Research Project:

Interviews with firms on innovation investment

Final report for NESTA

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Introduction

A recommendation from the revision of the System of National Accounts (SNA) 1993 is to include R&D as an intangible fixed asset. This reflects the increasing role of knowledge in the economy. An increasing amount of analytical work is also being done on the possible effects of moving the asset boundary beyond just R&D and software to include other non technical, knowledge based, activities[1], with interesting results on investment and productivity (Corrado et al 2004 and Giorgio Marrano et al 2007).

The definition of an asset within the National Accounts is to deliver benefit to the owner for more than a year; a characteristic that R&D and other non technical activities often demonstrate. The result on the production account of capitalising intangible investments is to increase the level of GDP whilst providing more detailed data on the sources of productivity growth. Net wealth is increased as stocks of intangible assets are recorded in the balance sheet; as these stocks are used up they provide capital services to the asset owner. Therefore in order to 'capitalise' intangible investment within a national accounts framework it is necessary not only to estimate the levels of stock but also the rate at which the stocks depreciate and become obsolete over time. That is, to estimate their service lives.

The UK Office of National Statistics (ONS) and its academic partners have undertaken considerable research into developing measures of intangible assets. Recent papers have focussed on:

- Software investment - both purchased and own account (Chamberlin 2007);
- R&D capitalisation - in support of the OECD IPPTF, (Galindo-Rueda 2007, Evans et al 2008);
- International comparisons of intangible investment - for the European Union Framework Seven programme on 'International comparison of Intangibles and growth accounting' (Haskel and Giorgio Marrano 2007);
- Innovation investment and an innovation measurement framework - for NESTA's measurement programme (Clayton et al 2008).

The purposes of this study[2] are:

- to seek answers on asset lives, using a framework developed by the OECD;
- to test whether companies can provide data on non-technical innovation activities, in addition to data provided on conventional R&D.

In the Pilot phase we tested a questionnaire developed from the OECD model used internationally. We conducted a set of preliminary structured interviews with companies that undertake technical R&D and non-technical activities in order to determine the length of

[1] Other non technical innovation activities includes software and computer networks, design of new products, design of new processes, employer-funded training, organisation/business process improvement and reputation and branding.

[2] We gratefully acknowledge financial support from NESTA for conducting the interviews reported herein.

asset service lives. In phase two the questionnaire was adjusted according to feedback from respondents and used on a further set of firms.

This report discusses the methodology of previous studies and of this one. It goes on to outline the questionnaire used and brings to attention the main points raised regarding the format of the questions. It goes on to discuss firm selection and industry characteristics of the sample. Results of the questions are presented before the data about life-lengths. Finally the report makes conclusions and recommendations for future work.

Methodology

Various methods have been used to try to establish intangible asset service lives. Mead (2007) undertook a review of the four basic approaches; production functions, amortization models, patent renewal models, and market valuation models - he concluded:

> *"None seem completely satisfactory because they are based on strong identifying assumptions or applied to data that lack sufficient variation to separately identify R&D depreciation rates".*

An alternative approach, suggested by Charles Aspden of the OECD as part of the framework of the Canberra II group, has been to estimate service lives by directly receiving information from experts working within the field of R&D. The Central Bureau of Statistics in Israel undertook a number of pilot interviews and concluded that by interviewing experts it may be possible to obtain relatively consistent responses in a business survey on the duration of R&D projects, length of application lags, and length of use in production (Peleg 2008a). In order to estimate whether service life lengths are similar internationally, the service life sub-group of the OECD Intellectual Property Products Task Force (IPPTF) recommended that other National Statistical Agencies undertake a similar survey of businesses.

The ONS adopted this framework and (with part funding from NESTA) applied it to both technical and non-technical R&D. We interviewed forty firms from six broad sectors (outlined later in this report). The objectives of the interviews were threefold;

a) to find out if firms were able to provide the information required;
b) to test the feasibility of, and solicit constructive feedback on, the questionnaire;
c) to collect data.

Ten Pilot phase interviews were undertaken between 10 September and 3 October, 2008, phase two took place between 6 November 2008 and 27 February 2009 and saw thirty firms interviewed. The interview process lasted for around an hour and was interviewer led. Due to the multiple aims of the interviews a joint 'cognitive[3]' and 'survey[4]' interview technique was employed. The interview was conducted using a scripted questionnaire in order to collect data, whilst supplementary questions were asked to check the comprehension of the interviewee and to draw out additional information. In accordance with the recommendation from the Israeli survey and initial findings from the German study, the interviews endeavoured to be conducted with technical personnel. Most interviews were taped but not transcribed[5]; all tapes were destroyed after the results were recorded.

[3] Cognitive interviewing techniques focus on the process of answering the question. They attempt to understand how the respondent fulfils the task of answering questions and detect any actions or understandings that are not what the designer intended.
[4] Survey interview techniques are focussed on collecting answers. Generally they are fully scripted, contain closed questions and are non-conversational as the interviewer accepts the respondent's answer.
[5] One firm refused permission for the interview to be taped.

Questionnaire

The questionnaire was designed using the template provided by the Central Bureau of Statistics in Israel and supplemented by contributions from the Economic Analysis, Methodology and Surveys and Administrative Sources Departments of ONS; NESTA; and Professor Jonathan Haskel of Imperial College, London. The full questionnaire used in phase two has been included in **Annex 2**; please contact the authors for further resources including the questionnaire used in the pilot phase). The questionnaire was divided into two distinct sections:

Box 1: Examples and definitions - Section A / Section B split

Section A: Technical R&D -	Spending to resolve scientific and technological uncertainty.
Section B: Non-technical R&D -	Spending to support the commercialisation of new knowledge in your business, or spending to develop new business processes or organisation.

Feedback from the pilot phase encouraged us to refine our definitions and examples to help respondents understand this split. For example the pilot stage questionnaire had (in hindsight) ambiguous examples about non-technical activities, while phase two respondents were given much more specific example steps in the creation of a DVD player with explanation as to whether they should be covered in section A or section B. This encouraged discussion and generally resulted in a much easier understanding of the difference between the two sections before any data had been collected. Please refer to **Annex 1** for full details of definitions and examples given for this purpose.

Some phase two respondents still struggled with the distinction. For example one response was that:

> *"… I cannot relate with the examples and definitions for non-technical R&D. You can't have the same examples across such a wide range of industries. Perhaps you could tailor them to specific industries?"*

There was often lively debate around the definitions of section A and section B. Generally the companies were comfortable with 'technical R&D' (although some companies said they do 'design and development' rather than R&D). There are three main issues gathered from discussion around the separation of the sections.

1. Firms do recognise the split but cannot respond on one section or another. It was found in the pilot that the interviewee found it difficult to provide information for both technical R&D and non-technical activities.

   "I am the right person to talk to about section A (technical R&D), but section B is too wide ranging for one person to answer."

   "This should be two questionnaires."

2. Firms struggle to distinguish between the sections; in fact several firms actively seek to combine the technical and non-technical elements of a project in both their planning and accounting.

   "We do not distinguish between technical and non-technical like this… all departments are encouraged to work together on a project."

   "It is very hard to separate technical and non-technical elements of a project."

3. The polarity between sections A and B was more pronounced for larger firms, where it was typically difficult for a single interviewee to cover both sets of activities. In addition, some larger firms declined to participate in the project on the grounds that they could not provide a single individual to cover both sets of activities. Some firms

offered to complete the questionnaire independently, but it was felt that more work was needed to develop the questionnaire in order to be confident that self-reported responses would be reliable.

The pilot stage interviews and discussion at the OECD's Taskforce on deriving capital measures of intellectual property products led to a number of improvements to the questionnaire for phase two. These included:

- changing the order of the questions
- providing clearer definitions
- giving more examples
- being more specific on geography and timeframe
- developing the service life length table to include questions relating to both in-house and purchased technical and "non-technical R&D"
- including a weighted expenditure column within the service life length table
- providing the potential interviewees with more of a brief prior to the interview in order that they could ensure that the correct people were there to answer questions for both technical and "non-technical R&D".

General responses to the survey

Generally, the interviews with technical personnel were positive and open, and several interviewees said they felt that the R&D and wider intangibles agenda had been neglected. This was not always the case though, particularly when it became apparent that some financial respondents were not the most appropriate people to talk to. Some of these interviewees were defensive and less forthcoming with their answers. This finding is in accordance with the Israeli and German study which highlighted the importance of interviewing technical personnel when discussing technical R&D.

Only a minority of pilot interviewees were able to answer both parts of the questionnaire with most of the interviewees answering either section A (technical) or section B (non-technical). This dramatically improved in phase two; when respondents were given the questionnaire in advance and when it was known that more focus must be put towards ensuring the appropriate person was being interviewed.

Table 1

Response rates (ability to provide data)		
	Section A	**Section B**
R&D manager	86%	59%
Finance manager	88%	88%
Director	70%	100%

Table 1 must be interpreted with caution. Many of the second phase 'finance managers' had done preparation with their R&D colleagues. Generally speaking it has been learnt from interviewer feedback that, in terms of data quality, section A is best answered by R&D manager and Section B is best answered by the finance manager (or a director) with broad knowledge of business activities.

As technical R&D is often managed internationally, rather than nationally or at a unit basis, throughout the interview some respondents had difficulty answering the questions from a consistent geography. Similarly, the time frame for the collection of data also caused confusion to some interviewees - some questions related to the last financial year, whereas some of the R&D questions related to a period considerably longer. The questionnaire was adjusted to ensure improved clarity on the geography and timeframes reported.

One of the most important results from the pilot phase interviews was that companies were able to provide answers to many of the questions; including estimates of R&D service life lengths – this was also a finding from the Israeli and German studies and encouraged us to continue to phase two of the project.

Throughout many of the interviews; the concept of a three-stage service life (development, transition and use) was felt to be simplistic by a number of respondents. That said, many of the respondents did not recognise the transition phase:

> *"These life length phases feel unrealistic and not a reflection of real life."*

> *"There is no 'transition phase'. This is a milestone, not a period of time."*

The concept of a typical project was questioned by various interviewees; a general response was that a typical project does not exist as projects are individual by nature:

> *"R&D investment is often used in multiple products and multiple R&D investments may be built into a single product… therefore estimating the product life-length of an R&D project can be problematic".*

> *"There is a long time between expenditure and success. We don't know if our spending has worked yet"*

Firm selection

Pilot phase

Firms were sourced from the UK Innovation Survey respondents. Firms were filtered by industry and such that they had responded positively to the following questions:

q1310 or q1320. *Did this business engage in the following innovation related activities: Internal R&D OR Acquisition of external R&D?*

q2900. *Would this business be willing to be approached by DTI or its appointed agents, in connection with further enquiries on innovation?*

Letters were then sent to a selection of these filtered firms. In total thirty-three letters were sent to ONS contacts. The letters were followed up with telephone calls and interviews were arranged. Nine face-to-face interviews were conducted at the firm's premises and one telephone interview. At this stage respondents were not given the questionnaire in advance in order to encourage spontaneous answers and strengthen the cognitive analysis.

Phase two

Firms were selected using a combination of the pilot approach and also utilised respondent information from the Business Enterprise Research and Development survey (BERD). Respondents were given advanced notice of the questionnaire form and advised to consider it before the interview took place. This had the noticeable effect of both increasing the quality of data gathered and also ensuring that the most appropriate person within the firm was interviewed.

Characteristics of firms interviewed

The industries targeted for our sample were not a random selection, but selected to cover particular sectors (as requested by NESTA). They are summarised in Box 2 and Table 2.

Box 2: Industries featured in "high-tech" "low-tech" split

Major technology sectors ("high-tech")	Non-technological sectors ("low-tech")
Average employment: 820	***Average employment: 570***
Average technical R&D spend: £15.7mil	***Average technical R&D spend: £950k***
Including:	Including:
Pharmaceutical	Consumer goods
Aerospace	Consumer services
ICT	
Engineering	

Given the small sample size, this report will take advantage of the "high-tech" "low-tech" sectoral split in the results section. Table 3 demonstrates that there is a large difference between the technical R&D spend of the average firm in the two sectors (the average firm in a "low-tech" sector spending only approximately 6% of that of the average firm in the "high-tech" sector). It also shows a large range of technical R&D spends suggesting the firms represent a good range of R&D intensity within our sample.

A similar trend appears when looking at the non-technical spends (Table 4). "High-tech" firms also tend to spend more on "non-technical R&D" (the average "low-tech" firm spending only 3.8% that of the average "high-tech" firm) and there is an even wider range of reported spends.

Firm size can be measured through employment, shown in Table 5. Again, the sample appears to represent a good range of small firms through to large firms.

Table 2

Respondent sector split	
"High-tech"	22 firms
"Low-tech"	18 firms
Total	**40 firms**

Table 3

'Technical' R&D spend	
"High-tech" mean[6]:	£15.7mil
"Low-tech" mean:	£950k
"All firms" mean	£11.4mil
Sample minimum:	< £50k
Sample maximum:	> £200mil

Table 4

"Non-technical R&D" spend	
"High-tech" mean:	£45.1mil
"Low-tech" mean:	£1.7mil
"All firms" mean	£22.5mil
Sample minimum:	< £10k
Sample maximum:	> £400mil

Table 5

Size of firm: Employment	
"High-tech" mean:	820
"Low-tech" mean:	566
"All firms" mean	707
Sample minimum:	< 20
Sample maximum:	> 6,000

[6] All averages reported are un-weighted unless stated otherwise.

As well as the broad “high-tech” / “low-tech” split, in order to allow greater analytical flexibility, some of the results given in this report break the respondents into the six-sector split shown in Box 3[7].

Box 3: SIC92 (2 digit) Industrial breakdown of six sector split[8]

Manufacturing - Chem / Pharma (<10 firms)
Average employment: 350
Average technical R&D spend: £2.5mil
Including:
24. Chemical and chemical products

Manufacturing – Electrical & communication (<10 firms)
Average employment: 200
Average technical R&D spend: £8.5mil
Including:
30. Manufacture of office machinery and computers
32. Manufacture of radio, television and communication equipment and apparatus
74. Other business activities

Manufacturing - Other high tech (14 firms)
Average employment: 1,100
Average technical R&D spend: £22.5mil
Including:
29. Manufacture of machinery and equipment
34. Manufacture of motor vehicles, trailers and semi-trailers
35. Manufacture of other transport equipment

Manufacturing - Other low tech (<10 firms)
Average employment: 350
Average technical R&D spend: £650k
Including:
15. Manufacture of food products and beverages
17. Textiles
21. Pulp, paper and paper products
22. Publishing, printing and reproduction of recorded media
25. Rubber and plastic products
36. Manufacturing not else classified
37. Recycling

Services – Finance & business (<10 firms)
Average employment: 1,300
Average technical R&D spend: £400k
Including:
65. Financial intermediation, except insurance and pension funding
66. Insurance and pension funding, except compulsory social security
67. Activities auxiliary to financial intermediation

Services – Other (<10 firms)
Average employment: 120
Average technical R&D spend: £30k
Including:
64. Post and telecommunications
74. Other business activities

[7] The six sector split does not map exactly to the “high-tech” “low-tech” split because there is a certain amount of interviewer discretion in the classification of firms.
[8] Some numbers of observations have been suppressed for reasons of confidentiality.

Results

Section A: Technical R&D

Categories of R&D

The opening question was intended to gauge firms' attitudes and methods with regards to the measurement of technical R&D. On a cognitive level it was intended to encourage the respondent to think about the R&D activity taking place within the firm. This was an open question asking firms:

"What categories of Technical R&D projects go on in your business?"

The question gave suggested examples (outlined in Box 4). Every firm who responded to this question was able to (and chose to) use the example categories.

Box 4: Examples and definitions - categories of technical R&D

Basic:	*Blue sky research without any particular application or use in view*
Applied:	*Pursuit of new knowledge directed primarily towards a specific practical aim or objective*
Experimental development:	*Drawing on existing knowledge, which is directed to producing new products or processes or to improving substantially those already produced or installed*

Interviewers reported very few instances where this question gave the respondent issues for interpretation. However, one technical manager reported that:

> *"It is very hard to give figures here, categories are not pigeon holed like this."*

This question was generally interpreted as intended; especially when the respondent had a financial background (probably because the definitions are in line with the Frascati Manual (2002)). Thirty-two firms were able to give data on for this question. Non-responses were concentrated among the "low-tech" firms.

Results shown in Figure 1 show that:

- All sectors spend the smallest proportion of their R&D spend on "Basic" research;
- High-tech sectors spend proportionately most on "Experimental development";
- Low tech sectors spend proportionately most on "Applied research".

Feedback from interviews shows that many firms do not consider 'Basic research' to be a commercial activity. Attitudes were that if it does not have a commercial aim it would be senseless to pursue. When probed further; respondents felt that 'Basic research' could only be conducted at any meaningful level by universities and governments.

Breaking the firms into six sectors (Figure 2) allows deeper analysis of the trends. The most striking result is that both of the services sectors spend the vast majority of their technical spend on applied research (with a very small proportion on basic research). The manufacturing sectors have a more even spread between applied research and experimental development, with the electrical & communication industries and 'other high tech' spending proportionately more on experimental development and the remaining sectors spending proportionately more on applied research.

Figure 1: Proportions of technical R&D (two-sector)[9]

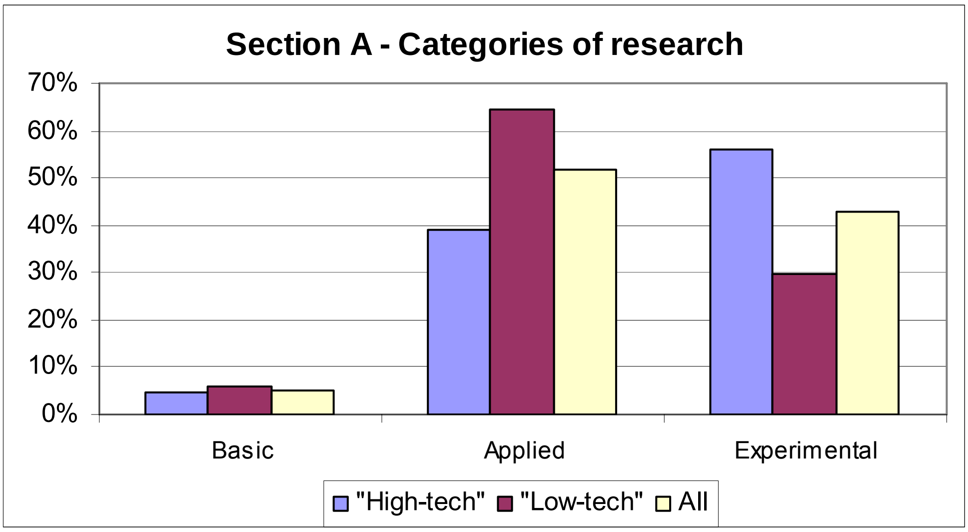
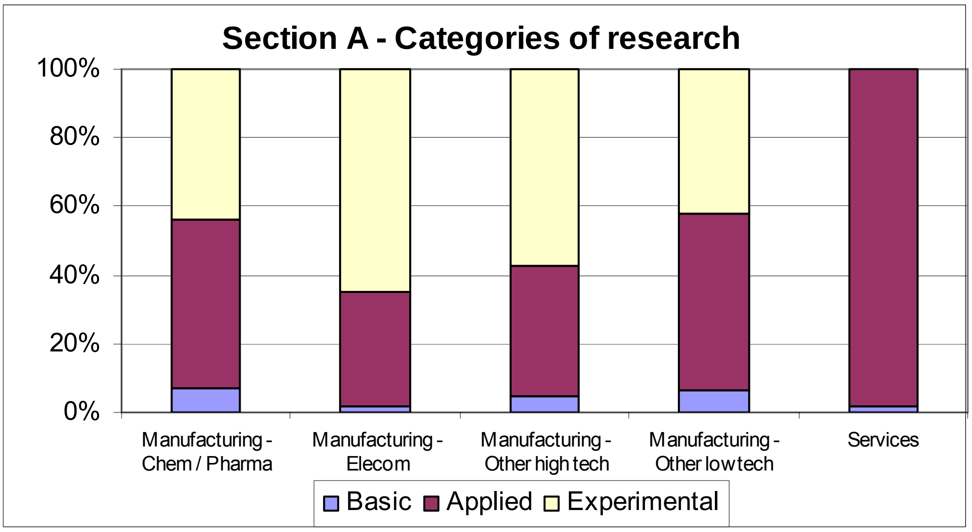


Figure 2: Proportions of technical R&D (six-sector)[10]



There are no discernable trends from analysis by size of firm.

Sources and structure of technical R&D

The questionnaire asked firms where their technically based knowledge came from. They were invited to divide the sources between four options:

What proportion of technically based knowledge in your business that is new in the past financial year comes from:

% Technical R&D done in the business, in the UK
% Technical R&D done in the business, outside the UK
% Licensed / purchased technical R&D from outside the business
% Technical ideas / knowledge freely available outside the business

[9] Figures may not add up to 100% due to rounding.
[10] Services sectors combined for disclosure and confidentiality reasons.

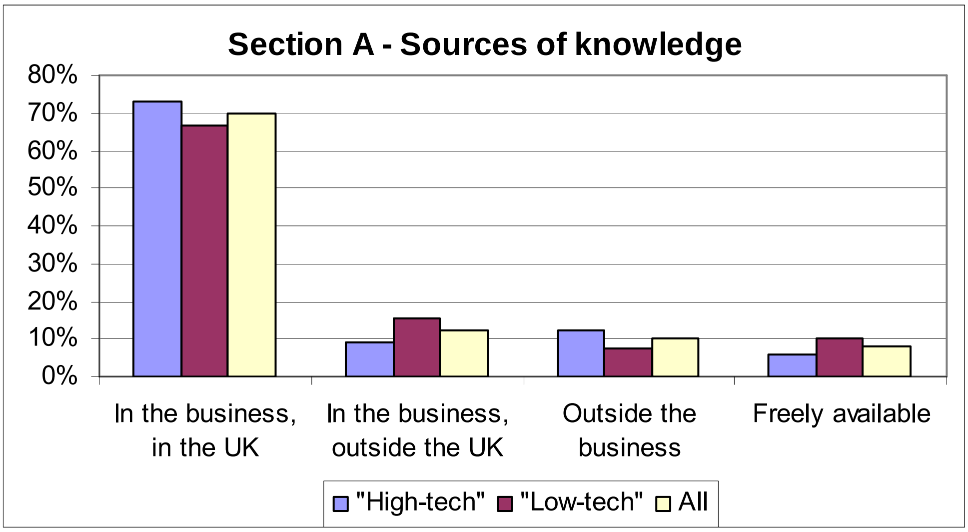
Respondents were generally able to answer this question, albeit that some found it easier than others. The sources and structures of R&D production and management varied from firm to firm. The responses suggest that firms are prepared to use a combination of internal and external sources, resourced from different geographies, to achieve the optimum outcome. The comments below give a better insight into the management of R&D at the firm level:

> *"…it was undertaken across a number of departments internationally."*
>
> *"…there is a dedicated R&D site internationally but design was undertaken across a variety of sites internationally. We also buy in R&D from suppliers and do a lot of collaborations with both universities and other small companies."*
>
> *"…we have a dedicated department in the UK and source some from outside the company."*
>
> *"…we have a dedicated department in the UK and internationally as well as sourcing from outside the company."*
>
> *"…R&D is undertaken in the UK across a number of departments, we also source from outside the company."*
>
> *"…R&D is undertaken in the UK across a number of departments; machinery is brought in from outside the company."*

The complex structure of production and ultimate ownership has implications for estimating service lives. If R&D is produced in the home country but owned abroad, either through outright sale or affiliate transfer, the estimates of service lives are less relevant for the nation's capital stock - it may therefore be more appropriate to interview companies that only own and use R&D in the domestic market.

Twenty-one "high-tech" and eleven "low-tech" firms provided data. It was the larger firms; in the main, who were able to answer this question most satisfactorily. Also those respondents who had had a prior look at the presentation and spent some time talking to people in the firm to prepare for the interview tended to provide good data.

Figure 3: Sources of technical knowledge (two-sector)



The four options are shown in Figure 3. A clear pattern is apparent that the average firm sources the large majority of their technical knowledge from within the firm, in the UK. There is no discernable differentiation between "high-tech" and "low-tech" firms.

Figure 4: Sources of technical knowledge (six-sector)[11]

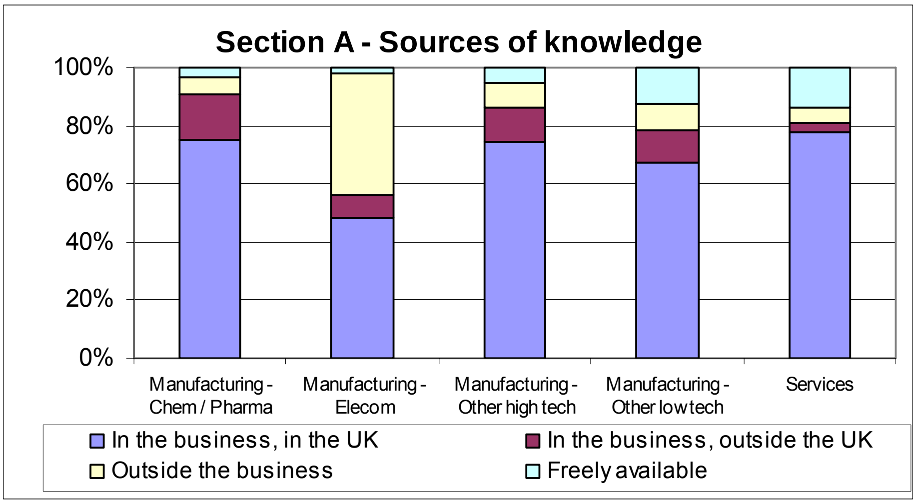
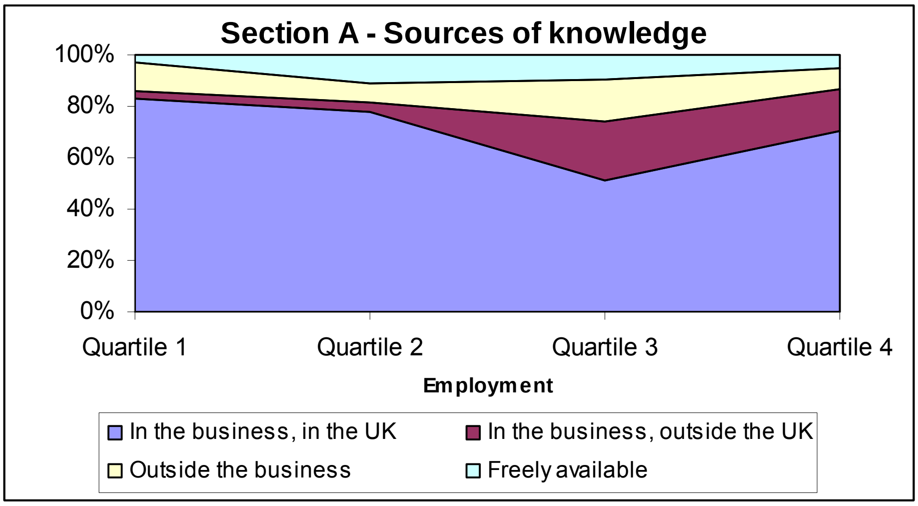


Figure 4 divides the respondents into the six sector split. It can be seen that the 'financial and business services' sector source their technical knowledge only from within the firm in the U.K. Of the technical knowledge that is sourced from outside the firms, the majority of it ends up in the 'electrical and communications' manufacturing sector. Most of the freely available technical knowledge tends to flow to the 'other' services sector.

Figure 5 demonstrates that while the proportions of the sources of knowledge changes over the size of firm, there are no distinct trends or patterns to be extracted.

Figure 5: Sources of technical knowledge by firm size

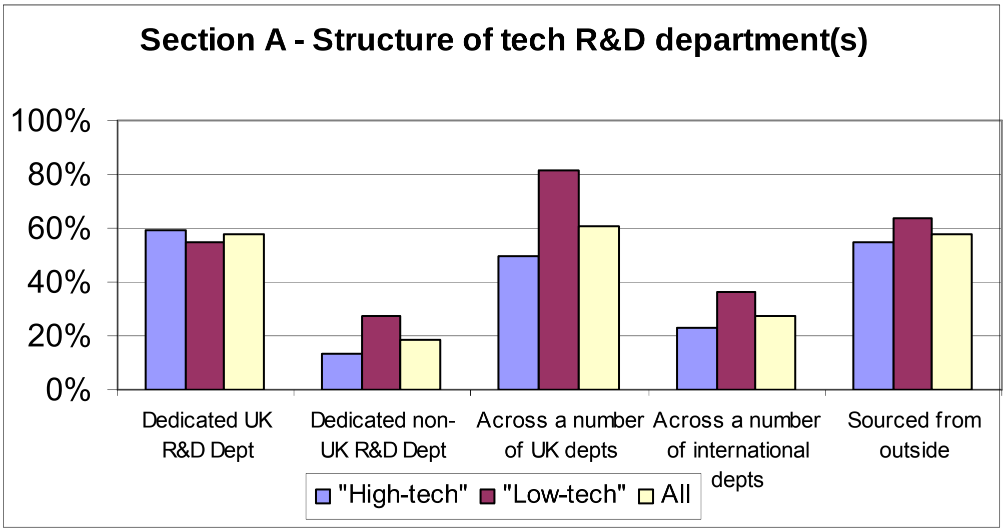


The issue was taken further by asking respondents about the structure of their R&D departments in the firm:

[11] Services sectors have been combined for disclosure and confidentiality reasons.

Can you describe how technical R&D is undertaken within the structure of your business? *a. Within a dedicated R&D department…* *In the UK* *Internationally* *b. Across a number of departments…* *In the UK* *Internationally*

Figure 6: Structure of R&D (two-sector)



The question asked the respondent to tick all the options (outlined in Figure 6) that applied to their firm. The options were not exclusive and the respondents were not restricted to any number of 'ticks'.

Responses to this question are consistent with those collected regarding the sources of technical knowledge. Figure 6 shows that of those firms asked approximately 60% had a dedicated R&D department in the UK and more than 60% reported spreading their R&D activity across a number of UK departments. Fewer than 20% had a dedicated R&D department abroad and fewer than 30% spread their R&D activity across a number of international departments.

By and large there is little industry group differentiation in the responses to this question. In four of the five options the largest difference between the "high-tech" and "low-tech" firms was 13%. The exception to this is the tendency for "low-tech" firms to spread their technical R&D activity across a number of UK departments (more than 80% of "low-tech" respondents reported doing this, compared to 50% of "high-tech" firms).

Successful and unsuccessful R&D

In the pilot phase, interviewees were asked whether they monitor and measure successful and unsuccessful R&D[12] - in nearly all cases the companies reported that they do but in one case the respondent stated:

> *"There is no such thing as an unsuccessful project as you learn from all projects whether they are commercialised or not."*

[12] The 'at cost' approach to valuing R&D includes measuring expenditure on both successful and unsuccessful R&D.

Most companies had internal procedures to monitor R&D projects and systems in place for closing down projects once it became clear that the project would not meet its objectives - this finding mirrors that of the Israeli survey. The companies' strategies for minimising unsuccessful projects ranged from only undertaking experimental development projects, which resulted in near 100% success rates, to undertaking a high proportion of unsuccessful projects but which only accounted for a low proportion of overall expenditure. The companies achieved this paradox through tight project management controls by ensuring that projects are regularly assessed and shut down early if they are unlikely to meet their objectives. Companies who undertook blue sky or large scale projects often undertook these with external funding and/or with project partners in order to minimise the risk to the firm.

Patents

Interviewers reported a lot of variation between respondents' ability to answer the question:

Over the past ten years, how much of your technical R&D expenditure gave rise to patents (share in all technical R&D expenditure)?

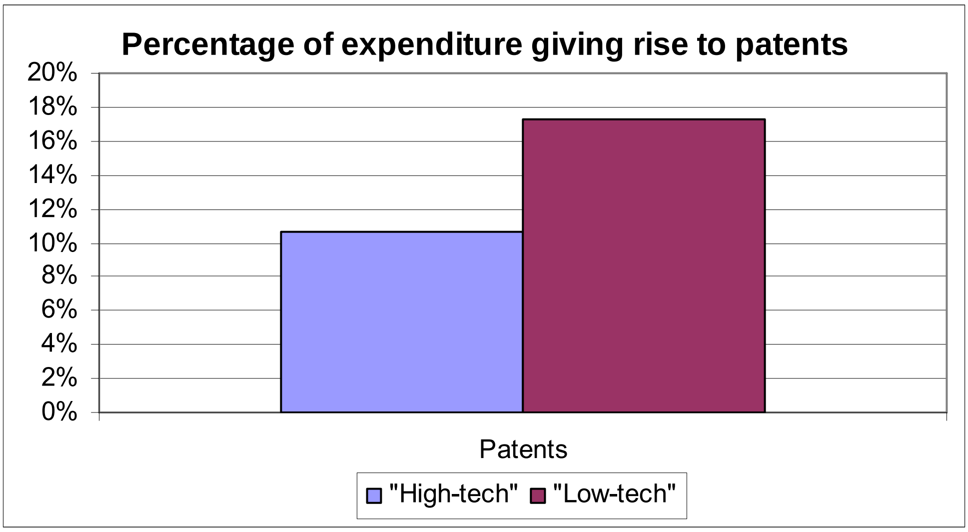
Stemming from the fact that technical personnel were targeted to answer the survey; many of whom felt that this was a question for a finance manager. A common response for this question was:

> *"We do use patents, but I cannot give a figure."*

The result of which is that we have a lot of non-responses, "ball park" figures and "gut feeling" indicators attached to the data for this question. Only twenty-eight firms were able to provide data responses to this question with only about half of the "low-tech" firms responding at all. That respondents struggled to answer this question is itself is an important finding. It also implies that patents are a weak measure of R&D, especially when talking to technical personnel.

It comes as little surprise, then, that there are erratic findings in those data that we have been able to collect for this question. Splitting the firms into "high-tech" and "low-tech", it appears that the average "low-tech" firm uses patents more than the average "high-tech" firm (Figure 7).

Figure 7: Patents (two-sector)



At first this result may be surprising until you consider the feedback from interviewers that some "high-tech" firms reported not using patents because they:

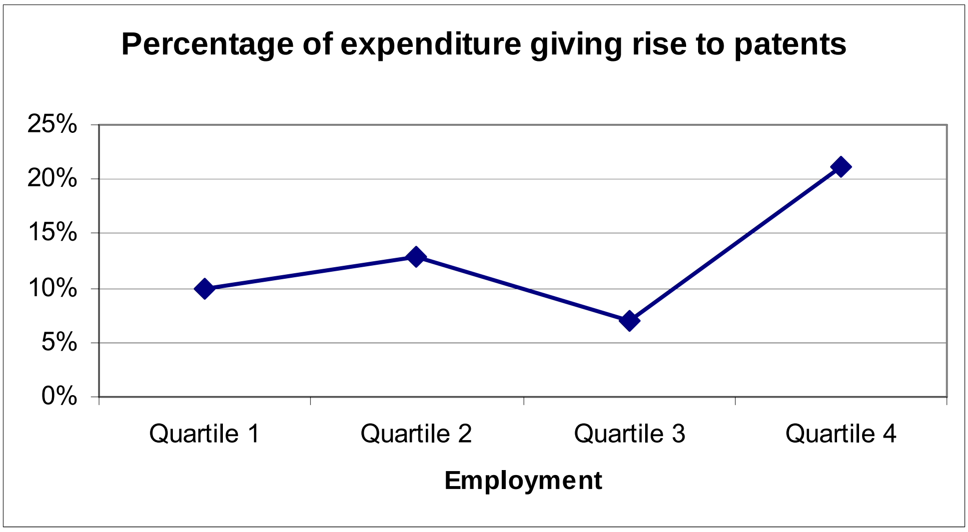
> *"…don't want to tell people how we do it."*
>
> *"…only use patents as a way of differentiating ourselves from our competitors."*
>
> *"…used to patent but it is too expensive now and not worth it. Foreign competitors copy us anyway; luckily they don't do it very well!"*
>
> *"… have an employee confidentiality clause which works better than patents."*
>
> *"… conduct R&D for third parties who will almost certainly patent them, but these don't appear in our books."*

None of the service based firms that we interviewed used patents at all, despite several of them reporting technical and "non-technical R&D" spends; suggesting that patents are a fundamentally ineffective method of indicating whether a firm performs technical or "non-technical R&D".

Of the remaining four industry groups that did report using patents, there is a large amount of variability, with some possibly surprising trends (namely that the chemical & pharmaceutical sectors tend to patent least). Interpretation of these responses is very difficult and potentially dangerous for reasons mentioned previously. As well as this, the sample is too small to display results in this report. As well as this the small number of responses may allow individual firm dynamics to have too big an effect on the results.

When looking at the patent data and firm size in Figure 8 it is apparent that the largest firms tend to patent relatively more than the smaller firms. The pattern is less obvious amongst the smaller three quartiles, possibly because of the data collection problems discussed previously.

Figure 8: Patents (firm size)



Destination of technical R&D knowledge

Discussion often took place around the subject of the destination of technical R&D knowledge. Responses varied according to the firm type and were very firm specific.

The question was phrased:

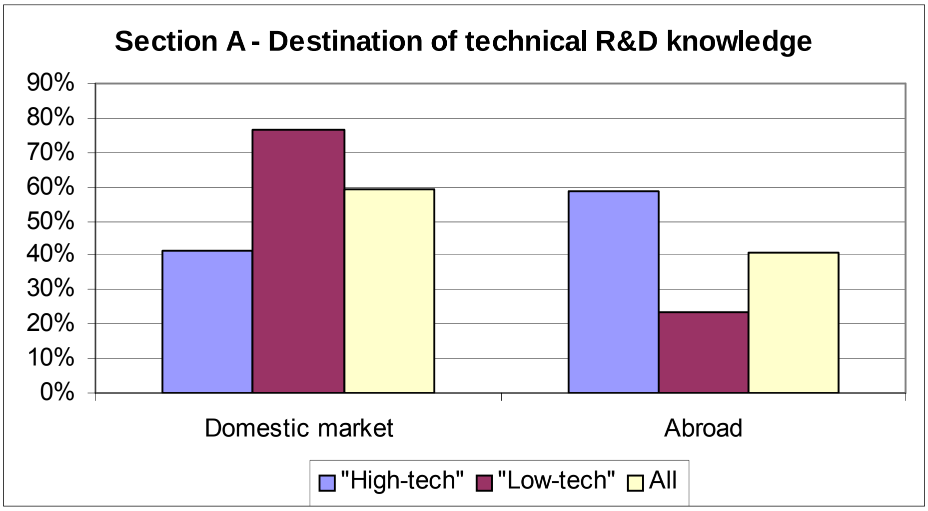
"How much of the technical R&D done in the U.K by your company (in terms of expenditure) is used:

% in domestic market?
% abroad?

Interviewers found a certain amount of variation in the respondents' interpretation of this question, dependant on the individual firm and the nature of their product / service. The vast majority of firms answered this question in terms of sales / exports, i.e. what proportion of their products end up abroad or are sold domestically. Some firms, however, could not relate their sales to this question and instead used (for example) the location of production teams. Thirty-two firms provided data responses to this question. It is interesting to note that one firm unexpectedly reported a split totalling 150% - the interviewee explained that 100% of products are sold in the UK market whilst half of these products are also sold abroad.

Figure 9 shows that the general trend is for "high-tech" firms to export more of their technical knowledge than "low-tech" firms. This alone is interesting but becomes even more significant when one considers the relative technical R&D spends of "high-tech" firms compared to "low-tech" firms. The average spend of a "low-tech" firm amounts to only about 6% of the average spend of a "high-tech" firm.

Figure 9: Destination of technical R&D knowledge (two-sector)



Splitting the firms into six sectors reveals that service firms focus the majority of their R&D to the domestic market, while the R&D conducted in the remaining three manufacturing sectors tends to end up outside the U.K.

Figure 10: Destination of technical R&D knowledge (six-sector)[13]

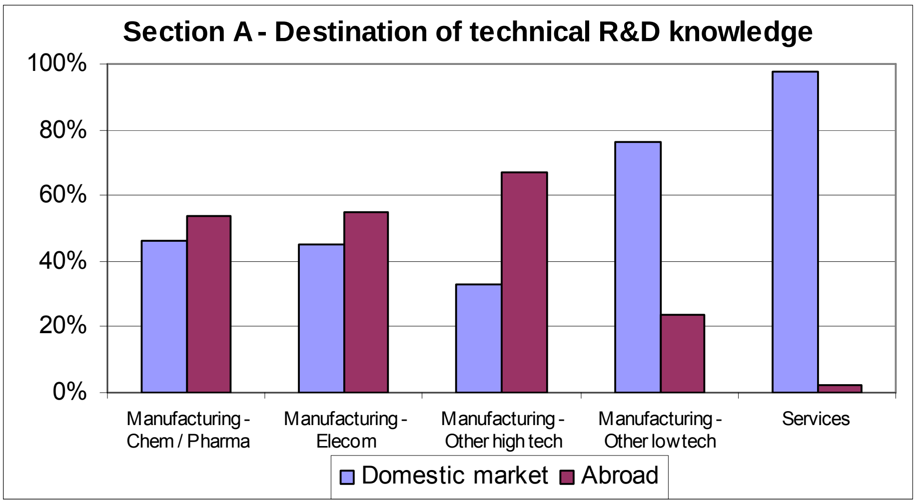
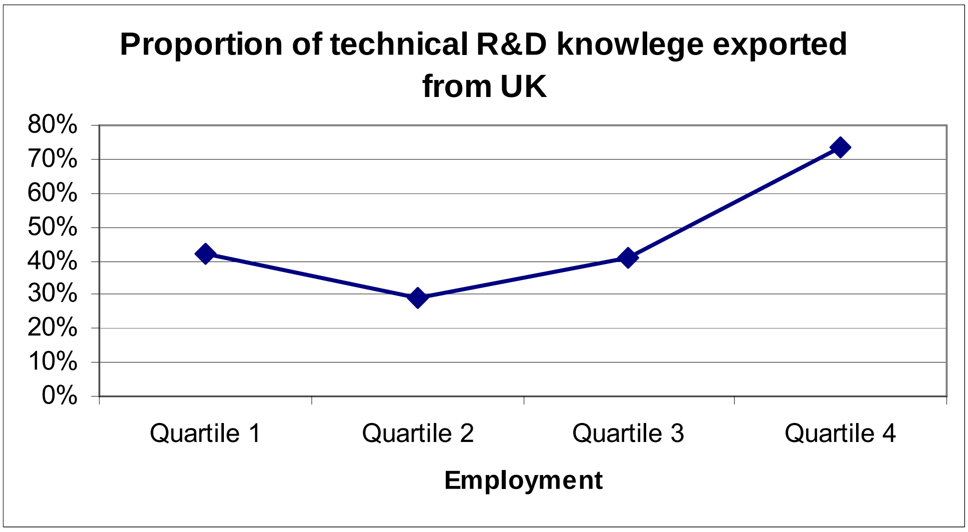


Figure 11 demonstrates the (perhaps expected) result that firms in the largest size quartile (based on employment) are most likely to export their technical R&D knowledge outside of the U.K. The relationship is not so obvious, however, amongst the smaller firms with the smallest quartile appearing to export relatively more knowledge than quartiles two and three (although the actual difference is modest).

Figure 11: Proportion of technical R&D knowledge exported (firm size)



Section B: "Non-technical R&D"

Categories of intangible spending

The split between section A ("technical R&D") and section B ("non-technical R&D") is a potentially confusing one. In fact the headings themselves are something of a compromise, to emphasise the distinction. Alternative headings for section B such as "knowledge investments", "innovative activities" and "intangible investments" were also considered by the project team. For this reason the opening question in section

[13] Due to the number of responses; services sectors have been combined for disclosure and confidentiality reasons.

B was designed to give the respondent a clear idea of the kind of categories included[14]:

How much did you spend in the last financial year in each of these categories of non-technical R&D? (if you find it easier to indicate a total and then proportions please do so)

Different to the opening question of section A, this question was closed to five categories with clear definitions given for each (Box 5). The interviewer was also briefed to guide the respondent through the category definitions if necessary, often referring them back to the examples given on the opening page of the questionnaire to distinguish between technical and non-technical spends (Annex 1).

Despite these measures this question still stimulated constructive debate around three main factors:

1. *Level of activity*. This was the most common conversation; it centred on the broadness of the question. These expenditures often involved gathering data from 5 different departments. Some interviewees did this before talking with the ONS, others were unable to.

   "Some of these activities are answered at group level; I can only speak for this plant."

   "Branding is taken care of at head office."

   "The company does these activities but I cannot give you figures here. No one person would know about all of these."

   Interestingly, one firm commented that they would only be able to do this kind of question as a postal form because it would need to be passed through the relevant departments and then quality checked before returned.

Box 5: Examples and definitions - categories of non-technical R&D

Software and computer networks
Includes purchased and own account (in-house) software development and computerised database and computer networks, but excludes spending covered under technical R&D.

Design of new products and services
Design functions for the development or implementation of new or improved goods, services and processes. Design in the technical R&D phase of product development should be excluded.

Employer-funded training
All internal or external training for your personnel.

Organisation/business process improvement
Including purchased consultancy services and in-house investment of managerial time spent on improving the effectiveness of business organisations.

Reputation and branding
Including all spending on advertising and market research.

2. *Ability to answer with tangible units*. Another issue raised from conversations with the firms was that they were unable to give actual spends on the activities. Many respondents were aware of these activities taking place but could not give a numeric investment figure.

[14] Categories in this question are informed by Corrado et al (2004) and Giorgio Marrano et al (2007).

“Some of these activities are very hard to physically measure in terms of pounds and pence.”

“The product is the reputation.”

3. *Correct interpretation of categories*. As mentioned previously, interviewers ensured that respondents understood the categories before collecting data on this question. A frequent issue was that the technical respondents assumed that we were only interested in spends relating to R&D activity. We were, in fact, looking to collect data about these spends throughout the entire firm. Once technical respondents understood this they often reported that they did not have figures at that level and would need to talk to the financial director or go directly to a number of departments and send the figures later.

   “I can only speak for the I.T spending that goes on in my [R&D] department as it’s on my budget.”

Respondents liked examples and clear definitions and many of them frequently referred to the examples given on the first page of the questionnaire. Some firms commented that the examples were not relevant to their industry, speculating that had an interviewer not been present they would probably have misinterpreted some of the categories.

In spite of these issues, once the interviewer was satisfied that the respondent had interpreted the question correctly, meaningful data were collected from twenty-three firms (eleven “high-tech” , twelve “low-tech”) which imply some interesting patterns.

Figure 12: Categories of non-technical expenditure (total sample)

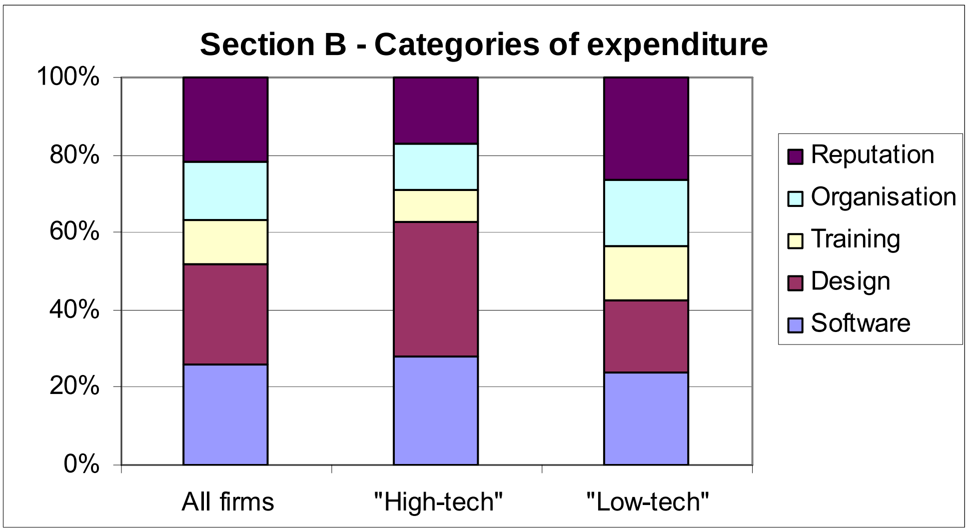


Figure 12 breaks the relative spends between “high-tech” and “low-tech” firms. It shows that “high-tech” sectors spend relatively more on ‘software and computer networks’ and ‘design of new products and services’, while “low tech” sectors have a more even spread. The average firm in both sectors spend least money on ‘employer-funded training’.

It is important to note that the “high-tech” total spend is larger than the “low-tech”. As such, it is not necessarily true that the average “high-tech” firm spends less on ‘reputation and organisation’ but it is more likely that they do spend much more on ‘software and computer networks’ and ‘design of new products and services’.

Because of the relatively low response rate to this question it is not possible to display the six-sector split. An interesting point is that the means presented in Figure 12 cannot be applied to any single respondent. There is a large amount of variability even within the sectors.

Sources of intangible knowledge

Similar to the sources question in Section A, the questionnaire asked firms:

> *What proportion of non-technical R&D in your business that is new in the past financial year comes from:*
>
> *% Technical R&D done in the business, in the UK*
> *% Technical R&D done in the business, outside the UK*
> *% Licensed / purchased technical R&D from outside the business*
> *% Technical ideas / knowledge freely available outside the business*

Because of the similarities between this question and the one in section A, once respondents understood the split between section A and B they generally interpreted this question correctly. Thirty-two firms gave meaningful responses.

Figure 13: Sources of "non-technical R&D" (two-sector)

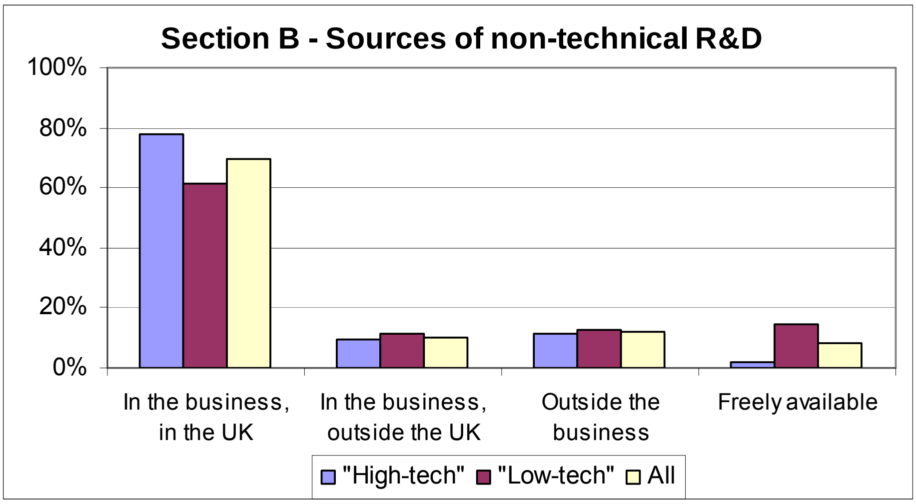


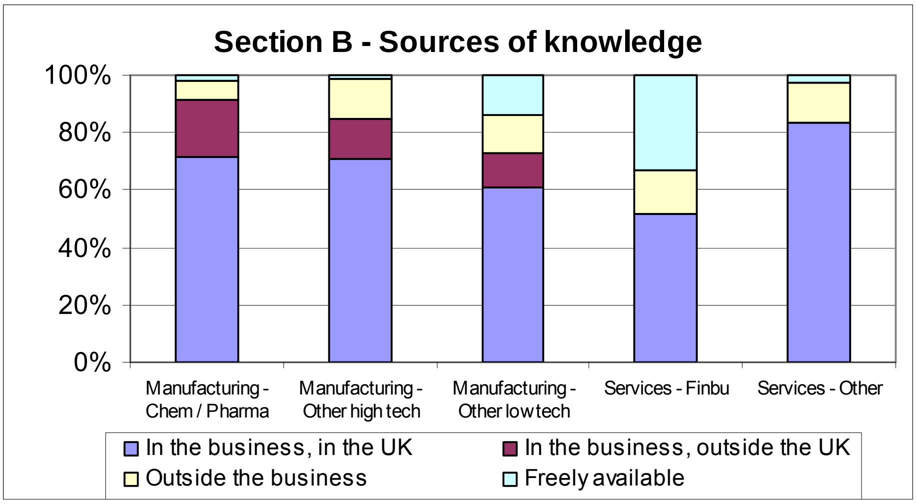
Figure 13 demonstrates that the vast majority of "non-technical R&D" is sourced within the firm, in the UK. When looking at the industry split there are fairly consistent answers between the "high-tech" and "low-tech" sectors (with the majority of non-respondents coming from the "high-tech" sector).

That said; it is interesting to note that "low-tech" sectors utilise noticeably more 'freely available' sources of knowledge relative to "high-tech" sectors (who hardly use this option, if at all). Some respondents struggled with the concept of "freely available" knowledge in the context of a survey which generally focuses on expenditure and investment. When asked to elaborate further firms stated that they consider this category to include:

- Trade conferences
- Trade journals
- Relationships with academia
- The internet
- Copying competitors.

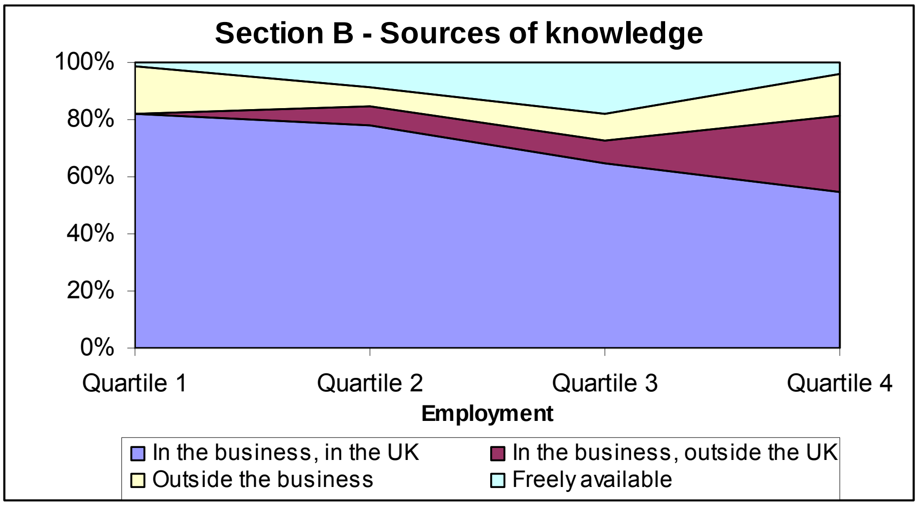
Figure 14 illustrates that, in contrast to the sources of technical (Section A) knowledge the 'finance & business' services sector utilise the most freely available non-technical knowledge.

Figure 14: Sources of "non-technical R&D" (six-sector)[15]



Analysing responses by size (Figure 15) shows that as firms grow, they tend to utilise more "non-technical R&D" from within the firm, outside the U.K. They possibly do this as a replacement for within the business, in the U.K, which decreases as the size of firm grows.

Figure 15: Sources of "non-technical R&D" (firm size)



Project Life-lengths

An important aim of this project was to gather life-lengths for technical and "non-technical R&D". Starting with the template provided by the Central Bureau of Statistics in Israel we asked respondents to consider actual projects and report on the lives of these projects in three stages, the definitions of which are found in Box 6.

[15] Due to the number of responses; Manufacturing – Elecom has been removed from this figure for disclosure and confidentiality reasons.

Box 6: Examples and definitions - breakdown of life-lengths

Development	Average length of time in development
Transition from development to production/operation	Average length of time between end of development to start of use of the R&D asset in production/operation
Use in production/operation	Average length of time from start of use of the R&D asset in production until end of use

The question's focus on "projects" generally paid dividends as the interviewees generally felt that it was possible, albeit difficult, to estimate service lives of a project. The interviewees said they were qualified to comment on projects that they had knowledge of but were uncertain as to whether these projects could be thought of as typical. The majority of respondents could relate the question to "real world" projects. It is interesting to note that it tended to lead respondents to talk about active or recent projects. The consequence of which is that the 'use' period is anticipated rather than actual use of some earlier project with many respondents basing their 'use' estimates on previous cycles of similar products or product improvements.

In general, the interviewees said that the concept of a typical project may be flawed as companies undertook various different types of projects, for example, short/medium/long term; process and product innovation; new products and product development.

As various types of project have different service life lengths, an important conclusion drawn from the interviews is that the types of project should be tightly defined within the questionnaire. To enable a more meaningful estimate of service life length, data should also be captured to enable an expenditure weighting for the different types of R&D. This conclusion is in accordance with the preliminary results from the German study. Respondents who had had prior viewing of the questions were able to give better answers; in particular there was a noticeable improvement from financial respondents because they had spoken to their technical colleagues for the information. An important finding is the importance of respondents' understanding the reason for us asking the question. Once confidentiality had been assured and some background given, the respondents were generally open and were pleased that they were able to talk about projects that they were involved in.

A number of interviewees stated that the three stage breakdown was simplistic and did not reflect how projects were managed within their firm. One firm specified a five stage approach to service lives within their firm; 'idea generation, opportunity assessment, technical feasibility, scale up and customer trials'. A number of the companies did not recognise a transition phase, stating that the transition phase would be built into the development phase in order to limit the delay of going into production. This reflects the findings of the Israeli study which reported the length of the application lag was quite short in many cases. This is also in accordance of the findings of Kashani et al (2000) who examined the role of innovation and its contribution to the performance of brands of sixty major European companies - they concluded:

> *"speed to market appears to be an important contributor to brand performance. Our research indicates that the elapsed time from an innovation's initial review to its market launch is negatively correlated with market share, i.e., the shorter the process, the higher the anticipated growth in market share".*

Section A – Technical R&D Project Life Lengths

In total 67 technical projects were discussed (across 32 firms). Example projects include:

- *Development of a new product*
- *Derivative of a microchip*
- *Project aimed at minimising losses from raw materials*

Splitting the data by simple "high-tech" and "low-tech" industry allows simple average life lengths to be calculated as shown in Table 6. Interpretation of the life-lengths using this industry split is difficult because the groups contain a number of potentially conflicting sub industries. For example the "high-tech" industry group contains both the pharmaceutical and chemical industries and also the electrical communication and ICT industries. It would be reasonable to expect these industries to have different attitudes and expected life-lengths, despite both being "high-tech" industries.

Table 6: Technical R&D life-lengths (two-sector)

	Development (years)	Transition (years)	Use (years)	Total (years)
"High-tech"	2.3	1.0	9.9	**13.1**
"Low-tech"	1.5	0.9	6.0	**8.4**
All projects[16]	2.0	1.0	8.6	**11.5**

A quick descriptive analysis of the responses suggests that "high-tech" projects are generally longer in development and use. The average project in a "Low-tech" firm spends nearly 35% less time in 'development' but also enjoy 36% less 'use' time (when compared to the average "high-tech" project).

Splitting the projects into a lower level industry classification allows the examination of technical R&D life lengths in more detail as shown in Table 7.

Table 7: Technical R&D life-lengths (six-sector)[17]

	Development (years)	Transition (years)	Use (years)	Total (years)
Manufacturing – Chemical & Pharmaceutical	4.2	0.9	12.3	**17.4**
Manufacturing – Electrical & communication	1.1	0.9	5.6	**7.6**
Manufacturing - Other high tech	2.0	1.1	9.8	**12.8**
Manufacturing - Other low tech	1.3	0.9	6.0	**8.2**
Services	1.1	0.7	4.7	6.5

As suspected, there are significant differences within the "high-tech" "low-tech" industries. For example the 'chemical & pharmaceutical' group have long development times, coupled with long use periods and are a vivid contrast to the 'electrical & communication' industry group, who have both short development and use periods.

High-tech manufacturing firms have longer projects (dominated by the use period) when compared to the low-tech manufacturing industries. This could be related to the fact that the R&D budgets for the "high-tech" firms are significantly larger than those of the "low-tech" firms. Also in what is perceived to be a highly competitive industry it is likely that a project will be abandoned much earlier than a low tech project if it looks unlikely to succeed.

[16] Mean across all projects. The Project team recognised after the Pilot Phase the advantage of weighting project lifetimes by expenditure. However, it proved difficult to collect representative data on project expenditures and no weighted results are reported in this report.

[17] Due to the number of responses; services sectors have been combined for disclosure and confidentiality reasons.

Simple development to use ratios announce that the electrical & communication sector enjoys the highest ratio, with one year of development paying more than an average of five years use. By contrast one year development in the chemical and pharmaceutical industry group yields (on average) less than three years use.

No distinct trends appear from analysing project life-lengths by firm size (Table 8).

Table 8: Technical R&D life-lengths (firm size)

Employment	Development (years)	Transition (years)	Use (years)	Total (years)
Quartile 1	1.7	0.9	11.6	**14.0**
Quartile 2	1.0	0.9	6.9	**8.8**
Quartile 3	2.4	1.1	6.5	**9.8**
Quartile 4	2.9	1.0	9.7	**13.7**

Finally the survey asked the respondent to specify whether the project was in-house or bought in. Consistent with the results reported in the results section of this report; the vast majority of the technical projects discussed were in-house (in fact less than 5% of the projects reported were 'bought-in'). For this reason the results presented in Table 9 must be interpreted with a certain degree of caution. More observations are required in order to provide a representative analysis of this break.

Feedback from the interviews has shown that some firms struggled to split the projects into these two categories, especially when considering larger projects which may involve a combination of in-house investment and bought in expertise.

> *"R&D projects involve a lot of research into the market to see what is available. This may be in house or involve external consultants, we don't compartmentalise as such"*

From the responses that were gathered it appears that there is very little differentiation in the total lives of these projects.

Table 9: Technical life-lengths (project-type)[18]

	Development (years)	Transition (years)	Use (years)	Total (years)
In house	2.0	0.9	8.6	**11.6**
Bought in	***	***	7.7	**13.2**

Respondents were asked to judge how representative these projects are compared to their industry. The results of which are shown in Table 10, showing a fairly even range, though with a discernible bias towards shorter life lengths. This typically reflected firms' assessments that their project development timescales were more efficient than their competitors.

Table 10

	Number of projects
Shorter	16
Typical	42
Longer	9
Total	**67**

Section B – "Non-technical R&D" project life lengths

Firms were asked to repeat the life-length exercise for section B, this time discussing non-technical projects. Some examples include:

[18] Some numbers have been suppressed for reasons of confidentiality.

- *Focus groups – Qualitative research*
- *Creation of software to filter prospective clients*
- *New factory layout to improve efficiency and cleanliness*
- *Training of operators for a new piece of equipment*
- *Promotional DV*D – Brand building

From fifty three projects discussed (across twenty-nine firms), the most obvious result in Table 11 is that the average “non-technical R&D” project life length, at around 6 years, is approximately 50% shorter than the average technical R&D project life length.

Using the simple development to use ratios; one year of development on a “non-technical R&D” project yields an average of 8.1 years use, more than double that of the average technical R&D project (which yields 4.2 years).

Table 11: “Non-technical R&D” project life-lengths (two-sector)

	Development (years)	Transition (years)	Use (years)	Total (years)
"High-tech"	0.7	0.7	5.1	**6.5**
"Low-tech"	0.6	0.3	5.0	**5.9**
All projects[19]	0.6	0.5	5.0	**6.2**

To investigate the possibility of within industry effects a lower level industrial break is shown in Table 12. There is much less variability between the industry groups when considered against their technical counterparts from section A. It appears that, in terms of project lengths, “non-technical R&D” projects are more consistent across industry groups than technical projects. The biggest relative time diversity occurs in the development stage, but there is no industry with an average project longer than 10 months.

Table 12: “Non-technical R&D” project life-lengths (six-sector)

	Development (years)	Transition (years)	Use (years)	Total (years)
Manufacturing - Chemical & Pharmaceutical	0.2	0.2	7.5	**7.9**
Manufacturing – Electrical & communication	0.8	0.6	6.8	**8.3**
Manufacturing - Other high tech	0.7	0.8	4.2	**5.7**
Manufacturing - Other low tech	0.6	0.4	6.3	**7.3**
Services – Finance & Business	0.7	0.6	3.2	**4.5**
Services – Other	0.5	0.2	4.1	**4.8**

Development to use ratios do show rather more variability between the industry groupings. Shown in Table 13, the chemical & pharmaceutical industry group has unprecedented large ratios, with one year development yielding thirty-nine years use for a non-technical project. The other industries all enjoy higher ratios for their non-technical projects than the average technical project.

Table 13: “Non-technical R&D” project development to use ratios (six-sector)

Manufacturing - Chem / Pharma	***1 : 39***
Manufacturing - Elecom	***1 : 9***
Manufacturing - Other high tech	***1 : 6***
Manufacturing - Other low tech	***1 : 10***
Services - Finbu	***1 : 5***
Services - Other	***1 : 9***

[19] Mean across all projects.

Table 14 breaks the non-technical projects into size quartiles. An interesting pattern is that as firms grow, they tend to take longer to implement (shown in longer transition stages). This is affirmed by respondent's comments:

> *"Because we are a big company, we tend to be more bureaucratic compared to our smaller competitors."*
>
> *"The time it takes for us to get a product out is shorter than that typically found in the industry. I attribute this to the fact that mine is a much smaller business."*

Table 14: "Non-technical R&D" project life-lengths (firm size)

Employment	Development (years)	Transition (years)	Use (years)	Total (years)
Quartile 1	0.5	0.2	4.4	**5.1**
Quartile 2	0.6	0.4	4.5	**5.5**
Quartile 3	0.8	0.7	7.1	**8.5**
Quartile 4	0.7	0.9	4.4	**5.9**

Conclusions

The conclusions drawn from this study fall into two categories; method based and result based. Conclusions drawn from the results should be interpreted with extreme caution as this is still a relatively small dataset. Much more work needs to be done to validate and develop the results.

Methods

- The most important conclusion is that firms can generally provide the information we requested. In particular, respondents were generally comfortable with the concept of project service lives and (with some reservations) with the 3-stage breakdown of service lives between development, transition and use. Most respondents were able to provide meaningful estimates of expenditure on technical R&D or non-technical intangible spending, or in some cases on both categories.
- That said, some further development of the questionnaire is required before we would be confident of scaling it up to a full-scale postal survey. For example, we need to develop a structure which will allow us to weight service lives by the relative magnitude of the project.
- There is no doubt that the breadth of the questionnaire was an issue for some respondents, particularly in larger firms. We hope to address this by focussing the postal questionnaire on the key questions of interest. The postal route also provides a route for larger firms to distribute the questionnaire across different parts of the organisation (although we recognise that this increases the administrative burden).

Results on expenditure

- We collected 32 responses on expenditure on technical R&D. Perhaps surprisingly, our sample of "high-tech" firms focus more on experimental development, and less on applied research, than our sample of "low-tech" firms. All respondents report low emphasis on basic research.
- Respondents report around 70% of their technical knowledge is sourced "within the business, in the UK". There is some evidence that other sources of knowledge become proportionately more important as firms increase in size.

- We find varying approaches to patenting of technical knowledge, and a variety of motivations among those respondents who did use patenting. We found no evidence that "high-tech" firms are more likely to use patents than "low-tech" firms.
- We collected 23 responses on non-technical R&D, covering the principal components of intangible investments in the Corrado et al (2004) framework. One preliminary conclusion is that all 5 components are non-trivial. There is tentative evidence that "high-tech" firms place more emphasis on "upstream" activities such as software and design, whereas "low-tech" firms place comparatively more emphasis on training, organisation improvements and expenditure on reputation and branding.
- As with technical R&D, most non-technical activity takes place within the business, and in the UK.

Results on service lives

- We collected information on a total of 67 technical R&D service lives. The average service life was 11.5 years, comprising 2 years in development, 1 year in transition and an average use period of 8.6 years. Use periods for projects of "high-tech" firms averaged 13.1 years, compared with use periods of 8.4 years for projects of "low-tech" firms.
- There is some evidence that service lives of technical R&D projects tend to be shorter in the service sector than in manufacturing. However, we identified only a small number of service sector technical R&D projects, so this finding should be treated with caution.
- The great majority of projects were "in-house". Most respondents reported that their project service lives were typical of those in their industry, with some suggestion that development and transition periods were shorter than those of their competitors.
- We also collected information on 53 non-technical projects. The average service life of such projects was 6.2 years, comprising 0.6 years for development, 0.5 years for the transition period, and a use period of 5.0 years.
- There is much less difference between average service lives of "high-tech" firms and "low-tech" firms than was the case for technical projects.
- But as with technical projects, we found shorter service lives in the service sector than in manufacturing, typically reflecting shorter use periods.
- Lastly it should be recalled that the range of projects was extremely wide, both in terms of service lives and in terms of expenditure. A priority for the next stage of exercise is to develop metrics to reflect this heterogeneity via a weighting structure.

Next steps

- Redesign the questionnaire in the light of feedback from these interviews, with a view to scaling-up to a production-level postal survey, to be conducted using the CIS sampling frame.
- Furthermore, the aim is to replace parts of the CIS with questions drawn from this exercise, to provide more effective capture of data on intangible expenditure and rates of depreciation of knowledge assets.

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Annex 1 – The development of section A / section B examples

Pilot phase

R&D is defined as by investigation or experimentation, the outcome of which is new knowledge (with or without a specific practical application), enhanced materials, products, devices, processes or services.

This survey is in two parts and seeks to obtain information about:

a. *Technical R&D: R&D to build new knowledge to resolve scientific and technological uncertainty. For example, invention of a new laser to read a CD would be technical R&D.*

b. *Non-technical activities: Spending to build new non-technological knowledge to support the commercialisation of new knowledge in your business. This might include: software, non-technical design of new products (e.g market research and package design for the laser), non-technical design of new processes (e.g the design of the assembly of production for the new laser), and also spending by businesses in training, organisation/business process and reputation and branding.*

Phase two

These questionnaires are about research and development that is both technical and non-technical. Here are some definitions and examples to help:

a. *Technical Research and Development is defined as original investigation to acquire new knowledge in order to resolve scientific or technological uncertainty.*

b. *Non-technical R&D is work to support the commercialisation of new knowledge in the business and/or changes in the process and organisation in the business itself.*

Example: Consider the steps in the sale of a new DVD player.

1. *An improved mechanism for the laser that reads the DVD. This is technical R&D (i.e. R&D resolves scientific or technological uncertainty).*

2. *Pre-production market research. Non-technical R&D (i.e. non-technical since it is not trying to resolve scientific or technological uncertainties).*

3. *New software to improve the working of the DVD. Non-technical R&D.*

4. *Advertising and branding spend to support the product. Non-technical R&D*

5. *New business process to change the way the product is produced and sold. Non-technical R&D.*

Annex 2 – Phase two questionnaire (used on thirty firms)

ONS Interviewer	
Company	
Job Title of Interviewee	

These questionnaires are about research and development that is both technical and non-technical. Here are some definitions and examples to help:

c. Technical Research and Development is defined as original investigation to acquire new knowledge in order to resolve scientific or technological uncertainty.

d. Non-technical R&D is work to support the commercialisation of new knowledge in the business and/or changes in the process and organisation in the business itself.

Example. Consider the steps in the sale of a new DVD player.

6. An improved mechanism for the laser that reads the DVD. This is technical R&D (i.e. R&D resolves scientific or technological uncertainty).
7. Pre-production market research. Non-technical R&D (i.e. non-technical since it is not trying to resolve scientific or technological uncertainties).
8. New software to improve the working of the DVD. Non-technical R&D.
9. Advertising and branding spend to support the product. Non-technical R&D
10. New business process to change the way the product is produced and sold. Non-technical R&D.

We are interested in learning more about your expenditure relating to your companies UK operations – if you are unable to provide a breakdown at the UK level please specify at what level you are responding.

Level of response (if not UK):

A. Technical R&D

Technical R&D is spending to resolve scientific and technological uncertainty.

1) What categories of Technical R&D projects go on in your business? Examples could include basic (e.g. blue sky research without any particular application or use in view), applied (pursuit of new knowledge directed primarily towards a specific practical aim or objective) or experimental development (drawing on existing knowledge, which is directed to producing new products or processes or to improving substantially those already produced or installed).

	Type of R&D project
1	
2	
3	
4	

2) Approximately how is technical R&D spending in your business divided between the different types of R&D outlined above?

	Proportion of technical R&D spending
1	%
2	%
3	%
4	%

3) How much did you spend on technical R&D in the last financial year?

£

4) Over the past ten years, how much of your technical R&D expenditure gave rise to patents (share in all technical R&D expenditure)?

	%

5) What proportion of technically based knowledge in your business that is new in the past financial year comes from:

Technical R&D done in the business, in the UK	%
Technical R&D done in the business, outside the UK	%
Licensed / purchased technical R&D from outside the business	%
Technical ideas / knowledge freely available outside the business	%

6) How much of your technical R&D activity, in terms of expenditure, did you sell or license in the last financial year?

Domestically	%
Internationally	%

7) Can you describe how technical R&D is undertaken within the structure of your business?

a. Within a dedicated R&D department…

- in the UK ☐
- internationally ☐

b. Across a number of departments…

- in the UK ☐
- internationally ☐

c. Sourced from outside of your company ☐

Comments:

8) How much of the technical R&D done in the UK by your company, in terms of expenditure, is used

In domestic market	%
Abroad (either by an affiliate or sold)?	%

Comments:

9) The table below attempts to better understand time lapses from starting a specific technical R&D project, to developing a usable concept, to moving into production, through to the point where it no longer provides competitive advantage.

Description

i) **Development**: Gestation period- length of period of production of R&D (time lag between the start and completion of R&D projects)

ii) **Transition**: Application period - length of time passing between the end of the R&D phase of the project and the start of the use of the R&D in commercial production

iii) **Use**: Length of the period that the R&D is used in commercial production

Using the table below, please select at most three technical R&D projects and fill out the time lapses. In the case of purchased R&D please just fill out the use row.

Technical R&D projects for own use						
			Details on stages in the "life" of project			
No.	Type of R&D project	Proportion of R&D expenditure	Stage	Information needed	Time in years	Comments
1			Development	Average length of time in development		
			Transition from development to production/operation	Average length of time between end of development to start of use of the R&D asset in production/operation		
			Use in production/operation	Average length of time from start of use of the R&D asset in production until end of use		
2			Development	Average length of time in development		
			Transition from development to production/operation	Average length of time between end of development to start of use of the R&D asset in production/operation		
			Use in production/operation	Average length of time from start of use of the R&D asset in production until end of use		

Technical R&D purchased from others						
			Details on stages in the "life" of project			
No.	Type of R&D project	Proportion of R&D expenditure	Stage	Information needed	Time in years	Comments
1			Use in production/operation	Average length of time from start of use of the R&D asset purchased until end of use		
2			Use in production/operation	Average length of time from start of use of the R&D asset purchased until end of use		

8) In your opinion, how does the whole service life of the projects (includes all three development, transition and use stage outlined in the table above) compare to those typically found in your industry?

	Shorter	About the same	Longer
1	☐	☐	☐
2	☐	☐	☐
1	☐	☐	☐
2	☐	☐	☐

Comments:

B Non-technical R&D

Non-technical R&D is spending to support the commercialisation of new knowledge in your business, or spending to develop new business processes or organisation**.**

Definitions

Software and computer networks - Includes purchased and own account (in-house) software development and computerised database and computer networks, but excludes spending covered under technical R&D.

Design of new products and services - Design functions for the development or implementation of new or improved goods, services and processes. Design in the technical R&D phase of product development should be excluded.

Employer-funded training – All internal or external training for your personnel.

Organisation/business process improvement - Including purchased consultancy services and in-house investment of managerial time spent on improving the effectiveness of business organisations.

Reputation and branding - Including all spending on advertising and market research.

1) How much did you spend in the last financial year in each of these categories of non-technical R&D? (if you find it easier to indicate a total and then proportions please do so)

	Total expenditure
Software and computer networks	£
Design of new and improved products and services	£
Employer-funded training	£
Organisation / business process improvement	£
Reputation and branding	£

2) What proportion of non-technical R&D in your business that is new in the past financial year comes from:

Spending on such knowledge within in the business, in the UK	%
Spending on such knowledge within the business, outside the UK	%
Spending on such knowledge bought from outside the business (e,.g. licensed / purchased ideas/knowledge) (either in or outside the UK)	%
Ideas / knowledge freely available outside the business	%

3) Using the table below, can you describe the typical time lapse from starting a specific non-technical project, to developing a usable concept, to moving into production, through to the point where it no longer provides competitive advantage? To help answer the questionnaire:

a. Estimates are acceptable
b. You may wish to set out your answer by considering up to three non-technical projects. It would be helpful if they were typical of say, design, software and business process re-engineering projects in your location but they might be projects involving more than one subcategory of non-technical activities, in which case please indicate this.

Non Technical R&D projects for own use						
No.	Type of R&D project	Proportion of R&D expenditure	Details on stages in the "life" of project			Comments
			Stage	Information needed	Time in years	
1			Development	Average length of time in development		
			Transition from development to production/operation	Average length of time between end of development to start of use of the R&D asset in production/operation		
			Use in production/operation	Average length of time from start of use of the R&D asset in production until end of use		
2			Development	Average length of time in development		
			Transition from development to production/operation	Average length of time between end of development to start of use of the R&D asset in production/operation		
			Use in production/operation	Average length of time from start of use of the R&D asset in production until end of use		

Non Technical R&D purchased from others						
No.	Type of R&D project	Proportion of R&D expenditure	Details on stages in the "life" of project			Comments
			Stage	Information needed	Time in years	
1			Use in production/operation	Average length of time from start of use of the R&D asset purchased until end of use		
2			Use in production/operation	Average length of time from start of use of the R&D asset purchased until end of use		