# Shell Step Innovation programme – Exploring the absorptive capabilities of host SMEs

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**Objectives:** The research undertaken looked at the capacity of firms involved in Shell Step/SEEDA in the South-East to absorb knowledge and innovation opportunities, as well as exploring how Shell Step enhances these capabilities.

**Prior Work:** Technopolis has published a number of papers on absorptive capabilities. The work builds on the concepts introduced into the R&D and innovation literature by Wesley Cohen and Daniel Levinthal Absorptive capacity: a new perspective on learning and innovation, Administrative Science Quarterly, Vol 35 (1), March 1990, pp128-152. Other important work in the area includes Peter Lane, Belaji Koka and Seemantini Pathak, A thematic analysis and critical assessment of absorptive capacity research, Academy of Management Proceedings, 2002 BPS:M1 and W Cohen and D Levinthal, Innovation and learning; the two faces of R&D, Economic Journal, Vol 99, 1989, pp 569 - 596.

**Approach:** Two face to face surveys with the 15 firms were undertaken at the start and finish of the Shell Step placement. The interviews covered quantitative and qualitative information addressing the intensity of firms' innovation activities and analysing aspects of absorptive capability as well as tying it to the firms' involvement in the scheme. The interviews covered general company data, important factors influencing the growth of these businesses, human resources and how these relate to innovation activities and the organisation of knowledge flow and the Shell Step experience.

**Results:** The results of the study show a high level of R&D and entrepreneurial activity within the firms although in the classical sense, there were few mechanisms in place for knowledge flow. Their involvement in Shell Step improved the companies' knowledge, skills and capabilities. The limitations of the research are associated with the short time between initial interview and follow-up and in order to see economic impacts, there would need to be a delay in the second round of data collection.

**Implications:** The Shell Step model of putting students into SMEs is one mechanism of improving the absorptive capabilities and innovation potential of firms through access to undergraduates. It is of interest to policy makers as a way of enhancing the economic potential of SMEs, improving survival, encouraging SMEs to employ graduates and encouraging graduates to work in SMEs.

**Value:** Looking at the change in absorptive capabilities of firms involved in 'programmes' helps to test new indicators which measure changes in the firms that could equate to increased productivity and economic growth. We are always seeking ways of measuring growth and value of public intervention.

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**Introduction:**
In Innovation policy we devote a great deal of money and attention to the 'knowledge infrastructure' of universities, research institutes and other public sector organisations that produce and manipulate knowledge. Increasingly, we recognise that knowledge is also produced, managed and developed on a large scale elsewhere in society, not least in SMEs. It is uniquely companies (and not the institutions of the knowledge infrastructure) that transform new and existing knowledge into jobs, money and economic growth. Their ability to absorb, generate and exploit knowledge is therefore critical to social and economic well being.

Shell Step forms part of this process. It plays a key role in bringing together undergraduates on placements to help SMEs and community organisations to undertake a specific development project.

The study undertaken was two-fold. It looked in depth at the capacity of the companies involved in the scheme to absorb knowledge and innovation opportunities, as well as exploring how Shell Step fits into this process and in fact enhances the capabilities of the firm. This paper concentrates on the impact on the host SME.

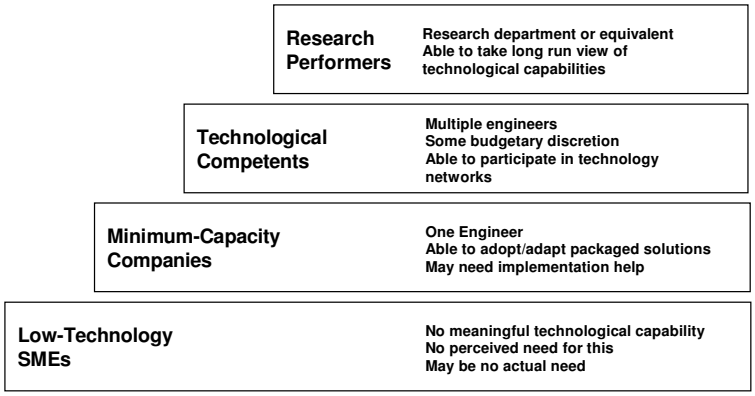
**Theoretical background:**
For the most part, literature on research and innovation tends to treat absorptive capability as a black box. We can however see five more or less distinct elements within the box

- Human capital, especially in the form of graduates and especially scientists and engineers
- Ability to network with external sources of knowledge and other resources
- Organisation, routines and organisational processes
- Learning processes
- Codification – gathering and recording information in a systematic way

In the "Hierarchy of Technological Capabilities", a model of the technological competence of firms can be related to a number of elements including those above, related to absorptive capability. The segmentation suggests that there are four reasonably distinct levels in the development of firms' research capabilities. At the bottom level, there is no meaningful capability and there will tend to be a presumption that none is needed. At the next level up, the 'minimum capability' level, the firm acquires at least one person able to speak the language of technology, to monitor and understand the significance of technological changes happening outside the firm. These bottom two levels of firm rarely have much contact with universities.

Inherently, behind these hierarchies of abilities must lie a hierarchy of capabilities. Exhibit 1 shows a simple hypothesis for a useful way to segment companies according to their level of capability.

**Exhibit 1 Hierarchy of Technological Capabilities**



Human capital
Conventionally, numbers of qualified scientists and engineers in firms are seen as the proxy measure of absorptive capacity. In a study of 577 companies across 7 EU countries, Knudsen, Dalum and Villumsen looked at willingness to participate in strategic alliances, R&D personnel as a proportion of total employment, and the share of companies' sales attributable to new products. The results showed that openness towards knowledge sharing defined by participation in strategic alliances as well as high R&D intensities is important for innovative performance; second, a high share of R&D personnel as well as a high share of academics form the foundation for knowledge access and finally, the knowledge to be absorbed should be supplementary and preferably be directed towards the later stages of the innovation process. Provision of training by the companies was only weakly related to innovativeness, and companies who co-operated with universities were actually **less** likely than other equivalent firms to be innovative.

Networking
Outside the mainstream innovation discussion, in the research evaluation literature, the term 'Knowledge Value Collectives' (KVCs) has been used to describe the set of people and institutions that work with a related set of knowledges. The idea is similar to that of a community of practice, but where knowledge production is an explicit part of the community's activity. These collectives can be thought of as building blocks of innovation systems, and an ambition of policy for absorptive capacity would be to foster the growth of such collectives.

Organisation and routines
Other elements such as organisation and processes within which the firm's human capital are also important and it is interesting to distinguish between know-how embodied in people, routines/organisation and other kinds of codified know-how.

In a study on 'Firm capabilities and economic development', Teece argues that, in relation to absorptive and technological capacities, organisational routines have four roles

- Coordination/integration
- Routinisation, including aspects of the ways that informal or tacit knowledge are codified so that it can more effectively be exploited
- Learning, involving both organisational and individual skills
- Reconfiguration and transformation, flexibly adapting processes and resources to make economic use of learning

Learning processes
Absorptive capacity is also exploited in various kinds of learning processes.

1. *Learning by searching,* refers to the generation of new knowledge achieved through formalised search activities such as R&D.
2. *Learning by doing,* refers to the accumulation of knowledge gained through carrying out the same kind of activities repetitively.
3. *Learning by using,* refers to learning through the utilisation of products;
4. *Learning from advances in science and technology,* refers to the absorption of new developments in science and technology.
5. *Learning from inter-industry spillovers,* refers to the activities of competitors and other firms in the same industry.
6. *Learning by interacting,* refers to 'horizontal' or 'vertical' forms of interaction with other sources of knowledge such as cooperations with other firms.

The first three kinds of activities are internal to the firm; the remaining three are instead external to the firm. While the outcome of internal activities is completely dependent on the firm's efforts, the access to external sources of knowledge and the market conditions for knowledge are not homogeneous. Depending on the kind of knowledge firms are looking for, availability and transmissibility can vary significantly. Regardless of its availability, firms should know where and how to find knowledge, and how to assimilate it. This ability is achieved through the previous accumulation of knowledge via different modes of learning and provides firms and agents in general with the idea of 'what to look for', 'for which purpose' and 'how to use it'.

Codification
Codification is also considered to be an important aspect of absorptive capability. Only when knowledge is transformed from being tacit and personal to being 'codified' (written down in a systematic way) can it be systematically developed or adequately communicated. Creating understanding in this formal sense is one important source of innovation and this is why looking at the ways in which a company documents and deals with its strategy forms an important part of absorptive capability.

**The Shell Step process:**
Shell Step is a UK wide programme offering undergraduates project-based work within a small to medium sized business over an 8-week period during the summer holidays. The students' capabilities are matched to the companies' applying to host a student. The aim is that the business will benefit from the new skills without having to commit to training courses or additional employees. Shell Step in the South-East was piloting a particular kind of scheme focusing on companies with projects that focused on some kind of innovation in terms of new products, new forms of management, organisation and procedures. For more information, please see www.step.org.uk.

**Methodology:**
Overall the requirements of the study were to interview both the companies and the students involved in Shell Step in the South-East in order to answer questions on the absorptive capabilities of the firms involved, the effect this has on receptiveness to innovation and the types of skills acquired and transferred between the students and the host companies. A first set of interviews took place during the scheme and a second set of interviews followed up with the companies 4 months later.

*Measuring entrepreneurial activity in the companies*
A series of questions were posed to help gauge the entrepreneurial activities of the firm's, both before and after the Shell Step scheme.
These questions covered:

- The number of staff doing development of products, services or processes, or doing other kinds of R&D in the firm
- The introduction onto the market any new or significantly improved products
- Human resources
- Training opportunities
- Sources of knowledge flow within the company
- Cooperation activities

**Results of the company surveys:**
This section reports on the results of the two interview surveys from the companies. It addresses the intensity of firms' innovation activities and analyses aspects of absorptive capability as well as tying it to the firms' involvement with Shell Step. The findings underpin the relevance of human capital and knowledge to the innovation process.

*Types of companies*
The survey covered both the manufacturing and services sectors with 8 manufacturing and 7 service sector companies. The majority of the companies are owner managed and are not part of an enterprise group. 10 of the 15 companies have fewer than 50 employees. The smallest companies tend to be from the services sector as would be expected as manufacturing companies tend to need higher numbers of production staff.

**Exhibit 2 Size of companies interviewed**

| Size range | Number of companies |
|---|---|
| 0-50 | 10 |
| 50-100 | 2 |
| 100+ | 3 |

Innovation activity is continuously carried out in the majority of companies interviewed. Overall, in the last three years 12 of the 15 companies surveyed have introduced a new product or new services and 9 out of 15 have introduced new processes or continually upgrade their existing processes. Sales from innovative products/services represent some 51.6% of total turnover.

**Exhibit 3 Innovation activity**

| | Total responses | Total | % |
|---|---|---|---|
| Companies introducing new products or services in the last three years | 12 | 15 | 80% |
| Development: Mainly internally | 10 | 12 | 83% |
| With others | 3 | 12 | 25% |
| Mainly externally | 0 | 12 | 0% |
| Sales from innovative products introduced in the last 3 years(% average) | 10 | 12 | 51.6% |
| Companies introducing new processes in the last three years | 9 | 15 | |
| Development: Mainly internally | 7 | 9 | 78% |
| With others | 1 | 9 | 11% |
| Mainly externally | 1 | 9 | 11% |

Innovation activity is undertaken formally or informally by a large number of company employees. All companies have dedicated staff either developing products, services or processes and the R&D intensity of these companies is high with an average of 41% of staff being involved in these activities.

**Exhibit 4 R&D activity**

| Company | Total Staff | Number of staff involved in developing products/processes/services | % Developing products/services/process |
|---|---|---|---|
| 1 | 10 | 8.5 | 85.00% |
| 2 | 7 | 2 | 28.57% |
| 3 | 6.5 | 1 | 15.38% |
| 4 | 141 | 10 | 7.09% |
| 5 | 3 | 2 | 66.67%* |
| 6 | 2 | 2 | 100.00% |
| 7 | 76 | 6 | 7.89% |
| 8 | 4 | 2 | 50.00% |
| 9 | 56 | 8 | 14.29% |
| 10 | 3 | 3 | 100.00% |
| 11 | 3 | 2 | 66.67% |
| 12 | 160 | 7 | 4.38% |
| 13 | 120 | 25 | 20.83% |
| 14 | 33 | 3 | 9.09% |
| 15 | 12 | 1 | 8.3% |

* Plus 2 outsourced

*Business needs and abilities*

Companies were asked to give an indication of the most important factors contributing towards business success. The most important were

- Responding to changing customer needs
- Finding or using new technologies
- Accessing innovative new customers/markets
- Regularly introducing new products or services

A high proportion of companies also stressed the importance of the protection of knowledge, although this was balanced with an equal proportion showing an 'outward orientation' in the development of innovations, stressing the high importance of cooperating with others. These are not mutually exclusive and few companies are cooperating with external organisations. Companies also stressed the importance of improving the productivity of personnel, which

forms part of the production process and remains an important focus, particularly in manufacturing companies.

**Exhibit 5 Important success factors in the view of respondents**

| Important success factors | 5 | 4 | 3 | 2 | 1 | Total |
|---|---|---|---|---|---|---|
| Responding to changing customer needs | 11 | 3 | 1 | 0 | 0 | 15 |
| Accessing innovative customers and/or markets | 7 | 3 | 2 | 2 | 0 | 14 |
| Complying with new regulatory or legislative obligations | 4 | 4 | 6 | 0 | 0 | 14 |
| Regularly introducing new products or services | 7 | 2 | 2 | 1 | 0 | 12 |
| Regularly introducing new processes | 3 | 1 | 3 | 3 | 0 | 10 |
| Introducing new organisational and management techniques | 1 | 5 | 6 | 2 | 0 | 14 |
| Finding or using new technologies | 10 | 3 | 1 | 0 | 0 | 14 |
| Improving the productivity of personnel | 4 | 10 | 1 | 0 | 0 | 15 |
| Employing qualified scientists or engineers | 7 | 3 | 2 | 1 | 0 | 13 |
| Employing people with higher degrees (MSc, PhD, etc) | 1 | 0 | 4 | 5 | 2 | 12 |
| Improving the efficiency of machinery and equipment | 3 | 2 | 1 | 3 | 1 | 10 |
| Protecting your knowledge | 8 | 2 | 1 | 2 | 0 | 13 |
| Co-operating with others (customers, suppliers, colleges, etc) in innovation projects | 4 | 6 | 3 | 0 | 0 | 13 |
| Finding or mobilising financial resources | 3 | 4 | 1 | 3 | 1 | 12 |
| Accessing international markets | 5 | 4 | 0 | 1 | 0 | 10 |
| Improving your technological understanding of your products and processes | 6 | 3 | 3 | 1 | 0 | 13 |
| Quality certification (eg ISO 9000, supplier approval, ISO 14000) | 5 | 3 | 3 | 1 | 0 | 12 |

Although employing qualified scientists and engineers is of high importance to this set of companies, employing people with higher degrees is not. This is a point, which will be explored further in the section on human resources, but ties in very well with the overall qualifications level of those presently employed in the companies.

This attention to factors associated with knowledge accumulation and innovation is reflected in the overall competitiveness of the businesses interviewed. The majority felt themselves to be at least as competitive as their most successful competitors and many outperformed them in several areas. The most likely areas in which the companies indicated they do better than their competitors are responding to changing customer needs and accessing innovative customers and/or markets. This correlates well with the results in Exhibit 5 and overall suggests that the companies are ahead in the areas that they feel are the most important to their success.

*Human resources*

Innovation activity is generally believed to be sustained by the employment of skilled workers. The overall education levels and previous qualifications of employees is given in Exhibit 6. Out of a total of 624.5 staff, 92 have relevant qualifications (14.7%). Out of these 92 staff, the following breakdown of qualifications is seen.

**Exhibit 6 Overall education levels and previous qualifications**

| Company | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A non-scientific or technical BSc or BA degree but not a higher degree | 0 | 5 | 0 | 0 | 0 | 1 | 2 | 2 | 12 | 1 | 1 | 2 | 0 | 0 | 0 |
| A BSc in science or engineering but not a higher degree | 7 | 0 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 0 | 0 | 5 | 15 | 0 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A higher degree (master's or doctorate) | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Qualifications as technicians, but not a degree (NVQ) | 0 | 0 | 1 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 5 | 3 | 0 | 0 |
| Apprenticeships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| | | | | | | | | | | | | | | | |
| Experience of working in a major foreign or multinational firm in your industry | 10 | 3 | 0 | 0 | 0 | 0 | 4 | 1 | 2 | 0 | 0 | 0 | 3 | 0 | 3 |
| Total number of staff in company | 10 | 7 | 6.5 | 141 | 3 | 2 | 76 | 4 | 56 | 3 | 3 | 160 | 120 | 33 | 12 |

Relating back to our diagram on 'technological capabilities' Exhibit 1, the number of staff with degrees would indicate the companies are either second tier - minimum capacity companies or third tier – technologically competent, although 3 companies have no graduates at all. There are higher levels of graduates in the IT related companies, or knowledge intensive companies involved in the schemes and fewer in the larger manufacturing companies.
The presence of multinational experience provides important opportunities to obtain knowledge externalities, in the form of information but also in less direct ways. Such companies in practice can function as 'training schools' for the supply chains or clusters that they inhabit. 23 of the staff have previous experience of working in a multinational, however these staff are concentrated in 7 of the companies interviewed. Many of the companies have few qualifications throughout the organisation. This does not seem to correlate with a low level of R&D but would indicate a lower level of absorptive capability, as defined by the literature.

Upskilling the workforce is also a good indication of absorptive capability within firms. Seven of the firms involved reported no formal training of staff, although this does not exclude the possibility that informal training takes place. This appears to be true across the size ranges of companies and across manufacturing and services companies.

**Exhibit 7 Company training by size**

| Size range | Number of companies | Number of companies delivering formal training | % delivering formal training |
|---|---|---|---|
| 0-50 | 10 | 5 | 50% |
| 50-100 | 2 | 1 | 50% |
| 100+ | 3 | 2 | 67% |

The skills and qualifications within the companies involved in Shell Step would appear to be low (in a formal sense) but do not necessarily represent the level of entrepreneurial activity that is seen within them.

*Working with others*
Working with others is a way of transferring knowledge from the outside environment. Although the majority of the companies in the study interact with external actors in some way, this is not done in any formalised manner. A number say they talk informally to customers and others in the sector. Seven are members of a trade or industry association, one, a formal business network and 4 are members of a technology oriented network.

**Exhibit 8 Number of companies that are members of networks or associations**

| Type of network/association | No. of responses |
|---|---|
| Trade or Industry Association | 7 |
| Formal business-orientated network | 1 |
| Technology-orientated network | 4 |
| - University/College involved? | 1 |

Ties with domestic organisations were strong with all buying or using of services taking place with other UK companies or institutions. Over half the companies had bought services from a University other than the Shell Step student, which shows a reasonably high engagement with Higher Education.

Very few cooperation agreements had taken place overall. The highest number were with Universities and these were also potentially the most useful according to the results. Only 3 of the 15 companies interviewed had arranged cooperation activities with other companies in the last three years.

**Exhibit 9 Cooperation agreements**

| | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|
| Clients or customers | 2 | 0 | 0 | 0 | 0 |
| Universities or other higher education institutes | 3 | 1 | 1 | 0 | 0 |
| Consultants | 1 | 1 | 1 | 2 | 0 |
| Competitors and other firms from the same industry | 0 | 1 | 1 | 1 | 0 |
| Commercial laboratories /R&D enterprises | 0 | 1 | 2 | 0 | 1 |
| Government or private non-profit research institutes | 0 | 0 | 0 | 1 | 2 |

(Where 5 is the most useful, 1 is the least useful)

*The organisation of knowledge flow*

In 7 out of the 15 companies interviewed there is somebody specifically appointed for monitoring opportunities for technical innovation. The difference between the types and size of firm is not marked. In most cases, market opportunities are identified through the Internet and the exchange of information with suppliers and customers. The links with universities and colleges, technology networks and monitoring services appear to play a more marginal role in these companies. The lack of monitoring through links with Universities and Colleges is perhaps interesting considering the firms' involvement with Shell Step and may increase in the future. In the firms that did not have formal monitoring systems in place there was nevertheless an understanding of the need to monitor the business environment and most were very sensitive to market opportunities.

In the majority of cases, management met regularly to discuss the company strategy and new products and services form part of this process. The process of suggestions is less widely used but is still present in over half of the companies interviewed, only a small number (5) of companies link this to some kind of financial reward.

**Exhibit 10 What does innovation mean to your company (tick all that apply)?**

| Type of innovation | Number of responses |
|---|---|
| Product innovation | 7 |
| Process innovation | 4 |
| Marketing innovation | 1 |
| Organisational innovation | 2 |
| Business model innovation | 1 |

*The Shell Step experience*

The interviews also asked companies about their involvement in Shell Step, their experiences and expected outcomes. These are reported and followed up to see to what degree these outcomes were achieved and if they have improved the capabilities of the firms.

The main reason for approaching Shell Step is that the company had a specific project in mind. The formal pursuance of the project shows companies with a high degree of comprehension of the need for innovation and change. Below are the types of objectives the projects were hoping to achieve.

**Exhibit 11 Project objectives hoping to achieve**

| | **Importance** *5=extremely important, 1=not important)* | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project objectives** | **5** | **4** | **3** | **2** | **1** | **Total responses** | **Av score** |
| To enter a new area of technology | 7 | 1 | 0 | 0 | 2 | 10 | 4.1 |
| To develop or improve products | 2 | 1 | 0 | 1 | 3 | 7 | 2.7 |
| To develop or improve services | 4 | 1 | 0 | 2 | 2 | 9 | 3.3 |
| To develop or improve processes | 4 | 1 | 4 | 0 | 0 | 9 | 4 |
| To increase activities in existing markets | 2 | 4 | 1 | 0 | 0 | 7 | 4.1 |
| To increase profitability | 0 | 1 | 1 | 4 | 2 | 8 | 2 |
| To reduce costs | 2 | 2 | 1 | 2 | 1 | 8 | 3.25 |
| To improve quality | 0 | 0 | 0 | 3 | 4 | 7 | 1.4 |
| To respond to regulatory requirements | 1 | 0 | 0 | 0 | 0 | 1 | 5 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

The most important objectives are to enter a new area of technology and to increase activities in existing markets[1].

The projects were a mix of product, process and organisational innovation although product innovation was the most likely.

**Exhibit 12 Which category of innovation would you consider your project to fall under?**

| Type of innovation | Product innovation | Process innovation | Organisational/management innovation | Other |
|---|---|---|---|---|
| Number of companies | 11 | 5 | 2 | 0 |

(more than one answer allowed)

The motivation of applying to Shell Step, in most cases, was to access the skills and expertise of the undergraduate (Exhibit 13). The companies seemed quick to identify the benefits of using Shell Step to undertake their projects. This points to an understanding of the importance of bringing in new knowledge from external sources.

**Exhibit 13 Motivation for applying for Shell Step**

| **What was the company's motivation for applying for Shell Step** | **Importance** *(5=extremely important, 1=not important)* | | | | | |
|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | Total |
| To access skills and expertise of the undergraduate | 10 | 2 | 0 | 2 | 0 | 14 |
| To access skills of the host institution | 0 | 1 | 0 | 2 | 5 | 8 |
| To employ an undergraduate in the business for the length of the placement | 2 | 5 | 0 | 1 | 1 | 9 |
| To investigate the possibility of employing graduates in the future | 1 | 2 | 2 | 2 | 2 | 9 |
| To take part in a structured scheme | 0 | 2 | 2 | 2 | 5 | 11 |
| To access funding for a project | 2 | 3 | 0 | 5 | 1 | 11 |
| Other | 2 | 0 | 0 | 0 | 0 | 2 |

The majority of companies considered the risk of achieving the project objectives to be medium to high. However, the commercial risk was considered by most to be low. This is in spite of the fact that 13 of the 14 companies indicated that the project was of strategic importance to their

[1] A response to regulatory requirements is important to one company but the total number of responses is low.

business. If you triangulate these three parameters it may be that the companies have the foresight to see the potential importance of having an innovative project, which is of interest to their company, therefore, the risk of achieving the objectives is relatively high due to the duration of the placement and the fact it is not necessarily core business. However the commercial risks remain low due to the same facts, that it is a low cost student placement and not necessarily core business. This does not mean the project cannot lead to long-term economic gains.

**Exhibit 14 Project risks**

| | Risk (1= low risk, 5=high risk) | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Total |
| How did you rate the risk of achieving the project objectives at the outset? | 2 | 1 | 4 | 4 | 4 | 15 |
| How did you rate the commercial risk of the project? | 3 | 2 | 4 | 0 | 0 | 9 |
| | Yes | | No | | Don't know | |
| Is the project of strategic importance to the company? | 13 | | 0 | | 2 | |

**Exhibit 15 Change in knowledge flow and organisation as a consequence of Shell Step**

| **As a consequence of the project have any of the following factors either increased, decreased or stayed the same within the company?** | | | |
|---|---|---|---|
| | Increased | Decreased | Stayed the same |
| Use of the Internet for finding out market information | 2 | 0 | 12 |
| Information from suppliers | 4 | 0 | 9 |
| Information from customers | 1 | 0 | 12 |
| Attend exhibitions / fairs | 0 | 0 | 13 |
| Links with professional bodies / trade associations | 1 | 0 | 12 |
| Involvement in technology network(s) | 2 | 0 | 9 |
| Links with universities or colleges | 3 | 0 | 10 |
| Making new contacts | 5 | 0 | 8 |
| Links with public bodies/fund holders | 3 | 0 | 9 |

Changes in knowledge flow happened in a few of the companies as a consequence of the Shell Step placement. The most likely change has been in making new contacts. Four of the companies report increased information flow from the suppliers, this is mainly due to the nature of the project set for the student which sometimes involved market research and contacting suppliers. There is little change in the amount of contact with customers, but this is already seen by the companies as one of the most important ways of keeping up with new opportunities. Companies reported few links with universities and colleges before involvement in Shell Step and only three reported an increase as a consequence of Shell Step.

Outcomes expected

The results of Shell Step were extremely positive. All the companies expressed their delight at the student's knowledge, skills and capabilities and considered their involvement to be worthwhile. Almost all the companies report that the technical objectives were fully met. The commercial outcomes were also positive although expected at a later point.

**Exhibit 16 Do you think the project will achieve its objectives? *(5=fully met, 1=not met at all)***

| | **5** | **4** | **3** | **2** | **1** |
|---|---|---|---|---|---|
| Technical objectives | 12 | 3 | 0 | 0 | 0 |
| Commercial objectives | 10 | 3 | 1 | 0 | 0 |

The effects of the projects both now, and those expected in the future are promising, both in terms of the impact of the scheme and also the increased innovation and absorptive capability of the company. The biggest impact so far has been the greater willingness to access external expertise. This change can be linked to the innovative potential of the company and its ability to absorb knowledge and skills from other sources, particularly in this case from undergraduates. The following table looks at the effects relating to absorptive capabilities of the firms. The results show a much higher level of awareness of innovation opportunities and also a willingness to access external expertise. A better understanding of the recruitment of graduates will also help companies chose appropriately skills individuals in the future.

**Exhibit 17 Effects of the projects to date and expectations of effects in the future**

| **Which of the following have been effects of the project to date and what do you expect the effects to be in the future?** | | | | |
|---|---|---|---|---|
| | **To date** | | **Expected** | |
| The company has/will have | Yes | No | Yes | No |
| Better awareness of innovation opportunities | 4 | 6 | 9 | 3 |
| Better organisation and management | 4 | 9 | 5 | 4 |
| Better awareness of innovation structure | 3 | 7 | 4 | 5 |
| Improved technical understanding/knowhow | 8 | 4 | 8 | 3 |
| Improved approach to R&D/Innovation | 7 | 6 | 8 | 3 |
| Better understanding of the recruitment of graduates | 9 | 2 | 9 | 0 |
| More skills in general | 7 | 6 | 6 | 4 |
| Greater willingness to access external expertise | 10 | 3 | 10 | 1 |
| Increase the number of employees | 1 | 8 | 8 | 5 |

*Company follow up*

The companies were also followed up four months after the end of the scheme. This was a short time lag between the first interviews and the follow up and subsequent studies will wait longer before reporting on any likely impacts of the scheme. The majority of the companies' product development cycles are longer than 6 months.

However, in terms of the absorptive capabilities of the firms, companies listed the following different types of outcomes

- Change in the way they cooperate with other companies
- Change in training plans
- Change in balance or composition of skills in the company
- More receptive to using university graduates/undergraduates
- Change in organisation of knowledge flow
- The formation of strategic alliances
- Greater willingness to access external expertise
- Greater willingness to look for more funding for R&D

Few companies would give a definitive 'yes' to changes as a consequence of the Shell Step project so far, however, in the future, they expected both hard and soft outcomes as a consequence of the scheme.

Nonetheless, a number of companies already recognise a change in soft outcomes which form part of a multiplier effect. They tend to relate to process and management innovation rather than product innovation and as such have long term effects on the sustainability of the company in terms of its knowledge and understanding of its own business processes.

All of the companies interviewed considered the project to have been of strategic importance to the company either already or in the future and half were already seeing the value. One of the barriers mentioned was that continuation of work needs revenue streams for funding so there is always a tension between selling existing products and concentrating on new developments.

**Overall findings:**
A good range of companies (size, sector, and stage of growth) was covered and a good selection of projects covering product, process and management innovation were chosen – although it was slightly skewed towards product innovation. The programme should not devalue the importance of process and management innovation in bringing economic rewards to users and as good business practice demonstrations to students.

The effects of the projects both now, and those expected in the future are promising, both in terms of the impact of the scheme and also the increased innovation and absorptive capability of the company. The biggest impact so far has been the greater willingness to access external expertise. This change can be linked to the innovative potential of the company and its ability to absorb knowledge and skills from other sources, particularly in this case from undergraduates. In the next section we have drawn together the findings and offered some thoughts for policy makers.

*Human capital and skills*
The general perception of high growth stemming from high tech businesses started by highly qualified entrepreneurial start-ups is not borne out by our sample. The formal skills and qualifications within the companies involved in Shell Step would appear to be low and although employing qualified scientists and engineers may be of importance to this set of companies, they are not actually doing it to any great extent. Also employing people with higher degrees is not considered important.

However, these businesses should be seen as 'high potential' in that they have a market or product niche that they are able to technically/flexibly satisfy. Also the motivation of applying to Shell Step, in most cases, was to access the skills and expertise of the undergraduate. This shows **a knowledge of capability needs**, even if they do not consider it necessary to have formally qualified scientists and engineers within the company structure. As a consequence of the scheme the companies are more receptive to using university graduates/undergraduates.

Policy implications: The use of university undergraduates is an effective way of increasing skills within an SME. These companies were not working in an academic context at all and yet, the willingness to participate and the apparent positive results of the scheme shows that Shell Step could change the perceptions of the companies' involved. Policy makers can use these results to raise awareness of the importance of new skills and and to support firms in building absorptive capability.

*Networking and knowledge flow*
Networking and knowledge flow is about capturing external and internal information of importance to the firm and using in as a strategic capability. The sample is aware of the importance of knowledge, with a high proportion of companies stressing the importance of the protection of that knowledge. This was balanced with an equal proportion showing an 'outward orientation' in the development of innovations emphasising the high importance of cooperating with others. Both internal and external knowledge resources are considered important factors by businesses in meeting the Shell Step project objectives.

However few companies indicate they are actually cooperating with external organisations. Also where interaction with external actors takes place, this is not done in a formalised manner. A number say they talk only informally to customers and others in the sector. Furthermore less than half are members of a trade or industry association.

Overall, the business principals have little appetite for collaboration/cooperation with other companies because the benefits are unclear whereas the disbenefits – eg the commercial intelligence risk –are quite clear. However, responses from the user businesses show that they are more likely to use external help in the future and changes in knowledge flow are being seen in a few of the companies as a consequence of the Shell Step placement, although this is at an early stage. The most likely change has been in making new contacts. Four of the companies report increased information flow from the suppliers. This is mainly due to the nature of the project set for the student which sometimes involved market research and contacting suppliers. There is little change in the amount of contact with customers, but this is already seen by the

companies as one of the most important ways of keeping up with new opportunities. Companies still report few links with universities and colleges before involvement in Shell Step and only 3 report an increase as a consequence of Shell Step.

Policy implications : Firms need not only to acquire information, but to understand it and process it effectively. This ties in with the need for appropriate human capital and skills in order for networking and knowledge flow to be effective. There has always been a resistance in firm's to sharing knowledge, however, Shell Step works and this may increase the long term inclinations of the companies to share knowledge and to network more effectively in the future. Policy maker's can use schemes like Shell Step in order to show case to SMEs, the benefits of collaboration and cooperation with other companies.

*Organisation, routines and organisational processes*
In seven of the companies interviewed there is somebody with specific responsibility for monitoring opportunities for technical innovation. However, in the firms that did not have formal monitoring systems in place, there was nevertheless an understanding of the need to monitor the business environment and most were very sensitive to market opportunities.

As mentioned in the section on networking, in most cases, market opportunities are identified through the Internet and the exchange of information with suppliers and customers. The links with universities and colleges, technology networks and monitoring services appear to play a more marginal role in these companies. The lack of monitoring through links with Universities and Colleges is perhaps interesting considering the firms' involvement with Shell Step. The students involved in the projects did increase the monitoring activities of the companies and a improve awareness of a need for better organisation and management.

Policy implications: The increase in organisation brought about by the Shell Step placements should be capitalised in terms of helping companies to continue to use the results of the projects and to embed them into the companies routines.

Learning processes
Learning processes can be found throughout these businesses. Innovation activity is continuously carried out in the majority of companies interviewed. Overall, in the last three years 12 of the 15 companies surveyed have introduced a new product or services and nine out of 15 have introduced new processes or continually upgrade their existing processes. This generates new knowledge through formalised activities and is therefore part of a learning process.

Seven of the companies employ staff from multinationals, and although the level of qualifications may be low, the input of external experience into the company from larger corporations is important as an informal learning mechanism. This can be in the form of inter-industry spillover. The programme appears to have responded to the skills failings recognised within firms and the students were seen to be responding to these failings. This indicates that the placements are taken seriously – in effect, recruiting skills missing from a management/technical team and being seen as 'equals' from the outset. This of course considerably helps with management 'buy in' and the seriousness with which they treat the outcomes and implementation.

Policy implications: In the long run a key policy influence on learning processes is through ensuring that graduates have the skills their companies will need in identifying and managing their internal assets, and in not only creating knowledge but using it within the firm. This is something that Shell Step does well.

Codification
The systematic documentation of information is an important element of absorptive capability. In the majority of cases management met regularly to discuss the company strategy and new products and services form part of this process. The process of suggestions is less widely used but is still present in over half of the companies interviewed. Only a small number of companies link this to some kind of financial reward.

However, all these companies defined projects for the Shell Step student and this was mainly achieved internally. The project ideas also came in the most part from an internal need and therefore devised in line with the company strategy. The programme seems to work best where the company has this specific project in mind. This also ensures management and employee 'buy in' to the STEP process and implementation of the results. The process is improved if specific objectives are set at the outset and used for monitoring progress and outcomes.

Overall, Shell Step is addressing issues in companies' capacities, which if poorly developed may hamper innovation. The firms involved in this scheme have been receptive to the students as have been able to identify real gaps where the students made a difference.

Also as part of the work and through the interviews, it became apparent that the culture of the company is an important factor in its receptiveness to the student, ideas and therefore its absorptive capabilities. Firms are generally suspicious of any 'funded' schemes and tend to see public sector measures as overheads. They engage in activities where there are clear and quick benefits to involvement, where they will see an immediate pay off. Shell Step fits this description well. The companies involved can easily put a value on being involved in this scheme (although the interviews took place too early for the companies to estimate return on investment).

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