others are content to stay small (the security software firm being a case in point). Still others may eventually be incorporated into a larger firm through merger or acquisition.

At the other end of the size spectrum, the knowledge-intensity of individual companies may buck the sectoral trend. Sectors that are overwhelmingly not knowledge-intensive often contain exceptional cases. Usually large firms are involved here, though it is not uncommon to find a firm that offers a good deal of consultancy or research support nestled within a category of more operational services. The exceptional firms feature high numbers of professional staff, high levels of R&D or innovation expenditure, etc. The sectoral classification of a firm can sometimes be misleading as concerns its status as a KIBS or more generally a KIS business.<sup>12</sup>

---

<sup>12</sup> It could also be helpful to outline a distinction between “knowledge-intensive” and “knowledge-driven” businesses. Consider two large companies, each with high levels of shop floor or front office staff, who tend to have few formal qualifications. Neither will appear to be knowledge-intensive in terms of the share of graduates in their workforce. But one could be more knowledge-driven, investing more into technology and organisational development, and reshaping the work processes and the products supplied to customers accordingly. This might differentiate between, for example, different supermarket companies – or between high-tech and low-tech manufacturing sectors.

### **3.2 Links to the Science Base**

There have been many studies of academic-industry links in general, but few have specifically addressed KIS links. A useful task for future work might be to examine some of the results and data generated in these studies. We might pull out the specifically KIS linkages captured in such studies – what types of KIS firm and sector uses which University knowledge resources, and how?

One study has addressed the topic of how the UK Insurance Industry has been accessing knowledge relevant to the topic of Predictive Genetic Testing. Cutts et al (2001) found that insurance companies were highly dependent on external knowledge to inform them about developments in this area. The new technology may challenge standard underwriting principles, but it is far from clear how this may evolve in practice. Intermediaries and professional associations proved to be the most important sources of information for insurance firms in general. Participation in conferences and seminars was the companies' most important way of communicating in this area. Large firms tend to place more importance on gaining information, and on communicating it, than do small ones. Large firms seem to be rather pro-active in this field. Such firms are actively running in-house programmes to up-date their actuarial models so as to take account of the new developments. They are also co-operating with University departments, even to the extent of setting up joint research centres and programmes. The rationale for such co-operation was not entirely clear to the researchers; they suggest that it may reflect the high uncertainty about future technical and regulatory developments and their implications.

The importance of firm size is a theme that will be echoed in our own analyses. We address the insurance industry in particular in Chapter 5.

### **3.3 The Present Study**

The present study combines secondary survey analysis (Chapter 4), and original interview research and archival analysis (Chapter 5 and 6) to examine the use made of the science base by KIS. It is very much an exploratory study of this field, though a number of reasonably firm conclusions can be reached.

### 3 Secondary Analysis<sup>13</sup>

This Chapter draws on the results of a survey designed to investigate processes of industrial innovation. These allow us to investigate KIS' links to the science base through graduates as a source of employees, through information sources, and through collaborative arrangements for innovation. We find that KIS are heavily dependent upon graduates. Most KIS are relatively low users of the science base in other ways, however. There is a notable exception in Technical Services, where there are unusually strong links.

#### 4.1 The CIS3

The UK's third Community Innovation Survey (CIS3) is the most recent of a series of statistical examinations of innovation processes. It was administered in the year 2001. Originally restricted to manufacturing firms, more recent versions of CIS have been extended in reach. CIS3 provides 8,172 responses from enterprises engaged in primary, secondary and tertiary sector activities. Note that these data do not cover all sectors – indeed, they omit many non-Knowledge Intensive services, such as retail and personal services – and the public sector is not included. It is important to note, too, that the data do not cover very small firms (less than 10 employees). This means that the bulk of service firms in some sectors are being overlooked, and any generalisations are based on larger cases. Nevertheless, the picture is very revealing.<sup>14</sup> We will present results dealing with the entire spectrum of industries covered – [Box 4.1](#), outlines the sectors discussed below.

Let us now move to examine the survey data, and what it tells us about these industries – especially the KIS – and their links to the science base.

#### 4.2 Employment of Graduates

This topic gives us insight into the definition of KIS, as well as depicting one important link between firms and the science base. The CIS3 allows us to examine the extent to which different types of sector and firms sampled are reliant on graduate staff. This is an indicator of the use of certain types of qualified knowledge. As such, it is limited in various ways. For instance it gives no hint as to the quality of on-the-job and other professional training (some of these issues could be addressed from employee-level data such as the Labour Force Survey, or the European Working Conditions Survey). Nor does it tell us about the extent of use of higher levels of qualification. The production of graduates is liable to be one of the main contributions from the science base to industry. However, not all graduates are connected to the science base, since many graduates could be from arts and humanities subjects. The CIS3 data tell us about Science and Engineering (S&E) graduates as compared to other graduates – but this category will exclude social science graduates, and their contributions may be important to some KIS.

---

<sup>13</sup> This section draws extensively on work done by Peter Swann (Manchester Business School) and Bruce Tether (CRIC).

<sup>14</sup> 44% of the service sector and 61% of manufacturing sector respondents to CIS-3 were classified as having technological innovation activities.

### **Box 4.1 Sectors analysed in CIS3 Survey Data**

#### **Services activities**

These involve five main groups, the first four of which contain many KIS. The contents of these groups and some interesting subgroups are set out below.

- ◆ **R&D and Technical Services**: SIC92: 73.1; 73.2; 74.2; 74.3. This group is subdivided into
  - ➔ **TS1: architectural, engineering and related technical consultancy** (i.e., SIC 92 74.2)
  - ➔ **TS2: R&D and technical testing.**
- ◆ **Computer and Telecommunications Services (IT Services)**: SIC92: 64.2; 72.1 – 72.6; plus ‘reproduction of recorded media’ - SIC92 22.3. This group is subdivided into
  - ➔ **IT1: computer services** (excluding the maintenance and repair of office equipment)
  - ➔ **IT2: other IT services.**
- ◆ **Financial Services, incl. renting and letting**: SIC92 65.1 – 67.2; 70.12; 70.2; 71.1 – 71.4. This group is subdivided into
  - ➔ **FS1: services relating to banking, insurance, pensions and property trading**, and
  - ➔ **FS2: renting and letting services.**
- ◆ **Professional Services, including publishing, estate agencies and property development, and travel agencies**: SIC92: 22.1; 63.3; 70.11; 70.3, 74.1. This group is subdivided into
  - ➔ **PS1: qualification services** (i.e., legal and accountancy services),
  - ➔ **PS2: informational services** (publishing, estate and travel agencies, market research and opinion poll surveying),
  - ➔ **PS3: managerial / organisational services** (i.e., management and management consultancy, and travel organising).
- ◆ **Transport and Storage, incl. postal and courier services**: SIC92: 60.1 – 63.2; 63.4. This group is subdivided into
  - ➔ **TR1: passenger transport services,**
  - ➔ **TR2: freight transportation and storage,**
  - ➔ **TR3: other transport related services** (not relating exclusively to passengers or freight).
- ◆ **Wholesaling: WS**: SIC92: 51.1 – 51.7.

#### **Non-services**

Manufacturing activities can usefully be classified according to the OECD’s ‘classification of manufacturing industries based on technology’ (Hatzichronoglou, 1997; OECD, 2001).<sup>15</sup> This demarcates four classes by technological intensity (i.e., **High Technology Manufacturing (HTM)**; **Medium-High Technology Manufacturing (MHTM)**; **Medium Low Technology Manufacturing (MLTM)**; and **Low Technology Manufacturing (LTM)**). The ‘Construction Industry’ (SIC92 45.1 – 45.5) was classified separately. Those engaged in ‘extraction’ (SIC92 10.1 – 14.5), ‘recycling’ and ‘the utilities’ (SIC92 37.1 – 41.0) were combined into one category (‘Extraction, etc.’)

<sup>15</sup> There are two minor modifications made here. ‘publishing’ (SIC92 22.1 – n. 90) is here reclassified as a ‘Professional Service’, and the ‘reproduction of recorded media’ (SIC92 22.3 – n. 6) is reclassified as an Information Technology Service.

Figure 4.1 vividly illuminates the variations in knowledge-intensity across sectors (with no adjustment for the different size distribution of firms within sectors). The Figure plots the proportion of firms in each sector employing graduates (horizontal axis) against the median employment of graduates among these employers. Not surprisingly the two are correlated – in sectors where firms are more likely to employ graduates, these employers are also likely to have higher shares of graduates among their staff. Something about the business that they are in requires high inputs of the sorts of capability that graduates possess.

Some of the Information Technology and Technical Services are revealed to be exceptionally frequent, and intensive, employers of graduates. More professional services are somewhat less frequent, and markedly less intensive employers of graduates – but even then, on this measure their knowledge-intensity appears high compared to manufacturers and such services as transport and wholesale.

Seven of the KIS sectors appear to be very knowledge-intensive, with more than four-fifths of firms employing graduates, six have more than one-fifth of their staff composed of graduates. Only high-tech manufacturing attains such high levels of firms with graduates, and the shares of graduates in these firms is considerably lower.<sup>16</sup>

Let us move to examine the two broad classes of graduate that are differentiated in the survey data. Tables setting out the overall results from the UK CIS3 are presented in Annexe B (Tables B.1. B.2). Here we work mainly with graphical displays of a number of Figures.

#### 4.2.1 Science and Engineering graduates

Figure 4.2 is similar to Figure 4.1, but focuses only on S&Es. It vividly illustrates variations in use of S&E-based knowledge across sectors. In terms of *numbers of firms* employing S&Es (horizontal axis), few of the services sectors considered here approach the levels displayed by high tech manufacturing, (86% of HTM firms employ S&Es). However, one service does rival HTM. 87% of 'Technical Services 2' firms (engaged in R&D and related activities) employ S&E graduates. This is not surprising, but several other service sectors exceed the levels for medium high tech manufacturing (71%).

When we consider the *shares of S&E staff* in the sectors (vertical axis), the picture is different. Presumably this is because these service firms have fewer nongraduate production and related operatives compared to their manufacturing counterparts.<sup>17</sup>

High tech manufacturing employers of graduates have only a median of 8% of their employment constituting graduate S&E share. Many services have much higher levels.<sup>18</sup> Particularly notable is "Technical Services 2" (50% median), with "Technical

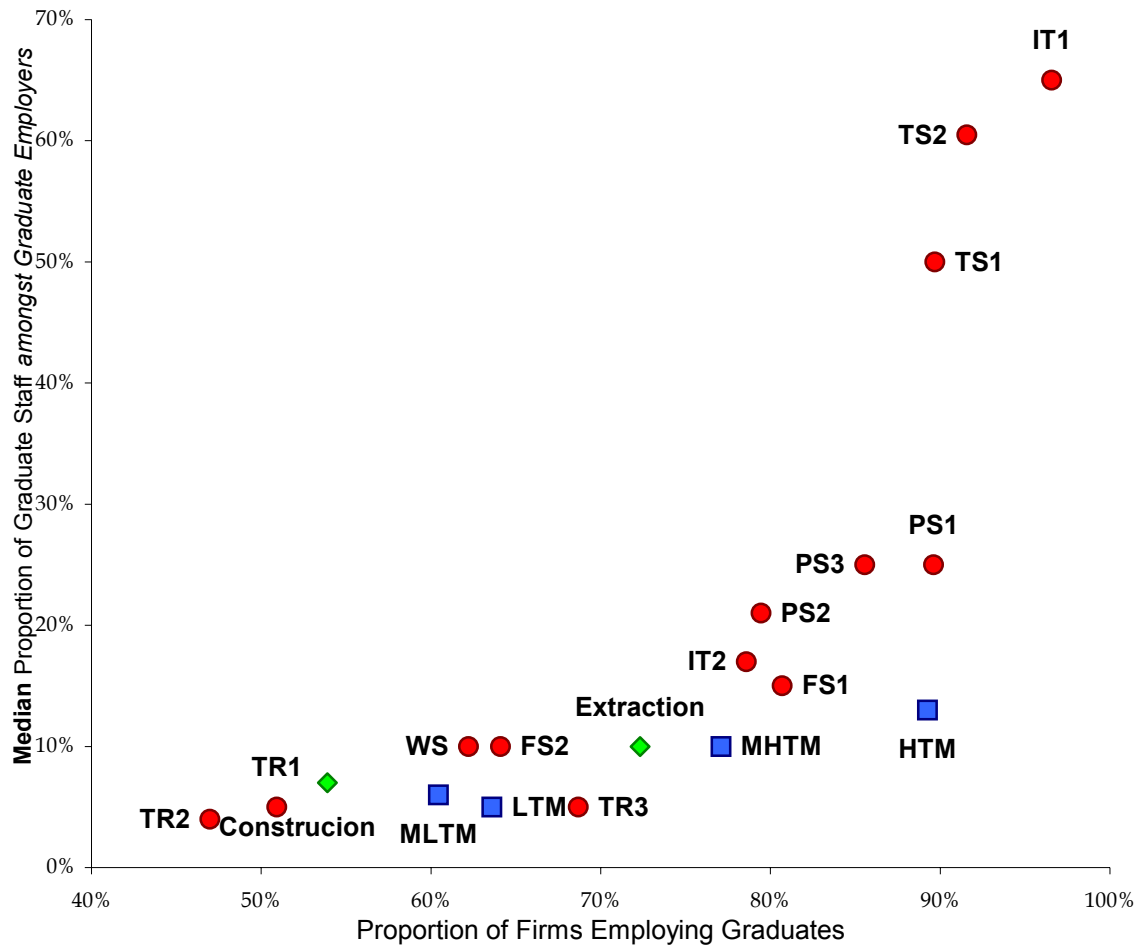
<sup>16</sup> It is some validation of the indicator that the various manufacturing sectors are spaced out so neatly along the two dimensions. We would have expected them to vary in the order depicted in terms of shares of graduate employment. In terms of firms employing graduates, low-tech manufacturing (LTM) features rather more than medium low tech manufacturing (MLTM) which is a minor deviation from expectations.

<sup>17</sup> Medians are generally lower than means in these data. This suggests that a few firms with high levels of graduate employment push up the mean scores, though more firms have lower ratios, more accurately captured by medians.

<sup>18</sup> The medians relate to the individual firms' employment shares. They cannot be read in terms of grand sectoral employment shares.

Services 1” and “InfoTech 1” (around 40% medians). These are, of course, highly technology-intensive sectors.

**Figure 4.1 Proportions of Firms Employing Graduates, by Shares of Graduate Employment**



<p><b>Service sector labels:</b></p> <ul style="list-style-type: none"> <li>Architecture &amp; Engineering - TS1</li> <li>R&amp;D &amp; Technical Testing - TS2</li> <li>Computer Services - IT1</li> <li>Telecommunications &amp; Other - IT2</li> <li>Banks, Insurance, etc - FS1</li> <li>Renting &amp; Leasing - FS2</li> <li>Legal &amp; Accounting - PS1</li> <li>Informational Services - PS2</li> <li>Managerial Services - PS3</li> <li>Passenger Transport - TR1</li> <li>Freight &amp; Storage - TR2</li> <li>Other Transport Services - TR3</li> <li>Wholesalers - WS</li> </ul>	<p><b>Nonservices:</b></p> <ul style="list-style-type: none"> <li>LTM – Low Tech Manufacturing</li> <li>MLTM – Medium Low Tech Manufacturing</li> <li>MHTM – Medium High Tech Manufacturing</li> <li>HTM – High Tech Manufacturing</li> </ul>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Thus, three service sub-sectors stand out as having high proportions of scientific and engineering graduates: 'R&D and technical testing'; 'architecture, engineering and related technical consultancy' and 'computer services'.

But many other service sectors feature firms whose levels of employment of S&Es are comparable with high tech manufacturing employers. Many professional services, and telecommunication services, are cases in point. Financial services, informational professional services, transport/storage, and wholesale employers of S&E graduates fall below these levels of knowledge-intensity, however. These may resemble high tech manufacturing, with groups of S&E staff carrying out similar functions for a wider organisation with many "knowledge-driven" operatives. But this assertion requires more analysis on a sector-by-sector basis.

#### 4.2.2 Other Graduates

Turning to [Figure 4.3](#), we see that high tech manufacturing firms are almost as likely to employ some other graduates – OGs – as they are S&Es. 73% of the HTM firms did so. But the employment *shares* involved are much smaller. OGs are much less intensively used than S&Es; with a median OG employment share of 5% for HTM employers (as opposed to 8% for S&Es).<sup>19</sup>

Perhaps surprisingly, quite a few service sectors have lower shares of firms employing OGs than does HTM. Some make even lower intensive use of OGs. This is the case from some transport and wholesale sectors, for instance

But there are several service sectors where firms are more likely to employ OGs than even HTM, let alone other manufacturing sectors. Technical Services 2, IT Services 1, Financial Services 1, and all groups of Professional Services, are above HTM in this respect. And most of the services that do employ OGs, make much more intensive use of them, as reflected in the higher employment shares of OGs evident in the Figure. All of the services apart from transport/storage and wholesale have higher – often considerably higher – shares of staff here.

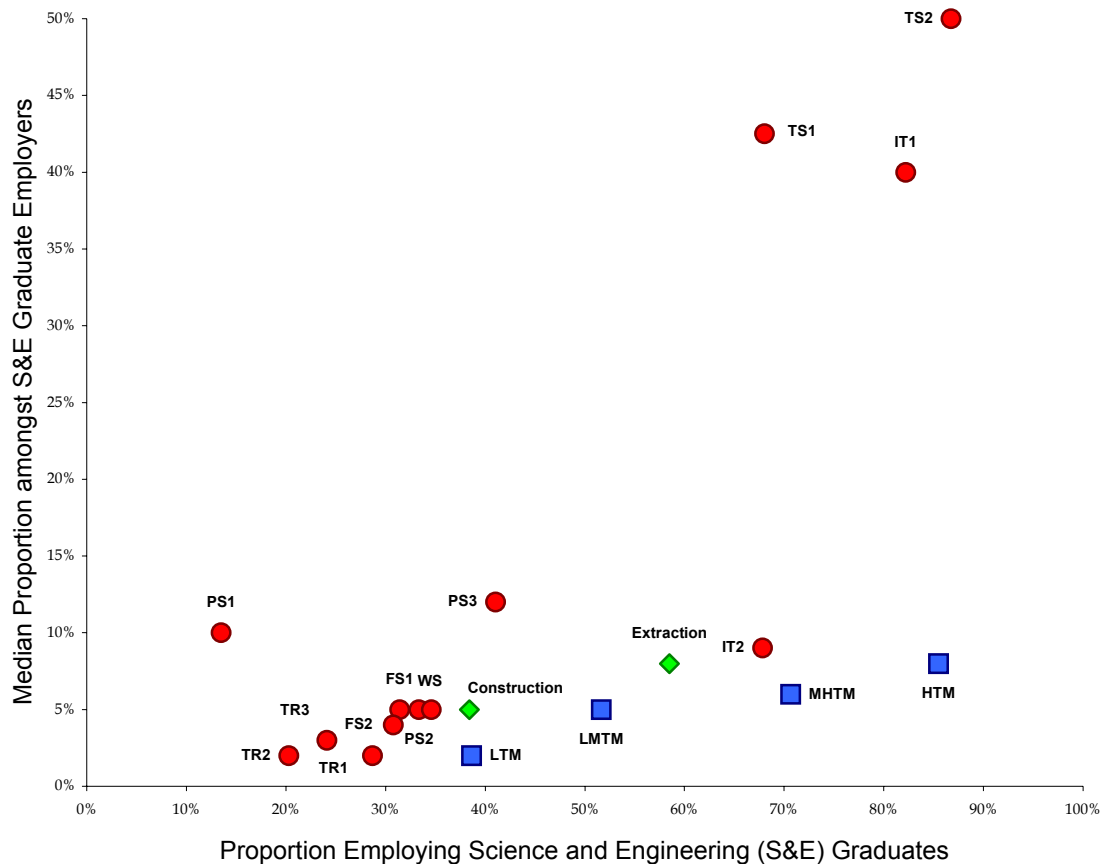
OGs include humanities graduates as well as those with closer links to the science base. It should not be assumed that such graduates have no links to the science base – they may often have undertaken courses based on a high research content. OGs are clearly important to a wide range of services – the chart in [Figure 4.3](#) is much more broadly filled than that in [Figure 4.1](#), and this is a matter of services employing OGs. Let us consider the relation between employment of the two types of graduate in a little more depth.

#### 4.2.3 Comparing the Two Types of Graduate

What of the relationships between OG and S&E graduate employment? [Figure 4.4](#) displays some of the results that can be developed here. It considers the graduate-intensity of those firms in each sector that do employ each type of graduate. (The sectors vary in whether firms use graduates at all, so overall sectoral intensities are rather different. Other results are displayed in Annexe B).

<sup>19</sup> Again, full results are in Annexe B.

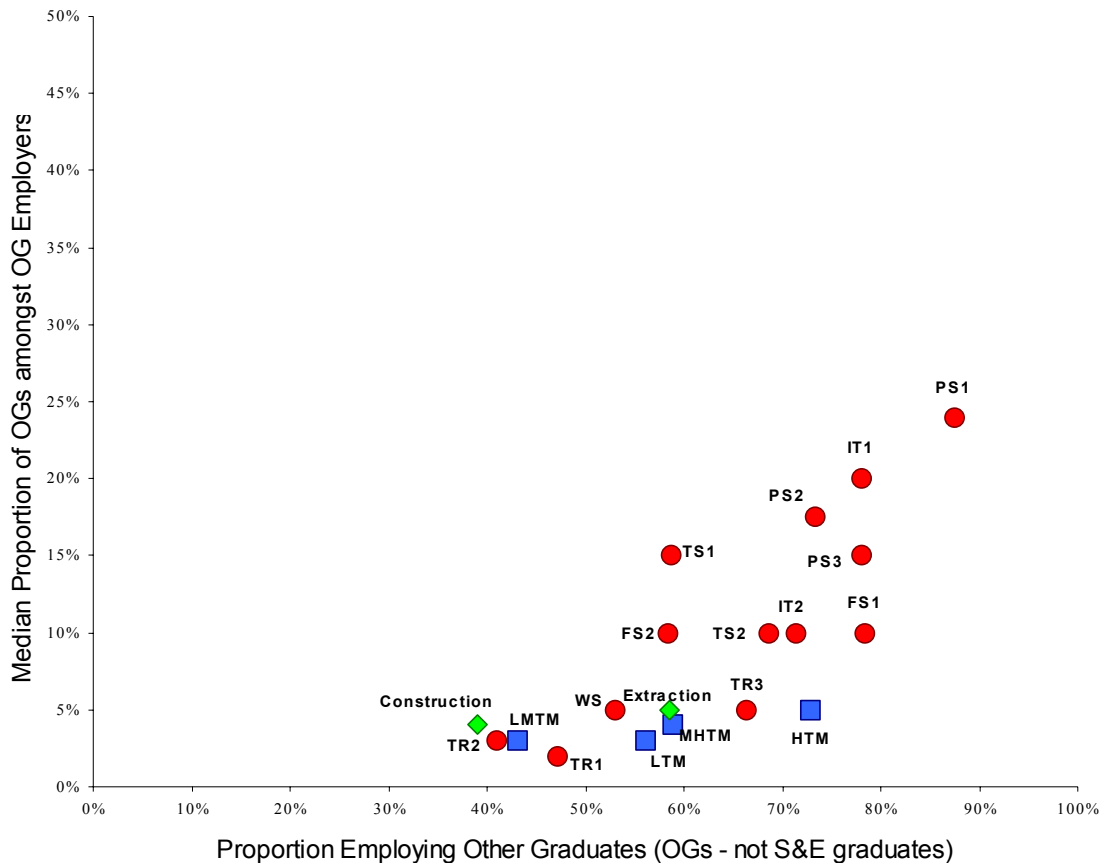
**Figure 4.2 Proportion of firms employing S&E graduates (horizontal), by median of Firms' S&E Graduate Employment (vertical), by Sectors**



Note: sectoral labels as [Figure 4.1](#)

The first thing that is apparent is a cluster of firms on the lower left-hand side of the graph, with the service sectors tending to display a relationship rather different from the manufacturing firms. For service sectors, with a couple of exceptions, the intensity of use of the two types of graduates appears to be correlated – with the employment shares of OGs rising more rapidly than those of S&Es. Across the manufacturing sectors, the positive relationship appears to be weighted more towards S&Es, in contrast. In both cases, the broad correlation suggests that there are needs for growing shares of both professional staff and S&E staff to back each other up as the knowledge-intensity of business operations grows. The reasons why non-technologists need technologists, and vice versa, would be interesting to investigate further – how far is this a product of firm size and technology-intensity, how far does it reflect the diverse core tasks of different sectors?

**Figure 4.3 Proportion of firms employing Other Graduates (horizontal), by median of Firms' OG Graduate Employment shares (vertical), by Sectors**



Note: sectoral labels as [Figure 4.1](#)

The second striking feature of this chart is the string of technology-based KIS on its right-hand side. Computer services and both groups of technical services are involved here. These sectors are among the most intensive users of OGs, sharing these high intensities with professional, financial and telecommunications services. But they are dramatically more intensive in their use of S&Es – compared both to other sectors' S&E use, and to all sectors use of OGs (including their own). Impressionistically, they lie further out on the trajectory established by manufacturing sectors, with S&S-intensity growing more rapidly than OG-intensity. The proportion of S&E graduates in their staff is around double that of OGs.

At a sectoral level, this broad-brush evidence allows us to identify the services that are most knowledge-intensive in terms of these two classes of graduate. In line with the results we have just been discussing, if we consider the share of firms employing graduates, and set a threshold of more than two-thirds of firms doing so, the key service sectors are:

Heavy employers of **S&E only**:

- ◆ *Technical Services 1*

Heavy employers of **OG only**:

- ◆ *Financial Services 1*
- ◆ *Professional Services (all types of service)*
- ◆ *Transport Services 3 (i.e. "other transport services")*

Heavy employers of **both** types of graduate:

- ◆ *InfoTech Services (both types of service);*
- ◆ *Technical Services 2*

These are sectors with high proportions of firms employing graduates.<sup>20</sup> In general, these firms that employ graduates also tend to enlist higher shares of graduates (compared to employers of graduates in sectors with fewer employers of graduates). In particular, technical services and computer services that employed graduates tended to have very high proportions of graduates – and especially S&E graduates – in their total workforce.

The implication is that whatever it is about the activities of the sector that drive firms to employ graduates, also drives them to employ more graduates.<sup>21</sup> Such KIS firms and sectors may also absorb higher levels of people with postgraduate qualifications – and thus with experience in research in the HEI sector. This is a topic that would benefit from further research (we are able to examine it to a limited degree in Chapter 5).

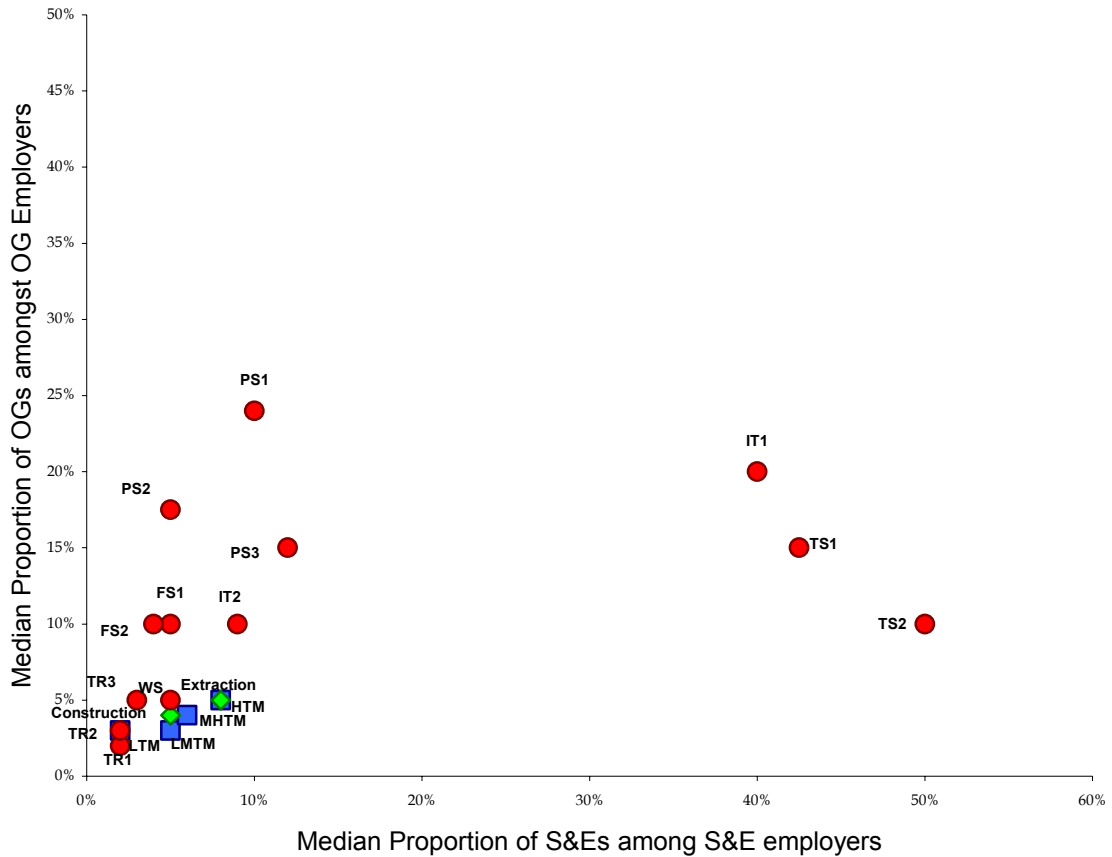
At a sectoral level, the services that intensively employ S&E staff also tend to employ OGs, if less intensively. Other sectors tend to employ OGs to a greater extent than S&Es. This corresponds fairly well to the distinction drawn between traditional professional KIBS and technology-based KIBS. The Swann and Tether analyses have therefore provided us with a statistical confirmation of a distinction between two classes of KIBS that has so far been based on observation rather than indicators.

But what these data tell us in a very stark way is that KIS sectors are highly dependent upon higher education as a source of employees. For whatever reason – and Chapter 5 will explore some of the reasons here – graduates are recruited to work in KIS. This is not necessarily a matter of deliberate strategy, and we shall see that many firms do not target new graduates at all. But University training is providing these people with something that is either found directly valuable by employers, or that can enable the future employees to gain other capabilities that are valued.

<sup>20</sup> Most of the services in the list above are predominantly business services (i.e. KIBS). Likely exceptions are financial services and Information Technology Services 2 - telecommunications – which are activities that mix business and consumer services. Some recreational software and related activities may be included in Information Technology Services 1. In contrast, the consumer-oriented passenger transport sector is not particularly high in terms of its employment of graduate human resources. This is also the case for wholesale.

<sup>21</sup> Of course, there may be graduate-intensive firms in sectors where relatively few graduates are employed in general. And some firms may have high **numbers** of graduates employed, but because these are a small share of the total employment – outweighed, say, by more routine service production or field staff - they will not appear as being knowledge-intensive by this criterion. This is despite the possibility that the activities of operatives are being designed and structured, and augmented, by their knowledge inputs – much as in high tech manufacturing.

**Figure 4.4 Median shares of S&E (horizontal) and Other Graduates (vertical), by Sectors**



Note: sectoral labels as [Figure 4.1](#)

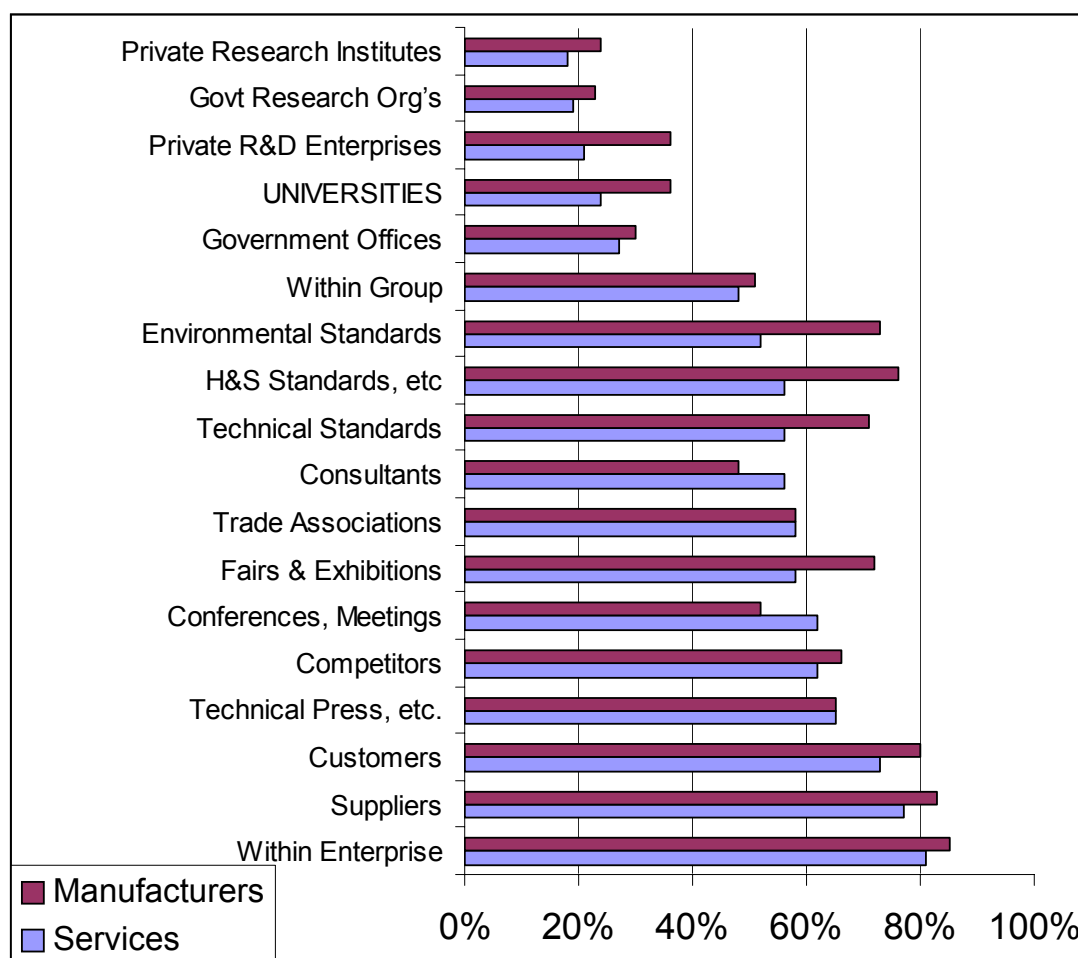
The university science base, and higher education more generally, thus plays a particularly important role in KIS human resources. It equips future employees of KIS with knowledge, skills, and other resources that are vital to the functioning of these services. It seems likely that this is the single most important and pervasive contribution from the science base to KIS (and one which may facilitate other knowledge flows).

### 4.3 The Science Base as source of Information for Innovation

The CIS3 questionnaire asked enterprises that had been engaged in innovation activities to indicate the importance of each of 18 sources of knowledge or information used in their technological innovation activities, using a scale spanning: 'not used', 'of low importance', 'of medium importance' 'of high importance'. [Figure 4.5](#) displays data on the use of various sources, for manufacturing and services overall.

Sources within the enterprise itself are the most widely used ways of obtaining innovation-relevant information. The next most important sources are other close business partners - suppliers and customers. Manufacturers are slightly more likely to use most of the sources of information than are services – though services report

using consultants, and conferences/meetings more frequently than do manufacturers, whilst the two sectors use trade associations to a similar degree.

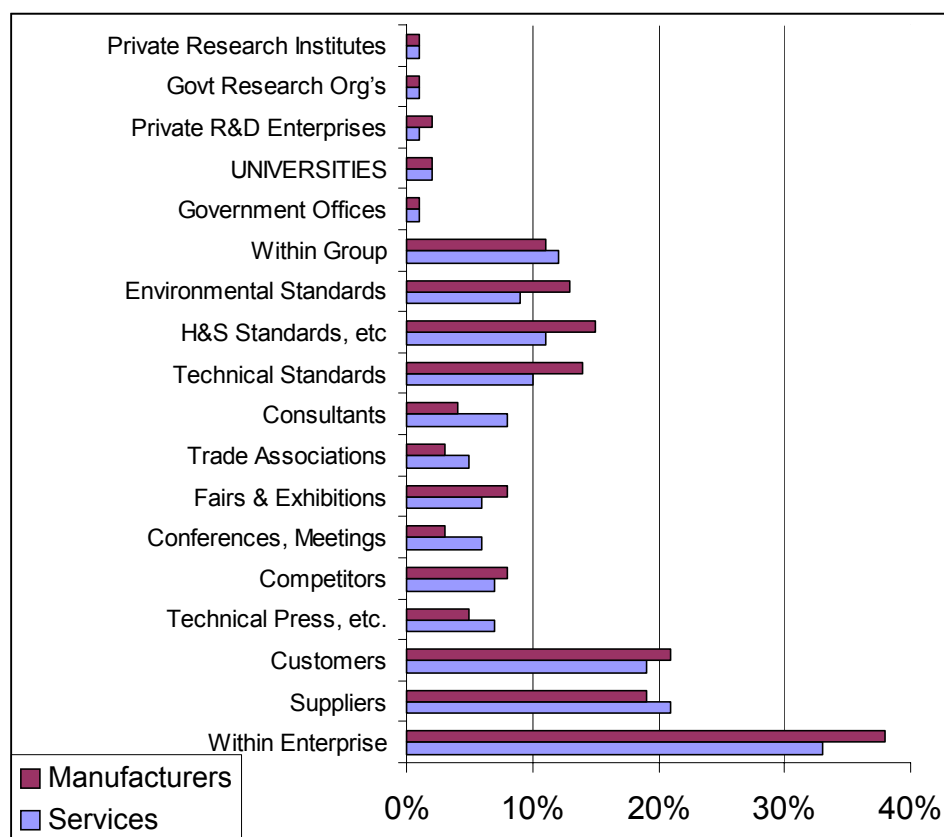
**Figure 4.5 Sources of Information used by Manufacturers and Services**

**Services are less likely than manufacturers to use public sector sources of information for innovation.** Nevertheless, Universities and government research organisations (GROs) were used by around a quarter and a fifth of the service enterprises respectively. The public science base has more connection with industry than some commentators suggest. As many as a quarter and a fifth of the service enterprises with innovative activities used universities and government research organisations, respectively, as sources of information for innovation.<sup>22</sup>

Private sector sources of expertise, such as consultancies, R&D enterprises and private research institutes, were dominant. They were more commonly used as sources of information for innovation – and overall private sources of information were more widely used by services than by manufacturers. Thus there appears to be a tendency for services to be somewhat more oriented towards private, and less oriented towards public sources of information, than manufacturing industries. In a few moments we will focus on KIS, but first we can consider sources that are regarded as “of high importance” (Figure 4.6).

<sup>22</sup> This is about an eighth and a tenth of the total sample of service firms.

**Figure 4.6 Sources of Information regarded as “Very Important” by Manufacturers and Services**



In many ways these data accentuate the previous results. Few sources are often cited as being really critical. Again, the most widely recognised sources of 'high importance' - to both service and manufacturing enterprises - were sources within the enterprise, followed by suppliers and customers. There is considerable emphasis on standards and on other sources within the group to which the company belongs. Universities and government research organisations receive fairly low ranks. Only 2% of both service and manufacturing enterprises regarded Universities as an information source of 'high importance' (and only 1% gave this status to government research organisations). Thus the impression is that the public science base plays a supporting role, rather than providing critical strategic inputs to the innovation process. This is very much in line with current conceptual models of the innovation process.

The next step is to examine the attitudes of different sectors within the manufacturing and service categories. [Figures 4.7](#) and [4.8](#) display very interesting patterns.

Amongst services, the public science base (Universities and, less commonly, government labs) is most widely drawn upon as a source of information for innovation amongst the Technical Services 2 ('R&D and technical testing') enterprises. More than three-quarters of these enterprises used the public science base as a source of information for innovation. A fifth considered it a very important source. Overall, these enterprises placed far more weight on the public science base

than in any other sector – including High and Medium High Technology Manufacturing (these use the public science base quite extensively). This sector also makes considerable use of private sources of information, roughly to the same extent as public sources are used.

The other service sectors, including KIS, were far less inclined to use the public science base. Fewer than half the enterprises in services sectors recognised it as a source of information for innovation. Transport, financial and professional services are particularly low users. Private sector sources of expertise are more likely to be used than the public science base. They are regarded as more important. This is generally true for manufacturing too, but the difference between the two sources appears greater for services than for manufacturing sectors.

How many innovating firms consider the public science base to be very important? Very few firms – and especially, very few firms in most services sectors - accord much weight here. Only Technical Services (both types) and 'Other Transport Services' tend to view the science base as an important source of information more than manufacturers. It is notable that IT services tend not to see public sources as important ones. Now, fairly few firms in all sectors do emphasise the public science base. But the shares are especially low for services, with the substantial exceptions mentioned above. As with the data on use of the sources of information, the experience of at least the more dynamic sectors of manufacturing shows that these linkages are by no means impossible for firms to develop. They simply seem to be less common for most KIS.

Statistical analyses conducted by Tether and Swann (2003) use multivariate techniques to control for factors such as size. (Since firm size varies across sectors, there is a problem in interpreting trends such as those reported above. The multivariate techniques allow us to examine what the trends are across different firm size, independent of sector, and vice versa, for example.) They report a number of interesting conclusions, including:

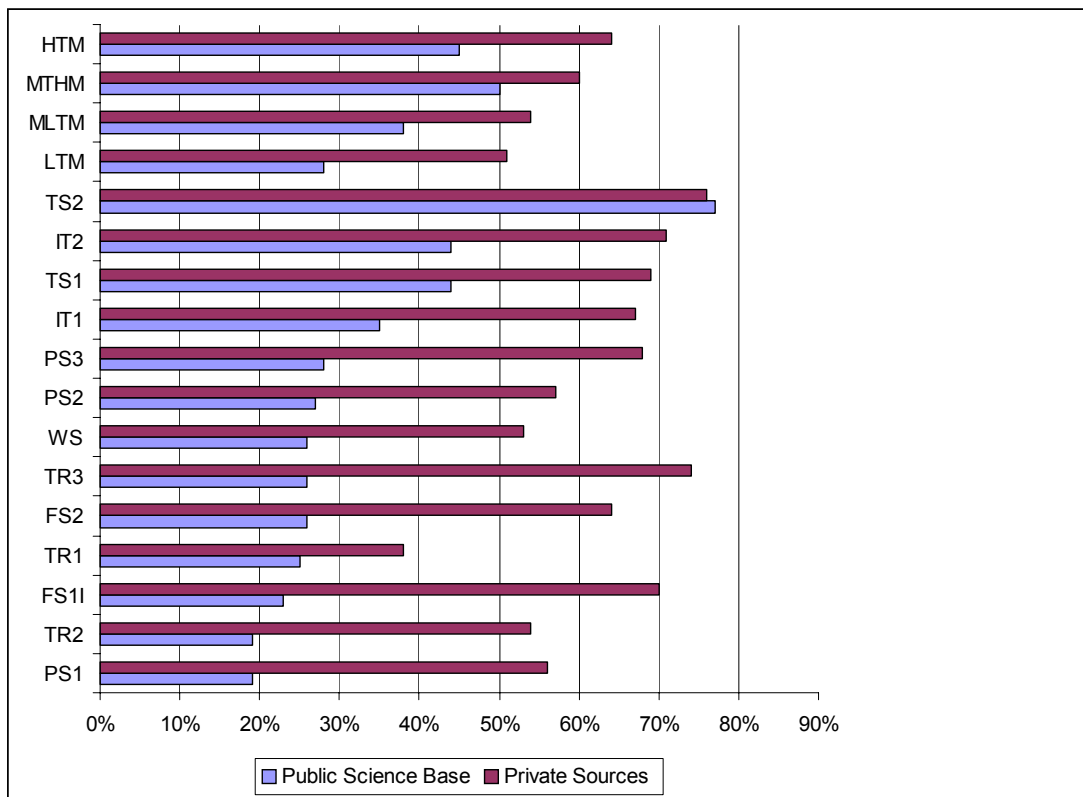
- ◆ The likelihood of using the (public) science base as a source of information for innovation increases with enterprise size. Bigger firms are more prone to use it.
- ◆ New firms are also more likely to use the science base - they may lack their own internal resources for innovation, they may be spin-outs, or it may be that current cohorts of entrepreneur are more oriented in this direction.
- ◆ Enterprises that are engaged in international markets are more likely to use it than are those that confined their activities to the UK.
- ◆ As for sectoral differences, the 'technical service sectors' of 'R&D and technical testing' and 'architecture, engineering and related technical consultancy' are more likely to use the science base as a source of information for innovation.

Other analysis suggested that the **more successful** innovators were more likely than other innovating enterprises to have used the science base as a source of information. Firms that had successfully introduced a 'new to the market' or 'new to the firm' product innovation, or a 'new to the industry' process innovation, had stronger links. These are firms taking on more of a leadership role in innovation, rather than following in the footsteps of others who have already introduced the innovations.

This implies that just highlighting the relatively low proportion of enterprises using the science base runs the risk of understating its importance for innovation. Where this resource was used, it was liable to be used to great effect – or at least, to be used by those firms who were achieving more substantial results through their innovations.

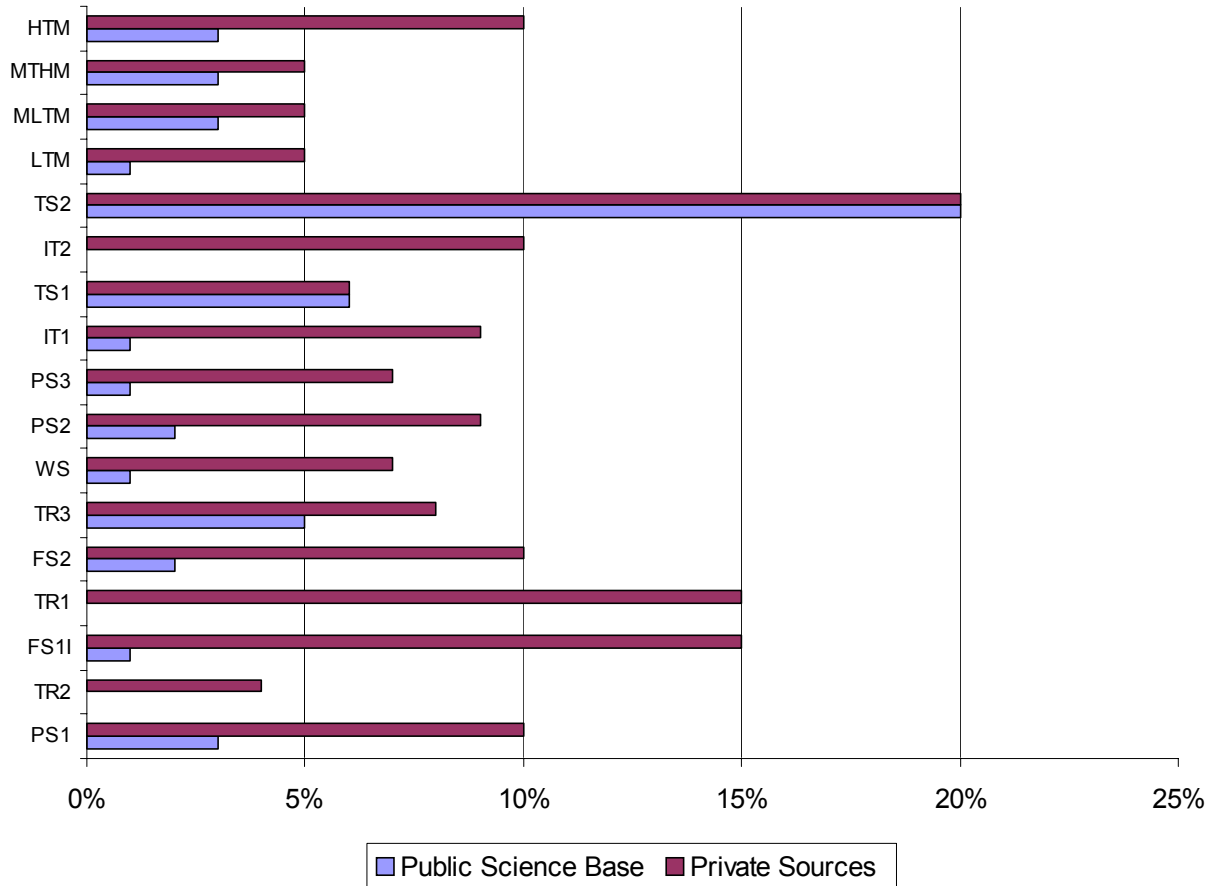
The interview research of the next two chapters allows for a little more insight into what it takes to constitute such valuable relationships.

**Figure 4.7 Sectoral Use of Public and Private Sources of Information**  
 (Manufacturing sectors at top, services ordered by extent of use of public sources)



**Figure 4.8 Sectoral Views of Importance of Public and Private Sources of Information (proportion regarding source as Highly Important)**

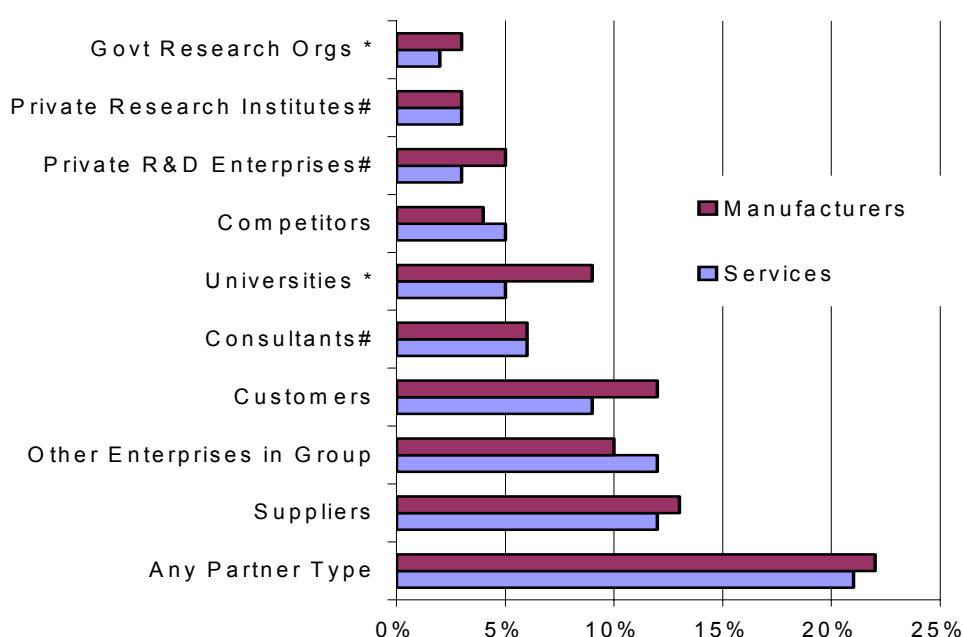
(Sectors in same order as **Figure 4.6**)



#### 4.4 The Science Base as Collaborator in Innovation

The CIS3 survey asked the enterprises about co-operative arrangements (meaning active participation in joint innovation projects). They were asked if they had any arrangements, during the period 1998-2000, with each of nine different types of partners. [Figure 4.8](#) presents basic data contrasting services and manufacturing. The first thing to note is that co-operative arrangements for innovation are fairly rare in both cases.

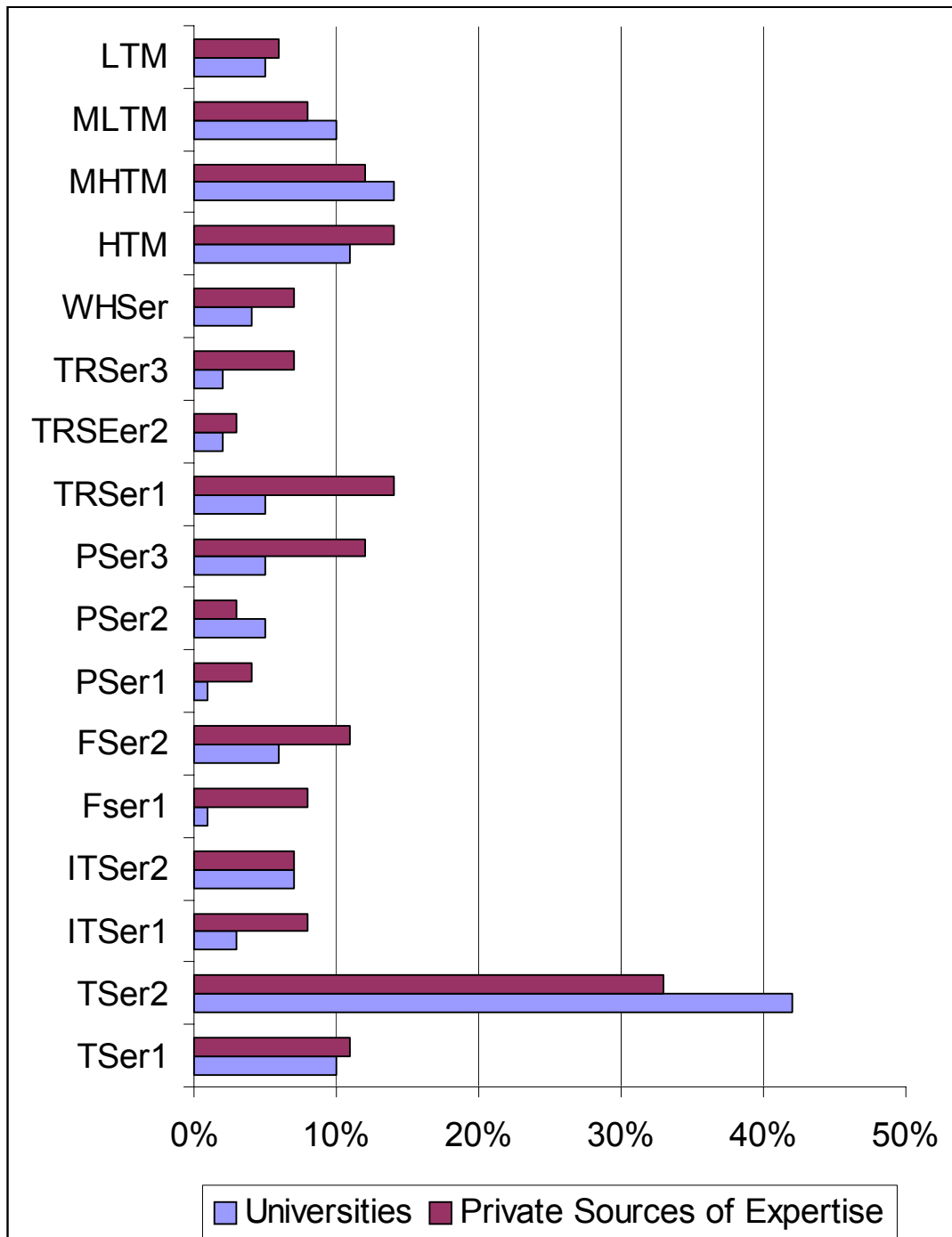
**Figure 4.8 Participation in Co-operative Arrangements for Innovation**



The most common partners were other enterprises in the enterprise group, suppliers and customers. Universities and government research organisations were engaged in these arrangements by only 5% and 2% of service enterprises respectively (6% had had co-operative arrangements for innovation with the 'public science base' - the corresponding proportion for manufacturers was slightly higher at 10%.)

[Figure 4.8](#) presents an analysis by sub-sector, which again displays a striking result. 'R&D and technical testing' enterprises are again exceptional. They are by far most likely to have collaboration arrangements with the public science base – almost half do so. A remarkable proportion - over 40% - had at least one such collaboration arrangement with Universities. Another KIS sector has (relatively) high levels of collaboration. 11% of the 'architecture, engineering and technical consultancy' services also had collaboration arrangements with the science base (10% with Universities).

**Figure 4.9 Co-operation Arrangements with the Public Science Base by Sector of Activity**



Other service enterprises are much less prone to have such links. Generally there are fewer than 5% doing so. In contrast, with the exception of Low Technology Manufacturing, at least 10% of innovating manufacturing firms are likely to have collaborations with Universities. (On average 5% of services, and 9% of manufacturers enter into such collaborations.)

The picture is similar to the use of public and private sources of information in another way. Overall, there is more tendency for service enterprises to collaborate with private sources of expertise than with Universities (8% as compared to 5%). For manufacturers, the tendencies are roughly equal (9% in each case). Manufacturers are somewhat more likely to engage in collaborations, and their collaborations are not so skewed towards private partners.

Examining individual KIS, 'R&D and technical testing' and the 'architecture, engineering and technical consultancy' services' are again relatively prone to collaborations with private partners. The former technical services are somewhat more oriented to Universities, the latter to the private partners. Private sources of expertise are also relatively commonly used in the non-technical service sectors, too. For instance, amongst the financial and professional services, over 10% of firms engage in such collaborations with private partners.

The overall impression, then, is that services and KIS in general are relatively disadvantaged in collaborating with the public science base, as compared to manufacturing – though there are striking exceptions in Technical Services.

Again, multivariate analyses of this data was undertaken by Tether and Swann (2003). Their analyses confirmed the sectoral differences outlined above, indicating that they are not just a matter of size differences across sectors. The pattern of results from these statistical appraisals was similar to those noted for information sources. Larger enterprises tend to have more collaborations. Enterprises primarily engaged in international markets, and those with export markets, are more likely to engage the science base as a collaborative partner for innovation. The more successful product innovators were more likely than other innovating service enterprises to have engaged the science base as a collaborative partner.

Again, the implication is that linkage to the science base characterises - and presumably benefits - the more dynamic firms. Such linkages as do exist may thus contribute more to economic performance than might be concluded simply on the basis of their relative infrequency.

#### 4.5 Innovation Problems

Finally, Tether and Swann (2003), examined the factors that firms reported as impeding innovation. The firms were asked about the role of various possible problems, one of which is especially relevant here.

*Access to technology* was, indeed, frequently identified as an impeding factor. But almost all the other factors (e.g. finance) were more frequently cited. Access to technology was rarely identified as being of high importance.

In any case, It may well be that most of the technical information that firms do use is not received directly from the science base. Various commercial intermediaries (including many engineering and IT KIS) help 'translate' the knowledge from the science base into forms required by industry. (They also often conduct their own R&D.) We saw before that the public sector is not the major source of innovation for innovation, and often this must refer to technological information.

Since access to technology is not cited as a major problem, should we conclude that links to the science base actually function well, and are quite adequate? The issue

may well be that many firms are simply not very innovative in practice, that the innovations they undertake are fairly limited ones, and that the needs for technology and technological information are rather basic and easily satisfied. Or it may be that the various intermediaries are seen as functioning very adequately, so that there is little difficulty in locating the appropriate resources. Both explanations – which are quite complementary – have some force.

But the evidence, as we have seen, is that some of the most innovation-active KIS do pursue strong links to the science base, that more dynamic areas of manufacturing also foster closer links than is typical for services, and that the more innovative and internationalised firms are more prone to do so. An increased linkage to the science base may be needed for services in general, and KIS in particular, to utilise innovation as a way of meeting increasing competitive challenges.

#### **4.6 Conclusions from Survey Analysis**

The survey data provide numerous insights about the nature of KIS, and the linkages between them and the science base.

Graduates constitute a very high share of employment in KIS. Some technology-related services are major users of Science and Engineering graduates. Usually this goes along with high employment of other graduates, too. Other KIS are much less prone to employ S&E graduates. The flows of graduates into these KIS sectors are clearly extremely important for the successful functioning of these firms. Our interview studies, reported later, suggest that this is a more complicated matter than might at first be thought, however.

The linkages with the science base through information sources and collaboration partnerships follow similar patterns, with some differences of detail. In absolute terms, however, these links do not appear to be very strong ones. Notable exceptions are the 'R&D and technical testing', and to a lesser extent the 'architecture, engineering and related technical consultancy' sectors. Almost 30% of innovating service enterprises did recognise and use the public science base as a source of information for innovation, even if it was rarely regarded as a source of 'high importance'. Private R&D enterprises and private research institutes are more widely used. Few service firms had collaborative arrangements for innovation with the science base. The striking exceptions in technical services, however, show that such arrangements can be very important in some dynamic areas of KIS. And the analysis suggests that the significance of the science base to innovation is greater than might be deduced from the simple share of enterprises using it as a source of information or collaborative partner. Indications are that the more dynamic firms make more use of the science base. The rise of the knowledge-based economy is liable to intensify the need for such links.

## 4 Interview and Qualitative Research – KIS Firms

### 5.1 Sectors

Following preliminary research and discussions with the Steering Group, it was decided that this study would primarily focus on a small illustrative range of KIS. These were to include business and consumer-facing services, and more or less technology-oriented services. The set is:

- ◆ Architectural, Engineering and Related Technical consultancy – within this group particularly looking at **Environmental Services**<sup>23</sup>
- ◆ Computer Services and within these **Business Continuity Services**. (These support the avoidance of, management of, and recovery from, disasters associated with IT systems failure).
- ◆ Financial Services (Banking, Insurance, Pensions, Property Trading) and within these **Long-term Personal Insurance** services.
- ◆ Informational Professional Services – especially **Market Research and marketing**.

The aim was to conduct interviews with knowledgeable informants in these areas. We used industry directories and similar sources to identify lists of firms and, where possible, named contacts in these firms. We then proceeded to develop target interviews that covered a range of service activities. For instance, we sought to capture representatives of different firm sizes, different types of service function (e.g. operational versus more consultancy-oriented services), and the like. Up to 20 interviews were conducted in spring/early summer 2003 with firms from each of the sectors (see [Annexe C](#) for more details.).

### 5.2 Questions

The key themes addressed in the interviews were:

- (1) Knowledge base: What are the firms' core technologies, and are these changing? Are new technical demands arising? What does their innovative effort focus on?
- (2) Human Resources: What are the levels and types of human resources acquired from the science base? What sorts of qualification, skill and capability are sought for? How are these used, especially in relation to innovative activities?
- (3) Training: How far is the science base used for other sorts of training and human resource development activity, and how?
- (4) Linkages: To what extent are there innovation-related collaborations (R&D and otherwise) with the science base? Is there outsourcing of R&D, testing or related activities? Is access to expertise and information sources an issue? Are there strategies to engage in LINK, CASE and similar schemes?
- (5) Management and Strategy: How are knowledge needs determined? How are partners and sources of intelligence identified? How are relationships managed and evaluated?

---

<sup>23</sup> This sector is hard to map in conventional statistical classifications, though it is well covered in industry newsletters and the like. Studies of the sector and its innovation characteristics include Miles (2000), Randles and Tether (2003). Some environmental service firms are clearly engineering services, but others are more concerned with providing information or support with a particular operation such as waste disposal.

- (6) Intermediaries: What is the role of intermediaries (such as consultants, trade and professional associations; government departments; and the ILOs and other officials of HEIs)?
- (7) Evaluation of the science base: How well the system works, how easy it is to find the right partner (and whether the system generates such partners)? Are members of the science base prepared sufficiently to be relevant, topical and timely, well-informed, expert, communicative and open enough where it comes to IP? What are the external obstacles to use of the science base?
- (8) Policy issues - experience and views of existing policies of relevance: Ideas about other sorts of policy, where things might help e.g. – accreditation, “marriage brokering”, IP and R&D management support, new fora, new types of publication, etc.

### 5.3 Interview Results

This section reports on some major themes arising from the interviews with KIS firms, organised roughly in the sequence of the main questions addressed in the interview. We seek to outline major tendencies and sectoral characteristics emerging from the studies.

One major feature of the results is the indication that links with the science base may very much involve two-way flows of information and resources. KIS firms may participate in teaching and curriculum development; they may steer and collaborate in research. The best use of the science base appears to be made where there are such interactive linkages.

#### 5.3.1 KIS: Size, Knowledge and Innovation

The firms interviewed varied considerably in **size** across and within the four sectors. For instance, the insurance sector was dominated by large firms. The marketing/market research group, in contrast, featured several firms with fewer than 20 employees - a couple of very large ones, one with many hundreds. This very skewed size structure is typical of many KIS. Most sectors feature a large share of microbusinesses and small firms, often serving local markets or specific technical niches. But most sectors also feature a few regional, national and transnational actors.

The size of firms is an important influence on links to the science base. Size was a prominent element in shaping firms' behaviours and strategies in relation to the science base in all sectors studied. Some of the larger firms have developed articulate strategies for developing and maintaining linkages that can provide sources of human resources, expertise and other types of knowledge. In terms of relevant expertise, such firms may look beyond the UK science base, too.

In contrast, smaller firms repeatedly reported that resource shortages - especially lack of management time - restricted their opportunity to develop longer-term relationships, to absorb knowledge of longer-term import, to even explore potential linkages. Smaller firms may have relationships with the science base. But these are often a matter of happenstance (contacts established through social networks). Often, too, they derive from founder members' background (especially where spin-offs are involved). The challenge of facilitating mutually useful linkages between small firms and the science base is pressing, given overwhelmingly the larger proportion of KIS are small firms. And, of course, such firms are seen by policymakers as particularly important for economic and employment growth.

The great majority of the firms interviewed, large and small alike, considered themselves to be innovative. This might be expected to lead to the need for better links with the science base. What can we say about the sorts of **innovation** that were being undertaken?

In small firms, in particular: innovation was often seen as being client-driven, demand-led. A market need has to be established before resources can be invested into developing a product. The firm focuses on a core service or set of services; these are further evolved in response client inputs. For instance, a client might ask whether a particular service would be feasible - the firm would investigate the proposition, exploring different ideas suggested by it.

A rather different situation applies to some start-ups organised around new technical knowledge. (Probably the same would apply to firms based on new social or organisational knowledge, too.) In these cases, it is the awareness that something can be done that is the stimulus to innovation. The innovators perceive scope for creating a market for a new or improved service - this applies, for instance, to some of the environmental services studied. We shall later see that the science base can play an important role here.

The larger firms in our sample saw themselves more as driving the innovation process. They may invest considerable resources into innovation projects. For instance, large market research firms are pioneering web-based data collection techniques. In one case the KIS firm was developing new web-based products and selling these to clients. It could see the opportunity of reducing the costs of projects, but the lack of confidence of clients as to the reliability of such data collection tools had first to be overcome.

There is a strong tendency to look within the firm for innovative ideas. For instance, this could involve examining internal processes and their scope for re-engineering or the being restructured through e-business methods. Existing service activities may be broken down into component parts that can be combined in new ways. Such in-house expertise is often combined with intelligence harvested from the customer. This is not always a matter of clients making direct suggestions or demands. Professional service workers who develop a rigorous understanding of client needs may be able to spot latent demand. Such professional knowledge was an important resource for innovation. The science base played a much less prominent role in our sample.

Much of the literature on innovation (in manufacturing) talks about R&D centres and managers as if these institutions and actors were typical in innovative firms. Actually, these tend to be common only in high-tech sectors and large firms (not surprisingly, much of the innovation literature has focused on sectors like automobiles and pharmaceuticals). Our current interviews confirm the picture painted in the emerging literature on services innovation.<sup>24</sup> These ways of organising for innovation are quite uncommon in services (though they are found in a few KIS sectors, for instance among large software and telecommunications firms). Innovation is rarely a formalised function in the KIS firms studied here. Instead, it tends to be project-related (and is managed by temporary project teams).

Innovation was driven by many different factors, many of these creating demands for new sorts of knowledge in the KIS. Insurance firms have famously had to gain

---

<sup>24</sup> E.g., Gallouj (2002), Preissl (2000), Sundbo (1998, 2000).

awareness of climate change and genomics issues, for instance. Likewise, environmental service (ES) firms reported substantial challenges (and opportunities) stemming from the evolution of legislation and regulation in environmental affairs. They are required to align their skills profile, and service solutions, to meet emerging demands & opportunities. This is likely to be the case for many technology-based services. In such circumstances, the science base might be expected to form a ready source of knowledge of new developments.

However, there was a prevalent view in many KIS that their **knowledge** of the science and technology underpinning their domains was “well ahead” of Universities'. The services knowledge is being developed on the basis of seeking solutions for clients' problems (knowledge developed in the context of application, to use the terminology of Gibbons et al (1994)). This knowledge is gleaned from practice, structured around such emerging problems. In contrast, much University research is structured round discipline-driven problems. University courses may be far from the cutting edge, and far and few between. Likewise, a conventional University department, required to span the whole set of topics associated with a discipline, is unlikely to have more than one or two people specialising on a specific topic that is the bread-and-butter of a KIS.

Thus we find statements coming from our interviewees such as: “the books on business continuity are still being written, and it is us that are writing them”. Of course this example reflects a view from a newly emerging area of activity. But similar points are made in more established fields. For example, in the case of market research, professional knowledge is longstanding and highly articulated. Professional bodies are seen by most practitioners as more useful repositories of knowledge than is the science base, despite the attention given to social research methods in many social science departments in UK universities. Indeed, it is sometimes suggested that academics are chasing hares that have little significance to the exciting challenges in the sector itself. This applies to technology-based and professional services alike (it is also a common assertion of interviewees in manufacturing firms).

The particular requirements for knowledge are important influences on the sorts of linkage that may be undertaken. Some types of technical knowledge highly related to services design and delivery may be very active areas of University research and training. This may be part of the explanation of the high degrees of linkages between technical services and the science base that were outlined in Chapter 4. In some other cases, however, practical application of knowledge has been consolidated into professional associations and similar institutions, as opposed to the science base. KIS vary in terms of the development of such professional associations and intermediary organisations. Whether and when these support the sharing of knowledge between KIS and the science base, as opposed to forming quite separate systems for knowledge development and exchange, is an interesting research question.

It is common to find some highly specialised firms, and some “full service” ones, in a KIS sector. Similarly, some firms are typically much more in the business of providing advice and consultancy, while others supply operational services. (In this study we sought to avoid too heavy a representation of the former class.) The sorts of knowledge employed in these different classes vary quite substantially. In general, though, KIS firms, especially those serving business markets, will have to combine three types of knowledge in their activities:

- Domain-specific technical knowledge. This may be knowledge of technologies which they help clients with; techniques and technologies they use themselves

(e.g. research skills, data collection software, accountancy and auditing methods, secure computer systems, etc.). It may also be knowledge of the parts of the world with which the service deals (e.g. microbiology or pollution control for some environmental services, demographic trends for some market research and insurance services).

- Interpersonal / client facing skills. Such 'soft' capabilities (e.g., human, interpersonal, and communications skills) are recognised as central requirements by almost all KIS. This may be a particular characteristic of most services industries, and of the service functions of other sectors in general.
- Knowledge of relevant market sectors. Business Awareness is a centrally important class of expertise and know-how for some informants. Many larger firms (particularly business services) operate in a "vertical" manner. Certain professional staff are given responsibility for dealing with specific market sectors, and develop detailed understanding of these sectors' operations and requirements.

Where it comes to the more domain-specific technical knowledge, most KIS sectors span many different specialisms, with quite distinctive knowledge bases. For instance, in the marketing/market research group<sup>25</sup>, we have firms who specialise in statistical sampling, in sophisticated data analysis, in computer-aided telephone interviewing, in focus group studies, and even in activities that are closely related to the design of advertisements and product packaging. Some of the quite distinct sorts of knowledge involved are addressed in the same University courses. Others are typically in quite different courses, and others still are very rarely treated in any substantial way in higher education.

### 5.3.2 Human Resources

#### *Recruiting Graduates*

As seen in Chapter 4, graduates are important sources of skills and capabilities. Many of the interviewees for the present study saw Universities primarily as a source of human resources. But the picture is complicated. While graduates are employed, this does not mean that new graduates are recruited. Indeed, many firms do not recruit people fresh out of University. Furthermore, graduates are rarely recruited for specific KIS-relevant technical knowledge. There were occasions cited where very specific technical skills and expertise were sought from Universities – for instance in the case of environmental services firm looking for specific postgraduate training with regard to a particular vacancy.

However, such cases were exceptions. Most often, even when graduates were sought, these were graduates in general - not people with highly domain-relevant knowledge. University degrees were valued as demonstrating the graduates' ability to engage in sustained intellectual work, to be highly literate (and, often, numerate).

In earlier work (the interviews in Miles et al, 2000) we have found some industrial managers who actually reported that they avoided graduates in their own fields. Thus, some accountancy and software firms believed that such graduates were liable to have various problems. They might be too wedded to specific techniques and lines of approach<sup>26</sup>. They might have unjustified aspirations and belief in their own efficacy. They will often lack awareness of business contingencies. (In the words of

<sup>25</sup> Already this label implies two broad sets of activity

<sup>26</sup> A point also made by a number of our market research firms

one interviewee in the present study: “Graduates are do-ers not business generators”.) The motto “we grow our own” captures this widespread attitude.

Some smaller firms did specify that they “typically” recruit graduates at a specific rate (“one or two a year”). Others see graduates as requiring so much orientation that they are a high-risk set of recruits – they would rather recruit people with relevant experience. This is reinforced by the fear (which seems strong in small firms) that staff will leave after receiving training). Larger firms across the KIS sectors are more likely to have graduate recruitment programmes, attending selected career fairs, offering structured graduate vacancies and further training. The large insurance firms studied in this project stated that their main links with Universities are, indeed, for graduate recruitment.<sup>27</sup> These firms have focused their strategies on closer relations with particular Universities' careers services - but provide little input into undergraduate teaching.

It is thus common for the science base to be accessed for human resources in terms of general knowledge and capabilities rather than specialist knowledge. How do firms access specific skills, then? Sometimes, and in some sectors, specific types of graduate are recruited.<sup>28</sup> Among our interviews, firms in the ES sector are active graduate recruiters (taking mainly natural & environmental science graduates). Reflecting the different sorts of knowledge required in various domains, specific S&E knowledge may be required in particular businesses. This will lead them to recruit people with, for example, statistical training.

The smaller firms studied, in particular, most often sought from people with professional experience. These would be people currently working (or with experience) in other firms in the sector (this can be seen as a means of avoiding the perceived risks in recruiting and training fresh graduates mentioned above). Less often, they involved people from relevant client or supplier firms.

### ***Professional Training***

Many firms prefer to develop skills on the job, or to have their staff undertaking professional training while at work. This is seen as preferable to recruiting graduates with academic training in supposedly relevant specialisms, but with no practical experience. Professional development and training is very important<sup>29</sup> – much of this is undertaken ‘in-house’, but some specialist training is provided by private organisations. Some KIS firms use Universities in professional development. This may be an alternative to private training suppliers and professional associations, but is often complementary to the latter. This is something that seems to vary considerably across KIS sectors, and of course from firm to firm:

<sup>27</sup> One exception in the set of interviews did have important research links - see [Box 5.8](#).

<sup>28</sup> Some courses may indeed be a major source of training - even if only background training that needs to be supplemented by on-the-job training - for specific types of KIS. Legal services are presumably heavy users of law graduates, for example. Punt and Cole (1999) show the high dependence of the solicitors' profession on legal training at University. Law is relatively well-studied as a profession. See also the Law Society's report on *Entry into the Legal Professions* (Halpern, 1994; see also Duff et al, 2000, Shiner, 1999). Other material from the Strategic Research Unit contains rich information on themes such as professional training and job mobility. It is of note to the present study that some of these pieces of research draw extensively on University research inputs! See the Society's website (at [http://www.lawsoc.org.uk/dcs/fourth\\_tier.asp?section\\_id=6154&Caller\\_ID=NS72](http://www.lawsoc.org.uk/dcs/fourth_tier.asp?section_id=6154&Caller_ID=NS72)) for more details.

<sup>29</sup> This importance is reflected in a body of research literature on professional development and the role of professional associations. See, for example, Friedman et al (2000).

- Some firms will contract Universities to establish a specialist course for them – for example, one insurance company involves Cardiff University for training on underwriting issues.
- Some of the case study firms see professional bodies as a primary source of training and qualifications. In the case of market research, none of the sample used Universities for training purposes. They all commented that the Market Research Society (MRS) diploma was the most relevant qualification, though had differing views about its worth.
- Environmental services, though recruiting many graduates, rarely involve the science base in training. Some collaboration between Universities and professional associations is evident in delivering professional qualifications for ES, and some high-level professional development is undertaken within the HEI sector.

A PIU report (2001) recently noted that small firms in the UK are in general fairly loathe to invest much in further development of their workforce. The same trend was apparent among our interviewees. Firms saw the likelihood of trained staff being recruited elsewhere as a deterrent to their providing training. This appeared to be particularly an issue for smaller firms. Nonetheless, most firms are generally prepared to recruit staff who have gained professional experience elsewhere.

### ***Inputs to University Training***

Some KIS firms are keen to be involved in University course development and delivery. (See [Box 5.1](#)) In particular, parts of the business continuity sector are making inputs to Business School courses. The rationale for this is not simply self-promotion. (Some firms do use links with the science base as a form of PR, for graduate recruitment and general marketing). The Business Continuity firms are attempting to raise awareness of the problems they are addressing, to inform and influence future generations of clients. Business Continuity services are also seeking to “professionalise” their relatively new sector. They need to create credentials for their practitioners, for instance. In such fields, where there are important ongoing technological developments, regular updates of state-of-the-art knowledge are required. This creates scope for University-based training and assessment - though the sector may well feel that it is well ahead of most academics, as is the case in BC services.

Traditional professional and financial services, such as insurance and market research, are long-established, with well-respected professional associations. But this is not the case for all KIS. Sometimes new subsectors are emerging - BC is a case in point within computer services. Sometimes KIS sectors and professions are fragmented. For instance, ES firms feature a very wide range of different professions and specialities. There is some feeling of an absence of a clear community in the field. Undergraduate students are accepted regularly (on sandwich and short courses) into some of the firms in ES. The experience for both parties is often positive, and companies have a role in planning student projects and evaluating the performance of individuals.

Long-established services can, of course, have a stake in University courses. For example, a market research firm commented that their inputs to University courses would “give something back and imbue graduates with an understanding of real life”. In this sector, again, there was a view that impressing graduates with the relevance of market research for businesses would help grow demand for the market research sector among its users. Prizes may be awarded for student essays and projects by individual companies or professional associations - e.g. the Institute of Actuaries; and

student bursaries are not unknown - e.g. from the Worshipful Company of Actuaries. (One of our environmental services firms also supported studentships - see [Box 5.5](#).) Actuaries need to be qualified as a Fellow of either the Institute of Actuaries or the Faculty of Actuaries, which requires passing professional examinations and satisfying the experience requirements. University courses at diploma and Master's level can satisfy the professional examination requirements, and are of course shaped by these professional associations.

### **Box 5.1 Involvement in University Teaching**

KIBS firms have involved themselves in University teaching in a variety of ways. (See the University case in [Box 6.1](#) for example of activity in the *insurance* sector.)

Several *environmental services* firms interviewed in this study had become involved in curriculum design. A number of interconnected reasons were involved. In particular they wanted to ensure that undergraduate and post-graduate courses better deliver trained graduates with knowledge that was appropriate to the needs of the sector.

In the *business continuity* sector, owner-managers of several small firms provide lectures and teaching on undergraduate and post-graduate University courses. In particular, participating in MBA programmes was seen by some as a means of getting the senior managers of tomorrow to consider business continuity issues in business planning and strategy development.

One of our case study firms was the UK life assurance and pensions arm of a top global financial services company. Many of its 900 technical specialists are graduates. Around 75% have relevant professional qualifications (e.g. the Chartered Institute of Insurers qualifications). These are attained by a mixture of internal and external training. The firm had abandoned a graduate scheme for the training of actuaries, having found that it could recruit sufficient numbers of qualified actuaries more easily than recruiting at new graduates. (However, managers sometimes request placement students for one year, to complete some particular project work. There is seen to be potential for this to expand in the future.)

This firm is currently in negotiations with a UK University, regarding a Management Diploma for senior managers and professor advisers. Such staff are already provided with internal training on generic management skills. But they want accreditation of these skills and have requested the opportunity to study for a qualification. A reputable University was deemed to be more beneficial for this than an external firm running a tailored course. The insurance company scrutinised several Universities and Business Schools. While several Universities offer relevant courses, the one chosen is geographically close, and informal links already exist via staff members who had graduated from that institution. The relationship allows the firm access to facilities and learning resources, help with design of projects (specialist expertise is seen as valuable here), etc. Simply locating staff out of the office in a different environment is seen as a benefit, and it is hoped that the new environment will allow for "synergy across business units with a more structured and theoretical basis".

### 5.3.3 Information, Expertise and Collaboration with the Science Base

#### ***Motives and Obstacles***

There are a wide variety of types of links that can be developed. The science base can be used as a source of *information*. This may be highly generic information (as will often be the case for published research). It may be much more specific (as in the case of, for example, strategy awareness reports). It may be used as a source of equipment and skills for specific tasks – as in the case of environmental or biochemical testing, or complicated statistical analyses. The science base may be used as a source of *expertise*. Academics may be consulted concerning their views as to specific topics, their guidance concerning (and “translation” of) relevant research and research communities (especially as to what is worthwhile, reliable, and leading-edge). They may be involved in brainstorming groups, or in advisory panels of various kinds. The science base may be used to develop specific *knowledge* – collaboration in research projects, or outsourcing of research to Universities.

There are various motivations for linking in any of these ways with Universities. Accessing specialised expertise is important, but not necessarily the dominant factor. Sometimes the science base is simply seen as a source of cheap labour.<sup>30</sup> Sometimes collaborations are entered upon in order to increase chances of gaining funding from DTI or EC support schemes, where such links may be mandated, or at least be believed to be favourable.

The interviews also elicited a few cases of firms using University links to make their own presence felt. In some cases displaying willingness and enthusiasm to engage with scholarly knowledge development and the science base was seen as good PR. This may be behind sponsored professorships from insurance companies, or sponsored working paper series by an accountancy company. But such activities were relatively uncommon.

In contrast, many KIS firms did target industry-organised conferences, publications, magazines, and the like, in order to raise their profile. In some sectors, more academic conferences, or ones that spanned Universities and industry, were of interest, however. Thus professionals/chartered engineers from the ES sector do quite often attend academic conferences.

Among the great majority of KIS firms, linkages between companies and the science base are invariably ad hoc. They may reflect graduate recruits' backgrounds, involvement in locality-based activities, or chance encounters. Formalised and ongoing relationships are seldom in evidence, and only a very few firms have begun to develop explicit strategies for such relationships. Thus: “we are reactive not proactive in our links with Universities [but] there is no requirement for a formal strategy”.

Many of the firms studied, especially smaller firms, reported no links with the science base, though many worried that this was not a good state of affairs for their company. (This does not mean that they do not access relevant information in indirect ways – through the knowledge of their recruits, through second-hand information purveyed by intermediaries and publications, etc.) Some smaller firms expressed the view

---

<sup>30</sup> This is the converse of another claim that we encountered. Some KIS regarded the science base as sometimes providing cheap and subsidised competition to the services of the private sector. This has been reported in other studies, and also been claimed to be a problem with government laboratories and their successors.

that they did not know enough about what universities could provide, why they should interact with them, and what their relevance might be to their business.

### **Expertise**

Access to expertise was used fairly often. Expert opinion might be required in new projects (for example market research firms investigating specific social issues or research methodologies), or where the use of the name of an academic or institution would support a project bid (without necessarily requiring any real collaboration over and above general advice). Only larger firms moved beyond an ad hoc basis for such contacts. Furthermore, much requisite (professional) expertise can be sourced from outside the university sector - there is much knowledge exchange and collaboration within most KIS sectors, through professional bodies and locality-based contacts.

The search for relevant expertise may be progressed in various ways. But the picture that emerges in this study (as in other work on academic-industry links) is that the search is generally for the right sort of people. These are people with well-grounded domain knowledge, but critically with the ability to interface with industrial users, to accept their practice-based problems as a basis for dialogue. (In contrast with "narrow" academics, focused only on discipline-based problems.) It is expertise that is typically required, not specific projects or research results. (Though media coverage of results may be the key to locating expertise.) Informed users may have quite detailed understanding of who is who in the research community – this is likely to be more prevalent where there is much debate over the appropriate science for a particular problem (whether this be econometric modelling or the development of nanotechnology). Such understanding is sometimes provided by key academic informants; sometimes through ongoing links with University departments and research centres; sometimes through participation in joint industry-academic conferences. Shove et al (1998) suggest that such strategies are less common in the business world than from policy users of the science base. They also suggest that users of research tend to select as experts certain 'stars' who have become visible beyond academic settings, finding interaction with the wider part of the science base much more difficult.

### **Collaboration**

Collaborative research was quite uncommon in the KIS sectors studied, as was outsourcing of any research to Universities. This is in line with the survey analysis presented in Chapter 4; our sample did not include R&D-oriented technical services, the exceptions to the general rule.<sup>31</sup> Some of the environmental services may be close to such technical services, however, and we have seen that these often have active links with Universities (e.g. [Boxes 5.5](#), and especially [5.6](#)). We also found one large insurance company that was quite actively involved with a University research centre, contributing to a programme of research ([Box 5.8](#)).

Smaller firms in most KIS sectors were generally unable to see much virtue in collaboration. Where they had problems or needs for knowledge that might involve the science base they had little idea of where to start (unless they had forged personal links already with academics). And, in general, they had little awareness of collaborative innovation support schemes, nor of such activities as CASE awards and the Teaching Companies Scheme. Most reported bewilderment about the

---

<sup>31</sup> An overview of various European Commission studies suggests that such collaborations are fairly prevalent in some areas of work. Impressionistically, they seem to be most common among those KIS that operate in providing strategic and policy-related research for public bodies.

opportunities here, and lack of time and resources to even find out about them.<sup>32</sup> Those who did know something of the schemes cited difficulties in engaging with their bureaucracies as a deterrent (justifiably or not); some said that this was more of a problem than lack of knowledge of relevant HEI partners.

Those collaborations that do exist often seem to have been initiated by academics themselves, rather than by the KIS firms. (It would be interesting to pursue this in more detail in a survey of collaborations.) The picture seems generally to be one of a researcher recognising that some new technique or problem that he or she was working with was very germane to the activities of one or other KIS.

One way in which collaborative relations might be established was when the science base was a *client* of KIBS firms. For instance, some market research and environmental services had been contracted by Universities to carry out services for them. (Sometimes this for the University's own functioning; sometimes it was support for research projects undertaken by academics.) The Universities are also often viewed in such cases as "intelligent customers", who can stimulate innovation in the KIS. Thus one business continuity product offering arose in this way. (See [Box 5.2](#)) Finally, it can be a source of prestige to be able to claim University customers. The linkages developed through such contacts can be important catalysts for ongoing exchanges. Nevertheless, we did not find KIS for whom Universities were seen as target customers, or as providing access to target markets (though certainly some specialised services do exist with this attitude).

One deterrent to collaborative research, in theory, might be concern about Intellectual Property protection matters. It could be the case that academics were viewed as difficult partners, with different attitudes to knowledge than businesses (For example, academics want to publish their knowledge, firms may want to keep theirs less apparent to competitors.) Some commentators have suggested that services innovations may be relatively easier to imitate and harder to protect than manufacturing ones, though the first point, at least, is contentious. Were these points to be the case, this might conceivably be a reason to be cautious with academic (or indeed any) collaborations.

However, IP issues did not emerge as major themes in the study. Firms use different approaches – e.g. market research companies found copyright of their reports to be important. But in general IP was not seen as a major challenge to innovation. Firms assume that there is only minor danger of leakage, and in any case little that can be done to protect intangible products. The attitudes of KIS firms here are of course liable to be very different from those of, say, the recording or pharmaceutical industries; and it is possible that if we investigated KIS associated with these sectors (e.g. computer animation or drug development firms) we might find different views.<sup>33</sup>

### 5.3.4 Some Case Studies

[Boxes 5.3](#) to [5.8](#) present a small number of case studies. These have been selected to highlight some of the range of experiences in KIS firms interfacing with the science base. We have chosen only a few of the large number of cases that are to hand. There is a bias in selection towards firms that feature relatively strong links. There are, of course, many more cases of firms with weak or non-existent links, but these

<sup>32</sup> Indeed, our interviewees were frequently asked to provide information on the opportunities, suggesting that the firms in question were able to envisage areas of collaboration.

<sup>33</sup> For a study of KIBS' intellectual property strategies, see Miles et al (2000). This study tends to cast doubt on the idea that services experience particularly acute IP problems.

cases make rather monotonous reading. Cases have been anonymised since permission to use the account presented here has not yet been forthcoming from all cases.

### **Box 5.2 Universities as “Intelligent Users” of KIS Firms’ Services**

Universities can play an important role in the innovation process as lead users and demanding consumers of knowledge intensive services.

In the *Business Continuity* sector, a small start-up firm that was developing advanced data storage technologies was approached to provide services by one of Britain's most prestigious Universities.

Acting as lead user for a new product, staff at Cambridge University helped the company specify this product in detail and suggested new functionality for it. Furthermore, the University provided a test-bed for the development and implementation of the new product. This support dramatically speeded-up the development process for the product, and the company has now sold almost 1,000 licenses world-wide.

This example gives rise to some interesting speculations. The role of Universities as informed users may be most strong where the relevant parts of the University already have a highly developed intellectual knowledge base related to the service in question. (In this case, computer scientists and risk management specialists were involved.) Such specialists can communicate effectively with the KIS firm without so much of a "learning curve". This may not be the case in various other KIS functions, where those members of the University involved in service specification are often members of the administrative rather than academic staff. (For instance, University human resource and marketing managers.). Here University practice may well be disconnected from the internal research into these topics (if there is any), as well as from the industrial leading edge.

### BOX 5.3 A Large Survey Firm

This large survey organisation has two divisions. Its corporate and consumer research division mainly provides market research for commercial organisations. Its social research arm mainly conducts work for public sector clients. Within each division there are specialist business units. Most of the company's social research involves impact measurement rather than opinion surveys. This work is often done in collaboration with other groups – whether academics or other consultancies.

*Human Resources:* Most staff possess a social science or humanities degree. Many have specific training in social research methods. However, the company has deliberately moved away from recruiting graduates trained in research methods. The view is that these skills often prove inappropriate, or at least difficult to transfer, to the commercial research context. The firm is now more interested in a generalist background - especially social science - than in experience with specific research methods. Its graduate recruitment activity targets Universities for good social science graduates. The firm has grown a great deal in recent years. There is therefore more scope for staff to specialise. There are, for example, statistical support staff, marketing support staff, etc.

An in-house training programme, lasting three months, caters for new staff. There is also on-going training provision. This combines technical (especially research methods) and business skills (e.g. project management, marketing etc). Elements of on-going training are sometimes outsourced – e.g. presentation, and general management, skills. Universities are never used as providers of this training. In the past the firm hosted a number of one-year *student placements* from a research methods degree programme. This was discontinued. There was no real role for the students in the organisation – it was not possible to fit them easily into the rhythms of work and the needs of specific projects, so they frequently became "glorified clerks".

*Research Links:* Links with academic researchers generally arise when University research groups approach the company for help in carrying out large-scale fieldwork for a major research project. In such collaborations, the academics provide the subject-specific skills and the company the social research infrastructure. Occasionally, and much more infrequently, collaboration is instigated by the company. In these cases, a particular skill or capability will be required for a project that requires a high degree of reflection and evaluation. Universities are not needed for assistance with the collection of data and the straightforward reporting of results.

There is, perhaps surprisingly, no collaboration with academia in the development of new techniques. According to the firm, little knowledge about new techniques seems to flow in either direction. (This point was in general confirmed by other interviews connected with market and survey research.)

### **Box 5.4 A Market Research Firm lacking linkages to Universities**

This case study is a fairly small research agency, offering strategic marketing consultancy to blue chip clients. It is in the business of communicating about market developments with senior decision-makers in industry.

However, the firm reports no direct links with Universities.

*Human resources:* The firm does not generally recruit new graduates. It generally requires at least 1 or 2 years commercial experience for new staff. Views of the relevance of University training are quite scathing. The interviewee reported one experience where the firm had wished to recruit a graduate statistician: they emailed various University careers services that ran apparently relevant courses. Very little response was elicited. The service provided by Universities was described as "shockingly bad". The firm now liaises directly with recruitment agencies.

The firm does not use Universities for training. They are not believed to provide any courses relevant to the business. The main training provider is, in fact, the Market Research Society (MRS - this runs a large number of training courses in client firms as well as at selected venues and via e-learning).

*Research:* There is no collaborative research at present. It is seen as something to be treated with great caution. The firm sees itself as a dynamic small organisation that provides, and is used to receiving, detailed and instant responses to requests. Universities are operating in a different world altogether. The firm had its "fingers burnt" when undertaking a joint project with a University. There was a "cultural mismatch" between what the academics expected and what the firm was looking for. The firm will be more careful in the future about whom it collaborates with - "this was a high profile client project that damaged our credibility".

Universities are seen as a repository of knowledge. They produce useful information on a range of topics round which the firm needs to form views and communicate intelligence. However, this rarely requires developing direct links with University departments or staff. Much relevant material can now be accessed indirectly through the Internet. Research results and informed opinions from all over the world can be garnered in this way. The staff believe that they are competent in accessing and validating material found in this way, and require little external support. "We do not need strong links with Universities to conduct our core business and even if we did, as a small business we do not have time to invest to cultivate these relationships." It might be speculated, however, that if they were requested to tackle problems that went far beyond their core areas of knowledge, they would have to consult expertise from the science base - or elsewhere - in order to find their feet. There are many cases of academics being requested to provide small sections of consultancy reports, where the consultants simply do not have the capability to assimilate the appropriate knowledge rapidly enough.

### **BOX 5.5 A Small Environmental Services Consultancy**

This 12-person consultancy is part of a small group of three firms, the others being a much larger waste operations company and a recycling enterprise. The consultancy activity was split off into a new business unit in order to promote diversification. The group was privatised out of a municipal waste authority in the mid-1990s. The majority of the work of the group as a whole is for local authority customers. There are approximately 200 employees across the group as a whole. Much of the consultancy work is in support of the other firms within the group. There was a recognition of the external market for the consultancy firm's knowledge. This largely revolves around environmental monitoring of waste management sites, both closed and operational. The company has no laboratory facilities. It outsources the analysis of samples to other technical services firms.

*Human resources:* The consultancy is split into two distinct divisions, environmental and engineering. Each involves roughly half of the staff. The staff are graduates from many sources. They include backgrounds in ecology, geology, chemistry, environmental sciences, mineral surveying, chartered engineers and engineering technicians. Each staff member has an annual review of training needs, and external training is often used (e.g. through professional bodies). Specialist technical training tends to be sourced on an individual basis, whilst business-related skills are often provided in groups.

The company does have contacts with several Universities. It sponsors undergraduates on courses in environmental science-related areas in a local University. This is not for recruitment purposes – they never hire these graduates – but for profile-raising. This training link does not really act as a knowledge resource for the firm.

*Research and Knowledge Inputs:* The knowledge activities of the firm are mainly driven by the need to keep up with **regulatory change**. The firm maintains information links through subscriptions to specialist and scientific publications, through membership of professional institutes, and through promoting the personal development of staff.

Collaborative research links are very uncommon. Where they do exist, they are project-based. They tend to arise from an approach from a University researcher to test a new idea using the firm's facilities, access to waste sites and expertise.

The firm is more likely to turn to other consultancies, or to professional bodies, for collaborators for its own projects. The company, being small, would be hesitant in getting involved in risky, leading edge research projects with no guaranteed return. They would consider outsourcing sample testing to university laboratories if these were suitably accredited. However, universities are not really present in this marketplace. Generally, the firm does not perceive university-based research to be an appropriate source of knowledge on the basis of which they can compete today, though they do recognise the potential for knowledge transfer. The interviewee identified a lack of awareness on both the industry and academic side as regards both needs and capabilities, and as regards the support schemes available to promote collaboration.

### Box 5.6 A Large Environmental Services Firm

This is a large firm for its sector, with over 500 employees and a turnover of some £40 million, providing multi-disciplinary consultancy for land-based industries. Originally it supplied free advice to the agricultural industry as a publicly-funded service. It was privatised in the late 1990s. The services include strategic business and technical advice for agriculture and horticulture, and work on food standards, environmental impacts and pollution control for agriculture. Multi-skilled teams deliver work commissioned by both government and industry. The business activities now include, among others, environmental planning, monitoring and impact assessment, environmental audits and management systems, landscape design, waste management and recycling, ecological and land management, land use planning, land restoration.

Strong links with UK Universities are reported. Universities - along with professional institutions - are seen as having an important role in *raising public awareness* in a range of environmental service areas. *Joint publication* in refereed journals is actively encouraged between staff and Universities, and students are recruited directly from universities for *graduate training* schemes or for sandwich degree *placement periods*. A joint research initiative has been undertaken with Nottingham University, where the firm is part-funding a *Crop Research Institute*, and also helps in the co-supervision of PhD projects over last 8-years. Universities of Reading and Leicester are also collaborators, with the firm having some of its salaried staff actually based full-time at these institutions (e.g. at Reading's *Centre for Dairy Research*). State-of-the-art, often highly expensive, equipment is housed in these University research centres.

The advantages of such collaborations are seen as:

- helping to create a critical mass of expertise that can attract research funding;
- access to facilities that the firm would be hard pressed to invest in;
- the opportunity to collaborate with other agents like DEFRA at these centres of excellence.

The company actively scans its external environment to keep up-to-date with any related research activities in universities. (For instance, it reviews recruitment advertisements in the New Scientist and similar publications, with a view to contacting the university group to discuss any collaboration proposals.) Universities also contact the firm's Quality Management Staff, who offer services in area of 'good laboratory practices' and compliance.

This case study illustrates the important role that can be played by centres of excellence possessing vital knowledge and facilities. This in part reflects the specific types of technical and scientific knowledge involved in this domain. The historic public service orientation of the firm, and the linkages established in that past, are also clearly important in raising its concerns with more fundamental research.

### **Box 5.7 A Business Continuity Firm linked to Universities**

This firm specialises in information security, business continuity and risk management services. It is 12 years old, and has around 70 employees, with a £7 million annual turnover.

*Human Resources:* The firm is involved with undergraduate teaching on Business and Management degrees – the interviewee, for instance, has given lectures on Information Systems. They have lectured on Business Law, too, and have assisted another University in establishing a module on IT security.

Students are "courted" as they are the potential future employees in 5 years time. But the firm does not actively recruit graduates. When staff are required, its strategy is to seek "second jobbers" – people with 2 years technical and business experience after graduation. The teaching involvement is not so much a specific training investment, as a way of reaching and orienting the specialist labour market.

Involvement with teaching is also justified as helping to generate business – "students are future decision makers within firms, and we need to educate them on the importance of BC services" in order to increase future revenues. "A lecture given two / three years ago will give us credibility within the market place". Involvement with Universities in this way additionally provides professional development opportunities for the firm's own staff. It is seen as enhancing community spirit within the business.

*Research:* In common with other BC firms interviewed, the interviewee argued that it is the KIS that are at the cutting edge of knowledge development. In general academic research has yet to grapple with many of the key issues that these services confront on a daily basis. (It is interesting to contrast this view with the example of Universities as "intelligent users" mentioned earlier. The implication is that when faced with similar problems, the academics may be able to bring very useful knowledge to the table.) There has been some collaboration and knowledge exchange, however: "Universities can contribute to improvements in knowledge in specialist areas". The firm has part-funded facilities in Universities, including a testing laboratory.

### Box 5.8 An Insurance Firm Linked to Universities

This large financial services firm offers life assurance and pensions. While its strategy for links with Universities is described by our interviewee as "opportunistic rather than clearly defined", it was seen as "Important for the business to retain a good interface with academia". A number of relationships with Universities were seen as providing important benefits to the business.

#### *Human Resources:*

**Graduate Recruitment** – the firm recruits approximately 35 graduates annually onto the General Management and Actuarial training schemes. It relies on the provision of high quality graduates as trained by Universities.

**Student sponsorship** - there are "ad hoc, isolated pockets" of sponsorship. The firm examines each case itself on a project by project basis.

**Training requirements** – Universities are used to provide training in professional qualifications including Chartered Institute of Marketing, Financial Planning Exams, in addition to self development and personal skills development courses.

#### *Research and Knowledge Exchange:*

The firm attends 4 meetings a year of the Financial Services Research Forum operated from Nottingham University Business School. It is described by our interviewee as a "wonderful way of seeing academia interact with business". Around 40 member firms attend the Forum activities. This allows for discussion of ideas and common problems, and as well as participation in research and sharing of the results.

Specific research topics are identified within the Forum and can then be furthered by University researchers. The firm sees this as assisting the University staff who are able to gain participants for their research. But most importantly, the interviewee considered that the collaboration provided huge benefits for the company. It generates useful research results (and ready access to them), and knowledge of different research methodologies and analysis tools. Furthermore, it assists the personal development of the KIS staff members, their horizons and networks are broadened.

## 5.4 Conclusions

The interview studies reveal that diverse, and sometimes highly complex, relationships underpin the quantitative results discussed in Chapter 4. Before summarising these, we should make the point that it is quite possible that our informants are not always liable to know about all of the links with the science base that their firm undertakes. An R&D manager may not know about the use the marketing department makes of academic work, a human resources manager may not know about the use of University equipment, for example. The problem of incomplete information is likely to be greatest in larger firms, however, and it is in these that the greatest density of links was actually reported. It is probably safe to assume that there are more links than we have learned of in some of the larger firms, but that the general pattern of contrasts across sectors and firms of different sizes is unlikely to be misrepresented in consequence.

For many KIS firms, especially smaller ones, the picture is, however, quite simple. Most of these firms have little contact with Universities. Even graduate recruitment is not usually performed on very much of a strategic basis, and staff with professional experience are preferred to new graduates. Founders and staff of small KIS firms are often drawing on the knowledge they themselves gained in University. But this is typically augmented by professional experience, whether this takes the form of explicit training or on-the-job learning, which is valued very highly.

Small and large firms alike largely see graduate qualifications as a matter of displaying capacity to gain and benefit from professional experience – on the job or through specialised training. It is much less common for these to be a source of discrete technical skills (though there are exceptions in such areas as actuarial and legal services). Graduates are not generally sought as a source of new knowledge derived from the cutting edge of research, though even here we found exceptions in the Environmental Services sector. Most often, when specific skills are being sought from graduates or postgraduates, these are sought from professional development programmes. In some sectors these are operated in collaboration with Universities, while others mainly rely on their own professional or training institutions.

KIS firms often report that the problems posed by discipline-driven academics are very different from those confronted by practice-driven KIS. This is why research inputs from Universities are rarely solicited, though there are a few examples of collaboration.<sup>34</sup> An interesting example of ongoing collaboration is the Financial Services Research Forum (cf. [Box 5.8](#)), which provides an opportunity for interactive development of research projects. Such fora - which are thin on the ground - can provide an opportunity for sharing intelligence about the two types of problem, and identifying areas of overlapping concerns. They may be set up by academics, or by professional associations. (For instance a body like the British Psychological Society brings together academic and KIS-based psychologists. They will need to liaise on

---

<sup>34</sup> Some informants suggested that the UK's experience may be quite different from that of some continental European countries. If these anecdotally described differences really do exist, they might be because academics are held in greater prestige and/or more managers have an academic background. Another possibility is that some countries feature a strong network of research centres (the case of Germany was mentioned here by several interviewees), intermediaries (the Netherlands), or academics who have to do "outside" work to be able to pursue their interests (Italy). We could also anticipate divergence from the USA. A comparative study of linkage policy and practice within and beyond Europe would clearly be an interesting topic for further research.

such issues as accreditation - in this case, for example, the qualifications required to be able to use various testing tools legitimately).

There appears to be considerable scope for linkages to be developed more extensively through fora of different types. These can include such intermediary bodies – professional associations, specialised business services offering training and consultancy, academic research centres and networks. Such parties could act alone and as partners in fostering closer links both in the human resources/teaching realms and in the provision of expert knowledge and research capabilities. We will consider further examples in the next chapter.

Very frequently, interviewees reported that they knew little or nothing about government and University initiatives to foster collaboration. Finding ourselves in the situation of having to outline and describe such initiatives, we were led to conclude that better promotion of existing opportunities would be at least as important as the creation of new structures.

## 5 Perspectives from the Science Base

A small programme of interviews has been undertaken with actors on the “supply side” of the science base. This included, especially, ESRC staff and University Industry Liaison Officers. A slightly modified version of the questions set out in Chapter 5 was used for these interviews. Use was also made of web searches and similar means to examine the issues arising, especially on the supply side.

### 6.1 Universities

Universities' strategies and organisation of linkages to business are quite diverse. Some Universities currently describe their main approaches at present as “bottom up” ones. The academic staff embedded in schools/departments and research centres are expected to be the primary points of contact for industry: “they are the agents to spot opportunities”. Others emphasise more elaborate interfaces between academics and businesses. One had an extremely devolved structure – with numerous, uncoordinated lines of business liaison (as well as a business liaison office, there were professional development, careers, and alumni offices, among others). Increasingly the structure of Industry Liaison Offices is being complemented by additional business-facing institutions, for instance Regional Offices that relate to regional firms and development agencies. In principle, such offices should be the entry point to industry in its contacts with academia. But many in industry are not aware of these offices. Small firms, in particular, are liable to find contact with University switchboards or websites a daunting affair. University websites, especially, tend to be organised almost completely around the needs of student recruitment.

All of the 12 Universities interviewed had a limited company arm, responsible for technology transfer and commercial exploitation of research. The core activities here have often traditionally been manufacturing-oriented. But many could equally be oriented to engineering and related KIS that support manufacturing – and increasingly to other sectors such as health. Thus, there are instances of commercialisation of biotechnology and medical assessment techniques, environmental services and methods for maintenance and prevention of corrosion, software for actuarial analysis, and so on.

Universities often have only limited central awareness of the full range of links with industrial and other users in which their staff participate. Many links are informal, and even formal links may escape central documentation. For instance, details of sources of research funds may be accumulated - the Research Assessment Exercise requires this. But the classifications of sponsors are crude and not always reliable, and there is little evidence on collaborators.

#### 6.1.1 Universities' Contact with Services Firms

None of the universities we studied target KIS in particular. Nor, according to our informants, is there any thinking about developing specific treatment for KIS (or any other broad sectoral groups). We might imagine that Universities with marked strengths in, say, social sciences (e.g. the LSE), might be particularly oriented to some KIS. (But in such cases it is often their links to the public sector that tend to attract most attention.) “Cluster policies” are currently very popular with regional development authorities and these often feature KIS sectors. Certain KIS play

important roles in some regional economies. These features may prompt more Universities to examine links with KIBS in the future. Thus the Regional Office, and the Information for Business Office, at the University of Manchester have been active in liaising between environmental services in the North West and environmental researchers at the University. (They have also encouraged the academics to develop more of a collective strategic orientation to the industrial world).

When asked specifically about KIS, the general view was that specific targeting was irrelevant. Responses such as the following were forthcoming: “Distinctions between sectors are blurred, firms are multi-service now, so targeting services would not help”. Working with business is about “providing services that are appropriate to their needs at any given time rather than treating groups of firms all in the same way – we may talk to one manufacturing firm about student placements and another about technology transfer – we would argue strongly against making a distinction based on sector”.

Despite such comments, Universities may target companies and market their services to them. But this is mainly based on their sense of their core strengths in key academic areas. One University had a highly explicit formulation of this: “Management committees consider all our strengths, and we target firms where we think we can make a contribution. This is based on research strength, teaching priorities and regional industrial needs.” In consequence, in several cases environmental services firms were targeted. This particular choice may also reflect the interdisciplinary nature of environmental problems. For other KIS, the Universities may have felt themselves to have no expertise in their domains, or seen links as a matter for specific departments to further.

Often there was indication of an orientation to natural science and engineering based industries - “We are a science based university and this is our core strength”. One University mentioned that it did wish to target the finance and banking sectors but did not have the resources to do so. Such a strategy could be beneficial - at three of the Universities surveyed, there was evidence of financial support, with research chairs and other posts being sponsored by financial services firms. The interviewees were, however, inclined to believe that this was most often a matter of philanthropic or PR/marketing efforts. It was seldom seen as an effort to tap directly into knowledge produced by Universities.

We enquired about any specific contacts being made with KIS firms in our four target sectors. Our informants suggested that such links largely took place through Business Schools and through Continuing Professional Development and Lifelong Learning services. (See [Box 6.1.](#)) In both cases a major emphasis was on businesses as customers to whom education services could be marketed. (As already indicated, the relations here were not always one way – KIS were notably involved in MBA courses, and also two examples of involvement at undergraduate level were noted.<sup>35</sup> The business schools also often provided consultancy services. This might be provided from within the school itself or as a separate entity (e.g. Oxford University Consulting).

One Industrial Liaison Officer commented that “we need to encourage departments to package knowledge in particular ways that are relevant to service firms”, while another saw this as a demand led problem – “Academics like chunky problems to

<sup>35</sup> KIS firms were in some cases involved in the design of professional development courses, and these might be codeveloped with professional associations.

solve rather than contract consultancy. Companies need to frame what they want to generate the interest of academics and make it relevant to the work at Universities.”

Of the KIS sectors studied here, Environmental Services appeared to have had strongest links with academics and the University research base. (This is broadly in line with results discussed in Chapters 4 - for technical services - and 5.) Thus, formal business links with Engineering and Environmental Science departments were noted at the Universities of Cambridge, Leeds, Liverpool, Oxford, Sheffield, Southampton, Newcastle, and Warwick - a majority of the cases examined.<sup>36</sup> Other than these examples, cases of collaborative research arose very rarely in the University interviews. KIS seemed to be viewed more as customers for educational services, and occasionally consultancy services, often from Business Schools.

There is reason to believe that these views are quite partial, and that more detailed research into KIS from a supply-side perspective would be very useful. Anecdotal evidence and some elementary websearching indicates numerous links that exist in practice. Some examples include:

- collaboration with consultancies in evaluation research to study public research programmes,
- identifying academic expertise and organising workshops in which these expertise can be accessed by engineering service firms;
- running industry “clubs” (spanning a range of research-intensive industries) whose members can exchange information about their own research management practices,
- addressing workshops investigating new ways of measuring and valuing intangible assets.

Short of surveying large numbers of researchers, it is hard to see how such a range of links could be assessed in practice.

Returning to the question of links through teaching and supply of Human Resources, it was noted that (large) KIS firms, with large graduate recruitment programmes, generally had strong links with University careers services. They would display a “heavy presence on the campus” in terms of such opportunities as careers fairs and similar presentations.

---

<sup>36</sup> Here we are noting the instances that were reported to us by the University interviewees. As the previous chapter noted, there are linkages identified from the KIS side. Thus, Business Continuity services had some limited investments in University facilities. Insurance and other financial KIS were networking with University research, through the Financial Services Research Forum. Occasional collaborations arise in the market research sphere - often opportunistically in raising funding.

### **Box 6.1 A University contributing to Professional Development**

Many Universities are active in professional development. One case especially relevant to our KIS sectors is Cardiff University. This has a variety of linkages with business and industry (and in common with other Universities surveyed, does not actively differentiate between services and manufacturing). The university's 'Research & Consultancy Division' helps to build external links for the university with new partners and their activities are split along lines of Technology Transfer, Research Section, Business Services and Other Areas. A Business Support Team is responsible for student placements and Teaching Company Schemes. The *Welsh Development Agency* funds some centres of excellence inside the university - and these lead to links with industry.

The Cardiff **Centre for Lifelong Learning** co-ordinates, develops and promotes the University's lifelong learning activities. The Centre provides around 700 Lifelong Learning Courses a year in almost 100 venues across South East Wales. This includes Continuing Professional Development (CPD) short courses. Interaction with the insurance sector is of particular interest here. An interesting recent development at Cardiff has been the university's links with the insurance sector. This collaboration was part of Cardiff's 'Innovation Networks', which encourages networking and fosters collaboration with business and industry. The insurance firm **Legal & General** have recently collaborated with the Centre for Lifelong Learning and the *School of Psychology* to develop an innovative course for insurance underwriters.

**Box 6.2 A University's linkages with Knowledge Intensive Service Firms**

The University of Sheffield's Office of Corporate Partnerships (OCP) operates at the "soft end" of business liaisons, as a gateway for businesses and helps academics to identify and build business relationships. It links together all faculties to focus on multi disciplinary research, assist departments to maximise commercial applicability of research. (A separate office is responsible for the "hard end" activities of technology transfer, IP licensing, spin outs, etc.)

The University benefits from close relationships with industry, which help it in conducting world-class industrially-relevant research and provide opportunities for research collaborations and secondments. They provide introductions to organisations overseas that would not otherwise be forthcoming. There is more scope for students to complete dissertations in conjunction with businesses. And strong commercial input into Masters programmes is achieved, with advice on curriculum and module content - and provision of teaching - e.g. 5 days per year on one Masters course is taught directly by private firms.

An example of a multidisciplinary project linking with Knowledge Intensive Services involves establishing a centre of excellence in sports science and engineering. This involves working with Montgomery Leisure (a sports management firm), Fluent (a global flow modelling company) the Chamber of Commerce and Sheffield Hallam University. The project was developed through contacts made at a Sports Engineering Conference held at Sheffield University and other informal contacts.

One department with strong links with KIS is the Civil and Structural Engineering Department. This is linked to environmental services firms, and in particular water companies. Research projects that are undertaken typically have a steering committee with 3-4 representatives from industry, who help ensure that research has outputs that can be transferred to the private sector and used immediately; that research ideas are formulated and tailored to the needs of the companies involved and that research is more commercially orientated. An example of a current project is one on Assessing Asset Management and developing a strategy for prioritising investment in infrastructure and water distribution system in order to minimise waste.

## 6.2 Individual Academics

There is a substantial literature on the general topic of University-Industry links, But little specifically addresses the question of KIS. On line of work that may be particularly relevant concerns the social sciences. Here the ESRC has commissioned several studies dealing with “user” interaction with academic research.

For instance, Shove et al (1998) draw attention to the different social contexts and reward structures within which academic and non-academic knowledge is developed and applied. Academic research networks are characterised by mutual, informal, exchange. Reputations are measured in terms of an individual’s standing in the eyes of research peers, and are formed through intellectual reciprocity. (This is embodied in debate; publishing, reviewing; refereeing and examining; and a huge range of meetings.) Researchers do report that the expectations that firms approach them with – their prior reputations – are liable to be in part based on the reputation of the research centre or University in which they are based. But this reputation is only partly based on academic prestige. In non-academic environments, the terms of reciprocity may be defined via formal contracts, specifying the sort of output required and the funds that will be available. Researchers need to use different strategies for building their reputations here, e.g. promoting work through non-academic media, taking part in specialist conferences and professional/industrial networks. In the 1990s the Foresight programme proved a valuable way for some academics to build their links with industry – including with KIS, in the case of several Panels.

Engagement with users is liable to require academics to enter new territories. They may have to prepare different types of report, and be used to writing and displaying information in different ways. They may have to participate in and host different types of meetings. They will need to put effort into targeting relevant industry bodies and media, or into more or less formal provision of (mainly) unpaid advice to businesses (alongside civil servants, voluntary bodies; journalists, etc.) Continuing dialogue might be required to relate elements of the science base to practical needs of KIS. It may be necessary to go beyond information exchange, to be involved in the development and application of knowledge in industrial contexts via ongoing relationships. (Such relationships feature in CASE studentships, Teaching Company Schemes and in some forms of collaborative research.) This interaction is demanding of academics’ time and personal resources, and is often not valued in terms of academic reputations and reward structures.

It can be hard to maintain lasting networks that span such different worlds. This is very apparent in CASE doctoral studentship schemes, for instance, which have a three-year duration. Over this time the industrial project to which the student was attached often moves on; the firm changes its priorities; key contacts in the industrial staff are replaced by people with other networks and agendas; the firm itself may change its identity through merger or acquisition.

Despite the difficulties described above, some individuals and research groups certainly do successfully establish and maintain links with KIS. Shove describes a key capability here as being the ability to “switch between academic and non-academic identities”, to establish multiple reputations. The researchers examined in her study rarely saw Universities as playing a significant role in promoting their (social scientific) work to potential users. Their Universities might do more to establish their reputations as a source of cutting-edge research and expertise in various domains. But University administrators could not have much capacity to

know of, and to integrate themselves within, the many networks that exist in the business world. Generally, they would be able to do little more than relay standard information about graduate opportunities and research funding. This view may be too pessimistic; the experience of Regional Offices at Universities like Manchester suggests that rather more integration of academic and business worlds may be possible. But this is new territory, on the whole, and requires a great deal of effort to master.

### 6.3 Research Centres

Increasingly, Research Centres are seen as a critical part of the “knowledge infrastructure”. It was hinted above that such centres are liable to be used as guides to locating relevant expertise by KIS. There is scope for much more attention to the role that such centres play in academic-industry linkages in general, and in those concerning KIS in particular. Here, a few general points and examples may be set out.

The science base features many types of research group. Some of these have arisen more or less spontaneously, for example as specialist groups within a discipline-oriented academic association. Some stem from the evolution of research arms, or practice-oriented lines of work, within traditional departments. (This is the case for many groups working on social and science policy issues, for instance.) Some are the outcome of bids for funding addressed to Research Councils, who may support seminar series and networks, and physical or virtual research centres. Such groupings can make the activity and people in the science base more visible, and interact with KIS in various ways – for instance by mutual representation on steering committees, working groups, standards setting activities, and the like. Shove et al (1998) concluded that researchers working in self-financing centres were especially good at developing and maintaining non-academic contacts and networks. They are liable to develop entrepreneurial skills, and become attuned to the language and practical problems of user organisations.

A research group’s reputation and range of competences, and the scope for members to be involved in various networks, may enable it to maintain linkages with users better than can individual researchers. Research centres are more likely to be useful points of contact in this respect than traditional academic departments, for several reasons:

- First, the range of problems covered in a typical academic department will have to span a wide range of a discipline’s concerns - not least so that these can be effectively taught. In contrast, a centre may be focused on specific classes of problems, often in a multi- or inter-disciplinary fashion.
- Second, membership of a centre is contingent on commitment to a collective exercise. The reward structures of traditional departments, in contrast, often encourage individuals to go their own ways in terms of research.
- Third, the problems addressed by many centres are ones where academic and practical concerns converge. They are not solely discipline-defined problems, typically, though they may be involve rather more fundamental questions than those typically addressed by industrial practitioners.
- Finally, Research Councils may require that their centres are multidisciplinary and demonstrate an orientation to users. This is indeed the case for the ESRC (and an analysis of interim and end-of-term reports from ESRC centres might be a useful way of identifying some of the stronger links between the social science base and KIS). Centres established through Research Council core funding may

go on to become viable organisations funded by a number of sources – though in general the UK business community is a minor part of this.

The Commission on the Social Sciences (2003) noted the importance of centres as intermediaries between the wider science base and industry. It stressed the potential for the science base to learn from instances of successful centres (such as the Centre for Economic Policy Research) and Institutions (such as the Royal Economic Society) to identify good practice here. An interesting exercise would be to examine the whole range of centres in the UK, and determine which are particularly relevant to KIS. For example, risk research centres were cited by our Business Continuity informants as sources that they used – the LSE's Centre on Risk and Regulation being a case in point. Another centre, Nottingham's Centre for Risk and Insurance Studies, is equally relevant to the insurance sector, and features a funded professorship here. (See [Box 6.3](#)) We would anticipate that the technical services who report high levels of contact with the science base will have ties to research centres as well as to individual academics and department, too.

Some centres and similar fora report considerable success in industry-academic liaison. It would be worth pursuing this topic further and identify what practices best facilitate this - the picture does not always appear to be so rosy. Just as funded University positions appear to be sometimes used mainly for PR purposes, so funds are apparently sometimes allocated to centres by industries that make little effort to interact with them. One centre we located was working on topics related to a financial KIS, and established with support from the main industry association here. But it reportedly sees itself as under-utilised by the industry. One researcher suggested that the motivation for funding the centre derived from industry's need to show government that it was seriously engaging with an urgent topic. They argued that individual firms have little or no interest in - or capacity to absorb and use - the results of their (technically challenging?) work. However, part of the lack of dialogue may derive from the centre's strategy, whereby researchers keep themselves at arms length from individual firms in order to protect the independence of their research. This reflects an ever-present dilemma for those concerned with questions of academic-industry links.

#### **6.4 Research Programmes**

Research Centres are one way in which Research Councils have the opportunity to make major inputs to specific problem areas - centres may also arise from the "bottom up", or be funded by other sources such as charitable foundations. Research Programmes are also funded both by Research Councils and from other sources. Various ESRC projects are relevant to the KIS, though few have been central interest to the sectors we have been focusing on. Other programmes are funded by the DTI and other agencies - [Box 6.4](#) provides an example of the latter. Some programmes (e.g. the Intellectual Property Initiative) are jointly funded by Research Councils and the DTI.

### Box 6.3 – The Centre for Risk and Insurance Studies (CRIS)

This Centre is based at Nottingham University Business School (NUBS); NUBS also hosts the Financial Services Research Forum. Nottingham University believes itself to be uniquely “seriously committed to insurance research”, with a long-established post in Insurance Studies, and at present three Chairs are funded by the Insurance Sector:

- Worshipful Company of Insurers Chair in Insurance Management,
- Norwich Union Professor of Insurance Studies
- Swiss Re Chair in the Management of Risk

CRIS has an *Advisory Board for Research* consisting of 6 industry representatives, provides comment and guidance on the Centre’s research, and feeds in information on industry trends and topics of interest. (It is also likely to play an important role in diffusing information on the Centre’s work more widely). It publishes a newsletter, CRISLINE that features “pen pictures” of recent research projects. The aim is to promote interest in insurance studies and show industry how the Centre is relevant to its concerns. Two conferences are held annually, for both academics and practitioners - an effort is made to ensure that presentations are framed towards those from a non academic background to help engage industry representatives. Links with trade bodies, institutes and regulators are seen as very important, as these organisations tend to have more continuity among personnel than many firms do.

Collaborative research is being undertaken with KIS – two current projects are funded by KIS (the Institute of Actuaries and an Insurance company). Additionally, Research Fellows are funded by organisations in the insurance sector to work on projects of mutual interest

Several issues confronted by academics working with the insurance sector were noted. First, it can be difficult to engage KIS staff in research. As the industry becomes more dynamic there is less emphasis on strategic planning and less strategic research is being conducted by insurance businesses themselves. It is even difficult to find people at higher corporate levels who are interested in the study of the insurance industry. Second, problems are engendered by the high level of movement within the industry, which was reported as being “in a state of continual flux” (the same is probably true of most KIS sectors). The frequency of movement of individuals, and changes in the ownership of companies, mean that it is difficult to maintain contact in a diverse and fluid industry. Research often requires long-term engagement, and this may be problematic - thus the importance of links with intermediaries.

The Financial Services Research Forum has a wider range of members - Banks, Building Societies, new entrants to retail financial services, organisations servicing the financial services sector such as IT companies, etc., with reinsurers and consultancies being eligible for associate membership and consumer interest groups as affiliated members. Its website (<http://www.nottingham.ac.uk/business/forum/>) outlines a range of research activities that are underway or completed, including studies of change management, regulatory environments, consumer education, and virtual distribution systems.

### Box 6. 4 The Tsunami Initiative (1997-2001)

TSUNAMI was a DTI Sector Challenge Project managed by the British Antarctic Survey (an institute of the Natural Environmental Research Council). TSUNAMI was jointly funded by the DTI and a consortium of companies (including Royal & SunAlliance, Aviva and brokers and Lloyd's managing agents) with a total budget of £960,000. Our information source here is an ex-manager of the initiative; the TSUNAMI websites provide more detailed information:

<http://www.nerc-bas.ac.uk/tsunami/> and [www.newton.cam.ac.uk/programs/muc](http://www.newton.cam.ac.uk/programs/muc)

The Finance & Insurance industries are highly competitive sectors, which are using ever more sophisticated methods of assessing risk. However, it was felt that the UK's science base has only transferred limited amounts of its relevant knowledge to the insurance sector. This industry relies heavily on the analysis of low probability events in the natural, economic and social environments.

This initiative mainly funded a full-time facilitator, small contract research studies, workshops and a conference, and larger research projects - there were four grant rounds for academics to bid for such funding. Examples of workshops conducted are those on *El Nino*, *earthquakes*, *UK floods* and *Y2K*. Projects initiated to engage companies and the science base include those on:

- *Tropical cyclone forecasting* (awarded to University College London, Reading University, and the Meteorological Office).
- *Improving prediction of risks from extreme weather events* (University of East Anglia – Climatic Research Unit; UCL – Dept. of Statistical Science with help from Imperial College).
- *Understanding how uninsured risks impact individuals, companies and local/ central governments* (Surrey University – Centre for Environmental Strategy)
- *UK Flood risks: insurance availability affordability issues* (Middlesex University and Southampton University).
- *Extreme Value Statistics and Non-Stationary Time Series Analysis* (University of Cambridge - Engineering Department)

As for the lessons learned from TSUNAMI, a key one was that "the task is about cultural change first and science application second in this sector." In other words, it is necessary to establish a culture of knowledge exchange before we can get down to "exploiting research". It is easier to engage individuals, but harder to bring in whole organisations - yet organisations are essential to the change process.

Both insurance companies and Universities (and other parts of the science base) need new processes to handle their interactions. It would be most desirable to establish a robust network with regular meetings and a "focus on user pull" in defining directions of research, topics for workshops, etc. Such a network should remain flexible and stimulate interests via workshops/ conferences/ dinners etc. In terms of research development, the academic community could be more than simply responsive in identifying research topics - the immediately perceived needs of industry are not always the best guide to longer-term studies. An effective network would help to stimulate new research that could help the insurance sector in the future. Once the needs for work in a particular area are established in the insurance firms themselves, they can formulate problems and help identify where science base can best respond.

## 6.5 Research Councils

Research Councils are keen to demonstrate the relevance and utility of their work - though they have not found it necessary to think about their contribution to KIS. Our interviews within research councils have been with the ESRC, and though ESRC-funded research points to the economic importance of KIS, there appears to have been little thought as to whether this suggests specific challenges in terms of interactions between the business and research communities.

The “Research Impacts” section of the ESRC websites’ “Business and Policy Users” page currently only features policy impacts, though some of these – like the 3G licence auction – have had a big impact on business. ESRC has a range of advisory boards with users as members, and the current ESRC Council has two industrial representatives (both from service sectors – TV and radio, and banking). The Edge newsletter is intended for policymakers, the voluntary sector and business readers, and ESRC Connect is a “club” of some 250 members who receive targeted information from ESRC research studies.

CASE studentships are a potentially important means of linkage. These give students experience in confronting business environments and problems, and bring supervisors into contact with non-academic partners. The ESRC reports not having developed any specific strategies for reaching out to KIS here. It appears that, despite initial expectations, relatively few of these are with private sector firms (as opposed to government or third sector bodies) though the lists of studentships could be examined with a view to demonstrating the role played by KIS here. We have not been able to undertake an exhaustive analysis here, but simply examine the material presented by the ESRC concerning its 2003 CASE awards.<sup>37</sup>

The data report on 36 collaborations with the public sector, 4 voluntary sector collaborations, and 18 with private sector bodies. This last figure is a little misleading, since 7 of these turn out to be charities or similar bodies (sometimes with a with a “Ltd” status). Of the 11 remaining, 5 are with manufacturing firms – from pharmaceuticals to footwear – and 6 with services. This somewhat underrepresented the share of services in the economy, of course; but it is interesting to note that 5 of these 6 are KIS. (The exception is Wessex Trains, a collaboration with the University of Exeter’s Department of Geography on “Railway branch line services: Franchises, scapes [sic] and flows, and economic and social membership”). The KIS collaborations are listed in Table 6.1.

---

<sup>37</sup> Source of the material which is analysed in the following paragraph is [http://www.esrc.ac.uk/esrccontent/postgradfunding/CASE-2003\\_esrc\\_case\\_studentships.asp](http://www.esrc.ac.uk/esrccontent/postgradfunding/CASE-2003_esrc_case_studentships.asp) and other pages linked to it; some research into the individual companies has been undertaken by further web searches. (Accessed June 2003) Interestingly, the web searches revealed several instances of the firms in question doing work for Universities – and this was revealed without any effort made to look for such links. It would be interesting to examine similar data on CASE awards for the EPSRC - this is not on its website.

**Table 6.1 ESRC CASE Awards 2003 – Links with KIS Firms**

<b>KIS Firm and University partner</b>	<b>Firms' Operating Fields</b>	<b>Title of Project</b>
<ul style="list-style-type: none"> <li>• Jenkins and Marr</li> <li>• University of Aberdeen, Dept of Land Economy, School of Resources, Environment &amp; Society</li> </ul>	Architecture, planning & development services, environmental assessments., feasibility studies.	The institutional capacity of the speculative housebuilding industry
<ul style="list-style-type: none"> <li>• Kielder Newport West Ltd</li> <li>• University of Lancaster, Entrepreneurship Unit, Management School</li> </ul>	International marketing and management consultants, market research, strategic and business plans performance.	An analysis of entrepreneurial learning during stages of franchise growth
<ul style="list-style-type: none"> <li>• Ove Arup &amp; Partners Ltd</li> <li>• Kings College London, Dept of Geography</li> </ul>	Consulting engineers, designers ("from automobiles to infrastructure, structural engineering to communications consultancy, financial, and socially led engineering")	The 'walkable city': the dimensions of walking and overlapping walks of life
<ul style="list-style-type: none"> <li>• Galen Research</li> <li>• University of Manchester, Faculty of Social Science and Law, Centre for Census &amp; Survey Research (CCSR)</li> </ul>	Developer of quality of life instruments for use in clinical trials and health economic studies.	The Use of Ranks in Response Elicitation and Analysis for the Measurement of Quality of Life in Health Policy Evaluation
<ul style="list-style-type: none"> <li>• Mercer Human Resources Consulting Ltd</li> <li>• University of Oxford, School of Geography and the Environment</li> </ul>	"Our services cover the full spectrum of human resource issues and have been developed to help...clients achieve peak performance through the optimal use of the talents of their employees. "	Culture, risk and responsibility in European defined contribution pension plans: The range of options and the exercise of choice by plan participants in the UK and continental Europe
<ul style="list-style-type: none"> <li>• The Standard Steamship Owners' Protection and Indemnity Association (Europe) Ltd</li> <li>• University of Wales: Cardiff, School of Social Sciences, Seafarers International Research Centre</li> </ul>	Specialist Insurance for shipowners aiming at "the containment of, and if possible, a reduction in, the cost of P&I insurance; high quality ship operation; first class financial security; etc."	Why do ship safety systems fail?

Source: ESRC and company websites

Several comments can be made. First, there are few KIS firms absolutely among the CASE awards, and these span a fairly wide range of the services that might be included. The firms tend to be large and often international ones. The social sciences featured are also diverse, but geography and related departments seem to be particularly prominent. The topics researched are also diverse, as are the styles

of research – some projects appear to be providing operational tools, some market assessment, and some an overview of business practices. They demonstrate the wide variety of ways in which social sciences might contribute to KIS, and suggest that there are many latent opportunities for other projects on similar (and similarly diverse) lines.<sup>38</sup>

The ESRC reports finding it difficult to establish collaboration with businesses, in establishing CASE collaborations and in other respects. It appears that fundamental research is usually too far from their bottom line. Something of an exception is the Teaching Company Scheme (TCS), which has a dedicated team of consultants seeking out projects. In terms of KIS, we see here that marketing is an area of the TCS with a large number of projects (though many of these are with end-users rather than the marketing sector itself). (There are also several projects that are liable to be related to parts of the IT services sector, though not to business continuity.)

As [Box 6.5](#) displays, the EPSRC has targeted a number of KIS in its own attempts to increase links with industry. The sectors that the EPSRC has been addressing include a number that are largely service-dominated, and arguably several others have a number of relevant KIS working close to them.

It has been suggested that, even in the services sectors, the EPSRC is liable to be a more relevant source of knowledge relevant to industrial innovation, than is the ESRC. This might be argued about "harder" technology - and the EPSRC supports programmes of work to do with human-machine interaction that involve many "softer" elements. (For instance, PACIT - People at the Centre of Information technology.) But it is not necessarily the case that only the EPSRC has a role here - for example, the ESRC funds much work on industrial innovation processes that is relevant to those working with "harder" Technologies. We would expect social research of many types to be highly relevant to many KIS - management studies, analysis of social trends and labour markets, studies of IP and intangible assets, and so on. Nevertheless, it does appear that the ESRC retains a greater orientation to public services than to private ones. In this respect, the EPSRC may provide a good model for furthering collaborative work and closer linkages between KIS and the science base. It will be very interesting to see how this strategy evolves and what lessons may be derived from it.

---

<sup>38</sup> Several of the public sector CASE studies could easily be seen as being conducted with private firms, with a little "tweaking".

### Box 6.5 Industrial Research and the EPSRC

The EPSRC has set up a "collaboration zone" on its website ([www.epsrc.ac.uk](http://www.epsrc.ac.uk)), with links to work on twelve sectors that it has prioritised:

- Aerospace and Defence
- Bulk Products and Materials
- Chemicals Pharmaceuticals and Biotechnology
- Computing and Communications
- Construction and Environment
- Electronics
- Financial Services
- Food and Drink Sector
- Healthcare
- Power
- Retail
- Transport

It is aiming to increase involvement of users in its longer-term strategic thinking, and develop strategic partnerships with its users. It seeks to increase awareness of EPSRC amongst the user community, and to build and sustain a better knowledge and understanding of user needs within the EPSRC itself. It intends to stimulate academic-user collaboration on research grants and training awards, and to increase the exploitation of research and training outcomes and knowledge transfer.

Two of the targeted areas are KIS: computers and communications and financial services. In **computers and communications**, three service activities are targeted: Computing services; Software services; and Telecommunications services. About 200 companies are involved in over 480 projects, of total value £78 million. Many of the companies involved are mainly thought of as manufacturers, though BT Laboratories is the most frequent collaborator (DERA is second, and the BBC the third).

In **Financial Services**, EPSRC collaborations focus on such topics as: software design; information management; financial risk management; fraud detection; construction risk assessment; and profitability and costs tendering. 12 collaborative research projects are supported in this industry sector, with the following companies and other organisations involved: Abbey National; ABN-AMRO Bank; AXA Insurance; Bank of Scotland; Barclays Global Investors; Capital Bank; Dresdner Kleinwort Wasserstein; General Accident; Halifax; Hughes Financial Analytics; Lloyds TSB Bank; Loss Prevention Council; NatWest; Nomura International; Open Computers and Finance; and The Financial Services Authority.

In both cases, it is believed that many other EPSRC-funded projects are relevant to the sector, even if not conducted in collaboration with KIS. Beyond these sectors, Some environmental activities may be relevant to environmental KIS, transport research for transport KIS, and so on.

## Conclusions

Chapter 4 noted the relatively weak relations between most KIS and the science base, except in terms of graduates as a source of human resources. Chapter 5 showed that those relationships that do exist are more complicated than might at first be thought. Chapter 6 confirms this complexity. It finds that academics - especially those in traditional University departments – may face rather similar barriers collaboration with KIS (and with industry more generally) to those encountered by smaller firms.

Chapter 6 also confirms suggestions that there appears to be considerable scope for various sorts of intermediary body to facilitate such linkages. Research centres and fora, research programmes with industrial participation, and similar types of initiative can play important roles. They can foster closer links in the development and availability of human resources; and also in the provision of expert knowledge and research capabilities. It would be useful to examine those initiatives that are in existence to draw lessons as to what constitutes effective and good practice. We already have some sense of where there are particular gaps that might be addressed. It is encouraging to note that some academic groups in Universities and the Research Councils themselves seem to be increasingly aware of the opportunities here.

## 6 Conclusions

This report has examined relations between KIS and the science base. It has done so using secondary analysis of survey data, interviews within a number of KIS sectors, and examination of some parts of the science base itself.

Both qualitative and quantitative studies indicate that the direct links between KIS firms and the science base are typically rather weak. One KIS sector - the R&D-oriented technical services - are outstanding in the survey analysis as users of knowledge from the science base (graduate human resources, information, and collaborative research).<sup>39</sup> The case study research was also able to identify some cases of strong links - in environmental services, and among larger companies. But these are exceptional. Far more commonly, linkages are weak or non-existent. This is particularly true for smaller firms, many of whom have no sense of the potential for such linkages, nor of how they might go about establishing them. They have no sense of how relevant expertise might be found, nor of the schemes that exist to support collaboration.

With the exception of enterprises in technical services, KIS in general fare poorly in terms of links with the science base as compared to most other sectors. Despite their knowledge-intensity, links with the knowledge generated by the science base seem to be very limited - more so than, for example, the more high-tech parts of manufacturing. These even applies to IT services, whose weak links are clearly demonstrated in survey results.

The survey analysis revealed that in general the science base appears to be a secondary source of information and a rare partner in collaboration. But it did suggest that KIS users of the science base are likely to be particularly dynamic firms. Two implications arise. First, though few enterprises do report close links with the science base, these links do play a significant role in the innovation process in (at least some parts of) the UK economy.<sup>40</sup> Second, the experience of these successful innovators could be emulated more generally. If the knowledge economy really does mean that many more firms need to be innovative in order to compete effectively, they may need to establish such links themselves<sup>41</sup>.

The survey analysis also suggests that the issue is not simply that services and KIS in particular have no need for knowledge to support their innovation. If anything, there is a tendency for services, and KIS, to be more oriented to private sources of knowledge, and less to public sources, than are manufacturing firms. Both the sectoral features, and the generally smaller size, of KIS firms, seem to be implicated in their low links to the science base. We can think of them as suffering a "double deficit".

Of course, directly searching for information and collaborators in Universities is not the only linkage that firms have to the science base. Knowledge flows are also mediated via graduate recruitment and through professional and other intermediary associations. The significance of the science base is likely to be higher than the

---

<sup>39</sup> The structure and functioning of these "anomalous" technical services is a topic that requires further research.

<sup>40</sup> Parts which, furthermore, are strategically important - some because of their size and international significance (e.g. financial services), some because of their contribution to the functioning of the whole economy (e.g. KIBS).

<sup>41</sup> Many of the interviewed KIS firms raised this point without prompting.

relatively low levels of information exchange and collaboration imply. To quote Tether and Swann. "it is likely that the indirect contributions of the science base to innovation in service enterprises are considerably greater than the direct contribution".

This is also the implication of the qualitative analysis. Actual interactions and collaborative research are fairly rare, though they are often evaluated very positively when they do occur. (That being said, the case studies do reveal examples of "mismatches" between the content and timing of academic work and the needs of KIS collaborators.) Ongoing interaction seems to be the most important precondition for linkages that are successful in terms of contributing to the KIS.

Lack of relevant knowledge and expertise does not appear to be a major problem for most KIS in the UK, according to the survey analysis. Other factors are cited as impeding innovation to a greater extent. This is similar to the results for other sectors, of course. How one evaluates this result depends upon one's assessment of the need for firms to be innovative in the contemporary world. We should probably just accept that the managers of many small firms, in particular, are not very concerned about growth and internationalisation of their businesses. They are contented to function at a satisfactory level within their local economies or niches, and dealing with overseas partners, for example, is just too much trouble.<sup>42</sup> However, there are other firms for whom growth may already be seen as desirable. And there are grounds for thinking that many service activities are liable to find themselves more challenged as sheltered markets disappear and new entrants emerge, and innovation will have to rise on their agenda, too.

These arguments suggest that there are liable to be more requirements for links with the science base than are currently expressed by KIS firms. The lack of knowledge as to just what resources are available in Universities, and for making use of University facilities, means that opportunities are liable to be missed.

This is not to say that the science base is simply ripe for industrial exploitation. However, there are signs that in many dynamic areas of KIS, there is a large - and possibly growing - gap between academic knowledge, and that developed in the professional world. A professional knowledge infrastructure has grown up, sometimes closely intertwined with (certain) Universities, especially in connection with professional development. In some cases it is much less connected. In some fields, University training in fields that are closely related to the KIS activities is regarded as lagging behind KIS practice, or even as largely irrelevant. In other cases, University courses are tied more closely to professional accreditation systems. This does not seem to be entirely a matter of how well-established the KIS activity is - some longstanding professional services are much more closely linked to Universities than are others. The costs and benefits such different arrangements are liable to vary over time and across sectors. This could be a valuable topic for further research - and for dialogue between KIS and academia.<sup>43</sup>

KIS are usually dominated by small firms. Most sectors do nevertheless feature a handful of large companies (and these dominate the insurance sector). The differences between small and large firms were repeatedly underlined in the study. The problems that small firms have in identifying the potential that the science base

<sup>42</sup> This has been labelled the "two Jags" syndrome, and was found to be the case in KIBS in Denmark, too - the major obstacle to their internationalisation was lack of motivation. See Henten and Vad (2003).

<sup>43</sup> For instance, how and in what cases do links concerning professional development interface with research in Universities and in KIS themselves?

could offer their activities were very striking. Even where the larger KIS firms have active link, and are strategically able to recruit graduates and mobilise expertise, smaller firms are generally out of contact with the science base. Their recruits are some years away from their University courses, they have no current University contacts, they are unaware of government programmes that could help them forge better links.<sup>44</sup> On this last point, the low level of awareness of such schemes, despite years of seeking to promote them through mechanisms such as Business Links, needs to be understood. If better and more targeted marketing of such schemes could be achieved, this might well prove to be more effective than the creation of new schemes and programmes.

The institutions of the science base – Universities, Research Councils, etc., and their research groups and centres – will be familiar with the next conclusion. This does not make it redundant. These institutions should be playing more of a role in actively promoting the expertise of the science base. Beyond exhortation, it is important to provide individual and groups of researchers with appropriate incentives (and resources) to engage with users and with networks of users in a meaningful way.

These principles apply to industry-science base links in general. The time is ripe for them to be extended to KIS. Lessons should be drawn from the practice of those UK centres that have proved successful in these respects – and also, anecdotal evidence from our interviews suggest, from comparative studies of practice in other EU member states such as Germany. It may also be appropriate to design new centres, initiatives, and community-building activities (from seminars and conferences to industry clubs and informal events) that can effectively articulate links between the science base and KIS sectors.<sup>45</sup>

Given the small-scale nature of many KIS firms, this may require specific efforts to meet their limited resources and feed into their existing networks. For instance, activities may need to be organised at local and regional levels, or through trade bodies and professional associations that they belong to. The KIS that themselves play a role in knowledge translation and transfer may have a role to play here.

The study has found very little previous experience or accumulated wisdom to draw on in investigating the topic of KIS and the science base. Despite the recognition of the importance of KIS to the UK, the ways of fostering this sector and its innovative potentials are still largely unexamined. The UK is not alone in this; these services have only recently attracted much attention anywhere. Pioneering work in this respect has been conducted in Finland. In Uusimaa (and elsewhere in Finland) KIS have been explicitly adopted as a focus for Foresight studies. Here, KIS firms investigated as to their knowledge needs, training strategies, emerging challenges, and the like.<sup>46</sup>

---

<sup>44</sup> CASE, TCS, LINK, various EU schemes, etc.

<sup>45</sup> A very interesting example of such an initiative is The Ottawa Centre for Research and Innovation (OCRI - website is: <http://www.ocri.ca/> and many interesting presentations are downloadable from here). This organisation, seeded with government funds, is now mainly funded by fees paid for attendance at a large range of events for industry (and other audiences). Breakfast and lunch meetings, together with half-day seminars and other initiatives are held; some are targeted at specific industrial sectors (some of them, KIS) who are liable to have a stake in, say, knowing about an emerging technology (e.g. photonics, life science developments). Typically a "champion" from within the sector is located, who establishes a small working group to design the event. The events allow for environment scanning, networking, the establishment of better relationships among players. Work spans local, regional and national levels of organisation. Another activity supported here is Research Chairs - the current three include ones on product design, multimedia databases, and real-time software. Thanks to Jack Smith of NRC for information on this initiative.

<sup>46</sup> Cf. Toivonen (2001, 2002).

The sorts of networking and crystallisation of industrial and research knowledge that Foresight-type activities encourage make these sectors relevant ones for activity in the UK as well – especially where there is rapid technological change (as in business continuity). Properly designed such activities could themselves build links between KIS and the science base, as well as pointing to future directions for policy and strategy on the part of the supply and user sides. Given the diversity of KIS, it is likely that such activities will need to be tailored to highly specific sectors, rather than attempt to span the whole range of activities. A first step could be to identify a small number of KIS which are promising candidates, and to develop experience as to how best to conduct further initiatives on the basis of these pilots.

## References

R Bilderbeek, P den Hertog, G Marklund, I Miles, 1998, **Services in Innovation: Knowledge Intensive Business Services (KIBS) as co-producers of innovation.** Report of WP 5 and 6 of SI4S project, PREST mimeo, University of Manchester: available at SI4S website at <http://www.step.no>

Commission on the Social Sciences, 2003, **Great Expectations: the social Sciences in Britain**, available from <http://www.soc.surrey.ac.uk/~scs1ng/C.Univ-Gt.Expectations.pdf>

R Coombs & I Miles, 2000, "Innovation, Measurement and Services: the new problematique" in J S Metcalfe & I Miles (eds.) **Innovation Systems in the Service Economy** Dordrecht: Kluwer, 2000

CRIC/IDSE/ISE, 2001, (B Tether main author) **ANALYSIS OF CIS DATA ON INNOVATION IN THE SERVICE SECTOR: Final Report**, report to European Commission DG12, CRIC, University of Manchester

R Cutts, S Brusoni and A Geuna. 2001, **Competence-Building in the Insurance Industry in Response to Predictive Genetic Testing** mimeo, SPRU, University of Sussex Report (Deliverable 11 – D11) prepared for 'NewKInd – New Indicators for the Knowledge Based Economy' Project N: IST-1999-20782

E Duff, M Shiner, A Boon, A Whyte, 2000, **Entry into the Legal Professions: The Law Student Cohort Study Year 6** Research Study 39, London: Law Society  
Available at: [http://www.lawsociety.org.uk/dcs/pdf/sru\\_39entry\\_v1.pdf](http://www.lawsociety.org.uk/dcs/pdf/sru_39entry_v1.pdf)

A Friedman, K Davis, C Durkin, & M Phillips, 2000, **Continuing Professional Development in the UK: Policies and Programmes** Bristol, Professional Associations Research Network

F Gallouj, 2002, **Innovation in the Service Economy**, Cheltenham: Edward Elgar

M Gibbons et al, 1994, **The New Production of Knowledge**, London: Sage.

D Halpern, 1994, **Entry into the Legal Professions: The Law Student Cohort Study Years 1 and 2** Research Study 15, London: Law Society  
Summary available at: [http://www.lawsociety.org.uk/dcs/pdf/sru\\_15entry\\_v1.pdf](http://www.lawsociety.org.uk/dcs/pdf/sru_15entry_v1.pdf)

T Hatzichronoglou, 1997 "Revision of the High Technology Sector and Product Classification", **STI Working Papers**, 1997/2, OECD, Paris.

A Henten and T Vad, 2003, "Services internationalization: characteristics, potentials and barriers of Danish service firms" in Miozzo and Miles op cit.

I Miles, 1999, "Services and Foresight" **Service Industries Journal** vol. 19 no 2 pp 1-27 April

I Miles, 2000a, "Environmental Services: Sustaining" In B Andersen, J Howells, R Hull, I Miles, and J Roberts (eds.) **Knowledge and Innovation in the New Service Economy**, Aldershot, Elgar

I Miles, 2000b, "Services Innovation: Coming of Age in the Knowledge-Based Economy" **International Journal of Innovation Management** Vol. 4, No. 4 December 2000 pp 371-390

I Miles, N Kastrinos (with K Flanagan) & R Bilderbeek, P den Hertog (with W Huitink & M Bouman) 1995, **Knowledge-Intensive Business Services: Users, Carriers and Sources of Innovation**, Luxembourg, European Innovation Monitoring Service, Publication no. 15 (ed/d-00801 mas)

I Miles, B Andersen, M Boden & J Howells 2000, "Services Processes and Property", **International Journal of Technology Management** vol. 20 nos. 1-2, pp95-115

M Miozzo and I Miles (eds.) 2003, **Internationalization, Technology and Services**, Aldershot, Elgar

M Murphy and G Vickery, 1999 **Strategic Business Services** Paris: OECD.

OECD (2001) OECD **Science, Technology and Industry Scoreboard: Towards a Knowledge Based Economy**, OECD Paris.

PIU, 2001, **In Demand: Adult skills for the 21st century** London: Performance and Innovation Unit (now Strategy Unit) available at:  
[http://www.number-10.gov.uk/su/wfd\\_1/report/1.html](http://www.number-10.gov.uk/su/wfd_1/report/1.html)

B Preissl, 2000, "Service Innovation: What Makes it Different? Empirical Evidence from Germany" in J S Metcalfe and I Miles (eds.) **Innovation Systems in the Service Economy**, Kluwer Academic Publishers, Boston, Mass.

T Punt & B Cole, 1999, **Routes into the Solicitors' Profession and the Utilisation of Professional Time** Research Study 36, London: Law Society  
Summary available at: [http://www.lawsociety.org.uk/dcs/pdf/sru\\_36routes\\_v1.pdf](http://www.lawsociety.org.uk/dcs/pdf/sru_36routes_v1.pdf)

S Randles and B Tether, 2003, "Services, scale and structures of internationalization: North West England's environmental technologies firms" in Miozzo and Miles (op cit.)

M Shiner, 1999, **Entry into the legal professions: The Law Student Cohort Study Year 5** Research Study 33, London: Law Society  
Available at: [http://www.lawsoc.org.uk/dcs/pdf/sru\\_33entry\\_v1.pdf](http://www.lawsoc.org.uk/dcs/pdf/sru_33entry_v1.pdf)

E Shove, B Robson, O Fulton, P Halfpenny, I Miles & A Warde, 1998, **Exchanging Experience of Exploitation** report to the ESRC, mimeo: Universities of Lancaster (CSEC) and Manchester (Dept of Geography)

J Sundbo, 1998, **The Organisation of Innovation in Services** Aldershot, Edward Elgar

J Sundbo, 2000, "Organisation and Innovation Strategy in Services" in Boden, M. & I. Miles (eds.) **Services, Innovation and the Knowledge Economy**, London, Continuum

B S Tether & G M P Swann, 2002, "Services, Innovation and the Science Base: An investigation into the UK's 'System of Innovation' using evidence from the UK's Third Community Innovation Survey" presented at, **International Workshop on Innovation in Europe: Empirical Studies on Innovation Surveys and Economic Performance**. Rome, 28 January 2003 (Institute of Socio-Economic Studies on Innovation and Research Policy; National Research Council, ISPRI-CNR and University of Urbino, Faculty of Economics)

M Toivonen (ed.), 2001, **Growth and Significance of Knowledge based Services** Helsinki, Finland, Uusimaa TE Centre Publications 3

M Toivonen, 2002, "Internationalization of Knowledge-intensive Business Services in a small European country: experiences from Finland" in Miozzo and Miles op.cit.