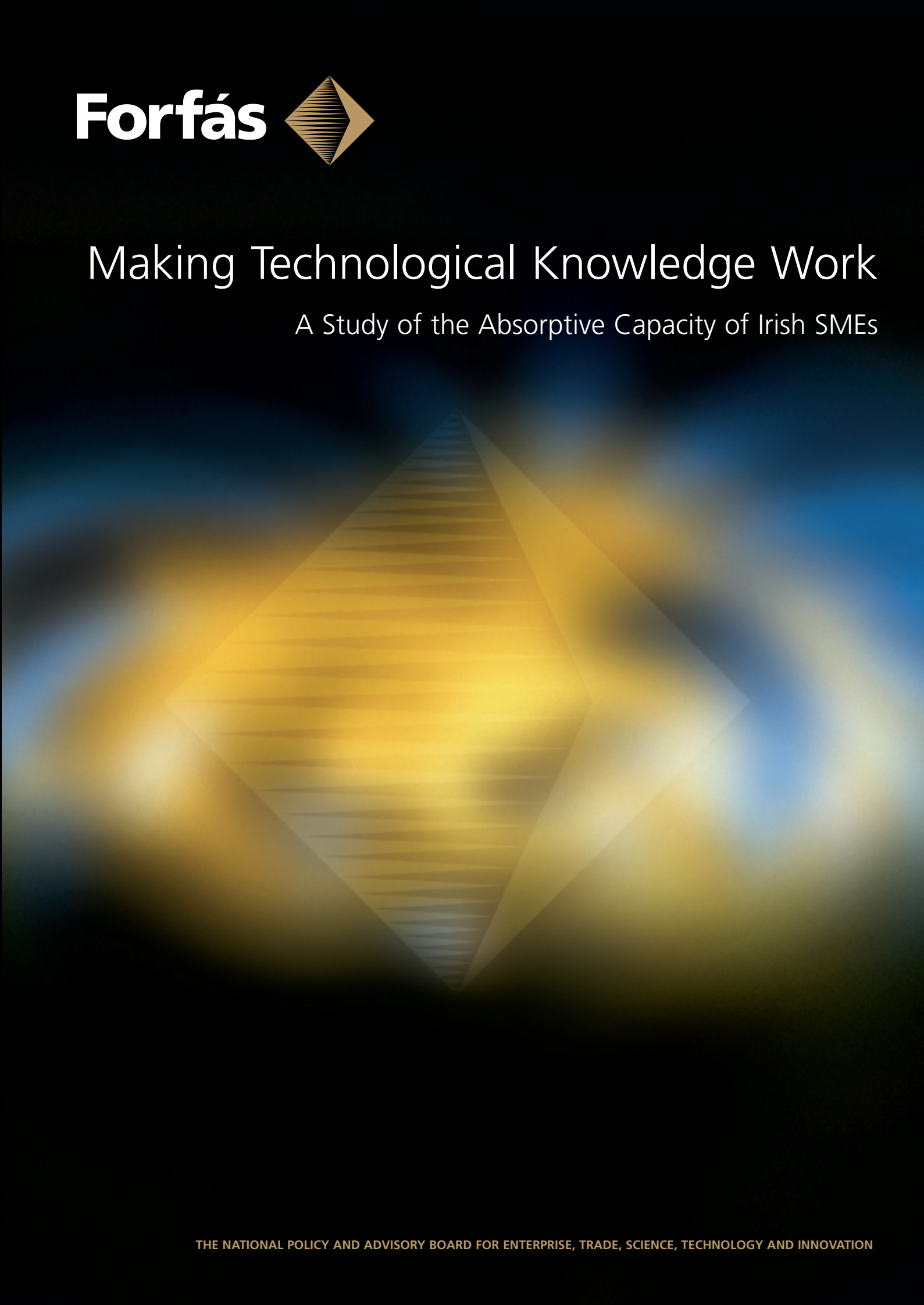
Forfás

Making Technological Knowledge Work

A Study of the Absorptive Capacity of Irish SMEs



THE NATIONAL POLICY AND ADVISORY BOARD FOR ENTERPRISE, TRADE, SCIENCE, TECHNOLOGY AND INNOVATION

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February 2005

Foreword

Increasingly, it is recognised that knowledge produced, needs to be managed and developed in society, not least in industry. It is uniquely companies that transform new and existing knowledge into jobs, money and economic growth. Their ability to absorb, generate and exploit knowledge is therefore critical to the national social and economic well being.

The National development Plan 2000 - 2006 has allocated €2.48billion to research and development. Such a significant of investment in research will generate a great deal of knowledge which will need to be made accessible to industry and utilised by companies.

Forfás commissioned Technopolis to carry out a study examining the capacity of Irish SMEs to absorb and use knowledge from outside the firm. The focus of the study was to identify areas which require strengthening ensuring that these firms have such 'absorptive capacity' and enable them to play a key role in developing the Irish economy. The unique contribution of this study was to define absorptive capacity in terms of a number of its components that can be identified, benchmarked and incorporated into policy instruments to help improve company performance.

This Forfás published report presents the results of the Technopolis study on the absorptive capacity of Irish SMEs.

Acknowledgement

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Executive Summary

Invention is an important but overrated source of innovation and wealth. Most of the knowledge that companies use in innovation comes from outside, so' absorptive capacity' – the ability of a firm to recognise the value of new, external information, assimilate it and apply it to commercial ends – is key to performance. The Irish environment, with a rapidly growing economy, expanding education and research systems and a rich variety of multinational companies, is especially rich in external knowledge, so the potential to gain advantage through absorptive capacity is especially great.

This study provides a basis for making policy to improve the absorptive capacity of Irish firms. It reviews available literature on absorptive capacity, examines relevant policy instruments in other countries, reports the results of a telephone survey of 123 Irish SMEs and of qualitative interviews with a further 15 and draws broad policy conclusions. It does not attempt to audit the repertoire of policy instruments currently used in Ireland.

While there has been a great deal of interest in 'absorptive capacity' since the term was introduced to the research literature in 1990, it is itself very poorly specified. Generally, the employment of technically qualified manpower, especially of R&D personnel, is used as a proxy measure. Our literature review focused on trying to understand what the **ingredients** of absorptive capacity are. Unless these are specified, it is hard to devise policies to improve it.

Purely from the literature, we can see five more or less distinct elements

- 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 (cognition)
- Codification

Companies tended to see technological innovation and the skills needed to undertake it as an important success factor. The keys to performing better than their competitors were to produce new products and services, improve personnel productivity and improve the efficiency of machinery and equipment. Improved technological understanding of products and process was a requirement in order to do this.

Respondents' innovation activities depended upon the employment of skilled people, especially graduates. Low-effort sources of information, like the Internet or trade fairs, were widely used to monitor opportunities, but there was much less use of continuous and specialised monitoring through networks, Third Level institutions or monitoring services. While new products and processes were often integrated into business planning, the human resources needed to implement the plan were rarely considered. There were few signs that companies had developed or systematised routines for identifying innovation opportunities or realising the value of external knowledge.

We analysed the responses from the interviews to see whether differences in behaviour were associated with success. Successful (growing) firms were more likely to be in the service sectors than manufacturing, did more product (but not process) innovation and had better qualified, more dedicated human resources for innovation. They had higher technological capabilities (in the sense of ability to adopt, adapt and change technology) than slower-growing firms, and therefore higher absorptive capacity. They tended to network more and were more likely to have received financial support for innovation. They used more formal or structured processes to capture and exploit innovation opportunities.

The evidence from the survey, then, provides a strong endorsement of the central messages of the literature about absorptive capacity. In particular, it underlines the importance of appropriate human resources and the benefits of deliberate management of innovation.

The more qualitative interviews showed that, while clearly there is significant innovation capability in the firms interviewed, there are also opportunities for wider, more skill-based and more systematic innovation. The most concerning feature of those interviewed was that innovation actions appeared often to be taking place in isolation from important external networks and knowledge, resulting in 'safe' incremental innovation, often through related-product diversification. Links with higher education were poor and relationships often characterised by mistrust. There appears to be regular contact between many of the businesses and EI, and funding is available for business growth and training, but there appears to be a missing element of awareness, mentoring and motivation that could be applied to businesses to build on the absorptive capacity present.

Our study shows that there certainly is some level of good practice within Irish industry, as regards absorptive capacity. But it also suggests a number of directions in which absorptive capacity needs improvement, especially in

- Recognising the relevance of external knowledge
- Increasing the employment of qualified scientists and engineers by indigenous companies
- Modernising and professionalising management
- Reducing firms' comparative isolation and by improving external linkages
- Accelerating the rate at which firms develop technology-networks.
- Helping firms to search more widely for knowledge
- Reducing their levels of perceived risk associated with innovation, through better information and access to knowledge

Where they exist, R&D and innovation functions appear to be organisationally isolated and often sub-critical. Half the firms said that they need external help to undertake almost any kind of technological innovation, including the adoption of externally produced turnkey technologies, confirming the perception that Ireland requires 'catching up' policies for absorptive capacity development in many if not all branches of industry. Existing policy measures are limited in this area. Little help is available for firms, which need to become more adventurous in their innovative activities, without at the same time going so far as to become involved with 'science push' activities. Here, Ireland is deficient not only in schemes but also in the knowledge infrastructure. This kind of intermediate knowledge development is not interesting for most HEIs: it is not their mission. Internationally, it is satisfied by

specialised Research Institutes, such as the Danish GTS Institutes, whose mission involved delivering ‘technological service’ to industry, especially SMEs.

Improving the capabilities of smaller firms with low technological capability can not be achieved simply by hanging up a sign advertising support, and waiting for companies to apply. A **proactive** approach is needed to

- Broaden awareness of innovation and recognising the value of external knowledge
- Develop human resources
- Increase networking
- Improve management organisation and routines
- Develop learning processes within companies

Contents

1 Introduction

In policy for Research, Technological Development and Innovation (RTDI), 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 massive scale elsewhere in society, not least in industry[1]. However, 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 well being.

This study focuses on the capacity of Irish SMEs to absorb and use knowledge from outside the firm. Ensuring that these firms have such 'absorptive capacity' is a key role for the Irish state. The unique contribution of this study is to define absorptive capacity not (as does most of the research literature) as an abstract quantity or as a 'black box' that somehow '**explains'** performance, but in terms of a number of its components that can be identifies, benchmarked and incorporated into policy instruments to help **improve** company performance.

Wesley Cohen and Daniel Levinthal introduced the idea of 'absorptive capacity' to the R&D and innovation literature in a landmark 1990 article[2]. They define it as "the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends."

According to Cohen and Levinthal, it is impossible to predict what the 'right' level of investment in absorptive capacity is for an individual firm. This depends on individual circumstances. Equally, the concept of absorptive capacity has not been developed in such a way that it is readily amenable to international benchmarking. The best we can do on this front is probably to compare proxies like the proportions of qualified scientists and engineers in business employment and other 'input' measures such as R&D-intensity.

Recent Irish history has involved very rapid 'catching up' with levels of wealth and technology prevalent elsewhere in the European Union and the OECD. This success has been achieved to a significant extent through attracting Foreign Direct Investment (FDI), which has allowed Ireland to use foreign multinationals as motors of growth and development, especially in electronics but to a growing extent also in other areas, notably the life science based industries. Indigenous industry has been significantly strengthened, and some strong niche players have emerged, which have enjoyed national and international success – especially, again, in electronics.

Exhibit 1 compares Business Expenditure on R&D (BERD) across the OECD, indicating the comparative weakness of the Irish effort. The absolute amount of BERD has, of course, been rising quite quickly because the economy was growing rapidly during the

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1 Michael Gibbons, Camilla Limoges, Helga Nowotny, Schwartzman, S., Scott P. and Trow, M., *The New Production of Knowledge*, London: Sage, 1994

2 Wesley M Cohen and Daniel A Levinthal, 'Absorptive capacity: a new perspective on learning and innovation,' *Administrative Science Quarterly*, Vol 35 (1), March 1990, pp128-152

period considered. But the growth in BERD is a bit slower than the growth in GNP, so on average production is not becoming any more knowledge-intensive.

Exhibit 1 Business expenditure on R&D as a percentage of GDP/GNP

	1993		1995		1997		1999		2001	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Australia	0.69	17	0.86	16	0.75	18	0.65	18	0.72	18
Belgium	1.23	10	1.23	10	1.34	9	1.40	8	1.45	9
Canada	0.90	14	1.01	13	1.01	14	1.02	15	1.08	14
Czech Rep.	0.88	16	0.66	17	0.73	19	0.78	17	0.79	17
Denmark	1.02	11	1.05	11	1.19	10	1.32	10	1.32	11
Finland	1.27	9	1.45	7	1.79	6	2.19	2	2.39	2
France	1.48	7	1.41	8	1.39	8	1.38	9	1.37	10
Germany	1.58	6	1.50	6	1.54	7	1.70	7	1.80	7
Greece	0.13	25	0.14	25	0.13	26	0.19	25	0.19	25
Hungary	0.32	22	0.32	22	0.30	23	0.28	24	0.36	22
Iceland	0.42	21	0.49	20	0.76	17	1.10	13	1.77	8
Ireland	**0.89**	**15**	**1.01**	**13**	**1.04**	**13**	**1.03**	**14**	**0.95**	**15**
Italy	0.60	18	0.53	18	0.52	20	0.51	19	0.56	19
Japan	1.90	2	1.94	2	2.04	2	2.08	3	2.11	3
Korea	1.84	4	1.84	4	1.95	3	1.76	6	1.96	5
Netherlands	0.99	12	1.04	12	1.11	12	1.14	12	1.13	13
New Zealand	0.31	24	0.26	24	0.31	22	0.31	22	0.31	23
Norway	0.93	13	0.97	15	0.93	15	0.92	16	0.92	16
Poland	0.32	22	0.27	23	0.28	24	0.31	22	0.24	24
Portugal	0.12	26	0.12	26	0.14	25	0.17	26	0.17	26
Slovak Rep.	0.51	19	0.53	18	0.83	16	0.42	21	0.44	21
Spain	0.44	20	0.39	21	0.40	21	0.46	20	0.52	20
Sweden	2.28	1	2.57	1	2.75	1	2.84	1	2.84	1
Switzerland	1.86	3	1.86	3	1.93	4	1.95	5	1.95	6
UK	1.42	8	1.30	9	1.18	11	1.25	11	1.21	12
United States	1.78	5	1.80	5	1.91	5	1.98	4	2.04	4
OECD Avg.	1.44		1.45		1.48		1.52		1.56	
EU Average	1.18		1.12		1.13		1.19		1.21	

***Source**: OECD Main Science Indicators*
***Note**: Irish figures are based on GNP; others on GDP. This reduces the effects of Irish-based multinationals' transfer pricing as a distorting factor*

Comparing **Exhibit 1** with **Exhibit 2** presents a bit of a puzzle, because **Exhibit 2** shows R&D employment as a proportion of total industry employment as stable, rising slightly in the same period. Presumably the difference between the expenditure and the employment pictures is caused by increased labour productivity in business as a whole. But while Irish BERD lies well below the OECD and EU averages, the number of R&D workers per 1000 lies between the corresponding averages (though these themselves are at about half the US or Japanese levels).

Exhibit 2 R&D workers per thousand in industry

	1991	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Australia	2.3	2.3	2.3	2.4	2.4	2.5 *b*	-
Austria	..	..	3.9	..	..	..	..
Belgium	3.6 *c,u*	5.4	6.0	6.3	6.2	6.7	6.8 *b,p*
Canada	3.2	5.1	4.7	4.6 *p*		..	..
Denmark	3.0*u*	4.3*u*	4.5*u*	5.1*u*	..	5.3*u*	..
Finland	3.2*u*	9.5*a,u*	10.7*u*	11.4*u*	12.2*u*	13.4*u*	..
France	3.8	4.8*a*	4.7	4.9	5.1	5.4*a*	..
Germany	4.9*a*	5.0	4.9*c*	5.5	5.5*c*	5.7	..
Greece	0.4*b*	0.6	..	0.7	..	..	..
Hungary	1.5*b*	1.1	1.1	1.2	1.4	1.4	1.5
Iceland	..	..	..	..	..	..	..
Ireland	**2.5*b***	**4.2**	**4.1*c***	**4.3**	**4.4*c***	**4.5**	**..**
Italy	1.8	1.7	1.7	1.6	1.6	..	..
Japan	7.5*l*	9.0	9.8	10.0	9.8	10.2	..
Korea	..	3.9	3.6	3.9	4.2	5.7	..
Luxembourg	..	..	..	..	6.8	..	..
Mexico	..	0.1	0.1*c*	0.1*c*	..	..	..
Netherlands	..	3.3	3.4	3.5	3.6	3.9	..
New Zealand	1.6	1.8	..	2.1	..	2.4*a*	..
Norway	5.2*u*	6.7*u*	..	6.8*u*	..	7.8*u*	..
Poland	..	0.9	0.8	0.8	0.8	0.8	..
Portugal	..	0.3	0.5*c*	0.6	0.7*b*	0.7*b*	..
Slovak Rep.	..	2.1*a*	1.7	1.6	1.5*b*	1.4*b*	1.3*b*
Spain	1.1	1.2	1.3	1.4	1.8	1.6	..
Sweden	4.9*m,u*	8.6*u*	..	9.0*u*	..	10.5*u*	..
Switzerland	..	..	..	..	5.4	..	..
Turkey	0.1	0.2*b*	0.2*b*	0.2*b*	0.2*b*	..	..
UK	4.0	4.1	4.5	4.5	4.2	4.5*a*	..
USA	9.0	9.6	9.9	10.1	10.2*p*	..	..
EU	3.3*a,b*	3.7*b*	3.9*b*	4.0*b*	4.1*b*	4.3*b,p*	..
Total OECD	5.0*a,b*	5.3*b*	5.5*b*	5.7*b*	5.7*b,p*	..	..

***Source**: OECD Main Science Indicators*

a) Break in series with previous year for which data is available.
b) Secretariat estimate or projection based on national sources.
c) National estimate or projection adjusted, if necessary, by the Secretariat to meet OECD norms.
d) Defence excluded (all or mostly).
e) National results adjusted by the Secretariat to meet OECD norms.
f) Including R&D in the social sciences and humanities.
g) Excluding R&D in the social sciences and humanities.
h) Federal or central government only.
i) Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF).
j) Excludes most or all capital expenditure.
k) Total intramural R&D expenditure instead of current intramural R&D expenditure.
l) Overestimated or based on overestimated data.
m) Underestimated or based on underestimated data.
n) Included elsewhere.
o) Includes other classes.
p) Provisional.
q) At current exchange rate and not at current purchasing power parities.
r) (note not currently used).
s) Unrevised breakdown not adding to the revised total.
t) Do not correspond exactly to the OECD recommendations.
u) University graduates instead of researchers.
v) The sum of the breakdown does not add to the total (see General Methodology).
w) Including extramural R&D expenditure.

Overall, Ireland spent only 1.39% of GDP on R&D in 2001, compared with the EU average of 1.93%. Some 65% of business expenditure on R&D in Ireland was incurred by foreign multinationals. In Electrical and Electronic Equipment, Instruments and Pharmaceuticals, Irish-based business (including the multinationals) spent between a quarter and a tenth as much on R&D as a proportion of their sales as the OECD average.[3] Behind the economic success story, therefore, lies a pattern of very uneven development and a need to strengthen the knowledge basis of the economy – not least against the background of wider European attempts to reach the ambitious knowledge and competitiveness goals set by the Council of Ministers in Lisbon and Barcelona. Strengthened absorptive capacity is a requirement if Ireland is to continue to catch up with and equal or surpass international levels of technology and adequately to exploit the presence of the multinationals.

The overall objective of our work here is to provide a basis for policymaking about absorptive capacity in Ireland. What we have therefore done in this study is to

- Review available literature on absorptive capacity, with the aim of achieving a more detailed understanding of what it absorptive capacity comprises. This is needed in order to operationalise policy for increasing the amount of it that firms possess
- Try to extend this understanding by looking at policy instruments that appear to promote absorptive capacity in a range of countries, since our experience in innovation policy is that policymakers often run ahead of the research literature in identifying and tackling problems in the innovation system
- Conduct a survey of Irish SMEs, in order to explore the extent to which they possess various characteristics of absorptive capacity, and how these link to their performance
- Undertake interviews and generate a number of case studies that aim to illuminate problems and potential in companies relating to absorptive capacity
- Generate policy conclusions

A key message from the conclusions is that, while the huge recent increase in national investment in R&D is likely to be an important contribution to national economic development, both realising the benefits of this investment (which focuses especially on ICT and biotechnology) and building on the great progress of the previous years across the whole economy requires renewed policy measures to build absorptive capacity.

[3] Figures are taken from the Enterprise Strategy Group report, Ahead of the Curve: Ireland's Place in the Global Economy, Dublin: Forfás, 2004

2 What do research and practice tell us about absorptive capacity?

This chapter provides theoretical context to our study of absorptive capacity in Irish SMEs, for Forfás, and uses the research literature and international policy practices as ways to understand the elements of absorptive capacity.

The terminology is unfortunate: 'absorptive capacity' sounds as if it is the complement of universities' research capabilities; as if research policy could focus on giving money to the scientists to make new knowledge while innovation policy could focus on ensuring that industry has the absorptive capacity to acquire and exploit the resulting ideas. This is not what Cohen and Levinthal meant. Their article, and much of the succeeding literature that uses the concept, both stress that absorptive capacity is part of firms' wider technological capabilities, and that successful innovation makes use of both new and existing knowledge (most of which does not come from universities). We need, therefore, in this chapter to discuss that context a little and to stress the central roles of imitation and re-use of the stock of existing knowledge in innovation.

Since innovation depends significantly on **existing** knowledge (often located outside the firm) as well as new knowledge. It follows that absorptive capacity is especially important as a way to take opportunities in environments that are rich in externalities. This is the case in Ireland, both because much of the economy is still 'catching up' in economic development and has therefore many opportunities to learn from others and because of the presence of many world-leading multinational companies and the considerable knowledge resource they represent.

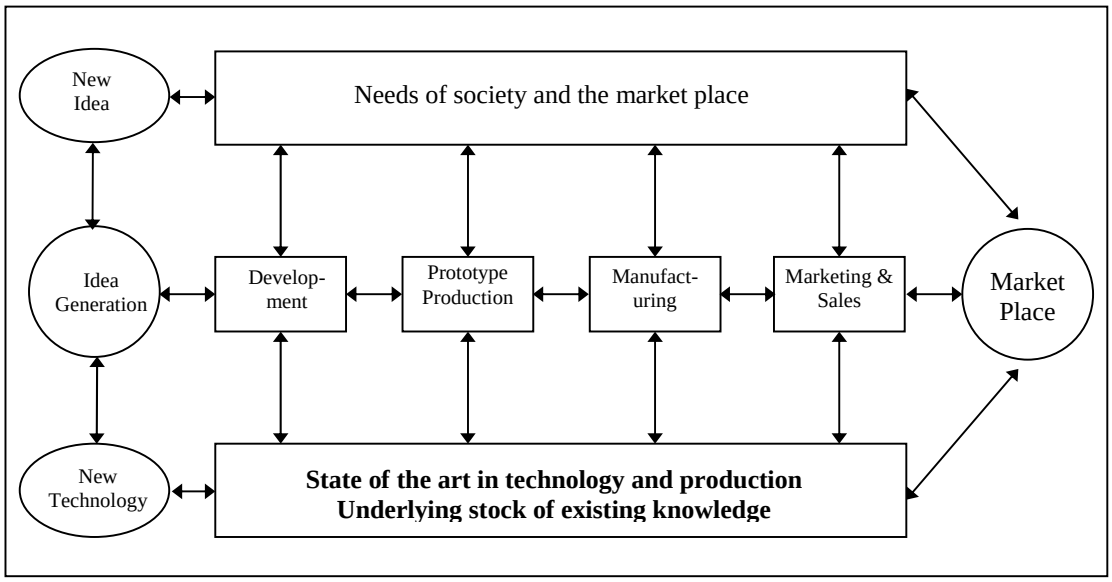
Given the limited resources allocated to this task, our review cannot be exhaustive. In order to try to ensure that we captured as up to date picture of the literature as possible, we adopted the tactic of focusing much of our attention on the DRUID conferences, where for the last few years' current research relating to innovation systems has been discussed by practitioners. This was complemented by a wider search through the literature focusing on 'absorptive capacity'. We are therefore reasonably confident that we have picked up most of the important things the literature has to say about absorptive capacity, though we are equally confident that our coverage of the available publications is not complete.

2.1 Where does knowledge for innovation come from?

For most of the post-War period, it was assumed that science in some way **caused** innovation. While there was never much empirical evidence for this so-called 'linear model of innovation', it was and is highly influential in policy discussions. In the current thinking, innovation is a much more complex process[4] (**Exhibit 3**) and innovation is seen as taking place in a complex system, where the **coupling** between science, technology, the marketplace and the other parts of the innovation system is important.

[4] Mowery, D.C. and Rosenberg, N., 'The Influence of Market Demand upon Innovation: A Critical Review of Some Recent Empirical Studies', *Research Policy*, April 1978

Exhibit 3 Modern 'Coupling' Model of Innovation



Source: *Mowery, D.C. and Rosenberg, N., 'The Influence of Market Demand upon Innovation: A Critical Review of Some Recent Empirical Studies', Research Policy, April 1978*

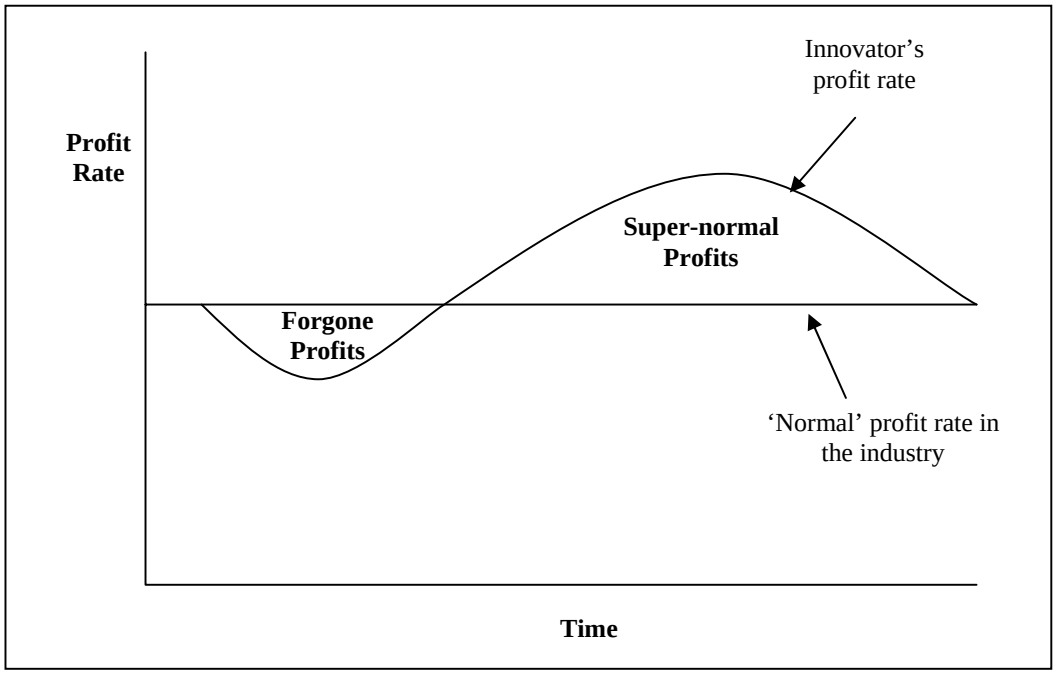
It can be argued that absorptive capacity is a distinct component of overall technological capabilities, based on the idea that creating new knowledge and using old knowledge require different skills. This runs counter to the experience of most research workers and, indeed, to Cohen and Levinthal's 1989 arguments about learning being one of the two faces of R&D. Of course, there may be differences of **emphasis**, depending on how important internally generated new knowledge is, compared with new or existing external knowledge, but in economic terms, companies should be indifferent to whether they use new or old, internally- or externally-generated knowledge. They are in business for money.

The preoccupation of the linear model is with the link between the **flow** of new knowledge and economic innovation. In the new view, the **stock** of existing knowledge indicated at the bottom of **Exhibit 3** is very important. The vast majority of the knowledge used in any innovation comes out of this stock, and is not created afresh in the project that gives rise to the innovation. Thus, in product development, considerable efforts are devoted to monitoring competitors' products and to reverse engineering – both as a source of ideas and in order to benchmark the company's own processes. Important parts of the knowledge stock can be very old, as was shown in the TRACES and HINDSIGHT[5] projects, which tracked the movement of knowledge elements respectively from applied and basic research into industrial practice across very long periods of time.

[5] Illinois Institute of Technology, 1969, *Technology in Retrospect and Critical Events in Science (TRACES: A report to the National Science Foundation)* , NSF Contract C535; Office of the Director of Defense Research and Engineering, *Project Hindsight - Final Report,* National Technical Information Service, 1967

The importance of **existing** knowledge in explaining the economic importance of innovation is also clear from the conventional economists' way (at least, post-Schumpeter) of explaining the incentives for innovation. By creating a temporary advantage, an innovator forces competitors to react – often in creative ways involving improvements and 'innovating around' the first innovator's design, rather than through simple copying. In this way, innovations give rise to changes in the economy, which may be several times larger than the effect on the original innovator.[6] **Exhibit 4** shows the conventional representation of the effects of successful innovation on the entrepreneur's profit rate. Initially, profits drop below the industry norm, as the entrepreneur pays the investment costs of innovation. Success of the innovation allows the entrepreneur to earn super-normal profits for a period by monopolising the innovation. These profits are then competed away by the innovative and imitative activities of other entrepreneurs, who tend to use much of the same knowledge stock as the original innovator.

Exhibit 4 Innovation and Profits



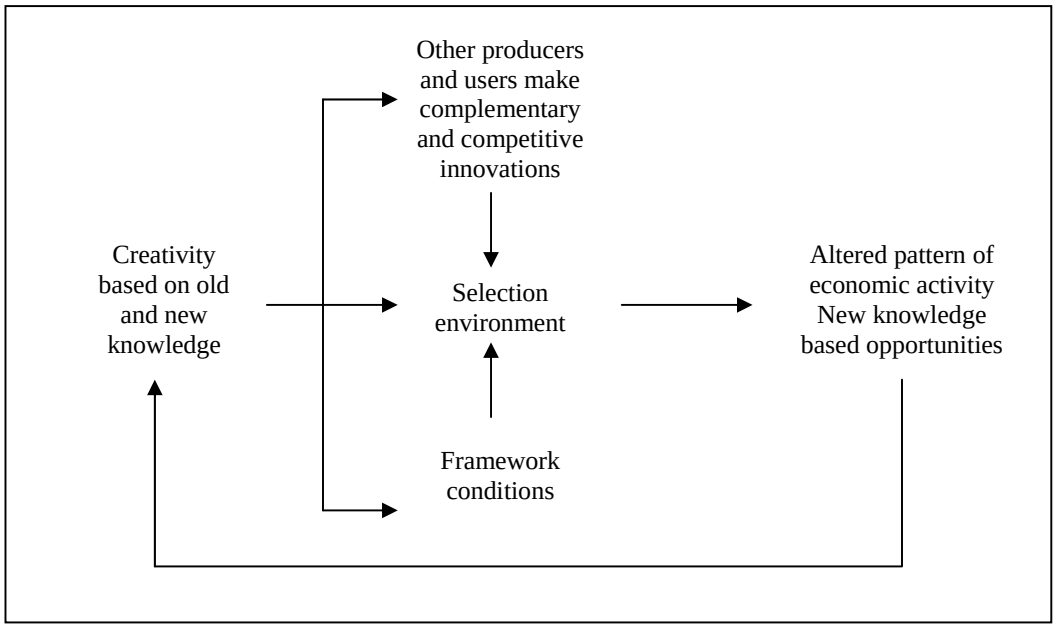
However, it is often only in this kind of simple theoretical exposition that a difference between original and imitative innovation is clear. A normal pattern is for an industry to experience a continuous sequence of innovations. Whether we describe these as innovations or – recognising their common but developing knowledge base –'creative imitations' matters only in so far as 'imitation' has a bad press. **Imitation is perhaps *the* central fact about innovation and economic development under capitalism.**

Innovation and imitation drive growth because there is constant competition to improve. Unlike in the neo-classical models, where technological change is seen as external to the economic system so that equilibria tend to develop, the now orthodox innovation

[6] R Brainard, C Leedman and J Lumbers, *Science and Technology Policy Outlook*, Paris: OECD, 1988

system approach sees the constant evolution of technology as **internal** to the system. Each change in technology creates a new set of economic and technical opportunities, under which economic actors compete to create advantage, so that innovation constantly triggers new innovation (**Exhibit 5**). This means that firms constantly have to learn in order to survive, let alone prosper. The ability to absorb external innovations and knowledge is not optional but is central to this learning process.

Exhibit 5 Evolutionary View of Innovation in Innovation Systems



***Source**: While the diagram is our own, it was inspired by JS Metcalfe, 'Co-Evolution of Systems of Innovation,' paper presented at the Volkswagen Foundation Conference, Prospects and Challenges for Research and Innovation, Berlin, 8-9 June 2000, CRIC, Manchester University 2000*

There is now a large body of survey data about OECD firms, which shows that their main sources of technology are internal knowledge and other firms. Public sector research accounts for a very small share of their important knowledge inputs for innovation. **Exhibit 6** is based on 12 EU countries' responses (the 15 states, minus Ireland, UK and Luxembourg, whose surveys were conducted later than the rest) to the third Community Innovation Survey, analysing the responses of companies that had introduced product and/or process innovations within the previous three years. It shows clearly that the use of external information as an important input to innovation grows with firm size, as also does the employment of graduates. Universities are important sources of information for innovation among only 4% of the industrial firms and 6% of the service firms, which had introduced innovations within the previous three years, even though a little over a third of these innovating firms had some sort of innovation co-operation with universities or HEIs. (Clearly, there are other reasons than only directly applicable new knowledge why companies enter such arrangements.) Innovating companies were more likely to employ graduates than non-innovators.

The equivalent UK survey has been analysed[7] in more detail. There is a clear link between innovativeness and openness to working internationally and with many partners. Those companies with the highest expenditures on innovation were also those with the highest number of external relationships providing information important to innovation. They were also the most likely to make best use of links to the higher education sector. The analysis also shows clearly that companies, which employ graduates are more likely to be innovators and to work in international markets. Where the graduates were qualified scientists or engineers, the companies were even more likely to be innovators. Its authors argue that this is a significant indicator of one of the indirect effects of universities on innovation: specifically, increasing the absorptive capacity of companies.

Exhibit 6 Main Sources of Information for Innovation in the EU, 1998-2000

	Industry					Services				
	Enterprises with innovation activity (*Absolute figures*)	Percentage of enterprises with innovation activity indicating that selected sources were of high importance				Enterprises with innovation activity (*Absolute figures*)	Percentage of enterprises with innovation activity indicating that selected sources were of high importance			
		All	Small	Med.	Large		All	Small	Med.	Large
Within the enterprise	47 663	37	32	40	70	28 638	40	37	41	69
Other enterprises within the group	8 776	7	3	10	28	9 662	13	9	23	38
Suppliers	25 336	19	19	17	29	14 014	20	19	19	29
Customers	34 456	27	22	32	51	22 079	31	32	25	37
Competitors	13 801	11	9	13	21	9 978	14	14	13	22
Universities, HEIs	5 122	4	3	4	11	4 269	6	6	6	6
Govt./ non-profit research institutes	3 491	3	2	3	7	2 098	3	3	4	3
Conferences, meetings, journals	11 399	9	8	9	15	10 660	15	15	15	18
Fairs and exhibitions	22 697	17	17	18	20	9 956	14	15	9	10

***Source**: Paul Crowley, Sources and resources for EU innovation, Statistics in Focus: Science and Technology, Theme 9-5/2004*

[7] Bruce Tether and Peter Swann, 'Sourcing Science: The use by industry of the science base for innovation; evidence from the UK's innovation survey,' CRIC, University of Manchester and UMIST, 8 August 2003 (mimeo)

Frenz, Michie and Oughton, also analysing the UK CIS3 data, conclude[8] that innovativeness is related to firms'

- Cooperativeness, both in working with universities and with other companies
- Employment of skilled personnel
- Spending on R&D
- Investments in equipment

A weakness of the innovation surveys is that their unit of analysis is the firm. Since SMEs form a large numerical majority of companies in all countries, this means that the picture the innovation surveys paint is primarily one of how SMEs behave. Were the responses weighted by the economic importance of the respondents, the picture would in certain respects change dramatically. Arundel, van de Paal and Soete showed in the ground-breaking PACE study[9] of large companies' use of R&D in innovation that these companies – which, though few in number, account for a big proportion of economic activity – that their use of the knowledge infrastructure as a source of ideas is much more intensive.

2.2 What is 'absorptive capacity'?

Absorptive capacity is a mixture of cognition and capacities. Cohen and Levinthal argue that because most innovation results from borrowing rather than invention, "the ability to exploit external knowledge is … a critical component of innovative capabilities." Absorptive capacity can be generated as a by-product either of companies' R&D or their manufacturing efforts, or more directly through staff training. They appeal to the cognitive and behavioural literatures on learning to explain absorptive capacity. These suggest that, in effect, prior knowledge gives the conceptual framework or frame of reference needed to understand new knowledge – the complementary observation to the well-known 'learning paradox': namely, that it is only on the basis of having learnt something that we can know what it is we need to learn. (Or, to put it in the terms of our earlier discussion, we need to understand some existing knowledge in order to know what to do with knowledge that is either new to the firm or new to the world.)

Individuals in firms may act as 'gatekeepers' to external knowledge, but they need to be embedded in appropriate structures and routines. Cohen and Levinthal argue that "A firm's absorptive capacity is not… simply the sum of the absorptive capacities of its employees, and it is therefore useful to consider what aspects of absorptive capacity are distinctly organisational." Active networking is needed both within the organisation and between it and external knowledge sources. "To integrate certain classes of complex and sophisticated technological knowledge into the firm's activities, the firm requires an existing internal staff of technologists and scientists who are both competent in their fields and are familiar with the firm's idiosyncratic needs, organisational procedures, routines, complementary capabilities and extramural relationships." Crucially, they must be coupled to the problems and challenges where innovation is needed.

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[8] Marion Frenz, Jonathan Michie and Christine Oughton, 'Co-operation and innovation: evidence from the Community Innovation Survey,' paper presented at the Schumpeter Conference, University of Bocconi, 2004

[9] A Arundel, G van de Paal and L Soete, *Pace Report: Innovation Strategies of Europe's Largest Firms: Results of the PACE Survey for Information Sources, Public Research, Protection of Innovations and Government Programmes*, Final Report, Maastricht: MERIT, University of Limburg, 1995

Cohen and Levinthal reach a new conclusion about spillovers from R&D. Traditionally, leakage or spillover is considered to be a reason why companies do not invest in R&D: a lot of the information they obtain through R&D would benefit their competitors; and they would have difficulty in generating a competitive edge by investing in R&D. Cohen and Levinthal's argument implies that, where there are a lot of knowledge spillovers ('externalities') available from others' activities, it makes sense to exploit them by investing in absorptive capacity. In so far as such spillover is enhanced by proximity, it adds a further aspect to the benefits of clustering and industrial districts.

In general, the literature that uses the concept of absorptive capacity is disappointing as a guide to understanding what absorptive capacity **is**. Lane, Koka and Pathak have reviewed 189 papers that cite Cohen and Levinthal's 1990 article, and conclude[10]

> *The strength of this literature is that its fundamental concepts continue to resonate with researchers interested in a wide range of organisational phenomena. It has made especially noteworthy contributions to research on knowledge management, organizational learning, and alliances. The … literature sees absorptive capacity as a strategically valuable capability because it is a path dependent, firm-specific, and socially embedded means to use other firms' knowledge to create competitive advantage. Furthermore, well developed absorptive capacity lowers the transaction costs of contracting for knowledge-intensive products or services.*
>
> *Three major shortcomings of this literature are limited attempts to revise the definition of absorptive capacity, little attention to the actual processes underlying absorptive capacity, and few attempts to measure it outside of the R&D context. We believe that these problems are interrelated. Absorptive capacity is a complex construct which is difficult to operationalise. The first dimension of absorptive capacity, ability to identify and value external knowledge, is the easiest to measure for large sample cross sectional studies as it is the most heavily dependent on a firm's stocks of prior knowledge. The other two dimensions (the abilities to assimilate and to commercially apply external knowledge) are fundamentally process oriented and thus not readily measurable by publicly available archival data. Furthermore, even within the first dimension, there is no consensus among researchers on how to measure it. Each study that measures this tends to do so using its own unique operationalisation.*

R&D data are often used as proxies for absorptive capacity simply because they exist as a statistical category. In the empirical section of their 1990 paper, Cohen and Levinthal themselves use firm R&D data as proxies for absorptive capacity, even though their paper begins by making a much wider claim about the relation between innovative capacity and **innovation**. Were they writing today, they might have had access to newer surveys, which try to measure innovative activities rather than just R&D, but these data began to be collected seriously only after their paper was published, notably in Europe through the Community Innovation Survey. Similarly, their very good paper published the previous year, which points out that R&D has two 'faces' – the learning

[10] Peter Lane, Belaji Koka and Seemantini Pathak, 'A thematic analysis and critical assessment of absorptive capacity research,' *Academy of Management Proceedings*, 2002 BPS:M1

face, which acquires and absorbs technology; and the innovative face, which seeks and applies new knowledge[11] – suffers from over-focus on formal R&D.

For the most part, the research and innovation literature treats 'absorptive capacity' as a black box. Purely from the literature, we can 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 (cognition)
- Codification

Taken together, these give us a view of the firm's absorptive capacities that lets us represent the successful firm as in constant change: searching for knowledge and opportunities; constantly adapting itself to changing conditions; a creature adapted to survive and flourish in the evolutionary world of **Exhibit 5**.

2.2.1 Human capital

Conventionally, numbers of qualified scientists and engineers in firms are seen as the proxy measure of absorptive capacity. Narula argues that the core of absorptive capacity is human capital[12]. In a study of 577 companies across 7 EU countries, Knudsen, Dalum and Villumsen[13] 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. They found that having a high share of R&D staff and a high proportion of graduates among the overall staff both correlated with a high rate of product innovation. 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. Using data on firm survival and growth, Laursen, Mahnke and Vejrup-Hansen[14] showed not only that more highly qualified staff promoted firm growth but that **relevantly** qualified staff did so to an even greater extent. Specific prior knowledge is better than general knowledge for learning.

The evidence for the Third Community Innovation Survey discussed above also supports the idea that human capital is a key driver of innovation.

2.2.2 Networking

Outside the mainstream innovation discussion, in the research evaluation literature, Bozeman and Rogers[15] have coined the rather useful term 'Knowledge Value

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11 W Cohen and D Levinthal, 'Innovation and learning; the two faces of R&D,' *Economic Journal*, Vol 99, 1989, pp 569 - 596

12 Narula, 2004

13 Mette Præst Knudsen, Bent Dalum and Gert Villumsen, 'Two faces of absorptive capacity creation: access and utilisation of knowledge, DRUID Conference, Aalborg June 2001

14 Keld Laursen, Volker Mehnke and Per Vejrup-Hansen, 'firm growth from a knowledge structre perspective,' DRUID Working Paper 99-11, Copenhagen Business School, 19909

15 Barry Bozeman and Juan Rogers, 'A churn model of scientific knowledge: Internet researchers as a knowledge value collective,' *Research Policy*, Vol 31, 2002, pp 769 - 794

Collectives' (KVCs), 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. Motives for membership of a KVC seem not to be wholly economic – and can include factors such as a desire to 'play' within groups of individuals with similar interests as well as the more obvious resource-based motivations, such as access to infrastructures, building skills and solving technical problems. These need not all know, or even know of, each other. But, in effect, we can think of KVCs as being building blocks of innovation systems, and an ambition of policy for absorptive capacity would be to foster the growth of such collectives.

Nielsen's study of changes in co-operation between companies and institutions in the knowledge infrastructure showed, first, that companies with 50 or more employees were more likely to co-operate and, second, that for companies both smaller and larger than 50 employees, having at least two graduates among the employees increase the likelihood of co-operation.[16] Reviewing these findings, Lundvall argues that this provides a strong case for 'ice breaker' programmes, making it attractive for firms to hire an academically qualified person. He also notes evidence that the proportion of graduates among company employees is related to the use of new management techniques and to the rate of new product innovation.[17]

Laursen and Salter show, using Community Innovation Survey data for the UK, that it is larger firms and firms with a higher proportion of graduates and researchers that make greater use of universities.[18] These findings are repeated in various surveys all over the recent innovation literature. Laursen and Salter, however, do not only ask the **structural** questions ('what aspects of firm structure predict their use of universities) but also consider whether different styles of management effect use of universities. Their analysis shows, not surprisingly, that companies with 'open' management styles that encourage collaboration with others also make greater use of universities.

2.2.3 Organisation and routines

Teece (**Exhibit 7**) suggests that other elements are important – not least the organisation and processes within which the firm's human capital is situated and distinguishing between know-how embodied in people, routines/organisation and other kinds of codified know-how.

[16] P Nielsen, Personale og fornyelse; Menneskelige ressourcer I den nationale innovationssystem, DISKO Project Report No 7, Copenhagen: Erhvervsudvicklingsrådet, 1999

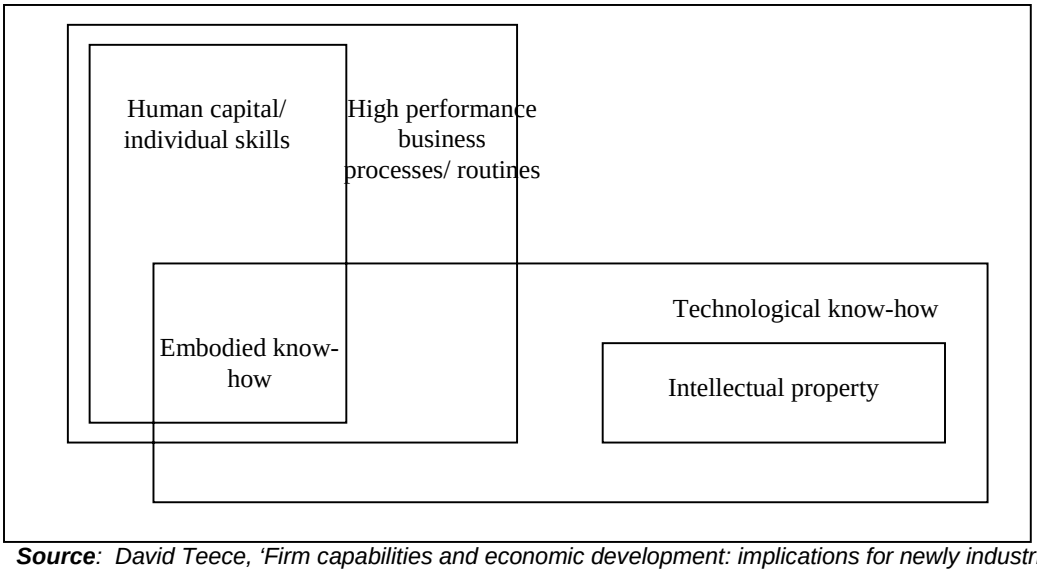
[17] Bengt-Åke Lundvall, 'The university in the learning economy,' DRUID Working Paper No 02-06, Copenhagen BusinessSchool, 2002

[18] Keld Laursen and Ammon Salter, 'Searching high and low; What types of firms use universities as a source of innovation?, DRUID Working Paper No 03-16, Copenhagen Business School, 2003

Teece[19] is unusual in the innovation literature in focusing on organisation and routines. He 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

Exhibit 7 The Firm's Industrial Knowledge Assets



***Source**: David Teece, 'Firm capabilities and economic development: implications for newly industrialising countries,' in Linsu Kim and Richard R Nelson (eds), Technology, Learning and Innovation, Cambridge University Press, 2000*

An important role of organisation is to span the limits' of individuals' ability to know. "The world system of knowledge is far from complete, and the knowledge possessed by – or even accessible to – any individual is a very small proportion of that world system. Nobody knows how a Boeing 737 works; and nobody knows how the Boeing Company works."[20] Organisationally knowing and improving these things is a key function of the Boeing Company itself.

Ducatel draws the following wider conclusions from the apparent success of these newer forms of work organisation

[19] David Teece, 'Firm capabilities and economic development: implications for newly industrialising countries,' in Linsu Kim and Richard R Nelson (eds), Technology, *Learning and Innovation*, Cambridge University Press, 2000

[20] Brian Loasby, 'Industrial dynamics: why connections matter,' DRUID Working Paper No 01-09, Copenhagen Business School, 2001

1 The fundamental point in the knowledge economy is organisational learning, which is a social process and depends upon the application of appropriate management practices
2 By implication, skill development does not merely take place at the individual level but amongst groups, a fact which many training programmes still seem to ignore
3 Knowledge creation and transfer takes place in a wide variety of ways and places within the organisation - not just in formally recognised settings such as engineering departments, labs and classrooms or amongst a few designated knowledge workers
4 It is possible, necessary even, to devise techniques to capture and/or mobilise the vast amount of tacit knowledge which is currently under utilised in the informal routines and expertise of the workforce[21]

2.2.4 Learning processes

Absorptive capacity is exploited in various kinds of learning processes.[22]

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 on repetitively the same kind of activities.
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'.

Indeed, if the firm willing to *learn* must possess some degree of appropriability accumulated through previous learning processes, it must not be implied that such learning processes have been accumulated through R&D activities. Therefore in the case of SMEs, it is important to extend the analysis to sources of knowledge additional to internal R&D activity and acknowledge the importance of other sources of learning.

[21] Ken Ducatel, Learning and skills in the knowledge economy, DRUID Working Paper No 98-2, Copenhagen Business School, 1998

[22] F. Malerba, Learning by Firms and Incremental Technical Change, *Economic Journal*, 102/1992, pp.845-859

Lundvall and Johnson[23] have suggested that knowledge can be sub-divided into four types

- Know what - which involves the transfer of codified information as facts
- Know why - which involves understanding basic principles, rules and ideas
- Know how - which involves direct experience
- Know who - which requires direct contact between individuals, the ability to communicate, form relations of trust and so on

These four types differ in respect of how easily they can be transferred from one application to another and/or from one group or place to another. Generally, 'know what' and to some extent 'know-why' knowledge can be more readily formalised, written down or reproduced as codified information. By contrast know-how and know who types of knowledge are more socially embedded. They are acquired in social contexts such as the work place, or in clubs and associations, conferences or in real-live market places. This is because a large proportion of these forms of knowledge is 'tacit' - which means it is either not yet articulated or else it cannot be written down. It has to be acquired either by experience or direct interpersonal contacts.

2.2.5 Codification

Like many writers on innovation, Teece emphasises the importance of codification of such tacit knowledge, as far as this is possible. Only when knowledge is transformed from being tacit and personal to being 'codified' (written down in a systematic way) can it be systematically and scientifically developed or adequately communicated. (This is the sense in which 'technology' is 'the scientific study of the practical or industrial arts'[24]) Creating understanding in this formal sense is one important source of innovation. Teece, again: "understanding of processes, both in production and in management, is the key to process improvement. In short, an organisation cannot improve what it does not understand."[25] However, it seems that in reality innovation – especially incremental innovation – involves a considerable element of tacit as well as codified knowledge.[26] This can mean that some innovations are not portable between companies: what works in the context of one set of tacit knowledge and internal processes may not work in another. More generally, whether in technical change or even in the reality of doing scientific experiments, codified knowledge may only be used through recourse to tacit knowledge.[27] and may involve significant complementary investments. It is therefore as wrong, in many respects, to regard scientific results as 'public goods' any more than is technology.[28]

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23 B Lundvall and B Johnson, 'The learning economy,' *Journal of Industrial Studies*, 1 (2), 1994

24 *Oxford English Dictionary*

25 Teece, 2000, p198

26 B Johnson and B Lundvall, 'Why all this fuss about codified and tacit knowledge?' paper presented at DRUID Conference, January 18-20 2001, Copenhagen; J Senker, 'Tacit knowledge and models of innovation,' *Industrial and Corporate Change,* 4(2), 1995

27 F Belussi and L Pilotti, 'Learning and innovation by networking wthin the Italian industrial districts: the development of an explorative analytical model,' 4th international seminar on Technological Development in Industrial Networks, Urbino, 7-8 April 2000

28 Michel Callon, "Is Science a Public Good?" *Science, Technology and Human Values*, 19, 1994, pp 395-424

If, as the literature suggests, we need to understand 'absorptive capacity' in a rather broad sense, as relating to the set of capabilities and relationships that enable firms to use knowledge to innovate, then we need to pay much more attention than the mainstream economics and innovation literatures do to how organisations learn, and how they need to organise in order to do the continuous learning that the market requires of them. Most of the practices used in the past 10- 20 years to try to change firms into 'learning organisations' involve changing practices and organisation so that "inventing new knowledge is not a specialised activity… it is a way of behaving in which everyone is a knowledge worker."[29] Innovation and the exercise of absorptive capacity need to become more or less routine internal processes rather than occasional adventures, so that firms are continuously adjusting and seeking advantage in the competitive process we sketched in **Exhibit 5**. This very much underscores the point that absorptive capacity is not limited to the R&D function but is a much wider characteristic of the firm, relating to its innovation capabilities as a whole. This is clear whether we consider the various Japanese production practices (just-in-time, continuous improvement, quality circles) that have been widely imitated over the past few years, the 'Business Process Re-engineering' wave of the second half of the 1990s[30] or the High Performance Workplace practices that Kling shows are associated with increased productivity[31].

2.3 Absorptive capacity and 'catching up'

Especially since 1950, there has been a clear pattern of convergence among the developed economies in total factor productivity and in labour productivity.[32] This is generally ascribed to their ability to operate at or near the scientific and technological frontier. There is more to this than R&D, because these economies' spend on R&D/GDP varies by two or more percentage points. But there is a huge gap in both absolute and relative spending on R&D between these countries and developing nations, as well as in factor productivity and per capita incomes. Closing this gap is not a passive process.[33] Among other things, this depends on the rate of investment in R&D activities by the follower countries.[34]

Until the late 1960s, economists assumed that technology was developed in the advanced countries and 'transferred' between countries in the form of capital goods. In the neo-classical approach, technology transfers are assumed to be smooth and costless - essentially because technology is not theorised in neo-classical economics. Technology would therefore automatically be acquired in the course of capital accumulation. Subsequently, a substantial literature has grown up which describes the realities of technology transfer. It points out

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29 K Nonaka, 'The knowledge creating company,' *Harvard Business Review*, Nov-Dec 1991

30 M Hammer and J Champey, *Re-engineering the corporation – a manifesto for business revolution*, London: Nicholas Brealey Publishing, 1993

31 Jeffrey King, 'High performance work systems and firm performance,' Montthly Labor Review, May 1995

32 E. Woolf, 'Technology, capital accumulation and long-run growth,' in J Fagerberg, B Verspagen and N von Tunzelmann (eds), *The Dynamics of Technology, Trade and Growth*, Aldershot: Edward Elgar: 1994

33 Martin Bell and Michael Albu, 'Knowledge systems and technological dynamism in industrial clusters in developing countries,' *World Development*, No 9, 1999, pp 1715 - 1734

34 Jan Fagerberg, 'A technology-gap approach to why growth rates differ,' in Christopher Freeman (ed) *Output Measurement in Science and Technology*, Amsterdam: Elsevier, 1987

- The role of learning
- The fact that any particular technology embodies assumptions about the environment in which it will be used
- That considerable innovative activity is required in order to make use of transferred technology

Starting with the neo-classical idea of simple technology transfer, a tradition of 'technology gap' analysis has arisen to investigate the differences between 'leader' and 'follower' nations. The idea is that in leader economies the growth of output depends on the rate at which the scientific/technological frontier moves. In follower economies, it is determined by the speed at which they adopt and adapt technologies developed by the leaders. Catching up is, in important respects, thought to be easier than moving ahead of other developed nations. In the catching up process, the 'gap' with the state of technology in leader countries helps define the capabilities that are needed and the directions in which resources should be allocated.

Successful strategies for closing the gap have focused on creating technological capabilities in industry. The approach taken in the SE Asian 'Tiger' economies in the 1960s and 1970s was to combine massive capital investment with deliberate 'reverse engineering' and experimentation in selected branches of industry. While the research and education systems were important producers of qualified personnel, they do not appear to have played a direct role in industrial development.[35] The Mercosur countries provide a stark contrast. While they also made significant investments in foreign technology during the same period as the 'Tigers,' a similar investment in using R&D for learning was not made, and the contribution made by foreign technology to development was correspondingly lower.[36]

Since the development of technological capabilities during catch-up is a learning process, we would expect there to be stages or levels of learning. Thus, Schnarr[37] has proposed a staged description of imitative product development at the firm level

- Duplicative imitations, of two kinds
  - Counterfeits – illegal copies branded as the original products
  - Knockoffs – (generally) legal copies which make no pretence of being the original, but which sell under their own brands at lower prices
- Design copies – mimic the style of the brand leader, but introduce unique engineering specifications
- Creative adaptations – are inspired by existing products, but differ from them
- Technological leapfrogging – where a latecomer uses more recent or more appropriate technology to improve on the original product concept
- Adaptation to another industry – where technology from one branch is reapplied in another

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35 Linsu Kim and Richard R Nelson (eds), *Technology, Learning and Innovation: Experiences of Newly Industrialising Countries*, Cambridge University Press, 2000

36 José Eduardo Cassiolato and Helene Maria Martins Lastres, 'Local systems of innovation in Mercosur countries,' *Industry and Innovation,* Vol 7 No 1, 2000, pp 33 - 53

37 Stephen P Schnaar, *Managing imitation strategy: How later entrants seize markets from pioneers*, New York: Free Press, 1994

The interest of Schnaar's description is that it focuses on the use of existing products and processes as a 'school' in building up technological and business capabilities. The firm's internal development and design capabilities grow as it moves between successive stages, but there is no role for research. On the basis of the East Asian experience, at least, successful firms in developing economies may go through a kind of 'reverse product cycle.'[38] They begin with simple assembly processes but gradually and systematically accumulate the capability to modify, design and build their own product and process technologies. Customers play a major part in this cycle, which proceeds through successively higher value-added forms of production.

Bell offers a four stage, firm level analysis of technological and absorptive capacities needed by manufacturing firms at different stages in development (**Exhibit 8**). This clearly illustrates the importance of developing practical, 'lower level' capabilities first, and building up to research capabilities later on. Others[39] have developed Bell's scheme further, but it then becomes very industry- and process-specific.

[38] Michael G Hobday, 'Export-led technology development in the four Dragons: the case of electronics,' *Development and Change*, Vol 25 No 2, 1994

[39] See for example Paulo N Figueredo, 'Learning, capability accumulation and firms' differences: evidence from latecomer steel, *Industrial and Corporate Change*, Vol 12 No 3, 2003

Exhibit 8 Knowledge-Based Capabilities and Competitiveness: Broad Profiles Required at Different Stages of Technological Development

TYPES OF KNOWLEDGE-BASED CAPABILITY	'STAGES' OF TECHNOLOGICAL DEVELOPMENT			
	Acquisition and Assimilation of imported technologies	**Technology deepening and upgrading**	**Closing in on the International Technological Frontier**	**Generating 'core' Advances at International Frontiers**
	Profile 1	**Profile 2**	**Profile 3**	**Profile 4**
Knowledge and skills for acquiring, using and operating technologies at rising levels of complexity, productivity and quality	***	***	****	****
Design, engineering, and associated managerial capabilities to acquire technologies, develop a continuous stream of improvements, and generate more substantial innovations to sustain product-market positions and capture new ones	**	***	****	****
research capabilities to underpin technology acquisition, implementation and development by acquiring or generating new knowledge and understanding.	*	**	***	****

* A limited level of scale and capability – required as a basis for problem-solving support for design, engineering and technology acquisition, and also to support higher level university training

** An emerging significant capability, still lagging well behind the level and scale in technology frontier firms and industries in similar areas of the economy

*** A significant capability that is closing in on the level and scale of equivalent firms, industries and other organisations in technology frontier innovation systems

**** A level and scale of capability comparable to that of firms, industries and other organisations in technology frontier innovation systems

***Source**: Martin Bell, Knowledge Resources, Innovation Capabilities and Sustained Competitiveness in Thailand, Final Report to NSTDA, Brighton: SPRU, 2003*

At the national level, Narula suggests a four-stage process of developing absorptive capacities. He argues that, as the distance from the 'technology frontier' decreases, so the opportunities for absorbing knowledge from others also decrease, though the **ability** to absorb continues to rise as the economy is forced into doing more novel R&D by the declining opportunities for imitation.

- **Pre catching-up stage:** Natural resource-based, commodity exports. No technological capabilities. Little or no basic infrastructure. Underdeveloped institutions. Few domestic firms with technological capabilities. Little or no inward FDI. No outward FDI
- **Catching-up stage:** 'Generic' basic infrastructure. Growing capacity to imitate. Engaged in low-value-adding manufacturing, often as OEM supplier. Growth of domestic industry in support and related sectors. Little outward FDI. Growing inward FDI
- **Pre frontier-sharing stage:** Increasingly specialized knowledge infrastructure. Decline in potential to imitate and adapt. Increasing integration into efficiency-based global production networks. Strong domestic industry, move towards OBM. Increasing use of networking to achieve modularity. Rising inward FDI, Rising outward FDI
- **Frontier-sharing stage:** Technological opportunities primarily rest on long-term innovation and collaboration. Pushing back frontiers of knowledge. Considerable in-house R&D activity by both domestic and foreign MNEs. Outward FDI to augment domestic capacity. Growing use of R&D alliances and networking. Strong knowledge infrastructure. Growing use of outsourcing to earlier-stage countries of lower-value added activities. High outward and inward FDI stocks[40]

Elsewhere, Narula argues[41] that "there are diminishing returns on marginal increases in absorptive capacity as firms approach the frontier of knowledge," as if absorptive capacity and wider technological capabilities were different things. His arguments about national-level absorptive capabilities, rather, suggest that they are the same and that what changes with development and learning is the extent to which components of the knowledge used are 'new to the world' rather than only 'new to the firm'.

At the national level, Nelson and Pack have argued that the success of the 'Tiger' economies[42] was the outcome of several inter-related features, including

- Their openness to foreign knowledge and their ability and willingness to tap international markets
- The pressures brought to bear on firms to increase their productivity to continue to increase exports rather than to use the knowledge obtained to extract rents from the domestic economy, thus creating a demand for foreign technology
- The high productivity of foreign technology as its dissemination and successful use were enhanced by an educated domestic labour force[43]

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40 Rajneesh Narula, 'Understanding absorptive capacity in an 'innovation systems' context: consequences for economic growth, DRUID Summer Conference, 2004

41 Rajneesh Narula, *Globalisation of Technology: Interdependence, Innovation Systems and Industrial Policy*, Cambridge: Polity Press, 2003

42 Hong Kong, Korea, Singapore and Taiwan

43 Richard R Nelson and Howard Pack, 'The Asian growth miracle and modern growth theory,' *The Economic Journal,* Vol 109, 1999, pp 46 - 436

Pack[44] describes two stages in the development of the 'Tigers,' as they built up absorptive capacity. In the first stage of 'early industrial development,' they focused on exporting labour-intensive products, under intense national and international competitive pressure and using imported production technology. There was a strong policy focus on providing universal primary education, allowing these technology inflows and the use of the technology acquired. There was limited interest in educating high-level research or R&D staff. At this stage, the probability of domestic R&D producing viable innovations was very low.

The second stage of 'more complex industrial development' involved building a more advanced local education and skills base in order to enable learning and to allow local evolution of foreign technology. Technical changes and innovations continued, however, to be generated firmly within companies. Universities and the large Research and Technology Organisations such as ITRI continued to contribute few product and process innovations. However, they did play increasingly important roles as educators of qualified manpower.

An important omission from the available accounts of catch-up development is the creation and role of 'mid-level' craft and technician skills, which are crucial to the absorption and use of production technologies and to a great deal of innovative activity not classed as formal R&D. A further key omission concerns the need to develop **design** capabilities.[45]

During the catch-up process, then, research plays a limited role. Major, unfocused investment in the basic research and scientific system risks creating capabilities disconnected from the economy and society, which are unlikely to have developed the absorptive capacity to make use of such investments. Given the limited resources available for research, they also risk being below critical mass unless they are highly focused. Investments in research institutions do not produce returns in the form of innovations, but may be useful sources of the technology-literate people needed by the business system. Given the long lead times involved in creating sustainable research communities, the rate at which it makes sense to invest in national **research** (as opposed to broader R&D) capabilities is a matter of delicate balance. It is very easy to over-invest, in anticipation of an industrial demand for linkage which then fails to materialise.

Once at the scientific/technological frontier, the way forward is no longer so clear. Huge amounts of effort are devoted to R&D in the developed economies, and a very large proportion of this is 'wasted' – in the sense that it does not result in a commercialised products or process innovations. Well over half of all R&D projects in leading US technology-based companies are cancelled.[46] Of completed innovation activities, very few are highly profitable. Modern product life cycle theory builds in the idea of

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44 Howard Pack, 'Research and development in the industrial development process,' in Linsu Kim and Richard R Nelson (eds), *Technology, Learning and Innovation: Experiences of Newly Industrialising Countries*, Cambridge University Press, 2000

45 Bell & Albu, Op Cit; N Forbes and D Wield, 'Managing R&D in technology followers,' *Research Policy*, Vol 29, No 9, 2000, pp1095 - 1110

46 D Leonard-Barton and J Doyle, 'Commercialising technology: Imaginative understanding of user needs,' in R Rosenbloom and W Spencer (eds), *Engines of Innovation: US Industrial Research at the End of an Era*, Boston: Harvard Business School Press, 1996

competing attempts to define a 'dominant design'[47] or 'product recipe'[48] early in the life of a new product. The effort devoted to failed designs is not wholly 'wasted,' because this is a source of learning about where **not** to innovate and a source of background knowledge that is likely to prove valuable elsewhere (since it links directly to firms' core business). However, once at the frontier, there is no choice about whether to invest in this less certain kind of search for opportunities. In contrast with this searching and experimentation, the targets for 'catching up' are relatively clear because much of the searching and experimentation have already been done by others.

Within the newer literature on absorptive capacity, we find echoes of the 'catching up' discussion. 'Catching up' countries have the opportunity to develop more quickly than 'leader' countries, because they can exploit a backlog of existing knowledge – but only if they have adequate absorptive capacity.[49] In the Irish situation, with its mixture of highly advanced and comparatively backward parts of industry, the required policy mix will involve handling the different development needs both of the more advanced and the 'follower' parts of the economy, in order to build a robust pattern of national development. While the trajectory will differ, a clear lesson from others' experience of successful development concerns the need consciously to develop absorptive capacities in companies, balancing the Irish investment in the knowledge infrastructure. It is not obvious that most absorptive capacity will be devoted to valorising in a direct way the huge national investment in biotechnology and ICT research currently being made. It is, however, clear that without such capacity any new growth in ICT and biotechnology industries will at best be in 'enclaves' within the wider economy and may turn out to be unsustainable, owing to inadequacies of industrial infrastructure, for example in the needed supply chains.

2.4 MNCs and absorptive capacity

A new body of research has developed around the investigation of the role of absorptive capacity in determining whether or not domestic firms benefit from productivity spillovers from FDI.[50]

Recent surveys of the literature conclude that there does not appear to be much evidence that there are aggregate benefits from the presence of multinationals, which accrue to all types of domestic firms equally[51]. Rather, it appears that conditions in the host country seem crucial for whether or not there are positive spillovers. In particular, the absorptive capacity of domestic firms, that is their ability to utilise spillovers from multinationals to improve their productivity, has been found to be an important

47 William J Abernathy and James M Utterback, 'Patterns of industrial innovation,' *Technology Review*, No 80, 1978

48 Erik Arnold, *Competition and Technological Change in the Television Industry*, London: Macmillan, 1986

49 Paula Criscuolo and Rajneesh Narula, "A novel approach to national technological accumulation and absorptive capacity: Aggregating Cohen and Levinthal", MERIT Research Memorandum 2002-16

50 Sourafel Girma and Holger Görg, Foreign direct investment, spillovers and absorptive capacity: Evidence from quantile regressions, IIIS Discussion Paper, No.1 / July 2003; Yuko Kinoshita, Technology Spillovers through Foreign Direct Investment, CERGE-EI Working Paper No. 39/1998

51 Holger Görg, and David Greenaway, Much Ado About Nothing? Do Domestic Firms Really Benefit from Foreign Investment?, CEPR Discussion Papers 3485, C.E.P.R. Discussion Papers, 2002; M. Blomström and A. Kokko, Multinational Corporations and Spillovers, *Journal of Economic Surveys* , Vol.12, No. 3, July, pp. 247-277, 1998

determinant for whether or not domestic firms benefit from foreign direct investment (FDI).

Blomström and Kokko[52] argue that exploitation of spillovers depends on the complexity of the technology transferred by multinationals, and the technology gap (interpreted in their study as the difference in labour productivity) between domestic firms and MNCs. Furthermore, domestic firms can only benefit if the technology gap between the multinational and the domestic firm is not too wide so that domestic firms can absorb the knowledge available from the multinational.[53]

Borenzstein et al[54] and Xu[55] have shown that FDI has a positive impact on economic growth only in those developing countries that have attained a certain minimum level of absorptive capacity. Knowledge accumulation is much more rapid once the initial threshold level of absorptive capacity exists. Technology absorption is easier, once countries have 'learnt-to-learn'.[56] This can be a particular problem in relation to multinationals, which are in principle seen as very important sources of knowledge externalities. "To capture some of the externalities generated by technologically advanced multinational corporations … [countries] … must have domestic firms with the ability to learn from them."[57] It follows that countries with significant FDI have an opportunity to accelerate development by investing in measures that close the capability gap between multinational subsidiaries and local firms.

However, it is important to stress that spillover effects on host countries and the capability to benefit from FDI may rather depend on the technological sector of non-indigenous firms and in particular on their value chains and on their capability to stimulate linkages[58] with other firms and sectors. With reference to this, it is useful to recall that evidence from policy interventions in support of less developed European regions such as Southern Italy that followed the recommendations of growth poles theories[59], completely failed to deliver any multiplicative effect on local industries. This has been especially the case of those industries with fully integrated value chains and very limited (backward) external linkages with producers of semi-processed products.

The policy implications include the need to focus some measures that create absorptive capacity in sectors and clusters where there is, first, one or preferably more 'motor' companies such as multinationals, with high but to some degree transferable technological capabilities; and, second, where there is at least the beginnings of an up-

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52 M. Blomström and A. Kokko, "Home Country Effects of Foreign Direct Investment: Evidence from Sweden," CEPR Discussion Papers 931, C.E.P.R. Discussion Papers, 1994

53 A. Kokko, R. Tansini and M. Zejan, Productivity Spillovers from FDI in the Uruguayan Manufacturing Sector, *Journal of Development Studies,* Vol. 32, pp. 602-611, 1996

54 Borensztein, E.; De Gregorio J.; Lee, J.W. (1998). "How does FDI affect economic growth", in *Journal of International Economics*, Vol. 45, pp. 115-135.

55 Xu, B. (2000). "Multinational enterprises, technology diffusion, and host country productivity growth", in*, Journal of Development Economics*, Vol. 62, pp. 477-93

56 Paula Criscuola and Rajneesh Narula, "A novel approach to technological accumulation and absorptive capacity: Aggregating Cohen and Levinthal," MERIT, University of Maastricht (mimeo), 2004

57 Sanjaya Lall, 'Technological change and industrialisation in the Asian newly industrialising economies: achievements and challenges,' in Linsu Kim and Richard R Nelson (eds.) *Technology, Learning and Innovation,* Cambridge University Press, 2000, p21

58 A. Hirschman, *The Strategy of Economic Development*, Yale University Press, New Heaven, 1958

59 F. Perroux, 'Note sur la notion de pôle de croissance', *Economie Appliquée*, Vol. 8, 307-320, 1955

or down-stream supply chain that can benefit. Correspondingly, different kinds of measures can be envisaged to support sectors in need of development but where there is no 'motor' company, for example by re-using some of the strategies employed in Emilio-Romagna.

2.5 Policy Instruments to Promote Absorptive Capacity

We have assembled an overview of relevant instruments in use in Ireland, the UK, the Netherlands, Sweden and Finland, in order to find out what we could learn about the way various policy makers have understood absorptive capacity and how to promote it. The full list of instruments and their description are in the appendix to this paper. Below, we present a table that classifies the instruments according to the aspects of absorptive capacity that they respectively tackle.

Compared with the plethora of instruments in place 5 – 10 years ago in these countries (at one point in the late 1990s, for example, Forbairt had 37 innovation-related instruments in place), the current portfolios are much simpler. It seems that the 1990s were a time of innovation and experimentation in innovation instruments, and that the resulting lack of transparency has prompted both a reduction in the numbers of instruments and, in many countries, a movement towards delivering company support services via 'one-stop shops' such as Enterprise Ireland (or 'first-stop shops' like the UK Business Links, whose function is to refer enquirers to service providers).

To some degree, the reduction in the numbers of instruments is illusory: some of the new instruments involve sub-schemes, which preserve elements of the previous variety. But there has also been a genuine focusing, especially towards the promotion of university-industry links and other kinds of networking. Ireland, particularly, has dropped many schemes aimed more broadly at technological capabilities, such as the Technology Audit, TechStart and Manufacturing Consultancy schemes. While reduced emphasis is also evident on these types of activities in the other countries considered, they benefit from Research Institute / RTO and testing infrastructures that are absent in Ireland. In, respectively, the Business Links, branch-specific innovation programmes, the TUFF programme and Finland's Centres of Expertise and Technology Clinics, the other countries also have technology-focused diagnostic services in the 'front line' of support to companies. In comparison, therefore, Ireland lacks both significant front-line technology services and the technological infrastructure that could to some degree substitute for such services in supporting and developing company absorptive capacities.

It can be seen from **Exhibit 9** that most of the countries have schemes focusing on developing human capital through training or placement. Human capital development is, of course, also a major expected indirect impact of instruments that promote links with the knowledge infrastructure and subsidise R&D. Academic linkage programmes are the most numerous category. We have included under these heading programmes that link to the further- as well as the higher education sector, though these are in a small minority. A number of innovation-related networking schemes aim to create groupings of companies, and usually to link these to the knowledge infrastructure, so some instruments appear as promoting both 'academic networks' and 'other networks'. A number of programmes aim to create **cognitive** change, or **learning** – often through exposure to good practice. However, few tackle the issues of organisation, routinisation

or codification that are given so much attention in the innovation and management literature.

In **Exhibit 9**, we have added two categories that are not present in our literature review. One is **capacity**, by which we mean increments to the amount of resources companies can devote to innovation activities. This is a **quantitative** rather than a qualitative change in companies' capabilities. The other is the **diagnostic** category, which is not a component of absorptive capacity but of delivery systems. This category involves organising technology support so that it helps – proactively, or as a 'first line' reactive service – to identify needs and opportunities for increasing company technological capabilities. This is a practical reaction to the cognitive or 'learning paradox' element in absorptive capacity: namely, that those whose capacity is deficient are often unaware of the fact.

Exhibit 9 International Overview of Schemes to Promote Absorptive Capacity

	Human Capital	Academic Networks	Other Networks	Organisation, Routines	Learning	Codification	Capacity	Diagnosis
Ireland								
RTI Programme	X						X	
Innovative Management Initiative			X	X				
R&D Support	X						X	
Innovation Partnerships		X						
R&D Awareness								X
Programmes in Advanced Technology		X						(X)
Fusion Scheme		X						
Expertise Ireland		X						
Country Enterprise Boards							X	X
UK								
Business Links								X
Technology Prog. - Collaborative R&D		X						
-Knowledge Transfer Networks	X	X						X
Grants to Investigate Innovative Ideas							X	X
Grant for R&D							X	
Knowledge Transfer Partnerships		X					X	
Access to Best Practice Business					X			X
Management and Leadership Programme				X	X			
LINK _ OST		X						
Faraday Partnerships		X	X		X			
Regional Skills Partnerships	X							
Phoenix Fund					X		X	
Netherlands								
Training Facility	X							
Training Impulse	X							X
Knowledge Transfer Branch Orgs/SMEs							X	X
Knowledge Transfer Entrepreneurs/SMEs	X						X	X
Dreamstart – NTBFs							X	X
WBSO R&D allowance	X							
O&O Fonds	X			X	X			
Sweden								
VINNVÄXT		X	X					
VINST		X	X					
Innovation Systems and Clusters		X	X					
TUFF Technology Transfer/Brokerage		X	X					X
Regions – IT		X	X					
IT.SME.se			X	X				
Finland								
Entrepreneurship Policy Programme								
TE-Centres	X							X
Centres of Expertise					X			X
Technology Programmes		X					X	
R&D Funding for Companies							X	
Feasibility Studies								X
Business from Research (TULI)								X
Technology clinics		X						X

2.6 Conclusions

Absorptive capacity is in the research literature an ill-defined but nonetheless central aspect of company competitiveness and performance. Since wealth is generated by companies in some relation to their ability to innovate, and since the ability to identify and use relevant knowledge is central to the innovation process, it is strongly in the national interest to ensure that industry's absorptive and other technological capabilities are adequate. While direct knowledge transfers from the knowledge infrastructure do play a role in industrial innovation, this role is minor – particularly in countries and sectors that are not at the technological leading edge, but also in more developed economies.

Absorptive capacity relates not merely to R&D but to the larger set of innovation activities in which firms engage. It comprises at least the following capacities, each of which, according to the innovation and research literature, influences innovation and economic performance

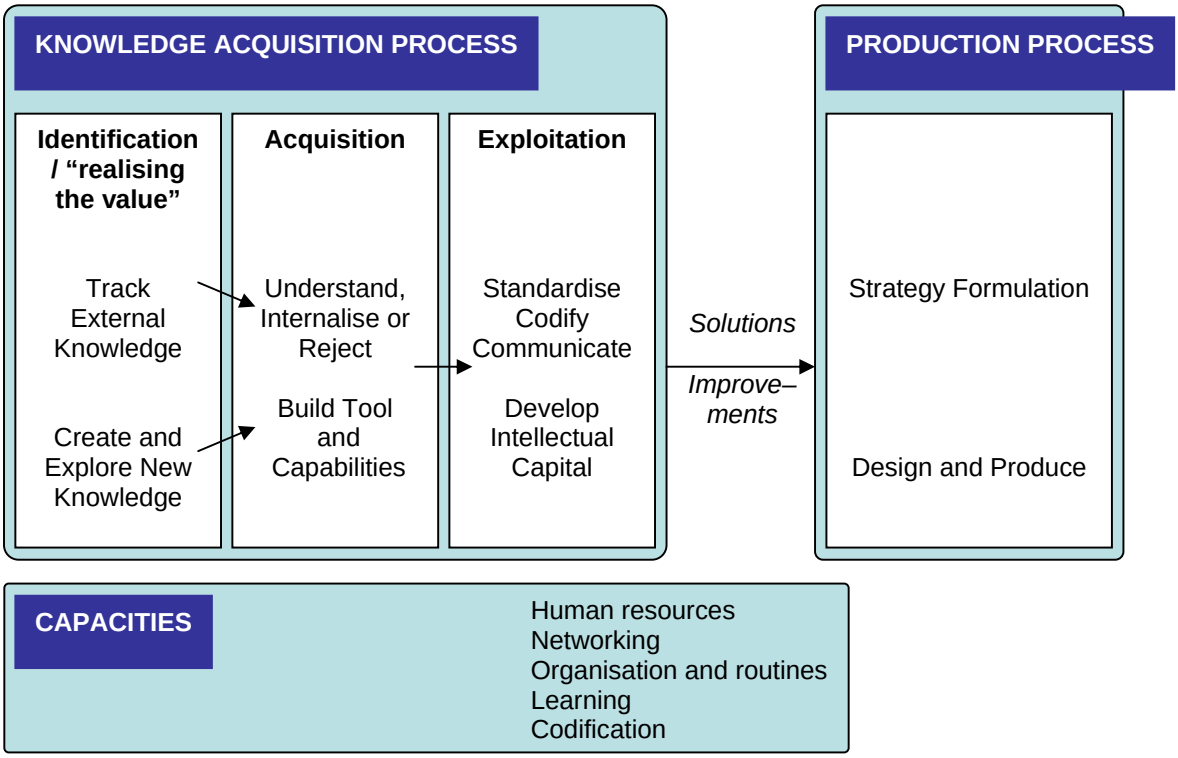
- Human capital, especially in the form of graduates, and especially scientists and engineers; but also in the form of middle-level competences in the work force
- Ability to network with external sources of knowledge and other resources
- Organisation and routines
- Learning processes
- Codification

We can summarise absorptive capacity using **Exhibit 10**, in which the firm is sketched as a sort of 'search engine'.

An important aspect of absorptive capacity is the ability to identify and value external knowledge. Without this, the firm is forever lost in the 'learning paradox' of knowing too little to allow it to learn. The firm then needs mechanisms to acquire knowledge – whether from outside or through internal discovery – to evaluate the usefulness of the knowledge and codify it so that it can be exploited. These things require relationships and routines, as well as appropriately skilled manpower. Traditionally, we see knowledge acquisition as a distinct function within the firm, and there is of course some truth in this view, which goes back at least to Adam Smith's "philosophers or men of speculation".[60] What the literature on innovation and, especially, learning organisations suggests is that knowledge acquisition should be built into routines more widely across the firm and at more skill levels.

[60] Adam Smith, *The Wealth of Nations*, 1776; reprinted, Harmondsworth: Penguin, 1974, p115

Exhibit 10 Absorptive Capacity: The Firm as a Search Engine



It is in practice hard to disentangle absorptive capacity from technological capability more broadly, because many if not all of the facets of absorptive capacity are needed to innovate – whether innovation is, in any particular instance, based more strongly on internally- or externally-generated knowledge. The presence of multinational and other 'leading' firms provides important opportunities to obtain knowledge externalities, in the form of information but also in less direct ways, for such companies in practice can function as 'training schools' for the supply chains or clusters that they inhabit. It can be important to ensure that such leading firms are well networked with other companies and to the knowledge infrastructure.

Internationally, many support instruments are devoted to increasing absorptive capacity. There is a considerable focus on university-industry links, despite the limited direct value of these as information channels to smaller firms. They are probably much more important in relation to developing human capital, which is generally seen as the core component of absorptive capacity. The countries we studied outside Ireland have stronger research institute, RTO and testing infrastructures than Ireland, so it is surprising to note the gradual disappearance in Ireland of programmes that provided equivalent functions. They appear also to have a more technology-focused set of support instruments available to **problematise** innovation: to help firms understand needs and opportunities in ways that lead to change and development.

These perceptions, and whether the differences among systems are important, need next to be tested through interviews and questionnaires to small Irish-based companies.

This discussion has several implications for policy.

- Nurturing absorptive capacity is a key policy need in many countries, but is especially urgent in a place like Ireland where the uneven development of the economy means that many sectors need to catch, and where there is a rich supply of MNCs providing opportunities for others to reap externalities
- Companies' innovation performance can be increased by encouraging greater employment of graduates – especially in science and technology. But increased skill at the graduate level needs to be complemented by less glamorous design and process skills and skills at the 'middle' level of craft and technician workers
- Absorptive capacity is not only about individuals' skills but also about developing organisational structures and routines that capture individual skills, making them reproducible and putting them into the service of the organisation
- Key elements of absorptive capacity involve companies' ability to relate to others. Ensuring that companies have the ability to network well with external sources of knowledge will contribute to their absorptive capacity and to their rate of innovation
- The individuality of companies' needs for absorptive capacity combined with the difficulties many SMEs experience in valuing both external knowledge and increases in their own absorptive capacity imply a need for support measures to be rather individualised. At least that part of the support system that encourages SMEs to change their understanding and behaviour in relation to external knowledge needs a highly individualised form of service delivery, through instruments such as audits or personalised training
- It is in practice hard to disentangle absorptive capacity from technological capability more generally. Just as Cohen and Levinthal argued more narrowly in 1989 that R&D has a 'learning face', so we can view absorptive capacity as the 'learning face' of wider technological capability
- Policy measures need to tackle the innovation process as a whole, and not solely tackle R&D

3 Results of the company survey

This chapter reports the results of our interview survey of Irish SMEs. It addresses the intensity of firms' innovation activity and analyses aspects of absorptive capacity associated with innovation and firm growth. It focuses on firms' ability to interpret and exploit such sources of knowledge. Firms' access to external sources of knowledge can be of critical importance for the development of innovation. The key findings of the analysis are the relevance of human capital in innovation and growth and identifying some of the key factors underpinning the innovation process in Irish SMEs.

3.1 Method

The empirical evidence is based on a telephone survey of 123 Irish SMEs. The names of firms interviewed were obtained from Enterprise Ireland via Forfás and represent a random sample of firms employing between 10 and 150 people. There is some bias in the sample in so far as the service companies interviewed tended to be knowledge intensive. Those responding were generally managing directors or other senior staff.

We designed a questionnaire (shown in the Appendix) comprising the following elements

- 'Demographic' questions, allowing us to classify firms by size, sector, growth rates, and so on
- Questions about their absorptive capacity, generated by translating the five categories under which we discussed absorptive capacity in Chapter 2 into more operational categories
- Questions asking them about their views on the importance of various innovation- and absorptive capacity-related success-factors for their business, and asking them to compare their performance on these dimensions with that of their competitors
- Questions directly about their ability to absorb and develop various kinds of technologies

The telephone interviews were arranged by contacting the companies on the list provided and informing them of the purpose of the study. If they were willing to be interviewed, a telephone appointment was arranged and an electronic copy of the interview questions was sent in advance to the participating company. This questionnaire was then filled in over the phone by us guiding the interviewees through the process.

Overall, 650 firms were contacted, of which 123 (19%) agreed to participate in the study. The main reasons that firms declined to participate in the survey were the high number of surveys they receive from various branches of government and the feeling that they have little to gain themselves from participating in these the kinds of surveys. Accordingly, people who agreed to contribute to the study were more likely to work in 'younger companies, which have not yet been contacted many times.

The survey covered both the manufacturing and services sectors. However the response rate from the manufacturing sector was much higher than from companies involved in services. The service sector was less likely to respond owing to a misapprehension that they are less likely to do innovation and to the idea that they do not produce 'real' products in the same way as the manufacturing sector. (In fact, service sector firms surveyed are more, not less, innovative than those in the manufacturing sector.) The literature on innovation in services, however, indicates that services innovation tends to have a higher organisational component and a lower 'hard technological' one, with networking also playing a greater role in services innovation than in manufacturing innovation.[61]

Despite the bias in the sample toward manufacturing firms, a comparison of the characteristics of respondents to the survey with those of non-responding firms shows the consistency of the sample collected.[62] As shown in Exhibit 11, the industry composition of the two groups of firms is almost identical. Furthermore, respondent and non-respondent firms are also very similar in size (Exhibit 12).

Exhibit 11 Characteristics of firms contacted: Industry

	Manufacturing	%	Services	%	Grand Total
Non-respondents	338	78.1%	95	21.9%	433
Respondents	95	77.2%	28	22.8%	123
Grand Total	433	77.9%	123	22.1%	556
	21.9%		22.8%		22.1%

Exhibit 12 Characteristics of firms contacted: Size

	10 - 50	%	51 - 100	%	over 100	%	Grand Total
Non-respondents	336	75.2%	71	15.9%	40	8.9%	447
Respondents	88	71.5%	22	17.9%	13	10.6%	123
Grand Total	424	74.4%	93	16.3%	53	9.3%	570
	20.8%		23.7%		24.5%		21.6%

[61] Djellal F., Gallouj F. "Innovation Surveys for Service Industries: a Review, *Innovation papers*, n° 18, 2002, Eurostat, European Commission, pp. 70-87

[62] The difference between the total number of firms contacted (650) and the total number of firms reported in Exhibit 11 and in Exhibit 12 is represented by companies that did non explicitly refuse to participate in the survey. In fact, in a large number of companies interviewees were not available at the time of the survey or they were not in the office. Furthermore, in Exhibit 11, a small number of companies was part of other industries (therefore the difference between the totals in the two tables).

3.2 Composition of the sample

Overall 95 companies in the manufacturing industry (77%) and 28 companies in the service industry (23%) were interviewed.

The majority of companies are owner-managed and are not part of any enterprise group. Accordingly, the composition of the sample is consistent with the purpose of this study, which is focused on indigenous SMEs.

Exhibit 13 Ownership and management

	Part of an Enterprise Group			
Company owner-managed	No	Yes	Grand Total	% Yes
No	17	22	39	31.7%
Yes	76	8	84	68.3%
Grand Total	93	30	123	100.0%
% Yes	75.6%	24.4%	100.0%	

Nearly three quarters of companies have fewer than 50 employees (72%). However, companies interviewed in the service industry are generally smaller than companies in the manufacturing industry. In fact, respectively 82% of service companies and 68% of manufacturing companies have fewer than 50 employees. Further information on companies considered in our analysis is reported in Appendix B. However, it is necessary to underline here that the sample of service companies considered includes almost exclusively knowledge-intensive companies.

Overall, only a third of companies have decreased their number of employees over the last three years. On average some 45% of companies have increased employment over the period considered: however, in line with the European trend, the service sector has grown more than the manufacturing sector.

Exhibit 14 Size and economic sector of companies interviewed

	Manufacturing	%	Services	%	Grand Total	%
1 – 50	65	68.0%	23	82.0%	88	72.0%
51 – 100	19	20.0%	3	11.0%	22	18.0%
Over 100	11	12.0%	2	7.0%	13	11.0%
Grand Total	95	100.0%	28	100.0%	123	100.0%

Exhibit 15 Employment growth in the last 3 years

	Manufacturing	%	Services	%	Grand Total	%
Decreased	35	36.8%	9	32.1%	44	35.8%
Unchanged	18	18.9%	3	10.7%	21	17.1%
1 - 10%	9	9.5%	2	7.1%	11	8.9%
Over 10%	31	32.6%	14	50.0%	45	36.6%
Don't know	2	2.1%			2	1.6%
Grand Total	95	100.0%	28	100.0%	123	100.0%

Exhibit 16 Exports

	Manufacturing	%	Services	%	Grand Total	%
No export	6	6.3%	7	25.0%	13	10.6%
1%-10%	25	26.3%	2	7.1%	27	22.0%
11% - 20%	9	9.5%	3	10.7%	12	9.8%
21% - 50%	16	16.8%	3	10.7%	19	15.4%
Over 50%	38	40.0%	12	42.9%	50	40.7%
Don't know	1	1.1%	1	3.6%	2	1.6%
Grand Total	95	100.0%	28	100.0%	123	100.0%

The dynamism of the service sector is not completely supported by data on exports. Despite a very positive general picture, with over 40% of companies exporting more than 50% of production, 25% of companies in the service sector do not export. Some of the services products appear to be inherently national.

Innovation activity is continuously carried out in the majority of companies interviewed. Overall, in the last three years 74% of the companies surveyed have introduced a new product or service and sales from innovative products/services represent some 35% of total turnover. Half the companies interviewed had also recently introduced process innovations.

Innovations in the companies interviewed are generally developed internally. However, 18% of companies have contracted the development of process innovations to external organisations. This is particularly pertinent for manufacturing companies who may purchase machinery that is designed to order, for example.

Exhibit 17 Innovation activity

		Responding firms	Total	%
Companies introducing new products or services in the last 3 years		91	123	74.0%
Development:	mainly internally	68	91	74.7%
	with others	19	91	20.9%
	mainly externally	7	91	7.7%
Sales from innovative products introduced in the last 3 years (average %)		86	91	35.2%
Companies introducing new processes in the last 3 years		61	123	49.6%
Development:	mainly internally	37	61	60.7%
	with others	26	61	24.6%
	mainly externally	11	61	18.0%

3.3 Absorptive capacity

3.3.1 Human resources

Innovation activity is generally believed to be sustained by the employment of skilled workers. The majority of our respondents employ graduates (especially in scientific subjects) and postgraduates, who together represent overall some 25% of total employment. 82% of companies also employ technicians, who are in many cases responsible for coordinating production processes and operating complex machinery. Indeed, in manufacturing companies these employees provide important feedback on the adaptability of innovations to existing production processes. Finally, nearly 87% of companies employ workers with no formal qualifications: on average, these employees represent some 47% of total workforce.

Overall, service companies employ staff with higher qualifications. This is reasonable, given the bias in the sample towards knowledge-intensive service companies is considered.

With reference to employment structure, very interesting results also emerge from the analysis of the data on employment of personnel with previous experience in foreign or multinational companies. In fact, at present over 78% of companies interviewed employ people with this kind of previous work experience and on average they represent some 21% of total workforce. Some 85% of companies employing people with previous experience in multinational or foreign companies confirmed that thanks to their previous work experience, these employees brought significant benefits to the company.

Exhibit 18 Education level and previous qualifications

	Responding firms	Total	%	If yes, average % employed
a. A higher degree (master or doctorate)	74	122	60.7%	6.1%
b. A BSc or BA in science or engineering but not a higher degree	86	120	71.7%	12.6%
c. A non-scientific or technical BSc or BA degree but not a higher degree	71	120	59.2%	5.8%
d. Qualifications as technicians, but not a degree (A National Diploma or Certificate)	100	122	82.0%	11.3%
e. A National Craft Certificate qualification, but not a degree	68	118	57.6%	7.6%
f. No formal qualifications	98	113	86.7%	47.4%
g. Other qualifications not listed	37	123	30.1%	14.0%
Does your company employ people with experience working in a major foreign or multinational firm?	90	115	78.3%	20.8%
If yes, do they bring any significant benefit to the company as a result of their 'large company' experience?	72	85	84.7%	

Innovation activity is undertaken formally or informally by a large number of companies' employees. Over 41% of companies have a formal R&D unit. On average some 15% of company staff are employed full-time in R&D units. However, innovation activity is also undertaken informally in 80% of companies without R&D units. In this case the number of people is generally higher, being on average 19% of total number of companies' staff.

Exhibit 19 R&D activity

	Responding firms	Total	%	If yes, average % emp.
Dedicated in-house R&D	51	123	41.5%	
If yes, number of FTEs	51	123	41.5%	14.6%
If no, what proportion of employees contributes to innovative activity?	61	76*	80.3%	19.1%

Note (*): In 4 companies with R&D departments, non-R&D employees also contribute to innovation

Upgrading skills within these companies is also a continual process, with nearly all the companies interviewed saying that they carry out in-house training activities. Furthermore, over 80% of companies also undertake external training for employees. This can be considered as a normal aspect of skills upgrading, as most SMEs tend to

acquire skills that they do not have in-house (because of their small size) from external organisations.

Exhibit 20 Training

	Responding firms	Total	%
In-house or formal training	119	123	96.7%
a. External	4	119	3.3%
b. Internal	22	119	17.9%
c. Both	93	119	75.6%

Off-the-job formal training is performed in some 85% of companies. It is done by all types of staff and on average takes between 5 and 7 days per employee per year.

Exhibit 21 Off-the-job training

	Responding firms	Total	%	average days p.p.p.y.
Off the job (formal) training	101	119	84.9%	
a. Shop floor	67	102	66.3%	6.80
b. Middle management	89	112	79.5%	5.10
c. Technical staff / graduates	84	112	75.0%	6.74
d. Top management	83	115	72.8%	5.72

3.3.2 Networking

The majority of companies continuously interact with external actors. As shown in Exhibit 22, 69% of companies are members of trade or industry associations and a minority of companies are involved in formal or technology networks. Overall, a higher proportion of manufacturing firms is involved in memberships in trade and industry associations.

Despite only 14% of companies being involved in technology networks, over 80% of companies have purchased services of a scientific nature from external organisations. In 70% of cases, companies have purchased services from a university or a research institute. Similarly, in most of the cases, the majority of companies have purchased services from test facilities, technical consultants or from business consultants.

Ties with domestic organisations are generally stronger than with organisations abroad. Especially in the case of links with Universities, the majority of interactions are with Irish universities. There is no information allowing us to infer whether the stronger ties with domestic organisations derive from proximity effects or from a superior quality of Irish services compared to competitors' abroad. However, the only field in which firms seem equally to access domestic and foreign organisations is to obtain access to test facilities or laboratories. This may be due to limited availability of some services in Ireland.

Confirming firms' close ties with domestic universities, nearly half of the companies interviewed had recently hosted students or recent graduates to do placements or projects. Apparently, hosting of students is a valuable source for firms' innovation activity: with the majority of companies indicating that they found students' contribution to the firm's innovation activity of at least "medium" importance. The presence of students probably has a number of less direct benefits, including recruitment of qualified personnel and on companies' willingness to engage with the Third Level.

Exhibit 22 Memberships

	Manufacturing	%	Services	%	Total	%
a. Trade or industry association	70	73.7%	15	53.6%	85	69.1%
b. Formal business network	19	20.4%	6	21.4%	25	20.7%
c. Technology network	12	12.8%	5	17.9%	17	13.9%
if yes, is a university involved?	5	41.7%	2	40.0%	7	41.2%

Exhibit 23 Purchase of services

	in Ireland		Abroad		Total	
	n.	%	n.	%	n.	%
a. University or college	35	28.5%	4	3.3%	39	38.6%
b. Research institute	18	14.6%	12	9.8%	30	29.7%
c. Dedicated test facility/ lab	34	27.6%	32	26.0%	66	65.3%
d. Technical / scientific consultant	53	43.1%	21	17.1%	74	73.3%
e. Business / management consultant	69	56.1%	18	14.6%	87	86.1%

Exhibit 24 Hosting students

		Responding firms	Total	%
Hosting of students or new graduates to do placements or projects in the last 3 years		60	123	48.8%
If yes, how important is their work to innovation activity	High	8	60	13.3%
	Medium	30	60	50.0%
	Low	22	60	36.7%

Exhibit 25 Co-operation agreements

	Responding firms	Total	%
Cooperation agreements on innovation with other organisations in last 3 years	43	122	35.2%

Importance of organisations involved in joint projects	High	Medium	Low	Total	%
a. Other enterprises within your enterprise group	47.1%	29.4%	23.5%	17	13.8%
b. Suppliers of equipment, materials, components or software	65.4%	30.8%	3.8%	26	21.1%
c. Clients or customers	73.3%	16.7%	10.0%	30	24.4%
d. Competitors and other firms from the same industry	33.3%	26.7%	40.0%	15	12.2%
e. Consultants	40.9%	45.5%	13.6%	22	17.9%
f. Commercial laboratories /R&D enterprises	57.1%	38.1%	4.8%	21	17.1%
g. Universities or other higher education institutes	30.0%	35.0%	35.0%	21	17.1%
h. Government or private non-profit research institutes	62.5%	25.0%	12.5%	16	13.0%

Despite their widespread use of business and scientific services, only 35% of companies interviewed had arranged co-operation agreements with other companies in the last 3 years. In most cases co-operation agreements are arranged “vertically” along the value chain, with suppliers and customers.

Apart from suppliers and customers the greatest satisfaction comes from co-operating with commercial laboratories and non-profit research institutes. Co-operation agreements with universities are much less significant. In fact, in the case of co-operation with universities, there are an almost equal number of companies indicating that this kind of agreement was important as the number claiming it was unimportant.

3.3.3 Organisation and routines

In half of the companies interviewed there is somebody specifically appointed for monitoring opportunities for innovation. Differences between manufacturing and services firms are not particularly significant. In most cases market opportunities are identified through participating in exhibitions and fairs. Equally important, for the identification of opportunities, are the use of the Internet and the exchange of information with suppliers and customers. In the case of services, firms’ access to suppliers is obviously more limited due to the nature of their business. A marginal role in identifying opportunities is played by access to technology networks, universities and even less by the subscription to monitoring services.

Exhibit 26 Monitoring of opportunities

	Manufacturing	%	Services	%	Total	%
Is someone in the company responsible for monitoring opportunities for innovation?	48	50.5%	15	53.6%	63	51.2%
How do you identify opportunities 'out there' that can be applied to your business?						
a. We use the Internet for research	77	81.1%	23	82.1%	100	81.3%
b. We get information from suppliers	82	86.3%	14	50.0%	96	78.0%
c. We get information from customers	84	88.4%	21	75.0%	105	85.4%
d. We attend exhibitions / fairs	86	90.5%	21	75.0%	107	87.0%
e. We use professional bodies / trade associations	42	44.2%	13	46.4%	55	44.7%
f. We use technology network(s)	24	25.3%	9	32.1%	33	26.8%
g. We have links with universities or colleges	21	22.1%	6	21.4%	27	22.0%
h. We subscribe to a monitoring service	15	15.8%	2	7.1%	17	13.8%

In the majority of cases staff are encouraged to provide suggestions on how to improve products or processes. The provision of suggestions is not a formalised process. In fact, only in half of the cases companies have dedicated suggestion schemes and only in a minority of cases are suggestions that are taken up linked to financial rewards for personnel.

Managements meet regularly to discuss company strategy and compile a business plan, which includes details on new products and processes, but only in some cases did this include the staff qualifications needed to achieve goals.

Exhibit 27 Statements about the company

	N	Total	%
a. Formal mechanisms, such as quality systems, are used to help the workforce to improve processes or products	88	123	71.5%
b. We have a suggestions scheme for product and process improvements	62	123	50.4%
c. Suggestions are regularly considered by management for implementation	89	123	72.4%
d. Those whose suggestions are taken up receive a financial reward	29	123	23.8%
e. Management meets regularly to discuss our company strategy	100	123	81.3%
f. The company documents its strategy in a business plan each year	78	123	63.4%
g. New products or processes form part of the business plan	95	123	77.2%
h. The plan includes detailed plans for employing people with specific qualifications (e.g. x graduates, y technicians, z craftsmen, etc)	50	123	40.7%

3.3.4 External support to business activity

As reported in Exhibit 28, nearly 44% of companies had access to financial support for their innovation activity, in most cases from Enterprise Ireland. However, what seems to represent the major issue in the support to the innovation process is not the lack of financial means, but the support of technological change (Exhibit 29).

Exhibit 28 Financial support

	N	Total	%
The company has received financial support for innovation activity	53	121	43.8%
If yes, from County Enterprise Board or other local agency	6	53	11.3%
From Enterprise Ireland	47	53	88.7%
From Shannon Development	2	53	3.8%
From the EU	11	53	20.8%

3.3.5 Technological capabilities

Despite their intense innovation activity, the majority of companies would benefit from some external help in sustaining both internal product and process innovations. Adopting new technologies and implementing radical changes to technologies are weak points for most of the companies interviewed. Confirming this, also the modification of

existing technologies, at least in the case of major modifications, would require some external support. As shown in Exhibit 29, these weaknesses are common to both product and process innovations.

Exhibit 29 Factors for which companies would need external help

	Products		Processes	
	N	%	N	%
a. Adopting new 'turn-key' technologies	65	52.8%	65	52.8%
b. Minor modification of technologies already used in-house	49	39.8%	47	38.2%
c. Major modification of technologies already used in-house	62	50.4%	63	51.2%
d. Making radical changes in technology	72	58.5%	69	56.1%

Data in Exhibit 28 and in Exhibit 29 were matched in
Exhibit 30. This was done to provide a comparison between companies needing external help among the ones receiving financial support. This comparison would help us understand the effectiveness of financial schemes supporting innovation in sustaining the process of technological change. As shown in
Exhibit 30, only in the case of minor modification to existing technologies does there seem to be a noticeable negative association between receiving financial support and the need for external help. In all the other cases receiving financial support is not associated at all with solving problems related to technological change.

Exhibit 30 Comparison of companies receiving financial support and the need for external help

	Financial support					
Need external help for products or processes	No	%	Yes	%	Total	%
a. Adopting new 'turn-key' technologies	37	51.4%	35	48.6%	72	59.5%
b. Minor modification of technologies already used in-house	32	59.3%	22	40.7%	54	44.6%
c. Major modification of technologies already used in-house	34	50.7%	33	49.3%	67	55.4%
d. Making radical changes in technology	38	52.1%	35	47.9%	73	60.3%

However, receiving financial support is still the most important concern for the majority of SMEs. Among other issues for which companies would need external help is support to training and finding competent employees, and support to exporting products. Companies say they would also benefit from less bureaucracy and easier access to

state agencies. Overall, innovating companies proved to be more aware of the kind of support needed in order to improve their innovation activity (Exhibit 31).

Exhibit 31 Support that state agencies could provide

	Product innovation			
Answer	No	Yes	Total	%
Capital		10	10	24.4%
HC and training		5	5	12.2%
Bureaucracy	1	4	5	12.2%
Export		5	5	12.2%
Improve communication with state agencies	1	3	4	9.8%
More focus on SMEs	1	3	4	9.8%
R&D		4	4	9.8%
Information on innovation activity		1	1	2.4%
Seminars	1		1	2.4%
Marketing		1	1	2.4%
Networking	1		1	2.4%
Total	5	36	41	100.0%
Don't know	2	5	7	
No	21	48	69	
Not applicable	4	2	6	
Grand Total	32	91	123	

3.4 How does absorptive capacity relate to success?

3.4.1 Success-factors in competition

We asked the respondents their views on the importance of a range of potential success-factors to the firm (**Exhibit 32**). They saw innovation as a key factor. Nearly three quarters of the companies interviewed stressed the importance of introducing new products and services for the success of their business. Half the companies indicated that 'improving the technological understanding of own products and processes' was an important success factor.

Despite the fact that 48% of companies indicated 'the protection of own knowledge' as a success factor, a large number of them are 'outward oriented' in the development of innovations. In fact, nearly 45% of companies stressed the high importance of co-operating with others in innovation projects for the success of their business.

Companies also indicated the importance of the continuous upgrading of the production process. 'Improving the productivity of personnel' and 'improving the efficiency of machinery and equipment' represented key factors of success for the majority of interviewees.

No relevant differences emerged from a comparison between manufacturing and service companies of potential success-factors. However, a higher proportion of manufacturing companies gives great importance to those factors among the ones listed in Exhibit 32 that due to their nature, are more easily applicable to the context of manufacturing companies (e.g. factors g, i, k, n).

Exhibit 32 Importance of success factors, in the view of respondents

	High	Medium	Low	Not applicable
a. Introducing new or improved products/services aimed at existing customers	72.4%	19.5%	7.3%	0.8%
b. Introducing new or improved products/services to attract new customers	74.0%	20.3%	3.3%	2.4%
c. Expanding customer base for existing products	75.6%	17.1%	5.7%	1.6%
d. Complying with new regulation or legislative obligations	43.9%	36.6%	16.3%	3.3%
e. Regularly introducing new processes	23.6%	45.5%	26.8%	4.1%
f. Introducing new organisational and management techniques	31.7%	43.9%	22.8%	1.6%
g. Finding or using new technologies	39.0%	43.9%	14.6%	2.4%
h. Improving the productivity of personnel	69.1%	23.6%	5.7%	1.6%
i. Improving the efficiency of machinery and equipment	58.5%	18.7%	14.6%	8.1%
j. Protecting your knowledge	48.0%	37.4%	9.8%	4.9%
k. Co-operating with others (customers, suppliers, colleges, etc) in innovation projects	44.7%	39.0%	13.0%	3.3%
l. Accessing sources of finance	29.3%	39.8%	24.4%	6.5%
m. Improving your technological understanding of your products and processes	49.6%	35.0%	8.9%	6.5%
n. Quality certification (e.g. ISO 9000, supplier approval, ISO 14000)	43.9%	27.6%	22.0%	6.5%

This attention to factors associated with innovation, knowledge accumulation and continuous upgrading is also reflected in the overall competitiveness of business. The vast majority of companies interviewed believe they are at least as competitive as their most successful competitors and in between a fifth and a third of the cases they say that they outperform their direct competitors (**Exhibit 33**).

Company responses imply significant scope for improving their performance on many of the success factors. Innovation- and technology-related factors were (by a small margin) among the most important areas where respondents felt they out-performed the competition. Correspondingly, across the different factors, two thirds to four fifths of the respondents claimed that they had no particular advantage over competitors. Given the likely positive bias in responses to this question, this suggests considerable scope for improvement.

Exhibit 33 Comparison of company performance with that of their most successful competitors

	Better	Same	Less well	Not applicable
a. Introducing new or improved products/services aimed at existing customers	32.5%	45.5%	14.6%	7.3%
b. Introducing new or improved products/services to attract new customers	36.6%	38.2%	16.3%	8.1%
c. Expanding customer base for existing products	26.0%	56.1%	12.2%	5.7%
d. Complying with new regulation or legislative obligations	23.6%	57.7%	5.7%	11.4%
e. Regularly introducing new processes	28.5%	47.2%	11.4%	12.2%
f. Introducing new organisational and management techniques	14.6%	52.8%	17.1%	14.6%
g. Finding or using new technologies	29.3%	42.3%	17.9%	8.9%
h. Improving the productivity of personnel	28.5%	48.8%	7.3%	13.0%
i. Improving the efficiency of machinery and equipment	21.1%	48.8%	7.3%	20.3%
j. Protecting your knowledge	21.1%	50.4%	10.6%	15.4%
k. Co-operating with others (customers, suppliers, colleges, etc) in innovation projects	23.6%	39.0%	23.6%	11.4%
l. Accessing sources of finance	17.9%	43.9%	14.6%	19.5%
m. Improving your technological understanding of your products and processes	30.9%	48.0%	5.7%	13.0%
n. Quality certification (egg ISO 9000, supplier approval, ISO 14000)	20.3%	44.7%	16.3%	17.1%

We wanted to understand whether companies prioritised absorptive capacity-related activities that were likely to increase their competitiveness. We therefore matched the values reported in Exhibit 32 and Exhibit 33 in Exhibit 34. We selected companies, which responded with the value “High” to the question on the importance of success factors (Exhibit 32) and “Better” to the question on the comparison of company performance (Exhibit 33), and matched the responses in Exhibit 34. Responses were then tested for Spearman’s correlation, which gives a non-parametric test for the strength of the relationship between pairs of variables. This correlation index is particularly suited for discrete or ordinal scale data (In our case the answer “High” to the question on the importance of success factors was coded with the value 1 and other responses with 0.)

As shown in Exhibit 34, companies investing in products/services innovations and in process innovations are generally more competitive than competitors with respect to these aspects. Indeed, investing in innovations makes companies more able to retain and expand their customer bases. This is also the case for companies focusing on co-operating with others and on improving their own technological understanding. In fact, these companies also tend to be more successful with respect to these knowledge-related factors and with respect to innovation. On the other hand, efforts spent in knowledge protection do not seem to lead to significantly superior competitiveness in any particular field.

Exhibit 34 Success factors and comparison with competitors

	Comparison with most successful competitors													
Success factors	a. New prod/serv for existing customers	b. New prod/serv to attract new customers	c. Expanding customer base for existing prod	d. Complying with new regulation	e. Regularly introducing new processes	f. Introducing new org and manag techniques	g. Finding or using new technologies	h. Improving productivity of personnel	i. Improving efficiency of machinery/equip	j. Protecting your knowledge	k. Co-operating with others in innovation proj	l. Accessing sources of finance	m. Improving techno understanding of prod/proc	n. Quality certification
a. New prod/serv for existing customers	90.0	80.0	81.3	69.0	80.0	88.9	75.0	68.6	69.2	73.1	72.4	86.4	81.6	84.0
b. New prod/serv to attract new customers	85.0	91.1	90.6	75.9	80.0	88.9	83.3	74.3	76.9	76.9	72.4	72.7	78.9	80.0
c. Expanding customer base for existing prod	70.0	73.3	90.6	79.3	62.9	77.8	75.0	74.3	80.8	73.1	86.2	81.8	73.7	76.0
d. Complying with new regulation	42.5	37.8	53.1	51.7	45.7	44.4	36.1	51.4	38.5	46.2	44.8	54.5	39.5	48.0
e. Regularly introducing new processes	35.0	28.9	31.3	34.5	34.3	44.4	27.8	28.6	26.9	23.1	31.0	36.4	34.2	32.0
f. Introducing new org and manag techniques	37.5	37.8	43.8	31.0	37.1	61.1	36.1	28.6	38.5	26.9	41.4	22.7	44.7	40.0
g. Finding or using new technologies	57.5	46.7	34.4	34.5	51.4	50.0	55.6	28.6	34.6	34.6	51.7	36.4	36.8	48.0
h. Improving productivity of personnel	85.0	82.2	75.0	72.4	82.9	77.8	77.8	77.1	76.9	76.9	86.2	81.8	81.6	88.0
i. Improving efficiency of machinery/equip	60.0	62.2	65.6	72.4	77.1	61.1	52.8	60.0	76.9	69.2	79.3	72.7	71.1	64.0
j. Protecting your knowledge	57.5	55.6	53.1	51.7	54.3	50.0	58.3	51.4	57.7	61.5	51.7	59.1	55.3	52.0
k. Co-operating with others in innovation proj	52.5	53.3	56.3	51.7	54.3	61.1	52.8	57.1	46.2	57.7	62.1	68.2	60.5	56.0
l. Accessing sources of finance	40.0	37.8	31.3	17.2	31.4	38.9	41.7	25.7	26.9	26.9	34.5	36.4	31.6	28.0
m. Improving techno understanding of prod/proc	62.5	60.0	65.6	51.7	60.0	72.2	66.7	54.3	53.8	53.8	62.1	59.1	68.4	64.0
n. Quality certification	40.0	46.7	50.0	58.6	34.3	50.0	38.9	42.9	46.2	34.6	44.8	59.1	52.6	72.0

Note: shaded cells represent values significantly correlated (see Exhibit 35)

Finally, improving productivity and efficiency of internal factors also leads to superior competitiveness in the field of innovation and in cooperating with others.

Respondents' views about the importance of the success factors, combined with their judgements about their positioning vis-à-vis their competitors, allows us to infer the relative performance of the success-factors. If we (arbitrarily) take those success factors for which in at least 50% of the cases the companies are also more competitive than competitors, then the key success factors are

- New products/services for existing customers
- New products/services for new customers
- Expanding customer base for existing products
- Improving personnel productivity
- Improving the efficiency of machinery and equipment
- Protecting knowledge
- Co-operating with others in innovation projects
- Improving technological understanding of products and processes

This is, however, somewhat tautological. But if we then look at those factors which correlate well with the first three judgements about performance compared with competitors (these are judgements about performance rather than behaviour) we still get the same list.

Exhibit 35 reports a ranking of the correlation indices estimated for the variables reported in Exhibit 34. Exhibit 35 lists all the couples of variables significantly correlated and ranks them in order of correlation coefficient. The fact that many success factors correlate with performing better than competitors on the same dimension is in one sense trivial, but does provide assurance that there is a link between what companies say is important and how they believe they perform. In our case studies, however, we show that there are also important gaps in companies' perceptions, and we will therefore argue that there is a need for the support portfolio to include instruments that increase companies' awareness of their innovation needs and opportunities.

The coefficients estimated are not very high, but are consistent. However, in most of the cases the factors shown appear more than once in the list. This implies that there is more than one factor influencing perceived competitiveness in another factor. For example, in our case say in column 2 of Exhibit 35, high competitiveness in factor *a: New product/services for existing customers,* is associated with 5 factors, namely *a, e, g, h, m*. Therefore, in our example, the fact that the company focuses on (a) introducing new products for existing customers, (e) new processes, (g) finding new technologies, (h) improving the productivity of personnel and (m) improving the technological understanding of product and processes, is significantly associated with being highly competitive in introducing new products/services for existing customers.

However, Exhibit 35 suggests that among the factors considered, protecting companies' own knowledge and accessing sources of finance are not correlated with any success factors. This supports the idea that accessing financial support does not lead to major changes in competitiveness in any of the fields considered. It also suggests that companies protecting own knowledge are also less outward oriented

and less ready to share knowledge, factors that appear to be associated with innovative success.

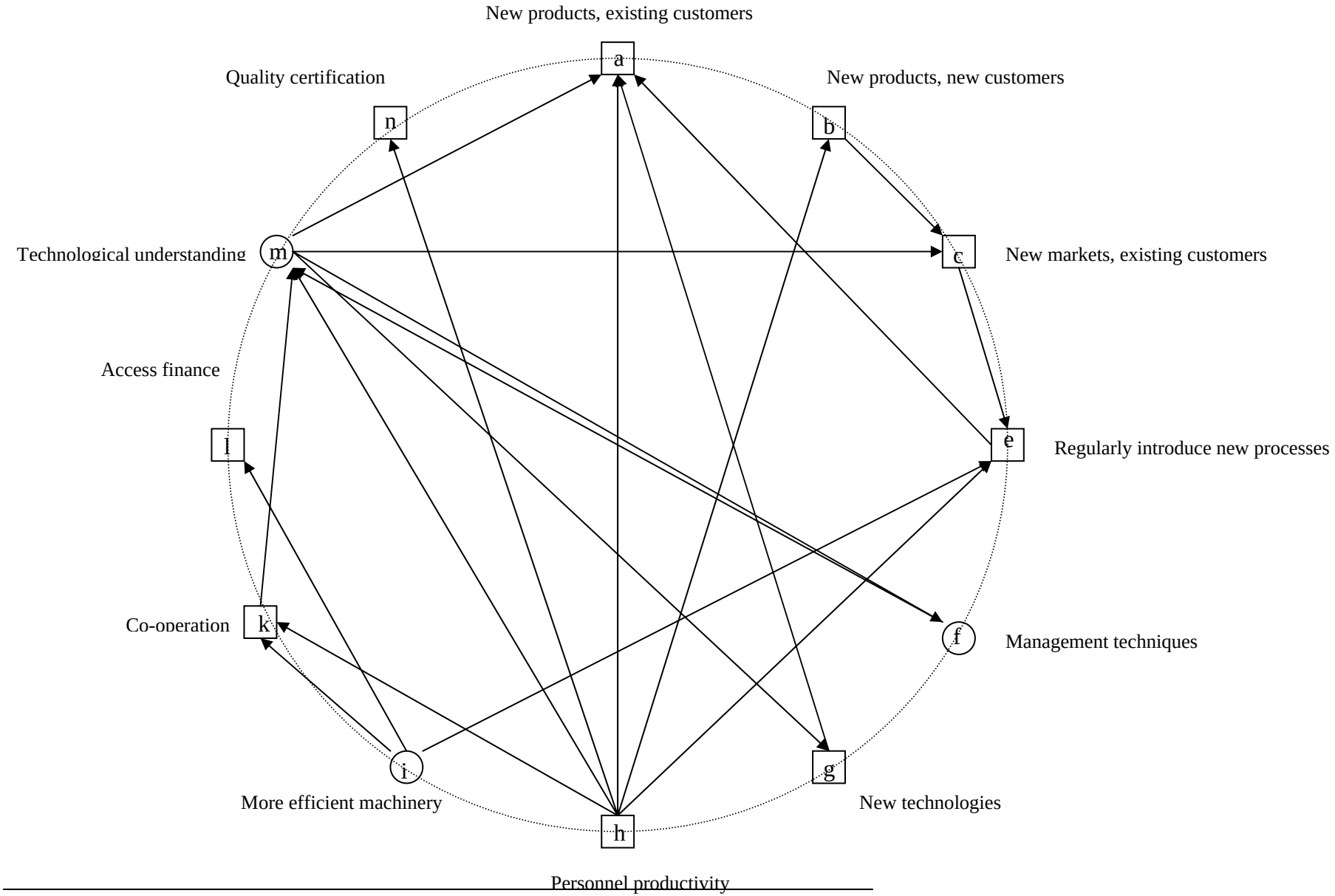
This kind of complex information is hard to visualise. Exhibit 36 is an alternative visualisation. It shows how the factors in Exhibit 35 are linked, with arrows showing the direction of causality. Factors that correlate significantly with themselves (as in the first row of Exhibit 35) are shown in squares; the others are in circles.

Exhibit 35 Correlation between success factors and firms' comparison with competitors

Success factors	Competitiveness	Correlation coefficient*
b. New prod/serv to attract new customers	b. New prod/serv to attract new customers	*0.297*
n. Quality certification	n. Quality certification	*0.286*
a. New prod/serv for existing customers	a. New prod/serv for existing customers	*0.274*
g. Finding or using new technologies	a. New prod/serv for existing customers	*0.263*
f. Introducing new org and manag techniques	f. Introducing new org and manag techniques	*0.262*
m. Improving techno understanding of prod/proc	m. Improving techno understanding of prod/proc	*0.252*
h. Improving productivity of personnel	a. New prod/serv for existing customers	*0.239*
i. Improving efficiency of machinery/equip	e. Regularly introducing new processes	*0.238*
i. Improving efficiency of machinery/equip	k. Co-operating with others in innovation proj	*0.234*
b. New prod/serv to attract new customers	c. Expanding customer base for existing prod	*0.225*
k. Co-operating with others in innovation proj	l. Accessing sources of finance	*0.220*
m. Improving techno understanding of prod/proc	g. Finding or using new technologies	*0.220*
g. Finding or using new technologies	g. Finding or using new technologies	*0.218*
h. Improving productivity of personnel	b. New prod/serv to attract new customers	*0.216*
k. Co-operating with others in innovation proj	m. Improving techno understanding of prod/proc	*0.213*
c. Expanding customer base for existing prod	c. Expanding customer base for existing prod	*0.207*
h. Improving productivity of personnel	n. Quality certification	*0.207*
h. Improving productivity of personnel	k. Co-operating with others in innovation proj	*0.206*
e. Regularly introducing new processes	f. Introducing new org and manag techniques	*0.204*
k. Co-operating with others in innovation proj	k. Co-operating with others in innovation proj	*0.194*
i. Improving efficiency of machinery/equip	i. Improving efficiency of machinery/equip	*0.193*
m. Improving techno understanding of prod/proc	c. Expanding customer base for existing prod	*0.190*
h. Improving productivity of personnel	e. Regularly introducing new processes	*0.188*
m. Improving techno understanding of prod/proc	f. Introducing new org and manag techniques	*0.187*
f. Introducing new org and manag techniques	m. Improving techno understanding of prod/proc	*0.187*
e. Regularly introducing new processes	a. New prod/serv for existing customers	*0.187*
h. Improving productivity of personnel	m. Improving techno understanding of prod/proc	*0.180*
m. Improving techno understanding of prod/proc	a. New prod/serv for existing customers	*0.179*
c. Expanding customer base for existing prod	e. Regularly introducing new processes	*-0.187*

Note (*): Only coefficients significant at least at 5% level are listed.

Exhibit 36 Links between success factors and performance compared with competitors



3.4.2 Characteristics of innovating companies

In order to identify the characteristics of innovating firms, we selected a set of "drivers" of innovation and observed the differences between companies introducing product innovations and other companies with respect to such factors.

Overall, 91 companies in the sample selected have introduced product innovations over the last 3 years. The samples were defined as reported below:

- GROUP 1 = product innovation (91 cases)
- GROUP 0 = no product innovation (32 cases)

An independent samples T test was run on the means of the two samples considered.
We specified the direction of the difference in advance (e.g. the mean for factor X in group 1 is supposed to be lower than the mean for the same factor in group 0). Doing this, then the research hypothesis is directional and permits a one-tail test of significance. A non-directional research hypothesis would require a two-tail test.

The results of the calculations are reported in Exhibit 37. The last column of the Table reports the results of the T-Test for significant variables.

Exhibit 37 Characteristics of innovating companies

	Product innovation	No product innovation	1-tail T-Test
	Mean	Mean	
Services company	0.22	0.25	
Company owner-managed	0.71	0.59	
Dedicated in-house R&D	0.53	0.09	**
Postgraduate employees	0.06	0.07	
Graduate and postgraduate employees	0.24	0.19	
Internal training	0.96	0.88	
Employees with experience in multinationals	0.75	0.69	
Student hosting	0.46	0.56	
Someone in the company is responsible for monitoring opportunities for innovation	0.58	0.31	**
Financial support for innovation	0.49	0.25	**
Purchase of services in Ireland	0.84	0.59	**
	N = 91	N = 32	

Note: * T-Test passed at 5% level, ** T-Test passed at 1% level

Overall, the results reported in Exhibit 37 show the importance of R&D and human capital for innovation. R&D activity is clearly a driver of innovation activity and the difference in means is highly statistically significant. In innovating companies, the number of graduates and postgraduates is higher than elsewhere and training activity is more intense.

Innovating companies are more likely to have employees with previous work experience in multinational companies but are also less likely to host students. However, innovating firms pay great attention to monitoring technological opportunities for innovation and employ personnel specifically responsible for this.

Finally, innovating companies are more likely to access financial support for innovation and purchase services from Irish organisations. They are also more likely to be owner managed.

3.4.3 Research and innovation in fast growing firms

In order to identify the contribution of knowledge intensive processes to employment growth, we selected a group of fast-growing companies among the group of companies interviewed and observed the differences between them and the other companies with respect to several factors.

Overall, 45 companies in the sample selected experienced employment growth above 10% over the last 3 years. The remaining 78 companies (excluding missing values) had employment growth below 10%, unchanged or had even decreased the number of employees.

We then selected a set of key factors concerning innovation, skills, learning and access to external organisations and compared the means in the two groups of companies selected.

An independent samples one tail T test was run on the means of the two samples considered. The samples were defined as

- GROUP 1 = employment growth >10% (45 cases)
- GROUP 0 = employment growth <=10% (78 cases)

The results of the calculations are shown in Exhibit 38. The last column of the Table reports the results of the T-Test.

The majority of fast growing companies are service companies and are less likely to be owner managed. The difference in means of the variable referring to the service sector is also statistically significant.

Service companies appear to grow faster than manufacturing companies even if they perform less well in terms of innovation (see Exhibit 37). A few remarks are necessary in order to provide an explanation for this phenomenon. Firstly, it is very difficult to provide comparisons of innovation performance across manufacturing and service companies. In fact, regardless of the indicator used (e.g. qualitative or quantitative indicators, indicators on product, process or service innovations, etc.) service companies and manufacturing companies tend to have a different perception of innovation activity. Secondly, the present NACE classification (used here) of the service sector includes companies with very diverse economic (and innovation) activities. Thirdly, the sample of service companies considered here includes almost exclusively knowledge-intensive companies. Fourthly, the superior growth performance of service companies (despite lower innovation performance) complies with the trend in most other European countries, where in the last decade service companies have consistently outperformed manufacturing companies. This is also due to the growing role played by services in manufacturing companies.

Exhibit 38 Characteristics of fast growing companies

	Emp. growth over 10%	Emp. growth below 10%	1-tail T-Test
	Mean	Mean	
Services company	0.31	0.18	*
Company owner-managed	0.64	0.71	
New products/services	0.76	0.73	
Internal development of new products/services	0.60	0.53	
Sales from innovative products/processes	0.29	0.22	
New production processes	0.51	0.49	
Internal development of new processes	0.24	0.33	
Postgraduate employees	0.09	0.05	*
Graduate and postgraduate employees	0.26	0.21	
Dedicated in-house R&D	0.56	0.35	**
R&D personnel FTEs	0.09	0.05	
Employees with experience in multinationals	0.71	0.74	
Internal training	0.91	0.95	
Student hosting	0.56	0.45	
Cooperation agreement on innovation with other organisations	0.40	0.32	
Someone in the company is responsible for monitoring opportunities for innovation	0.53	0.50	
Financial support for innovation	0.58	0.35	**
Purchase of services in Ireland	0.82	0.74	
	N = 45	N = 78	

Note: * T-Test passed at 5% level, ** T-Test passed at 1% level

Fast growing companies are moderately more innovative than other companies. A higher share of their turnover is generated by sales of innovative products. Whilst product and service innovations tend to be developed internally, the development of new processes is commissioned externally.

In fast growing companies innovation activity is supported by stronger efforts in sustaining skills of human resources. In fact, fast growing companies employ a higher number of graduates and postgraduates. However, in the case of fast growing companies the number of companies doing internal training is marginally lower. At first sight, the unexpected negative difference in means with regards to training does not support the belief that upgrading skills is associated with growth. However, it must be stressed that in many SMEs upgrading of skills via formal training is a tacit process. Alternative forms of learning such as learning by doing and learning by using assume key relevance. Further, training activity is carried out in most innovating companies and therefore, although not directly linked with growth, it drives innovation activity.

Fast growing companies are also far more likely to host students and recent graduates for the completion of projects. It is here worth remembering that, as stressed in Exhibit 24, student hosting is generally beneficial for the innovation process.

Most of the 'fast growing companies' have formal R&D units and have a higher share of employment in R&D activity. Fast growing companies are more likely to have cooperation agreements with other organisations. Despite the difference in means not being significant, this result supports the importance of networking and collective efficiency for the success of small firms. On the other hand, no significant differences emerge from the data on monitoring of opportunities for innovation. This may be due to the fact that monitoring activity is a common practice informally undertaken by most entrepreneurs in SMEs and therefore no direct relationship with employment growth emerges.

Finally, the difference in means concerning the support to business in Ireland provides some encouraging results. In fact, most fast growing companies have accessed financial support for innovation and preferred purchasing services from domestic organisations.

A comparison of statements about companies' internal management of the innovation process evidences how fast growing companies tend to encourage and support contributions of the workforce to improve products and processes (Exhibit 39).

Most of the growing companies have formal mechanisms and suggestion schemes aiming at supporting contributions to innovation activity even if these suggestions in fewer cases receive any financial reward.

Mixed results emerge from the comparison of data on statements regarding management of innovation. In fast growing companies, new products and processes form part of a business plan and the plan also takes into consideration future employment of staff necessary to achieve specific goals. However, in such companies the management is less likely to meet to discuss company strategies or to document its strategy in business plans.

Finally, according to the evidence provided in
Exhibit 40, fast growing companies need less support for undertaking technological change. Indeed, both in the case of products and process innovations, most successful companies seem to face fewer problems with respect to the adoption of new technologies and to the modification of existing ones.

Fast growing companies seem to have the internal capabilities to adopt with less effort new technologies and therefore respond better to new market challenges. Indeed, this may depend on the major focus in fast growing companies on internal skills, internal R&D activity and interaction with external organisations.

Exhibit 39 Statements about the company

	Emp. growth over 10%	Emp. growth below 10%	1-tail T-Test
	Mean	Mean	
Statements:			
a. Formal mechanisms, such as quality systems, are used to help the workforce to improve processes or products	0.82	0.65	*
b. We have a suggestions scheme for product and process improvements	0.60	0.45	
c. Suggestions are regularly considered by management for implementation	0.67	0.76	
d. Those whose suggestions are taken up receive a financial reward	0.16	0.28	
e. Management meets regularly to discuss our company strategy	0.78	0.83	
f. The company documents its strategy in a business plan each year	0.60	0.65	
g. New products or processes form part of the business plan	0.80	0.76	
h. The plan includes detailed plans for employing people with specific qualifications	0.44	0.38	
	N = 45	N = 78	

Note: * T-Test passed at 5% level, ** T-Test passed at 1% level

Therefore, this provides some support to the idea that easing the process of upgrading and embodying new technological opportunities in the innovation process leads to companies' growth and fosters their competitiveness.

Exhibit 40 Factors for which companies would need external help: growth

	Emp. growth over 10%	Emp. growth below 10%	1-tail T-Test
	Mean	Mean	
Products/services			
a. Adopting new 'turn-key' technologies	0.36	0.63	**
b. Minor modification of technologies already used in-house	0.36	0.42	
c. Major modification of technologies already used in-house	0.47	0.53	
d. Making radical changes in technology	0.47	0.65	*
Processes			
a. Adopting new 'turn-key' technologies	0.42	0.59	*
b. Minor modification of technologies already used in-house	0.36	0.40	
c. Major modification of technologies already used in-house	0.47	0.54	
d. Making radical changes in technology	0.51	0.59	
	N = 45	N = 78	

Note: * T-Test passed at 5% level, ** T-Test passed at 1% level

However, when R&D activity is considered, the analysis of companies' needs provides quite different results. Whilst fast-growing companies generally need less support in adopting new technologies, firms with a formal R&D department seem to be more exposed to such issues. In fact, both for product and process innovations, the major proportion of R&D performing companies would benefit from some external help in applying changes to their own technologies. Indeed, these results provide support for the arguments on absorptive capacity. R&D activity seems to increase firms' awareness about internal problems and stimulates firms to search for possible solutions.

Exhibit 41 Factors for which companies would need external help: R&D

	R&D	No R&D	1-tail T-Test
	Mean	Mean	
Products/services			
a. Adopting new 'turn-key' technologies	0.53	0.53	
b. Minor modification of technologies already used in-house	0.47	0.32	*
c. Major modification of technologies already used in-house	0.59	0.46	
d. Making radical changes in technology	0.55	0.57	
Processes			
a. Adopting new 'turn-key' technologies	0.57	0.50	
b. Minor modification of technologies already used in-house	0.47	0.35	
c. Major modification of technologies already used in-house	0.65	0.40	**
d. Making radical changes in technology	0.63	0.56	
	N = 51	N = 72	

Note: * T-Test passed at 5% level, ** T-Test passed at 1% level

3.5 Conclusions

The sample of firms surveyed is highly innovative. Three quarters said they had introduced a new product or service in the last 3 years. The majority of product (75%) and process (61%) innovations were developed internally.

Companies tended to see technological innovation and the skills needed to undertake it as an important success factor. The keys to performing better than their competitors were seen as producing new products and services not only to meet the needs of existing customers but also to capture new ones. It was important to improve personnel productivity and to improve the efficiency of machinery and equipment. Improving companies' technological understanding of products and process was a requirement in order to do this.

Respondents' innovation activities depended upon the employment of skilled people, especially graduates. While only 14% of companies were involved in formal technology networks, companies made quite extensive use of scientific and business services to obtain information. Low-effort sources of information, like the Internet or trade fairs, were widely used to monitor opportunities, but there was much less use

of continuous and specialised monitoring through networks, Third Level institutions or monitoring services. While new products and processes were often integrated into business planning, the human resources needed to implement the plan were only considered in 40% of the cases. In general, there were few signs that companies had developed or systematised routines for identifying innovation opportunities or realising the value of external knowledge.

Given the presence of Enterprise Ireland, it did not appear all that difficult for companies to finance innovation, but there was no evident link between getting finance and having a particular kind of need for external help in order to compensate for gaps in internal capabilities.

We analysed the responses from the interviews to see whether differences in behaviour were associated with success. We had to experiment with different ways of defining 'success' statistically, and settled on dividing the respondents into two categories: 'successful' firms, whose employment grew 10% or more in the last 3 years; and others. Successful firms were more likely to be in the service sectors than manufacturing, did more product (but not process) innovation and had better qualified, more dedicated human resources for innovation. They had higher technological capabilities (in the sense of ability to adopt, adapt and change technology) than slower-growing firms, and therefore higher absorptive capacity. They tended to network more and were more likely to have received financial support for innovation. They used more formal or structured processes to capture and exploit innovation opportunities, but these were not always integrated into the planning process.

The evidence from the survey, then, provides a strong endorsement of the central messages of the literature about absorptive capacity. In particular, it underlines the importance of appropriate human resources and the benefits of deliberate management of innovation. There are, of course, limits about what such a survey can tell us about the 'softer' aspects of absorptive capacity.

4 Summary of face to face / extended telephone interviews and case studies

Face to face interviews are always useful in evaluation work as they permit informal discussion, allow unanticipated aspects to emerge and provide the interviewers with a working impression of the actors involved.

It proved very difficult to arrange interviews on this particular piece of work, perhaps due to the rather oblique nature of the subject in comparison to the more direct interests of businesses and due in some degree to a 'survey overload' being experienced by Irish businesses. A series of fifteen interviews was conducted, most of them during visits to the companies and some by extended telephone discussion where visits proved too difficult to arrange. Ten of these have been written up as case studies, and are shown at the Appendix.

4.1 The businesses

The smallest business interviewed employed 9, the largest 140. With an average number of employees of 51.6, the businesses were considered large enough to have sufficient grasp of innovation and related business issues. Sectors ranged from digital mapping to pharmaceutical labelling and the length of time in business averaged 22.4 years – 17.4 years if one exceptional company (founded 67 years ago) is ignored.

Length of time in business is very important in the Irish context. Not only have most of the businesses interviewed been exposed to the usual problems of start-up, second stage growth and maturity, they have also survived a period of significant change – towards the 'knowledge economy' in Ireland and the dramatic effects of globalisation on manufacturing in developed economies. The sample therefore, although small, is seen as representative of the main issues that form the core of the study – the capacity to innovate in their products, processes and management and the internal and external resources they make use of to achieve change in these areas.

4.2 Product Innovation

The 'products' of the companies interviewed ranged from rainwater guttering to financial investment packages, so were very diverse in nature. In general, product development tended to be a rather linear kind of related product diversification. The company produces one kind of product, can see a market for another product that uses the same or similar technology and moves in that direction. A classic example here is Company D who makes and installs fascia boards for houses. Rainwater guttering usually needs to be replaced during installation of fascia boards. The company could therefore see that if they made these components they had a ready distribution network and market as a base for later selling more products. The manufacturing technology and materials used for both product types are the same, so investment was restricted to increasing capacity and mould making – both well within the company's existing capabilities.

A company that is even more closely linked to established technology is Kenilworth Products, a company highly specialised in pharmaceutical labelling. The company keeps in close contact with their machinery and material suppliers and when any new

product or requirement comes along they work jointly with both groups to arrive at suitable solutions.

Although simple, related-product diversification models of this nature are the 'safest bets' for companies in terms of investment versus their likely outcomes, it is unlikely that this model will cater for more than incremental change and growth. In both of the cases mentioned the only external inputs were from customers and suppliers who are closely tied to either the products or the known technologies of the companies interviewed. This again tends to restrict the inflow of new ideas to the linear process.

One company that did demonstrate a small but important move outside of the linear innovation model was Company E. The company produce a range of golf wear, some under licence from US companies and some as their own designs. In reviewing one their own designs a senior member of staff suggested that the garment could be made more waterproof by incorporating zips that are used on ski clothing. This was done and the garment sold well. In making this small step the company had in effect introduced a design innovation from another branch of activity: ski clothing. This concept could have been pursued in other designs to give them a greater market edge, but was not formally recognised or acted upon.

In discussion on sources of information on new products, the majority of those interviewed quoted exhibitions, the internet, trade journals and suppliers as their prime sources.

It may be seen from these examples that the companies recognise the importance of innovation, but in the absence of any other influences quite rightly opt for a linear or incremental related-product innovation model in areas that they are familiar with and where they can see substantial evidence of likely success. In doing so, they miss out on potential products that are within their technical and marketing capabilities.

4.3 Process Innovation

Process innovation can be considered as three separate aspects – totally new 'step change' processes that will dramatically affect production, 'incremental' improvements in the efficiency of current processes and the outsourcing of processes for economic reasons.

'Step change' improvements are rare and were not in evidence to a great degree from the companies interviewed. Perhaps the only examples identified are Company A and O'Brien Press. Company A saw the potential of digital mapping, recognised a market opportunity in Ireland and has since gone on to link the technique to special customer requirements. O'Brien saw similar potential in computerised publishing which was seen to have 'saved the company' a decade ago, but the company appears to be slow in capitalising on another 'step change' technology - e-trading - to market their specialist Irish literature titles to the USA. In order to capitalise on such changes – which can offer major benefits in terms of profitability and market share – companies often need to invest in the transition of these 'leading edge' improvements from experimental or prototype processes into full production. To achieve this they need strong links to the sources of development – often university departments or the research units of commercial suppliers. None of the companies interviewed had links with research teams in higher education, but some of them do keep in close contact with suppliers. Links with higher education institutes (HEIs), whilst perhaps less pertinent to the immediate business issues of the companies concerned, could offer a greater variety of solutions in a less biased way. Probably, however, the type of help needed by the companies is rather less advanced that that

which would be interesting to the HEIs. It involves reworking existing knowledge rather than developing new knowledge. This is the kind of help that in other countries is available from Research Institutes – for example the Danish GTS institutes, whose mission is to provide 'Technological Service' to industry, especially SMEs. Trade suppliers on the other hand are likely to offer solutions of more direct interest – as is the case with Kenilworth Products - but inevitably tie customers into their own fields of research, perhaps resulting in them missing out on developments elsewhere.

Incremental improvements offer perhaps the greatest potential for savings in return for lower levels of investment. Most of the production companies interviewed were of sufficient size to have their own production specialists and there was evidence – in companies such as Company B Partners and Company D - that incremental improvement was part of their operation. Such improvements inevitably veer into management techniques and these again were evident, using quality circles and supply chain management techniques to good effect. For less enlightened companies there is an earlier stage in process improvement, which of external advice being used to assess processes and to question ways in which things are done, with a view to suggesting improvements. Company D and Millennium Controls had used private consultants in this respect; the process of identifying and engaging the specialists had been informal and not through any business support organisation.

A good example of the outsourcing of processes may be seen at Company E, where the company originally set up to manufacture sports clothing in a new factory, but has subsequently completely outsourced production to suppliers in South America and the Far East. The effects of globalisation on manufacturing jobs in the developed economies are well known and the facts on low technology, high labour content products are simple – either invests heavily in automation or shift production to lower cost areas. Company E took this message firmly on board and has managed to expand its market share to a point where most of their former manufacturing space is now used for warehousing. This dramatic – and crucial – shift in their business was achieved entirely from their own market intelligence and management knowledge, without any external input. A contrast may be seen at Company C where foreign competition in mould making has already resulted in a reduction from 25 to 9 staff in 2 years.

4.4 Management Innovation

This is a broad ranging subject area, from managing the innovation process itself – the acquisition and development of ideas, intellectual property protection, etc, - through to being more innovative in managing a business – using techniques such as lean production, quality circles, etc. The two of course often blend together; using more innovative management techniques may also result in the creation of more innovative products and processes.

Management innovation in both a minor and major way could be seen at Company E. The process of managing the product innovation mentioned earlier – the waterproof zip – could be seen as 'common sense', in that staff regularly meets to consider new designs and on one occasion a senior member of staff suggested a design improvement that was adopted, resulting in a design feature unique to the market. This comparatively minor event should not however mask the underlying importance of the process that successfully took place.

The important stages were;

- Staff from all levels meet regularly to discuss products
- There was sufficient foresight for a suggestion to be made that was 'new to the firm'
- The management process allowed the suggestion to become reality
- The suggestion was successfully implemented
- The result was recognised

Perhaps the only flaw in this case was that the suggestion was seen as a minor one and the principle behind the innovation – that of using features from other activity clothing sectors – was largely missed in terms of future product development.

The major management innovation at Company E was allied with their shift to outsourcing. The company realised that a new system of production and stock control was needed in order to quickly translate orders into stock situations and production instructions. This is particularly important if a new line sells well in a season and production has to be quickly stepped up to meet short-term demand. A new system was introduced using Enterprise Ireland grant aid, but with hindsight was based on software that did not, and could not, meet with the company's demands. Eventually the system was scrapped and an entirely new one has since been developed. Although everyone has sound vision in hindsight, a conclusion could be that the right level of advice from those with systems experience in the industry could have averted an expensive mistake.

Several of the companies interviewed make use of higher management training through FÀS and participating HEIs. This shows foresight on the part of companies that are prepared to allow senior executives the time to attend, and vision from the HEIs who have perceived the need for on-going management development using top level international courses and tutors. The process was universally well received by the participants who welcomed both the input of international experts and the facility to discuss management issues with their peers in an informal network of well educated and experienced managers. There was however some evidence that infusing the new ideas and thinking that they were exposed to into their own management structure was proving difficult, especially where businesses were family owned. Such frustrations can of course result in the process being counter-productive for the participating businesses as they may well lose skilled managers to companies that are more receptive to change.

4.5 Use of External Sources of Help and Information

Discussions on external help and advice focused on the interviewees' use of HEIs and state funded support through Enterprise Ireland. There were clear responses to both sets of questions.

Although the range of businesses interviewed could not be considered in the main as 'high tech', it was surprising that none of them made use of universities for product or process innovation. The only reported use was in the field of training, in particular management training. Whilst this situation may not be unusual, the stance of many of the interviewees was one of mistrust and questioning as to the relevance of the work done in HEIs for businesses such as theirs. Comments were made about the inability of academe to deliver practical solutions on time and there was a general feeling that HEIs would create projects around their own research interests rather than to fulfil genuine business requirements.

In discussing state funded support, many of the businesses reported regular contact with Enterprise Ireland and many of them had made use of grants for market studies, technology acquisition and training support. The general feeling was however one of the business making decisions in isolation, then applying for support – in effect using the state support rather as a more friendly bank than as business and technology mentors. Whilst it could be argued that free market philosophies advocate non-intervention on the part of the state, many of the instances discussed in the earlier sections could have been prompted, developed or acted upon more quickly and efficiently if appropriate resources had been made available when needed. This then begs the question of whether suitable resources are available and, if so, whether the means of accessing them work.

'Other sources of help' were the usual categories that tend to be cited by SMEs – their suppliers and independent consultants for advice, and the internet, exhibitions and journals for information. Given the use of these resources - perhaps in the absence of any other obvious support – it is worth considering how these sources are organised, accessed and paid for if wider use is to be made and quality is to be assured.

The essence of the internet is that it is of course free of controls, but in some countries services are available that will scan the massive volume of available information and home in on items of particular interest. It could therefore prove useful to offer an internet based current awareness service that could focus on particular products, services and sectors. Similarly, assistance could be provided to make companies more aware of relevant exhibitions and to fund their attendance.

When questioned about their means of accessing consultancy advice, those interviewed gave a variety of sources ranging from the internet to business associates. The organisation and quality control of consultants is again an area that has received much attention in other countries. A system that lists consultants according to skills, sectoral experience and project track record could prove a useful resource for companies seeking a verified source of help and advice in Ireland. Again, funding could be used to assist the companies towards paying for the advice.

4.6 Conclusions

The interviews showed that, while clearly there is significant innovation capability in the firms interviewed, and in many cases it is being used to expand businesses, improve their efficiency and improve their management, there are opportunities for wider, more skill-based and more systematic innovation. The most concerning feature of those interviewed was that innovation actions appear generally to be taking place in a 'bubble' – isolated from important external networks and knowledge. The motivation for change and implementation of actions for change appear to be driven almost entirely from within the company, with very little external input, resulting in 'safe' incremental innovation, often through related-product diversification.

Given the achievements of the businesses that have undergone change – and the difficulties faced by those that have not - more could potentially be provided to facilitate the external input described in the earlier sections. There appears to be regular contact between many of the businesses and EI, and funding is available for business growth and training, but there appears to be a missing element of awareness, mentoring and motivation that could be applied to businesses to build on the absorptive capacity present.

Other than training courses, links with higher education among the businesses interviewed were found to be almost non existent. Although this may not be surprising for companies of the type and size concerned, the level of mistrust added to the lack of common ground, networking and means of access indicate that the situation will not easily be changed. Improving the links between academe and businesses in order to improve the take up of research and innovative products has been the subject of considerable research over the years. Whilst there is no magic answer, efforts are still needed to bridge the divide between the two, often beginning with networking events, showcasing of research and liaison staff.

5 Conclusions

The usefulness of this kind of study is to build a basis for policy formulation. It would of course be helpful if there were a stable definition of 'absorptive capacity' and an internationally agreed process for measuring it, so that benchmarking was possible. But, as our literature review clearly shows, there is no such stable definition. Guesses about comparative capacity may be made on the basis of comparisons like the Community Innovation Survey, but are in practice little more than guesses.

We therefore need to say things about the Irish situation based primarily on the evidence collected in this study. Mainstream economists would argue that what this report presents is simply a description: even if they drive economic performance, the fact that the levels of different aspects of absorptive capacity vary has no implications for policy. In the long run, the more capable firms will drive out the less capable ones, and all will be for the best in this best of all possible worlds. In the framework of Innovation Systems thinking, however, we recognise the idea of 'capability failure': that is, that poor capabilities can lead to under-performance by firms, and that the state therefore has a legitimate role in increasing capabilities, so as to improve the performance of the Innovation System as a whole[63]. Increasing capacities among the best performers may have no more effect than to allow them to take over others' market share. Raising the **average** level of capability is more likely to have a positive and sustainable effect on the economy.

5.1 Findings

Our study shows that there certainly is some level of good practice within Irish industry, as regards absorptive capacity. But it also suggests a number of directions in which absorptive capacity needs improvement.

A key weakness of many firms appears to be in the aspect of absorptive capacity that involves **recognising the relevance of external knowledge**. Improvements can only begin once firms understand there are external opportunities or solutions to existing problems. This partly means there have to be internal cognitive capabilities, typically in the form of appropriately educated people with the character and training to see opportunities. It partly means that these people have to be linked into the way the firm is managed in such a way that, when they recognise the value of external knowledge, this recognition can affect what the firm actually does. Without such linkages, Irish firms will not be well placed to exploit the considerable externalities available to them in the economy, not least those generated by the presence of the multinationals. While at the overall level, Irish-based industry is approaching the EU average level of employment of R&D personnel, the bulk of this work for the multinational. This means that **measures to increase the employment of QSEs** by indigenous companies need to be complemented by **measures that modernise and professionalise management**, making it possible to exploit the perceptions of those best equipped to understand and translate external knowledge into business opportunities. Closed management styles make it as difficult to exploit external financing and other support activities as it is to exploit external knowledge.

[63] Erik Arnold, 'Evaluating research and innovation policy: a systems world needs systems evaluations,' ***Research Evaluation,*** April 2004

A corollary of firms' limited ability to perceive value in external knowledge is their comparative **isolation** and their **poor external linkages**. In a competitive situation where both products and services, on the one hand, and the external context, on the other, provide bases for competition (cross-ref Exhibit 3) this clearly makes them vulnerable. It means that many firms are not only ignorant of opportunities but lack the networks of people and the communities of others' with similar or compatible interests that they need in order to get good signals about (and partners in) innovation. It seems to be true that 'innovators do not innovate alone'[64] . Our study, and other studies, show that to a considerable extent those who are alone do not innovate. There is strong evidence in the literature that the number of firms' external linkages increases with their size. We should therefore try to generate policy **measures that accelerate the rate at which firms develop technology-networks**.

The innovation processes we describe in the case studies are narrow – generally rather 'linear' extensions of existing products and processes. Firms' 'search space' is too narrow, both in terms of the knowledge they seek and in terms of the apparent risks they are prepared to take. **Firms need help to search more widely for knowledge** and to find **ways to reduce their levels of perceived risk**, making them more willing to undertake innovation. Finance can be important here, but – in the context of Enterprise Ireland's generous grant provisions, our survey shows that **understanding** is probably more important. No sane entrepreneur willingly takes risks. She appears to take risk because there is information asymmetry: she (believes she) knows more than others about the situation, and can therefore make a better judgement about risks.

Where they exist, R&D and innovation functions appear to be organisationally isolated and often sub-critical. Half the firms said that they need external help to undertake almost any kind of technological innovation, including the adoption of externally produced turnkey technologies. This suggests a massive gap in capabilities. More broadly, it confirms the perception that Ireland requires 'catching up' policies for absorptive capacity development in many if not al branches of industry.

Existing policy measures are weak in this area. Little help is available for firms, which need to become more adventurous in their innovative activities, without at the same time going so far as to become involved with the 'science push' schemes in the RTDI programme. That is, their needs are more to do with accessing and manipulating the **stock** of knowledge than with producing wholly **new** knowledge.

Here, Ireland is deficient not only in schemes but also in the knowledge infrastructure. This kind of intermediate knowledge development is not interesting for most HEIs: it is not their mission. In many respects, the more mundane activities of the PATs in the past correspond to this level of need. Internationally, it is satisfied by specialised Research Institutes, such as the Danish GTS Institutes, whose mission involved delivering 'technological service' to industry, especially SMEs. **This structural deficit needs to be tackled.**

It is well-known that improving the capabilities of smaller firms with low technological capability can not be achieved simply by hanging up a sign advertising support, and waiting for companies to apply. A **proactive** approach by people who themselves have technological capabilities is needed, using measures such as technology audits, visits to good-practice competitors at home and abroad, and so on. This

[64] Christopher de Bresson, 'Networks of innovators: a synthesis of research issues', Research Policy, 20 (5), 1991, pp 499-514

raises important questions about the capabilities and operating style of the support system.

5.2 Opportunities to intervene

This section summarises opportunities for the state to act in support of increased absorptive capacity and therefore innovation. It is recognised that some services are already available in these areas, but they are listed for completeness.

Broadening awareness of innovation and recognising the value of external knowledge

- Regular exposure to a 'shop window' of potential innovative products
- Closer contact with potential sources of process improvement – HEIs and suppliers
- Better pooling of knowledge and experience on process improvement
- Greater awareness of the effects of global trading on specific sectors – and assistance where possible in taking advantage of these changes
- Contact with experienced product/market development specialists who could 'raise the product innovation horizons' of companies
- The use of external advice to provide a process audit and suggest improvements and implementation assistance

Develop human resources

- Recruitment and mobility schemes, intended to increase the proportion of staff with technical training, degrees and higher degrees in relevant areas of science and technology
- Continuing the on-going education of managers and providing a means to integrate new techniques into their own management structure

Networking

- Network and cluster policies, especially those focusing on technology (cp the AMT and Materials PATs, which have some actions of this type)
- Schemes to promote university-industry co-operation. These should operate not only at the large project level but also at the less intimidating level of student final-year projects

Organisation and routines

- Encouragement of the entrepreneurship and intrapreneurship processes within companies, perhaps using external facilitation
- Wider use of established management innovation tools such as supply chain development, quality circles, etc.
- Linking improvement grants with advice on justification
- Innovation and project management training

Learning processes

- On-going advisory support as a new product is introduced
- Financial assistance to offset the development costs and market doubts of new products

Codification is an area where few policy measures have been developed, and there is a need for innovation in instruments. Instruments that promote quality standards

are useful, because they force organisations to write down how they do things, but there is scope for new ideas here.

International experience clearly supports the idea that service delivery should be proactive and done by people with a technical background as well as intimate understanding of small business.

Appendix A Overview of instruments used to support the generation of absorptive capacity

1 Introduction

This paper provides a summary overview of instruments that are used to support the generation of absorptive capacity in Ireland, the UK, Netherlands, Finland and Sweden. The emphasis was on highlighting schemes that have an element of either technology transfer or skills development capabilities, especially those focused on SMEs.

Numerous types of schemes that can be put in place to address these capability issues, depending not only on the current capabilities of the firms but also on their long term specific needs. These can include, for example

- General business planning support
- Market assistance
- Training schemes (new skills development)
- Technology transfer (through mobility, access to research activities, access to facilities)
- Funding for innovative activities
- Sector specific knowledge enhancement
- Access to knowledge repositories

Internationally there is a variety of schemes that are building capabilities through people and knowledge. The following table gives an overview of instruments that are ongoing in the countries under review

Exhibit 42 Overview of existing international instruments

Country	Scheme	Target	Type of measure	SME specific
IE	RTI	R&D for all manufacturing and international countries	Funding	No
IE	IMI	Companies who want to undertake R&D for the first time	Funding of training courses	No
IE	EI Tailor-made support	Companies who wish to undertaken large R&D projects	Funding	No (excluded)
IE	Innovation partnership initiative	Companies wishing to link up with universities and institutes of technology	Funding for research project	No
IE	R&D Awareness initiative	Companies who want to understand more about R&D	3 days consultancy	No
IE	Initiatives in specific advanced technology	All companies wanting help with sector specific R&D	Funding given to centres of excellence	No

Country	Scheme	Target	Type of measure	SME specific
IE	Fusion scheme	Companies with specific technology needs undertake research with a graduate (From NI)	Technology Transfer	No
IE	Work of country enterprise boards	All companies needing business support	All – General business support	More focused on SMEs
UK	DTI – Technology programme	Companies wishing to undertake collaborative R&D	Funding	No
UK	Grants for investigating an innovative idea	For companies who have an idea but are not sure whether they can take it forward successfully	Grant	No – although more focused that some
UK	Grant for R&D	For helping SMEs and individuals to research and develop new products	Grant	Yes
UK	Knowledge Transfer Partnerships	Companies who wish to join up with research institutes to do research	Funding towards person	No but more so
UK	Management and Leadership programme	Companies wishing to undertake more informal learning	Not yet started	Yes
UK	LINK	All industry – wishing to link up with research base	Funding	Any size
UK	Faraday partnerships	All businesses	Funding/ Knowledge	Any size (specific mention of SMEs)
UK	Phoenix Fund	Enterprises in disadvantaged areas	Funding/advice	Yes
NL	Training facility	Firms - to increase the attractiveness of investing in training	Tax deduction	No
NL	Scholingsimpuls " training initiative	Training of individuals based on gap in industry	Training	No
NL	Knowledge Transfer Branch Organisations/ SMEs	Companies that want to get a knowledge position study carried out by a third party or a knowledge transfer project	Funding	Yes
NL	Knowledge transfer Entrepreneurs	For SMEs to help boost innovation	Feasibility study Knowledge carriers	Yes
NL	Dreamstart	Technostarters - many schemes	Funding	Yes
SE	TUFF	SMEs who wish to cooperate with R&D centres	Funding	Yes

SE	VINNVAXT	Regional innovation systems	Funding for regional networks of companies and knowledge infrastructures	No but supported
SE	VINST	Companies with self developed products	Funding collaborative projects	No
SE	IT.SME.SE	Companies wanting to do IT	Funding/ consultancy	Yes
FI	Entreprene ur-ship policy programme	All businesses	A number of measures	A specific focus on SMEs
FI	TE-keskukset	SMEs looking for general advice – Regional centres	Funding for development and export assistance	Yes
FI	Centre of Expertise	All companies	R&D support	No but supported
FI	TEEs – Technology programme	All companies- research centre set up to pass on knowledge	Funding for the centres to do research	No
FI	R&D funding for companies	All companies wanting to do R&D	Funding	No
FI	TEKES Feasibility Studies	SMEs wanting to work with RI and Universities	Funding	Yes
FI	TEKES TULI	Companies wishing to define business/research ideas	Funding	Yes
FI	Technology Clinics	Technology Transfer for SMEs	Clinics	Yes

2 Overview

The instruments that have been identified have a broad variety of aims ranging from the general business support which contains elements of 'improving technological capability' to very specific technology transfer schemes for the more innovative firms. The policy context is an important reason for the countries collection of tools. The UK for example, has recently undertaken a review of their whole approach to business support. This consultation exercise identified a number of specific areas for improvement, including

- Better evaluation of the economic impact of business support activities in the UK
- Marketing business support solutions in a more customer friendly way
- Streamlining delivery to cut down duplication and improve response times.

As a consequence the complex array of DTI business support schemes have been replaced with fewer strategically focused business support products. Business support for SMEs is mainly delivered through the business links, which in turn are administered by the Small Business Service, an executive agency of the DTI. The 2002 review recommended that the main focus for business support in the UK be to "build capability for small business growth". The government is emphasising the need

for a more holistic approach to support R&D with marketing and investment readiness as well as assisting in the funding of the innovation process.

In Ireland, the main providers of business support are Enterprise Ireland, the County Enterprise Boards and the Chambers of Commerce. Support for training is delivered through FAS, Ireland's national training and employment authority. This includes increasing employability, skills and mobility of job seekers and employees to meet labour market needs and promote competitiveness and social inclusion. Enterprise Ireland provides a set of integrated one stop shop systems with regionally based officers being responsible for contact with companies, identifying needs and offering support.

In 2003, Enterprise Ireland invested over €40 million in support of more than 186 R&D initiatives which included: €21 million under the Research, Technology and Innovation Competitive Fund, supporting more than 133 initiatives. They also established a new fund specifically aimed at improving the competitiveness of small and medium sized companies through gains in output and productivity. The Competitiveness Fund totalled €10 million and supported 97 individual company development projects.

The Netherlands also underwent a period of review between 2000 and 2003 and the government focused on improving existing innovation instruments rather than inventing new ones[65]. Two reports[66], the MAIT and IBO activities acted as building blocks for the government in preparing the new White Paper on Innovation, published in October 2003[67], which strongly focused on streamlining innovation policy instruments. The IBO exercise prompted a reduction in the number of instruments, as well as a more systematic categorisation of types of measures. To a certain extent, innovation policy in the Netherlands now has less of an emphasis on SME development, especially with the demise of one of its oldest schemes, the credit facility for SMEs (the reason being given that it was considered SMEs can get their financing from the private sector). The Government however plans several initiatives to improve the climate for high-tech start-ups. These include: extending the Twinning concept to other fields of technology; promoting facility-sharing (i.e. equipment, test facilities and business premises); combining and strengthening existing, often highly fragmented, regional initiatives for tech-starters; and promoting strategic alliances aimed at joint business development between large and small businesses – this means that innovative ideas that do not fit into a company's portfolio need not be shelved, and can lead to new business activities elsewhere. Also, although the priority given to strengthening the absorptive capacity of SMEs seems to have become somewhat less (the number of measures that existed previously having been trimmed down), there is more emphasis on training the workforce specifically for innovation and formal recognition of learning in informal processes.

In Sweden, the emphasis of innovation policy and technology transfer lies within the universities. Many programmes have been designed to promote effective co-operation between companies and research and development organisations and innovation policy is focused on funding and facilitating this interaction between research institutes and industry (mostly SMEs). Furthermore technology foresights are supported by governmental institutions. Invest in Sweden (ISA) is a partner of networking programmes and supports the networks by presenting companies to the

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65 Trend chart reports : The Netherlands 2003 www.cordis.lu/trendchart

66 MAIT – Monitoring and Impact Assessment of Instruments for Technology policy. *Samenwerken en stroomlijnen: Opties voor een effectief innovatiebeleid*, May 2002

67 Scope for industrial innovation 2003

international public. Recently there has been a major reorganisation of the organisational structure for public funding of research and technological development (RTD) and support to business and regional development.

Finland is seen as a country that is strong on innovation, and the Science and Technology policy council of Finland is responsible for its strategic development and coordination. It published its sixth triennial review '*Knowledge, Innovation and Internationalisation*' in December 2002. In addition to increasing research funding, the Council recommended that the major knowledge and know-how assets (education, research careers and the use of research findings) must be further developed and that the development of new growth areas, research-based innovation and innovation environments must be strengthened.

The Council recommended that public funding should be increased faster than the estimated growth in the GDP. In the case of research, this would mean an increase of €300 million from the 2002 level by 2007. In addition to increasing research funding, the Council proposes three main targets to develop innovation and ensure the successful future development of Finnish science and technology policy. These targets are

- enhancing education, research careers and the utilisation of research findings,
- boosting social and technological innovation,
- ensuring flexible expert development of innovation funding.

Tekes is the main public funding organisation for research and development in Finland. Tekes funds industrial projects as well as projects in research institutes, and especially promotes innovative, risk-intensive projects.

3 International instruments

Instruments that in some way address the capabilities of SMEs can be found in all of the countries analysed.

3.1 Ireland

In Ireland, the county enterprise boards provide the most comprehensive set of business support programmes covering mentoring, business advice, information provision, training and financial support.

The main objective of the City and County Enterprise Boards is to provide support to facilitate the establishment, development and growth of micro-enterprises (small businesses employing less than 10 people) in their city or county. They do this by providing business information and advice, counselling and mentoring support and by providing financial assistance in the form of capital grants, employment grants and feasibility studies.

Enterprise Ireland as the government agency responsible for the development of Irish industry, works with companies of all sizes and has three strategic priorities

- Technology Innovation
- Business Development
- Internationalisation

The majority of the following schemes are funded through Enterprise Ireland.

3.1.1 RTI Schemes

This Enterprise Ireland scheme is aimed at improving the level of high quality R&D in businesses in Ireland. It supports commercially focused, industry led projects in product and process development.

It comprises the following

- RTDI for industry, comprising schemes to help companies build R&D capacity, to subsidise in-house R&D and increase companies' innovation management capabilities
- RTDI Infrastructure, which involved both research and training grants for researchers in the Third Level Institutions (TLIs) and the large Technology Foresight Fund, now operated by Science Foundation Ireland (SFI), funding strategic or 'oriented basic' research in biotechnology and ICT
- RTDI for Collaboration between companies and researchers in the TLIs

A major Programme of Research in the Third Level Institutions (PRTLI) was also set up under the plan, to develop both the physical and human research infrastructure needed in the universities in an increasingly knowledge-based economy.

RTDI for collaboration was an important component of the Productive Sector Operational Plan, 2000 – 2006. The plan implemented the very large increase in R&D funding decided by government at the end of the 1990s, and marked a radical change in the importance of research and innovation in Irish policy
The plan says that under RTDI for Collaboration there will be an emphasis on collaborative research networks, which will

- Build partnerships that enhance company capability and competitiveness in firms, particularly SMEs, through collaboration networks nationally
- Help firms, particularly SMEs, to exploit technology effectively by improving access to appropriate technology available internationally

RTDI for Collaboration comprises three main schemes - – Innovation Partnerships, the Commercialisation Fund and the Programmes in Advanced Technology – plus four smaller initiatives[68].

All manufacturing and internationally traded services companies in Ireland are eligible. The scheme is particularly directed at established companies planning to undertake their first R&D projects, and companies significantly developing their existing R&D activity.

3.1.2 Innovation management initiative

The Innovation management initiative from Enterprise Ireland is aimed at increasing the number of companies undertaking R&D for the first time and to improve the efficiency and effectiveness of the innovation and R&D process in those companies already undertaking R&D to achieve value added R&D by capturing the creative potential of employees.

[68] The Intellectual Property Assistance Scheme, Networking Initiatives, Technology Transfer and the International Collaboration Programme.

EI cover 50% of the course fees for the following courses

- Introduction to R&D Management
- Introduction to R&D Management (Pilot Action - web based delivery)
- Certificate in Innovation and R&D Management for the Food & Drinks Industry
- Building New Products and R&D Capability
- Masters in Technology Management
- Masters in Technology Management by distance education
- Diploma in Technology Management

The programme is open to all manufacturing and internationally traded services companies are eligible and it is open to R&D novices as well as advanced R&D performers.

3.1.3 Tailor made R&D Support

Enterprise Ireland also has a budget put aside for large R&D projects. This relates to companies who wish to undertake projects in excess of €3millon over three-years on an individual company basis. Percentage aid rates and amounts of funding available are determined by value for money considerations and EU state aid limits.

To qualify for support, the proposal from the company has to represent a significant "step-up" in the development of the R&D function compared with the current situation. Therefore the investment can be for R&D staff, equipment and facilities along with a programme of R&D projects.

3.1.4 Innovation partnerships initiative (Technology transfer)

The Innovation Partnerships Initiative provides financial support to encourage companies to undertake research projects with Irish universities and institutes of technology.

The programme is open to all manufacturing, processing and internationally tradable service companies, with an operating base in the Irish Republic, who are collaborating with Irish third-level institutions.

The idea is that the company and the institution jointly define a research project of real commercial benefit to the company.

3.1.5 R&D awareness initiative

The R&D awareness initiative provides support for up to three days technical consultancy to help companies

- Understand the R&D process
- Establishing the right strategy
- Identifying the right project(s) for the company
- Developing a project plan
- Apply for funding

Companies that spend less than €65,000 a year on R&D or have not spent more than €130,000 a year over the last three years are eligible for support.

Individual companies commission a consultancy firm of their choice from a panel of three.

3.1.6 Specific programme in advanced technologies (PATs)

The PATs were launched in 1988 as partnerships between Enterprise Ireland, industry and third level institutions. The programmes currently aim to "make Irish industry more competitive through innovation, research and access to technical experts". They undertake applied research and provide contract research, design, and development and consultancy services to Irish industry. There are currently six PATs associated with some 30 centres in universities and colleges. They are

- Informatics Research Initiative
- BioResearch Ireland (BRI)
- Materials Ireland
- AMT Ireland
- PEI Technologies
- Optronics Ireland

3.1.7 Fusion Scheme – Intertrade Ireland

The idea behind the fusion scheme is to help companies find innovative ways of doing business. This technology transfer scheme aims to develop and support three-way partnerships between companies with specific technology needs, research centres with specialist expertise, and science and technology graduates.

A company in the Republic of Ireland, for example, could source academic expertise and a graduate from the North. They then jointly implement a technology project to solve a particular problem. InterTradeIreland pays for half of the graduate's salary and all of the associated costs such as academic support and travel.

3.1.8 Expertise Ireland[69] – Intertrade Ireland

Expertise Ireland is a joint initiative between the CHIU (Conference of Heads of Irish Universities) and Intertrade Ireland with the aim of bringing together "innovators" and those at the forefront of developing the knowledge economy both from businesses and from academia.

3.1.9 County Enterprise Boards

The main objective of the City and County Enterprise Boards is to provide supports to facilitate the establishment, development and growth of micro-enterprises (small businesses employing up to 10 people). They do this by providing business information and advice, counselling and mentoring support and by providing financial assistance in the form of capital grants, employment grants and feasibility studies. There is little innovation-specific support involved.

3.2 United Kingdom

The UK has a broad array of business support schemes, with the Business Links providing baseline delivery of services to small businesses.

[69] http://www.expertiseireland.com/Default.aspx

All the following new services from the DTI are also being made available through Business Link, with a strong emphasis on innovation and best practice. As well as the following business support programmes, the UK also has the UfI, the Sector Skills Development Agency and the Learning and Skills Council – all of whom have provision for skills training for businesses.

According to the SBS action plan " A Government Action Plan for Small Businesses" (January 2004), the government is putting greater emphasis on providing integrated support which builds strategic, internal and external capabilities in small firms with growth potential.

3.2.1 Technology Programme

The Technology Programme is a DTI initiative, the purpose of which is to provide funding to facilitate further investment in science, engineering and technology.

UK-based firms and consortia may submit proposals to the DTI under this Programme for funding through two business support products – Collaborative R&D (CR&D) and Knowledge Transfer Networks (KTN). Each has been designed to promote a particular activity. The main objective of "**Collaborative R&D**" is to improve the UK's innovation performance by increasing the breadth and depth of collaborative research and development between the UK science, engineering and technology base and UK based businesses.
The main objective of "**Knowledge Transfer Networks**" is to improve the UK's innovation performance by increasing the breadth and depth of knowledge transfer into UK based businesses and accelerating the rate at which this process occurs. KTNs extend the former Teaching Company Scheme, which placed graduates in R&D positions in companies and provided support to them from the university from which they graduated. KTN now also includes inputs from further education colleges and no longer demands that the R&D project to be undertaken is of such a high level as previously was required.

3.2.2 Grants for investigating an innovative idea - DTI

The grants for investigating an innovative idea is for businesses who have an idea to develop an innovative product, process or service, but are not sure whether they are ready to take it forward successfully.
The idea of the grant is to reimburse some of the costs of the consultants chosen to provide expert advice on identified barriers to successful implementation of the businesses innovative idea. The outcome of the project being an action plan.

The company can receive no more than 100,000 euros (£65k) de-minimis aid in any 3-year period.

3.2.3 Grant for Research and Development - DTI

Grant for Research and Development is the Department of Trade and Industry's (DTI) initiative that provides grants to help individuals and small and medium-sized businesses to research and develop technologically innovative products and processes.

- Micro Projects are simple low cost development projects lasting no longer than 12 months. The output should be a simple prototype of a novel or innovative product or process. A grant of up to £20,000 is available to businesses with fewer than 10 employees.

- Research Projects typically involve planned research or critical investigation lasting between 6 and 18 months. The result of the project could be new scientific or technical knowledge that may be useful in developing a new product or process. A grant of up to £75,000 is available to businesses with fewer than 50 employees.
- Development Projects involve the shaping of industrial research into a pre-production prototype of a technologically innovative product or industrial process. A grant of up to £200,000 is available for businesses with fewer than 250 employees.
- Exceptional Projects involve technology developments which have higher costs. These projects are likely to generate much wider economic benefits and must be recognised as of 'strategic' importance for a technology or industrial sector. A grant of up to £500,000 is available to SMEs with a qualifying project.

3.2.4 Knowledge Transfer Partnerships - DTI

A knowledge transfer partnership is set up to help businesses to develop their capabilities by joining up with the UK's universities, colleges and research organisations.

All approved partnerships are part funded by the government and involve a business working with a college or research organisation that has expertise relevant to that business that will increase profitability. The knowledge transfer does not just relate to high level R&D, but can be something as simple as working with tutors in a Further Education College on a technical, but not leading edge, project, like helping to develop a database or website, for example.

The partnership must, however be about

- helping businesses to access knowledge new to them
- helping companies to make a step change
- strategic projects managed by 'graduates' working with and in businesses.

The company identifies a university or college or research organisation with the help of a Knowledge Transfer Partnership Consultant. The agreed project could be for any length of time between one and three years, with the overall aim of helping the business make a step change in an area identified as high priority for the business.

3.2.5 Access to Best Practice Businesses - DTI

The DTI provide a three-stage support process for businesses who wish to implement best practice. This is done through

- investigation and benchmarking
- tailored implementation and funding
- evaluation

Investigation and benchmarking involves a free facilitated critical evaluation of the business's competitive performance working with a business link adviser. Based on the results of the evaluation and analysis, the adviser creates, in consultation with the company, an action plan for key areas of improvement.

Tailored implementation and funding involves the next step. If a company does not feel able to make the necessary changes themselves, a tailor made implementation plan may be necessary with the help of an expert consultant. When this is necessary, the DTI provide funds for half the project costs up to a maximum of £5000.
The final stage is the evaluation where the business link adviser will arrange a follow up meetings 6-12 months after the initial consultation to review progress.

This programme helps with the strategic capabilities of the company by buying in external expert support.

3.2.6 Management and Leadership programme

The management and leadership programme was announced in the skills strategy[70]. The aim of the programme will be to offer owners and managers funding to support tailored training to suit the business. This informal approach to learning will be demand led and will be delivered though a variety of media including face to face, helplines and the central business link site.

3.2.7 LINK - OST

LINK is the Government's principal mechanism for promoting partnership in pre-commercial research between industry and the research base. It aims to 'stimulate innovation, wealth creation and improve the quality of life'. The idea behind LINK is to get academia to tackle new scientific and technological challenges so that industry can go on to develop innovative and commercially successful products, processes and services.

Government Departments and Research Councils provide up to 50% of the total eligible costs of a LINK project with the balance of support coming from industry. The level of funding available to each participant will depend on the costs directly attributable to the project, in terms of the salaries of personnel working on the project, materials consumed, capital equipment purchased and other factors, such as licensing.

3.2.8 Faraday partnerships

Faraday Partnerships are dedicated to improving the competitiveness of UK industry through more effective interaction between the science and technology base and industry. Effective interaction requires the identification of industry needs and the subsequent synthesis of the knowledge and experience of those who can satisfy these needs. Each Faraday Partnership employs a number of technology translators - people with broad experience of knowledge transfer - who can facilitate projects between Partnership members.

Established Faraday Partnerships are widely recognised for their technological expertise and understanding of industry's needs. Industry therefore benefits from interactions with the relevant Faraday Partnership(s) and participation in their activities when embarking on new product and process development.

3.2.9 Regional Skills Partnership

The Skills Strategy from the UK government highlighted that there is a strong regional dimension to skills issues, and that responses at regional and local levels would be required to deal with these. It proposed the establishment of Regional Skills

[70] 21st Century Skills Realising Our Potential (http://www.dfes.gov.uk/skillsstrategy/)

Partnerships aimed at integrating the work of the key agencies in each region, including the Regional Development Agencies, Small Business Service, local Learning and Skills Councils, Jobcentre Plus and the Skills for Business network. These are now being rolled out by the RDAs in conjunction with their FRESAs (Framework for Regional Skills and Employment Action).

3.2.10 Phoenix Fund

The Phoenix fund is set up to encourage entrepreneurship in disadvantaged areas.

It includes

- A Development Fund to promote innovate ways of supporting enterprise in deprived areas. (England only)
- A pilot network of volunteer mentors to pre and early start-up businesses, through the Business Volunteer Mentoring Association.
- Capital, revenue and loan guarantee support for Community Development Finance Institutions (CDFIs).
- A Community Development Venture Fund (CDVF) to create a venture capital fund for SMEs in disadvantaged communities.
- City Growth Strategies (CGS) designed to encourage towns and cities to develop and implement strategies which put enterprise and business at the heart of regeneration, focusing on the competitive economic advantages of inner city areas rather than the social disadvantages.

This fund provides a similar service to the mainstream services offered by the DTI, but it focuses on social inclusion.

3.3 The Netherlands

Tax breaks and training are the two most prolific types of enterprise support schemes in existence in the Netherlands.

3.3.1 Scholingsfaciliteit - Training Facility

The aim of the measure is to increase the attractiveness of investing in training of employees. For companies the measure is delivered as a deduction on corporate and income taxes; for non-profit organisations the measure is delivered as a deduction on wage taxes. Prior to January 1,1998 training costs could already be fully deducted from profits. Since January 1, 1998, it is possible to deduct an extra 20%. In addition to this extra deduction, firms with relatively low training costs can benefit from an additional deduction of 20% over the first € 29,026. Training of older employees has also been made more attractive with an extra deduction of 40% for training employees older than 40 years. From 2001 onward there was also an extra deduction for additional training of employees up to a start-level qualification. An additional deduction exists for job-related language training and courses.

3.3.2 Scholingsimpuls

The **"Scholingsimpuls" training initiative** is designed in order to facilitate the process of companies and training providers working together to devise innovative training processes. In each customised training process, at least 50 people are guided towards a profession in which there is a risk of a structural deficit. Some of

the incentives include the reduction of regulatory barriers and the use of ICT-supported, modular forms of learning (tele-learning, learning in the workplace)

3.3.3 Knowledge Transfer Branch Organisations SMEs

'Branch' organisations which support SMEs can obtain subsidies for two kinds of projects:

- 'Knowledge position projects': i.e. projects in which a knowledge position study is carried out by a third party. A knowledge position study draws out the possibilities that technology or technological knowledge can present within a branch with respect to strengthening the competitive position. The study should among others contain a plan of activities and should produce recommendations. The results of the knowledge position study should be distributed among the entrepreneurs within the branch and should be available to anyone at a reasonable price. A knowledge position project may serve as a preparation of a knowledge transfer project.
- Knowledge transfer projects: through knowledge transfer projects entrepreneurs are stimulated to adopt a technological innovation. This involves a technology that already exists, but that is not yet applied extensively throughout a branch. The subsidy is explicitly not intended for the development of new technologies. By way of a feasibility study or a demonstration carried out by third parties additional information about the applicability can be gathered. The activities and reports should be accessible to anyone at a reasonable price. A knowledge transfer project may follow upon a knowledge position study but this is not necessary.

3.3.4 Knowledge Transfer Entrepreneurs SMEs

The aim of this measure is to stimulate SMEs in the adoption of technologies that already exist but are new to the company. This may involve a product, production process or service. The new measure is the result of the streamlining of technology policy instruments by the Ministry of Economic Affairs. The reason for launching this kind of instrument is to boost innovation and the adoption of new technologies in SMEs.

The programme works by entrepreneurs applying for a subsidy to have a strategy or feasibility study undertaken, or the employment of a knowledge carrier (recent graduate from a university or (technical) college) in order to elaborate their innovation plans. A strategy project is understood to be the development of a strategic plan by an external expert.

This strategic plan is then used in order to implement the particular product/process or service.

3.3.5 Dreamstart, platform for technostarters

Dreamstart is a foundation that serves to increase the transparency and accessibility of measures that currently exist for start-up companies in the Netherlands. Also, Dreamstart encourages universities/institutes of higher education and research institutes, and market organisations such as firms and financial organisations to build networks e.g. in order to set up incubators in various technology areas.

3.3.6 PMTs Participation Companies for New Technology-based Firms

This measure is designed firstly to boost the amount to be invested in the New Technology-based Firms, and secondly to act as a financial incentive by offsetting the high costs of hands-on management and the increased risk associated with the financing of these firms.

3.3.7 The Research and Development Allowance scheme

The **Research and Development Allowance (WBSO)** is a government scheme for promoting R&D in the Netherlands. Under the scheme, companies can deduct from their wage tax 40% of the wage costs for R&D, as long as the wage costs stay beneath €90,756. This figure is reduced to 13% where the wage costs are more than the above. A recent evaluation showed a positive correlation between R&D expenses and participation in the WBSO scheme[71]

3.3.8 O&O- fondsen

The **O&O- fondsen** is funded as part of EQUAL in the Netherlands and as a consequence is administered by the social partners. These funds contribute part of the cost of training aimed at enhancing employees' knowledge and skills. The Government has adopted a number of measures designed to encourage employers and employees to invest in employability, and aims to co-operate with the social partners to make conditions as conducive as possible for businesses to gain easy access to knowledge and programmes in this field. Examples of government measures include: the development of the "Investors in People" approval mark; experiments with employability consultants for SMEs; and the development of a system of identifying acquired skills (EVC).

3.4 Sweden

3.4.1 VINNOVA schemes

The TUFF scheme, run by VINNOVA, aims to facilitate the trade in technological services between public RTD technology providers and SMEs. Launched in 1999, during the first phase the scheme stimulated SME demand through supporting feasibility studies, creating groups or networks of firms, and co-operative projects. It also created and still maintains a network of qualified technology brokers with different competencies, initially primarily individuals in research institutes, 'technopole' organisations, industrial development centres (IUC) and private consultants. Currently there are around 50 technology brokers in operation, trained and certified by VINNOVA.

As part of the TUFF process, a broker acts as a 'single entry point' to the expertise offered by the whole network. TUFF also has an ICT-based service to support the network of technology brokers and generally assist with the scheme.

During 2002-03 VINNOVA drastically decreased its support to the TUFF system although TUFF may survive through market income and regional and local sponsors. The Association of Technology Brokers has evolved into a strong key organisation in the TUFF system.

[71] Evaluation of a major Dutch Tax Credit Scheme (WBSO) aimed at promoting R&D

VINNOVA has currently launched a new programme, VINNVÄXT designed to stimulate innovation and growth in Swedish regions. The budget for the programme is €67 million over ten years. VINNOVA also launched the BioNanoIt-programme during autumn 2001. The aim is to integrate university research in areas like microelectronics, physics and biotechnology and to stimulate researchers to cooperate with companies.

3.4.2 VINST

A new programme, VINST allocates grants for research projects conducted in collaboration between researchers at Swedish universities and/or research institutes, and companies which have self-developed products on the market. The new knowledge generated is meant to benefit the individual company and the group of researchers, and in the long run also the research community, industry, and society at large.

The programme is a joint venture between VINNOVA and SSF (Swedish Foundation for Strategic Research). A short-term goal is to initiate a small number of collaboration projects while also disseminating knowledge of the programme in order to attract qualified proposals from a broad spectrum of Swedish industry and research. In the longer term, the ambition of VINNOVA and SSF is to have started some 15-20 projects, enabling some 20 patents as a direct result of the programme.

3.4.3 National programme for support and development of innovation systems and clusters

Several Swedish regions have already devoted resources to establish innovation systems and clusters in order to enhance their competitiveness and attract new investments. The main object of the programme is to develop these initiatives, by making them more effective and functional.

The three public agencies, ISA, NUTEK and VINNOVA, have a common responsibility for the implementation of the programme.

3.4.4 IT.SME.SE

The aim of IT.SME.se is to increase entrepreneurs' competence in strategic IT-use. The programme is financing actions initiated by regional actors (county administration, universities, entrepreneurial networks etc.). The target group is the entrepreneur of small businesses (0-10 employees) and the action aims to increase competence in IT to a basic level. This involves giving companies an overview in how they can use IT in different strategic segments of the enterprise - e-business, production system, marketing etc.

The measure was initiated by the Ministry of Industry, NUTEK developed and administer it with the cooperation of Företagarnas Riksorganisation. There are going to be three calls for proposals during the two year period the programme is run.

3.4.5 REG-IT programme

The objective of the **REG -IT** programme, run by NUTEK, is to support the development of competitive industries in regions in need of extra support, by stimulating and facilitating IT use within businesses. The aim of this programme is to

- increase basic, specialist and strategic competencies in IT among the participating companies

- support business development, focusing on IT, through co-operation between companies within and outside the focus regions
- support initiatives to develop businesses with IT as a central factor and to aim at developing new products and services
- build networks for knowledge about and diffusion of IT
- stimulate the development of clusters

3.4.6 Technology Bridge Foundations

The Technology Bridge Foundations acts at a regional level in order to increase the exchange of knowledge and co-operation between universities and industry. They are independent of each other and of the central government, so they use a wide range of instruments and schemes to improve links between universities and the economy, and to promote entrepreneurship in their respective regions.

3.5 Finland

3.5.1 The Entrepreneurship Policy Programme

The Entrepreneurship Policy Programme is part of the Finnish Government's economic and industrial policy. The aim is to create operating conditions that contribute to the establishment, growth and internationalisation of enterprises. Another objective is to create such conditions for enterprises that allow them long-term investments and employment. The Entrepreneurship Policy Programme consists of five sub-sectors as follows

1) Entrepreneurship education and training and advisory services for enterprises
2) Set-up, growth and internationalisation of enterprises
3) Taxes and payments affecting entrepreneurial activity
4) Entrepreneurship in regions
5) Legislation pertaining to enterprises and functioning of the market.

The Entrepreneurship Policy Programme is a tool for the Government to ensure that the resources allocated to this type of business support will be efficiently used, that the measures implemented will be as parallel as possible to avoid overlapping and that the synergies obtained from the horizontal cooperation between the various administrative sectors can be fully exploited. Efficient utilisation of resources (for instance, technology funding, general aid to business, the regional centre programme, the rural policy programme, the use of labour policy resources for promotion of entrepreneurship and the network of polytechnics and universities) will be safeguarded with inputs in increasing the horizontal collaboration capacity and in capitalising on the expertise of the regions.

3.5.2 Employment and economic development centre, TE-keskukset

Regional units of three ministries (the Ministry of Trade and Industry, the Ministry of Labour and the Ministry of Agriculture and Forestry) were merged into 15 regional employment and economic centres, which among other tasks aim to provide support and advice to SMEs by promoting their technological development and assisting them with export.

3.5.3 Centre of Expertise Programme

The Centre of Expertise Programme was created to pool local, regional and national resources to develop selected internationally competitive fields of expertise. Initial implementation of the programme over the period 1994 to 1998 was based on eleven Centres. The Council of State has extended the programme by nominating new fields of expertise and new Centres of Expertise to implement a second national programme over the years 1999-2006. 14 regional Centres and two nationally networked Centres of Expertise have been appointed for this purpose.

3.5.4 TEKES - Technology programmes

Technology programmes are used to promote development in specific sectors of technology or industry, and to pass on results of the research work to business in an efficient way.
Programmes have proved to be an effective form of cooperation and networking for companies and the research sector.
During 2003, a total of 34 extensive national technology programmes are under way.
In 2002, Tekes provided 204 million euros to financing technology programmes.

3.5.5 R&D funding for companies

Tekes funding is intended for challenging and innovative projects, some of which will hopefully lead to global success stories. Tekes funding may be a low-interest loan or a grant, depending on the stage of the innovation and the nature of the proposed project.

R&D funding for companies Tekes offers companies grants, capital loans and industrial loans. Funding is given within the following parameters:

- Industrial R&D grants run from 15 to 50 percent of the eligible costs
- Capital R&D loans run from 35 to 60 percent of the eligible costs
- Industrial R&D loans run from 45 to 70 percent of the eligible costs

Differing funding measures can be combined in a single project. One project may, for example, receive a grant of 15 percent of the eligible costs, and in addition, a loan of 45 percent.

3.5.6 Tekes Funding for Feasibility Studies

Funding for Feasibility Studies is targeted to small and medium sized companies, universities and research institutes. The instrument aims to improve chances to launch and carry out successfully R&D-projects and new technology based business.

3.5.7 TULI scheme

The TULI (Business from Research) service aims to assist enterprises in defining their business ideas. The service is intended to help researchers to identify, evaluate and develop their research-based business ideas, the scheme is run by Tekes. TULI services support the research projects of universities and research institutions with a view to commercialisation of their results. The services are used by publicly financed research projects, groups and individuals.

3.5.8 Technology Clinics

The Technology clinics carry out technology transfer from research institutes and universities to SMEs. It is an organisational innovation that responds to the needs and ambitions of both suppliers and users in the SME-technology supplier

relationship. By making it easier for SMEs to tap into sources of external technological assistance, technology clinics aim to help to teach SMEs to use the expertise of technological service providers. In each technology clinic, there are four organisations involved: the customer SMEs, Tekes, the clinic co-ordinator and the technological service provider.

4 Case Studies

4.1 Case study 1 - Company A

Company A is a leading GIS (Geographical Information Systems) and LBS (Location Based Services) solutions provider. The company has a staff of twenty-five people and was established in 1997 and is based in Dublin.

Company A's flagship product is LocationAgent, which allows accurate locating from generic input of data and provides data related to the area including points of interest and route directions. LocationAgent uses Internet technology to integrate customer's management information systems, including mobile operators' location systems, SMS, MMS mobile messaging systems and GPS data collection systems, to provide new business solutions. Another main product is MatchPro Geocoding software, which is a desktop address geocoder that matches customers' address records to geographic locations with or without a postcode. This is an interesting piece of software as it allows the synthesis of customer and enterprise data into location data and can help with issues such as strategic planning (where to open new shops), database marketing (targeting customers), customer profiling (clustering of customers), market penetration analysis (market shares in specific areas).

4.1.1 History of the company

The company was started by two entrepreneurs, who knew each other from school. One, an engineer, had the idea that there was an opening in the market in Ireland for a commercially oriented in depth mapping system that was not covered by ordinance survey. They raised €4 million in venture capital, which was enough investment to hire a plane and start flying over Irish cities to acquire images and data for map making. This had never been done before and when the company started, it managed to make a good profit selling this type of information to companies.

4.1.2 New products and services

The focus of the company has however changed over the years and continues to change, adapting to the changing markets. The main focus now is in leveraging knowledge and repackaging their own intellectual capital into new products for the market. Finding new value in their existing products and services and selling to new customers is the current driving force of the company. The majority of their products are developed internally although they look to the market for ideas.

4.1.3 Human capital

The company of 25 people all have first degrees and the majority hold masters. The GIS members of staff are qualified geographers and the programmers all have master's degrees. The technical manager has an MBA. The firm is technologically competent and there is capacity to do a fair amount of internal research and development.

4.1.4 Networking

Company A see market intelligence as crucial to the development of the company. The Chief Technical Officer undertakes trips to the States on a regular basis.

The company is currently also working closely with Enterprise Ireland and use their offices in London with a view to expanding their operations in the UK.

Company A also have a number of research projects that are ongoing. One of their main reasons for getting involved in research projects was 'to build IP, to learn from the partners and to build relationships with the partners'. The have good commercial relationships with Logica, Vodafone and O2 as well as a number of other niche players in the market.

The links with higher education are less well defined, and there was a general reticence to get involved with the local University (UCD) due to past experience in terms of the way that they treat companies with whom they undertake research. In the opinion of Company A, the way that Universities in the US interact with young companies is much better as the attitude of a University like Stamford is to see the company as being an important new part of the economy rather than a loss of revenue to the education system.

4.1.5 Organisation and routines

As a small company, Company A has a flat structure. At the top of the company is the Managing Director who is ex-Accenture and comes from an IT/business background. There is also the Chief Technical Officer who is the remaining founder member of the company. He is the main source of new ideas generation and spends time interfacing with the programmers to implement new projects where necessary. There is also a Technical Manager and the rest of the staff consisting of programmers and equivalents would work on selling and developing the new packages and products.

The company holds weekly sales meetings for most staff and there is a drive for everyone to take an active role in marketing and look at the market for new ideas. There is also a quarterly strategy meeting and the business plan is updated on a regular basis. The company does not have a long term business plan as working in the software industry means that customer needs change fast and the company has to be responsive to these changes. There is a constant drive for Company A to repackage its products, introduce new products and to keep prices down. They work in a highly competitive market and innovate on much shorter timescales than other industries in order to keep their market share.

4.1.6 Learning processes

The environment of a small software company such as this relies on relatively specialised skills from the geographers/geologists and the programmers. The first process is facilitating the information flow between the two skills sets of the company and this is done on an informal basis.

If Company A introduces a new project, the tendency of the organisation is to employ **someone new with the appropriate skills**, thus bringing in new capability from the market place to enhance the existing skills base. This shows the firm understands its needs and demonstrates its ability to bring in new knowledge from outside the organisation using

All skills that are needed, but considered non-core, are bought in from sub-contractors. This decision from management keeps the company focused on the sets of expertise that it needs in IT and geography. Database work or any other routinised

tasks are done by sub-contractors and the choice between upskilling and outsourcing is taken for every new project or product development.

The technical manager plays a crucial role in internal learning and, as the interface with the customer, takes on the role of 'gatekeeper' to the company. The fact that the technical manager is a trained programmer (in spite of the skills not being up to date) was considered to be an important asset.

4.1.7 Codification of knowledge

There is a risk in a company such as Company A that the ideas are generated only by a core group of staff members and this puts the company at risk if any one of the 'star performers' leaves. Although so far the staff turnover has been low, Company A is aware of this risk and has recently put in place a system whereby, when new packages of bespoke systems are put together, there is a process of documenting how this is done so that the existing systems could be rebuilt from scratch and to ensure that the knowledge is shared with all the programmers.

They did lose a key knowledge generator a few years earlier which had quite a major knock on effect in the company. The other main issue for codification is working out how to address their IP. The company does not have a background in managing IP but are currently anxious to maximise the ability for leverage.

4.1.8 Conclusions

The absorptive capability of Company A is potentially high. It is a company that regularly introduces new products and services and the firm consists entirely of graduates and people with higher degrees. As evidenced by the Third Community Innovation Survey, the employment of graduates is an important indicator of the innovation activity of the company as is the ability to bring in knowledge externally from the market. Company A have systems in place for bringing in knowledge externally from the market and the acquisition and exploitation of knowledge is dealt with through the company's organisation and routines.

The current disinclination to work with Universities may hamper the opportunities for knowledge transfer to which the company otherwise seems very receptive. There is a general openness to change and also an understanding within the company of the need to adapt constantly to the market when working in an IT dependent environment. Linking up with a local institution such as UCD may be beneficial for these reasons.

The risk of holding key know-how in a tacit form within a core group of employees is also being addressed by Company A. It is codifying its knowledge via improved documentation to address this, making the information available to a larger number of employees and also transferring the knowledge between the programmers and the geographers.

4.2 Case study 2 - Company B

Company B is a Cork-based pharmaceutical company involved in the production of a single product – Gingko Biloba. The plant produces extracts from the leaves of the maidenhair plant and the active ingredient is added to a prescription drug which is sold in France and Germany. The drug is used in the treatment of memory and blood disorders. Company B Partners is a daughter company of the French and German pharmaceuticals that it supplies, therefore this case study offers some insight into how companies operate that are not owner managed.

The company started up in 1978 and went into production in 1980. They are the world's biggest producer of pharmaceutical grade Gingko Biloba. The company shows interest in undertaking process innovations, but is restricted in undertaking any major product innovations by the parent company.

4.2.1 New products and services

Company B would be keen to expand into new areas and the Managing Director makes it his responsibility to look to the market for new ideas. However, the company makes its one product in response to the needs of the parent company and the current climate is not conducive to introducing new products. It would need approval from the parent to produce anything else. This has not always been the case and in the past, Company B has produced two other drugs.

The company has equipment that could easily be exploited for testing other types of extractions, new products and processes.

4.2.2 Human capital

The company has a staff of around 100. About 60 are involved in production and around 9 are chemists and engineers. Only 30% of the staff are graduates, which is lower than in some more modern companies in the pharmaceutical industry. Although they have a lower number of graduates than many competitors, as the existing product is not R&D intensive, employing more graduates would be seen as increasing the employee costs rather than increasing the capabilities to undertake more product or process innovation.

Company B has a relatively low staff turnover and there is a culture of 'settling down' with them for the long term. At the time of the interview there was no active recruitment drive but generally, when new staff is needed, the company hires qualified individuals on short term contracts and it believes there is no shortage of expertise available externally.

4.2.3 Networking

Networking is vital in the pharmaceutical industry and takes place at many levels. Company B partners are more limited in the networking that they undertake due to the control of the parent company. The majority of the networking is business oriented rather than technology oriented. For example, in order to address regulatory and environmental issues, a team of chemical engineers within the company has responsibility for keeping up to date with current concerns. This is done through attendance at trade shows, journals and also through information from the FDA (Food and Drug Administration). The planned EU directives on drugs will also affect the company, but through membership of IBEC (Irish business and Employer's

Confederation), they are involved with CEFIC (The European Chemical Industry Council) who are lobbying in this area.

Company B is also active in the Pharmaceutical Associations in Ireland and has maintained strong links with both Enterprise Ireland and IDA. Although it currently has no formal links in Ireland with any research institutes or Universities, the parent company in France and Germany has links in those countries, which are where the majority of its R&D is carried out. It is noteworthy that other Irish-based multinational subsidiaries have been able to strengthen their positions in internal competition for R&D and production activities through such links with Third Level Institutions.

4.2.4 Organisation and routines

Although Company B is not in a position to undertake product innovations per se, it has a track record in process improvement and has obtained positive feedback from the companies who buy its products. The company operations unit analyses the process to improve yield and has made some significant improvements over the last few years. There is a system of refining processes and reporting back to the parent company. The production cycle of one batch is about a week and there is sufficient machinery downtime in the normal production cycle to allow time for process innovation to occur.

Another recent process change was introduced in order to comply with registrations in the companies in which the product is distributed. As a botanical raw material, the quality of Gingko Biloba leaves can vary according to the climate and as a consequence the company has to vary the processes in order to compensate for the variability of the raw materials.

One of the main barriers to process innovation is regulation and environmental standards. These tend to discourage the company from making significant changes, or slow the change process significantly.

4.2.5 Learning processes

Due to the lack of freedom to expand their existing product base, the focus of training is on investing in staff empowerment and modern management techniques. All staff is encouraged to participate in training courses in team working, coaching and mentoring. There is an in-house education assistance programme. Company B supports internal promotions and will invest in training courses for existing staff to upgrade or change, rather than first looking to the market.

Company B has a scheme for work placements for local undergraduates (sandwich students) and have found this beneficial for both parties. Every year they have an IT undergraduate working with them. The small projects undertaken have generally been seen as successful and produced results that have been used in the company's management and production processes.

4.2.6 Codification of knowledge

Company B has invested in benchmarking its management practices in order to see how work practices within the company need to evolve. As a consequence, in the last few years there has been a significant change from a hierarchical company structure to a much flatter structure with the responsibilities being driven downwards. The management of change is always an issue and the company is moving towards

a system of empowerment. Central to this has been ‘constant communication and the ability to get middle management buy-in’. There was originally a drive from the top to change how the system is working but the change requests are now as likely to come from the bottom up. ‘De-layering’ and empowerment of staff at the operational level normally puts middle management under pressure, and employment is often reduced at this level. Buy-in to change is therefore seen as crucial for the absorptive capability of the company. The initial resistance to change that was encountered meant that there was no real sharing of knowledge across the company. In the view of top management, freeing middle management to focus on strategy and innovation by looking externally benefits the whole company.

4.2.7 Conclusion

All the elements for absorptive capability are present in Company B partners and although they in general employ fewer graduates than their counterparts, they still make up a large proportion of the company and are an important element in the manufacturing of pharmaceuticals. As a company that is not generally permitted to undertake major product innovation, it has focused its efforts on the introduction of process and management innovation.

The process improvements are done internally by the firm and this is an area where they could benefit from external intervention, for example from consultants. The management change has been facilitated by external intervention and is something that the company sees as bringing benefit to the organisation as a whole. Empowering the staff gives a feeling of management buy in and also helps facilitate the exchange of knowledge between employees at all levels. The firms’ receptiveness to new ideas from all elements of the company means that the process of innovation becomes a lot easier in terms of improving its processes and routines.

It is interesting to highlight the benefit that the Company Gets from hosting university undergraduates as this is backed up by the results of the questionnaire. The questionnaire data indicated that companies, which had recently hosted students or recent graduates, found them to be valuable sources for innovation activity, with the majority of companies indicating that they found the importance of students’ contribution to innovation at least ‘medium’. Company B specifically highlights that, even at the undergraduate level (sandwich students), some really useful results can be obtained from student projects and fed into the company’s management and production processes.

4.3 Case study 3 - Company C

Company C is a Shannon based company manufacturing moulds and spare parts for moulds. The company started up in 1990 and had a small but international market. Ireland used to be well known for the quality of its precision in mould making. Its main markets were the electrical connector, precision components and telecommunications industries.

4.3.1 Human capital

The company employs 9 people. There are two management staff and the rest are machinists who have undertaken apprenticeships with the company. The tool making apprenticeship is a four-year course operated in conjunction with FAS. At the end of the apprenticeship the individual receives a national Craft Certificate. There are no graduates and the two members of management, who are also trained machinists, will step into the shoes of an employee on the production floor if there is a deadline to meet.

The Company grew from a two-man operation in 1990 to twenty-five people by 2002. However the last couple of years have been difficult for the industry. Staffing levels have now reduced to nine and there are no current plans to increase this number.

4.3.2 Networking

In general there is little networking done by Company C. The company maintains links with a local company, where the company Managing Director used to work. They still have regular meetings and 'bounce' ideas off each other. This local network seems to be the only active one for this company. All new ideas are filtered through the Managing Director who reads trade journals and goes to trade shows to meet other people in the industry.

In this industry there are an increasing number of competitors, both in the Shannon area and in the Far East. Currently Company C has no active way of managing to keep up with the fast pace of change in the industry. Tools made in the Far East used to be of inferior quality, but are now excellent. Even taking shipping costs into account, companies Company C struggle to compete.

4.3.3 New products and services

The future looks bleak for Company C. They have no plans to introduce any new products and the uptake of new technology within the firm is considered to be low by the Managing Director. All the machine tools were bought second hand when the company started up and none of them has ever been replaced. The only new investment they have made has been in CAD (Computer Aided Design).

There was a general reluctance to thinking about investing in change and the Managing Director was of the opinion that the investment costs would be too big, even though they may pay off in the long run. The general climate in the industry would mean that the risk would be too high.

In comparison to its closest neighbours, Company C has taken little initiative in adapting itself to market change or innovating. The Managing Director's former employer employs 60 people and has a national and international market. In order to deal with the downturn in the market it diversified into medical and domestic appliances. The also introduced e-business processes (mould flow analyses

available to the customer) and a new electronic scheduling system for delivery dates, dealing with emergencies and controlling the production flow. In order to do this, they undertook a feasibility study with a view to increasing customer satisfaction. The results showed that customers were looking for faster response times to quotes, deliveries and a better price.

4.3.4 Organisation and routines

Company C has ISO 9001 certification and adheres to the processes and procedures. Mould making is a routinised process and all the machines are optimised for the processes that they undertake. In accompany of this size, there is little need to review and change processes on a regular basis, according to the Managing Director.

4.3.5 Learning processes

After apprenticeship, it is considered that little training is required in a company where no new equipment is being introduced. The main training is on the moulding machines and CAD, but there is a general reluctance to upgrade staff skills in these areas as then ‘they tend to leave and go elsewhere’. The company lost one of its CAD trained staff not long before our interview, so now the only person trained was the Managing Director. This could be seen as short sighted, but the company is minimising its investments in the current climate. There is no external training after the staff completes their Craft certificate.

4.3.6 Codification of knowledge

The codification of knowledge is not something that is seen as a particular priority in Company C. The main knowledge source within the company is the Managing Director and all other staff is seen as ‘production line’ technicians. The capabilities of the firm are hampered by this approach to knowledge as it reduces its capacity to learn. This is not seen as a particular problem by the Managing Director who likes to protect his assets by not sharing knowledge.

The company is not looking for new opportunities or to expand the number of employees in the short term. The current focus is having enough work for the nine staff to keep the company ‘ticking over’. There is no drive for the company to seek out new opportunities.

4.3.7 Conclusions

The innovative capabilities and ‘absorptive capacity’ of Company C are low. The company relies heavily on the Managing Director for ideas and Company C has not embraced a culture of innovation and change. It started up when the need for precision moulds was high and the market in Ireland was booming. There has been no significant effort to undertake any research and development or adapt, unlike at his former company. This failure can be seen to have had a direct effect on the ability of the company to survive.

The human capital of the company consists of qualified craftsmen, who are crucial to the processes and the production of the moulds but appear to generate little innovative capability. The company could benefit from having graduate employees if it is to grow again as they would bring with them external knowledge which would improve the absorptive capacity.

Company C does not network out of its local environment or get involved with Universities or Research Institutes. The company is inward facing and currently concentrating on staying in business. The Managing Director does not see investment in new products as a potential solution but as expenditure.

Company C could benefit from a greater awareness of potential new products and processes and external business support could help the company to see how to do this. Given help with market planning and product diversification it might be possible to compete in the same way that similar companies in the Shannon area have done.

4.4 Case study 4 - Company D

Founded in 1990, the company produces moulded PVC sections for domestic building cladding (Kentish boarding) and fascia boards for roofs and eaves – 'Roofline PVC products'.

For the first two years of business the company sold only in Ireland, and then began exporting to the UK and France. Some 60% of its output is now exported, primarily to the UK, and it has a depot in Northampton. The company still shows impressive annual growth of 25% and has a €33m turnover. The company believes that it can compete on price with UK suppliers by holding down costs and increasing efficiency. Far Eastern companies tend not to be competitive on these products because their physical volume is high and their selling price is low, making shipping expensive.

4.4.1 Human capital

Company D has a workforce of 140, including 30 UK employees.

4.4.2 Networking

Company D use its sales team to monitor client needs for special fittings, colours, etc. It has been approached by universities with a view to doing collaborative R&D, but believes that the universities 'only want cash to burn up on their own whims' and that it can invest more wisely in doing things itself. They once invited a team from a university to quote for assisting them on product testing, but there was no follow through from the university – therefore they assumed they were not big enough, or the work was not scientific enough to interest them.

Other types of networking include staff visiting exhibitions and trade shows, suppliers and reading journals. Enterprise Ireland also visits twice a year.

4.4.3 New products and services

The company has been hard pressed to cope with demand for their PVC extrusions. Two years ago they also introduced rainwater goods (guttering, downpipes and brackets) to their range and these are selling well alongside their traditional products as they are closely related in use.

The introduction of the rainwater goods was a decision that was made 'because it was an obvious thing to do' because new guttering is likely to be installed at the same time as the company's fascia products. When the company introduced its newer rainwater range, it consulted with builders and installers who could identify the types of problems they experienced fitting gutters and downpipes, what they did not like about the products they usually fitted and what they expected to see in a "Rainwater System for Professionals". Using their feedback, Company D set about designing a rainwater system that solved the problems identified.

Company D designed the products and developed the moulds itself – a 'big investment' that necessitated a great deal of staff time and a restructuring of the business - using existing cash and resources, plus an Enterprise Ireland grant of €120 000 based on a business proposal. No technical support or consultancy was received from Enterprise Ireland. However, the company would not necessarily seek to find new products unless sales of its existing products were hit and would certainly not move far outside the fields it knows and understands.

The R&D that the company undertakes focuses mainly on the choice of the materials it uses. It tends to go to materials suppliers for help in developing new products because 'if they wanted to sell the materials, they should be able to help us'. In this case, the company considered that the commercial world would be faster and far more knowledgeable that universities and take a wider view of all the implications.

The company has no particular budget allocation for R&D – although new tax allowances for R&D in Ireland mean that the company will begin to show R&D as expenditure in its accounts, in order to obtain the tax credit.

4.4.4 Organisation and routines

The Company D factory is quite highly automated in the extrusion and moulding areas with labour intensiveness concentrated in packing and distribution because of the awkward and bulky shapes of the finished products.

When the factory was set up, Company D used external consultants to organise the production but now uses internal staff. An internal team is looking at reducing the time taken for product changeover, covering production equipment design, scheduling, tool transfer, etc. No external help is being used.

Lean manufacturing techniques are fundamental to the maintenance of flexibility for customers needs. At any one time, several varieties of fascias, soffits and rainwater systems may be in production, which has the potential to cause downtime between production cycles.

Company D operate to strict procedural guidelines in compliance with ISO 9002 quality standards.

4.4.5 Learning processes

Company D give the majority of staff the opportunity to undertake management training. This happens across the shop floor, supervisory and production management. They also use a distance learning package on management which can be used by staff.

There are also informal meetings between the production staff and sales to discuss any issues but there is no formal structure for developing innovations. The meetings tend to be about pressing issues such as production, output and delivery, rather than business planning.

4.4.6 Codification of knowledge

Although under pressure to produce, there had been no systematic review of the company's IT systems and there are no plans for e-trading, although the firm does have a web site.

4.4.7 Conclusions

This is a company that has grown – and continues to grow – rapidly, so it suffers the problems of growth in terms of meeting demand. Most of the company's efforts have been driven by the ethos of growth – better organisation of production, concentrating on production down-time, etc. The major innovation – the addition of rainwater goods to their product range – was an obvious but brave (in terms of investment) move. However, it is a little troubling that the firm depends wholly on 1+1 product lines and

would only diversify if the market in these products declined - when it may be too late.

The firm sees itself as self-supporting in all its technical needs. The second line of defence is material and equipment suppliers. Research and the use of universities do not feature, to the point where they will potentially have an R&D budget but not know how to spend it.

There are a number of ways that a company like this could become more absorptive

- Availability/better knowledge of product and process development facilities
- Greater awareness of forward market planning and product diversification
- Provision of support beyond cash
- Greater awareness of university capabilities beyond research
- Assistance in R&D spending appropriate to their needs and budgets

4.5 Case study 5 - Company E

Founded in 1972, this company is typical of manufacturing progress over the past 30 years. The family started making golf wear as a cottage industry, grew to a point where it was able to take on board US franchises, then built a new manufacturing plant in the late 1980s. The past 10 years have seen them continue to expand, but manufacturing is now done entirely overseas in Turkey, China and Peru. The building that was the manufacturing facility is now the warehouse. The company designs in house and its only manufacturing activity is now bespoke embroidery of corporate logos – done in Ireland because of the rapid turnaround required and the danger of 'special' logos – eg the Ryder Cup competition – being pirated.

The company is now managed by second generation family members. They have diversified into other golf equipment – bags, trolleys, clubs, etc. along with a range of corporate giftware (all made and 'logoed' by suppliers) and a range of corporate clothing for restaurants, clinics, etc.

4.5.1 Human capital

Company E employs 70 – designers, sales staff, warehouse including four in manufacturing.

4.5.2 Networking

The company use trade journals, exhibitions and tournaments to gather information on new products and to gauge reactions to its brands. An investment in specialist embroidery machinery in 1980 resulted from a visit to a trade fair in Bobbin, Atlanta and the company considers trade fairs to be an important source of information and inspiration for new products.

The move into golfing wear was also inspired by a trip to America. The clothing was devised by the company in 1989 and marketed initially in Ireland and the UK.

The company does not network with universities or use any external help on product design. It sees itself as knowing its market best and therefore does not specifically see a need to investigate new kinds of developments that may be coming out of academia, which are not directly related to golf clothing. It does engage with Enterprise Ireland, however, on general business issues and grant information.

4.5.3 New products and services

As with many firms, Company E does not see itself as an innovator, and views the introduction of new products and services as 'common sense' or normal business development.

Its initial link to a leading US golf brand boosted sales and it was then given a licence to produce its own designs under this brand. The US partner produces stock lines that Company E order. The Americans then manage the whole process through to delivery into their warehouse. Company E then saw a niche for its own (same quality, lower price) brand, and created its own brand. This has gone well as it can more quickly react to market preferences for colours, styles, etc. For example, when Nick Faldo cut the sleeves off his waterproof jacket in a tournament and everyone suddenly wanted sleeveless waterproofs, Company E was able to be first in the market through Green Lamb.

When producing the sleeveless waterproof, one of the directors remarked that the zips used generally let in water. As a keen skier, he suggested using the waterproof zips found in ski clothing and this was done. This made a big difference to sales of the garment and the company will use them again.

Interestingly, this innovation had not been done through customer feedback or by following competitors. It could have happened through taking a look at what other specialist clothing manufacturers do, but this had not happened. Even given this example, there were no plans to consider the design/construction of performance clothing in other sectors. The company is happy to stick with golf wear rather than branch out into other outdoor clothing, even though it has their own internal designers. It did not appear to have internal meetings to discuss clothing construction and materials, although it did seem focused on fashion.

4.5.4 Organisation and routines

The company has its own designers, CAD system and pre-production facilities. The shift from its own manufacturing capacity to outsourcing has resulted in a huge change within the business. Now if quality, delivery and price are OK they the company does not have to worry about the processes used.

At the time of the IT boom, there was a problem with hiring enough staff to take on production roles and the firm reduced its workforce from 90 to just over 30 sales, marketing and customer service staff. It seems unlikely that the firm would have survived without making this transition to outsourced production. The ready availability international capacity means it is in a good negotiating position.

4.5.5 Learning processes

As a family run business, with the founder still in charge, there is some reluctance to take on new ideas and implement new thinking. The staff undergoes external training and the interviewee had undertaken a number of management courses, and as a consequence had added HR to his responsibilities.

The interviewee is also currently undertaking a M.Sc. in international business at Trinity College, Dublin (grant supported). He spends 3 days each month on this special course that brings together ‘high flyers’ from various Irish businesses and puts them in touch with business leaders. The course ‘has opened his eyes’ on global trading and the best ways of achieving it.

And although he is a key member of the management team, the interviewee – not a family member – has difficulty in getting new ideas through to others. For example, he suggested changing the way that it used external transport providers’ sin order to obtain faster service at lower cost. He has had great difficulty in pushing these changes through because the company has used the same contractor for 30 years.

4.5.6 Codification of knowledge

The shift to a sales driven organisation based on stock that can have long re-order lead times has resulted in a greater need for an integrated ordering/stock allocation system. Originally, salespeople would visit a golf shop, write out an order and mail/fax it in to headquarters in 1-2 weeks. Even if they had checked that items were in stock at the time of taking an order, these had sometimes been be sold by the time the order was processed. The company therefore decided that each salesperson should have a laptop that could link to headquarters by telephone and actually

checked on stock levels, allocated stock and processed the order. It invested in a proprietary system to do this – with Enterprise Ireland funding – but it did not work and is now the subject of litigation.

Undaunted, the company has since started to implement a system that is specifically designed to do the job (costing more money) and this now looks promising. Although there was no real in house knowledge of such IT systems, the firm could see the obvious benefits and a firm of consultants was used to help facilitate the process. Enterprise Ireland provided the cash towards the first system, based on a business plan but was not involved in providing expertise to assess needs or to select the right system.

Company E has a web site, but management have so far resisted e-trading because of security concerns.

Company E is a growing business that is doing well. Its management seems to have grasped the challenges of the shifting manufacturing base and made good use of it. It does not see itself as an innovator, although the above aspects were readily spotted. The change in IT systems alone is a major innovation for the firm. There is no real use of external help, mainly because (like so many SMEs) the company sees itself as a specialist that knows its own product/market best.

4.5.7 Recommendations

Suggested actions that would make this company more receptive/absorptive include

- Helping the management to realise that it already is innovative
- Drawing out innovations as examples (zip) and helping the firm realise that if this were built into the way it manage the business there could be more such innovations
- Demonstrating how new systems and ways of working/thinking could be profitable
- Identifying external sources that could help in all three innovation areas
- Providing specialist independent help alongside cash on big changes like the new computer system
- Making the company aware of developments in other sectors that could impinge on its own products and processes
- Helping it gain greater exposure to exhibitions, garment production events, etc

It will be important to recognise the differences in attitudes and receptiveness among the company's management, suggesting the need for a rather personalised form of support delivery.

4.6 Case study 6 - Company F

Company F is an independent investment fund manager. The funds are mainly hedge funds where investors want to get their investments looked after by a third party. Company F has a small number of clients and deal with around 75 funds, typically for investment managers. The firm gives impartial evaluation of options in creating new products. Its clients are financial institutions, institutional investors, professional investors, family offices and high network investors. The customers are mainly from the UK and Scandinavia and a few from Ireland.

4.6.1 Human capital

The office has around 40 staff, of which 30 work at the operational level. The outputs are numerous but mostly to do with keeping records. Dublin and Luxembourg are the two centres for this type of work, although Dublin is better known for hedge funds.

The vast majority of the staff have completed 3rd level education or are postgraduates and many of them are also qualified accountants. The area of work calls for people who are highly numerate with good business management qualifications.

4.6.2 Ability to network with external sources for knowledge and other resources

This is a highly regulated industry, so the company has a great imperative to keep on top of the regulatory changes that may occur. Company F is therefore in weekly contact with the Irish Financial Services Regulatory Authority. The company has to be on top of any changes that occur immediately, especially as over 95% of the domiciles are in overseas locations for tax purposes.

As a company it is also committed to attending conferences and reading trade journals. It considers that the most important source of information is the external consultant, employed in order to keep it up to date with the market and the technology needed. This use of external knowledge is an important characteristic of a firm that wants to enhance its capability to absorb knowledge and innovate.

4.6.3 Organisations and routines

The organisation of the technology is very important for financial services and the company has to be progressive in its approach. The company has a full time IT manager. The external consultant visits every two to three weeks to give advice and guidance. He maintains contact with suppliers and product updates as well as linking with companies overseas for any new product innovations in the market. There is also a database specialist who handles routine troubleshooting and the firm has a number of maintenance contracts, which help keep it, informed of developments. These are dealt with systematically, with evaluations of the new systems and services before full implementation.

Two of the biggest systems concerns for this type of organisation are contingency planning and security. They cannot have any down time at all, so all systems need to be fail-safe. System updates are quite difficult due to these issues of contingency and security.

4.6.4 Learning processes

Company F invests heavily in training and all staff are involved. The training is a mixture of in-house and external training. Company F recently made a decision to do the majority of their IT training in-house. The IT manager gets trained externally and then trains staff on the specific systems that they need in their job. This appears to be successful. The staff benefit from their own training template which is tailor-made to be relevant to their job/working environment.

Training needs are increasing as the software becomes more progressive (this is also true outside of the IT environment). Therefore if they can reduce the amount of time that staff needs to be outside the office and train people specifically for their jobs, then there is a reduction in downtime.

On the financial services side, there will be members of staff undertaking training at least 3-4 days out of every week. The other training schemes that take place are numerous and include training trainers, corporate actions, shareholder specific training, management training and some industry training. Some staff members also attended a recent training scheme on money laundering.

Due to its main concerns of contingency and security, the company would like to have a test environment in which to test out new tools and processes, but this is prohibitively expensive. This would reduce risk the firm the opportunity to weigh up all aspects of a potential system before buying. Currently they do ad-hoc work with beta systems of new technologies and if they like it they will buy it once it is bug free. They were recently interested in looking at a wireless network but it is not without its risks

4.6.5 Codification

Company F is highly reliant on good technology and all its systems and processes are technology driven. The concern about contingency and security means that all information is well documented.

Company F has the capacity to do all of its client contact through the online systems but this does not happen. In an ideal world the brokers would send through their files for download. Mostly the files are not quite compatible so changes have to be made ‘manually’. But at least few people now send faxes.

4.6.6 Conclusions

The financial services sector is an area of services that has traditionally been progressive in management and process innovation. Company F is a young company with a strong culture of training. The staff are all graduates and possess very specific knowledge relevant to this business environment. The training process in this business is one of the best ways for the company to keep ahead and on top of its fund management. The company undertakes continuous product adaptation. By keeping knowledge capacity high, company employees will tend to have a better chance of succeeding in the market place.

Company F considers that it absorbs high levels of technology and is receptive to both internal and external knowledge sharing. The use of an external consultant is considered vital, as is well planned training. All aspects of this business are highly specified: the networking; the IT environment; and the training. There is, however, little attention given to tacit knowledge. Capturing and mobilisation tacit knowledge could be advantageous in this type of business.

4.7 Case study 7 - Company G

Company G is a mutual funds company a significant player in the North American market, where it deals with the whole range of financial products. In Dublin it focuses on investment management and also has a small subsidiary, which delivers financial advertisements.

The company was formed in 1991. Originally the company was still only going to focus on North American clients. The Dublin office was set up in order to provide a 24 hour presence and to keep an eye on European and emerging markets. There were also tax reasons.

4.7.1 Human capital

Company G Dublin has 10 employees. There are 8 fund managers and 2 financial/administration people all of whom are tertiary educated. One of the bonuses of setting up in Dublin is the well-educated work force. Although there is not yet the same culture of investment banking as a profession as there is in the UK, Ireland is changing.

This company has no turnover of fund managers. This is unusual but may be to do with it being a small cohesive team. There is reportedly a very good atmosphere within the company and also the pay is good. In Ireland it is also particularly difficult to move into another company as it is quite a niche market, with only a small pool of companies for which they can work.

4.7.2 Ability to network with external sources of knowledge and other resources

One of the biggest problems in finance is keeping up with regulation and compliance. The company uses a major international accounting firm to help them to address these issues as it holds seminars throughout the year on all new aspects of new legislation.

The Managing Director is also a key networker in the organisation. The company structure is very flat, which is easy in a small company, and the Managing Director spends most of his time marketing in North America rather than in Dublin. His marketing performance is considered to be crucial, so he is extremely ‘hands off’ as a managing director.

The networking is also supported by the knowledge of the large company in North America. Company G Dublin would be in a different position if it were an Irish stand alone company in this market. It would than need a lot more help with accessing market information. As it happens, they now just pick up the phone to North America and use their resources and knowledge.

4.7.3 Organisations and routines

It is a difficult choice to make in asset management whether to move towards automated processes or to remain hands on. Fund managers work with a mixture of intuition and understanding of statistics. They work out certain formulas that work and then apply them to any number of funds. For example, if they work out formulae for a suite of European funds, they can then use the same ones – if they are doing well – across all of their portfolios.

Company G in Dublin have 34 clients and also manage one other client portfolio. The only other product that they have launched is a suite of funds for the Japanese market. The reason they did this was that Dublin branch wanted to develop its own products. If the Japanese experiment went well, they would buy and sell for other non-Irish-resident investors and eventually aim to distribute funds in Ireland.

Company G is always looking for an opportunity to expand in Dublin and is hoping long term to distribute in Europe. This hasn't yet come to fruition as the product launch in Japan was not as profitable as originally thought. This is due to high brand awareness in Japan, so launching a new one proved onerous. It was hard to penetrate the market and so therefore was not a runaway success.

The reason for launching new products is that it is very important in the financial world to provide new opportunities for staff to progress. Fund managers' profiles are extremely important and they can become minor celebrities in their own industry. This carries weight in their career and they become linked to successful funds, making the company and the individual much more marketable within the industry.

4.7.4 Learning processes

The company rarely recruits new people, but when it does so it normally takes MA Economics graduates, direct from the universities. They then go through four years of CFA qualifications (Chartered Financial Analyst) alongside work. This is a heavy investment in training but it pays off. It is good marketing for the company and qualifications are almost seen as more important than experience in this field. It gives the staff credibility and there is a quick return on investment. When people make the decision to become investment fund managers they take on a very specific challenge, which is probably why the company retains its staff.

The company has a strong training culture. If members of staff want to undertake training relevant to the job, they are actively encouraged to do so.

4.7.5 Codification

As a company in this area they are not that technology intensive. Everyone has their own PC and they all use excel as their main tool. Everyone has access to 'Datastream' – an asset performance management database which is a vast repository of company information. Anything that they need to know about historic data is there and it is used extensively for forecasting. They do not use any bespoke software but they know that other investment firms do so, and have become very technology driven. AFG does some modelling but this also involves a large amount of manual intervention, and is far from automatic.

4.7.6 Conclusions

Company G is a company with the right mind set for innovation. It has highly trained staff and a small team that is working on new products for launching in new markets. One of the main reasons for launching the new products and services is to improve the profiles of the asset managers – who are the firm's biggest asset.

Although part of a bigger company worldwide, there is still a feeling within Company G Dublin of being free to make local decisions. Staff also benefit from being backed up by Company G in Canada for knowledge and resources. This is a relationship that works well in the services sector.

Knowledge is less codified than in some firms in the sector. Company G relies very much on the personal abilities of the asset manager and the link to Datastream for information. It finds it difficult to pinpoint what actually makes a good asset manager and the qualities are not necessarily acquired through training.

The networking aspect of this firm is related to knowledge transfer of regulations. There is little evidence that it networks with a view to starting up new products and services in particular. This is a growing industry in Ireland with more small companies involved in portfolio services appearing. The networking aspect could therefore be improved as the industry becomes bigger.

4.8 Case Study 8 - Company H

Company H is a large company with over 700 employees in Ireland and is the second largest concrete manufacturer there. It is a subsidiary of RMC. The plant visited had 500 employees and is an interesting example of an old-established company with a traditional hierarchical management structure. The interviewee was the plant manager, and was formerly a design engineer in Japan.

4.8.1 Human capital

The majority of the workers come straight from school and stay there long term. Overall there are three graduates in the Eastern Region (Dublin, Clare), all engineers.

4.8.2 Ability to network with external sources for knowledge and other resources

Networking is generally done through the ICF (Irish Concrete Federation) and employees will go to the awards ceremonies. To keep up to date, the plant manger also reads trade journals. As most concrete innovation goes on in the United States, it is important to keep up with US trade journals.

Other local networking takes place between Company H and the nearest other concrete manufacturer. They help each other out. For example, if there is a big investment decision to be made, and the other company has already invested, it will allow Company H to go and try out the new machinery. Company H sponsors engineers through their studies and send people to the UK in order to access courses in the technical areas of geology and quarrying.

4.8.3 Organisations and routines

The plant is very simple and all the products are made on site. The plant is being made more efficient all the time and output increases at a pace of around 40% year on year. This is usually achieved through rearranging plant to be more efficient and the introduction of new equipment to improve processing time. This company is at an advantage compared to some in the construction industry in having a qualified engineer as a plant manager. He suggested that the management would do well to hire in MSc engineers to revamp processes when they needed to make changes, but such a service is not is widely available in Ireland.

Little IT is used in the plant. Many of the control systems are logic control, rather than being computer-based. The mixes are run by computers and some use of planning software that helps relate batch production to shipping. All is based on logic control. It is very ancient software and there is a lot of management information that is not used.

Mostly when dealing with a customer, the order is just phoned through. Once the order is placed, it is made and then shipped out via lorry.

There are two main innovations that would help change this business

1. To bring in a new shipping and batching system
2. To bring in some form of vehicle tracking system. There are 25 trucks on the road and it would be good to try and control them more efficiently. The idea

would be to have an electronic system on the wall in real time so you could see where they were.

4.8.4 Learning processes

R&D is all done internally. There is a technical group and the equivalent of two people is devoted to R&D. The IT manager has been working with an external consultant to develop a new electronic batch tracking system. At the moment there is a four docket system which tracks goods leaving the plant. The tracking would be better handled electronically and linked to the order.

This summer, the company has been working on a new type of concrete floor. The idea is to use concrete with steel fibres already embedded and then align them using magnets but it is still quite a long way from the market.

They are also looking at doing away with the concrete block altogether. This would require more skills among those who lay concrete, but skilled layers are expensive and hard to get. The firm is 50 years old and is very hierarchical. They also now have to deal with the baggage of RMC.

There is always a need for training, but there is none given at this particular plant, except for safety training. The structures are not in place. It is a very static industry. People come and work at the plant for 60 years until they retire. There is no career ladder. There is the plant supervisor, the plant manager and then the people who operate the process. Finally, there are then the truck drivers who are mostly self employed.

4.8.5 Conclusions

The level of graduates in the organisation is low. The firm needs to have a large number of machine operators on the floor and these jobs are not seen to require any formal qualifications.

The company sees itself as having low capabilities in terms of technology and innovation and although there are areas where improvements have been made, this is largely thought to be due to the employment of an engineer as the plant manager. The plant manager's enthusiasm and knowledge has facilitated the process of change in spite of a general reluctance from the top management to invest.

The company has good networks in place through Plato and the ICF. It also works with other local companies and takes students from universities to improve its capabilities.

4.9 Case Study 9 - Company I

Company I Metal processing is a subsidiary of a German company. The company is a consortium of businesses located in Europe, North America and Asia involved in all stages of precious metal production and processing. The UK part of the business produces precious metal compounds and solutions to serve the chemical, pharmaceutical, electronic plating and automotive industries.

4.9.1 Human capital

The Irish arm of the company started up in 1989 and currently employs 20 staff. In 2003 they lost one third of the staff as the R&D department closed down. Now no R&D takes place in Shannon. All of these activities are now undertaken in Germany or in the United States. Staff turnover in the company is low. All the senior managers have been in post for over 10 years and five or six of the production chemists have been there since the company was set up.

4.9.2 Ability to network with external sources for knowledge and other resources

The main external sources of knowledge are trade journals and chemical abstracts. The Managing Director is mainly responsible for keeping check on external developments although there is rarely anything of relevance or interest in the journals.

The most important sources of knowledge for the company are internal rather than external, although this has been hampered by the closing down of the R&D department. All product development used to be done internally and at one point the company obtained an R&D grant from Enterprise Ireland. However, in general the funding is found within the company.

In the past, Company I has been in contact with the University of Limerick, but the relationship did not lead directly to any joint projects and there is little likelihood of this happening. Now that the R&D has effectively been moved out of the business, there is little impetus to explore new opportunities for knowledge sharing.

4.9.3 Organisations and routines

New technology introduction is generally approached in an ad-hoc manner. Procedures are in place for devising and implementing new products and processes. It is initially done at a laboratory scale, then the safety and environmental issues are addressed, follower by trial batches on a plant scale and finally a qualification process with a customer. This type of innovation diverts time and capacity away from affects production, because the number of appropriately skilled employees is small.

The company deals with its supply chain using a mix of telephone and email. It has a website but does not use it to receive orders as the products are too specialised.

The company could not think of how they could benefit from external money to help them absorb new technologies or to improve process innovation. Company I had a tendency to think that internal knowledge was more important than external market information. The company's view of available external knowledge is certainly rather static. Company I is not part of an innovation network, nor does it have active links

with external sources of scientific and technological or management innovation or advice.

4.9.4 Learning processes

There is little formal training, though it was said that most training occurs ‘on the job.’ The only formal training is for new staff, which has to spend two days training for safety on the factory floor. The company considered that there was a decreasing need for training within the organisation since both the R&D department and another arm of the business had been closed.

The Managing Director has spent the last two years doing a course in International Management, which includes sales, marketing, strategy, staff motivation etc. No other member of staff is undergoing this sort of professional development.

4.9.5 Codification

The company has ISO 9002 accreditation.

4.9.6 Conclusions

The company’s knowledge and training needs are highly specialised, and not readily served by generalists. Its loss of the R&D function appears significantly to have reduced its absorptive capacity and its ability to innovate, in which it needs support – either from parts of the company abroad or from the Irish knowledge infrastructure.

4.10 Case Study 10 - Company J

Company J investments is an asset management firm, part of a global company. It operates from, and is regulated in, Ireland. It used to be seen as more as a back office hub but has now been successful at attracting funds to domicile in Ireland. Asset management itself is quite new in Ireland. The Bank of Ireland and PI have 2/3 of the assets.

4.10.1 Human capital

The Dublin branch has 500 staff and has regular assets and hedge funds. There is 1600 staff worldwide. Staff qualifications are all tertiary and beyond. Other qualifications include languages and financial management. There are 150 investment professionals and most of the asset managers are based in Dublin. This is both for fiscal reasons and to obtain corporation tax benefits. Labour turnover is around 10% and on the operational side a bit more. In the boom period, they had a turnover of around 30-40%.

Ireland does not have an indigenous asset management workforce. There is therefore not a culture of producing asset managers in the University sector, as there is in the UK, where asset management is considered a legitimate career choice.

4.10.2 Ability to network with external sources for knowledge and other resources

Company J undertakes high level of research and development. Currently it has a joint project with Cambridge University, in the area of applied research in financial engineering. They are developing an asset liability management tool to forecast assets and liabilities. The company chose Cambridge because the university happened to be doing research in that area. It was important that they found exactly the right partner. In the past, the company has undertaken other programmes with universities and also sponsored programmes.

The company take on graduates on a summer programme after they have completed their masters' degree. This is one method of instilling new blood into the company. This is done on a cycle every four to five years as it is an expensive programme/ The company would be receptive to doing this more often if there were schemes in place to do so with government funding.

4.10.3 Networking

Company J attends conferences and events and trade war stories. They are very insulated from the problems of the UK market and its regulatory environment. While there has been something of a collapse in the UK, Dublin has stayed relatively intact – partly because the Dublin market was still growing at the point where the UK collapsed. Irish-based companies could therefore temper their expansion plans rather than having to cut back.

4.10.4 External knowledge

The Company gathers external knowledge about markets from a variety of sources, such as Merril Lynch, which both provides stock-broking information and conducts more fundamental research into company performance.

The firm has an internal research team of around 50 people who are split between Boston and Dublin. They consist of sector analysts who look at companies within the industry.

The portfolio managers are also an important source of knowledge and come up with new ideas that are integrated into the portfolio. All members of the team are highly technologically competent and there are always new tools being created to help manage the environment.

In terms of programmes, there is a Taoiseach initiative to increase asset management capabilities in Ireland and seed capital for start ups. However, there is never going to be a mass market or an enormous source of indigenous expertise due to the education system not being geared towards investment management capabilities.

Company J were interested in the idea of a Teaching Company Scheme, where they could take PhD mathematicians for example and get them to work on new projects/tools that could be integrated into the company. It would help create career opportunities for people to move beyond the basics.

4.10.5 Learning processes

The financial services industry moves fast and therefore they have to invest in training in order to keep up with the pace of change in the industry.
They train in staff management and leadership, the technical training is mostly outsourced to local or international companies. There is also time management induction.

There is a real issue with the education system in Ireland as there is not the culture of producing graduate who enter into the financial markets in the same way as the UK. They also have to deal with the high cost of living that is associated with living in Dublin. This is also an issue for all recruitment as bringing people in from abroad and training them up means that they have to ensure that there is an incentive to buy into Ireland as a long term option for living and working. Ireland has recently also gone from being very employer friendly to employee friendly. If they were to hire Irish people and train those up they really would have to be exceptional.

The CFA programme in Ireland is run by the National College of Ireland. It is the industry standard and is a self study programme (pass rate of around 40%). They offer a preparation course with a degree at the end. This is increasingly a right of entry into asset management.

4.10.6 Conclusions

Company J is a big company and the investment in obtaining knowledge from the external environment is high. This is increasingly important in the financial services where global competition means that human capital and knowledge are key to the functioning of the market.

Appendix B Classification of companies interviewed

Exhibit 43 NACE classification of manufacturing companies interviewed

NACE classification	N	NACE classification	N
Other fabricated metal products n.e.c.	5	Electric motors generators and transformers	1
Other plastic products	5	Electronic valves and tubes and other electronic components	1
Computers and other information processing equipment	4	Fasteners screw machine products chain and springs	1
Printing n.e.c.	4	Industrial process control equipment	1
General mechanical engineering	3	Instruments and appliances for measuring checking testing navigating and other purposes except indust	1
Insulated wire and cable	3	light metal packaging	1
Publishing of newspapers	3	Luggage handbags and the like saddlery and harness	1
Bread; fresh pastry goods and cakes	2	Machinery for food beverage and tobacco processing	1
Fabricated metal products except machinery and equipment	2	Made-up textile articles except apparel	1
Growing of vegetables horticultural specialities and nursery products	2	Metal structures and parts of structures	1
Medical and surgical equipment and orthopaedic appliances	2	Non-electric domestic appliances	1
Other general purpose machinery n.e.c.	2	Operation of dairies and cheese making	1
Other special purpose machinery n.e.c.	2	Other chemical products n.e.c.	1
Other wearing apparel and accessories n.e.c.	2	Other electrical equipment n.e.c.	1
Pharmaceutical preparations	2	Other food products n.e.c.	1
Plastic packing goods	2	Other manufacturing n.e.c.	1
Processing and preserving of fish and fish products	2	Other non-metallic mineral products n.e.c.	1
Production and preserving of meat	2	Other wearing apparel and accessories	1
Production of meat and poultry meat products	2	Paper and paperboard	1
Tools	2	Paper stationery	1
Basic pharmaceutical products	1	Parts and accessories for motor vehicles and their engines	1
Bearings gears gearing and driving elements	1	Perfumes and toilet preparations	1
Builders carpentry and joinery of metal	1	Pesticides and other agro-chemical products	1
Carpets and rugs	1	Plastics in primary forms	1
Ceramic household and ornamental articles	1	Processing and preserving of fruit and vegetables n.e.c.	1
Chairs and seats	1	Processing of tea and coffee	1
cocoa; chocolate and sugar confectionery	1	Publishing of books	1
Concrete products for construction purposes	1	Radio television and communication equipment and apparatus	1
Corrugated paper and paperboard and of containers of paper and paperboard	1	Sawmilling and planing of wood; impregnation of wood	1
Cutting shaping and finishing of stone	1	Structural metal products	1
Distilled potable alcoholic beverages	1	Television and radio transmitters and apparatus for line telephony and line telegraphy	1
Grand Total			**95**

Exhibit 44 NACE classification of service companies interviewed

NACE classification	N
Software consultancy and supply	16
Business and management consultancy activities	3
Lifting and handling equipment	2
Adult and other education n.e.c.	1
Architectural and engineering activities and related technical consultancy	1
Bookbinding and finishing	1
Medical practice activities	1
Other financial intermediation	1
Research and development	1
Technical testing and analysis	1
Grand Total	**28**

Appendix C Questionnaire

Company/respondent identifier

Survey for Forfás on Company Capabilities and Support Needs

These questions relate to the company named at the location where you work, and not to associated companies or companies outside Ireland.

1. ABOUT YOUR COMPANY

a. **Your Name**

b. **Company Name**

c. **Is the company owner-managed?** Please select

d. **Is it part of an enterprise group?** Please select

If so, where is the head office?

e. **How many employees do you have at your location (please estimate)**

No of employees in 2001

Plan/expectations for 2007, do you plan to have more, the same or fewer employees. Please select

g. What are your main products and services?

h. What is the approximate percentage of sales your company exports %

2. ABOUT PRODUCTS AND PROCESSES

2.1

Concerning products

a. **Have you introduced any new or significantly improved products or services on to the market in the last 3 years?**[72] Please select

b. *If yes, w***ere the products or services developed** (Tick one)

Mainly internally (within your company or group) ☐

By your company in cooperation with other companies or institutions ☐

Mainly externally (by other companies or institutions) ☐

c. **Roughly what proportion of your sales comes from products introduced in the last 3 years?** %

2.2

Concerning processes

a. **Have you introduced any new or significantly improved production processes**[73] **in the last 3 years?** Please select

b. *(If yes)* **and were the processes developed** *(read all three out and only*

[72] This means a product or service, which is either new or significantly improved in its design, technical specifications, software, intended uses, or user friendliness. It should be new to your company; it does not necessarily have to be new to the market. It does not matter whether the new or improved product was developed by your company or by someone else. Do not include simple changes in appearance or pure selling of products of other companies

[73] This means new and significantly improved: production technology, methods of supplying services or of delivering products. It should have a significant effect on the level of output, quality of products (goods/services) or costs of production and distribution. It should be new to your company; but your company is not necessarily the first to introduce this process. It does not matter whether the improved process was developed by your company or by another one. Purely organisational or managerial changes should not be included.

tick one)

Mainly internally, (within your company or group) ☐

By your company in cooperation with other companies or institutions ☐

po **Mainly externally** (by other companies or institutions) ☐

2.3 What were the main factors behind your decision to undertake these innovations?

3. SUCCESS FACTORS FOR YOUR BUSINESS

3.1 How important is each of the following factors to the success of your business.

	Factors	Importance to the success of your business
a.	Introducing new or improved products/services aimed at existing customers	Please select
b.	Introducing new or improved products/services to attract new customers	Please select
c.	Expanding customer base for existing products	Please select
d.	Complying with new regulation or legislative obligations	Please select
e.	Regularly introducing new processes	Please select
f.	Introducing new organisational and management techniques	Please select
g.	Finding or using new technologies	Please select
h.	Improving the productivity of personnel	Please select
i.	Improving the efficiency of machinery and equipment	Please select
j.	Protecting your knowledge	Please select
k.	Co-operating with others (customers, suppliers, colleges, etc) in innovation projects	Please select
l.	Accessing sources of finance	Please select
m.	Improving your technological understanding of your products and processes	Please select
n.	Quality certification (eg ISO 9000, supplier approval, ISO 14000)	Please select

3.2 Compared to your international competitors, how well does your company perform in the following areas?

	Factors	Companies performance compared to competitors
a.	Introducing new or improved products/services aimed at existing customers	Please select
b.	Introducing new or improved products/services to attract new customers	Please select
c.	Expanding customer base for existing products	Please select
d.	Complying with new regulation or legislative obligations	Please select
e.	Regularly introducing new processes	Please select
f.	Introducing new organisational and management techniques	Please select
g.	Finding or using new technologies	Please select
h.	Improving the productivity of personnel	Please select
i.	Improving the efficiency of machinery and equipment	Please select
j.	Protecting your knowledge	Please select
k.	Co-operating with others (customers, suppliers, colleges, etc) in innovation projects	Please select
l.	Accessing sources of finance	Please select
m.	Improving your technological understanding of your products and processes	Please select
n.	Quality certification (eg ISO 9000, supplier approval, ISO 14000)	Please select

4. ABOUT HUMAN RESOURCES

4.1	Please estimate the number of people in the company with..	No. of people
a.	A higher degree (master's or doctorate)	
b.	A BSc or BA in science or engineering but not a higher degree	
c.	A non-scientific or technical BSc or BA degree but not a higher degree	
d.	Qualifications as technicians, but not a degree (A National Diploma or Certificate)	
e.	A National Craft Certificate qualification, but not a degree	
f.	No formal qualifications	

4.2 Do you have any dedicated in-house R&D personnel? Y/n

If yes, how many people are employed in this capacity?

Number of Full Time Equivalents

If no, what proportion of company employees contribute to your innovation activity %

4.3 How many people in your firm have experience of working in a major foreign or multinational firm in your industry **Don't know** ☐

If yes, do they bring any significant benefit to your company as a specific result of their 'large company' experience? Please select

4.4 Does your company do any kind of training either in-house (on-the-job) or formal (off-the-job)? Please specify

4.5 At the following levels approximately how many days per person per year does your company devote to formal (off the job) training

	Level of staff	No of days per person	Not relevant
a.	Shop floor		☐
b.	Middle management		☐
c.	Technical staff/graduates		☐
d.	Top management		☐

5. COOPERATING WITH OTHERS

5.1	Does your company belong to any of the following types of industry association or network	
a.	**A trade or industry association** (eg IBEC, ISME, etc)	Please select
b.	**A formal business network with other companies**? *(eg Shannon Supply Network; a Plato network – a network where other businesses in the sector get together in order to share information for example*)	Please select
c.	**A technology network with other companies** *(eg a network that is supporting technological developments or innovation within your sector eg Ceramnet Ireland, Bioengineering Network)*	Please select
d	*If you are a member of a **technology** network* is a university or college involved?	Please select

5.2	Have you bought or used services from any of the following in the last three years? *If they answer yes, ask whether this was inside or outside of Ireland.*	Yes, In Ireland	Yes, In other countries

a.	University or college	☐	☐
b.	Research institute	☐	☐
c.	Dedicated test facility/lab (not covered above)	☐	☐
d.	Technical/scientific consultant	☐	☐
e.	Business/Management consultant	☐	☐

5.3	**Has your enterprise had any co-operation arrangements (for example a joint project) on innovation activities with other enterprises or institutions in the last 3 years?**	**Please specify**

5.4 If yes, from the following list what types of organisations were involved in these projects and what was their importance to your business?

		Yes	Level of Importance
a.	Other enterprises within your enterprise group	☐	**Please select**
b.	Suppliers of equipment, materials, components or software	☐	**Please select**
c.	Clients or customers	☐	**Please select**
d.	Competitors and other firms from the same industry	☐	**Please select**
e.	Consultants	☐	**Please select**
f.	Commercial laboratories /R&D enterprises	☐	**Please select**
g.	Universities or other higher education institutes	☐	**Please select**
h.	Government or private non-profit research institutes	☐	**Please select**
i.	Other	☐	**Please select**

5.5 Have you hosted students or new graduates from colleges to do placements or projects in the past three years? Please select

If yes, how important has their work been to your innovation activities Please select

6. IDENTIFYING TECHNOLOGICAL OPPORTUNITIES

6.1 Is someone in your company specifically responsible for monitoring opportunities for technical innovation *(eg via trade press, new products by competitors, patents, licences)?* **Please select**

a. (If yes) What is their job title?
b. What qualifications do they have?

6.2 How do you identify opportunities "out there" that can be applied to your business?

a.	We use the Internet for research	Please select
b.	We get information from suppliers	Please select
c.	We get information from customers	Please select
d.	We attend exhibitions / fairs	Please select
e.	We use professional bodies / trade associations	Please select
f.	We use technology network(s)	Please select
g.	We have links with universities or colleges	Please select
h.	We subscribe to a monitoring service	Please select
i.	Others _____	

6.3 Which of the following statements is applicable to your company

a.	Formal mechanisms, such as quality systems, are used to help the workforce to improve processes or products	**Please select**
b.	We have a suggestions scheme for product and process improvements	**Please select**
c.	Suggestions are regularly considered by management for implementation	**Please select**

d.	Those whose suggestions are taken up receive a financial reward	**Please select**
e.	Management meets regularly to discuss our company strategy	**Please select**
f.	The company documents its strategy in a business plan each year	**Please select**
g.	New products or processes form part of the business plan	**Please select**
h.	The plan includes detailed plans for employing people with specific qualifications (eg x graduates, y technicians, z craftsmen, etc)	**Please select**

7. SUPPORT

7.1 Concerning public support

a. Has your company received any public financial support for product or process development activities in the last 3 years? Please select

(If yes) From which sources?

- From the County Enterprise Board or another local agency ☐
- From Enterprise Ireland ☐
- From Shannon Development ☐
- From the EU ☐
- From other sources, please specify ☐

7.2 For which of the following options would your company need external help (e.g from suppliers, consultants or colleges)?

		New product/services	New process improvement
a.	Adopting new 'turn-key' technologies	Please select	Please select
b.	Minor modification of technologies already used in-house	Please select	Please select
c.	Major modification of technologies already used in-house	Please select	Please select
d.	Making radical changes in technology	Please select	Please select

7.3 Do you have any further comments on your company's ability to innovate and the kind of support you think state agencies could provide?

Thank-you for your participation.
We will e-mail you a link to our report to Forfás once the work is complete.