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NESTA Making Innovation Flourish

Measuring sectoral innovation capability in nine areas of the UK economy

Report for NESTA Innovation Index project

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Foreword

Measuring innovation is a challenging but important task. This report sets out the findings of work commissioned by NESTA to study innovation by UK businesses across a number of sectors. It forms one of the key strands of NESTA's Innovation Index.

The report's findings provide a useful insight into firm and sectoral innovation activities, taking into account several types of innovation often regarded as 'hidden', and providing comparisons both within and across sectors.

The Index is an ongoing project, and the scope exists both to analyse these data further and to build on the methodology.

As always, we welcome your comments.

Stian Westlake
Executive Director of Policy and Research, NESTA

November, 2009

NESTA is the National Endowment for Science, Technology and the Arts.

Our aim is to transform the UK's capacity for innovation. We invest in early-stage companies, inform innovation policy and encourage a culture that helps innovation to flourish.

Executive summary

Our understanding of innovation has changed: where once it was understood to be largely the result of scientific research and development, it is now seen more widely to include changes to services, ways of working and delivery, customer insight and many other forms. This has been described by NESTA and others as 'hidden innovation'.

There has been a gap in knowledge about the extent of such innovation. Traditional metrics have focused on investment in research and development, and its outputs. But there has been no comprehensive measurement of hidden innovation within the UK economy.

The Innovation Index seeks to measure the wider forms of innovation and to present the results comprehensively at both the aggregate level of the national economy and at the level of individual sectors and firms. It adds to the knowledge generated by existing surveys, such as the Community Innovation Survey, as well as work in the United States and by the OECD, by, for example, providing further contextual data of the specific type of wider innovation undertaken and the particular sources of external engagement.

This part of the Index sets out a framework for measuring innovation at a firm and sector level – insights can be provided at the level of individual firms and among sectors.

Our research has achieved this through a detailed survey based on a well-developed framework that reflects how innovation takes place in a wide range of businesses. It makes it possible, for example, to see the strength of company networks, the degree to which companies invest in design or new products and services, and their ability to commercialise and market those products or services. In doing so, it is possible to track the innovation process from conception to commercialisation.

Presenting the results

A significant strength of this research is in the number and detail of the questions that it was possible to ask. This made it possible to present the results in a way that any firm or sector can locate itself. The results, presented through a capability framework, show the relative strengths and weaknesses of firms and sectors, highlighting capability gaps at the firm level, and differences between sectors' levels of innovation.

Key findings

Other research has shown innovation to be important to economic growth. This research suggests that innovating firms grow significantly faster that those not undertaking innovation in each of the nine sectors surveyed. On average, innovating firms surveyed experience around four times the sales growth of non-innovators within the same sector.

The study found significant levels of hidden innovation in several sectors where levels of traditional R&D investment are low. This highlights the importance of using an appropriately broad measure of innovation when analysing low R&D sectors. Furthermore, the study found that hidden innovation was also important for high R&D sectors, such as the automotive sector.

Innovation capability also varies strongly between firms within sectors. The differences are most pronounced in energy production, software and IT services, and specialist design. Disseminating better innovation practice in these sectors could help weaker firms to perform significantly better.

Innovation in the nine sectors

The survey was designed to examine the strength of innovation activity in nine specific sectors of UK industry through an end-to-end process.

The nine sectors were chosen so that the framework and survey could be tested across a cross-section of traditional and growing professional services where a significant amount of hidden innovation is to be expected, as well as in sectors – such as the automotive industry – where scientific and technical R&D has traditionally been at the heart of the innovation process.

Professional services

Accountancy is a traditional professionalised and regulated sector. The survey suggests that most small accountancy firms undertake little innovation, but that innovation is more common in the biggest firms, which spend more on marketing and new ways of organising themselves. Where smaller firms innovate, it is often a response to taxation and auditing changes. While there is a difference between levels of innovative activity between small and large firms, the low level of within-sector variation indicates that when it comes to innovation capability there is little difference between them.

Architectural services include architects, quantity surveyors and others designing buildings and spaces. Flair and design is essential to their competitiveness. There is significant movement of professionals between countries, supporting a sharing of ideas, with most of the larger firms exporting their services. Forty per cent of the firms had developed a new product or service in the previous three years. But while the sector is good at accessing new ideas and commercialising new services, it is weaker at developing them. Small firms in particular show a limited capability to innovate.

Business and Management Consultancy was the most innovative of all nine sectors. Small consultancy firms are particularly good at introducing new services or products. In terms of firm size, smaller firms in the sector were more likely to be innovators than larger, the converse of the pattern exhibited in other sectors within the survey and the findings of other innovation surveys. This sector is strong on accessing external ideas and using different skill groups, relying heavily on team-working. Over a fifth of sales are for innovative products, and the sector is strong on image building and self-promotion. However, there are wide variations in innovative activity among firms within the sector which may impact on the overall sector performance.

Legal Services is another highly regulated and professionalised sector, including solicitors, barristers and patent agents. The sector is not normally recognised for being innovative, and the survey found that it engaged less than other sectors accessing external product or service ideas, suggesting less openness to potential new knowledge. Where there are innovations, they tend to be the result of talking to customers. However, the nature of legal work does mean many practitioners engage with other professions on a day-to-day basis. This may suggest a potential to learn from such sectors as architectural services and business consultancies, as well as the more innovative law firms.

Software and IT Services is a sector that relies heavily on skilled workers, external collaboration and networks. It is unsurprisingly strong on R&D and design, and on using a range of skills and outside partners. As a result, it is also generally strong on innovation: external ideas are used twice as much as average and more is spent on process innovation than any sector bar automotive. A quarter of sales – the highest of the nine sectors – derive from innovative products, and the sector is also strong on commercialisation, with a low marketing spend compensated by engaging with a wider set of external sources. Nevertheless, there are big differences between firms, and there is much potential for firms in the sector to learn more from each other.

Manufacturing and design

The *Automotive* sector, which includes the manufacture of car parts and accessories, combines R&D, design and innovative technological development to develop new products to keep ahead of the competition. The sector also undertakes higher levels of knowledge exchange, with external sources to generate innovative ideas – it is the highest sector in the survey with nearly twice as much as the average, a process often leading to better cars and parts. New processes, on which the sector is a relatively big spender, often lead

to significantly higher sales of new products. However, the sector could benefit by spending even more on upgrading its processes and on encouraging more development work by teams of engineers and designers.

Construction is the largest and potentially most diverse of the sectors. The area is heavily regulated, particularly in planning and safety. At all stages of the innovation process, the sector is comparatively weak. There is less investment in new knowledge and process development and there are low levels of innovative activity. Firms are also less likely to access external knowledge or encourage employee team-working.

The *Energy* sector includes electricity and gas distributors and petroleum product manufacturers, as well as renewable suppliers. The sector spends more on R&D than other sectors outside of the software and IT sector, and is strong in using multiple skill sets and involving external partners. Surprisingly little is spent on process change, though slightly more than average sales are for innovative products. Overall, the sector is better at accessing and building innovation than commercialising it. More investment in marketing could pay dividends.

Specialist design includes fashion, textile and interior design. New products are often developed by project engineers working with autonomous teams of designers, engineers and marketing specialists. The sector is aware of the need for innovation, particularly in online activities. They learn from their customers, doing a lot of market research and hearing feedback, and many firms had developed new products recently. The sector is good at accessing external ideas and strong in building and selling new products, though there is significant variation between firms. The sector would benefit from sharing best practice between its firms more widely, and a greater investment in new technologies.

Taken together, firms across all nine sectors are better at generating new ideas through their contacts and intelligence and in selling new products or services in the marketplace. Their most common weakness lies in translating the knowledge they gain from their contacts or research into products or services.

Clearly without this intermediate process, firms are not making enough of the potential for innovation. More investment on improved processes could not only benefit these firms, it could make a real difference to the wider economy.

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Part 1: Towards the Innovation Index

1.1 Introduction

Innovation is vital to our economic prosperity. Innovative companies grow faster and generate more jobs than less innovative ones.[1] Innovation is an important driver of productivity, both in terms of efficiency through improvements in processes but also in generating competitive advantage for manufacturers and service sectors, through increased market share and entry into new markets.

But traditional measures of innovation suggest the UK is not as innovative as it should be. Less is spent on research and development than in global competitors like the US, France or Germany. Spending on R&D in the UK was less than 2 per cent of GDP in 2003, significantly below a 3 per cent EU target for 2010.

One reason for this innovation gap is that traditional metrics do not reflect the nature of innovation in today's economy. Internationally agreed indicators have traditionally looked at spending on research and development, or numbers of patents and science graduates.

Of course, research is an important contributor to economic growth. But product and service design, new business models, and the ability to take on and adapt research done by others all contribute to successful innovation. Any measure of innovation that fails to take these aspects on board will give an incomplete picture, and will provide a misleading basis for policymaking and for businesses seeking to innovate.

A new way to measure innovation
Three years ago, NESTA helped change the terms of debate about how innovation is measured and what should be done as a result. *The Innovation Gap* advocated a new approach to measuring innovation reflecting the importance of 'hidden' innovation in driving economic growth. Traditional metrics of R&D and patents are incomplete indicators of innovation activity. They have been unable to keep pace with the changing economic landscape, even in new sectors that have evolved from traditional industries such as high-tech and advanced manufacturing.

In *The Innovation Gap* and *Hidden Innovation*, NESTA drew attention to the shortcomings of viewing innovation as synonymous with R&D or science policy and proposed better and more holistic measurement. In 2008, the UK Government White Paper *Innovation Nation*[2] charged NESTA with developing a new Innovation Index to measure the UK's performance. A commitment was made to publish a pilot index in 2009.

The nine sectors of the survey
As part of that process, this report examines the strength of innovation activity in nine specific sectors of UK industry.

These nine sectors were chosen to reflect a cross-section of traditional and growing professional services where a significant amount of hidden innovation is to be expected, as well as the industries and services – including automotive – where traditional R&D has always been seen as strong but where other aspects of innovation may have been missed.

All these sectors are knowledge intensive. The sectors selected are knowledge-intensive business services (KIBS) and high-value added manufacturing. KIBS firms and employment

1. NESTA (2009) 'The Vital Six Percent: How high-growth innovative businesses generate prosperity and jobs.' London: NESTA.
2. DIUS (2008) 'Innovation Nation.' White Paper. London: DIUS.

have grown dramatically in recent years and it is acknowledged that they innovate in their own right, but also encourage innovations amongst their clients.[3] High-added value manufacturing makes an important contribution to the British economy in terms of innovation-driven wealth creation. Some services, notably the professional services like legal and accountancy were chosen precisely because few would regard them as innovative sectors.

This cross-section is not exhaustive, but it offers the basis for an approach that can be applied to other sectors. These nine sectors are:

- Architectural Services
- Accountancy Services
- Business Consultancy
- Legal Services
- Software and IT services
- Automotive
- Construction
- Energy
- Design Services

A new methodology

This project's objective is twofold. First, it aims to identify a series of metrics which can be used to reflect the strength of innovation capability in each sector. Second, the project aims to develop a framework which can be used to compare levels of innovation capability between sectors to identify priorities for policy and strategy development.

As this is still part of the pilot stage of the Innovation Index project, the primary focus is methodological. However, the survey has also yielded considerable new insights into the strengths and limitations of innovation capability in the nine sectors considered. Both the methodology and these insights will be of value to firms in these and other sectors, and to policymakers.

The study reaffirms NESTA's argument for accurate and timely measurement of innovation and in particular hidden innovation. It also reinforces the view that these sources of innovation are important drivers in achieving competitive advantage and that they contribute to wider economic growth.

1.2 The value of sectoral innovation metrics

In *Hidden Innovation*, NESTA demonstrated that sectors which a traditional R&D-focused definition might not regard as innovative are actually important and diverse contributors to innovation and economic growth.

The report shows that different sectors innovate in different ways. For example, architectural services learn a lot from the international nature of their business, whereas automotive uses the insights gained from a more domestic supply chain. Designers use project engineers to develop new designs, whereas innovation in legal services, where it occurs, is more responsive to client needs. There are often significant differences between sectors as to forms and processes of innovation, making the reliance on a very small set of metrics supposedly common across sectors unsuitable to providing an accurate overview of innovation performance in the economy.[4]

A number of studies have also shed light on the diversity (and often paucity) of practical measures of innovation performance. Among these, Cooper and Edgett (2008) found that the most used measures to gauge the performance of individual projects tend to be sales and profit measurements.[5] Yet, such financial measures – as with other traditional indicators like R&D and patent counts – have been criticised for providing only a partial and overly technological view of firms' innovation capability.[6] These metrics are unlikely to be useful for many sectors of the economy.

One size does not fit all

Sectors innovate differently and the metrics used to measure innovation in one sector may therefore not be as important to others. This study makes a significant addition to the sum of innovation data. A major element of the study included a bespoke telephone survey of 1,500 companies across the nine sectors that were investigated. This survey provides the key data for the report and the profiles of sectoral innovation capabilities that emerge.

The results provide new dimensions in innovation survey data within firms. No other data sources provide similar firm-level information on the type of innovation metrics considered in this report. The Community Innovation Survey (CIS) is currently the most widely used and detailed source of innovation data, but it does not provide the detail that

3. Bryson, J.R., Daniels, P.W. and Warf, B. (2004) 'Service Worlds: People, Organisations, Technologies.' London: Routledge.
4. NESTA (2007) 'Hidden Innovation: How innovation happens in six 'low innovation' sectors.' London: NESTA.
5. Cooper, R.G. and Edgett, S.J. (2008) Maximizing Productivity in Product Innovation. 'Research Technology Management.' 51(2), pp.47-58.
6. Kuczmarski, D. (2001) Five fatal flaws of innovation metrics. 'Marketing Management.' 10(1), pp.34-9.

makes it possible to examine how firms perform at different stages of the innovation process.

This approach gains information from firms about their behaviour separately for all stages of the innovation process. While the CIS, for example, looks at some aspects of the process, such as the use of external knowledge sources to gain ideas for innovation, this approach allows more detailed metrics, broken down by sector, across the whole process.

So, firms were asked about their use of external knowledge in three different phases of innovation – when they are hunting for new ideas, developing them in the business and commercialising their outputs. This makes it possible to analyse how types and stages of innovation relate to value creation – where the CIS measures innovation activities, this approach measures innovation capabilities.

In addition, the structure of the CIS does not include any questions tailored towards sector-specific metrics of innovation or any differentiation as to which types of metrics might be more appropriate for which sectors. It therefore understates some elements of innovation which may be important to particular sectors. This approach asks a number of new, more sector-specific questions, which provide for a better account of innovation in different sectors. It also delves into a wider range of innovations.

As a result, this approach makes it possible to capture the specific forms of innovation which are most relevant for different sectors, and to compare innovation between sectors. As a result, it is a good guide for policymakers about the innovative performance of different sectors. This will help them to target policy and resources to support improved innovation performance. It also provides a starting-point for sectors and firms to consider the respects in which they might learn from other sectors in order to improve their innovation performance.

Measuring the diversity of innovation

Earlier work in the Innovation Index project, particularly the Innovation Index Working Paper by Adams *et al.* (2008),[7] has highlighted the diversity of innovation processes between sectors – even within areas such as high-tech manufacturing – and the value of both final and intermediate innovation indicators. Similar diversity has been evident in studies on innovation processes in biotechnology,[8] aerospace,[9] business services[10] and design services.[11]

This suggests that metrics of innovative behaviour should be able to reflect sectoral variation, but this is rarely the case in practice. There are often significant differences between sectors as to forms and processes of innovation, making reliance on a very small set of metrics supposedly common across sectors unsuitable to providing an accurate overview of innovation performance in the economy.

In this report a structured end-to-end view of the innovation process in each sector is adopted, linking firms' knowledge investments to innovation and ultimately value creation. At the same time metrics are proposed, which can be validly used for cross-sectoral comparisons. To provide the end-to-end perspective the conceptual framework provided by the Innovation Value Chain (IVC) proposed by Hansen and Birkinshaw (2007) is used.

This provides a general framework within which firms' innovation activities can be considered: "a sequential, three-phase process that involves knowledge investment, innovation process capability and value creation capability" (Hansen and Birkinshaw 2007, p.122).

To reflect this diversity, this study builds specific sets of indicators for the individual sectors. Within each sector metrics are identified for each of the three phases of the process – knowledge investment, innovation and value creation. This approach provides a holistic view of the innovation process in each sector. It makes it possible to highlight specific weaknesses, and also help to identify more generalised weaknesses in UK firms' innovation capability.

Within each sector metrics are identified for each of the three stages of the innovation value chain. Three steps were taken to achieve this:

- First, a group of metrics was identified, which related to firms' activities in **Accessing Knowledge** for innovation including both the scale of firms' financial investments in new knowledge and ideas, but also the extent of their 'open innovation' activities with other organisations.

- Second, a group of metrics was identified that related to **Building Innovation** as firms translate their knowledge investments into innovation outputs.

- Finally, a group of metrics was identified that was designed to capture firms'

7. Adams, R., Neely, A., Yaghi, B. and Bessant, J. (2008) 'Proposal for measures of firm-level innovation performance in 12 sectors of UK industry.' London: NESTA.
8. Xia, T. and Roper, S. (2008) From capability to connectivity: absorptive capacity and exploratory alliances in biopharmaceutical firms - a US-Europe comparison. 'Technovation.' 28, pp.776-785.
9. Bryson, J.R. and Rusten, G. (2008) Transnational Corporations and Spatial Divisions of 'Service' Expertise as a Competitive Strategy: The Example of 3M and Boeing. 'The Service Industries Journal.' 28(3), pp.307-323.
10. Bryson, J.R and Rusten, G. (2006) Internationalisation of management consultancy. In Harrington, J.W. and Daniels, P.W. (Eds) (2006) 'Knowledge-Based Services, Internationalization and Regional Development.' pp.79-100. Aldershot: Ashgate; Love J., and Mansury, M.A. (2007) External linkages, R&D and innovation performance in US business services. 'Industry and Innovation.' 14(5), pp.477–96.
11. Rusten, G. and Bryson, J.R. (2009) 'Industrial Design, Competition and Globalization.' Basingstoke: Palgrave Macmillan; Rusten, G. and Bryson, J.R. (2007) The Production and Consumption of Industrial Design Expertise by Small and Medium-Sized Firms: Some Evidence from Norway. 'Geografiska Annaler.' 89:1, pp.75-87.

Commercialisation activities as they seek to exploit their innovations in the market place.

These innovation metrics were then combined to form firm-level innovation indices for each of the above stages. Subsequently a grid showing how well each sector performs at each stage of the innovation value chain was developed.

Of course, there are good reasons why some sectors will innovate more than others, or in different ways that are appropriate to their sectors. This research shows where there are large gaps between the best- and worst-performing sectors in different stages of the IVC, and where there is scope for firms to learn from the best-performing firms within their sector.

The strength of this approach is that the innovation metrics can be scaled to different levels. At an economy wide level, information can be combined from the individual sectoral value chains in a chart to provide a quick visual comparison between sectors. This approach has the potential for informing policy and strategic development at a macro-level, while retaining the diversity between firms and sectors. The potential for consistent metrics at different scales is important. It can highlight the processes through which firms innovate, exposing potential fragilities, such as organisational capabilities that could undermine national economic growth.

1.3 Organisation of the report

The rest of the report is organised as follows:

- Part 2 of the report provides a brief overview of the methodology of the study, including the initial exploratory interviews, the main telephone survey and subsequent derivation of the sectoral innovation indices and innovation capabilities map. Appendix 1 provides a more detailed methodological account with subsequent Appendices including survey questionnaires etc.

- Parts 3 to 11 focus on innovation in each of the sectors considered. In each case the existing research literature on innovation in the sector is briefly reviewed, it is considered how innovation occurs in the sector and the sectoral innovation indices are outlined. These parts include a series of case studies designed to illustrate some of the key issues raised.

- Part 12 compares the sectors and draws some conclusions across them. It concludes with a brief review of lessons and limitations and some consideration of the potential for future development for new sectors and other improvements as the Index is developed.

Part 2: Defining the sectoral innovation indices

2.1 Introduction

This section provides a brief outline of how this approach develops sectoral innovation indices. Details of the empirical methodology can be found in Appendix 1. A key element of the Innovation Index is to build an understanding of the sectoral systems of innovation that matter. This requires a balance between a generic framework that enables comparability and scalability, and a framework that recognises that these systems differ between sectors.

By undertaking a CATI survey it was possible to tailor key questions to specific sectors. Thereby a rich source of sector-specific data is generated, which can be combined with generic metrics to derive a detailed analysis of specific innovation issues within sectors.

While the survey has generated a large source of sectoral data, the approach presented below is aimed at generating comparative metrics that focus on key areas of the survey.

The approach taken here is based around an activity-based view of innovation. That is, the innovation process is regarded as comprising a number of different activities each of which has different characteristics and resource requirements.

More specifically, the focus is on a particular model of innovation: the Innovation Value Chain (IVC). This framework provides an end-to-end view of the commercial benefits to the firm from accessing and creating knowledge, building innovation and commercialising those innovations. A further advantage of the framework is that it provides an effective structure for more in-depth research and analysis.

While developed initially by Hansen and Birkinshaw[12] as a diagnostic tool for corporations to assess innovative capabilities, the IVC framework has the advantage that it can be readily scaled to a sectoral level. This brings in the potential for different distributions of innovation activity within individual sectors and also the potential for inter-sectoral comparisons. Both are reflected in the derivation of the sectoral innovation indices detailed in Part 12.

The argument is developed as follows. First, Section 2.2 provides an overview of the notion of the IVC identifying three separate activities, which are refered to here as accessing knowledge, building innovation and commercialising innovation. Section 2.3 then outlines firm-level metrics for each activity in the IVC. Section 2.4 describes how these firm-level metrics were used to develop sectoral innovation indices reflecting both the diversity of innovation practice within each sector and the potential for inter-sectoral knowledge transfer.

2.2 The framework for analysis

The strength of this approach is that it makes it possible to assess, from the wider survey data, the variation between firms within sectors as well as the gap between sectors in terms of the elements of the IVC. The IVC approach can be used to identify and explore more traditional forms of innovation as well as hidden innovation[13] and the degree to which firms within sectors are open to external ideas.

12. Hansen, M. and Birkinshaw, J.M. (2007) The Innovation Value Chain. 'Harvard Business Review.' 85(6), pp.121-131.
13. NESTA (2006) 'The Innovation Gap: Why policy needs to reflect the reality of innovation in the UK.' London: NESTA.

Hidden innovation is captured within the survey through measures of activity in strategic, management, organisational and marketing innovation. The study also identifies the level and intensity of expenditure committed to process innovation and marketing. Furthermore, the study captures measures of multi-functional team working and the diversity of innovation activity. These measures, along with survey metrics on the degree of external engagement in sourcing, building and commercialising knowledge capture the importance of open innovation to the sectors.

Roper *et al.*[14] extended and formalised the work of Hansen and Birkinshaw through econometric modelling. This formal modelling approach provide a practical interpretation and modelling framework reflecting three innovation activities.

- **Accessing Knowledge**. The collaborative process of knowledge sourcing or creation for innovation which may involve firms' in-house R&D and design activities alongside, and either complementing or substituting for, external knowledge sources. Accessing knowledge can highlight the sectors' level of engagement with open innovation activities.

- **Building Innovation**, which involves knowledge transformation to develop codified innovations, i.e. new products, processes or organisational forms. This element of the IVC may include the use of multi-skill teams within the company, as well as different forms of external partners in the process of building new innovations. In the building innovation stage the framework captures rates and intensities of different types of hidden innovation such as organisational and marketing activities.

- **Commercialising Innovation**. This is the process of exploitation through which new innovations are translated into productivity or sales gains. This link in the IVC may include different forms of customer involvement as well as internal spending on reputation and branding and the use of intellectual property protection. As with accessing knowledge, the study highlights the degree of openness that exists within sectors.

Two particular factors are important throughout the IVC:

- The availability of skilled employees.
- Firms' engagement with external partners.

Both have been shown in numerous previous studies[15] to be significant determinants of firms' innovation outputs and their effective translation into enhanced business performance. Below it is briefly outlined how these influence the elements of the IVC framework.

Accessing knowledge
In the first link of the innovation value chain for example, creativity and design skills are seen as being of crucial importance alongside firms' R&D capabilities. The skill mix which is important here however, will differ sharply between sectors: for example in the automotive sector R&D may dominate; in other creative industries (e.g. software) creativity will be the essential driver of innovation. Design skills have a role at this stage, forming a bridge to subsequent links in the innovation value chain as the innovation moves from creative idea through prototype towards a marketable product or service.

Building innovation
In this second stage of the innovation value chain, technology management skills will also be important as will those linked to organisational design, logistics and project management.

Commercialising innovation
In the third stage of the innovation value chain, marketing and sales skills will be important as the firm seeks to maximise the commercial returns from its innovation activity.

The IVC is able to capture many of the activities which NESTA has previously identified as 'hidden' innovation,[16] such as the reorganisation of back-office functions to deliver innovative customer services, or new organisational forms of working. These represent various forms of process innovation, service innovations, innovation created from the novel combination of existing technologies and a range of innovations that are not included in traditional measures of innovation.

In summary, while reflecting firms' engagement with its wider operating environment at each stage of the process, the innovation value chain framework can be used to:

- Identify and understand the strengths and weaknesses of firms' innovation processes.

14. Roper *et al.* (2008) Modelling the Innovation value Chain. 'Research Policy.' 37, pp.961-977.
15. Adams, R., Neely, A., Yaghi, B. and Bessant, J. (2008) 'Proposal for measures of firm-level innovation performance in 12 sectors of UK industry.' London: NESTA.
16. NESTA (2007) 'Hidden Innovation: how innovation happens in six 'low-innovation' sectors.' London: NESTA.

- Help prioritise upgrading, focusing management attention on the weak links within the process.

- Identify those factors that contribute to enhancing or constraining capability at each stage in the process, highlighting potential strategic and policy priorities.

- Identify the skills and linkages relevant at each stage of the IVC, and overall for the innovation process.

2.3 Developing metrics for the sectoral innovation indices

Key to the Innovation Index project are relevant and accurate metrics, which reflect the actual drivers of innovation. Within this study the metrics are based on the findings of previous research and were validated through an extensive programme of exploratory interviews with firms and representative groups in the sectors considered here (see Appendix 1).

Through this process 16 firm-level metrics were identified. Five of these metrics relate to Accessing Knowledge; six to firms' Building innovation; and, five to their Commercialisation activities (Figure 1). In some cases the metrics defined are purely cross-sectoral – i.e. reflect the same indicator in each sector – and are denoted (C) in Figure 1.

To tailor the survey towards the individual sector, other metrics reflect the same innovation issue but are defined differently for each sector. For example, in metrics A4, B4 and C3 different skill groups are used for each sector. The individual metrics are described in detail in Appendix 1 and summarised in Table 1.

Reflecting the points made earlier, some elements of the index are common across the three stages of the IVC such as the use of different internal skill groups (A4, B4, C3) and the use of external partners (A5, B5, C4). In each case the relevant metric is measured specifically for that stage of the IVC.

Other elements of the index are unique to a particular stage. For example, the accessing knowledge stage includes metrics reflecting both the firm's internal R&D and design expenditure (relative to sales) as well as the extent to which innovative ideas are sourced externally. Building innovation includes metrics which reflect both the input and output elements of the process of building innovations, including spending on process change, a measure of the extent of new products and services in total sales, and a measure of the diversity of innovative activities undertaken by the company (including organisational changes, the introduction of new management or marketing techniques etc). Commercialising innovation includes metrics relevant to successfully taking an innovation to market, such as the nature of involvement with customers, spending on reputation and branding, and the use of IP protection.

Figure 1: Innovation metrics for the IVC

	Accessing Knowledge	Building Innovation	Commercialising Innovation
Cross sectoral	A1. Proportion of externally sourced ideas (C) A2. R&D intensity (C) A3. Design intensity (C) A5. Use of external partners in accessing knowledge (C)	B1. Process innovation intensity (C) B2. Percentage of sales from new products (C) B3. Diversity of innovation (C) B6. Use of external partners in building innovation (C)	C2. Spending on reputation and branding (C) C4. Use of external partners in commercialisation (C)
Sector specific	A4. Multi-functionality (I)	B4. Multi-functionality (I) B5. Team-working (I)	C1. Types of customer relations (I) C3. Multi-functionality (I) C5. Use of IP protection (I)

While the exploratory interviews were central to the development and validation of the individual metrics captured in this study, they closely reflect research on econometric modelling of the Innovation Value Chain[17] and the literature contained therein. For example, the extent of externally sourced ideas in Accessing Knowledge and the emphasis on the use of external partners throughout the IVC reflects the recent literature on 'open innovation' and the value of external linkages, which has been shown to boost innovation in appropriate conditions.[18] The emphasis on multi-functional working reflects research on the value of this activity in enhancing innovation. For example, recent analysis suggests that optimal combinations of cross-functional teams in the innovation process increases innovation success in UK and German manufacturing.[19]

The Building Innovation metrics include both input and output measures of innovation, and, reflecting NESTA's work on 'hidden' innovation, allows for diversity of innovative activity as well as simply product and process innovation. This is important to the metrics, because the evidence suggests different routes through which knowledge of different types might influence different aspects of firms' innovation activity and hence business performance. For example, there is evidence that knowledge of customers' preferences shapes firms' product innovation success,[20] while backwards and horizontal knowledge linkages are more important for process change.[21]

The one area in which the selected metrics differs from the empirical research on modelling the IVC is in Commercialising Innovation. Previous research on modelling the IVC has used performance indicators such as productivity or sales growth as the ultimate test of the added value of innovation for the firm. While this is appropriate and feasible for firm-level econometric estimation of the effects of innovation, output measures such as sales growth or productivity are less appropriate for developing sectoral-level innovation metrics. Sectoral differences in growth and productivity levels are affected by myriad factors unrelated to innovation, and merely comparing, for example, the relative growth rates of the construction and consultancy sectors does not provide insights into innovation activity in these sectors.

Of course, it is possible to compare the performance of innovators and non-innovators within sectors, or after allowing for sectoral effects generally, but that is a quite different exercise from that of developing sectoral level innovation metrics. For this reason the metrics on commercialising innovation are predominantly input measures of how firms in each sector go about the process of maximising the commercial value of their innovations, allowing direct comparisons across sectors. Further research on linking activities to outputs is planned.

The developed metrics therefore go beyond many of those found in, for example, the Community Innovation Survey (CIS). This is because the metrics developed here are designed to indicate the capabilities of firms for developing innovation of various types, and therefore requires detailed information on each element of the IVC. Where the activity measures align with those collected by the CIS, the survey goes further, asking more detailed and in many cases sector specific questions. For example, in terms of accessing knowledge, the CIS has metrics only for A2 and (partly) A3.[22] In building innovation the CIS has metrics only for B2 and B3. Finally, in commercialising innovation, the CIS has metrics only for C1 and C5, and in part for C2.

Measurement of the metrics was undertaken using a specially commissioned telephone survey of around 1,500 companies (see Appendix 1). This covered nine sectors with the sample being structured to give representative results. Table 2 gives response numbers by sector together with some basic descriptive data for firms in each sector. On average around 80 per cent of respondents were single-site companies although this ranged from a low of 44.8 per cent in Energy Production to a high of 88.9 per cent in Specialist Design. Similarly wide variances were evident in sectors' share of graduate level employment and export propensity (Table 2).

Firms were asked if they had undertaken particular types of innovation. Wide variation was also evident between sectors in terms of their innovation activities. In the case of product and service innovation, firms were asked if they had introduced a new or significantly improved product or service between 2006 and 2009. In the case of process innovation, firms were asked if they had implemented changes to the business processes in the period. The other four categories relate to the levels of wider innovation, providing more detail of the types of activity than is reported in the CIS. In each case the response was a binary yes/no indicator.

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18. Chesbrough, H. (2003) 'Open Innovation: the new imperative for creating and profiting from technology.' Cambridge, MA: Harvard Business School Press; NESTA (2008) 'We're all innovators now: how users are changing the rules of innovation.' Policy Briefing. London: NESTA.
19. Love, J.H. and Roper, S. (2009) Organizing innovation: complementarities between cross-functional teams. 'Technovation.' 29, pp.192-203.
20. Joshi, A.W. and Sharma, S. (2004) Customer Knowledge Development: Antecedents and Impact on New Product Performance. 'Journal of Marketing.' 68, pp.47-59.
21. Roper *et al.* (2008) Modelling the Innovation value Chain. 'Research Policy.' 37, pp.961-977.
22. The CIS has data on overall spend on marketing and design, a combination of A3 and C2. The CIS also has data on whether new products/services come from external ideas, but not the extent of this (A1). It also has data on whether firms engaged with external sources, but not the extent to which firms did this, and not differentiated by stage of the innovation value chain (e.g. A5, B6, C4).

Table 1: Sectoral innovation metrics

Name of metric	Description of metric	Purpose of metric
Accessing Knowledge		
A1 – The proportion of externally sourced ideas (%)	Proportion of new products or services typically coming from ideas initially developed outside the firm	Reflects the openness of firm's knowledge gathering activities
A2 – R&D intensity (%)	R&D expenditure as a percentage of sales	A measure of firms' commitment to technological innovation
A3 – Design intensity (%)	Design expenditure as a percentage of sales	A measure of firms' commitment to design as part of their innovation activities
A4 – Multi-functionality in accessing knowledge (%)	Firms score 100 per cent if all of the five or six identified skill groups were involved in accessing knowledge	An intensity index intended to reflect firms' use of multiple skill groups in accessing knowledge
A5 – External knowledge sources for accessing knowledge (%)	Firms reporting all eight potential external partners as either 'very important' or 'fairly important' score 100 per cent	An intensity index intended to reflect firms' engagement with external knowledge sources for innovation
Building Innovation		
B1- Process innovation intensity (expenditure per sales) (%)	Expenditure on process development as a percentage of sales	A measure of firms' commitment to process innovation
B2 – Percentage of sales of innovative products (%)	Percentage of firms' sales derived from new or improved products or services over the last three years	An output measure of how successfully the firm 'builds' innovative products and services
B3 – Diversity of innovation activity (%)	Takes value 100 if a firm engaged in all six types of innovation activity, 50 if the firm undertook three different forms of innovation etc.	An intensity index designed to reflect the range of innovative activities carried out by the firm
B4 – Multi-functionality in building innovation (%)	As A4 for building innovation	
B5 Embeddedness of team-working in building innovation (%)	Takes value 100 if firms engaged in all five different attributes of firms' team working activity	Intended to reflect the extent of commitment to team-working
B6 – External knowledge sources for building innovation (%)	As A5 for building innovation	
Commercialising Innovation		
C1 – Range of customer relation modes (%)	An intensity index. Firms using all of the modes of customer interaction score 100 per cent etc.	Reflects the range of customer interaction that firms employ
C2 – Branding, marketing intensity (expenditure per sales)	Expenditure on branding, marketing as a percentage of sales	A measure of firms' commitment to commercialisation through their spending on branding and marketing
C3 – Multi-functionality in commercialising innovation (%)	As A4 for commercialisation	
C4 – External knowledge sources for commercialisation (%)	As A5 for commercialisation	
C5 – Use of IP protection (%)	Firms using all six forms of IP protection score100 per cent etc.	Reflects the diversity of firms' use of different forms of legal IP protection

Table 2: Sample descriptives

	n	Single site company (% firms)	Workforce with degree or equiv. (%)	Exporting firms (%)
Accountancy services (SIC 74.12)	192	82.1	42.0	36.6
Architectural services (SIC 74.2)	217	71.8	35.7	48.6
Consultancy services (SIC 74.14)	190	65.8	52.9	47.1
Legal services (SIC 74.11)	178	72.6	49.7	15.6
Software & IT services (SIC 72.2, 72.3, 72.4)	189	66.1	53.2	60.9
Automotive (SIC 34.3)	61	58.1	15.9	83.7
Construction (SIC 45)	194	86.4	20.4	10.7
Energy production (SIC 23.2, 40.1, 40.2)	91	44.8	30.2	36.5
Specialist design (SIC 74.87/2)	185	88.9	56.0	52.9
Total	**1497**	**79.6**	**37.7**	**29.5**

Source: Innovation Index Survey, responses weighted to give representative results.

Table 3, for example, summarises the results from a series of questions relating to product or service innovation, process innovation, innovation in management, organisation, marketing and strategy.

Overall, 35.2 per cent of respondents reported some product or service innovation over the 2006 to 2009 period rising to a high of 65.1 per cent in the Software and IT Services sector.

Similarly, while 21.8 per cent of respondents reported some strategic innovation, this was most common in Consultancy Services (43.7 per cent) and Software and IT Services (37.9 per cent).

Average sectoral values of the sixteen innovation metrics are given in Table 4. In each case these reflect both the proportion of firms in each sector engaging in innovation

Table 3: Innovation indicators by sector

	Product or service innovator (% firms)	Process innovation (% firms)	Strategic innovation (% firms)	Innovation in management techniques (% firms)	Organisational innovation (% firms)	Marketing innovation (% firms)
Accountancy services (SIC 74.12)	26.2	19.4	13.6	11.7	10.7	24.5
Architectural services (SIC 74.2)	40.3	32.6	19.0	19.6	26.5	31.3
Consultancy services (SIC 74.14)	63.8	33.2	43.7	31.9	42.4	55.5
Legal services (SIC 74.11)	27.5	22.4	14.6	15.5	18.5	31.9
Software & IT services (SIC 72.2, 72.3, 72.4)	65.1	34.5	37.9	27.6	42.2	48.8
Automotive (SIC 34.3)	64.3	48.2	26.8	22.2	30.5	40.2
Construction (SIC 45)	21.2	14.3	16.0	20.2	18.1	29.2
Energy production (SIC 23.2, 40.1, 40.2)	49.1	35.4	33.0	29.8	36.3	39.9
Specialist design (SIC 74.87/2)	50.2	39.0	29.7	18.8	34.3	53.1
Total	35.2	23.8	21.8	20.6	24.6	36.0

Source: Innovation Index Survey, responses weighted to give representative results.

Table 4: Contributions of individual assets

	Accountancy services	Architectural services	Consultancy services	Legal services	Software & IT services	Automotive	Construction	Energy production	Specialist design	Total
A1 – The proportion of externally sourced ideas (%)	4.9	10.7	13.4	4.5	20.1	16.0	6.6	13.8	11.7	9.1
A2 – R&D intensity (%)	0.0	1.4	0.7	0.0	4.3	1.0	0.1	1.1	1.0	0.7
A3 – Design intensity (%)	0.4	1.1	2.4	0.1	5.2	0.7	0.2	0.7	1.0	1.0
A4 – Multi-functionality in accessing knowledge (%)	13.2	21.8	42.1	21.0	41.7	35.6	15.2	34.6	34.6	23.2
A5 – External knowledge sources for accessing knowledge (%)	11.8	21.3	26.0	12.8	29.5	30.2	12.2	26.7	20.3	16.9
B1 Process innovation intensity (expenditure per sales) (%)	0.6	1.6	1.1	0.3	1.9	2.1	0.3	0.2	0.9	0.7
B2 Percentage of sales of innovative products (%)	4.4	12.4	22.1	5.7	24.4	19.5	4.8	12.0	17.4	10.2
B3 Diversity of innovation activity (%)	17.6	28.2	44.7	21.7	42.4	38.4	19.8	37.0	37.3	26.9
B4 Multi-functionality in building innovation (%)	12.9	21.6	37.4	21.0	42.3	33.6	13.6	31.3	35.6	22.2
B5 Embeddedness of team-working in building innovation (%)	7.8	16.9	29.6	11.9	36.6	25.3	10.0	22.9	21.6	16.1
B6 External knowledge sources for building innovation (%)	6.7	13.1	14.3	7.5	14.6	14.2	6.8	17.6	12.3	9.6
C1 Range of customer relation modes (%)	50.6	50.2	66.0	54.3	69.1	56.9	37.8	56.2	70.1	51.3
C2 Branding, marketing intensity (expenditure per sales)	0.6	0.4	2.1	0.5	0.8	0.3	1.3	0.5	1.0	1.0
C3 Multi-functionality in commercialising innovation (%)	11.4	18.3	30.8	14.4	28.6	26.3	9.0	25.9	29.4	16.6
C4 External knowledge sources for commercialisation (%)	4.1	4.6	10.7	4.6	11.1	4.4	3.8	11.2	9.2	5.8
C5 Use of IP protection (%)	12.3	26.7	36.1	14.6	43.9	39.1	10.8	36.9	37.3	21.2

Source: Innovation Index Survey, responses weighted to give representative results.

(of various types) in the 2006 to 2009 period along with the prevalence of each type of activity among innovative firms. For each of the metrics it is also evident that within each sector variations in performance are considerable with relatively large coefficients of variation (Appendix 1). Following sections discuss these metrics in considerable detail, but it is worth making some preliminary observations at this point:

- Across the entire sample around 9.1 per cent of new product/service ideas derived from outside the firm. This varied from a high of 20.1 per cent in Software and IT Services to a low of 4.5 per cent in Legal Services.

- R&D intensity averaged around 0.7 per cent for all firms in the sample but was highest at 4.3 per cent of turnover in Software and IT Services. A similar pattern was also evident

Table 5: Sales growth for innovators and non-innovators

	Non-innovators	Innovators
Accountancy services (SIC 74.12)	11.40	28.55
Architectural services (SIC 74.2)	11.37	15.37
Consultancy services (SIC 74.14)	10.11	22.54
Legal services (SIC 74.11)	-3.93	10.46
Software & IT services (SIC 72.2, 72.3, 72.4)	1.09	12.80
Automotive (SIC 34.3)	1.83	5.77
Construction (SIC 45)	2.48	16.59
Energy production (SIC 23.2, 40.1, 40.2)	32.67	36.78
Specialist design (SIC 74.87/2)	6.43	25.65
Total	4.10	18.47

Source: Innovation Index Survey, responses weighted to give representative results.

in terms of design intensity with Software and IT Services again having an average level of investment (5.2 per cent of turnover), significantly higher than the overall sample average (1.0 per cent).

- Multi-functionality in accessing knowledge varied strongly between sectors with the highest levels in Automotive, Consultancy Services and Software and IT Services. External partnering for accessing knowledge is most extensive in the Automotive sector.

- Perhaps unsurprisingly spending on process innovation was greatest in the Automotive sector (2.1 per cent of sales) considerably above the 0.7 per cent average for all sectors. The Automotive sector was also one of three sectors (together with Consultancy Services and Software and IT services) to have particularly high levels of sales of innovative products and the greatest diversity of innovation activity.

The innovation metrics included in Table 4 focus relatively specifically on the organisation and performance of firms' innovation activities within the framework of the IVC. Optimising the organisation of the innovation process should help firms to maximise innovation outputs with longer-term impacts on growth and profitability.

While it is planned to model the relationship between innovation and performance in detail in the future, it is outside the scope of the current study. To highlight the contribution that innovation has on performance however, the report presents some high level relationships. Table 5 provides a simple comparison of sales growth rates among firms undertaking and not-undertaking product or service innovation over the 2006 to 2009 period.

In all of the nine sectors innovative firms were growing more strongly than those which were not innovating with, on average, innovating firms growing more than four times as fast as non-innovating firms.

2.4 From innovation metrics to the sectoral innovation indices

To compare sectors, it is necessary to place a value on different aspects of the innovation process, and on the extent to which firms draw on different sources of innovation. Combining those metrics – the 16 outlined above – into three indices representing the stages of the process in each sector allows such comparisons to be made. This section explains the methodology.

How these sectoral indices can then be benchmarked against each other to provide an indication of the relative strengths and weaknesses of each sector is subsequently

considered. This leads ultimately to the chart or map in Section 12.

The combination of metrics into three sectoral indices raises two key issues: first, the different innovation metrics are different in scale; and second, how the metrics should be weighted in the innovation index. The approach of this study to both issues is described in detail in Appendix 1 and in outline here. The scale issue is solved by normalising each innovation metric so that for each sector values range from zero to 100. Then each of the innovation metrics is weighted equally to derive the sectoral innovation indices. This means, for example, that the innovation index for accessing knowledge is the simple average of the normalised values of metrics A1 to A5. Of course, other approaches to weighting the individual metrics are possible and may be a useful area for future research.

This leaves three innovation indices, reflecting the stages of the innovation process. Within each sector, the value of these metrics will vary considerably ranging from firms which represent leading practice to those whose innovation processes are less well developed. This raises the potential for two different types of knowledge transfer which could help improve the innovation performance of firms. First, firms within a sector could learn from each other to improve the effectiveness of their innovation process. This might occur, for example, through competitor observation and benchmarking or movements of employees between firms. The potential will be greatest in sectors with significant variations between firms. This will be reflected in the variability of each of the innovation indices within each sector.

Second, there may be the potential sectors to learn from each other. The potential for inter-sectoral learning is clearly greatest where the gap between the best practice sectors and a specific sector's benchmark is large. Clearly, each sector is different and has its own professional practice and culture. But there are still ways they can learn from each other. This type of learning may involve client transfer, generic or technology specific business association or policy interventions to spread best practice between sectors. The index can point to potential areas for such inter-sector learning.

To represent these two dimensions of capability within a single diagram, a two-element approach is adopted. **Colours** are used to represent sectors' position compared to leading practice, i.e. inter-sectoral variation. **Letters** (H-high, M-medium, L-low) are used to reflect intra-sectoral variation. Green combined with 'L' would indicate a sector where levels of innovation capability were close to or at leading practice, with a low level of intra-sectoral variation in levels of innovation capability. Red combined with 'H' would indicate a situation where intra-sectoral variation in innovation capability is high and the sector lagged significantly behind leading

Figure 2: Variations within and between sectors

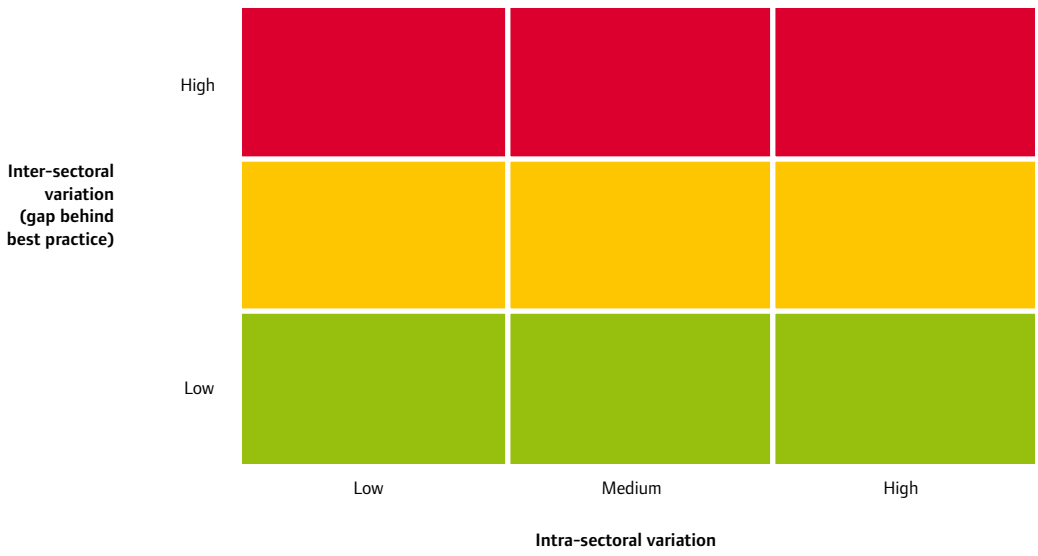


Figure 3: Linking variation within and between sectors

	Sector 1	Sector 2	Sector 3
Accessing Knowledge	L	L	M
Building Innovation	L	H	H
Commercialising Innovation	M	L	M

practice. This indicates sectors in which there is considerable scope for both intra- and inter-sectoral learning.

In practice, intra-sectoral variation in each index is measured using the standard deviation of the measure within the sector. The extent to which a sector falls below best practice is measured by subtracting the sectoral mean of each sectoral index from the mean of the highest-scoring sector. Inter-sectoral variation and the gap between each sector and national best practice come together in Figure 3.

Figure 3 illustrates how these two factors – intra-sectoral variation and the gap behind national best practice – come together. Thus Sector 1 is close to sectoral best practice in accessing knowledge (green), but lags far behind other sectors in terms of building innovation (red) and is weak on commercialisation. In addition, the variations in performance within sectors are low for the first two elements of the innovation process, indicating little scope for firms learning from each other. Thus Sector 1 is not good at developing new ideas or products: the sector lags far below other sectors, and there is little scope for the poorly-performing firms in the sector to learn from the better performers. By contrast, Sector 3 lies close to sectoral best practice for accessing knowledge and commercialisation, with medium variation in performance between its firms. Sector 2 is at a medium level of performance relative to other sectors on building innovation, but there is considerable variation between firms within the sector, indicating plenty of scope for the rest to learn from the best. Sector 2 demonstrates a different combination of outcomes.

The aim of this presentation is therefore to provide a quick visual overview of the results of the sectoral element of the innovation index project. As with the innovation value chain itself the idea is to help decision-makers identify those elements of the innovation process which might be working well and those where there might be potential for improvement.

The next sections present the findings for the individual sectors. The sections begin with an initial overview of the characteristics of the size and distribution of firms within the sectors and a review of previous research on innovation within the sector. The discussion then presents an overview of the Index survey findings for each sector. This is then followed by a discussion of the individual metrics that make up the IVC framework.

Part 3: Accountancy services

3.1 Sector structure

Although some accounting firms are very large multinational enterprises, the vast majority of firms in the UK are small, with over 6,000 of the 7,715 accountancy practices in the UK (79.1 per cent) having 5-19 employees, and only 230 practices (3 per cent) employing more than 100. The Innovation Index survey provided strong representation in all three size bands (Table 26). As with most sectors, the largest size band was over-represented, supplying 21 (10.9 per cent) of the 192 responses. Compared with the other sectors considered in this report, accountancy practices tend to be slightly older on average, and to have a slightly higher proportion of degree-level employees (Table 6). However, the proportion of degree-level staff in accountancy is markedly lower than in, for example, the software or design samples of firms (cf. Table 1).

3.2 Innovation in accountancy services

A survey of the research on the accountancy sector found little information on any innovation metrics routinely used in accountancy services firms. Instead, innovation in accounting services is generally viewed in terms of product innovation, process or back office innovation and the relationship with customers facilitated by information technology.

3.3 Our results

By undertaking initial exploratory interviews with representative sector associations and a small group of companies, it was possible to ascertain what firms within the sector thought were their key drivers for innovation. The interviews reinforced the view that there

Table 6: Characteristics of accountancy firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	86.9	93.1	95.2	88.2
Single site organisations (% firms)	88.9	62.5	19.0	82.1
Workforce with degree (% firms)	39.1	50.8	64.5	42.0
Percentage of firms exporting (% firms)	33.7	45.5	70.6	36.6

Source: Innovation Index Survey, responses weighted to give representative results.

are broad variations in the indicators used by accountancy firms to measure success.

These interviews highlighted some important drivers of innovation within the sector. Process innovation is focused on making the accounting process more cost effective and so delivering better value for money. In some cases, this has involved international outsourcing (e.g. outsourcing tax returns etc. to India) or using IT services, electronic data handling ('paperless office' services), or new software to speed up internal processes. New service innovations have included offering financial management 'health checks', environmental or CSR audits.

Key drivers of innovation relate to the increased complexity and professional liability in auditing, the changes in global accounting standards and legislative changes that have reduced the proportion of firms whose accounts now need to be audited. Collaboration makes an important contribution to the success of innovation with firms emphasising the role of other partner and benchmark firms, professional bodies and authorities such as the Inland Revenue who provide information on various tax issues. Alongside internal sources, a similar set of organisations provided ideas for innovation.

Skills – both technical and softer skills – were emphasised by interviewees as central to innovation success. Accounting skills and technical (IT) skills were said to be important in improving and developing internal systems and processes and continuous professional development (CPD) was emphasised as a source of new ideas. CPD was essential for keeping up-to-date with technical developments in accountancy, but also provided opportunities to learn from other accountancy firms. Innovation processes tend to be informal however, or 'organic', with few dedicated resources, training or incentive structures. Innovation exploitation is done primarily on a client-list basis with new clients being acquired through word of mouth and websites. There was little evidence of very active marketing being undertaken with no evidence from the exploratory interviews of either market scanning or marketing approaches such as cascading (developing a service for a client and marketing it to others).

3.4 Detailed results

The full survey allowed it to assess the degree to which the key drivers outlined above are reflected across the sector. In accountancy services, unsurprisingly, dealing with taxation changes and legislative/regulatory requirements were mentioned by over one-fifth of respondents, and was the most commonly cited response among firms in all size bands. Customer satisfaction and improving the level of services were the next most common response, each attracting around 15 per cent of respondents. Notably, however, the latter was markedly more common among the larger (100+ employee) practices, while the

Table 7: Innovation in accountancy firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	23.2	34.7	52.4	26.2
New to market product/service innovation (% firms)	5.1	8.3	14.3	5.9
Process innovation (%)	18.2	22.2	33.3	19.4
New to market process innovation (% firms)	1.0	6.9	4.8	2.2
Strategic innovation (% firms)	11.3	16.9	55.0	13.6
Managerial innovation (% firms)	8.2	22.2	42.9	11.7
Organisational innovation (% firms)	6.1	23.6	55.0	10.7
Marketing innovation (% firms)	19.2	40.3	71.4	24.5

Source: Innovation Index Survey, responses weighted to give representative results.

former was entirely the preserve of the SME respondents, perhaps indicating a difference in attitude towards the drivers of innovation among large and small practices. This view is enhanced by the fact that around 13 per cent of both small (5-19 employees) and medium-sized (20-99 employees) respondents mentioned maintaining the current level of service as an important innovation issue, while none of the largest firms did so.

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 7 presents the comparative rates of innovation activity within the sector segmented by the size of firms.

Just over a quarter of responding firms indicated that they had introduced a new product or service in the last three years, a proportion that rises steadily with firm size. This is the second lowest level of innovation recorded among the nine sectors. In addition, very few respondents (5.9 per cent) indicated that they regarded these new products or services as being 'new to market', the lowest of any of the nine surveyed sectors. Levels of process innovation are also relatively low, with fewer than 1 in 5 firms reporting having done so. These levels of product and process innovation are all very close to those recorded for the legal services, indicating a low level of innovation generally among these traditional, professionalised services. As with most sectors, all levels of innovation are higher among the largest firms, but this is most notable in accountancy for organisational, strategic and (especially) marketing innovation, where the levels among the largest cohort of firms approach the average for all nine sectors.

The Index survey suggests a profile of a sector in which product and process innovation is relatively scarce, and in which the largest firms are markedly more innovative than the smaller practices, especially in the marketing and organisational dimensions of innovation. Much of the innovation in products and processes is driven by legislative and regulatory requirements, especially as it relates to taxation and auditing requirements which are a staple part of the profession, especially among SMEs. There appear to be marked differences in the drivers of innovation between SMEs and the largest practices in the profession.

3.5 Innovation capabilities

Section 2 outlines the innovation value chain (IVC). The following section details the results of the survey of accountancy firms.

In terms of the first stages in the IVC, accessing knowledge and producing it internally, the performance of accountancy relative to the other sectors shows the following pattern:

- The sector exhibits relatively low level of openness in building on external sources. The average proportion of externally sourced products/services is the second lowest of any sector (4.9 per cent), and close to that of the lowest sector, legal services.

- Unsurprisingly, the level of R&D expenditure is minimal and joint lowest (with legal services) of any sector. Design expenditure is also low at 0.4 per cent of turnover. Only legal services and construction have lower levels of design intensity.

- The sector is also narrow in terms of the range of people it uses to access external knowledge. Accountancy firms use a lower percentage of different skill groups than any other sector (11.8 per cent) in accessing knowledge for innovation, and show very little use of external partners.

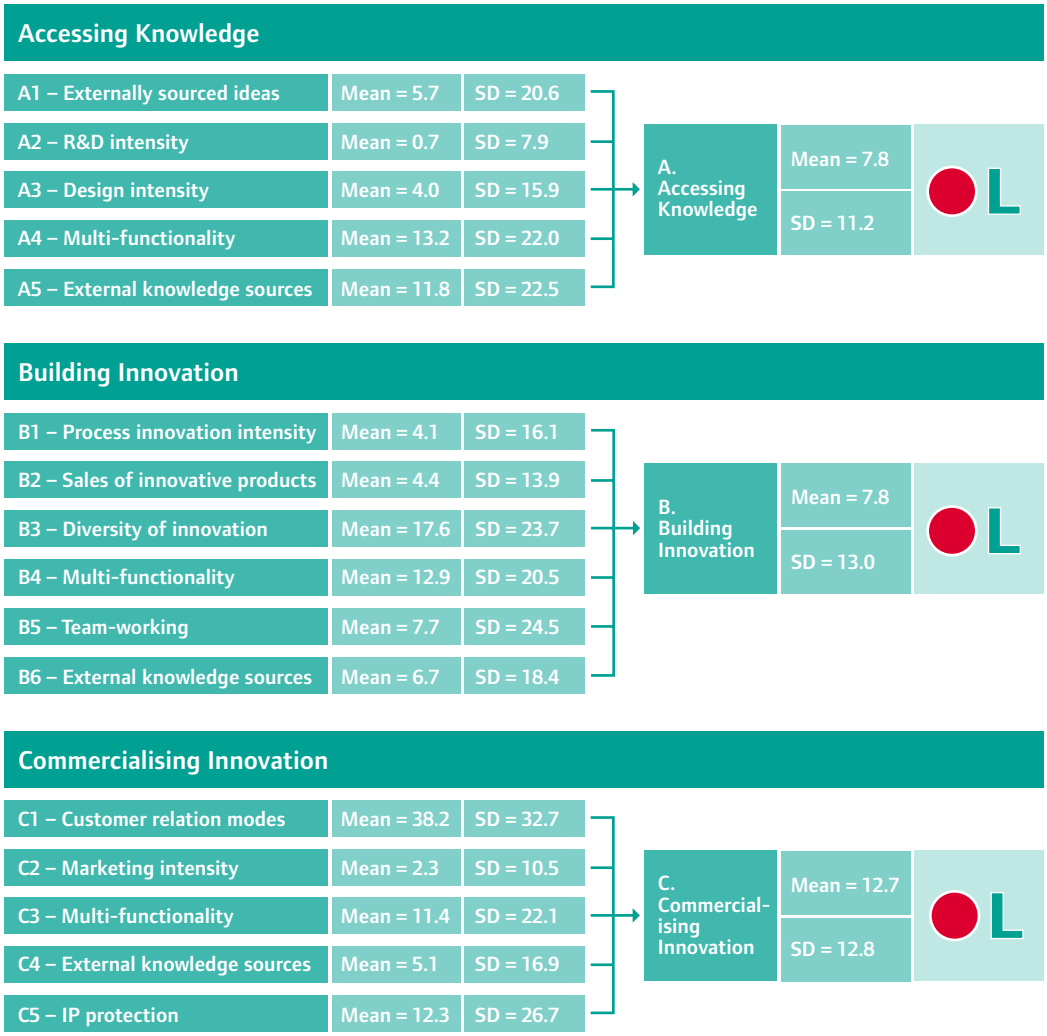
These findings suggest that the degree of open innovation in the accountancy sector is limited; there is very little investment in accessing or creating the knowledge required for innovation. This is also a sector in which those sources accessed to develop potential new ideas are very narrowly based. The intra-sectoral variation in accessing knowledge is also very low, suggesting that, at present, there is relatively limited scope for firms to learn from best practice from within the profession.

In the second stage of the IVC framework, building innovation, the sectoral Innovation Index measures spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. The metrics for accountancy services indicate:

- The sector spends close to the overall average on process change (0.6 per cent of turnover versus 0.7 per cent).

- The percentage of sales arising from innovative products or services is the lowest

Figure 4: Normalised innovation metrics and sectoral innovation indices for accountancy



of any sector (4.4 per cent), less than half of the average for all sectors and less than a fifth of the level of software and IT, the highest performing sector in this metric.

- The sector records the lowest levels in the use of team-working, drawing on different skill groups within firms and engaging with external partner involvement in building innovation.

The results indicate lower levels of hidden innovation. The results above mirror those of the preceding stage of the IVC framework, the accessing knowledge stage above, which suggests that the sector generates a relatively low level of innovative outputs and relies on a restricted range of internal skill sets and external partners to do so.

The final link in the innovation value chain is commercialisation. In the sectoral Innovation Index this includes measures of firms' spending on branding and marketing, the range of types of customer interaction in which they engage, IP protection and again the involvement of different skill groups and external partners in the commercialisation process. For accountancy firms it was found:

- There is little variation between all the sectors as regards the diversity in the types of customer relations. Accountancy is marginally below the average for all nine sectors, suggesting a reasonable use of e.g. market research, CRM systems etc.

- There is a greater level of variation in expenditure on branding and marketing. In accountancy, expenditure on branding and marketing is 0.6 per cent of sales turnover, around half the average for all nine sectors, but higher than other business services

sectors such as architectural services and specialist design.

- Accountancy firms use relatively few forms of IP protection in commercialising innovation, reflecting the nature of their business.

3.6 Sectoral innovation indices for accountancy

In this next section the individual metrics are combined into a broader sector index. Developing a sectoral innovation index for construction involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of how the index components were derived).

Figure 4 summarises the resulting index giving the normalised values for each of the sixteen innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. For accountancy, all three elements of the value chain are characterised by relatively large average inter-sectoral gaps, but small intra-sectoral variation, suggesting considerable scope for inter-sectoral learning but little scope for intra-sectoral learning.

3.7 Summary

Previous studies have emphasised that accountancy is a highly professionalised and regulated sector in which innovation is often driven by regulatory requirements, and is frequently more process than service driven. The survey analysis emphasises the relative strength of accountancy firms' ability to access knowledge – the first stage of the innovation value chain – and their somewhat weaker performance in subsequent activities in the innovation process.

In comparison to the other sectors considered here accountancy is unusual in having relatively low levels of innovation capability relative to other sectors but a relatively uniform level of innovation capability among firms within the sector. This may relate to the regulatory requirements that firms face, which sets minimum standards for accounting processes and procedures.

The relative weakness of accounting firms' capability in all elements of the IVC suggests that upgrading should relate to 'accessing knowledge', 'building innovation' and 'commercialisation' activities. The relatively low average level of innovation capability in the sector suggests the potential for learning from other sectors, with design or consultancy services providing useful potential benchmarks.

Part 4: Architectural services

4.1 Sector structure

The vast majority of architectural firms are small with 9,845 firms in the UK with 5-19 employees (77 per cent of the total) and only 320 firms employing over 100 (3 per cent of the total) (see Table 25) . The Innovation Index survey provides a strong and representative coverage of architectural service firms in each of the three employment size bands based on responses from 217 UK architectural firms. The response includes 95 firms with 5-19 employees (44 per cent of the total) and 54 firms employing over 100 (24 per cent of the total). The sample has an over-representation of larger firms. These tend to be more innovative and also export more of their services compared to smaller firms (Table 8). Just over 80 per cent of architectural firms in the sample are over ten years old and the majority of firms are single site organisations (71.8 per cent of the total). A higher proportion of employees working for the larger firms had a degree level qualification compared to the smaller firms (Table 8). Overall, nearly one-third of employees were educated to degree level compared to an average of 37.7 per cent for all the sectors considered in this report.

4.2 Innovation in architectural services

Previous research has highlighted the drivers of innovation within the sector. Innovation in an architectural firm tends to be produced through team work within the firm and collaborative arrangements between experts with different skill sets. This requires strategic management and the effective deployment and utilisation of project knowledge and project management skills. In their study of architecture, engineering and construction firms, Kamara *et al.*[23] stressed the importance of a number of factors in managing knowledge management in these firms. These factors include the accumulation of knowledge from individuals, long-standing relationships with suppliers, lessons learnt from completed projects, formal and informal feedback, transfer of people in different activities, informal networks and collaborations,

23. Kamara, J., Augenbroe, G., Anumba, C. and Carrillo, P. (2002) Knowledge management in the architecture, engineering and construction industry. 'Construction Innovation.' 2(1), pp.53-67.

Table 8: Characteristics of architectural firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	78.7	85.1	88.9	80.3
Single site organisations (% firms)	77.9	57.4	13.0	71.8
Workforce with degree (% firms)	35.6	34.8	42.9	35.7
Percentage of firms exporting (% firms)	44.7	59.7	79.6	48.6

Source: Innovation Index Survey, responses weighted to give representative results.

the reliance on the departments to disseminate the knowledge gathered and the use of IT tools to support information sharing and communication.

The architectural profession is global and tends to pull talents and innovative ideas from around the globe. The movement of architects between countries is suggested as one of the reasons why it is often difficult to locate the 'place' where innovation in architectural services occurs.[24] In the same study, emphasis was placed on the role of teams and networks for effective knowledge management within architecture firms. Whilst social relationships are very important in protecting knowledge, it appears that the key difficulties in architectural practices are the management of architects who tend to be 'culturally resistant' to being managed.[25]

Very few studies on innovation metrics in architectural services have been published. Amongst other things this is caused by the use of different terms in referring to the same sector. The majority of the studies refer to architectural services by bundling the sector with other 'knowledge-intensive services',[26] 'creative services',[27] 'knowledge-intensive professional services',[28] or 'technical engineering services':[29] many of these studies refer to architectural practices only in passing.

4.3 Our results

By undertaking initial exploratory interviews with representative sector associations and a small group of companies, it was possible to ascertain what firms within the sector thought were their key drivers for innovation. Within architectural services these main drivers were: developing new ways of working for clients using the space available; developing new designs; innovations related to sustainability; and cost reduction. Flair and design, or having something new to say, were seen as key to maintaining competitiveness in this sector with firms increasingly focusing on identifying and developing their core capabilities. There is a tendency towards specialism in the sector. Key issues in the current business climate relate to the security aspects of design, cost and speed. Current market conditions also present very significant issues for many firms.

Skills were emphasised as central to the innovation process, with softer skills such as a flair for design and elements of absorptive capacity (i.e. ability to research materials, components and systems, and the ability to take advantage and make opportunities for innovation) considered to be important. CPD was seen as important in maintaining and developing the skill base.

The innovation process is managed on a project-by-project basis with resources typically allocated by the managing director or directors of the practice. Project plans are drawn up and continuously developed and refined through the process. Few if any firms have a dedicated innovation team and the final marketing of new innovations is done in-house in various ways: e-mails are circulated to the various departments to inform them of the innovation; products are marketed through the press and via a firm's website or blogs.

The full survey made it possible to assess the degree to which the key drivers outlined above are reflected across the sector. Firstly, drivers of innovation in the sector were primarily market-related (clients) or related to network-based relationships (architectural associations). Maintaining current levels of service and sales levels was the second most common innovation issue highlighted by 12.5 per cent of firms, while 11.1 per cent said they were interested in improving the services they provide to clients.

Technological developments were less of a driver for innovation, with only 7.8 per cent of firms reporting that the need to identify and utilise new technology including software packages as important. This is reflected in the main partners for innovation which were said to be: design engineers; test houses within the industry; component and material manufacturers; Business Link; universities; and product suppliers. Ideas for specific innovation projects tended to come from both internal sources – from the staff within the firm – as well as external sources such as architectural ironmongers, manufacturers, schools of architecture, the trade and construction press, and professional bodies such as the Royal Institute of British Architects (RIBA).

Developing environmentally friendly designs, including energy saving designs and those that would have low carbon footprints, was identified by only 5.6 per cent of firms as being of concern. This is perhaps surprising given the emphasis that is currently being placed by government on adaption to climate change. It is interesting that this was seen as more important for larger firms (11 per cent of firms with 100+ employees) compared to

24. Falconbridge, J.R. (2006) Stretching tacit knowledge beyond a local fix? Global spaces of learning in advertising professional service firms. 'Journal of Economic Geography.' 6, pp.517-540.
25. Winch, G. and Schneider, E. (1993) Managing the knowledge-based organization: The case of architectural practice. 'Journal of Management Studies.' 30(6), pp.922-937.
26. Kemppilä, S. and Mettänen, P. (2004) Innovations in knowledge-intensive services. In 'Proceedings of the 5th International CINet Conference.' 22-25 September 2004, pp.326-335.
27. Winch, G. and Schneider, E. (1993) Managing the knowledge-based organization: The case of architectural practice. 'Journal of Management Studies.' 30(6), pp.922-937.
28. Lu, S. and Sexton, M. (2006) Innovation in small construction knowledge-intensive professional service firms: A case study of an architectural practice. 'Construction Management and Economics.' 24(12), pp.1269-1282.
29. Bilderbeek, R. and Brouwer, E. (2000) 'Innovation indicators for the technical engineering industry: A meso perspective.' Utrecht: Dialogic.

Table 9: Innovation in architectural service firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	35.8	54.4	63.0	40.3
New to market product/service innovation (% firms)	20.2	25.0	37.0	21.7
Process innovation (% firms)	27.4	51.5	42.6	32.6
New to market process innovation (% firms)	6.5	9.0	9.4	7.0
Strategic innovation (% firms)	15.8	26.5	51.9	19.0
Managerial innovation (% firms)	14.7	35.3	42.3	19.6
Organisational innovation (% firms)	20.0	46.3	64.2	26.5
Marketing innovation (% firms)	27.4	42.6	57.7	31.3

Source: Innovation Index Survey, responses weighted to give representative results.

smaller firms (5.3 per cent of firms with 5-19 employees).

4.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 9 presents the comparative rates of innovation activity within the sector, segmented by the size of firms.

On average, just over 40 per cent of firms reported developing a new product or service over the 2006-09 period, with on average one in five reporting these as 'new to market'. Just under one-third of firms had been involved in some form of process innovation, but only 7 per cent of these were considered as 'new to market'. Larger firms were more likely to have undertaken a product or service innovation but medium-sized firms were more likely to have undertaken a process innovation. Marketing innovation was reported by just under one-third of firms with larger firms employing over 100 being more engaged with marketing innovations (57.7 per cent) compared to small firms (27.4 per cent) (Table 9). Over one in four firms had been involved in some form of organisational innovation, but this was an activity that was more common amongst larger firms. Overall, larger firms tend to be more innovative than their smaller counterparts.

4.5 Innovation capabilities

Part 2 outlines the innovation value chain (IVC). The following part details the results of the survey of architectural services firms.

In terms of the degree of openness, architectural firms appear to be relatively strong in accessing the knowledge needed for innovation. The focus of the analysis is on the sources of new ideas, spending on R&D and design and the use of a range of different skill groups and external partners in gathering new ideas. The following observations can be made from an analysis of the performance of architectural services compared to the other sectors in this study:

- The average proportion of externally sourced products/service ideas in architectural services (10.7 per cent) is above the average for all sectors in this study (9.1 per cent), but less than half compared to the 'leading practice' sector Software and IT Services (Table 4).
- R&D expenditure as a proportion of sales for architectural services at 1.35 per cent is higher than the the average for all sectors (0.68 per cent).
- Architectural firms use more external partners in accessing knowledge for innovation compared to the average for all firms.

Taken together this suggests that on average architectural service firms are investing more in accessing knowledge than many other sectors in this study. In terms of overall investment in accessing knowledge for innovation, architectural services come second to consultancy services in that group of activities in the analysis that are often classified as knowledge-intensive services, or producer services.

Firms draw together the various forms of knowledge and expertise that they acquire in order to build new innovations. This 'hidden innovation' is an important driver for innovation and the Innovation Index explores these processes through measures that reflect spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. These measures reveal for architectural services that:

- Average spending on process change by architectural service firms is more than double that for the average for all sectors considered here (1.6 per cent of turnover compared to 0.7 per cent) (Table 4).

- The average percentage of sales that come from selling innovative products or services at 12.4 per cent is also slightly higher compared to the average of 10.2 per cent for all sectors (Table 4).

- The use of team-working, multi-functional working and involvement of external partners by architectural firms in building innovation is nearer the average of the sectors considered in this study. Very often this reflects client interaction in specific projects and can be a strongly structured process.

Overall, architectural services are both investing in activities to increase access to knowledge to build innovation, and are also investing in process innovation and this is reflected in the proportion of sales that are accounted for by innovations. Team working is used to build innovations as are external partners.

The third element of the IVC is the commercialisation of innovation. This includes measures of firms' spending on branding, marketing, the range of types of customer interaction in which they engage, IP protection and the involvement of different skill groups and external partners in the commercialisation process. The following points can be made:

- Architectural service firms perform slightly below the average for all firms in terms of the diversity of their relationships with customers, scoring 50.2 per cent compared to the survey average of 51.3 per cent. This includes, for example, undertaking market research, monitoring customer feedback and the use of structured CRM systems.

- Architectural service firms spend less than the average of all firms on branding as a proportion of sales with 0.4 per cent of sales turnover being directed at branding compared to an average 1 per cent across all sectors within the study. (Table 4).

- Compared to the average for all sectors, architectural service firms apply more forms of intellectual property protection with 26.7 per cent compared to an overall average of 21.2 per cent.

4.6 Sectoral innovation indices for architectural services

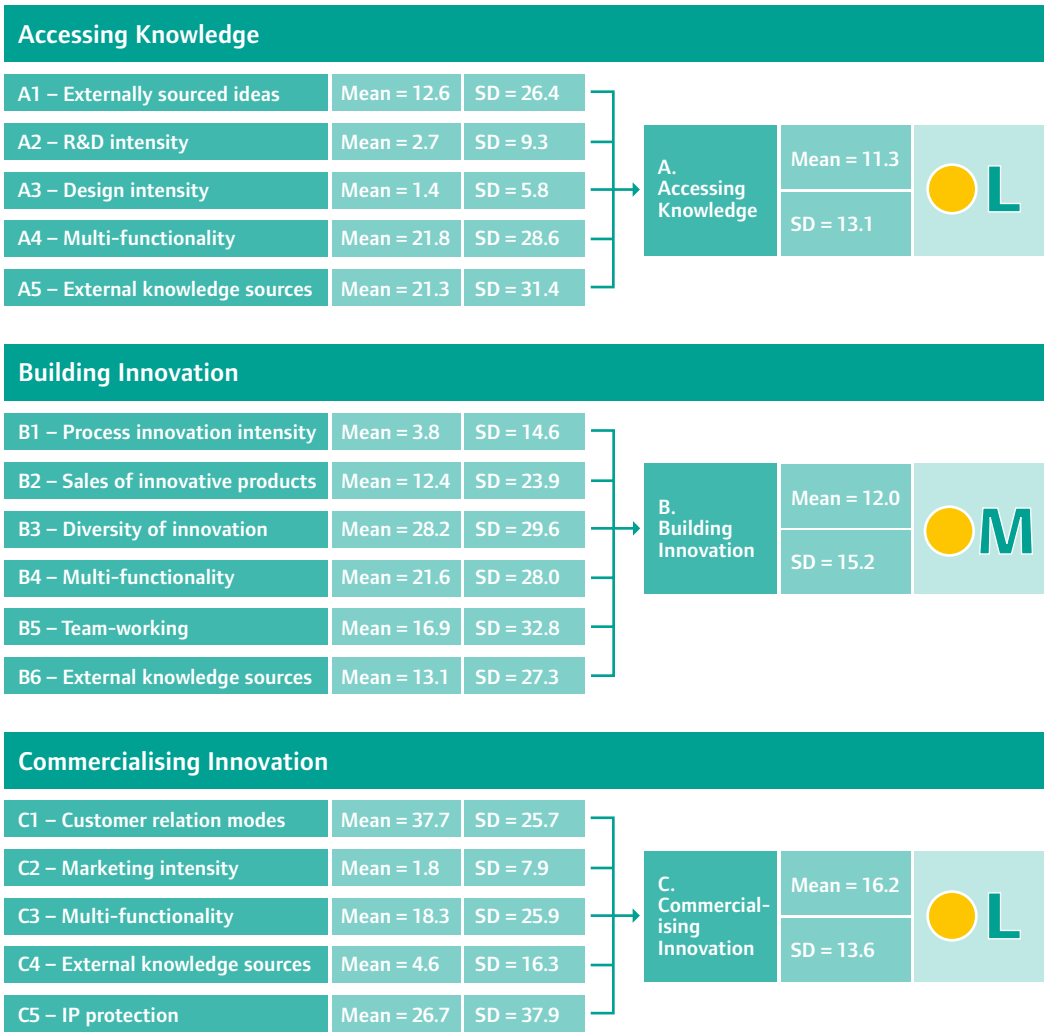
In this next section the individual metrics are combined into a broader sector index. Developing a sectoral innovation index for architectural services involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of how the index components were derived).

Figure 5 summarises the resulting index giving the normalised values for each of the sixteen innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. For architectural services the sectoral innovation indices for each stage of the IVC compare reasonably well compared to those in the other sectors considered here. There appears to be room for improvement in terms of the process of building innovation and this offers interesting possibilities for intra-sectoral and inter-sectoral learning.

4.7 Summary

Architectural services firms emerge from the analysis as having reasonably strong innovation capabilities in terms of accessing knowledge for innovation and subsequent commercialisation. Less strong relative to the other sectors considered here is capability in building

Figure 5: Normalised innovation metrics and sectoral innovation indices for architectural services



innovation, i.e. the effective translation of knowledge into new services, processes or business models. This reflects architectural firms' relatively low levels of investments in process upgrading and the engagement of external partners in this element of the innovation process.

Relative to the other sectors considered in this study architectural services firms have relatively low levels of innovation capability although these are better than firms in the accountancy and legal services sectors. Innovation capability varies among firms within the sector of course with this variability broadly similar to firms in legal services and accountancy.

The relative strength of the accessing knowledge and commercialisation activity in architectural services suggest that there is a need to improve capability in building innovation. This is a strategic priority therefore for the sector with investment in process improvement, team working and the engagement of external partners in new innovation all potentially important factors. Comparison to the other sectors here suggests the potential value of inter-sectoral learning to help improve overall levels of innovation in the sector. Design and consultancy services both provide potentially positive models.

Part 5: Consultancy services

5.1 Sector structure

The size distribution of firms in the consultancy sector is fairly typical of that for the study as a whole. There are 9,490 business and management consultancy firms in the UK, of which 7,840 (82.6 per cent) have between 5 and 19 employees, while only 235 (2.5 per cent) employ more than 100 (Table 25). In the Innovation Index survey responses were received from 190 firms, of which 40 (21 per cent) were in the largest size band, suggesting the sample is over-representative of larger firms (Table 26). Some key characteristics are given in Table 10. Just over three-quarters of consultancy firms are over ten years old, making them on average among the youngest firms in the sample of nine sectors. Consultancy firms also tend to be fairly highly skilled: more than half of employees in the sampled firms had degrees, a figure which varies little with size. Consultancy firms also tend to be relatively export-intensive, a tendency often linked positively with innovation. Again, this varies little by size band.

5.2 Innovation in consultancy services

Previous research suggests that the innovation process in consultancy firms is thought of as a collective process in which consultants play a key role as both producers and carriers of knowledge.[30] Indeed consultancy has been defined as "the active process which conveys knowledge and enables it to be used by clients for their own purposes".[31]

Competitive success in consultancy demands almost continuous innovation, with firms required to continually renew their knowledge structures by creating new practices. From the clients' perspective the services provided by consultancy firms allow client firms to compensate for gaps in their services, to reinforce in-house expertise and to complement expert skills.[32] During this process there are exchanges, collaborations and interactions which may draw on knowledge from a variety of industries to provide solutions to clients based on a combination of new

30. Bessant, J. and Rush, H. (1995) Building bridges for innovation: the role of consultants in technology transfer. 'Research Policy.' 24, pp.97–114; Anand, N., Gardner, H.K. and Morris, T. (2007) Knowledge-based innovation: Emergence and embedding of new practice areas in management consulting firms. 'Academy of Management Journal.' 50(2), pp.406-428.
31. Wood, P. (Ed.) (2001) 'Consultancy and innovation: the business service revolution in Europe.' Routledge Studies in International Business and the World Economy. Abingdon: Routledge; Working Paper 2004/4. Available at: http://www.sustainabletechnologies.
32. Czarnitzki, D. and Spielkamp, A. (2003) Business Services in Germany: Bridges for Innovation. 'The Service Industries Journal.' 23(2), pp.1-31; Davila, T., Epstein, M.J. and Shelton, R. (2005) 'Making Innovation Work: How to Manage IT, Measure IT, and Profit from IT.' Philadelphia, PA: Wharton School Publishing.

Table 10: Characteristics of consultancy firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	76.3	75.4	90.0	76.5
Single site organisations (% firms)	69.9	48.2	33.3	65.8
Workforce with degree (% firms)	51.9	57.8	56.9	52.8
Percentage of firms exporting (% firms)	46.7	48.1	54.3	47.1

Source: Innovation Index Survey, responses weighted to give representative results.

and existing knowledge.[33] Solutions generally encompass high intellectual value added.[34]

There are a limited number of studies that directly explore innovation metrics in consultancy services. Studies on innovation performance of business services firms tend to apply traditional measures of R&D which, as the wider work on hidden innovation shows, severely underestimates the level of innovation in consultancy firms. In an effort to address some of these issues Czarnitzki and Spielkamp (2003), for example, used a series of indicators to measure innovation activity including indicators of human capital (qualification of employees, number of employees with training) and turnover.

5.3 Our results

By undertaking initial exploratory interviews it was possible to ascertain what firms within the sector thought were the key drivers for innovation. The initial findings were that innovation in consultancy services is driven largely by clients' needs. Training and continuous professional development are seen as important for innovation, with firms stressing the importance of having broad-based skills. There was little evidence from these interviews that the firms engaged in formal planning or management of innovation, but there was considerable emphasis on team-working. Innovative ideas are typically developed in an organic manner with some firms providing financial incentives with good ideas.

The full survey makes it possible to assess the degree to which the key drivers outlined above are reflected across the sector. The need to maintain or improve the quality of their services was the most common issue, raised by 17 per cent of firms, reaffirming the importance of market demands on innovation within the sector. The introduction of new products and services was the third most commonly cited issue in relation to innovation, mentioned by 9 per cent of firms, most commonly by the smallest enterprises.

However, technological issues also rated highly as a driver for innovation. Technological developments generally were mentioned by 10 per cent of firms, and online/internet developments by a similar percentage. Interestingly, the internet was a much greater issue for the smallest (5-19 employees) size band of firms.

5.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 11 presents the comparative rates of innovation activity within the sector, segmented by the size of firms.

On average almost 64 per cent of firms reported that they had introduced a new

33. Pilorget, L. (1993) Innovation consultancy services in the European community. 'International Journal of Technology Management.' 8, pp.687-696; Sundbo, J. (1997) Management of Innovation in Services. 'The Service Industries Journal.' 17(3), pp.432 – 455; Hargadon, A.B. (1998) Firms as Knowledge Brokers: Lessons in Pursuing Continuous Innovation. 'California Management Review.' 40(3), pp.209-227.
34. Gallouj, F. (1991) Les formes d'innovation dans les services de conseil. 'Revue d'économie industrielle.' 57:3, pp.25-45.

Table 11: Innovation in consultancy firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	68.8	40.4	37.5	63.8
New to market product/service innovation (% firms)	30.1	14.0	15.0	27.3
Process innovation (%)	31.2	42.1	45.0	33.2
New to market process innovation (% firms)	3.2	3.6	2.6	3.3
Strategic innovation (% firms)	42.9	48.1	44.7	43.7
Managerial innovation (% firms)	31.2	35.2	36.8	31.9
Organisational innovation (% firms)	39.8	54.5	57.9	42.4
Marketing innovation	55.9	53.7	53.8	55.5

Source: Innovation Index Survey, responses weighted to give representative results.

or improved product or service, a relatively high figure. Unusually, this figure declines with size, the reverse of the pattern apparent in most other sectors and in the literature generally. This is also the case with respect to the incidence of reporting on 'new to market' products and services. Perhaps not surprisingly, consultancy firms reported very high levels of strategic, managerial and organisational innovation (30-40 per cent), and especially of marketing innovation (55.5 per cent): in each case these were the highest levels of any of the nine sectors. There is little evidence of variation by size band in these reported levels of innovation.

The profile emerging from the Innovation Index survey is of a consultancy sector which is highly innovative across a range of different indicators of innovation, with smaller firms being at least as innovative – possibly more innovative – than their larger counterparts. While client requirements are a key driver of innovation, technological developments are clearly a substantial issue with respect to innovation in the sector, especially among SMEs.

5.5 Innovation capabilities

Section 2 outlines the innovation value chain (IVC). The following section details the results of the survey through the IVC framework.

The findings for accessing knowledge, a measure of the openness of the sector's firms to external ideas, suggest a sector which has very strong investment in knowledge production and accessing, coupled with a strong capacity to source ideas externally. In particular the survey found that for the sector:

- The average proportion of externally-sourced ideas (13.4 per cent) is above the average for the nine sectors (9.1 per cent), placing consultancy 4th behind Software and IT, automotive and energy.

- R&D intensity is – perhaps surprisingly – around average for the nine sectors at 0.7 per cent of sales turnover. However investment intensity in design at 2.4 per cent of sales turnover is more than twice the average for all sectors and 2nd only to Software and IT, which stands out at 5.4 per cent.

- Consultancy firms have the highest incidence of using different skill groups in accessing knowledge of any sector, perhaps a feature of the team-based way of working. Consultancy firms also display a very high incidence of external partnering for knowledge sourcing. This suggests that consultancy firms are both open and prepared to combine different skills in the pursuit of successful innovation.

The second stage in the innovation value chain is building innovation. In this stage the sectoral Innovation Index reflects spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. The findings for consultancy services indicate that:

- Spending on process change (1.1 per cent of turnover) is again above the average for all sectors. The level of process innovation intensity in the sector is below that of architectural services.

- However, in terms of exploiting innovations, the sector outperforms architectural services. The percentage of sales accounted for by innovative products by consultancy firms is an average of 22.1 per cent more than double the average for the nine sectors, and comparable to that of the leading sector Software and IT services.

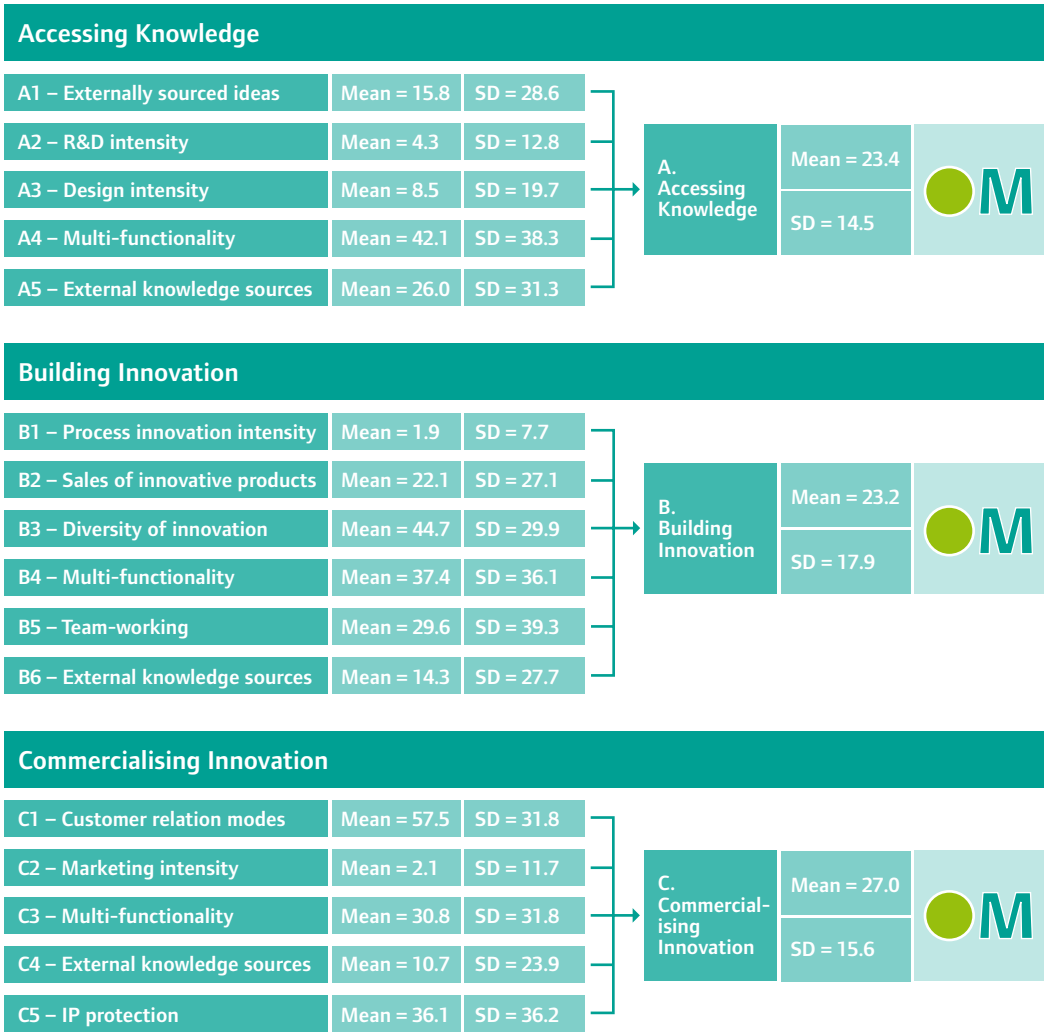
- The diversity of types of innovation is also very high in this sector (see Table 11 above), and building innovation is characterised by substantial use of team-working and of working with external partners.

As with the accessing knowledge stage, there is strong evidence of substantial strength in the building innovation capacity of consultancy firms. This is especially true in terms of the diversity of innovation activity, and there appears to be little scope for learning from other sectors in terms of building innovation.

The final link in the IVC framework is commercialisation. In the sectoral Innovation Index this includes measures of firms' spending on branding and marketing, the range of types of customer interaction in which they engage, IP protection and again the involvement of different skill groups and external partners in the commercialisation process. For consultancy firms the survey finds:

- The engagement with a broad diversity of types of customer relations is very high compared to all nine sectors, suggesting

Figure 6: Normalised innovation metrics and sectoral innovation indices for consultancy



a high use of e.g. market research, CRM systems etc.

- Spending on reputation and branding within the sector is the highest of any sector (2 per cent of sales), suggesting a sector which is conscious of the need for image building and self-promotion.

- Consultancy firms use a wide variety of types of IP protection in commercialising innovation, reflecting the IP-intensive nature of their business, but they also make use of a high incidence of external partners in commercialising innovation.

5.6 Sectoral innovation indices for consultancy services

In this next section the individual metrics are combined into a broader sector index. Developing a sectoral innovation index for consultancy involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of the derivation of how the index components are derived). Figure 6 summarises the resulting index giving the normalised values for each of the sixteen innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. In the case of consultancy, average values for all three elements are at or near the frontier for the nine

sectors, suggesting consultancy firms are more likely to be sources than recipients of inter-sectoral learning. However, there are quite substantial variations in performance within the sector, suggesting considerable scope for intra-sectoral learning, especially in accessing and commercialisation elements of the innovation value chain.

5.7 Summary

The findings of the Index Survey suggest that firms in the consultancy sector perform relatively well in each stage of the innovation value chain compared to the other sectors considered in this report. Unusually too there is little evidence of small firms being less innovative than larger firms, and possibly some indication of the reverse.

While the survey suggests that the average level of innovation capability in the consultancy sector is high, there is also considerable variation in the innovation capability of firms within the sector. This suggests a sector in which there is considerable potential scope for intra-sectoral sharing of best practice in innovation.

Part 6: Legal services

6.1 Sector structure

Although some law firms are large multinational enterprises, the majority of law firms in the UK are small in size. Of the 11,510 legal practices, 8,415 (73 per cent) have between 5 and 19 employees and 395 (3.4 per cent) have more than 100 employees (see Table 25). The Innovation Index survey surveyed 178 legal practices, split almost equally between small, medium-sized and large firms. The latter two categories are therefore over-represented in the sample of respondents.

Table 12 shows that most legal firms are relatively well established, with almost 90 per cent of respondents having been in business for more than ten years. Almost half of the workforce in responding firms had degrees, among the highest average of any of the nine sectors, and commensurate with the highly professionalised nature of legal services. Unsurprisingly, the incidence of exporting (15.6 per cent of firms) is very low.

6.2 Innovation in legal services

Innovation in legal services focuses primarily on adapting and changing internal processes, organisational structures, designing new service delivery solutions and in some cases convincing clients to test new processes. The most important source of knowledge to the firm in the innovation process is human capital. Partners, in particular, embody the most valuable human capital (tacit and explicit knowledge and relationships with clients).[35] The knowledge embodied may be categorised as administrative, procedural and analytical. In addition to this, knowledge-in-action is required for innovation and this is acquired from various sources such as libraries and online services. It has been suggested that information technology is a significant enabler of knowledge management improvement in law firms.[36]

Very few previous studies have explored innovation metrics and performance in legal services. Where innovation performance

35. Hitt, M.A., Bierman, L., Shimizu, K. and Kochhar, R. (2001) Effects of human capital and strategy on performance in service firms: A resource-based perspective. 'Academy of Management Journal.' 44:1, pp.13-28.
36. Gottschalk, P. and Khandelwal, V.K. (2004) Stages of Growth for Knowledge Management Technology in Law Firms. 'Journal of Computer Information Systems.' 44(4), pp.111-124.

Table 12: Characteristics of legal firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	87.0	94.4	96.4	89.0
Single site organisations (% firms)	84.1	41.5	36.4	72.6
Workforce with degree (% firms)	50.4	45.9	60.6	49.7
Percentage of firms exporting (% firms)	11.9	21.2	59.2	15.6

Source: Innovation Index Survey, responses weighted to give representative results.

is discussed it is either inferred from case studies[37] or discussed in more conceptual terms.[38]

6.3 Our results

By undertaking initial exploratory interviews it was possible to determine what firms within the sector thought were the key drivers for innovation. Key innovation issues were seen as relating to process and resource management with the aim of creating additional value for the firm while requiring fewer resources. For some firms – a minority – innovation also involved the development and provision of new legal services or capabilities, which is sometimes driven by legislative changes. Unlike the consultancy sector there was little evidence from the firms interviewed of any formal partnerships for innovation, with process changes being largely driven internally. The interviews suggested that this is due to the fact that process innovations could not be protected and therefore it would be naive to collaborate with professional associations as any innovation would be disseminated to all competitors.

The main barriers to innovation that firms identified were cultural and competitive factors as well as the nature of the legal labour market. Several firms suggested that conservatism is a major constraint on innovation in the sector. Globalisation also means that firms face increasing competition. Finally, it was suggested that current market conditions have a de-motivating and unsettling effect on mature trainees and this may also be discouraging creativity.

The full survey makes it possible to assess the degree to which the key drivers outlined above are reflected across the sector. Three areas were clearly dominant, each attracting 15-20 per cent of respondents. The first two were the general issues of maintaining and improving the level of service to clients. The final one was the need to respond creatively to new legislation or relevant regulation. Interestingly, in all three cases the incidence of response varied very little by size band. No other issue attracted more than a few responses. Issues relating to technology and the internet were rarely mentioned, and environmental issues did not figure at all in responses. This result reflects the nature and importance of the customised services provided to clients.

6.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 13 presents the comparative rates of innovation activity within the sector, segmented by the size of firms.

Overall, just over a quarter of responding firms reported developing a new product or service in the 2006-09 period, with 6.5 per cent of firms reporting these as 'new to market'. New

37. Løwendahl, B.R. (2000) 'Strategic Management of Professional Service Firms.' 2nd edition. Copenhagen: Copenhagen Business School Press; Alvesson, M. (2001) Social identity and the problem of loyalty in knowledge-intensive companies. In Blackler, F., Courpasson, D. and Elkjaer, B. (Eds) 'Knowledge Work, Organisations and Expertise: European Perspectives.' London: Routledge. pp.582-7.
38. Hansen, M.T., Nohria, N. and Tierney, T. (1999) What's your strategy for managing knowledge? 'Harvard Business Review.' (March-April), pp.106-116; Lorsch, J. and Tierney, T. (2002) 'Aligning the stars: How to succeed when professionals drive results.' Cambridge, MA: Harvard Business School Press.

Table 13: Innovation in legal firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	23.2	37.0	54.5	27.5
New to market product/service innovation (% firms)	4.3	11.1	20.0	6.5
Process innovation (%)	18.8	29.6	49.1	22.4
New to market process innovation (% firms)	1.4	0.0	11.1	1.4
Strategic innovation (% firms)	8.7	27.8	53.8	14.6
Managerial innovation (% firms)	11.6	20.8	63.0	15.5
Organisational innovation (% firms)	10.1	39.6	55.6	18.5
Marketing innovation (% firms)	23.2	53.7	67.3	31.9

Source: Innovation Index Survey, responses weighted to give representative results.

products (and processes) are much more common among large firms than among small practices. The figures for product and process innovation are among the lowest of the nine sectors, and comparable to those recorded in accountancy services. The other indicators of innovation also show relatively low levels in comparison to other sectors, and are also similar to those in accountancy. The degree of variation between small and large firms holds true across all types of innovation.

As with accountancy, the Index survey suggests that product and process innovation is relatively scarce in the legal services sector. The largest firms are significantly more innovative than smaller practices, especially in the marketing and organisational dimensions of innovation. Much of the innovation in products and processes is driven by legislative and regulatory requirements. Unlike accountancy, however, there appear to be few differences in the drivers of innovation between SMEs and the largest practices in the profession.

6.5 Innovation capabilities

Section 2 outlined the innovation value chain. The following section details the results of the survey for legal firms.

In terms of accessing knowledge and producing it internally, the performance of legal services relative to the other sectors shows the following pattern:

- The average proportion of externally sourced product/service ideas is the lowest of any sector (4.5 per cent) and less than half the average for all nine sectors.

- Unsurprisingly, R&D spending is almost absent in the sector. Only accountancy firms spend as little on R&D as legal firms.

- Legal firms do not broadly employ multi-functional teams to access innovation. At 21 per cent, this is marginally higher than reported in accountancy or architectural services, but below that of consultancies or specialist design firms..

These findings suggest a sector in which there is relatively little investment in accessing or creating the knowledge for innovation, and in which the source of potential new ideas is largely internal. However, the use of different skill groups within the firm is substantially greater than that in accountancy, for example.

The second stage in the IVC framework is building innovation. In this stage the sectoral Index measures reflect spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. The metrics for legal services indicate:

- At 0.3 per cent of turnover, the sector spends extremely low amounts on process change, which is comparable to the lowest sectors in the study (construction and energy).

- The percentage of sales derived from innovative new products and services is also extremely low (5.7 per cent of sales), around half the average for the study as a whole.

- Legal services rarely use external knowledge sources to build innovation (7.5 per cent). Additionally, the levels of team-working and the involvement of external sources is low, with only accounting services and construction lower. In contrast, the use of different skill groups in building innovation is around average for the study as a whole.

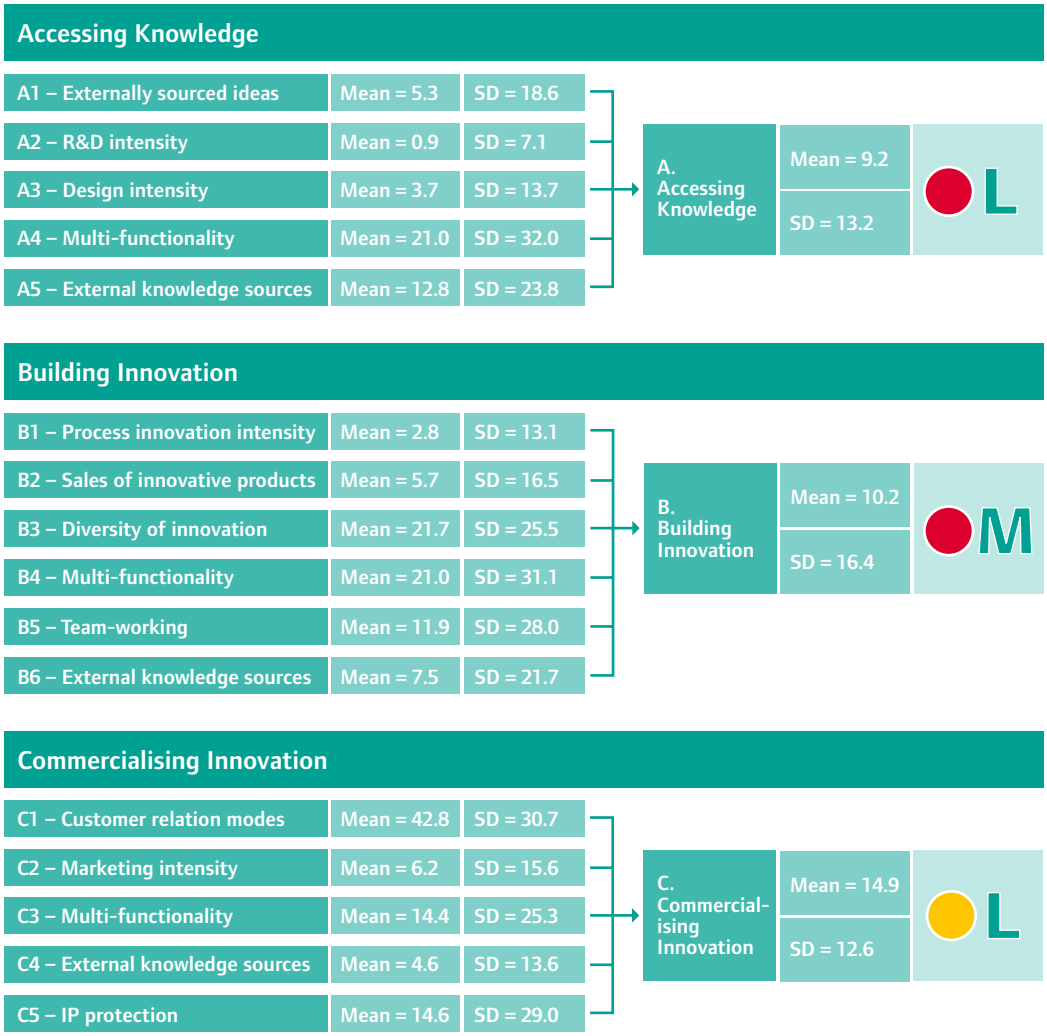
The results mirror those of the accessing knowledge stage above, and indicate low levels of hidden innovation, as the sector relies on a fairly restricted range of internal skill sets and external partners to innovate.

The final link in the innovation value chain is commercialisation. In the sectoral Innovation Index this includes measures of firms' spending on branding and marketing, the range of types of customer interaction in which they engage, IP protection and again the involvement of different skill groups and external partners in the commercialisation process. For legal firms the survey found:

- Outside of the construction sector there is little variation in sectors' adoption of a wide range of customer relations systems – the average is 51.3 per cent. Law firms are marginally higher with 54.3 suggesting a broad adoption of market research, CRM systems etc. but consistent with the broader sample of sectors

- Spending on reputation and branding is very low at 0.5 per cent of turnover, which is around half the average for all nine sectors and comparable to that of accountancy.

Figure 7: Normalised innovation metrics and sectoral innovation indices for legal services



- Legal firms use very few forms of IP protection in commercialising innovation, reflecting the nature of their business.

6.6 Sectoral innovation indices for legal services

In this next section the individual metrics are combined into a broader sector index. Developing a sectoral innovation index for construction involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of the derivation of how the index components are derived).

Figure 7 summarises the resulting index giving the normalised values for each of the sixteen innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. For legal services, the index suggests a relatively poor performance relative to other sectors, especially with respect to the building innovation and commercialisation stages. In the middle (building innovation) stage especially there is also considerable variation in performance within the sector, suggesting scope for both inter-sectoral and intra-sectoral learning and sharing of best practice.

6.7 Summary

The Index survey suggests that innovation capability for legal services is variable along the stages of the innovation value chain. The weak points for legal firms in the IVC are accessing knowledge and building innovation, where capability is low due to the limited use of external knowledge sources and relatively low levels of team-based innovation activity. The commercialisation phase of the innovation value chain is strongest with legal services firms, having relatively strong and varied communication channels to customers.

Compared to the other sectors, average levels of innovation capability in legal services are relatively modest – in line with those in accountancy. Levels of intra-sectoral variation in innovation capability are relatively low, however, perhaps reflecting the strong regulatory structures which govern and shape the activities of firms in the sector.

Part 7: Software and IT services

7.1 Sector structure

The overall size distribution of firms in the Software and IT Services sector reflects relatively closely that of the other sectors considered in this report. Of the 9,640 companies in the UK Software and IT Services sector 69.7 per cent were in the 5-19 employee size band, 24.4 per cent had 19-99 employees and 5.9 per cent (565) had more than 100 employees (Table 25). The Index Survey provided good coverage of firms in each size band, including data from 189 Software and IT Services firms (Table 26).

7.2 Innovation in software and IT services

Previous research has shown the knowledge intensive nature of activity in the Software and IT Services sector and this is reflected in the high proportion of graduate level employees – more than half of the workforce even in the smallest firms (Table 14). This makes the sector one of only three considered here (besides design and consultancy) in which more than half of all employees in the sector are graduates. The overall percentage of exporting Software and IT services is also second only to that in the automotive sector among the sectors considered in this report.

Studies of innovation in the software and IT services sector have also tended to emphasise the importance of human capital (i.e. level of education, prior experience and R&D expenditure per employee), external collaborations and innovation networks.[39] Interactions with suppliers, customers and external bodies such as public organisation and trade associations have also been highlighted as providing critical inputs which the firm itself would be unable to provide.

The Software and IT services sector includes software development, consultancy and supply, as well as data processing and database services. Both markets are characterised by "innovation-driven market growth, shrinking product and technology life cycles, high

39. Romingh and Alnaladejo (2001), for example, investigated the determinants of innovation in small electronics and software companies in the UK and highlighted education, prior work experience and R&D effort collaboration as key internal inputs to innovation. See also Romijn, H. and Albaladejo, M. (2002) 'Determinants of Innovation Capability in Small UK Firms: An Empirical Analysis.' QEH Working Papers Queen Elizabeth House. Oxford: University of Oxford; Trippl, M., Lengauer, L. and Tödtling, F. (2007) 'Innovation und Wissensnetze im Wiener Informations- und Kommunikationtechn-ologiecluster.' SRE-Disc sre-disc-2007_02. Vienna: Department of City and Regional Development, Vienna University of Economics and Business Administration; Lengauer, L., Nussmüller, N., Trippl, M. and Tödtling, F. (2008) 'Innovation and Knowledge Sourcing in the Vienna ICT Manufacturing Sector.' SRE-Disc sre-disc-2008_04. Vienna: Department of City and Regional Development, Vienna University of Economics and Business Administration; West, J. and Gallagher, S. (2006) Patterns of open innovation in Open Source software. In Chesbrough H., Vanhaverbeke W. and West J. (Eds) 'Open Innovation: researching a new paradigm.' Oxford: Oxford University Press; Misra, S.C., Kumar, V., Kumar, U. and Misra, R. (2005) Goal Driven Measurement Framework for Software Innovation Process. 'Journal of Information Technology Management.' 16(3), pp.30-42.

Table 14: Characteristics of software and IT firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	72.0	79.1	91.3	74.8
Single site organisations (% firms)	76.0	50.7	12.8	66.1
Workforce with degree (% firms)	52.0	56.5	53.1	53.2
Percentage of firms exporting (% firms)	54.2	78.3	74.4	60.9

Source: Innovation Index Survey, responses weighted to give representative results.

knowledge intensity and global markets".[40] R&D expenditure, patents and new software products and services therefore play a significant role in shaping firm performance, and firms' innovation capability is therefore crucial to building and sustaining competitive advantage.

7.3 Our results

The Index Survey found that the key drivers of innovation in the Software and IT Services were new technology and software, cited by 23.2 per cent of firms. Other key issues were the need to develop new products (22.0 per cent) and client services development (17.1 per cent). Other issues such as training (2.9 per cent) and changes in legislation (1.3 per cent) were not considered important by most firms in the sector.

7.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 15 presents the comparative rates of innovation activity within the sector, segmented by the size of firms.

65.1 per cent of Software and IT Services firms – the highest proportion of any sector – reported product or service innovation in the period between 2006 to 2009 (Table 15).

Process innovation was less common in the sector, although at 34.5 per cent of firms, still significantly above the average for the sectors considered in this report (23.8 per cent). Strategic, management, organisational and marketing innovation were also more commonly reported in the Software and IT Services sector than on average. This innovation was supported by relatively high levels of government support compared to other sectors considered here: 11.6 per cent of firms reported receiving government support for accessing knowledge, 6.8 per cent for building innovation and 7.3 per cent for commercialisation.

The Software and IT Services sector emerges as one of the most knowledge-intensive and innovation-led sectors considered in this report. High levels of graduate employment contribute to high levels of product, service and process innovation along with wider innovation in forms of organisation, marketing etc.

7.5 Innovation capabilities

This section explores the capabilities of the sector using the IVC framework developed in section 2 of the report.

In terms of the ability of firms in Software and IT Services the survey focuses on the sources of new ideas, spending on R&D and design, and the use of a range of different skill groups

40. Nambisan, S. (2002) Software firm evolution and innovation-orientation. 'Journal of Engineering & Technology Management.'19(2), pp.141-165.

Table 15: Innovation in software and IT firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	58.7	79.1	83.0	65.1
New to market product/service innovation (% firms)	41.3	56.7	51.1	45.7
Process innovation (%)	30.7	40.3	55.3	34.5
New to market process innovation (% firms)	4.2	12.1	21.7	7.2
Strategic innovation (% firms)	33.8	46.2	54.5	37.9
Managerial innovation (% firms)	23.0	35.8	47.8	27.6
Organisational innovation (% firms)	38.7	48.5	60.0	42.2
Marketing innovation	43.2	61.2	61.7	48.8

Source: Innovation Index Survey, responses weighted to give representative results.

and external partners in gathering new ideas. Comparing these measures for Software and IT Services firms to the other sectors included in this study it can be observed:

- R&D intensity in the Software and IT Services sector at 4.3 per cent of turnover was markedly higher than that in any other sector considered in this report and significantly above the next highest sector (architectural services at 1.4 per cent). Design intensity in the sector at 5.2 per cent of turnover was also significantly above the survey average (1.0 per cent) and above the next highest sector (consultancy services at 2.4 per cent).

- In accessing knowledge, the level of multifunctional working (41.7 per cent) and external knowledge sources (29.5 per cent) in Software and IT services was on a par with the best practice sectors considered here (consultancy services and the automotive sector respectively).

- The proportion of externally sourced ideas (20.1 per cent) was the highest of any sector considered here and significantly above the survey average of 9.1 per cent.

To reflect Software and IT Services firms' ability to effectively build new innovations from the knowledge they have gathered, the sectoral Innovation Index reflects spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. Comparing between sectors suggests:

- Spending on process innovation in Software and IT Services (1.9 per cent of sales turnover) was the second highest of any sector considered in this report (the highest was automotive at 2.1 per cent), and significantly above the survey average.

- The extent of multi-functionality, team-working and the involvement of external partners in building innovation in Software and IT Services were either at or among the strongest in the sectors considered here.

- 24.4 per cent of sales for Software and IT firms were derived from innovative products – the highest of any sector. The sector also had the second highest level of diversity of innovation after Consultancy Services.

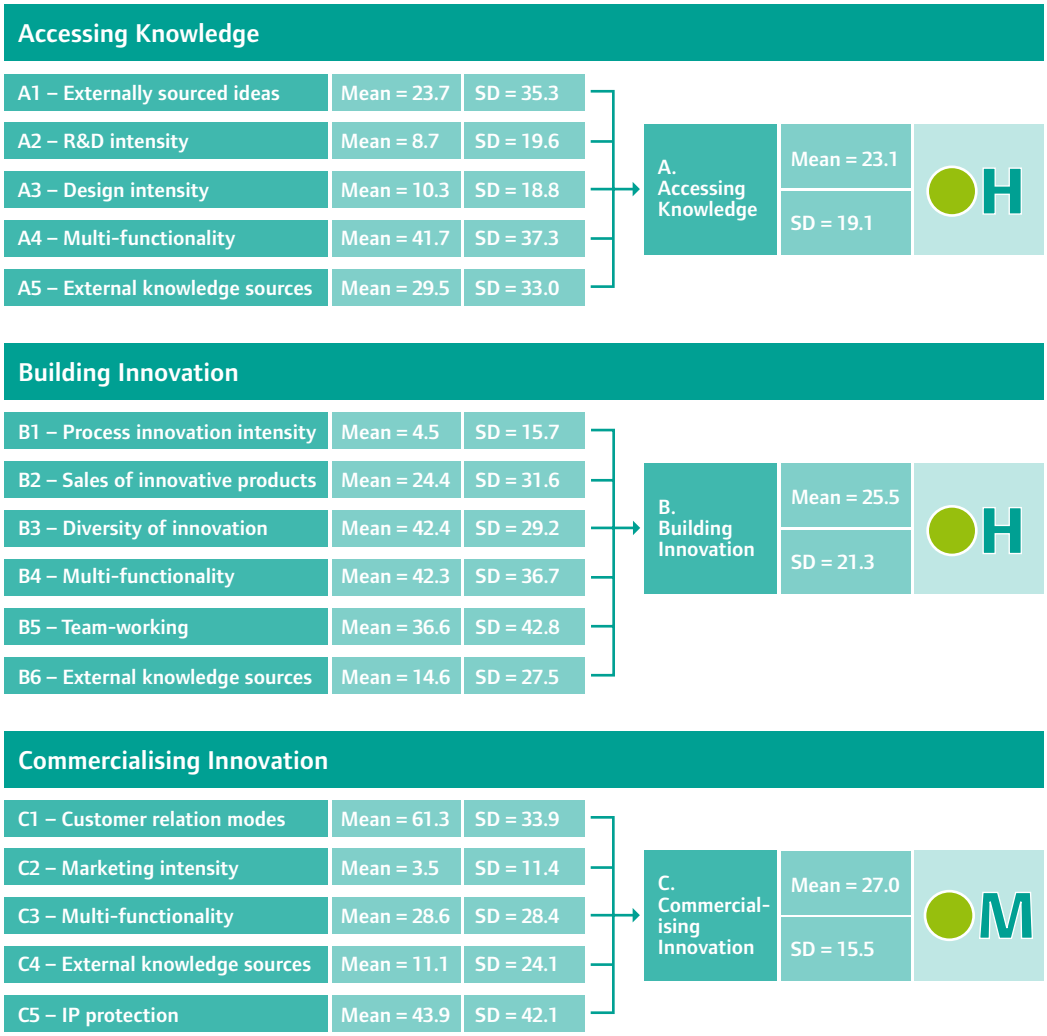
Despite relatively low levels of spending on process innovation software and IT, firms perform well on most of the innovation metrics relating to building innovation. This is the result of higher levels of team-working and involving a wider range of internal skill groups and external partners.

The third link in the IVC is the commercialisation of innovation. Here the sectoral Innovation Index includes measures of firms' spending on branding and marketing, the range of types of customer interaction in which they engage, IP protection and the involvement of different skill groups and external partners in the commercialisation process. Branding and marketing expenditure in Software and IT Services (0.8 per cent) was marginally below the survey average (1.0 per cent) but above that of the majority of sectors considered in this report. Multi-functionality and engagement with external organisations and customers was also close to leading practice in the survey and notably above the survey average on each measure (Table 4).

7.6 Sectoral innovation indices for software and IT services

In this next section the individual metrics are combined into a broader sector index. Developing a sectoral innovation index for construction involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of the derivation of how the index components are derived).Figure 8 summarises the resulting index giving the normalised values for each of the sixteen innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. For Software and IT Services the sectoral innovation indices for the first and third stages of the IVC compare strongly to those in the other sectors, combining relatively high levels of investment in innovation and well developed networks, teams and multi-functionality. The second stage of the IVC also shows high mean values of the innovation metrics in the Software and IT Services sector compared to other sectors. However, there is also significant variation between firms, suggesting the potential for improved intra-sectoral learning.

Figure 8: Normalised innovation metrics and sectoral innovation indices for software and IT services



7.7 Summary

The IVC for software and IT services is one of the most consistently strong of the sectors considered in this study. In general terms, average levels of innovation capability within the software and IT services sector were relatively high compared to the other sectors considered in this report.

The survey results also suggest however that there is significant variation between best innovation practice in the sector and the majority of firms. This high variation in practice within the sector is especially noticeable in the accessing knowledge and building innovation phases of the innovation value chain.

Part 8: Automotive sector

8.1 Sector structure

The typologies of sectors vary considerably. The following section gives an overview of the characteristics of the size and distribution of firms in the architectural services sector.

The distribution of firms by size in the automotive sector is broadly in line with that of the other sectors considered in this report. There are 820 automotive firms located in the UK and the majority of firms are small with 5-19 employees (43.9 per cent) and 190 firms employ over 100 (23 per cent) (Table 25). The Innovation Index survey provides a reasonable representative coverage of automotive firms in the UK in each of the three employment size bands based on responses from 61 UK automotive firms (Table 26). Forty-eight per cent of firms in the sample have 5-19 employees while 28 per cent have more than 100 employees (Table 16). The number of automotive firms in the sample is small. This reflects the small size of this sector in terms of number of firms compared with other sectors that are explored in this report. It also reflects the economic downturn and the difficulties that automotive firms were experiencing. Some firms refused to be interviewed as management time was focused on survival.

Just over 90 per cent of firms in the sample are more than ten years old and just under 60 per cent are single site organisations; the vast majority of large firms operate from more than one site. Around 1:6 employees in the automotive sector responding to the survey had a degree qualification and this was the lowest proportion of all sectors in the sample. The proportion of automotive firms exporting (83.7 per cent) was the highest in any of the nine sectors considered in this report (Table 1). The automotive sector is the only traditional manufacturing sector to be considered in this report. The low levels of graduate employment reflect the historically high levels of elementary occupations, semi-skilled and apprenticeships that have been a feature of the automotive sector for some considerable time. This explains why a sector with low levels of graduate

Table 16: Characteristics of automotive firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	86.2	100.0	93.8	92.5
Single site organisations (% firms)	86.2	53.3	11.8	58.1
Workforce with degree (% firms)	14.8	19.0	14.7	15.9
Percentage of firms exporting (% firms)	75.0	92.9	87.5	83.7

Source: Innovation Index Survey, responses weighted to give representative results.

employment can also have high levels of exports.

8.2 Innovation in the automotive sector

Previous research on innovation in the automotive sector has emphasised the importance of innovation in allowing firms to develop distinct sets of focused core competencies. Investment in product innovation and R&D is therefore crucial and innovation and technological development the only viable route to a healthy and sustainable future. The primary capital resource having the strongest influence on innovation in the automotive sector is human capital followed by cultural capital and consumer behaviour. In Clark and Wheelwright's (1993) study of innovation in the automotive and electronics industries, they reported that suppliers and customers tend to be the primary drivers of innovation.[41] Process innovation has centred on 'lean manufacturing (including just-in-time and supply chain management techniques)' and these are now common across the sector.[42]

8.3 Our results

By undertaking initial exploratory interviews with representative sector associations and a small group of companies, it was possible to ascertain what firms within the sector thought were the key drivers. Within the automotive sector firms tended to emphasise innovation as a defensive rather than offensive activity in the current climate. Also notable in some discussions was a shift in emphasis in innovation activity away from improvements in vehicle performance towards innovations to reduce costs. Customisation is also considered as an important issue in creating value.

Customer-led innovation was considered to be important by some firms but links to suppliers were seen as crucial by all firms. Universities also play an important part in the innovation process, but smaller firms were concerned that universities appeared not to be too interested in their activities. As a result, there may be no effective route to collaboration with scientific organisations for SMEs.

Systemic approaches to managing innovation were more strongly evident in the automotive sector than in any of the other sectors considered here. Ideas for innovation develop in an organic manner in small firms which are generally characterised by a very flat management structure. Larger firms tend to have idea schemes such as idea boxes and incentives to encourage innovative ideas. Ideas also come from interactions with industry peers during trade shows, interactions with customers and from trade magazines. In larger firms, ideas are shared within the firms through various means including intranets.

Innovation is usually organised around multifunctional project teams including engineers, designers, procurement staff and marketing and sales staff. Typically teams meet regularly and have a relatively high level of discretion in terms of the ways that the innovation process is managed. Development processes would be formally managed with periodic reviews to assess costs.

Innovation exploitation is a key issue for smaller firms as markets are highly competitive. The key distributors tend to partner with the larger players. This means that smaller firms, have to be innovative in the ways that they commercialise their innovations, with some using a direct selling approach targeting specific companies. Some products are patented but this is generally seen as a difficult process.

Key barriers to innovation are linked to the current economic climate and the resultant shortage of investment funding. Poor external relationships were also considered to limit firms' awareness of potential opportunities and this was something which was a particular issue for smaller firms.

The full survey allowed us to assess the degree to which the key drivers identified through the interviews are reflected across the sector. Automotive firms were asked to identify their most important innovation issues. The need to develop products (including their range, quality, innovation, new markets, specialist products) was by far the most commonly cited factor by 45 per cent of firms.

The next most commonly cited factor was customer satisfaction (10.8 per cent of firms), followed by technology (10 per cent of firms). In many cases projects span these different aspirations, of course, with new products shaped or driven by new technological development.

41. Clark, J. and Wheelwright, S. (1993) 'Managing New Product and Process Development.' Cambridge, MA: Free Press.
42. Dodgson, M. (2001) 'Measuring Innovation.' International Conference on Measuring and Evaluating Industrial R&D and Innovation in the Knowledge-based Economy. Taipei.

Table 17: Innovation in the automotive sector

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	51.7	60.0	94.1	64.3
New to market product/service innovation (% firms)	20.7	46.7	47.1	35.4
Process innovation (% firms)	27.6	60.0	70.6	48.2
New to market process innovation (% firms)	3.4	13.3	12.5	8.7
Strategic innovation (% firms)	17.2	20.0	56.3	26.8
Managerial innovation (% firms)	6.9	20.0	56.3	22.2
Organisational innovation (% firms)	20.7	26.7	56.3	30.5
Marketing innovation (% firms)	44.8	40.0	31.3	40.2

Source: Innovation Index Survey, responses weighted to give representative results.

It is important to remember that many firms in the sample are manufacturers of parts and the competitiveness of such firms is closely associated with their ability to produce parts as cheaply as possible; innovation may thus focus on re-engineering products to reduce raw materials and to increase the ease and cost of manufacture. One interesting difference between employee size bands relates to the emphasis automotive firms placed on customer satisfaction. This was unimportant for small firms (3.4 per cent of firms employing 5-19), but was much more important for medium-sized firms (20.0 per cent of firms employing between 20 and 99), and less important for large firms (11.8 per cent of firms employing over 100).

8.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 17 presents the comparative rates of innovation activity within the sector, segmented by the size of firms.

Over 60 per cent of firms reported developing new products and services over the 2006-09 period. This was especially important for larger firms (94.1 per cent of firms employing over 100). Just over one-third of these innovations were new to market which suggests that firms are learning from one another and from other sectors. Process innovations were less important, being introduced by fewer than 50 per cent of firms and managerial and organisational innovations were even less important (Table 17). Marketing innovations had been introduced by just over 40 per cent of firms.

There are interesting size band differences here with fewer larger firms reporting innovations in this area compared to their smaller counterparts. Notably in this sector there appears to be a strong association between innovation and the size of a firm. Nevertheless, this relationship is not mirrored in the number of patents held by automotive firms. Thus, large firms reported that they held, on average, 2.3 patents, but medium-sized firms held 20.1 patents. Medium-sized firms also reported that they had applied for, or been awarded, on average, 6.6 patents in the last three years compared to only 0.83 for the larger firms.

Overall, the profile emerging from the Index survey suggests that innovation amongst automotive firms is driven by the market and a concern by the firms to constantly introduce new products. Firms in this sector perhaps adopt the most structured innovation process of any considered in this study reflecting levels of investment in R&D and other aspects of the innovation process. Process innovation is less important, but marketing innovation is reasonably important. It is perhaps surprising that automotive firms were not too concerned with innovations that were been driven by environmental agendas. This may reflect the timing of the Innovation Index survey as this occurred during an economic downturn

and firms were more concerned with survival strategies than adaptation to climate change.

8.5 Innovation capabilities

Section 2 outlines the innovation value chain (IVC). The following section details the results of the survey of automotive firms.

In terms of a firm's ability to access the knowledge required for innovation, the focus of the analysis is on the sources of new ideas, spending on R&D and design, and the use of a range of different skill groups and external partners in gathering new ideas. The following observations can be made by comparing these measures for the automotive sector to the other sectors included in this analysis:

- The average proportion of externally sourced products and service ideas in the automotive sector (16.0 per cent) is above the average for the sectors considered here (9.1 per cent) (Table 4).

- Average R&D spending on design as a proportion of sales of 1 per cent is also higher amongst the automotive sector compared to the other sectors considered in the analysis, but is still much lower than the 'leading practice' sector Software and IT services, which spends 5.2 per cent (Table 4).

- The degree to which automotive firms access knowledge is high and tends to be a more multi-functional process involving more external partners. In fact, the automotive sector is the strongest of the nine sectors in this report for using external partners for knowledge transformation (30.2 per cent for automotive compared to an average for all sectors of 16.9 per cent). For this indicator, automotive firms are the 'leading practice' sector.

Overall, this suggests that the automotive sector invests in accessing the knowledge and information that is required in order to engage in innovation. In terms of accessing knowledge it would appear that firms in the automotive sector are in a strong position.

Firms draw together the various forms of knowledge and expertise that they acquire in order to build new innovations. The IVC framework explores this process through measures that reflect spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. These measures reveal for firms in the automotive sector that:

- Average spending on process change in the automotive sector is the highest of all sectors (2.1 per cent of turnover compared to an average of all sectors of 0.7 per cent of sales) (Table 4).

- The percentage of sales that are accounted for by innovative products and services is higher (19.5 per cent) than the average for all firms in this study (10.22 per cent) (Table 4).

- The diversity of innovation or breadth of innovation activity in the automotive sector is above the average for the sectors considered in this study. In terms of the diversity of innovative activity, the sector scored 38.4 per cent, significantly above the average for all sectors of 26.9 per cent, while it draws on a wider diversity of employees than the average, scoring 33.6 per cent compared to 22.2 per cent across all sectors.

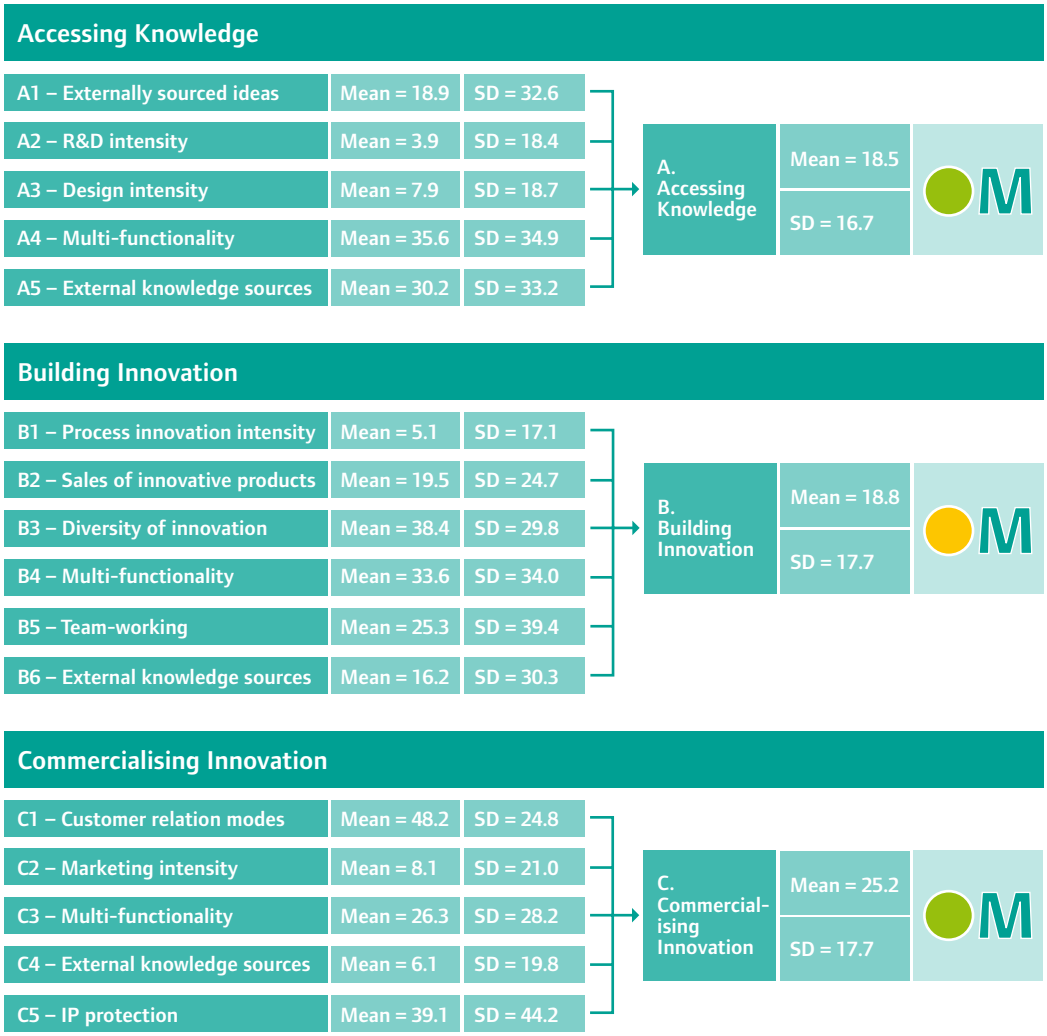
The findings indicate that automotive firms are investing in building innovation and at a level that is slightly higher than the average for all firms in this study. There are examples of excellent practice in this sector, but also areas in which improvement would be possible.

The third element of the IVC is the commercialisation of innovation. This includes measures of firms' spending on branding, marketing, the range of types of customer interactions in which they engage, IP protection and the involvement of different skill groups and external partners in the commercialisation process. The following points can be made:

- Automotive firms perform close to the average for all firms in terms of the diversity of their relationships with customers (56.7 per cent compared to the average for all firms of 51.2 per cent). This activity includes, for example, undertaking market research, monitoring customer feedback and the use of structured CRM systems.

- The sector uses a diverse range of staff to commercialise innovations, scoring 26.3 per cent compared to an average for all sectors of 16.6 per cent. However, the sector is less diverse in drawing on external knowledge

Figure 9: Normalised innovation metrics and sectoral innovation indices for the automotive sector



sources, scoring 4.4 per cent, lower than the overall average of 5.8 per cent.

- Automotive firms spend less than one-third of the average expenditure of all firms on branding as a proportion of sales (Table 4).
- This sector has extremely strong networks in place that enhance the ability of firms to commercialise their innovations.
- Compared to the average for all sectors, automotive firms apply more forms of intellectual property protection.

8.6 Sectoral innovation indices for the automotive sector

In this next section the individual metrics are combined into a broader sector index. Developing the sectoral innovation index for automotive firms involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of the derivation of how the index components were derived).

Figure 9 summarises the resulting index giving the normalised values for each of the sixteen innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation.

For automotive firms the sectoral innovation indices for each stage of the IVC compare extremely well compared to those in the other sectors considered here. There appears to be some room for improvement in terms of the process of building new innovations and this offers possibilities for intra-sectoral and inter-sectoral learning.

8.7 Summary

The observed pattern of innovation capabilities in the automotive sector reflects a pattern similar to that observed in architectural services. That is, firms in this sector emerge as having strong capabilities in accessing knowledge for innovation and commercialisation but weaker capabilities in terms of building innovation. This may reflect recessionary effects on spending on process upgrading, but for some firms will also reflect the limited priority given to team-working as part of their innovation activity.

Relative to other sectors considered here levels of innovation capability in the automotive sector are above those in accountancy, legal services, architectural services and construction but lag those in software and IT development, design and consultancy. For each element of the innovation value chain, significant variability in innovation capability within the automotive sector can be observed suggesting the potential for the sharing of best innovation practice within the sector.

For automotive firms innovation is very different in nature from that in many of the other sectors considered here. Other sectors perform more strongly however both in terms of average levels of innovation capability (consultancy) and in terms of the uniformity of innovation capability (accountancy, legal services). The weakest link in the automotive IVC is in building innovation and this is clearly the strategic priority for upgrading. At a more general level, however, there is potential for both inter- and intra-sectoral learning in order to increase average levels of innovation capability within the sector and improve the innovation capabilities of weaker firms.

Part 9: Construction

9.1 Sector structure

Firm size distribution in the construction sector is broadly in line with that of the other sectors considered in this report with 39,525 UK construction firms with 5-19 employees (78.6 per cent of the total) compared to 77.9 per cent in the UK as a whole (see Table 25). The Innovation Index survey provides a strong and representative coverage of construction firms in each of the three employment size bands considered based on responses from 194 UK construction firms. Some of the key characteristics of sample firms are given in Table 16, with around 88 per cent of construction firms in the sample being more than ten years old. Around 1:5 employees in the construction firms responding to the survey had a degree level qualification compared to an average of 37.7 per cent in all the sectors considered here. The proportion of construction firms exporting (10.7 per cent) was also the lowest of any of the nine sectors considered here (Table 1). Other studies have linked both high levels of graduate employment and exporting to innovation. Low levels of both in construction would suggest *a priori* that levels of innovation in the construction sector might be lower than those in the other sectors considered.

9.2 Innovation in construction

Previous research on innovation in the construction sector has found that activity has been characterised by the extensive use of sub-contracting, low albeit reliable rates of profitability, low levels of investment in R&D, training and physical capital and price driven competition.[43] Previous studies have suggested that the construction industry lacks dynamism as far as innovation is concerned with innovation, where it occurs, tending to be incremental rather than radical.[44] A number of factors have been suggested which may be contributing to the incremental nature of much construction innovation.[45]

43. BERR (2008) 'Supporting Innovation in Services.' London: BERR. Available at: http://www.berr.gov.uk/files/file47440.pdf
44. Abbott, C., Aouad, G. and Madubuko, L. (2008) 'An innovation platform for construction.' NWUA Pilot Project to Develop Innovation Platforms in Non-science Research Disciplines. Salford: Salford Centre for Research & Innovation, University of Salford.
45. Lu, S. and Sexton, M. (2006) Innovation in small construction knowledge-intensive professional service firms: A case study off an architectural practice. 'Construction Management and Economics.' 24(12), pp.1269-1282.

Table 18: Characteristics of construction firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	88.1	84.6	95.5	87.7
Single site organisations (% firms)	91.7	75.8	13.6	86.4
Workforce with degree (% firms)	21.8	14.9	24.4	20.4
Percentage of firms exporting (% firms)	7.1	21.5	39.0	10.7

Source: Innovation Index Survey, responses weighted to give representative results.

First, innovation has been said to be largely project-based with limited knowledge transfers between projects and project teams.[46] Second, the fact that the industry is "predominantly made up of firms of less than five people, [which] have limited capacity to innovate due to their management abilities, limited resources and reduced opportunities for supply chain driven innovation".[47] Third, the importance of cost-based competition within the sector, its adversarial nature and tendency towards 'short-termism and opportunism', discourages long-term solutions and collaborative innovation.[48] Fourth, this short-termism has also been seen as reducing the level of Continued Professional Development (CPD) for professionals in the construction industry with impacts on organisations' ability to innovate successfully.[49]

Activity – and therefore also innovation – within the construction industry are strongly influenced by regulation from both governmental and non-governmental sources. Perhaps the main regulations affecting construction firms relate to planning, building regulations and control, contract resolution, health and safety and various professional codes and standards. The extent of regulation may constrain innovation in some areas of construction, however, recent changes to the building regulations which have enforced tight carbon emission for new build and renovations of existing buildings, also create a need for innovative technologies and processes.

The need to improve measures of innovation in construction has been highlighted in a number of studies with traditional science-based output metrics often seen as inadequate.[50] Particular attention has been focused on the need to develop better measures of the extent of collaboration,[51] and the importance of the contribution of different types of partners to innovation activity.[52]

Key innovation partnerships highlighted during the exploratory interviews were those with specialist suppliers, local and central government agencies, the Concrete Society, the Royal Institutes of British Architects and the Health and Safety Executive (HAS). These partnerships were said to play a key role in informing and supporting construction firms in making better use of resources, in tackling climate change, as well as stimulating innovation.[53]

9.3 Our results

The full innovation survey asked firms to identify the most important innovation issues. The need to develop aspects of firms' products (including their range, quality, innovation, new markets, specialist products) was most commonly cited by around 18 per cent of firms. Increasing either domestic or export sales was the second most common innovation issue highlighted by 12.9 per cent of firms. These two aspects of innovation were seen as most important by firms in each of the three employee size bands and reflects the pattern in most of the other sectors considered here.

Table 19: Innovation in construction firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	14.3	43.9	61.4	21.2
New to market product/service innovation (% firms)	9.5	19.7	29.5	12.0
Process innovation (% firms)	10.7	24.2	45.5	14.3
New to market process innovation (% firms)	2.4	3.0	4.9	2.6
Strategic innovation (% firms)	10.8	31.8	52.3	16.0
Managerial innovation (% firms)	16.7	30.3	51.2	20.2
Organisational innovation (% firms)	13.1	31.8	65.9	18.1
Marketing innovation (% firms)	26.2	37.9	54.5	29.2

Source: Innovation Index Survey, responses weighted to give representative results.

46. Gann, D. and Salter, A. (2000) Innovation in project-based, service enhanced firms: The construction of complex products and systems. 'Research Policy.' pp.955-972.
47. Sexton, M., Abbott C., Barrett, P. and Ruddock, L. (2007) 'Hidden Innovation in Construction.' International Conference, World of Construction Project Management 2007.
48. Sexton. M. and Barrett, P. (2003) Appropriate innovation in small construction firms. 'Construction Management and Economics.' 21(6), pp.623-633.
49. Latham, M. (1994) 'Constructing the Team: Joint review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry.' London: HMSO; also Egan, J. (1998) 'Rethinking Construction.' London: DTI.
50. Barrett, P., Abbott, C., Ruddock, L. and Sexton, M. (2007) 'Hidden Innovation in the Construction and Property Sectors.' RICS Research Series Papers, pp.1-21. London: RICS; Abbott, C., Aouad, G. and Madubuko, L. (2008) 'An innovation platform for construction.' NWUA Pilot Project to Develop Innovation Platforms in Non-science Research Disciplines. Salford: Salford Centre for Research & Innovation, University of Salford; BERR (2008) 'Supporting Innovation in Services.' London: BERR. Available at: http://www.berr.gov.uk/files/file47440.pdf
51. Akintoye, A. and Main, J. (2007) Collaborative relationships in construction: the UK contractors' perception. 'Engineering, Construction and Architectural Management.' 14(6), pp.597-617.
52. Ingirige, B. and Sexton, M. (2006) Alliances in construction: investigating initiatives and barriers for long-term collaboration. 'Engineering, Construction and Architectural Management.' 13(5), pp.521-35.
53. Eaton, D., Akbiyikli, R. and Dickinson, M. (2006) An evaluation of the stimulants and impediments to innovation within PFI/PPP projects. 'Construction Innovation.' 6, pp.63-77.

One interesting difference between employee size bands, however, relates to construction firms' emphasis on environmentally friendly innovation which was emphasised by 11.4 per cent of firms with more than 100 employees but only 3.6 per cent of firms in the 5-19 employee size band.

9.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 19 presents the comparative rates of innovation activity within the sector, segmented by size of firms.

On average one in five firms reported developing new product or service offerings over the 2006-09 period, with one in eight reporting these as 'new to the market'. Levels of process innovation were lower with around a fifth of construction firms also reporting innovation in strategy, managerial techniques and organisation. Marketing innovation was more common, being reported by around a third of construction firms. Notably in this sector a very strong link between business size and the likelihood that firms were undertaking innovation can be seen. In comparison to the other sectors covered by the Index survey levels of most types of innovation were less common in construction than in the other sectors considered.

The profile emerging from the Innovation Index survey suggests that innovation among construction firms is strongly driven by market requirements (and perhaps legislative changes) rather than by new technology. Overall levels of innovation are low by comparison with the other sectors considered here, as are levels of graduate employment and export activity. Marked differences are evident, however, between employee size bands with innovation – and particularly environmentally relevant innovation – strongly concentrated among larger firms.

9.5 Innovation capabilities

Section 2 outlines the innovation value chain (IVC). The following section details the results of the survey of construction firms.

In terms of firms' ability to access the knowledge needed for innovation, the IVC focuses on the sources of new ideas, spending on R&D and design, and the use of a range of different skill groups and external partners in gathering new ideas. Comparing these measures for construction firms to the other sectors included in this study, it can be observed:

- The average proportion of externally sourced product/service ideas in construction (6.6 per cent) is below the average for the sectors considered here (9.1 per cent), and less than a third of that in the 'leading practice' sector Software and IT Services (Table 4).

- Average R&D spending and spending on design as a proportion of sales, 0.1 per cent and 0.2 per cent are also markedly lower among construction firms than in the other sectors considered here (Table 4).

- Accessing knowledge in construction tends to be a more functionally specific rather than a multi-functional process, with the sector second lowest with 15.2 per cent with only accountancy services recording less. Construction firms also tend to involve fewer external partners in accessing knowledge for innovation than firms in other sectors, with the sector exhibiting levels similar to the professional sectors such as accountancy and legal services (Table 4).

Taken together these comparisons suggest that on average construction firms are investing less in accessing knowledge than firms in the other sectors considered here and exploring a narrower range of sources of potential new ideas. One result is perhaps the lower proportion of new externally sourced ideas which may, in turn, be reducing construction firms' ability to benefit from investment in later stages of the IVC.

To reflect firms' ability to effectively build new innovations from the knowledge they have gathered, the sectoral Innovation Index reflects spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. For construction:

- Average spending on process change by construction firms (0.3 per cent of sales turnover) is less than half of the average for the sectors considered here (0.7 per cent of sales turnover) (Table 4).

- The average extent of team-working, multi-functional working and involvement of external partners by construction firms in building innovation is also towards the bottom of the range of sectors considered here (Table 4). Where firms are able to effectively integrate internal capabilities and external knowledge for innovation, however, this can pay dividends.

- Perhaps, partly as a result, the percentage of sales derived by construction firms from newly introduced products or services (4.8 per cent) is below the average of the sectors considered here (10.2 per cent). The diversity of innovation or breadth of innovation activity in construction is also below the average for the sectors considered here.

On average, construction firms' relatively low levels of investment in building innovation are consistent with those identified for accessing knowledge. By involving a relatively narrow group of employees and external partners in building innovation, firms in the sector may also be contributing to relatively low levels of sales from innovative products.

The third link in the IVC is the commercialisation of innovation. Here the sectoral Innovation Index measures of firms include spending on branding and marketing, the range of types of customer interaction in which they engage, IP protection and again the involvement of different skill groups and external partners in the commercialisation process.

As the analysis of the preceding stages within the IVC would suggest, given construction firms' relatively low average level of innovative sales, they are found to be below average on each of the commercialisation indicators used here with the exception of spending on branding and marketing.

- The construction sector records the lowest for all sectors in terms of the diversity of their relationships with customers, with a narrower relationship with customers. The sector scores only 37.8 per cent compared to the average for all sectors of 51.3 per cent.

- Construction firms spend more than the average of all firms on branding as a proportion of sales, with 1.3 per cent of sales turnover being directed at branding compared to an average 1 per cent across all sectors within the study. By this measure the sector is second only to consultancy services, which spends 2.1 per cent. (Table 4).

- Compared to the average for all sectors, construction firms apply the lowest range of intellectual property protection methods, with a score of 10.8 per cent compared to an average 21.2 per cent across all sectors studied.

9.6 Sectoral innovation indices for construction

In this next section the individual metrics are combined into a broader sector index. Developing a sectoral innovation index for construction involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of how the index components are derived).

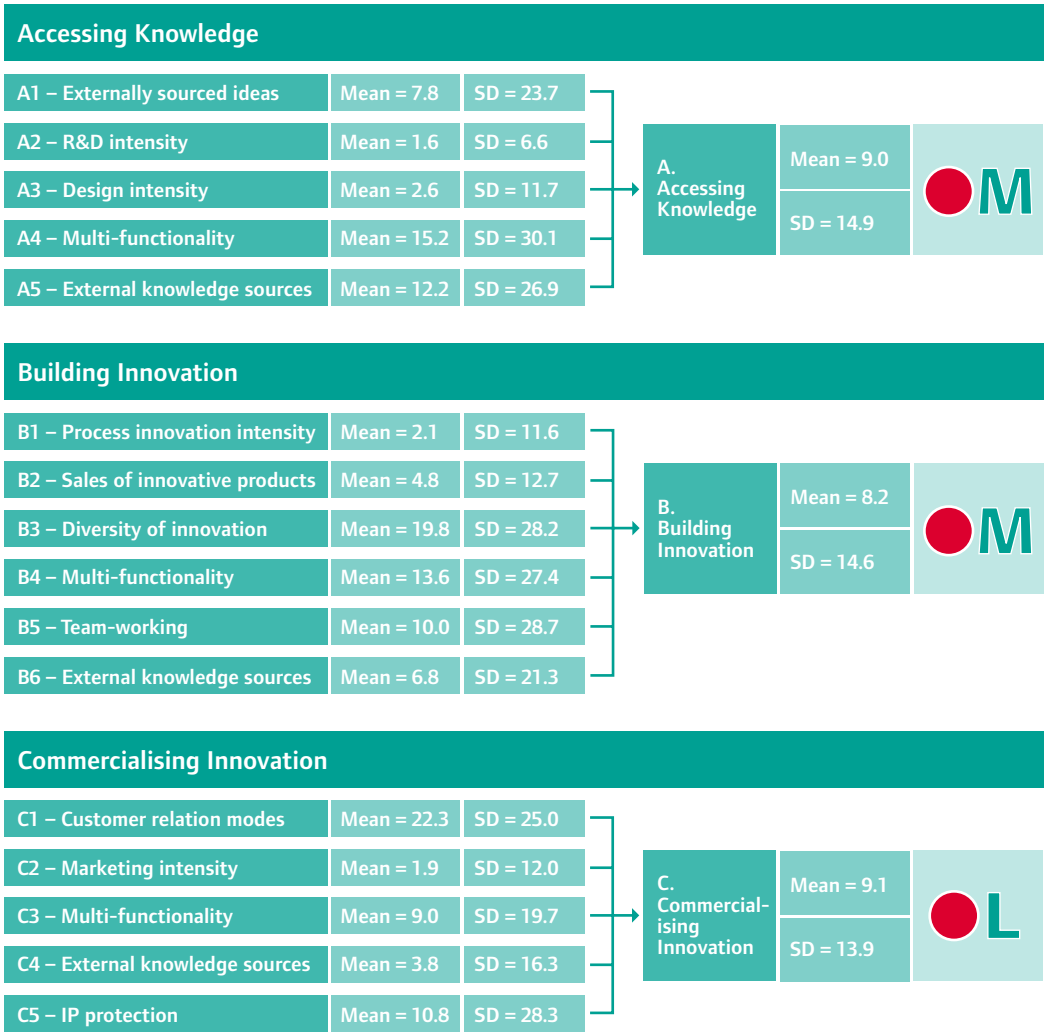
Figure 10 summarises the resulting index giving the normalised values for each of the 16 innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. For construction the sectoral innovation indices for each stage of the IVC compare relatively poorly to those in the other sectors considered here, suggesting the potential for both considerable intra-sectoral and inter-sectoral learning.

9.7 Summary

Despite some examples of excellence the survey highlights continuing issues for innovation in construction with low average levels of innovation capability in each phase of the innovation value chain. Limited openness reflected through low levels of investment in new knowledge and process development lead to relatively low average levels of innovation capability, and significant issues also remain in terms of many firms' use of team-working, external collaboration and multi-functional involvement in the innovation process.

For many construction firms these issues arise in each element of the IVC, something which the construction sector shares only with accountancy among all of the sectors considered here. In addition the analysis suggests marked variability in innovation capability within the construction sector with the impact of examples of excellence reduced

Figure 10: Normalised innovation metrics and sectoral innovation indices for construction



by many firms with less effective innovation processes.

This suggests that there is the potential for both intra- and inter-sectoral learning to improve innovation capability in many construction firms. First, good examples of innovation practice do exist within the construction sector and these provide potential exemplars for development. Second, comparisons with innovation processes in other sectors may also suggest learning points with the automotive or consultancy sectors perhaps of most relevance.

Part 10: Energy production

10.1 Sector structure

Unsurprisingly, given the capital requirements of the industry, the energy sector is more strongly biased towards larger firms than the other sectors considered in this report. Of the 880 firms in the UK sector in 2008, 195 (22.2 per cent) had more than 100 employees, compared to an average of only 3.4 per cent in the other sectors considered here (Table 25). Conversely, only 375 energy firms (42.6 per cent) were in the 5-19 employee size band compared to 77.9 per cent of firms in other sectors. The Innovation Index survey provided relatively good coverage of firms in each company size band in the energy sector including responses from 91 energy companies (Table 26).

Looking at the characteristics of respondents (Table 20) suggests that respondent firms in the energy sector are: relatively mature with nearly 84 per cent established for more than ten years; have around a third of their workforce with degree level qualifications; and have a relatively strong presence in export markets with nearly 40 per cent of firms exporting.

10.2 Innovation in the energy sector

Previous research of innovation in the energy sector has emphasised the global nature of the industry and the strong relationship between innovation in the UK and international R&D. Much recent attention, however, has focused on the development of sustainable energy systems, with a focus on enhancing energy efficiency – in production, distribution and use – and on decarbonisation. Internationally, the renewables sector in particular has seen significant changes in recent years as a result of growing demand for green energy.[54] In the UK the renewable energy sector is diverse with a wide range of technologies at different stages of development. Despite some successes, it has been suggested that current innovation systems are failing to progress these

54. Jacobsson, S. and Johnson, A. (2000) The diffusion of renewable energy technology: an analytical framework and key issues for research. 'Energy Policy.' 28(9), pp.625-640.

Table 20: Characteristics of energy firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	76.7	82.6	100.0	84.0
Single site organisations (% firms)	69.8	30.4	20.8	44.8
Workforce with degree (% firms)	38.0	21.1	32.8	30.2
Percentage of firms exporting (% firms)	30.2	31.6	57.1	36.5

Source: Innovation Index Survey, responses weighted to give representative results.

technologies along the path of development to successful commercialisation.[55] The end-to-end focus of the IVC approach to innovation therefore seems particularly appropriate in the energy sector.

Energy production is a complex and diverse sector with the focus here being on firms engaged in the production and distribution of electricity and gas for both domestic and industrial uses, and the manufacture of refined petroleum products (SIC 40.1, 40.2, 23.2). The inclusion of 'producers and distributors of electricity' means that the sector includes a number of firms in the renewable sector along with more traditional energy producers.

10.3 Our results

As part of the Innovation Index survey firms were asked to identify what they regarded as the key drivers of innovation for their firm and sector. As in most other sectors the need to develop new products or services was the most commonly highlighted driver of innovation, mentioned by 19.3 per cent of firms.

The need to develop more environmentally friendly or sustainable products was the second most common factor driving innovation among energy companies (16.9 per cent of firms) with 'renewables' the key emphasis of another 10.9 per cent of firms. Mainstream issues such as pricing (7.4 per cent), legislation (1.0 per cent) and other funding sources (1.0 per cent) were notably less common drivers of innovation in the energy sector.

55. Foxon, T.J., Makuch, Z., Mata, M. and Pearson, P. (2004) 'Informing policy processes that promote sustainable innovation: an analytical framework and empirical methodology.' Available as STP Working Paper at: http://www.sustainabletechnologies.ac.uk/PDF/Working%20papers/106b.pdf

10.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 21 presents the comparative rates of innovation activity within the sector, segmented by the size of firms.

Product and service innovation emerges as the most common form of innovation in the sector, undertaken by 49.1 per cent of energy firms. Process, managerial, organisational and product/service change were undertaken by around a third of firms over the 2006 to 2009 period.

The percentages of energy sector firms reporting all types of innovation activity are above the average for the sectors considered here (Table 2). For example, the 49.1 per cent of energy firms reporting product/service innovation over the 2006 to 2009 period contrasts with an average proportion of 35.2 per cent across the survey as a whole. For most other types of innovation the third of innovating firms in the energy sector contrasts to around a fifth of firms undertaking innovation in the survey as a whole.

10.5 Innovation capabilities

Section 2 outlines the innovation value chain (IVC). The following section details the results of the survey of firms within the energy sector.

In terms of firms' ability to access the knowledge needed for innovation, the IVC

Table 21: Innovation in energy firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	34.9	52.2	70.8	49.1
Process innovation (%)	20.5	39.1	58.3	35.4
Strategic innovation (% firms)	20.5	34.8	54.2	33.0
Managerial innovation (% firms)	20.9	26.1	54.5	29.8
Organisational innovation (% firms)	18.2	39.1	66.7	36.3
Marketing innovation (% firms)	39.5	39.1	41.7	39.9

Source: Innovation Index Survey, responses weighted to give representative results.

focuses on the sources of new ideas, spending on R&D and design, and the use of a range of different skill groups and external partners in gathering new ideas. Comparing these measures for energy firms to the other sectors included in this study it can be observed that (Table 4):

- Energy firms have an above average level of investment in R&D – 1.1 per cent of sales compared to a survey average of 0.7 per cent – but marginally below average level of investment in design (0.7 per cent of sales compared to a survey average of 1.0 per cent).

- Energy firms also have above average levels of multi-functional involvement (34.6 per cent compared to the average of 23.2 per cen) and involve a broader range of external partners in accessing the knowledge needed for innovation.

- Perhaps as a result the proportion of new product/service ideas derived from outside energy firms (13.8 per cent) is above the survey average (9.1 per cent).

Taken together, these comparisons emphasise the 'openness' of energy firms gathering the knowledge needed for innovation. Relatively high levels of external connectivity to innovation partners is reinforced by above average levels of R&D spend, which probably helps both to strengthen internal knowledge generation and also to reinforce absorptive capacity. This relatively positive profile of knowledge acquisition provides a strong first link in the sectoral IVC.

To reflect firms' ability to effectively build new innovations from the knowledge they have gathered, the sectoral Innovation Index reflects spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. For firms in the energy sector (Table 4):

- Spending on process change was perhaps surprisingly low at 0.2 per cent of turnover, significantly below the average of 0.7 per cent for all surveyed firms.

- As in the early stage of the IVC, energy firms engaged in above average levels of multi-functional involvement and engagement with external partners as part of building innovation. This was supported by above average levels of organisational support for team-working.

- Energy firms achieved levels of sales derived from innovative products or services of 12.0 per cent of sales, marginally above the survey average (10.2 per cent) but significantly below some other sectors such as automotive (19.5 per cent) and Software and IT Services (24.4 per cent). More impressive is the diversity of the innovation profile of energy firms – that is the range of different types of innovation they are undertaking – which falls only marginally short of survey best practice.

Despite relatively low levels of spending on process innovation, energy firms also perform well on most of the innovation metrics relating to building innovation. This emerges as a broadly based and diverse activity, making good use of team-working and effectively involving a wide range of internal skill groups and external partners.

The third link in the IVC is the commercialisation of innovation. Here the sectoral Innovation Index includes measures of firms' spending on branding and marketing, the range of types of customer interaction in which they engage, IP protection and again the involvement of different skill groups and external partners in the commercialisation process.

Here energy firms present a rather mixed profile with levels of multi-functionality and external partnering again above average but generally lagging best practice.

- Levels of investment in branding/marketing at 0.5 per cent of turnover. are significantly below average with, of course, a larger gap to the best practice sector (consultancy).

- IP protection in the sector is also above average at 36.9 per cent compared to 21.2 per cent across all sectors, but the sector lags best practice (Table 4).

10.6 Sectoral innovation indices for energy

In this next section the individual metrics are combined into a broader sector index. (See section A1.5 for a detailed discussion of how the index components are derived).

Figure 11: Normalised innovation metrics and sectoral innovation indices for energy

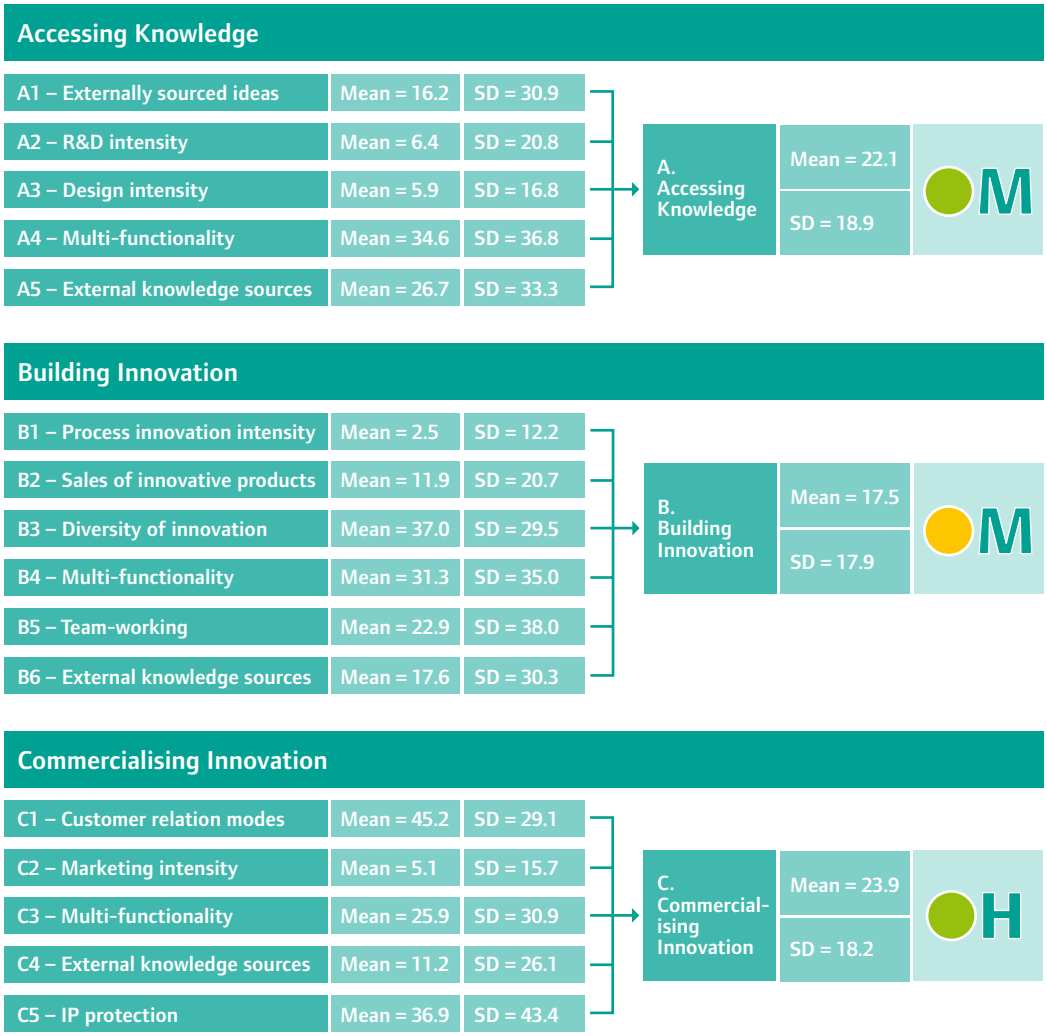


Figure 11 summarises the resulting index giving the normalised values for each of the sixteen innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. For energy the sectoral innovation indices for the first two stages of the IVC compare relatively well to those in the other sectors considered here, combining reasonable levels of investment in innovation and well developed networks, teams and multi-functionality. In the commercialisation element of the IVC the survey data suggests the gap between energy and the higher performing sectors is greater. This is primarily due to relatively low levels of investment in branding, marketing etc.

10.7 Summary

Comparing average levels of innovation capability across the innovation value chain in the energy sector suggests that firms have significant capability in accessing knowledge and commercialisation. The survey evidence suggests, however, that the intermediate building innovation phase is less strong compared to the other sectors considered.

Despite relatively high mean levels of innovation capability in the energy sector, there is relatively high variability in capability within the sector, with the survey evidence suggesting significant gaps between innovation practice in leading practice firms and the majority of innovative energy businesses.

Part 11: Specialist design

11.1 Sector structure

The size distribution of firms in the specialist design sector is broadly in line with that of the other sectors considered in this study (Table 25). There are 13,280 specialist design firms in the UK and 86 per cent of these have between five and 19 employees while only 1.6 per cent (220 firms) employ over 100. The Index survey has a strong and representative coverage of specialist design firms in each of the three employment size bands based on a response from 185 firms. Eight per cent of the respondents employed between 5 and 19 while 3.2 per cent of firms had over 100 employees (Table 26).

Just over 70 per cent of firms in the specialist design sector were over ten years old. It is worth noting that smaller firms tend to be younger. This suggests relatively high levels of new firm formation, but barriers might exist in terms of growing a small firm into a much larger one. Over half of employees in specialist design firms responding to the survey had a degree level qualification compared to an average of 37.7 per cent. The majority of firms are single site organisations with the exception of firms employing more than 100. Over 50 per cent of specialist design firms exported products and services. All firms in the sample with over 100 employees exported, compared to only 50 per cent of smaller firms. There are important relationships between high levels of graduate employment, high export levels and high levels of innovation. Specialist design appears to follow this relationship.

11.2 Innovation in specialist design services

Innovation in the design sector is seen as highly dependent on human capital, both in-house and external, and on networks with customers, colleagues, friends, suppliers, and design authorities and associations.[56] Environmental factors are also seen as important, with government playing a role in facilitating the

56. Flanagan, K., Miles, I. and Windrum, P. (2000) Web Services: Knowledge of the New. In Andersen *et al.* (Eds) 'Knowledge and Innovation in the New Service Economy.' pp.68-88; Rusten, G. and Bryson, J.R. (2007) The Production and Consumption of Industrial Design Expertise by Small and Medium-Sized Firms: Some Evidence from Norway. 'Geografiska Annaler.' 89(1), pp.75-87; Sunley, P. *et al.* (2008) Innovation in the creative production system: the case for design. 'Journal of Economic Geography.' 8(5), pp.675-698.

Table 22: Characteristics of design services firms

	Number of employees			
	5-19	20-99	100+	Total
More than 10 years old (% firms)	69.9	87.5	83.3	72.2
Single site organisations (% firms)	93.2	65.6	33.3	88.9
Workforce with degree (% firms)	57.9	43.3	49.0	56.0
Percentage of firms exporting (% firms)	51.0	61.3	100	52.9

Source: Innovation Index Survey, responses weighted to give representative results.

creation of networks, encouraging enterprise and finance, and academia providing suitably skilled and design-educated graduates.[57] The importance of human capital in design services emphasises the role of training and continuing professional development as part of the development process.[58]

Innovation processes in this sector are often unstructured and dominated by individual creative staff or small teams working under close direction. Network collaborations with suppliers, customers, competitors and universities and interactions with clients are all seen as important, as firms seek new creative opportunities and attempt to secure the requisite capacity and capability to address new design challenges.

The specialist design sector is relatively heterogeneous, consisting of a number of distinct subsectors. Interior designers work directly for individual consumers and for companies, while textile designers tend to work for other companies or are self-employed. Firms in this sector tend to be small with the emphasis on creativity rather than commercial processes, and previous studies have often stressed the failure of design companies to effectively protect and exploit their intellectual property.

Design companies have faced particular challenges in identifying the areas in which to focus innovative efforts. Key issues were the delivery of better products and services, strategic product development, and focusing on improving business processes. In each case the aim was to improve customer care and service.

Innovation is not a formalised process in most design firms. For many design firms the current economic climate is characterised by a contracting market for the provision of product development services in the UK, lower fees, and an absence of business opportunities. At the project level, new product development is often controlled by project engineers who head a broadly based team of designers, engineers, and marketing and sales teams in the process. Generally, teams would have complete autonomy in how they approach product development problems. Occasionally senior management would be consulted, but the strategy for a project would be agreed with a team at various stages of the development process.

The commercialisation of design innovation tends to be a difficult process and differs substantially across different types of design businesses. In technology-driven sectors, simulation tools are used during the design process (i.e. databases, software tools, CAD). In other sub-sectors, the firms' reputation is the most important factor to exploit for innovative products and services. In these sectors, reputation benefits are seen as more important than any intellectual property that is produced by an innovation.

57. Howard, J. (2008) 'A background paper prepared for the National Innovation Review.' Council for the Humanities, Arts and Social Sciences Occasional Paper 5. Canberra: Council for the Humanities, Arts and Social Sciences.
58. Rusten, G. and Bryson, J.R. (2007) The Production and Consumption of Industrial Design Expertise by Small and Medium-Sized Firms: Some Evidence from Norway. 'Geografiska Annaler.' 89(1), pp.75-87.

Table 19: Innovation in specialist design firms

	Number of employees			
	5-19	20-99	100+	Total
Product or service innovator (% firms)	14.3	43.9	61.4	21.2
New to market product/service innovation (% firms)	9.5	19.7	29.5	12.0
Process innovation (% firms)	10.7	24.2	45.5	14.3
New to market process innovation (% firms)	2.4	3.0	4.9	2.6
Strategic innovation (% firms)	10.8	31.8	52.3	16.0
Managerial innovation (% firms)	16.7	30.3	51.2	20.2
Organisational innovation (% firms)	13.1	31.8	65.9	18.1
Marketing innovation (% firms)	26.2	37.9	54.5	29.2

Source: Innovation Index Survey, responses weighted to give representative results.

11.3 Our Results

Exploratory interviews with specialist design firms identified their most important innovation issues. The highest priority issue was the need to develop 'Online and Internet activities', which 24 per cent of firms cited. The second most important issue concerned the development, range, quality, and innovation intensity of design products. Sixteen per cent of firms identified this issue. The third most important issue was a desire to expand the markets serviced by specialist design firms. This concern was particularly pronounced in small firms.

11.4 Detailed results

The Index survey, as with the CIS, makes it possible to identify comparative levels of innovation activity. Table 23 presents the comparative rates of innovation activity within the sector, segmented by the size of firms.

Fifty per cent of firms reported that they had developed new products or services over the 2006-09 period, one in six of which developed new to the market products or services. Levels of process innovation were much lower, yet still relatively high compared to other sectors, with 39 per cent of firms reporting some form of process improvement, 6 per cent of which were new to the market. Firms were more innovative with regard to organisational structures compared to managerial processes. However the most significant number of firms innovated in the area of marketing, where 50 per cent of firms reported innovations. Large firms are more likely to have introduced a new product or service that was new to market than smaller firms, and larger firms are also more likely to have undertaken managerial and organisational innovations. However, larger firms paid less attention to marketing innovations compared to medium-sized firms.

The profile emerging from the Index survey suggests that larger firms tend to be more engaged in innovation than small and medium-sized firms.

11.5 Innovation capabilities

This section explores the capabilities of the sector using the IVC framework developed in section 2 of the report.

In terms of a firm's ability to access the knowledge required for innovation the focus of the analysis is on the sources of new ideas, spending on R&D and design, and the use of a range of different skill groups and external partners in gathering new ideas. The survey suggests the following observations:

- The average proportion of externally sourced products and service ideas in specialist design (11.74 per cent) is above the average for the sectors considered here (9.1 per cent), but is still nearly only half that of the 'leading practice' sector (Software and IT Services) (Table 4).

- Average R&D spending in the sector is 1 per cent of sales turnover, which is higher than most other sectors considered in the analysis, but is still much lower than the 'leading practice' sector Software and IT services, which spend 4.3 per cent (Table 4).

- Accessing knowledge for specialist design firms tends to be a more multi-functional process involving more external partners reflecting very often the specific market niche at which firms are aiming.

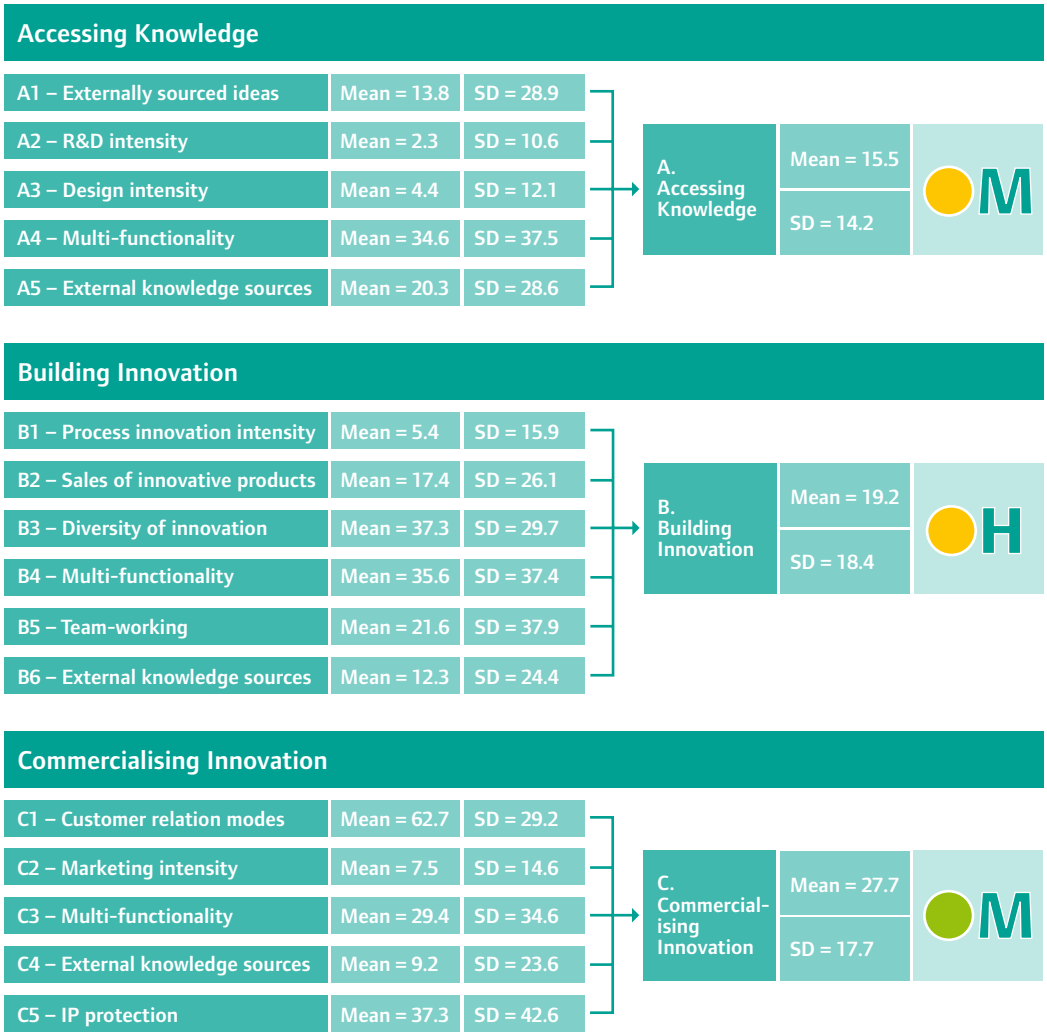
Overall, this suggests that specialist design firms are investing in accessing the knowledge and information that they require in order to engage in innovation. In terms of accessing knowledge it would appear that specialist design firms are in a strong position.

Firms draw together the various forms of knowledge and expertise that they acquire in order to build new innovations. The Index survey explores this process through measures that reflect spending on process change, indicators of the extent and diversity of innovation, and the use of team-working, different skill groups and external partners in the innovation process. These measures reveal for specialist design firms that:

- Average spending on process change by specialist design firms is more than 32 per cent (.91 per cent of turnover) of the average for the sectors considered in this study (0.7 per cent of turnover) (Table 4).

- The percentage of sales that are accounted for by innovative products and services is higher (17.4 per cent) than the average for all firms in this study (10.22 per cent) (Table 4).

Figure 12: Normalised innovation metrics and sectoral innovation indices for specialist design



- The diversity of innovation or breadth of innovation activity in specialist design is above the average for the sectors considered in this study.

On average, specialist design firms are investing in building innovation and at a level that is slightly higher than the average for all firms in this study.

The third element of the IVC is the commercialisation of innovation. This includes measures of firms' spending on branding, marketing, the range of types of customer interaction in which they engage, IP protection and the involvement of different skill groups and external partners in the commercialisation process. The following points can be made:

- Specialist design firms perform well above the average for all firms in terms of the diversity of their relationships with customers (70.1 per cent compared to 51.2 per cent). This includes, for example, undertaking market research, monitoring customer feedback and the use of structured CRM systems.

- Specialist design firms spend close to the average of all firms on branding as a proportion of sales (Table 4).

- Compared to the average for all sectors, specialist design firms apply more forms of intellectual property protection.

- On average, specialist design firms invest in the commercialisation of their products and services. They pay attention to the demands placed upon them by their customers and appear to be willing to learn from their customers. They appreciate the

role intellectual property protection can contribute to their competitiveness.

11.6 Sectoral innovation indices for specialist design

In this next section the individual metrics are combined into a broader sector index. Developing a sectoral innovation index for construction involves normalising and then combining the individual metrics discussed above. (See section A1.5 for a detailed discussion of the derivation of how the index components are derived). Figure 12 summarises the resulting index giving the normalised values for each of the 16 innovation metrics and the resulting innovation index for accessing knowledge, building innovation and commercialising innovation. For specialist design the sectoral innovation indices for each stage of the IVC compare well to those in the other sectors considered here.

11.7 Summary

The survey suggests that innovation capability in specialist design compares relatively well to the other sectors considered in this study. Less satisfactory is the relatively high level of variability between the innovation capability of firms within the sector, something which is markedly higher, for example, than that in architectural services.

For sectoral bodies this suggests that a key focus of activity should be the building innovation element of the IVC. Addressing this weak point is likely to have significant benefits particularly given the relative strengths of design firms in terms of accessing knowledge for innovation and commercialisation. Dissemination of innovation best practice within the sector is also required, however, to help lagging firms learn from those with established good practice.

Part 12: Comparing sectoral innovation capabilities

12.1 Introduction

This section presents the combination of the individual sector indices into an overall capabilities framework. The idea of the capabilities framework is to provide an immediate graphic representation of the profile of innovation capability in the nine sectors considered in this report. This inevitably involves a trade-off between the diversity in innovation activity and profiles in the different sectors and the uniformity required for comparability. It is important therefore that comparisons between sectors shown within the capabilities framework should be considered in light of the more detailed narrative discussion of previous sections of this report.

The derivation of the capabilities framework is discussed in detail in Appendix 1. Here, therefore, this section presents the final framework emerging from this pilot project and in Section 12.3 focused on identifying the strategic and policy priorities which are implied. It is important to acknowledge, however, that this is a pilot project focusing on a small number of sectors and the results are not therefore representative of the UK as a whole. Section 12.4 discusses this and identifies some other limitations of the ICM. Lessons from this study for the future development of sectoral aspects of the Innovation Index are outlined in section 12.5.

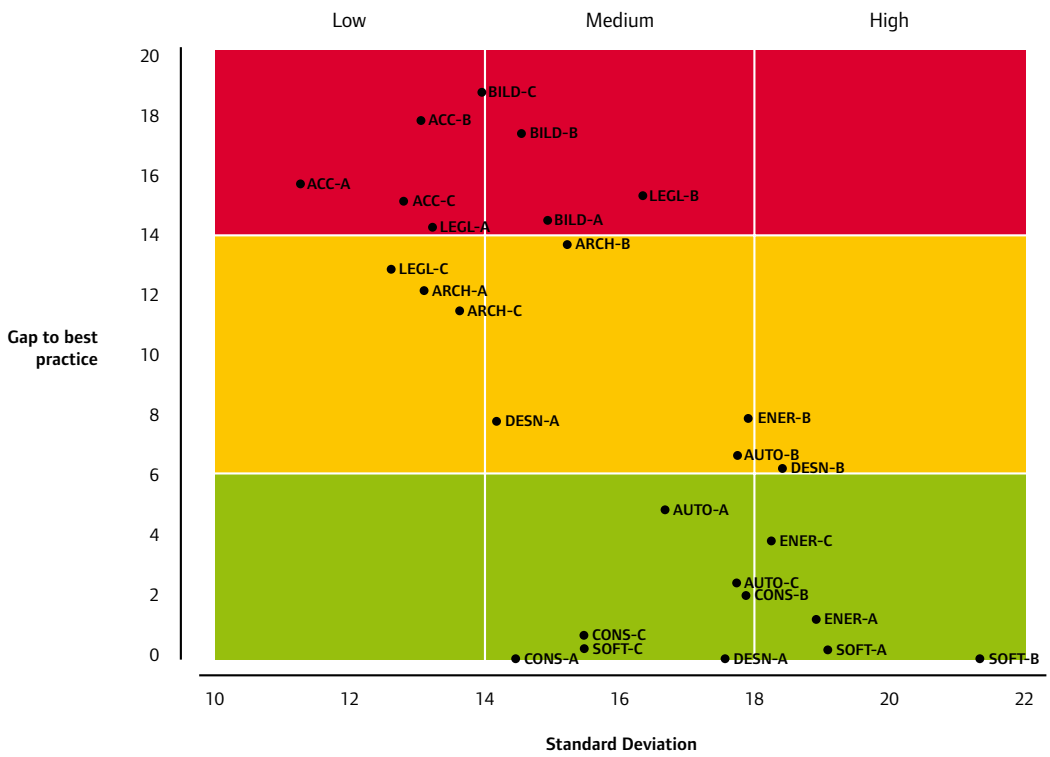
12.2 Overview of the capabilities framework

For each of the nine sectors considered, indices of innovation capability provide a score for Accessing Knowledge, Building Innovation and Commercialisation. The capabilities of each sector were ranked and rated – by red, orange and green – on the basis of the average level of the innovation index relative to that of other sectors. The higher the average level of each innovation index the more likely a sector is to be in the 'green' zone for that element of the IVC. In addition, the spread or disparity of the innovation index within the sector is also split into three categories, labelled 'high', 'medium' or 'low' respectively. Thus a sector in the 'red-low' zone has both a large gap between its level of the index and that of the highest-scoring sector, and a low spread between the highest and lowest-performing firms in the sector.

Starting with the normalised innovation indices (see section A1.5) intra-sectoral variation is measured in each sectoral innovation index using the standard deviation of the measure within the sector. The gap behind best practice is measured by subtracting the mean of each sectoral index from the highest sectoral mean. Plotting the resulting indices suggests Figure 13 where sectors are identified as follows: Accounting (ACC), Architectural Services (ARCH), Construction (BILD), Specialist Design (DESN), Energy (ENER), Software and IT (SOFT), Consultancy (CONS), and Automotive (AUTO). A denotes accessing knowledge, B building innovation and C commercialisation. Hence LEGL-C is commercialisation in legal services.

The position of each sectoral innovation index on this chart is fixed by its intra-sectoral standard deviation and the gap from each index to the sectoral innovation index with the highest average value. Subsequently, indices are classified into the zones as depicted above. The capabilities framework in Figure

Figure 13: Plotting the normalised index values



14 provides a summary of the resulting classification by sector and for each of the three activities in the innovation value chain.

12.3 Interpreting the capabilities framework

As suggested before, the aim of the innovation capabilities map is to provide an overview of the innovation capability landscape in the sectors considered in this report. This suggests two alternative perspectives on the capabilities framework – looking at sectors, and looking at the different stages of the IVC.

From a sectoral point of view, four sectors stand out as having rather extreme profiles. Accountancy and Construction are the only sectors for which the innovation indices fall into the 'red' zone for each stage of the innovation value chain. At the other extreme, Consultancy and Software/IT fall into the 'green' zone for each element of the innovation value chain.

Figure 14: The capabilities framework

	Accountancy	Architectural services	Automotive	Construction	Consultancy services	Energy production	Legal services	Software & IT services	Specialist design
Accessing Knowledge	L	L	M	M	M	H	L	H	M
Building Innovation	L	M	M	M	M	M	M	H	H
Commercialising Innovation	L	L	M	L	M	H	L	M	M

In this case of Accountancy and Construction the allocation to the 'red' zone reflects a large gap between average levels of innovation and those in the best practice sectors. This suggests the potential for significant inter-sectoral learning for firms from the way in which other sectors organise and undertake innovation. However, the very low levels of intra-firm variation in Accountancy and moderate levels of variation in Construction suggest limited scope for learning between firms within the respective sectors.

For both Consultancy and Software/IT, investment and organisation of innovation is close to or represents best practice in each element of the IVC, placing these sectors firmly in the 'green' zone. The difference between them is, however, the potential for intra-sectoral learning to reduce the disparity in innovation practice within the sector. Software/IT in particular shows very high intra-sectoral variation, especially in the first two elements of the IVC, whereas this variation is more modest (but still substantial) for Consultancy.

Two other sectors (automotive and energy) are 'green' for Accessing Knowledge and Commercialisation but 'orange' for Building Innovation. The suggestion in these cases, therefore, is that overall the IVC is relatively strong but in terms of Building Innovation there is scope for enhanced inter-sectoral knowledge transfers to help lagging firms improve this element of their IVCs.

Architectural services is the most 'middling' sector, the only one with orange for all three elements of the IVC. This sector is also characterised by relatively low levels of intra-sectoral variation, especially in Accessing Knowledge and Commercialisation, suggesting some scope for learning from outside the sector, but limited scope for intra-sectoral learning. Specialist Design is also a relatively medium performer. However, its profile differs from Architecture in having greater intra-sectoral variation, and therefore scope for within-sector learning throughout, and in having a very strong performance on commercialisation.

Legal services shows a profile not dissimilar to Accountancy, but with evidence of slightly more scope for intra-sectoral learning in the Building Innovation stage, and a substantially better performance than Accountancy in commercialisation.

Now, turning to an IVC perspective it is interesting to consider which elements of the IVC are strongest across the sectors considered. Here perhaps the strongest elements of the IVC in the sectors considered are Accessing Knowledge and Commercialisation, with respectively four and five of the nine sectors falling into the 'green' zone. More concerning is the Building Innovation element of the IVC where the picture is more mixed with only two sectors in the green zone (consultancy and software/IT), four in the orange zone (automotive, architecture, energy and specialist design) and three in the red zone (accountancy, construction and legal services). These rather mixed results suggest that this element of the IVC is most variable across the nine sectors and is a potential focus for policy and strategic intervention.

12.4 Project limitations

Perhaps the clearest limitation of this pilot project is its sectoral scope. Nine relatively narrowly defined sectors are considered here and while the project provides considerable information on innovation capability for these specific industries it cannot be said to provide representative coverage of the UK as a whole. In particular, the focus here has been on nine knowledge-intensive sectors – eight in services and one in manufacturing – with no coverage of any less knowledge-intensive sectors. The lack of coverage of retailing and wholesale, any aspect of financial services other than accounting and other manufacturing sectors are notable gaps in coverage. The partial nature of the coverage achieved here reduces the strength of the general inferences which can be drawn from the results. The results – most notably the ICM – cannot therefore be taken as an indication of the innovation capability of UK plc generally although it clearly does reflect capability in the sectors covered.

A second limitation is that the initial project design focused on ten sectors rather than the nine discussed in this report. The tenth sector – Aerospace – contains a relatively small number of in-scope firms relative to the other sectors considered here (around 400 compared to around a minimum of around 800 in the other sectors). Initial exploratory interviews with aerospace companies were positive but in the early telephone fieldwork for this sector it proved difficult to achieve sufficient response to provide robust results. A decision was therefore made to drop this sector from

the study and focus fieldwork resources on the other nine sectors. It was disappointing to have to make this decision but it suggests the difficulty of basing sectoral innovation indices on a telephone survey methodology where sectors contain 'small' numbers of companies. Conversely, of course, defining sectors too broadly may ease practical issues relating to index fieldwork but is likely to raise issues around the homogeneity of firms' innovation processes and therefore the validity of sectoral metrics or indices.

More generally the telephone survey-based methodology adopted here proved very effective in generating high quality data over a relatively short timescale. This approach does, however, pose limitations on the number of questions which can reasonably be asked and on the types of questions to which respondents are able to make reasonable answers. In particular, it is much more difficult to obtain quantitative information from a telephone survey than using paper-based questionnaires or face-to-face interviews.

During the pilot fieldwork, each of these issues was exacerbated by the need to shorten the questionnaire, through simplifying the questions that were found to be overly complex and removal of some quantitative questions, which proved difficult for respondents. Survey methodology therefore poses some limits on type and range of questions which can be asked and therefore the type of metrics and indices which can be constructed.

A third limitation of the study is that it focuses specifically on the innovation capability of incumbent firms and does not include any indication of the strength or weakness of innovative start-ups. More specifically, the fieldwork was limited to firms with more than five employees and which had been established for longer than three years. This might be seen as a particular issue in some of the creative sectors (most notably specialist design) where firms tend to be small and in the rapidly developing sectors such as renewable energy.

It is also worth considering briefly the limitations which the 'index' construct places on the analysis. First, the nature of any index inevitably focuses attention on a relatively small number of metrics – here 16 – which can provide only a partial picture of the complexities of the innovation process. More narrative or descriptive accounts and case studies therefore provide a useful accompaniment to the narrow set of index metrics. Second, the structure of an index misses any contingent benefits or losses – complementarities – which might occur between metrics. For example, the open innovation literature stresses the potential complementarities between external linkages and internal knowledge sharing perhaps through innovation teams. Third, the index construct also lacks any causal structure. Instead, its role is primarily descriptive and comparative. Both issues of contingency and causality could be examined econometrically using data from the innovation index survey.

Finally, it is worth considering some of limitations of the approach to the derivation of the sectoral innovation indices and the innovation capabilities map. One of the key initial decisions involved in the project was the selection of the specific innovation metrics. What became obvious in the exploratory interviews, however, was the lack of any clear metrics-based approach to measuring innovation by many firms. In the majority of sectors considered here therefore business practice provided little guidance on the selection of metrics. In some sectors – legal services, architectural services and accountancy – this difficulty was exacerbated by the paucity of academic research on innovation. The choice of metrics was also constrained to some extent by the objective of benchmarking innovation capability between sectors which suggests an emphasis on generic rather than sectorally specific metrics. One solution adopted here – for example in measuring the involvement of skill groups in the innovation process, forms of customer interaction etc. – is to define an index which measures the same aspect of the innovation process but has different components (e.g. different skill groups) for each sector.

Another issue which arises in index construction is weighting. The simplest possible structure of weighting the individual (normalised) metrics equally was adopted to derive sectoral innovation indices. Other approaches or weighting structures could equally validly be used, however, with inevitable impacts on the sectoral innovation indices.

Finally, in moving from the sectoral innovation indices to the traffic light structure in the innovation capabilities map two important design choices were made. The first choice was to reflect in the ICM both the mean level and variability of each sectoral innovation index with the intention of capturing both the

potential for inter- and intra-sectoral learning. The second choice related to the division between the red, orange and green zones and the high, medium and low zones in Figure 13, which is an essentially arbitrary choice. The positioning of the dividing lines was intended to give a broadly even spread across red, orange and green categories.

Given these limitations, many of which reflect the pilot nature of the study, a number of positive learning points emerge for future Innovation Index development.

First, the innovation value chain works well as a framework on which an innovation index can be based. In the survey fieldwork firms were generally able to answer questions specific to each IVC activity and the IVC provides an intuitive framework for the sectoral narratives.

The notion of innovation metrics, sectoral innovation indices and the summary capabilities matrix approach also works relatively well in capturing both the detail of firms' innovation capability as well providing an indication of the broader geography of innovation capability in the sectors being considered. Future development of sectoral Innovation Indices might therefore retain the IVC structure and the tiering of individual metrics, sectoral indices and the capabilities matrix.

More pragmatically, the empirical approach based on a telephone survey proved relatively effective although some issues did arise around quantitative questions particularly relating to investment. Other issues arose with a telephone survey-based approach in 'smaller' sectors (here aerospace) where it proved difficult to achieve an adequate representative response. Subject to these limitations a telephone survey does provide a relatively cost effective basis for the Innovation Index. Indeed, in future, unit costs could also be reduced as surveys could be reduced in length focusing more specifically on the innovation metrics.

Finally, it is worth noting the limitations of the index format and the difficulty of capturing the complexities and diversity of the innovation process in a small group of metrics. Narrative accounts, case studies or vignettes will therefore continue to provide a valuable supplement to numerical innovation indices.

12.5 Next steps

The Index survey was undertaken as part of the pilot of the Innovation Index. The selection of the data gathered has been presented within this report within a set of indices that allow for inter-sector comparisons and analysis of the variation of innovative capabilities within individual sectors.

The project provides a basis on which further work can be done. Two potential future areas of work are:

- Conducting econometric analysis of the individual contributions of the IVC framework to innovative outputs, linking the data with official surveys.
- Widening the future coverage of the survey to other firms and industries, and to extend coverage to UK regions.

Formalising a weighted index
The construction of the sectoral indices presented within the report was based on a simple composition, where metrics within each stage of the IVC framework were given equal weight. The survey has generated a significant source of additional data on the innovation activities of firms providing scope to formalise the individual metric's contributions by sector.

The end-to-end structure of the IVC provides an opportunity to undertake econometric analysis to measure the contribution of individual metrics to performance.

The study has generated a large amount of firm level data, which can be matched with official datasets housed in the Office for National Statistics Virtual Micro Lab. This would enable the data to be linked to other official surveys and with the Business Structures Database[59] to provide data on the wider economic characteristics of the sectors covered in this study, as a basis for further analysis on the causes of innovation.

Extending coverage
It will also be possible in the future to widen the survey to more sectors and increase the coverage to enable regional analysis. Initial discussions with other industrial sectors have highlighted wider interest in adopting the approach.

The Index survey at present covers only the UK. Innovation within key sectors is clearly important for regional bodies. The business

59. See Anyadike-Danes, M., Bonner, K., Hart, M. and Mason, C. (2009) 'Measuring Business Growth: High-growth firms and their contribution to employment in the UK.' London: NESTA.

environment within each of the nine English regions, and the devolved administrations have their own distinctive features. To ensure that the sampling framework is reflective of regional sectoral structures, without loss of sectoral detail, will require a much larger sample size.

NESTA welcomes feedback on how the work might be extended in the future, and of which of these potential next steps would be of greatest interest to businesses and policymakers.

Appendix 1: Detailed methodology

A1.1 Introduction

This Appendix describes in detail the process of developing the sectoral Innovation Indices presented in the main text and also the comparative framework through which sector performance is analysed. Initial sections of this Appendix focus on the preparatory elements of the project with each of the index measures described in detail towards the end.

As indicated in the text the conceptual basis for the sectoral Innovation Indices as well as the ICM is the notion of the Innovation Value Chain (IVC) proposed by Hansen and Birkinshaw (2007) as a general framework within which firms' innovation activities can be considered: 'a sequential, three-phase process' (Hansen and Birkinshaw 2007, p.122) that involves Accessing Knowledge, Building Innovation and Commercialising Innovation. The IVC is useful as it provides a readily comprehensible framework to identify the key innovation bottlenecks for individual sectors as well as to generate top level messages for policy and opinion formers.

Within each sector therefore metrics were identified for each of the three stages of the IVC which together form the sectoral Innovation Indices. First, a group of metrics relating to firms' approaches to Accessing Knowledge including both the scale of firms' financial investments but also the extent of their 'open innovation' activities with other organisations (Chesborough 2003, 2006). Second, metrics relating to the way in which firms go about Building Innovation, or translate knowledge investments into innovation outputs. Third, a group of metrics designed to capture firms' ability to successfully commercialise their innovations in the marketplace. Together these metrics are the sectoral Innovation Index. At a comparative level, these Sectoral Innovation Indices are then used to compile the Innovation Capabilities Map which provides a visual map of UK innovation capabilities and challenges in the nine sectors considered here.

A key issue in developing the sectoral Innovation Indices was the choice and development of individual metrics. Traditional measures of innovation activity which tend to focus on R&D, patents counts and financial performance measures have been heavily criticised for their emphasis on products and for failing to capture the characteristics of the innovation process as well as the diversity of innovation outputs (Kuczmarski, 2001). The IVC provides a corrective, emphasising process and intermediate indicators. More specifically, the choice of metrics was shaped by an introductory literature review and series of consultations with companies and representative bodies in the sectors being studied and this process is described in section A1.2. As no existing survey could provide the metrics this suggested for the sectoral Innovation Indices, a dedicated telephone inquiry was conducted, which focused on the Innovation Index metrics. This is described in detail in section A1.3 with the individual Index metrics outlined in section A1.4. This approach to data analysis and the derivation of the sectoral Innovation Indices is described in Section A1.5.

A1.2 Literature review and exploratory interviews

An initial literature review was conducted during Spring 2009 to identify prior research in the sectors being considered here and identify relevant innovation metrics. Papers were identified on the basis of academic database searches, snowballing and the recommendations of industry experts and academics.

Following the literature review a series of industry workshops were organised to explore further the specific metrics to be used in the sectoral Innovation Indices. However, due to the timeline available to complete the project there were difficulties attracting a viable number of participants to the workshops. A decision was made instead to conduct exploratory interviews with firms, industry experts (trades associations and professional bodies) and other innovation practitioners. These were conducted either face-to-face or by telephone depending on availability.

Overall, 39 exploratory interviews were conducted during May and early June 2009 covering all ten sectors then included in the study and based on a semi-structured interview approach. Interviews were recorded and notes were taken and used where necessary to inform questionnaire design. Appendix 2 provides a list of the organisations with which exploratory interviews were conducted.

The questionnaire included the following sections reflecting the innovation value chain:

- The nature and drivers of innovation in the firm and sector.
- The nature of the firm's partners for innovation and the nature of collaboration.
- Skills involvement in innovation and skills shortages.
- Knowledge sourcing mechanisms and idea generation.
- Innovation management and organisation.
- Teams and their role in the innovation process.
- Knowledge exploitation.
- Marketing and customisation.
- Process innovation.
- Barriers to innovation.

Not all areas of the exploratory questionnaire were relevant to all firms and in the case of representative organisations areas were either skipped or modified to ask for a sectoral perspective. Exploratory interviews were taped wherever the respondent was willing – this was in the vast majority of cases.

The initial literature review and exploratory interviews provided robust insights into the nature of the innovation process in each sector and highlighted key skill groups, partnerships and sector specific issues for innovation. These shaped the design of the survey questionnaire and the sectoral Innovation Indices themselves.

A1.3 Survey design and development

The overall aim of the telephone survey was to provide a representative view of innovation in the ten sectors being considered with the potential to compare the behaviour and metrics for firms in different size categories. The sampling frame therefore differentiates between firms of different sizes in each sector and between the ten sectors originally considered.

A1.3.1 Sampling frame

The starting point here was the translation of the ten sectors covered by the project outline into SIC codes which could be used to guide company selection and these are summarised in Table 24.

In the majority of cases SIC codes provided a good representation of the specific sectors identified. The exception is design services which are represented in a number of SIC codes relating to the role of design services in specific activities. The range of design services addressed here is therefore specific to those included in the SIC code 74.87/2. The coverage of the individual sectoral samples is as follows:

- Construction (Section F, SIC 45) – this broadly based sector includes general construction and special trade construction for buildings and civil engineering, building installation and building completion. It also includes new work, repair, additions and alterations, the erection of pre-fabricated buildings or structures on the site and also constructions of a temporary nature.

Table 24: Study sectors and matched SIC codes

Sector	SIC 2003
Construction	Section F, SIC 45
Energy production	40.1, 40.2, 23.2
Software and IT services	72.2, 72.3, 72.4
Aerospace	35.3
Automotive	34.3
Specialist design	74.87/2
Architectural services	74.2
Consultancy services	74.14
Accountancy services	74.12
Legal services	74.11

- Energy production (SIC 40.1, 40.2, 23.2) includes the production and distribution of electricity and gas, and the manufacture of refined petroleum products.

- Software and IT services (SIC 72.2, 72.3, 72.4) includes software consultancy and supply, data processing and the provision of database services.

- Aerospace (SIC 35.3) includes the manufacture of aircraft and spacecraft and their component parts.

- Automotive (SIC 34.3) includes the manufacture of parts and accessories for motor vehicles and their engines.

- Specialist design (SIC 74.87/2) includes fashion design related to textiles, wearing apparel, shoes, jewellery, furniture and other interior decoration and other fashion goods as well as other personal or household goods. This includes the activities of interior decoration designers and the activities of graphic designers.

- Architectural services (SIC 74.2) includes architectural activities, urban planning and landscape architecture activities, quantity surveying activities and supporting engineering consultative and design activities.

- Consultancy services (SIC 74.14) includes business and management consultancy activities, public relations activities, financial management and business and management consultancy.

- Accountancy services (SIC 74.12) includes accountancy and audit activities, book-keeping activities and tax consultancy.

- Legal services (SIC 74.11) includes legal activities including the activities of patent and copyright agents.

These sectors vary in size considerably and for the purposes of the survey are distinguished in three business size bands: small-businesses with 5-19 employees; medium – businesses with 20-99 employees; and larger – businesses with 100 plus employees. The target population of businesses (establishments) in the UK in each sector and size band is given in Table 25.

The survey company (OMB Research) was tasked with achieving a response of 50 in each size band by industry cell, a total of 1,500 company interviews. A sample of firms for the survey was drawn randomly from within each sector and size band with data provided by a commercial database provider.

A1.3.2 Questionnaire Design

The telephone questionnaire was aimed primarily at collecting the data for the sectoral Innovation Indices, however, it also includes some questions designed to provide a reference point to other innovation datasets. Discussions with other teams working on the Innovation Index projects also led to the inclusion of a number of questions relating to firms investments in R&D and intangible assets

Table 25: Survey target population

	Number of employees			
	5-19	20-99	100+	Total
Construction	39,525	9,250	1,525	50,300
Energy production	375	310	195	880
Software and IT services	6,720	2,355	565	9,640
Aerospace	140	115	140	395
Automotive	360	270	190	820
Specialist design	11,485	1,575	220	13,280
Architectural services	9,845	2,545	390	12,780
Consultancy services	7,840	1,415	235	9,490
Accountancy services	6,105	1,380	230	7,715
Legal services	8,415	2,700	395	11,510

Source: UK Business: Activity, Size and Location – 2008, Table A3.1, ONS.

(e.g. questions D4, D5 F3) as well as the wider environment for innovation (see question G8).

The final questionnaire therefore included four main sets of questions:

- First, it aimed to collect background information on the firm itself which might help to set its innovation activity in the context of the wider business.
- Second, it aimed to collect innovation output metrics and performance information to enable some comparison with other similar data sources such as the Community Innovation Survey. In addition to these generic (cross-sectoral) metrics the survey also collected information on a group of sector-specific innovation metrics.
- Third, it aimed to collect information on each stage of the firms' innovation value chain focusing on the internal organisation and management of the innovation process, the use of teams and collaboration.
- Fourth, questions suggested by other Innovation Index projects were incorporated. The Manchester group suggested questions on wider framework conditions and these were included – albeit in modified form. The Imperial group also suggested a series of questions around firms' investments in R&D and non-technical knowledge generation and these are also included.

The questionnaire was piloted initially prior to the main survey fieldwork.

A1.3.3 The pilot survey

The pilot survey was held on 3-4th June 2009 with members of the research team attending along with managers from the survey company to brief interviewers and monitor initial survey interviews. Four key issues arose with the pilot questionnaire.

- The original questionnaire was too long. In early pilots the average time to completion was 32 minutes, well over the 20 minute target. A number of questions were dropped focusing the questionnaire more tightly on the indicators needed for the sectoral innovation indices.
- Non-innovators. In the pilot questionnaire all questions on the process of innovation – the IVC – were asked even of non-innovators, causing frustration among some respondents. Addressing this issue meant re-routing several questions so that they would only be asked of firms which did one of the following: product or service innovation; process innovation or R&D. This significantly improved the flow of the questionnaire and minimised the time burden on non-innovating (non-R&D performing) firms.

- One of the questions on investments in non-technical knowledge investments relating to how much firms spent on training proved especially problematic. Essentially firms found it impossible to put a figure on spend on in-house training and this question was therefore dropped at the pilot stage. Other elements of firms' investments in knowledge were more regularly answered and were retained within the questionnaire.

Subsequent to the pilot, a number of further changes were made to the questionnaire relating to the inclusion of further sectoral metrics, an open-ended question on the key drivers of innovation in each section and the re-inclusion of a question on documentary sources of information for innovation.

A1.3.4 Main fieldwork

Main survey fieldwork was conducted between early June and mid-August 2009. Response rates in the majority of sectors were as anticipated around 15 per cent. Significant issues were identified relatively early in the main survey with the Aerospace sector. As Table 1.2 shows this sector has far fewer companies than any of the other sectors being considered here and the number of responses in this sector was low. A decision was therefore made to stop fieldwork in this sector and focus interviews on the other sectors being considered. Survey results therefore relate to nine sectors only and final achieved responses are given in Table 26.

In general terms the main fieldwork went well with response rates in most sector 5-19 size band cells close to the anticipated level. The relatively small number of larger firms in the specialist design sector is reflected in a relatively low number of interview responses in this sector is 100+ size band.

Because of the structured sample, it is necessary to weight survey responses in order to derive representative results for each sector. As usual weights were constructed as the reciprocal of the response proportion, i.e. the number of firms in the target population over the achieved response. Weights are given in Table 27.

A1.4 Defining the index metrics

The sectoral innovation indices are based on a series of 16 individual metrics derived from the weighted responses to the questionnaire data. Five metrics (A1 to A5) relate to firms' activities in accessing knowledge, six metrics focus on building innovation (B1 to B6) and five metrics relate to firms' commercialisation activities (C1 to C5). The definition of the specific metrics are as follows:

A1 – The proportion of externally sourced ideas (per cent) – intended to reflect the openness of firms' knowledge gathering

Table 26: Achieved response by sector and size band

	Size band			
	5-19	20-99	100+	Total
Accountancy services (SIC 74.12)	99	72	21	192
Architectural services (SIC 74.2)	95	68	54	217
Automotive (SIC 34.3)	29	15	17	61
Construction (SIC 45)	84	66	44	194
Consultancy services (SIC 74.14)	93	57	40	190
Energy production (SIC 23.2, 40.1, 40.2)	44	23	24	91
Legal services (SIC 74.11)	69	54	55	178
Software & IT services (SIC 72.2, 72.3, 72.4)	75	67	47	189
Specialist design (SIC 74.87/2)	147	32	6	185
Total	**735**	**454**	**308**	**1,497**

Table 27: Weights by sector and size band

	Size band			
	5-19	20-99	100+	Total
Accountancy services (SIC 74.12)	61.667	19.167	10.952	40.182
Architectural services (SIC 74.2)	103.632	37.426	7.222	58.894
Automotive (SIC 34.3)	12.414	18.000	11.176	13.443
Construction (SIC 45)	470.536	140.152	34.659	259.278
Consultancy services (SIC 74.14)	84.301	24.825	5.875	49.947
Energy production (SIC 23.2, 40.1, 40.2)	8.523	13.478	8.125	9.670
Legal services (SIC 74.11)	121.957	50.000	7.182	64.663
Software & IT services (SIC 72.2, 72.3, 72.4)	89.600	35.149	12.021	51.005
Specialist design (SIC 74.87/2)	78.129	49.219	36.667	71.784
Total	**123.361**	**48.018**	**12.808**	**77.766**

activities, this metric is a commonly used 'openness' measure. Based on question D2 this metric is defined as the 'proportion of new products or services typically coming from ideas initially developed outside the firm'. The same question was asked of firms in each sector. In the survey, firms were asked to give a categorical response. The central values of each range of the categorical response variable were used in the construction of index metric A1.

A2 – R&D intensity (per cent) – a standard measure of firms' commitment to technological innovation, this is defined as R&D expenditure as a percentage of sales in 2009 (or the most recent business year for which data were available). R&D expenditure data were derived from question D5 (asking whether the firm conducted R&D and how much it spent on R&D) and related turnover data from questions C4a to C4e. The same question was asked of firms in each sector. Where firms responding to the survey were unable to give an absolute response they were asked to provide a categorical response. Where necessary, the central values of each range of the categorical response variable were used in the construction of index metric A2.

A3 – Design intensity (per cent) – a non-standard measure of firms' commitment to design as part of their innovation activities. This is defined as design expenditure as a percentage of sales in 2009 (or the most recent business year for which data were available). Design expenditure data were derived from question D7, and asked whether the firm had invested in the design of new or improved products and services, and how much had been invested, and related turnover data from questions C4a to C4e. The same question was asked of firms in each sector. Where firms responding to the survey were unable to give an absolute response they were asked to provide a categorical response. Where necessary, the central values of each range of the categorical response variable were used in the construction of index metric A3.

A4 – Multi-functionality in accessing knowledge (per cent) – intended to reflect firms' use of multiple skill groups in accessing knowledge, this metric is defined differently for each sector. This reflects the different skill needs of innovation in each sector as reflected in the exploratory interviews. This metric is defined using questions D9 to D14 in the questionnaire, and asks who in the firm is involved in obtaining the ideas and information needed to produce new or improved products and services. The skill groups considered for each sector are as follows:

- For construction – directors, project management staff, professional occupations (such as architects, engineers), trade occupations (such as plumbers, electricians), health and safety staff and marketing staff.

- For energy production and automotive – directors, other management staff, supervisors, shop floor workers, administrative staff, technical staff (including

R&D, engineering and design), marketing staff.

- For software – directors, project or other management staff, software designers, software developers, administrative staff, marketing staff.

- For specialist design and accountancy services – partners and senior fee earners, associates and junior fee earners, para-professionals, administrative staff, marketing staff.

- For architectural services – partners and senior fee earners, associates and junior fee earners, project management staff, client management staff, administrative staff, marketing staff.

- For consultancy services – partners and senior fee earners, associates and junior fee earners, IT and knowledge management staff, client management staff, administrative staff, marketing staff.

- For legal services – partners and senior fee earners, associates and junior fee earners, para-legal staff, administrative staff, marketing staff.

In each case, an index was constructed reflecting the percentage of the identified skill groups used in this element of the innovation process. For example, in construction six skill groups are identified. Firms using all six skill groups score 100 per cent; firms using three skill groups score 50 per cent, and so on.

A5 – External knowledge sources for accessing knowledge (per cent) – previous studies have emphasised the potential importance of external knowledge sources for innovation. In question D16 eight potential types of external partners were identified: suppliers, clients or customers, competitors, consultants, universities, government or public research institutes, professional and trade associations and commercial labs or R&D centres. The same question was asked of firms in each sector. Firms reporting all of these as being either very important or fairly important sources of the ideas and information needed for product/service development score 100 per cent. Firms citing four of these external knowledge sources score 50 per cent etc.

B1 Process innovation intensity (expenditure per sales) (per cent) – a non-standard measure of firms' commitment to process innovation. This is defined as expenditure on process development as a percentage of sales in 2009 (or the most recent business year for which data were available). The same question was asked of firms in each sector. Process expenditure is taken from question D15b and related turnover data from questions C4a to C4e.

B2 Percentage of sales of innovative products (per cent) – a relatively standard measure of the percentage of firms' sales derived from new or improved products or services over the last three years. This is derived from questions C8 and C8a. The same question was asked of firms in each sector. Where firms responding to the survey were unable to give an absolute response they were asked to provide a categorical response (question C8a). Where necessary, the central values of each range of the categorical response variable were used in the construction of index metric B2.

B3 Diversity of innovation activity (per cent) – in the survey six different types of innovation activity were identified, relating to product/service, processes, strategy, management systems, organisational change, marketing innovation (question C15). The same question was asked of firms in each sector. This metric is designed to reflect the diversity of firms' innovation activity and takes value 100 if a firm engaged in all six types of innovation activity and 50 if the firm undertook three different forms of innovation.

B4 Multi-functionality in building innovation (per cent) – intended to reflect firms' use of multiple skill groups in building innovation, this metric is defined differently for each sector. This reflects the different skill needs of innovation in each sector as reflected in the exploratory interviews. This metric is defined using questions E4 to E9 in the questionnaire with the skill groups considered the same as those in A4. The question asks who in the firm is involved in the process of developing new or improved products and services. In each case, an index was constructed to reflect the percentage of the identified skill groups used in this element of the innovation process. For example in construction six skill groups are identified. Firms using all six skill groups score 100 per cent; firms using three skill groups score 50 per cent, and so on.

B5 Embeddedness of team-working in building innovation (per cent) – intended to reflect the extent of commitment to team-working as part of firms' building innovation,

this metric is based on questions E11a and E11b. These identify five different attributes of firms' team-working activity:

- Team-working plays a major role in the development of new products/services.
- Development teams are cross-functional and involve people from different parts of the firm.
- Teams operate very independently and are left to get on with solving the problem.
- Firm invests in training in team working.
- Teams often involve customers or suppliers.

Firms agreeing with all five statements score 100 per cent. Firms agreeing with any two of the five statements score 40 per cent etc.

B6 External knowledge sources for building innovation (per cent) – previous studies have emphasized the potential importance of external knowledge sources for innovation. In question E13 eight potential types of external partners were identfied: suppliers, clients or customers, competitors, consultants, universities, government or public research institutes, professional and trade associations and commercial labs or R&D centres. The same question was asked of firms in each sector. Firms reporting all of these as being either very important or fairly important in helping them to develop new or improved services/products score 100 per cent. Firms citing four of these external knowledge sources score 50 per cent etc.

C1 Range of customer relation modes (per cent) – this indicator reflects the range of customer interaction which firms employ. The firms are asked to indicate what forms of interaction they have with customers. Specific measures differ by sector (question F2) but wherever firms are using all of the modes of customer interaction suggested, they score 100 per cent etc. Specific measures of customer relations asked about in the survey are:

- For construction – conduct market research, monitor customer feedback to shape new products/services, use structured CRM systems or approaches, hold regular customer seminars or workshops on new products/services, develop customer-specific solutions.
- For energy production – conduct market research, monitor customer feedback to shape new products/services, use structured CRM systems or approaches, hold regular customer seminars or workshops on new products/services or develop customer-specific solutions.
- For software and IT, consultancy services, accountancy and legal services – involve customers in product/services evaluation and development, monitor customer feedback to shape new products/services, use structured CRM systems or approaches, hold regular customer seminars or workshops on new products/services, develop customer-specific solutions.
- For automotive – regularly engage in market research, work closely with customers to identify new requirements, share information and expertise, use a direct selling approach to target specific companies, use structured CRM systems or approaches, develop customer-specific solutions.
- For specialist design – modify designs to meet client requirements in terms of production costs and styling, target potential clients that you would like to work with, develop your own designs and then consider their patent or licence potential, use structured CRM systems or approaches, develop customer-specific solutions.
- For architectural services – work closely with customers to understand their requirements, participate in architectural competitions, develop a strong reputation for particular types of building (such as buildings for the education, health or housing sectors, etc.), use structured CRM systems or approaches, develop customer-specific solutions.

C2 Branding, marketing intensity (expenditure per sales) – a non-standard measure of firms' commitment to commercialisation through their spending on branding and marketing. This is defined as expenditure on branding, marketing as a percentage of sales in 2009 (or the most recent business year for which data were available). Spending on branding, marketing etc. is taken from question F3 and related turnover data from questions C4a to C4e. The same question was asked of firms in each sector.

C3 Multi-functionality in commercialising innovation (per cent) – intended to reflect firms' use of multiple skill groups in commercialising innovation, this metric is defined differently for each sector. This

reflects the different skill needs of innovation in each sector as reflected in the exploratory interviews. This metric is defined using questions F4 to F9 in the questionnaire with the skill groups considered the same as those in A4. The question asks who in the firm is involved in marketing and selling new or improved products and services. In each case, the index was constructed to reflect the percentage of the identified skill groups used in this element of the innovation process. For example, in construction six skill groups are identified. Firms using all six skill groups score 100 per cent; firms using three skill groups score 50 per cent, and so on.

C4 External knowledge sources for commercialisation (per cent) – previous studies have emphasised the potential importance of external knowledge sources for innovation. This question has some variation by sector, and asks how important each of a range of partners are in helping the firm market and sell new or improved products and services. In question F13 seven potential types of external partners were identified: suppliers, competitors, dealer networks or agents (only automotive), market research agents, advertising agencies, leasing companies (only automotive), professional and trade associations. Firms reporting all of these as being either very important or fairly important in helping them to develop new or improved services/products score 100 per cent etc.

C5 Use of IP protection (per cent) – reflects the diversity of firms' use of different forms of legal IP protection. Question F10 defines six forms of legal IP protection (registration of new designs, trademarks, patents, copyrights, confidentiality agreements, NDAs). Firms using all six forms of IP protection score 100 per cent etc.

A1.5 Deriving the sectoral innovation indices

This section describes how the 16 innovation metrics defined earlier are summarised in three innovation indices for each sector to reflect the sector's capacity in accessing knowledge, building innovation and commercialising innovation. This process has two main steps – normalisation and averaging.

Normalisation involves ensuring that each of the 16 innovation metrics has a standardised range between zero and 100. Some of the variables take this form already, being defined as percentage variables. Others have more limited ranges where, for example, the maximum spending of firms in a given sector on say IP protection is less than 100 per cent of turnover. To give each innovation metric the same weight in the sectoral innovation indicators, each innovation metric was normalised to be between 0 and 100 as follows. If IMi is an innovation metric for sector i, the normalised value is:

$$Normalised\ (IM_i) = \frac{IM_i - \min(IM_i)}{(\max(IM_i) - \min(IM_i))}$$

Where max(IMi) and min(IMi) relate to the maximum and minimum values of indicator IMi within a given sector.

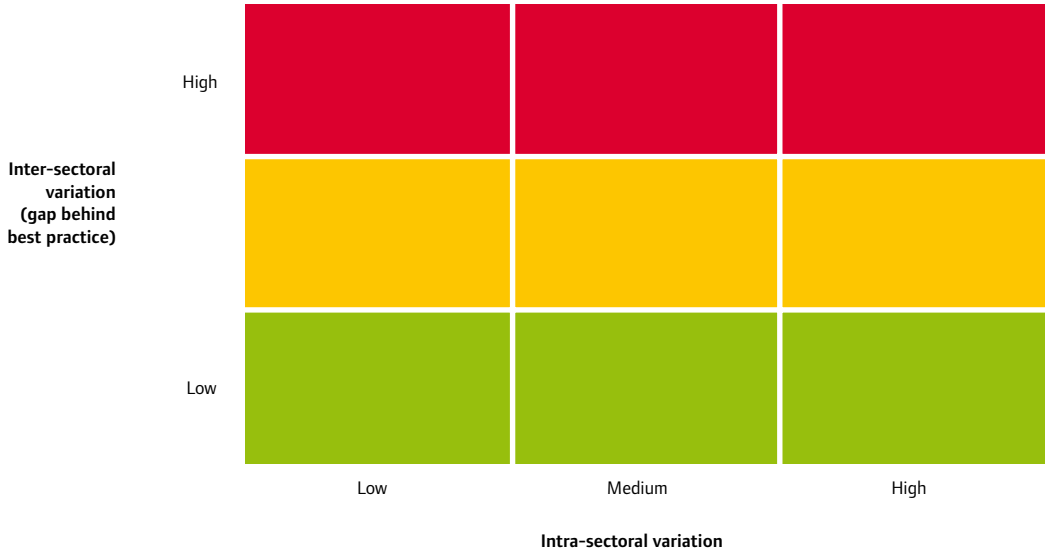
Once normalised the innovation metrics are averaged to give the three sectoral innovation indices for each sector. That is, the normalised A1 to A5 was averaged to give the innovation index for accessing knowledge, average normalised B1 to B6 to give the index for building innovation and average normalised C1 to C5 to give the innovation index for commercialisation.

A1.6 Deriving the innovation capabilities map (ICM)

The aim of the ICM is to provide a quick visual overview of the results of the sectoral element of the innovation index project. As with the innovation value chain itself, the idea being to help decision-makers to identify those elements of the innovation process which might be working well and those which might be working less well and therefore where there might be potential for improvement. The strength of each element of the innovation value chain in each sector will be indicated in the ICM using a red/orange/green traffic light indicator along with a high/medium/low indicator reflecting intra-sectoral variation.

To represent these two dimensions of capability within a single diagram, a two-element approach was adopted. Colours are used to represent sectors' position compared to leading practice, i.e. inter-sectoral variation. Letters (H-high, M-medium, L-low) are used to reflect intra sectoral variation. Green combined with 'L' would indicate a sector where levels of innovation capability were close to or at leading practice, with a low level of intra-sectoral variation in levels of

Figure 15: From the sectoral innovation metrics to the ICM



innovation capability. Red combined with 'H' would indicate a situation where intra-sectoral variation in innovation capability is high and the sector lagged significantly behind leading practice. This indicates sectors in which there is considerable scope for both intra- and inter-sectoral learning.

In practice, intra-sectoral variation was measured in each sectoral innovation index using the standard deviation of the measure within the sector. The gap behind best practice was measured by subtracting the mean of each sectoral index from the highest sectoral mean. Plotting the resulting indices suggests Figure 16. Where sectors are indicated as follows: Accounting (ACC), Architectural Services (ARCH), Construction (BILD), Specialist Design (DESN), Energy (ENER), Software and IT (SOFT), Consultancy (CONS), and Automotive

Figure 16: Actual sectoral index values

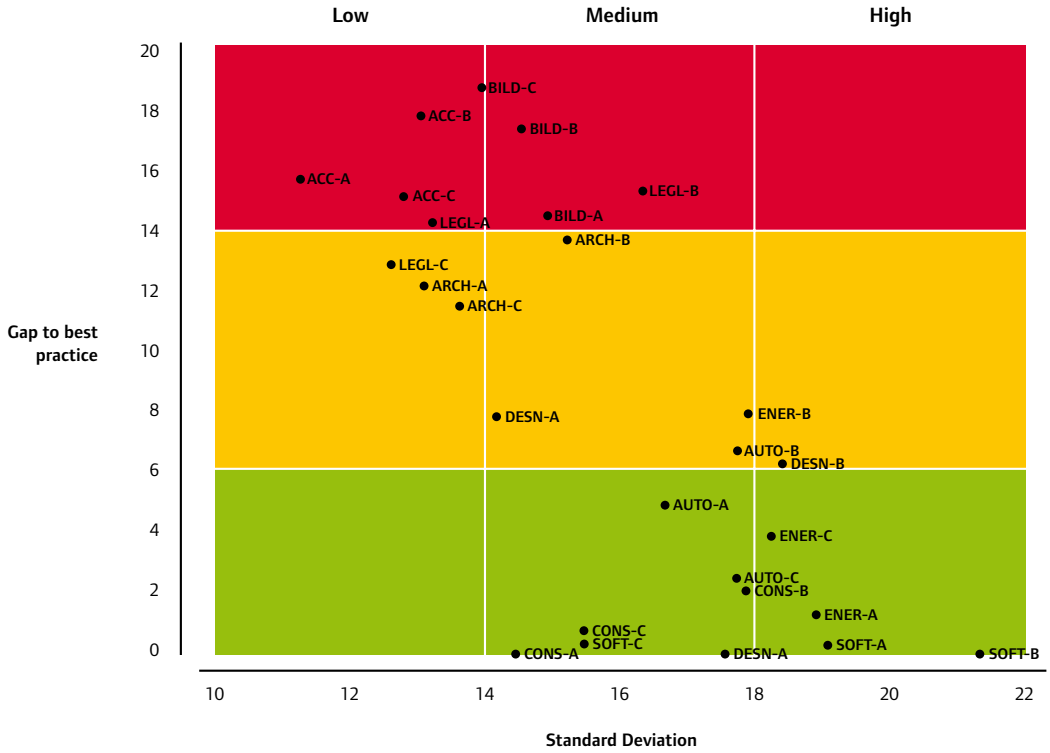


Figure 17: The innovation capabilities map

	Accountancy	Architectural services	Automotive	Construction	Consultancy services	Energy production	Legal services	Software & IT services	Specialist design
Accessing Knowledge	L	L	M	M	M	H	L	H	M
Building Innovation	L	M	M	M	M	M	M	H	H
Commercialising Innovation	L	L	M	L	M	H	L	M	M

(AUTO). A denotes accessing knowledge, B building innovation and C commercialisation. Hence LEGL-C is commercialisation in legal services.

The position of each sectoral innovation index on this chart is clearly fixed by its standard deviation and distance to the highest mean innovation index. More arbitrary is the choice of the limits for the red/orange/green and high/medium/low zones which is made here to try and best highlight sectoral strengths and weaknesses. The implied ICM is given in Figure 17 and its interpretation is discussed in detail in Chapter 12.

Appendix 2: Exploratory interviews

Exploratory interviews were held during May and June 2009 with the following trade associations and professional bodies:

Association of Electricity Producers

British Design Innovation

Design Council

Institute of Interior Designers

Institute of Business Consulting

Midland Aerospace Aviation

Midlands Architecture and the Designed Environment – MADE

Renewable Energy Association

RIBA West Midlands

Society of Motor Manufacturers and Traders (SMMT)

The Institute of Chartered Accountants in England and Wales

West Midlands Centre for Constructing Excellence (WMCEE)

West Midlands IT Association

In addition, exploratory interviews were held with the following companies:

Accountancy	Clement Keys Yevs and Co. Ltd
Aerospace	Umeco plc Aeromet International Plc Eccles Tooling Systems
Architecture	Associated Architects LLP Associated Finishes Bryant Priest Newman Architects Kinetic AIU ARUP
Automotive	Vector GB M A LLOYD BURCAS LTD
Construction	VINCI Construction UK Ltd John Sisk & Son Ltd Twin Building Consultancy Limited
Consultancy	Genesis Consulting Amba-QA Limited
Design	Small Fry
Energy	Quiet Revolution Ltd
Software & IT	Genesis Integrous ltd CPIO Ltd ADECS Profita
Legal Services	Withers & Roger Anthony Collibs Solicitors LLP

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