INNOVATION AND THE SPATIAL DIMENSIONS OF INFORMATION CAPTURE

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Abstract

Recent theories from the field of industrial geography contend that region-specific, "untraded interdependencies", including networking, conventions and rules within the business community, are important assets in enabling small, innovative firms to learn about technological and organisational development. The "learning region" has since been adopted as a slogan for economic development and renewal, despite limited empirical analysis on the spatial dimensions of actual learning processes. The purpose of this study is to analyse how innovative firms combine sources of information in a spatial setting.

Analysis from the empirical findings reveals that small, innovative firms in the case study example of the instrumentation and control sector located in the outer area of the London Metropolitan Region (LMR), predominantly rely on a few key sources of information, recombined with knowledge of information from past employment. These key sources are usually linkages with other firms, particularly customers, that transcend regional and national boundaries. The spatial dimensions of information acquisition depend on the type of information. Sources that are more important at the regional level are relatively more important to more generalised aspects of information acquisition.

Underpinning these observations is the significance of the relationship between the spatial dimensions of information flows and the nature of the firms' innovation characteristics. The specific information required for technological development is spatially dispersed from the firms' home region, whereas more generalised types of information diffuse more easily from region to region. The location behaviour of the firms is nevertheless explained by the need to co-ordinate information flows. This is because transport links are important in enabling the firms to access specific information beyond the region. The availability of various sources of more generalised information in the London Metropolitan Region is still regarded as a vital support mechanism for small-scale innovation in the IC sector. The policy implications of this analysis are addressed.

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List of Acronyms

BSI	-	British Standards Institutution
CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
CC	-	County Council
CD	-	Compact Disc
CIS	-	Community Innovation Survey
DFEE	-	Department for Education and Employment
DoE	-	Department of the Environment
DTI	-	Department of Trade and Industry
EC	-	European Community
GDP	-	Gross Domestic Product
GRE	-	Government Research Establishments
GREMI	-	Group de Recherche European sur les Mileux Innovateurs
HE	-	Higher Education
IC	-	Instrumentation and Control
ISO	-	International Standards Organisation
IT	-	Information Technology
ITC	-	Information Technology Communications
KIBS	-	Knowledge Intensive Business Services
LBIO	-	Literature-Based Innovation Output
LED	-	Local Economic Development
LPA	-	Local Planning Authority
LMR	-	London Metropolitan Region
LQ	-	Location Quotient
LON	-	Learning Organisation Network
MD	-	Managing director
MoD	-	Ministry of Defence
MNC	-	Multi-National Company
NUTS	-	Nomenclature of Territorial Units for Statistics

NVQ	-	National Vocational Qualification
OECD	-	Organisation for Economic Co-operation and Development
OMA	-	Outer Metropolitan Area
PC	-	Personal computer
PCB	-	Printed Circuit Board
R&D	-	Research and Development
RDA	-	Regional Development Agencies
RSM	-	Regional Support Mechanism
RTP	-	Regional Technology Plan
RTD	-	Research and Technological Development
SE	-	South East
SEEDS	-	South East Economic Development Strategy
SER	-	South East Region
SIC	-	Standard Industrial Classification
SME	-	Small and Medium-Sized Enterprise
SPRU	-	Science Policy Research Unit
STITES	-	Scientific and Technical Instruments, Test Equipment and Services
SWOT	-	Strengths, Weaknesses, Opportunities and Threats
TEC	-	Training and Enterprise Council
UK	-	United Kingdom
USA	-	United States of America

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1

Introduction

1.1 Introduction

The increasing emphasis on learning in the field of economic development reflects the growing concern of regions and nations at being left behind in the recent era of rapidly changing technology, and globalisation.[1] In the "Condition of Postmodernity", David Harvey wrote of the "inability of Fordist structures to contain the inherent contradictions of capitalism" (Harvey, 1989, pp.141-142). The historical transition, generalised as the move from Fordist, mass production structures to post-Fordist, 'flexible' structures, reflects the changing nature of capitalism. This is driven by the recent developments on the demand and supply-side of product markets. On the supply-side technology is becoming increasingly complex and undergoing more rapid development and on the demand-side consumers with higher levels of education and awareness are making more varied and sophisticated choices (Piore and Sabel, 1984). The post-Fordist mode of production, characterised by "a greatly intensified rate of commercial, technological and organisational innovation," (Harvey, 1989, p.147) has engendered a reassessment of the ways in which policies and strategies deal with economic development in advanced industrial countries.

The increasing importance of knowledge as a factor of production (Hall, 1998, p.292) is closely allied to these underlying changes in the capitalist system. While arguing that the

[1] According to Castells (1996, p.30) the current process of technological transformation expands exponentially because of its ability to create an interface between technological fields through common digital language in which information is generated, stored, retrieved, processed and transmitted. The definition of technology, as quoted by Castells (Ibid. p.29-30) from Bell (1976), is "the use of scientific knowledge to specify ways of doing things in a reproducible manner." Later in his analysis Castells asserts that the economy is becoming more globalised (Castells, 1996, p.94) because capital is becoming more interconnected worldwide. Labour markets are becoming more global because firstly, there has been a substantial increase in inward investment. Firms are locating in a variety of places worldwide to find the labour supply they need. Secondly, there is greater labour mobility across nation states. Globalisation is still limited, however, by the regulatory frameworks of nation states such as immigration controls. For a more in-depth study of the arguments see Castells (Ibid., pp.92-99).

distinction between knowledge and information is difficult to detect, Castells (1996) showed that knowledge-based productivity has accelerated in the manufacturing sectors in the last 20 years. However, Castells goes on to argue that Western economies have not yet fully exploited the acceleration in the pace of technological change since the information revolution of the 1970s.[2] It is reckoned that the increasing pace of technological change will be exploited more fully when information flows more efficiently between individuals and organisations (Morgan, 1997). This study is primarily concerned with how information is acquired by firms from external sources and then combined with other forms of information for the purpose of technological and organisational development. It is argued in this study that while information is closely associated with knowledge it should be regarded as a separate concept.

The need to deal with the complexity of flows of information more effectively has led to a considerable increase in the significance attached to learning in the workplace. In policy terms, learning is an application of what has loosely been termed the "third way". This is an emerging policy paradigm that falls somewhere between a move towards greater reliance on planned intervention and the continuation of market reforms associated with the policies of the new right in British politics (see Giddens, 1998). The role of public sector support and governance in the implementation of policies for learning is providing a great deal of scope for debate. While we are still uncertain if the "third way" provides a coherent ideological alternative to the more traditional paradigms of the left and the right, there is still some debate over whether learning provides the powerful explanatory framework for understanding spatial inequalities in economic performance (Hudson, 1998).

Authors from the new school of industrial geography have suggested that untraded interdependencies or non-material assets - the region-specific networking, conventions and rules within the business sector - should be a key consideration in policies that aim to foster the learning capacities of firms (Storper, 1995). The idea of non-material assets has underpinned the development of the "learning region" as a framework for economic development policy (Morgan, 1997), but whether the exploitation of these types of assets at the regional level is an attainable policy objective in an era of globalisation is a question that requires thorough examination.

[2] See Castells (1996, pp.69-80) for an in-depth analysis of knowledge-based productivity in the 1970s and 1980s.

The purpose of this study is to add clarification and further understanding to this debate by developing an explanatory framework for analysing the spatial dimensions of information sources and using it as the basis for empirical observation. This opening chapter will introduce the key concepts and issues that informed the development of the methodology of the study. It will begin by justifying the research subject in terms of its chosen boundaries - innovation and small firms. The relationship between small firms and innovation defines the parameters of the innovation characteristics of the goods being surveyed in the context of the chosen sector. A central argument of this study is that the spatial dimensions of information capture need to be understood in the context of the innovation characteristics of the goods being studied. This provides an important lesson for local and regional policy-makers in responding to the government's objective of fostering clusters of innovation (DTI, 1998).

1.2 Setting the boundaries of the research

The infinate nature of concrete reality raises the important question of how social science researchers are supposed to identify phenomena that are supposedly culturally significant, important or interesting. Max Weber was instrumental in explaining the nature of the social scientist's pursuit. According to Weber the legitimacy of social scientist methodology is based on the "value-relevance" of the phenomena under investigation (Oakes, 1988, p.26). The emphasised facts and meaningful concepts involved in the research subject will depend on the given values of the investigator's subjects. Pure types of action are defined by the social scientist's criteria for value relevance (Ibid., p.29). The key difference between the natural sciences and the social sciences, in Weber's view, is that social science concepts are based on "meaningful interrelationships rather than commonality" (Hekman, 1983, p.26). Accordingly, the infinity of reality can only be overcome by the selection of value-relevant phenomena where

> "the value-relevance of an object (under investigation) . . . is an embodiment of a particular cultural value appertaining to a particular area of collective life which is of common concern in the society or societies, in which the observers are living" (Burger, 1976, p.40).

The value relevance of small firms and innovation, is partly explained by the continued policy interest in these particular subject areas. This was exemplified by Hertfordshire County

Council's publication on the findings of a survey on "knowledge-based" industries within the county (Howells, 1995).

1.2.1 Policy background

The Hertfordshire report described the current state of knowledge-based industry within the county and in doing so, added weight to the argument that small, innovative firms should be given greater focus in policy implementation. The report identified five clusters of knowledge-based activity within the county.[3] These were Pharmaceuticals and Biological Sciences; Chemicals; Defence, Electronics and Aerospace (DEA); Scientific and Technical Instruments, Test Equipment and Services (STITES); Knowledge-Intensive Business Services (KIBS) (Ibid., p.25). The fourth cluster identified by Howells, the Scientific and Technical Instruments, Test and Equipment Services (STITES) sector, was identified as a sector of particular interest:

> "A significant, but perhaps most neglected research field within the county is that associated with scientific and technical instrument and test and specialist process equipment manufacture and provision of related services. This particular research community, the Scientific and Technical Instruments, Test and Equipment and Services (STITES) cluster, is more widely dispersed amongst a range of smaller companies and foreign-owned subsidiaries with small R&D laboratories . . . (this sector would) seem to offer a good growth opportunity for the county and a way of diversifying its research base" (Ibid., pp.26-27).

Howells went on to consider the dynamics of knowledge-intensive development in a spatial context, identifying three broad components of change in the report (Ibid., pp.28-29). The first, "births or entries", is the creation of R&D facilities by firms that have never undertaken research before as well as the 'new entrants' that occur as a result of the location decisions of firms. A large proportion of these changes are the result of large and very visible greenfield investments. The second component was identified as "in situ" change. This component accounts for the expansion or contraction of firms or organisations within the spatial setting. The third component, labelled "deaths or exits", depend on outright closures or relocation decisions where organisations move away from the area. According to Howells,

[3] In this context the term 'cluster' is used to describe a co-location of similar firms.

> "those studies that undertake components of change analyses covering total employment changes suggest that it is not the high profile schemes such as greenfield investments, which make the biggest net changes to jobs, but rather more small scale (and numerous) incremental "in situ" changes within existing establishments" (Ibid.).

Howells added in a later report that "in particular focusing on large openings (entries) and closures (exits) can obscure the role of SMEs in their gradual build-up (or decline) in research and technical capacity" (Howells, 1997, p.58). An important element of these "in situ" changes is therefore the expansion of smaller establishments where R&D is less formalised. The main components of change in R&D activity in the south-east (SE) of England are displayed in **table 1.1**. Howells found that over half (57.6%) of the 6,053 jobs that were created in R&D in the SE[4] between 1990-95 originated from 'in-situ' growth which was the result of employment expansion in existing laboratories and factories (Ibid., p.60). The expansion of innovative activity in small, STITES firms would therefore lead to an expansion of the "in situ" component of design and research activity.

One of the reasons why the Instrumentation and Control (IC) sector was chosen to be the case study for this research was because it has a close resemblance to the STITES sector. This study will show that, like the STITES sector, there is a spatial concentration of IC firms in the SE, particularly the counties to the south-west, west and north of London. It will be shown in Chapter three that one of the ideas at the core of the learning region policy framework is the development of mechanisms that allow firms to work together to share information in order to find solutions to common problems. The less systematic nature of R&D in small businesses necessitates analysis of not only the internal processes underlying product development but also consideration of how firms interact with other individuals, firms and institutions in recombining sources of information that enable them to continue along their paths of development. An empirical study of a group of similar firms locating in close proximity is one way of examining the relevance of the learning region policy framework in nurturing spatial concentrations of innovative industry through a more efficient use of regional sources of information. The significance of small-scale innovation in setting the boundaries of the study is now considered in more detail.

[4] Here the SE is defined as the SEEDS study area, which consists of Bedfordshire, Essex, Hertfordshire, Kent, Sussex, Wiltshire.

Table 1.1: Main components of change in R&D activity in the SEEDS survey area

Main change component	Specific change component	
	Total R&D employment change: 1990-95	Percentage of: A) total growth B) total decline
1. 'Births' or entries:		
i)	407	6.7
ii) a)	1,933	31.9
b)	226	3.7
2. 'In situ' change:		
i)	3,487	57.6
A) Total growth	6,053	100.0
ii)	-1,032	33.5
3. 'Deaths' or 'exits':		
i)	-351	12.1
ii)	-1,527	52.5
B) Total decline	2,910	100.0

Source: Howells (1997, table 5.6)

1.2.2 The importance of innovation

The idea of the "learning region" as a framework for economic development policy emerged from debates that were considering the significance of non-firm institutions to the development of capacities for innovation in the business environment. These non-firm institutions are said to have a particular importance at the level of the region (Morgan, 1997). Theories on innovation had informed the development of the learning region framework because, to a large extent, innovation depends on the ability to acquire information on new organisational and technological developments and market opportunities.

Theoretical developments on innovation and the economics of technical change are usually associated with the body of academic work known as neo-Schumpeterian economics. This developed from Joseph Schumpeter's proposition that innovation is the one of the primary sources of economic growth (see Freeman, 1994). Recent studies on small firms and economic development have underlined this belief by demonstrating the importance of product innovation to growth-orientated small firms: "the surviving and innovative SME appears to be

part of a set of fast growth firms and as such would seem to warrant the attention it receives from policy-makers and academics alike" (Thwaites and Wynarczyk, 1996, p.145). There has indeed been an emerging policy consensus on the significance of innovation to economic development. In the broader sense:

> "Innovation is vital. It allows individual and collective needs to be better satisfied. It is also central to the spirit of enterprise . . . the competitiveness of a country, region or firm now depends predominately on its capacity to invest on research, know-how, technology and the skills which allow maximum benefit to be derived from these in terms of new products and services." (EC, 1996).

The definition of innovation and the effects of different types of innovation have been the subject of a growing body of literature in recent years. The narrow definition of innovation incorporates a broad range of activities relating to the technological and organisational side of product development at the level of the firm:

> "In an essential sense, innovation concerns the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organisational set-ups" (Dosi, 1988a, p.222).

The theoretical context for this study develops from analysis of innovation at the narrow level of the firm. The starting-point for analysing innovation is on the product side. The products that are surveyed in this research are important to the process of economic development through their combined effect on the potential and impetus for more innovations, development and growth. In narrow terms innovation is defined as a new product or any improvement in the quality and efficiency of a product that has been commercially exploited. This study will attempt to avoid the tendency to overlook the commercialisation of new products. It is widely acknowledged that one of the competitive weaknesses of the UK economy is not so much its record on new ideas but more in the commercial exploitation of these ideas (see for example, DTI, 1993).

For the purposes of this study the definition of innovation is taken within the context of a case study of innovation processes in the IC sector. This sector was chosen because it is commonly viewed as one of the most innovative for product development in manufacturing (DTI, 1996, Thwaites and Wynarczyk, 1996). The forthcoming second Community Innovation Survey

(CIS) (1999) also highlights the relatively strong innovative performance of IC firms. The development of individual products in the sector are not necessarily far-reaching, but the importance of the industry lies in the contribution it makes to industrial efficiency and the strong social benefits in terms of environmental monitoring and the control of hazardous processes (DTI, 1996, p.4). To reiterate an earlier point, an understanding of the innovation characteristics and performance of small firms in the IC sector is fundamental to an understanding of the spatial dimensions of the methods by which the firms acquire information.

1.2.3 The significance of small firms

The importance of the role of small firms in the process of product development and economic growth came to the fore during the 1980s when it became apparent that the importance of the small firm sector was increasing, and that employment creation was taking place in a relatively few but fast growing firms (Storey, 1988, p.156). However, the increasing internationalisation of trade, and the opening of the European single market in 1992 have drawn attention to the incapacity of small firms, generally, to deal effectively with innovation and technical change in a more open economy. This has been recognised by policy initiatives at the national and supranational levels (see for example, EC, 1994, DTI, 1994, 1995a, 1995b). Accordingly, governments have therefore devoted greater attention to the development of strategies and policies for improving the innovative potential of small firms. The small firm sector is now a major focus of economic development initiatives at the EC level, an example of which is the ADAPT programmes, where nearly 1,400 transnational projects are designed to help SMEs adapt and survive (The Guardian, 1997). In recent years, however, it has become apparent that the heterogeneity of activities in the small firm sector presents formidable problems for the implementation of common frameworks for economic development policy. Learning is one such framework that requires further examination.

There is a wide acceptance that smaller firms in terms of the more commonly used indicators of size, such as number of employees and turnover, contributed more to the production capacity of the economy at the end of the 1980s than they did at the beginning of that decade. The following statistics lend weight to this argument, although we need to bear in mind the limitations of statistical measures of small firms that hide the complexities of the small firm sector. These are discussed in chapter four, where small firms are defined for the purposes of the research.

Between 1980-1990 European firms with fewer than 200 employees did better than larger firms in terms of growth in added value and investment (OECD, 1993, p.17). **Table 1.2** shows the change in the numbers of businesses, employment and turnover share by size band. It shows that in the UK between 1979 and 1991 there was an increase of 51% in the number of businesses employing under 100 people. The share of workers in business organisations employing less than 200 people rose from 50% in 1979 to 58% in 1991. Employment in firms with under 50 employees, the cut-off point for this study, rose from 35% in 1979 to 43% in 1991. Most of this increase, however, can be attributed to workers in firms employing less than 10 workers, where there was a rise of 8%, from 20% to 28%. There were 65,000 businesses in this category compared to 49,000 in 1979. In the 1980s the most significant increases were in fact confined to the service sector where there was an increase of 100% in all firms between 1979 and 1989. The production sector saw an increase of 28% in the same period (Hughes, 1991, p.472).

The growth of the small firm sector in the 1980s was the result of a complex interaction of forces at work in the UK and global economies. Although not all of these forces relate to the changing nature of technological change, there is a widespread belief that the growing importance of the small firm sector relates to the development of new technologies that had an impact on the size structure in British industry. According to Castells (1996, p.153) vertically integrated corporations had become unable to perform all of their tasks under the new technological paradigm of information technology. This has resulted in small firms becoming an important source of innovation through the application of new technology. However, an understanding of the role of small firms in the development of technological systems requires a more detailed analysis of the relationship between organisational structure and the nature of technological innovation. The theoretical bases to these issues will be developed and elaborated in chapter two.

Empirical evidence on the growth of the small firm sector points to the fact that policy should now be less concerned with the number of new business start-ups, which increased significantly during the 1980s, and more concerned with the qualitative aspects of small firm performance such as innovation (Hughes, 1991). In the light of their growing position in the economy, successive UK governments have continued to emphasise the importance of support mechanisms for small firms (for example, DTI, 1995a). One of the important elements of this support in the UK is the regional or county business link one stop shop services, which are designed to provide information and training for small firms and start-ups. But in spite of its

tacit acceptance that there is a need for public sector assisted regional support mechanisms for small firms, exemplified in countries such as Japan, Germany and Italy, the last UK central government did not embrace an integrated spatial dimension to its policy on innovation and small firms. The region was viewed as more of a receptacle for funding from the European Community than a pro-active agent of economic development (Boland, 1998).

Table 1.2: Numbers of businesses, employment and turnover share by size band in the UK

Employment	Numbers ('000)			Share of total (percentage)					
				Businesses			Employment		
	1979	1986	1991	1979	1986	1991	1979	1986	1991
1-2	1,099	1,595	1,735	61	64	64	7	11	11
3-5	319	535	565	18	22	21	6	10	10
6-10	179	178	196	10	7	7	7	7	7
11-19	109	84	97	6	3	4	8	6	6
20-49	46	56	65	3	2	2	7	8	9
50-99	16	16	20	1	1	1	5	6	7
100-199	15	9	10	1	-	1	10	7	8
200-499	5	5	6	-	-	-	8	10	9
500-999	2	2	2	-	-	-	8	7	6
1000+	2	1	1	-	-	-	35	29	27
Total	1,791	2,481	2,697	100	100	100	100	100	100

Source: Storey (1994, Table 2 5)

The recently elected Labour government are keen to elevate the standing of the region in the governance of economic development policy. The co-ordination of business support, the co-ordination of training and the encouragement of innovation through technological transfer are now three of the suggested functions for the new Regional Development Agencies (RDAs) (DoE, 1997). The RDAs were originally proposed by the new Labour government in 1997. A greater understanding of the spatial dimensions of learning is therefore important because of

current debates on the relationship between local, regional and national government in different fields of policy. Analysis of the spatial dimensions of learning processes has implications for spatial economic development policy because it leads to questions concerning the potential for public sector support mechanisms to create the region-specific assets that enable sources of information to be combined more effectively in small, innovative firms.

1.3 Research problems and underlying arguments

The theoretical perspectives that informed the research problems are introduced in the following sections. This section deals with the underlying arguments of the study. In the light of recent theoretical developments in evolutionary economics and industrial geography this thesis attempts to come to terms with two fundamental research problems that have emerged from the literature.

-How do we explain the spatial dimensions of learning processes in small, innovative firms?

-What is the relevance of the learning region policy framework to product development in small, innovative firms?

The underlying argument of the study is that the predilection of the new industrial geography towards the region as the significant spatial level in which spatial concentrations of innovative firms acquire specific information is overstated. The reason for this is that the importance of tangible factors such as transport links in the location behaviour of firms and the nature and relative importance of sources of information beyond the region have tended to be overlooked. The most important sources of information utilised in the process of product development are more spatially dispersed than is sometimes recognised by those that emphasise the importance of the region. In accordance with recent developments in industrial geography, access to information is the underlying spatial question of this study. The value of information is weighed against the cost incurred to access it in the overcoming of space. In analysing the location behaviour of firms this should also be weighed against other costs and benefits of location such as access to the skilled labour which is able to deal with the complexity of information flows and the availability and cost of premises.

The structural basis for this argument is the significance of the relationship between the spatial dimensions of information flows and the nature of the firms' innovation characteristics. In this research the firms being considered are usually dealing with the adaptation of technologies developed elsewhere in response to market necessity. For these types of products information acquisition that occurs as a result of collaboration with customers is vital. The relationship between innovation and the spatial dimensions of information flows is a circular or path-dependent relationship. Firms are unwilling to depart from existing routines that they perceive to be effective in moving them along their chosen path of development. The networks of information accumulation that result from these operations in small IC firms reflect the globalisation of economic activity (see Amin and Robins, 1991) and the firms' place within the internationally decentralised network hierarchy of production (Castells, 1989). The position of the firms within these networks influences the location behaviour of the firms as well as the direction of their innovative activities in the future.

A further spatial question arises in relation to different forms of information. Sources of information, which are more important in terms of advanced technological development, are relatively more spatially dispersed. Generalised information, perceived to be less important to the firms' innovation processes, is more accessible at the regional level than specific information. The availability of these various sources of generalised information in the LMR is a vital support mechanism for small-scale innovation in the IC sector. This suggests that policy programmes emanating from the application of the learning region policy framework do have the potential to enable firms to develop their innovative capacity through a more efficient use of generalised information sources. These underlying arguments are underpinned and informed by theoretical perspectives introduced in the following sections. The three hypotheses to emerge from these arguments are listed below:

1. External sources of specific information make a more important contribution to innovation beyond the region than from within the region.

2. Generalised sources of information are relatively more important to innovation within the region than specific sources of information.

3. Tangible factors such as access to skilled labour and access to transport links are more important to location decisions than access to regional sources of information.

In the context of these hypotheses this study aims to further understanding on how spatially-based policy mechanisms can be developed for dealing with the provision of information in small firms with innovation potential. Accordingly, as well as being an empirically-based study of the nature of information capture in relation to small firms in a spatial setting it was decided to examine a spatially-based policy initiative that has been dealing with ways of improving information capture for the small firm community. Because the research was partly sponsored by Hertfordshire County Council it was agreed with the sponsor that one of their learning programmes should be the subject of the policy-based element of the research. The policy programme was assessed in terms of the learning region policy framework interrogated in the study. In order to relate to the core hypotheses of the study it was decided to examine the nature of information being made available to small firms in the programme and also to examine why the small, innovative IC firms being considered in the study were reluctant to participate. Lessons from the implementation of this programme were then used to inform the recommendations on the development of spatially-based policy on information capture at the national, regional and local levels in the final conclusions of the research as well as the questions for further research.

1.4 Theoretical perspectives

1.4.1 Evolutionary economics

This study analyses innovation and information within an evolutionary framework. Evolutionary economics has developed from the work of Jospeh Schumpter. One of the key themes in the development of neo-Schumpeterian economics has been the debate on the relative importance of large and small firms in the process of innovation. Schumpeter's ideas on the way new structures emerge from innovations and how existing structures lead to innovations were presented in two seminal works, *The Theory of Economic Development* (Schumpeter, 1934) and *Capitalism, Socialism and Democracy* (Schumpeter, 1942). The earlier Schumpeter model developed in *The Theory of Economic Development* had highlighted the importance of small-scale, spontaneous innovation whereas his later study emphasised the importance of bureaucratised R&D departments in large firms. Debates on the importance of large and small firms evolved from these initial ideas and a number of statistical studies ensued. In the light of these studies it is now widely accepted that small

firms are more innovative than R&D statistics lead us to assume, particularly with respect to incremental product improvements. Small-scale incremental product improvements have, nevertheless, been a relatively neglected area of research in the field of innovation. Moreover, there is a need to consider information flows with respect to different scales of innovation.

The neo-Schumpeterian debate on the roles of large and small firms has been synthesised by ideas emanating from evolutionary economics. A pioneering study on the theory of evolutionary economics was presented by Nelson and Winter's (1982) *An Evolutionary Theory of Economic Changes*. The publication of this book, and work by other academics at the Science Policy Research Unit (SPRU) at Sussex, generated some important ideas on the dynamics of organisational structures along the trajectories of new technologies (see Dosi et al, 1988). One of the important analytical tools to emerge within the evolutionary framework was the concept of heuristic search. Heuristic search operations are the routines and procedures that firms utilise in order to shorten the average search to solutions of survival in the market (Nelson and Winter, 1982, p.133). They lead firms towards innovation along the appropriate technological trajectories in spite of the uncertainty of future technological change and its adaptation. This study will explain how the idea of heuristic search can be used to underpin the relationship between the dynamics of organisational relationships and product innovation. Small firms have a role in the process of innovation because they have a role in the organisational and networking structures that evolve to cope with the adaptation and application of new technologies. The relative importance of small firms in the process of innovation is therefore related to the innovation characteristics of the technological trajectory. It is reckoned that small, autonomous firms are better equipped to deal with the types of adaptation and application of technology that go beyond the corporate visions of larger companies.

The evolutionary perspective, adopted in this study, highlights the need to conceptualise innovation in cumulative and historical terms. The process of innovation is, to varying degrees, a path-dependent process. The relationship between the process of innovation and the spatial dimensions of information flows can therefore be understood, to a large extent, in circular or interactive terms. The agents involved in the innovation process are faced with acute information problems and extreme uncertainty about the future. The increasing role of small firms has demonstrated the need for specialisation as information flows become more complex. These arguments are elaborated in chapter two.

1.4.2 Innovation and space

The introduction of the flexible specialisation thesis (Piore and Sabel, 1984), added a spatial dimension to debates on the role of small firms in the process of innovation. In its purest form, the flexible specialisation thesis is based on the ideal-typical depictions of interdependent firm arrangements in regional setting. It has been criticised in recent years, (see Simmie, 1997) on the grounds that it is more of a descriptive analysis of a number of unique regions than an exploration of the dynamics of innovation in relation to space. Explanations of the forces behind changing firm arrangements in a spatial context and the adaptation to new technologies have been dealt with more convincingly by industrial geographers applying the tools of evolutionary economics (Scott, 1987, Storper, 1995). On the other hand, one of the strengths of the flexible specialisation thesis has been its ability to raise important questions about the relationship between innovation, small firms and the importance of regional institutions.

Theoretical developments on the spatial dimensions of innovation, in response to the globalisation of economy, and the introduction of the flexible specialisation thesis, (Piore and Sabel, 1984) have been developed in the work of the new school of industrial geography (Scott, 1987, 1988b, 1993, Storper, 1995, Storper and Scott, 1992) which according to Hall (1998), owed an implicit debt to Marshall's (1890) pioneering theory of industrial districts. These set of authors have attempted to explain how innovations cluster as a function of their own internal dynamic. Storper (1995) suggests that "untraded interdependencies", which include material assets such as pools of skilled labour and non-material assets, such as the exchange of specific types of information, have become more important because trajectories of technology have become more open to adaptation. "Region-specific" social capital, in the form of shared civic values and trust (Putnam, 1993, Fukuyama, 1995), is said to be an important factor in facilitating the exchange of information that enables firms to adapt to technological change along those trajectories.

While we can say that the evolutionary framework is a significant development in our understanding of the spatial characteristics of innovative performance there is still no apriori reasoning to suggest that the most important forms of information that lead to innovation are spatially constrained to the region. In fact the increasing globalisation of economic activity means that certain types of innovations require forms of information that have become more spatially dispersed. Regional perspectives also tend to overlook the role of education, financial institutes and the macro-economic environment or what Nelson (1993) refers to as the

national system of innovation. The nature and importance of sources within the region therefore need to be considered in the context of an in-depth examination of the innovative products being studied. Chapter three focuses on theoretical debates surrounding the global / local interplay of innovation and their implications for understanding how the information associated with innovation is acquired and converted over space.

1.4.3 Towards the learning region?

Storpers's idea of untraded interdependencies was utilised in recent attempts to move towards the elusive and slippery concept of the "learning region" (Morgan, 1995). The "learning region" is now being used as a slogan for regions seeking funding from the EC for economic renewal. However, local authorities and agencies are aiming to move towards the concept of the learning region before the academic community has really come to grips with its meaning. As Keeble et al (1997, p.3) acknowledge, very few if any of the studies which advocate a "learning region" framework appear to have made any attempt as yet to test these ideas against empirical reality, or to have measured the nature and importance of learning processes operating within particular regions. There has also been very little attempt to conceptualise and measure the spatial dimensions of learning processes taking place within spatial concentrations of firms from particular sectors or product groups. In particular, the relative importance of intra-regional flows of information in relation to other factors that influence location behaviour has been overlooked.

Chapter three will go on to interpret the learning region policy framework through the cultural, economic, social and political aspects of its meaning. It is now recognised that there is a need to consider learning processes using a more qualitative approach so that we can begin to appreciate the role of power and influence from firms and institutions located beyond the innovative firm's home region (Pratt, 1997). The different dimensions of the learning region as a policy framework and the role of power will be the basis for understanding its relevance to the development of learning processes in the innovative firms being studied.

1.5 Methodology

Chapter four bridges the gap between theoretical explanations on innovation, the spatial dimensions of information flows and empirical observation. Attempts to conceptualise the role of the region in technological and organisational learning need to be made if the growing amount of literature on the learning region and regional innovation systems is to be tested empirically. The spatial dimensions of information flows are analysed by the differential between the importance of sources of information inside the firm's region compared to those located beyond the region. The sources are defined as the institutions, organisations and experience that individuals draw on in order to acquire information. The forms of information that the firms acquire from these sources are associated with different organisational and technological functions within the firms. The operationalisation of the research enables the importance of sources of information within the region to be measured against other reasons for firms being tied to their region such as access to specialised labour and transport links.

Chapter four goes on to provide a detailed description of the project's research process. The case study in this research consists of a novel three-stage fieldwork process in an area of the London Metropolitan Region (LMR), situated to the north-west, west and south-west of London. This area, which has been labelled as the "Western Crescent", is recognised as an area with a relatively high concentration of innovative manufacturing industries (Hall et al, 1987, Castells and Hall, 1994, pp.145-152). A map of the study area is shown in **figure 1.1** on page 31. Wynarczyk and Thwaites (1997) found that significant innovations in small firms are more likely to be introduced in the South-East than other regions in the UK. The latest Community Innovation Survey (CIS) also confirms the relatively strong innovative performance of firms located in these counties in relation to the rest of the UK. A particular justification for concentrating on the Western Crescent counties is the spatial concentration of IC firms within this area, which spreads from Cambridge in the north to West Sussex on the south coast, passing through Hampshire.

The first stage of the research process was a qualitative study based on 27 face-to-face interviews with managing directors of small, innovative firms in the IC sector in the county of Hertfordshire. The second stage was a postal questionnaire. The questionnaire was designed to generate coded information. The coded responses from the questionnaires were based on 50 responses from the sampling frame of 84 small, innovative IC firms from the wider case study

area. Personal contact through the use of the telephone made sure that the response rate was pushed up to 60%. The findings of the research are therefore based on a total of 77 responses from the first two stages of the research. The third stage of the fieldwork was concerned with policies aiming to develop learning networks for small firms in the county of Hertfordshire. Action research on the implementation of support mechanisms for learning networks was combined with an attitudinal survey on the development of such programmes from the interviews with IC firms in the first stage of the research. The policy implications of the study are discussed in chapter six. This has a particular focus on the implementation of Hertfordshire's learning region project using the findings from the research.

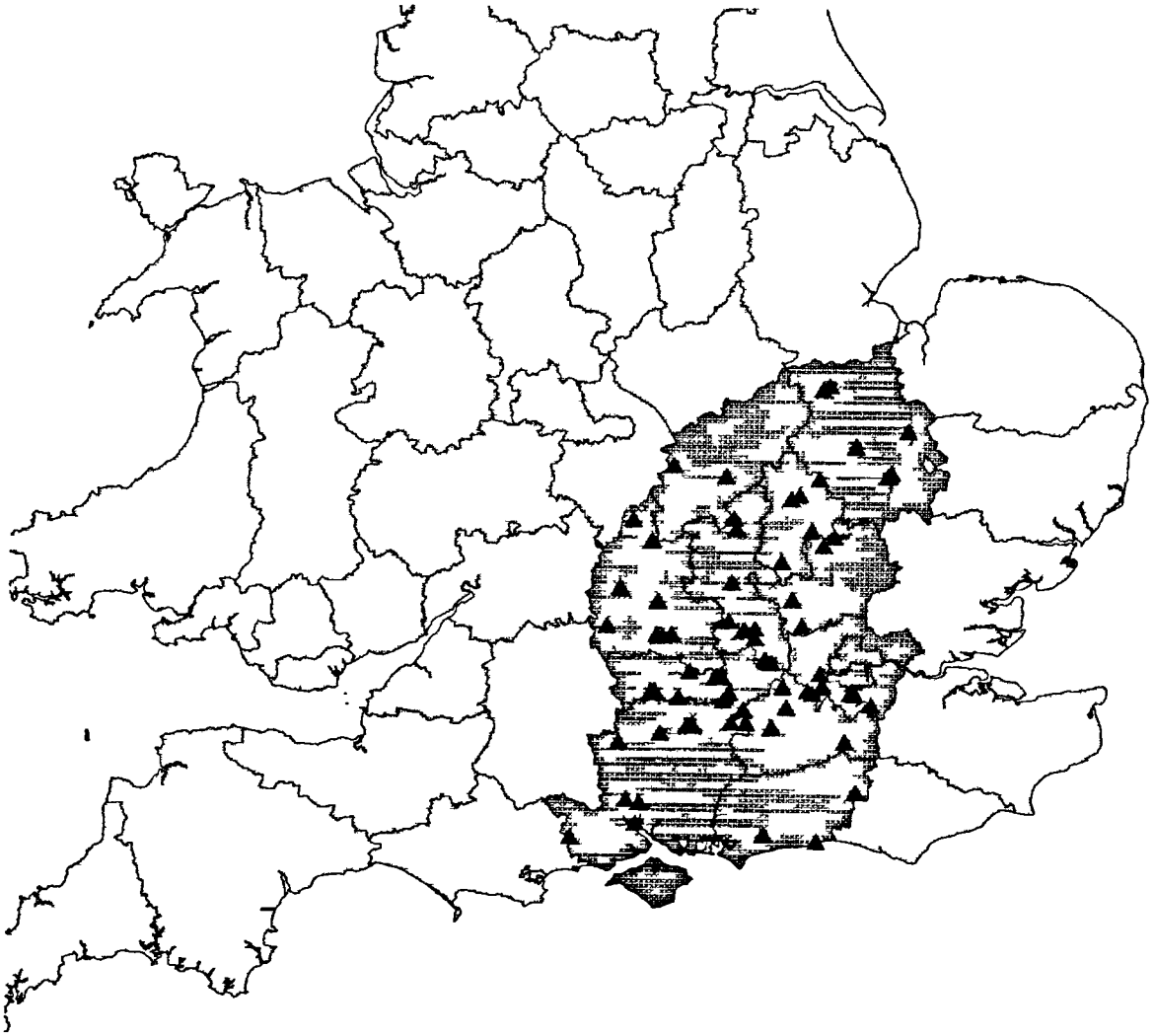
1.6 Summary and conclusions

The purpose of this study is to further understanding on a number of complex issues that have emerged at the interface of the disciplines of evolutionary economics and industrial geography in recent years. These are the global / regional interplay of organisational and technological development, the increasing importance of small firms in the process of product development, and in particular the meaning and significance of learning as a tool of regional economic development policy. This opening chapter has outlined the policy and theoretical background of the study. The boundaries of the project are defined by recent policy initiatives on small firms and innovation at the regional level. The chapter has introduced the explanatory underpinnings of the research where the underlying theme is the need to consider the spatial dimensions of flows of information within the context of innovation characteristics and performance.

The summary of the thesis structure is as follows. Chapter two provides an insight into the underlying perspectives on small-scale innovation and information and knowledge that inform the conceptual framework and the discussion on the relationship between information and space in chapter three. Chapter four translates the theoretical perspectives in chapters two and three into an empirical study and goes on to provide a description of the research instruments that were used in this process. Chapters five provides a dissemination of the findings of the research. Chapter six considers the policy implications of the study using a case study of a specific economic development project on learning and finally, chapter seven pulls the arguments together into a theoretical synthesis by referring back to the hypotheses developed

in chapters two and three. This concluding chapter goes on to offer recommendations and challenges for future policy development.

Figure 1.1: Map of study area and location of surveyed firms



2

Small-Scale Innovation, Knowledge and Information: underlying concepts

2.1 Introduction

The willingness of neo-Schumpeterian economists to emphasise the quality of goods and services and the evolution of new technologies and organisational structures, in the second half of the 20th century, presents a revolutionary critique of the static world of neo-classical economics. Neo-Schumpeterian economics has developed from the pioneering work of Joseph Schumpeter, one of the first mainstream economists to examine the impact of technological change on economic growth. The economics of innovation has led to interesting questions concerning the ways in which actors cope with the uncertainty of dealing with the complex information and knowledge flows that are associated with the development of technology. These questions have become particularly pertinent in the current era of rapidly changing technology. The important neo-classical assumptions to be abandoned in the neo-Schumpeterian literature were firstly, economic actors having access to perfect information and knowledge and secondly, firms dealing with a standardised range of products. Neo-Schumpeterians have also adopted a more pluralistic approach to economics by crossing the traditional disciplinary boundaries into other fields such as sociology and organisational science. A neglect of how technological change relates to institutional change, social relationships and organisational structures would limit our understanding of the forces behind its development and its effects on society.

In a subject area which embraces a range of theoretical perspectives and disciplines there are number of ways in which this study may have been approached. Neo-Schumpeterian economics was viewed as the most appropriate way of entering the discussion because it is the starting-point for looking at other disciplines that have impacted on theoretical developments in the field of innovation. Industrial geography is one such discipline of particular relevance to this study. The positive relationship between innovation and regional economic development

has come to the fore of policy debates and its empirical validity has also been emphasised in recent studies (see for example, Thwaites and Wynarczyk, 1996). In particular, an understanding of the relationship between firm size and innovation will inform an understanding of how the spatial dimensions of sources of information relate to the innovation characteristics of products.

The aim of this chapter is initially, to summarise and develop theoretical perspectives on the role of small firms in the process of technological innovation. The starting point is therefore the development of a taxonomy of innovation. This will be used as a basis for developing analysis on the relationship between the role of small firms and technological innovation. Some innovations have limited economic effects whereas others touch on almost every aspect of economic and social life. The foundations for the theoretical framework originate from this aspatial dimension which considers the theoretical perspectives underpinning the roles of small and large firms in relation to the scale of innovation. The chapter will go on to present an account of the aspatial aspects of recent theoretical perspectives on the nature of knowledge and information in relation to the process of innovation. This sets the scene for the development of spatial perspectives on innovation and information flows in chapter three.

2.2 The scale of innovation

One rationale for focusing on a particular size-band of firm is the relationship between the size-band and its general performance in terms of different types of innovation. The relationship between technological change and firm size has indeed been a central theme in the neo-Schumpeterian literature. The theoretical basis for policy debate has usually been the technologically deterministic elements of innovation with definitions based on the classification of technological change into either radical innovations or incremental innovations. *Radical innovations* are defined as discontinuous events, which despite being usually associated with long-term R&D investment, can also be attributed to inspiration and creativity. Freeman et al's (1982) extensive empirical analysis suggested that radical innovations are unevenly distributed in temporal terms. This claim contradicted the previous empirical analysis of Mensch (1975) which argued that radical innovations tend to cluster in periods of deep recession in response to the collapse or decline of established markets. This

study is more concerned with innovations of a less radical nature. The temporal dimension of innovation is therefore less important to the analysis.

Innovations of a less radical nature are usually described as *incremental innovations.* These can be classified as improvements to an existing product, either in terms of higher value for the buyer by improving performance or by adopting new techniques or practices to reduce cost savings in production. The recombination of different technologies is becoming more important to the process of innovation generally and it is now widely accepted that incremental innovations are extremely important to the growth of productivity. On their own, they do not necessarily have dramatic effects, which makes them difficult to record and difficult to capture in empirical analyses (Dosi et al, 1988, p.45). Much of the neo-Schumpeterian literature is therefore concerned with how innovations diffuse through the relevant sectors (Simmie and Kirby, 1995, p.12) and how firms adapt them for specific market niches. The shift of emphasis towards incremental innovations in the late 1980s led to debates concerning the ability of small firms to adapt new technologies for their own commercial ends. The ability to deal with important technological information and knowledge is seen as a major barrier to growth in the small firm sector (OECD, 1993, p.31). These issues are developed in section 2.3 as theoretical interpretations of the role of small firms in the process of innovation are elaborated.

Dosi et al (1988 p.45) created a more detailed taxonomy of innovation to take account of the types of technological change that have more far reaching effects on the economy and society. Certain innovations can affect several sectors in the economy while others affect an economy's entire system of production. Two further types of innovation were identified in their study. The first, *a change of technology system*, involves a significant change in technology. This is based on combinations of radical and incremental innovations, affecting several economic sectors and organisational structures. The second more far-reaching type of innovation is known as *a change of techno-economic paradigm.* A change in techno-economic paradigm is so pervasive that it requires a change in the social and institutional framework to allow for its diffusion (Perez, 1983, 1985). In the words of Freeman (1988, preface to part 2 in Dosi et al, 1988),

> "a techno-economic paradigm is a cluster of interrelated technological, organisational and managerial innovations whose advantages are to be found not only in a new range

> of products and systems, but most of all in the dynamics of the relative cost structure of all possible inputs to production."

The definitions show that we need to be aware of the scale of change in analysing innovation. In the more advanced economies of the world the development of microprocessing technology has had an impact on almost every aspect of economic life, not only having a profound effect on the way older products are updated but also on the way in which companies organise their production processes. The findings on the innovation characteristics of small IC firms in this study will demonstrate the importance of software development to the introduction of new measurement techniques.

As well as the scale of change, two further definitional distinctions need to be acknowledged. The first is the distinction between process and product innovation. A new process innovation adopted by a firm, whether technological or organisational, can also lead to improved product performance. Following on from this we also need to recognise the difference between organisational and technological innovation. This distinction can be blurred because on the one hand, organisational innovation within the firm can provoke technological innovation. On the other hand, technological innovation can lead to organisational change. These distinctions will be considered in more detail when innovation is operationalised in chapter four.

2.3 From large vs. small to an evolutionary framework

2.3.1 The roles of large and small firms

The definitions of innovations need to be borne in mind in considering the role of small firms in the process of innovation. Debates on firm size and types of innovation have developed from Schumpeter's original propositions. In his earlier work Schumpeter had emphasised small firms as the more important engines of innovation (Schumpeter, 1934). His analysis of the importance of spontaneous innovation emanated from the neo-classical, static model of the economy where innovation or technical change is absent and firms' profit levels would not be high enough to attract imitators into the market (Blaug, 1991, p 521). Schumpeter believed that this state of equilibrium could only be disrupted by a flow of income arising from

exogenous technological change. He put this down to the entrepreneur's inspiration and creativity:

> "Development . . . is spontaneous and continuous in the channels of the flow, a disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing" (Schumpeter, 1934, p.64).

Although Schumpeter used a perfectly competitive framework in his earlier work, it later occurred to him that the majority of important product innovations in the inter-war economy had been the result of long-term investments under monopolistic practices. The earlier emphasis on the entrepreneur was therefore modified by his later work that stressed the importance of large oligopolistic or monopolistic firms, with bureaucratically organised R&D departments (Schumpeter, 1942). Schumpeter later conceded that the encouragement of competitive practices would not necessarily lead to improved innovation performance:

> "What we have got to accept is that it (the large scale establishment) has come to be the most powerful engine of that (technical) progress and in particular of the long-run expansion of total output not only in spite of, but to a considerable extent through, this strategy which looks so restrictive when viewed in the individual case" (Ibid., p.106).

It has been suggested that the recent dichotomies in neo-Schumpeterian theory, some of the underlying themes throughout the theoretical background to this study in this and the following chapter, (fordist / post-fordist, entrepreneurship / corporate expansion, global dispersion / localised agglomeration) present complex reinterpretations of Schumpeter's original paradigms of technological change (Gordon, 1991, p.174). The role and importance of small firms in the process of innovation are underlying themes in each of these debates. Moreover, the dichotomy created by Schumpeter's original work is echoed by current debates on the extent to which government policy should assist the development of innovative small firms. While small firms can be viewed as significant innovators and engines of economic growth, they can also be seen as subordinates, relying on important information, knowledge and finance from large MNCs (Simmie and Kirby, 1995, p.17). This raises questions about the role of power and influence in the process of innovation and whether small firms are as pro-active in the development of new products as is sometimes assumed. There is some debate as to whether small firms, which have been acknowledged as innovative in the past, are really dependent on large firms for their knowledge and creative input, as well as being subject to

the influence of large MNCs in the direction of their final innovative outputs. The role of power and influence is considered in section 2.6.

2.3.2 Evolutionary perspectives

Despite the dualisms created by these debates, neo-Schumpeterian economists have attempted to synthesise explanations on the role of large and small firms. This has been achieved by the development of a theoretical framework that attempts to explain the structures and characteristics attributed to the organisational relationships associated with the evolution of technology. One of the most influential publications in this field was Nelson and Winter's "*An Evolutionary Theory of Economic Changes*" published in 1982. In attempting to understand the relationship between the nature of organisational activity directed to innovation and the results of such activity, Nelson and Winter turned to the idea of heuristic search operations. According to Nelson and Winter (1982, p.207) firms engage in various search operations whereby they discover, consider and evaluate possible changes in the ways of doing things. The purpose of these operations is to "shorten the average search to solution of the problems of survival and profitability" (Ibid., p.133).

The idea of "heuristic search" would seem to follow the later Schumpeter model of systematic innovation where bureaucratic rules and procedures are utilised in order to generate new inventions and innovations. Nelson and Winter do in fact indicate that the model of heuristic search is more compatible with the later Schumpeter model where organisations have well-defined routines for the support and direction of their innovation efforts. This assertion would seem to maintain the argument that the most important sources of innovations are large companies which have the capacity to develop innovation-orientated routines. The idea of heuristic search operations can nevertheless, be used to inform a structural framework for understanding the relationship between large and small firms in the process of innovation. The reason for this is that routine procedures do not necessarily have predictable results:

> "One way in which the routine functioning of an organisation can contribute to the emergence of innovation is that useful questions arise in the form of a puzzle or anomalies relating to prevailing routines" (Ibid., 1982, p.129).

If the effectiveness of the corporate strategy of the firm depends on its responsiveness to a changing market environment to maintain profitability, its routines must be flexible enough to

allow for adaptation and invention. This flexibility may involve the revision of its existing internal structures or lead to spin-off activity in small firms. Small firms then exploit the rigidity of existing operations in large companies which are geared towards certain technological outcomes. At certain stages in the development of technologies this requires the the "flashes" of inspiration that the younger Schumpeter had considered to be the main driver of innovation. The routine behaviour that organisations follow can lead to new ideas but the routines must be sufficiently flexible to allow this to happen.

It is a common assertion that the rules and procedures that govern the innovation process in larger firms are more averse to the process of dealing with change than in smaller firms where more flexible practices ensure greater responsiveness. However, "search" approaches can still be interpreted as "flexible" operations if large firms use these operations to evaluate possible changes in the ways of doing things. Flexibility can therefore be defined in terms of the firm's methods for adapting to new problems and procedures as they arise. This is their capacity for learning. In fact, the younger Schumpeter's elaboration of how structures emerged from the flexibility injected by creative entrepreneurs has equal pertinence to the idea of firms being able to adapt and respond to market opportunity. However, his later attempt to explain the emergence of new technology as the result of bureaucratised rules and procedures is also relevant to the study of how organisational structures, defined in terms of heuristic search procedures, lead to new innovations and product development.

Dosi and Salvatore (1992, p.179) referred to Nelson and Winter's work in distinguishing between "static" and "dynamic" routines. "Static" refers to the firm's capacity to replicate tasks although the firm is continually improving them over time in the light of experience. "Dynamic" routines are directed at coping with change through the development of new products, improvements in the product and the adoption of new processes: "The R&D activity proceeds through the employment of routines to ascertain where to probe, how to probe and how much to probe" (Ibid.). R&D activities are usually associated with the search for new technology but these types of routines can also be interpreted as the searches for new knowledge beyond the firm. Small firms perceive that these searches will lead them to new organisational and technological developments, even when a full appreciation of the future path of change is unrealistic. We are not necessarily referring to systematic searches. They can also be a by-product of the routine functioning of the firm.

Nelson and Winter (1982, p.133) suggest that the patterning of technological and organisational change through time is part of the genetic mechanism underlying the evolutionary process. Heuristic problem-solving activities can be described as patterns of activities that individuals utilise in order to lead their firms in what they perceive as being the right direction towards innovation along the appropriate technological trajectories (Lakshmanan and Okumura, 1995, p.69). Davelaar (1991, p.14) defines the new technological trajectories as the "paths" of further innovative activities underlying new types of products and services. According to Davelaar,

> "the evolution of technologies through time presents some significant regularities and one is often able to define 'paths' of change in terms of some technological and economic characteristics of products and services" (Ibid. p.12).

The 'paths' of change are characterised by evolving organisational relationships. For example, Lundgren (1991) studied the image processing industry in Sweden and found that the emergence of a new technology is accompanied by an evolving industrial structure which connects the supply and demand sides of product markets and so facilitates the development, production and application of new technology.

The role of large or small firms in the process of innovation depends on their respective roles in the production and application of new technologies. The linkages between different types of firms, whether large or small, are an organisational characteristic of the heuristic search operations that lead to innovations. The organisational relationships underlying these heuristic activities interrelate with the innovation characteristics of the technological trajectory. The particular attributes of each individual firm's capabilities relate to its specific position along the trajectories of technology. It is reckoned that small firms are better equipped to deal with the types of innovations whose future development goes beyond the corporate visions of larger companies. One explanation for the growth of the small firm sector therefore is that smaller organic companies possess greater potential in areas of innovation which go beyond the "range of technological and market outcomes for which the (larger) organisation can be prepared" (Swann and Gill, 1993, p.24). Small firms are part of the "genetic mechanisms" or heuristic structures that enable certain types of innovation to emerge. Innovative small firms are not islands. They are dependent on external sources of information for technology, marketing and distribution. Section 2.4 presents an account of why the process of innovation has increasingly been viewed as process reliant on interdependence rather than individualism.

Interdependence, both internally and externally, is crucial to the small firm's ability to acquire knowledge.

2.3.3 Empirical evidence

Although the inventive role which Schumpeter (1934) initially attached to small firms does have some empirical support, (for example, Rothwell, 1986), recent empirical evidence tends to suggest that small firms are more innovative in niche markets where there is scope for incremental product improvement. There is a growing recognition that small firms are better equipped to deal with the adaptation of technologies developed elsewhere, which are then sold in niche markets to meet the differing needs of sectors and consumers (See for example, Covin et al, 1990, Rosenberg, 1992). Empirical evidence does suggest that small firms mainly tend to remain small or grow moderately (Storey, 1994, p.112). This goes against the claim that small firms are more likely to grow rapidly by introducing radical innovations on to the market.

One of the most extensive surveys on the role of large and small firms was carried out by Pavitt et al (1987). Their survey was based on 4378 innovations, compiled at the Science Policy Research Unit (SPRU) over a period of 15 years up to 1984. The survey used a more qualitative approach to overcome the previous limitations of empirical measures of innovative activity such as levels of R&D expenditures. The results of the survey revealed a marked difference in the nature of innovative activity between large and small firms, with smaller firms (less than 1000 employees) being more innovative than the simple proxy of R&D expenditure would lead us to assume (Ibid., p.313). The results indicated that a positive relationship existed between smaller firms and a particular form of "technological ease of innovation". This is innovation of a more incremental nature. The importance of small firms to innovation was "reflected in bigger contributions to innovations by user firms from outside the sector, through vertical disintegration or untraded flows of information and knowledge" (Ibid., pp.310-311). The survey showed that there was a negative relationship between larger firms and process or incremental innovations. It also confirmed that larger firms (more than 1000 employees) were more likely to be associated with R&D based product innovations. The survey had attempted to overcome the assumption of earlier surveys where empirical measures of innovative activity had usually been final outputs of superior products, not inputs or intermediate outputs (Ibid., p.297).

Until recently the proportion of resources devoted to R&D activities has been the usual proxy for identifying innovative firms. In the small firm sector, however, it is more difficult to measure the level of R&D being carried out within any particular firm. This is because, smaller firms, unlike large high-tech firms, are less likely to have formal R&D procedures. Kleinknecht (1987, p.253) found, in a survey on R&D and small firms, that workers in smaller firms were more likely to associate R&D activities with formal R&D departments. If this is the case there would be a downward bias in the calculation of small firms dealing with design and product development. In reality, however, products are just as likely to be developed within the sales or production departments of smaller companies. Moreover, small innovative, firms are less likely to have formalised R&D departments than larger firms. In the smaller firms, in particular, where versatility is more important, workers might do a variety of jobs, including R&D activities. It is therefore just as appropriate to consider the nature of the product in the definition of an innovative firm. This is the output measure of innovation which is discussed further in section 4.5.2 of chapter four.

2.3.4 The role of small firms and industry-specificity

Nelson and Winter's emphasis on the need for sector analyses of inter-firm relations, emerged from the need to move towards a better understanding of how different types of industrial structures relate to the evolution of different types of technology (Nelson and Winter, 1977). Analysis of organisational structures within different industries has important implications for understanding the importance of the small firms sector's role in the process of innovation. Moreover, the role of the small firm sector will be exaggerated if there is a failure to distinguish small subsidiaries of large MNCs from more autonomous firms (Freeman, 1994, p.478). Surveys of the large vs. small nature such as that carried out by Pavitt et al, (see above) are limited because they do not necessarily capture the dynamics of innovation and firm relations in different types of industrial sector. Empirical evidence suggests that innovative small firms tend to be concentrated in a few industrial sectors, although their innovations may be used in many (see Thwaites and Wynarczk, 1996). Industry-specific analysis of innovation became an important element of neo-Schumpeterian economics in the late 1970s and early 1980s, when it attempted to explain how different types of innovation relate to the arrangements and linkages between firms in different industrial structures. Industry-specific analysis can also make an important contribution to debates on the spatial properties of firm arrangements and the innovation process by contributing to an understanding of the spatial organisation of functional linkages. Put plainly by Gordon (1991,

p.176), "the forward and backward linkages of inter-connected firms might have a local dimension or they might not." Similarly, certain aspects of knowledge acquired externally might be more important at close proximity to the innovative firm.

One of the first detailed sectoral taxonomies of innovation was formulated by Pavitt (1984, quoted in Dosi, 1988b, pp.1148-1149). These four types of manufacturing sectors are listed in **figure 2.1**, below.

Figure 2.1: Taxonomy of sectors

1. Supplier-dominated Sectors: Innovations are incremental in nature and tend to relate to improvements in equipment produced elsewhere.

2. Specialised Suppliers: Innovative activities usually relate to product innovations that are used as capital inputs for other sectors. The firms tend to be small, working in close contact with their users with tacit knowledge and "informal" activities being more important than formal R&D.

3. Scale-intensive sectors: Both process and product innovations are important. The sector tends to involve mastering complex systems, often manufacturing complex products. This requires economies of scale and large firms in this sector tend to integrate vertically into manufacturing their own equipment.

4. Science-based sectors: These are distinguished from the other production-intensive sectors because the product innovation tends to be used as inputs for a wide number of sectors. The sector relies on various benefits of economies of scale such as high R&D expenditure.

Pavitt's analysis provides a good example of how to classify firms in terms of their relationship with external sources of knowledge. It also provides an insight into the importance of in-house R&D activities in different sectors. For example, there is more likely to be innovative potential for small firms in sectors where large scale R&D is less important. In these sectors innovation tends to be characterised by gradual product improvement rather than radical technological advances. Pavitt's taxonomy can also be used as a baseline to study further developments in industry-specific analysis. A fifth classification of industries, typical of the craft-based Italian industrial districts, could be added to the taxonomy. These would be industries where large numbers of small firms compete and collaborate in niche markets. Piore and Sabel (1984, p.265) called this type of arrangement "regional conglomeration". A well

developed evolutionary theory will require a better developed taxonomy at all dimensions of firm arrangements in such a way that the relationships of the various units of analysis within each arrangement can be analysed (Saviotti, 1996, p.53). According to Saviotti (Ibid.) the taxonomy is far from complete and will need to extended and refined. While a taxonomy is useful for the development of innovation theory it only presents a snapshot of innovation systems at certain points in time. We also need to be aware of how technologies develop along their trajectories and whether external conditions are suitable for this development in the future.

Industry-specific analysis can be used to develop a comparative perspective on why certain regions specialise in certain industries (Dosi, 1988b, p.1149). Examples of regional development around the world and theoretical interpretations of sectoral dynamics suggest that socio-political and cultural factors are an important consideration in the analysis of why certain sectors succeed in certain regions. For example, analysis of industrial linkages sheds light on why Germany has been successful in the mechanical engineering sector and provides insights into the way in which the cultural context of the Japanese economy contributes to its impressive innovation record in the electronics industry. It is therefore interesting to find out why the conditions in the Western Crescent area of the LMR have been suitable for the growth of a group of small IC firms. These firms would seem to fit most appropriately into Pavitt's second type of manufacturing sector. They can be described as innovative in their own right and are largely specialised suppliers producing for other firms, where informal activities are more important than formal R&D. They provide value added for their customers through design improvements and development.

2.4 Innovation and the nature of knowledge and information

2.4.1 Interdependence

The fundamental change in the way in which the innovation process is interpreted theoretically reflects the changing nature of markets and technology and the increasing importance of interdependence, both internally and externally to the firm, to the process of product development. Through an appreciation of how the conceptualisation of the innovation process is changing, we can begin to appreciate why the spatial dimensions of information flows have

become an interesting research area. Until recently neo-Schumpeterian debates on the cause of innovation were polarised between those who believed that innovation was the result of demand-pull factors such as consumer preference and those who emphasised innovation as a linear process from the R&D stage through to marketing. It was only as late as the 1970s that neo-Schumpeterian economists began to accept that innovation was an interactive process (for example, Mourney and Rosenberg, 1979). Recent theoretical models point to a more complex interpretation of the innovation process. Shorter product cycles and more diversified technology lead to greater intensity of personal interaction beyond the firm during the process of innovation (Lundvall, 1988). More attention has been focused on exchange among different agents (Hakansson, 1987) and informal flows of information and knowledge (Hakansson and Johansson, 1988). It is now accepted that more sophisticated models of the innovation process should replace uni-directional or linear models (Freeman, 1994, pp. 479-480).

Among the key institutions external to innovative firms, Kline and Rosenberg (1986) highlight the importance of the basic research system. In their chain link model of innovation the research system is viewed as a pool of knowledge with a problem-solving capability that can be called upon at any time during the innovation process. These interactions constitute important elements of national systems of innovation as identified by Porter (1990), Lundvall (1992) and Nelson (1993). According to Nelson (1993) other crucial elements of a nation's innovative capacity are the education and training system and the macro-economic environment. While the role of the education and training system is not considered per se in this study its significance to the development of abilities to deal with information capture should be acknowledged. The extent to which the nation-state is responsible for the development of these problem-solving capabilities when there is an increasing international mobility of labour is an interesting question for a further research. Moreover, one of the criticisms directed at the concept of regional innovation systems is the neglect of the role of the macro-economic environment. This is considered in section 3.7.

The theoretical importance of the interactive vision of the innovation process was underlined in Porter's influential work on the sources of competitive advantage. Underlying Porter's work is the concept of the product value chain which emphasised the importance of linkages between firms during the process of product development. Although this is increasingly applied to studies of firm relations at the regional level, Porter views the value chain as being particularly important at the national level because of cultural norms and nation-specific regulations. Porter argues that a nation's competitiveness depends on the efficient operation of

an interdependent system or network of activities, connected by linkages between buyers and sellers: "The ability of a nation's firms to exploit linkages with home-based suppliers and customers will prove important to explaining the nation's competitive position in an industry" (Porter, 1990, p.42). Interactive linkages add to competitive advantage by contributing to greater buyer value. Linkages between the supplier and buyer facilitate innovative activities such as new procedures, new technologies and different inputs. Such activities are able to increase buyer value by increasing the quality of the product or by lowering its cost. Proximity is said to play an important role in these relationships.

The literature on national systems of innovation, particularly Nelson (1993), emphasises the importance of nation-specific cultural norms. Apart from the spatial level at which this is situated the idea of cultural norms as the basis for innovation potential is closely related to the main elements of the concept of the regional innovation system which will be considered in more detail in chapter three. The work on national innovation systems elaborates the interactive theory of innovation by emphasising aspects of information that are specific to the nation. In this study the role and importance of the research system and other aspects of information needs to considered in relation to the nature of specific types of innovation at the level of the firm.

While the national innovation systems literature takes a broad view of innovation this study will predominately be taking a narrow view by looking at the importance of information linkages from the perspective of the firm. Information linkages and their importance are being considered at the level of the region although certain qualitative responses from the findings indicate that non-firm institutions were specific to the nation. The broader view of innovation would consider the non-firm institutional structures that underpin the process of innovation. However, their role and importance in firm-based innovation should not be overlooked. The role of non-firm institutions as the basis of the learning region policy framework is considered in section 3.7.

2.4.2 Forms of knowledge and information

In this study the values of sources of information are considered in the context of innovation. The value depends on how a particular aspect of information feeds into existing knowledge-bases for the purposes of innovation. The definition of knowledge and information therefore requires further elaboration. In the Collins English dictionary information is defined as

knowledge of specific and timely events or situations. Similarly, knowledge is defined as familiarity gained through experience of learning or specific information about a subject. As these definitions suggest, information is closely associated with knowledge. However it is argued in this study that while information is used in the construction of new knowledge, it should be regarded as a separate concept. Knowledge is different from information because it is related to individual cognitive processes (Plotkin, 1994). The way in which actors use these cognitive processes to deal with complexity is discussed in section 2.5.

The classification of information and knowledge is sometimes represented as a dichotomy between codified and tacit knowledge. Saviotti (1996, p.170) argues that it is useful to think of different forms of knowledge on a spectrum with purely codified knowledge, which is also referred to in the literature as explicit knowledge, at one end and person-embodied, tacit knowledge at the other. In conceptual terms tacit knowledge is more specific and personal and therefore closer to the private extreme. Generalised, codified knowledge, on the hand, is closer to the public extreme. The two extreme types of knowledge and their associated characteristics are illustrated in **figure 2.2**, below. However, because the exchange of basic information can on occasions require cultural accessibility, the dichotomy of codified and tacit knowledge can be an over simplification. Codified knowledge or information is easier to transfer, but only to those users who have acquired the code (Saviotti, 1996, p.170). Moreover, as Nelson and Winter (1982, p.77) point out, "the possession of such a book - the articulable portion of the knowledge may be indicative of the ambition to learn, but it certainly does not certify possession of the skill." It is argued in this study that Saviotti's classification can be applied to information per se but not to knowledge. For example, certain types of information such as organisational techniques are more generalised while technological information is regarded as more specific. For the purposes of this study it is assumed that actors value specific information more highly than generalised information.

2.4.3 The process of conversion

In describing different types of learning process, Nonaka (1991) also highlights the distinction between explicit knowledge and tacit knowledge. Drawing on the work of Nonaka, Frybourg (1997, p.4) argues that "human knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge which can be called 'knowledge conversion'". **Figure 2.3** shows Nonaka's (1991) four modes of knowledge conversion in what he referred to as the 'knowledge creating company'.

Figure 2.2: Range of variations of types of knowledge having industrial applications

Source: Saviotti (1996, p.171)

Figure 2.3: Modes of knowledge conversion

i) *Socialisation*: Tacit knowledge is converted to tacit through strong personalised relationships where observation, imitation and practice are important. The individual acquires tacit knowledge directly from others by emulation. Regular personal interaction is vital to the conversion taking place.

ii) *Externalisation*: This is where tacit knowledge is articulated into explicit concepts, usually through the conceptulisation of images using language. Personal interaction is less important with this type of knowledge conversion.

iii) *Combination*: Explicit knowledge is converted to explicit knowledge. This is the process of exchanging and combining knowledge through such media as documents, meetings and telephone conversations. This characterises formal education and training.

iv) *Internalisation*: This is a process of embodying explicit knowledge into tacit knowledge. The conversion of explicit knowledge to tacit is helped by verbalising or the use of diagrams and through learning by practice.

Source: Nonaka (1991)

Those authors who feel that globalisation reduces the need for face-to-face contact rightly argue that electronic means of communication have reduced the barriers to information transfer. This is because increasing channels of information can be codified and accessed by way of computerised networks. However, we still need to consider the importance of the socialisation of knowledge conversion because "tacit" knowledge, or what is referred to here

as specific information, cannot be transferred through these information mediums. The scientist-philosopher, Polanyi's now famous and widely used quote "we know more than we can tell", (quoted in Nelson and Winter, 1982, p.76) has been used to express the limitations of language in articulating certain complex relationships and characterisations. Nonako argues that the limitation of articulation in expressing certain aspects of knowledge provides an effective barrier to its conversion. It is suggested that verbal instruction in matters of complex technological know-how is limited, leaving illustration by the instructor and imitation by the learner as the only possible means of knowledge conversion. This requires a high degree of social interaction and characterises many of the aspects of the process of innovation where a number of complex situations arise. Illustration by the instructor and attempted illustration by the learner is often employed as an alternative mode to verbal instruction and critique (Ibid., p.77). Nonako maintains that this conversion of tacit knowledge to tacit is usually more informal. It becomes an important aspect of the routine functioning of the innovative firm and is usually more important than formalised training procedures. However, in accordance with the arguments developed in this study, this should not be regarded as knowledge if it can flow from one person to another. Information and data used in the construct of knowledge can be said to flow. Gregerson and Johnson (1997, p.480) also suggest that tacit and codified knowledge may be largely complementary. They are nevertheless, produced in different ways, have different degrees of stickiness and play different roles in learning processes. Their argument also applies to the distinction between specific and generalised information.

2.4.4 Information flows and product development

One of the first economists to highlight the limitations of neo-classical economics in dealing with knowledge and information was Hayek (1945). Neo-classical economic analysis had assumed that economic exchange is carried out under the condition of perfect knowledge and information. As Hayek highlighted, in reality perfect information is never given to anyone in totality. And as technology becomes more complex and information more partialised, the assumption of perfect information becomes more unworkable. The interactive vision of innovation follows an acceptance that economics needs to account for the fact that solutions to economic problems depend on the circulation of partialised information between more specialised economic actors.

Much of the literature on innovation is concerned with how interactive relationships give rise to learning processes. Porter's value chain narrowly defines this as the relationship between the user and the producer. However, the exchange of information in relation to innovation as an interactive process goes beyond the relationship between the user and the producer. There are many ways in which information is acquired during the process of innovation. As Castells (1996, p.160) points out, "the organisational ability to increase its sources from all forms of knowledge (or information) becomes the foundation of the innovative firm." This raises interesting questions concerning access to different forms of information during the process of innovation and the potential role of public policy in facilitating this access.

In the context of innovation the process of knowledge conversion incorporates a variety of actors, both internal and external to the firm and information flows that have both a temporal and spatial dimension. A wider definition of learning in the context of the process of innovation should encompass analysis of how individuals cope with new situations, by utilising knowledge of information from past experience as well as information on new methods and how these are adapted for the means of product development. This raises the question as to whether markets and vertical hierarchies should be considered as learning networks (Murdoch, 1995). This is because the importance of being able to cope with change and adapt to new situations goes beyond the market-based attributes of simply responding to interactions along the value chain. It is argued in this study that market-based relationships and vertical hierarchies should be considered as learning relationships because they allow firms to access information for their means of development, although the importance of market-based relationships does vary depending on specific situations.

Von Hippel (1998, p.630), for example, argues that the reliance of the firms on users as sources of information does not necessarily lead to a positive outcome in terms of the innovation process. Von Hippel suggests that information transfer costs or "sticky" local information will tend to drive the locus of problem-solving activity away from specialist suppliers and towards those who directly benefit from a solution and have local information about a particular application. Von Hippel (1994) had earlier argued that when sticky information needed by problem solvers is held at one site only, problem-solving will be carried out at that site, other things being equal. The findings from this study show that specific information required for innovation is "sticky" and spatially dispersed from the firms' home region.

Von Hippel (1998) goes on to argue that the problem-solving work of certain products and service design to users will be economically attractive when the supplier faces heterogeneous demand for a given type of product; the costs of outsourcing design activity are huge; the stickiness of application-specific information is high; and the stickiness of information held by suppliers that is relevant to the product is low. The firms being considered in this study largely conform to these four characteristics.

2.5 Learning and coping with complexity

The conceptualisation of this study derives from the evolutionary framework outlined earlier in the chapter. The forms of information being considered in this study are defined in the context of the heuristic process of shortening the search to the solutions of the problems of organisational and technological change. The heuristic process depends on the knowledge-base of firms. Knowledge is an individually-centred cognitive structure that assimilates information and involves learning. The knowledge-base of firms determines the nature of its heuristic search operations. As we have seen, these are the methods and routines which are adopted by the firm and enable it to search for new ways of doing things. The ability to learn as a heuristic process therefore depends on how actors have learned in the past. In other words learning is a path-dependent process and it can be said that the learning capacity of an economy will to a large degree depend on its production capability (Gregerson and Johnson, 1997, p.480). How individuals and firms have coped with adaptation in the past on their trajectory of development will, to a large extent, define how they will cope with it in the future.

The heuristic process of introducing new products and incremental improvement is fundamentally about dealing with complexity along unpredictable paths of organisational and technological development. Actors cope by working under stable conditions with patternised routines. Saviotti (1996, p.161) interprets Nelson and Winter's (1982) idea of routines and heuristics as examples of the stable patterns of behaviour which are followed by organisations. According to Saviotti (1996, p.161), such patternised behaviour is the logical requirement for the stability of a complex system because a system whose internal structure fluctuated wildly in response to environmental stimuli would have no coherence or stability. Modern psychology suggests that humans are much better at pattern recognition than they are

at deductive logic (Batten and Karlsson, 1996, p.5). Where situations are complex, humans tend to search for recognisable patterns by simplifying the problem and using these patterns to build temporary mental models or hypotheses to work with. Waldrop used a chess analogy to explain how humans cope with a world which he referred to as fundamentally being an open system:

> "There is no conceivable computer that could examine all of those moves. And there is certainly no human being in the world. We human players have to make do with rules of thumb - hard-learned heuristic guides that tell us what kind of strategies will work best in a given situation." (Waldrop, 1992, p.151).

This explains why product innovation is often path-dependent. How firms innovate in the future depends greatly on how they have innovated in the past. However, there are occasions when an openess to new methods becomes important. This depends on the ability to forget methods which are no longer relevant to the problems of innovation facing the firm. The extent to which the adopted routines within the firm are flexible enough to accept new ones is important. This is acknowledged by Gregerson and Johnson (1997, p.480) who suggest that, "the enormous power of routines and habits of thought in the economy constitutes a permanent risk of blocking potentially fertile learning processes." Firms can be still be classed as innovative and yet rely on path-dependent processes of information acquisition that will ultimately become sterile unless they adapt their routines and procedures. When firms rely too greatly on path-dependent development there is a danger that they will be unable to cope with the prospect of widening their product range or moving on to new trajectories of development to survive in the long-term. This leads to questions concerning the role of policy in turning current innovators into more effective learners so that they can deal with the information problems of moving on to new trajectories.

2.6 Consideration of power and influence

The enduring nature of many networks of information accumulation raises questions about the role of power relationships in stabilising those networks. Murdoch (1995) suggested that network analysis could be used to understand structures as outcomes of active attempts to construct and maintain power relations. Underlying this notion in the context of innovation is the consideration of how powerful actors seek to enrol others behind the process of

information accumulation. The behaviour of important entities within the network is stabilised and channelled in the direction desired by the enrolling actor. Murdoch (Ibid., p.749) described this as a process of translation: "the dynamics of the network can only be understood if we attend the process of translation." The strongest networks are those where "the processes of translation have been effectively executed, allowing the enrolling actor to consolidate the network in its own right" (Ibid.). We therefore need to consider whether the small firm is subservient to the external source of information during the process of development. The question of power in networking relationships will be the subject of further discussions in considering the learning region as a policy framework in section 3.8 of chapter three.

2.7 A broader view of learning

If we are to begin to understand the complexity of the different types of learning processes that lead to innovations and new products, a broader view of learning is necessary. The common characteristic of almost all learning processes is that they are interactive and that they depend on the ability of individuals to combine and recombine different sources of information into something new (Gregerson and Johnson, 1997, p.480). However, there are various levels of learning that we need to consider in relation to innovation. The ability to cope with new situations as they arise, to adopt new ideas by utilising information through interaction and the ability to combine new information with past experience all contribute to the process of product development and the introduction of new products.

We also need to appreciate that some individuals are able to acquire and assimilate information more quickly than others. General education is of course a major consideration in analysing how individuals search for information but some individuals possess the innate qualities that are required to acquire and convert information more effectively. Knowing how to learn comes through experience. Product development is therefore the result of a series of interactions that take place within a complex network of information flows. The need for personal relationships in the transfer of specific information depends to a degree on the specificity of the information being acquired. This raises important questions about the need for geographical proximity between different institutions during the process of innovation.

According to Freeman (1994, p.468), in his comprehensive summary of neo-Schumpeterian economics at the firm level, it is now just as important to understand information accumulation as an interactive process as it is to understand flows of materials, components and intermediates. The interactive vision of innovation leads to inquiries about the spatial context of sources of knowledge that lead to innovations. In order to understand the relationship between information acquisition and the role of space we must appreciate how firms acquire information from external sources. The interactive process involves a myriad of sources of information. We need to explore how innovative firms draw on these important sources to enable them to cope with change through the implementation of new ideas.

2.8 Summary and conclusions

The theoretical foundations of this study have been derived from neo-Schumpeterian economics. This is a body of academic work which emanated from Joseph Schumpeter's proposition that innovation is one of the prime causes of economic growth. The theoretical approaches on innovation, knowledge and information reflect some of the underlying themes which emerge from Neo-Schumperterian economics. These are first, the roles of large and small firms during the process of technological development, and second, the interaction between innovative firms and other firms and institutions.

The question of whether small or large firms are the main drivers of innovation evolved from the dichotomy evident in Schumpeter's work on the role of large and small-scale innovation. The early Schumpeter model highlighted the importance of small firms whereas Schumpeter's later work emphasised bureaucratised R&D departments in large firms. The simple large versus small dichotomy has underpinned a number of developments in the neo-Schumpeterian literature. However, the question of whether large or small firms are the primary engines of innovation is now considered to be extraneous to an understanding of the development of new technological systems. Large and small firms both have an important role to play in the networking structures that evolve in response to the development of new technologies. The evolutionary framework shows that small, innovative firms have a particular role to play in adapting technologies, developed elsewhere, to specific niche markets. The ability to adapt to changing technology and organisational change becomes vital to the innovative firm, and this is the same whether the firm is large or small.

The role of small firms is important in understanding how information is acquired externally to the firm. The introduction of the interactive vision of innovation and exchange between different agents has raised important questions about the way in which different forms of information are transferred between organisations during the process of innovation. This depends on the ability of agents to draw on a myriad of sources of information that are characterised by a temporal dimension in terms of experience from past employment and a spatial dimension in terms of the location of these different sources of information. This chapter has also drawn attention to the difference between learning based on path-dependency and the ability to adopt new patterns of learning behaviour when existing patterns become sterile. The role of the region in relation to information flows and the role of small firms within the regional context will be elaborated and synthesised in the following chapter.

3

Spatial Perspectives on Innovation and Information Flows

3.1 Introduction

The acceptance that information is becoming a more important resource in the process of product development has coincided with the ascendancy of theoretical developments on the spatial dimensions of innovation and learning. One significant reason for this is that a better understanding of the geography of information flows enables us to draw conclusions on how different spatial levels of public sector support or governance can influence information acquisition. The re-invention of spatial perspectives on innovation and economic growth followed the increasing recognition that important innovations and economic growth were being disproportionately concentrated in particular regions, urban centres or localities. Spatial concentrations of innovation have led to a re-appraisal of the Marshallian theory of industrial districts incorporating ideas such as social embeddedness, and also the related emergence of new theories such as the innovative milieu and the significance of external linkages. These ideas have informed the development of the idea of the "learning region", but whether this can be regarded as a useful analytical tool for studying economic development, a sensible framework for policy, or simply a slogan for regions undergoing economic reconversion remains open to debate.

Theoretical expressions of the growing importance of the small firm sector and linkages within the regional context have developed from the thesis of flexible specialisation (Piore and Sabel, 1984). Despite its undoubted influence on theories of regional development, the model of flexible specialisation, in its basic form, has been criticised. Case studies of flexible specialisation in the successful regions of Baden-Württemberg in southern Germany and the Northeast and Centre (NEC) of Italy,[1] highlighted in the original exposition of the model, have also been used to illustrate the problem of transferring models of flexible specialisation to

[1] This was identified, amongst others, by Scott (1988) as an area of rapid industrial development in the 1970s and 1980s. He defined this area as comprising the seven administrative regions of Emil a-Romagna, Friuli-Venezia Giulia, Marche, Trentino-Alto Adige, Tuscany, Umbria and Veneto.

other regions. Moreover, it can be argued, using the evolutionary framework developed in the previous chapter, that the term 'flexibility' is not the correct term to explain the underlying changes in the capitalist system. It is argued that flexibility is just one way of describing the means by which firms learn about technological and organisational change in a more effective way. For this reason it is argued that learning is the central theoretical element of recent explanations on the spatial concentration of innovation (Storper, 1995).

While the exploitation of untraded interdependencies has become a central theme in the resurgent industrial geography there is some doubt as to whether region-specific labour markets and shared business conventions and rules explain the geographical concentration of certain types of innovative sectors and product groups. This is particularly so when the key shapers of economic activity are the large MNCs (Castells, 1996), and innovation-orientated networks are spreading over wider and wider distances. This chapter discusses recent theoretical developments on innovation and learning from a spatial perspective and attempts to summarise and critically evaluate the importance of proximity in relation to innovation and the nature of knowledge conversion and flows of information. This leads to the development of an explanatory framework that is used to inform the specific hypotheses and the operationalisation of the research in chapter four.

3.2 The model of flexible specialisation

3.2.1 Early developments

The model of flexible specialisation, introduced in Piore and Sabel's (1984) *The Second Industrial Divide,* developed from the proposition that the decline in world economic performance in the mid to late 1970s had resulted from the limits of the model of mass production. The thrust of the flexible specialisation thesis is that the exploitation of new flexible systems, based on the increasing availability of information technology, would depend on the ability of the political system to create an environment that encouraged the production of differentiated goods.[2] The flexible specialisation thesis is different from the Schumpeterian

[2] The regulation school had also argued that a change in institutional and organisational arrangements would be needed to regulate a new mode of organisation to match the needs of producers and consumers (Dosi et al, 1988, p.59). According to Hirst and Zeitlin (1992, p.84), however, the regulation school was more uncertain about the conceptual make-up of the new mode of production and had taken the concept of capitalism as its point of depature.

idea of a new "techno-economic paradigm", as defined in chapter two, because a new techno-economic paradigm describes the impact of new technology on the cost structures of production inputs (Hirst and Zeitlin, 1992, pp.82-83). Flexible specialisation as a new mode of production depends on changes in consumer behaviour as well as the technological effects on inputs to production. The flexible specialisation thesis was therefore proposed as an alternative mode of production, rather than a new technological system. According to Piore and Sabel (1984, pp.259-60), there were two reasons for believing that the flexible specialisation model would not be a temporary phenomenon. The first was that the application of information technology to industry favours more responsive systems of production. The second reason was that the use of computers in manufacturing is as much the result of shifts in the competitive environment favouring flexibility as it is of advances in the technology itself.

The flexible specialisation thesis has been particularly influential in highlighting the role of small firms in the process of production. The most important difference, however, between the flexible specialisation thesis and earlier Schumpeterian debates was the addition of a spatial dimension to the analysis of the growing importance of small firms. Following the work of Piore and Sabel, Hirst and Zeitlin (1989, p.169) characterised the ideal-typical attributes of the flexible specialisation thesis by two types of firm arrangements within a regional setting: First, by "interdependent networks of SMEs subcontracting to one another and sharing common services," and second, by large MNCs "decentralising into looser federations of operating units and associated subcontractors in search of more specialised products and more flexible production methods." These two basic models which form the foundation of the original flexible specialisation thesis, are depicted in **figure 3.1**.

3.2.2 Empirical validity

Many authors have attempted to test the empirical validity of the flexible specialisation thesis. Young et al (1993), for example, attempted to categorise types of firm arrangement in a regional setting and used an empirical study to see if inter-firm arrangements were conforming to the thesis of flexible specialisation. Their paper hypothesised that firm linkages at the regional level were characterised by three arrangements. The first two echoed Hirst and Zeitlin's hypotheses. The first arrangement is nothing but small firms interacting with the market. An example of this type of arrangement would be the craft industries in NEC Italy. The second is large firms interacting exclusively with small firm suppliers. As Castells and

Hall (1994, p.163) discovered, the Japanese economy, and particularly the Tokyo metropolitan area is characterised by the intimate relationship between very large electronics corporations and a large number of small subcontractors. Young et al's third hypothesised arrangement is a more realistic representation of the flexible specialisation thesis where large and small firms interact with each other in the same region, but also with many other customers from beyond the region (Young et al, 1993, p.29). This final classification was exemplified in Young et al's own study of two regions in New York where the vast majority of small firms were suppliers to large local firms, though they also supplied to firms in other areas.

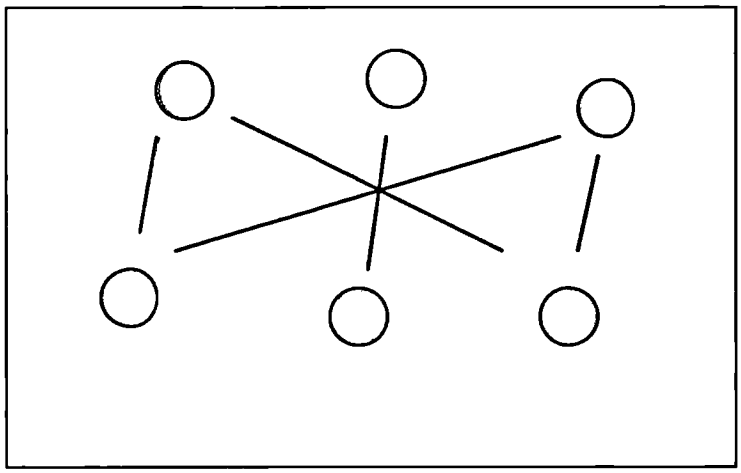
Young et al (Ibid., p.37) found that the firm arrangements in New York were somewhere in between those of NEC Italy and Japan. For this reason they rejected the flexible specialisation thesis in its original form. Their analysis was useful in drawing our attention to the importance of linkages beyond the region. However, it did not elaborate on how the nature and importance of such linkages relate to the process of product development within the smaller firms. This left scope for further research on the material basis of linkages between firms in relation to their spatial scale.

The innovation characteristics of NEC Italy warrant further consideration because this study is considering how information is transferred over space in the context of the nature of innovation. One of the key factors in the success of the manufacturing industries in NEC Italy has been the effective adoption of process innovations. Porter (1990, p.437) found in his extensive survey of Italy that "surging international success in a range of Italian industries can be traced to process breakthroughs and the application of modern flexible manufacturing technology to traditional products." For example, NEC Italy is the home of the Italian machine tool industry with a very large number of very small producers of machine tools controlled by computers. By the end of the 1970s its output had propelled Italy to the second largest machine tool producer in Europe, only behind Germany (Piore and Sabel, 1984, p.227). Despite the large aggregate output of the Italian machine tool industry, its production runs had tended to be very low, often amounting to a single, custom-designed machine (Brusco, 1982, pp.192-193). The Italian case provides an example of how process innovations have been used to enhance the product attributes of older types of goods. However, other highly competitive products from NEC Italy, which include more advanced goods such as shoemaking equipment and industrial robots, suggest that a local culture of networking can also be important to the development of more advanced products. In the 1980s

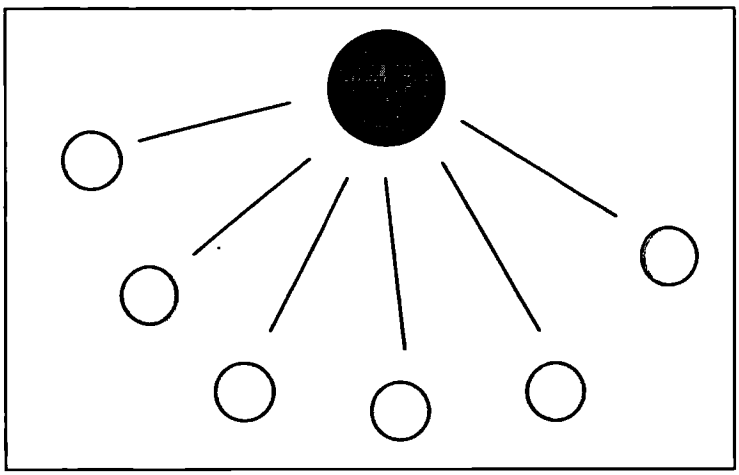
Italy was the world's third largest producer of industrial robots, and yet a third of that industry's output was produced by enterprises with fewer than fifty employees (Bamford, 1987, p.8).

Figure 3.1: The flexible specialisation models

1. Interdependent networks of small firms sharing common services.



2. Large multi-national companies decentralising into looser federations of operating units and subcontractors.



The application of process innovations and flexible manufacturing techniques had also been vital to the success of the craft-based industries in NEC Italy such as furniture, ceramic tiles, textiles and apparel. These industries dominated industrial production in Italy at the time of the introduction of the flexible specialisation thesis. By the end of the 1980s Italy produced around 60% of world exports and 30% of world production in the ceramic tile industry. In 1993, the trade surplus in the Italian textiles and apparel industries amounted to $18 billion (Fukuyama, 1995, p.103). In this industry, there are only two large-scale, publicly traded manufacturers, Benetton and Simint, with 68% of the workers being employed in companies of fewer than ten employees (Ibid.). Although these companies in Italy are innovative in the context of their own industries, they are not as technologically advanced as high-tech sectors which are usually defined by levels of R&D expenditure. This is not to suggest that the characteristics of adaptability and flexibility, displayed by small firms in NEC Italy, and the way in which the social infrastructure of their local communities contributes to their success, should be overlooked in the development of policy programmes for more advanced forms of production. However, the innovation characteristics of the dominant industries in NEC Italy and their related information flows need to be borne in mind in considering questions of transferability.

3.2.3 Criticisms

The flexible specialisation thesis has since been criticised from a number of directions. These criticisms centre around its failure to offer any theoretically coherent explanation for the dominance of small firms and its application to only a few sectorally specific cases in a limited number of regions. One of the empirical bases of Piore and Sabel's model is the growth in the number of small firms and empirical evidence does tend to support the notion of increasing subcontracting to smaller firms. For example, Imrie (1986) found that the total number of small firm subcontractors had increased markedly since the late 1970s. One explanation for this growing phenomenon, reiterating earlier discussions in chapter two on heuristic search and corporate strategies, is that the more systematic in-house procedures adopted by larger firms, do not have the flexibility to cope with the development of technologies open to diverse forms of adaptation. As we saw in chapter two, the importance of small firms in the diffusion of innovation depends on the accuracy of the larger firm's corporate vision. If the path of technological development is foreseen the large company will adapt its organisational structure to prepare for the development of the new technology. On the other hand, when the path of technological change is beyond the larger company's vision,

smaller organic firms are considered to be more adaptable and better equipped to deal with its diffusion.

The limitation of this argument in justifying the conceptual value of the flexible specialisation thesis is that is does not contain any explicit spatial dimension. It does not explain why production systems remain clustered in particular regions or to use Scott's (1988) term, why they become "territorialised". This leads to the criticism that the flexible specialisation thesis fails to offer any workable explanation for the territorial immobility of inter-firm relations (Storper, 1995). Other examples of successful regional growth such as Silicon Valley in California, possess large companies which have emerged from small-scale spontaneous innovations thus not necessarily supporting the flexible specialisation model in its original form (Simmie and Kirby, 1995, p.27). Moreover, the case of NEC Italy is an extreme case of localisation, based on a complex interaction of social and economic variables (see Storper, 1993). This makes its transfer to other regions and nations problematic.

In attempting to pre-empt these criticisms Hirst and Zeitlin (1992) argued that the limited empirical justification for the flexible specialisation thesis does not necessarily undermine its conceptual value. They suggested that the strength of the flexible specialisation thesis was found in its proposal for an ideal-typical conceptual alternative to the model of mass production. They went on to argue that the ideal-typical attributes of the original models would have to be adapted to other country's and region's institutional settings. Hirst and Zeitlin (Ibid., p.114) stressed that

> "flexible specialisation emphasises the effectiveness of regional institutions of economic cooperation. It points to the need to build regional autonomy and to foster the collaboration of industry, labour and public bodies at the regional level."

The flexible specialisation thesis also alerts us "to the complex relationships between economic and other social and political institutions and how these shifting organisational forms affect broader spatial changes" (Murdoch, 1995, p.741). In the UK greater attention is being devoted to how regional support mechanisms can assist small firms in adapting more effectively to technological and organisational change. In theoretical terms, however, the most compelling problem confronting advocates of the flexible specialisation thesis was justifying this elevated role for regional support in response to the increasing globalisation of economic activity.

3.3 Globalisation and the limits to regionalism

By emphasising linkages between firms at the regional level, the flexible specialisation thesis would appear to be at odds with the idea of an increasingly globalised economy. One of the primary economic dynamics of recent times is the more intensive integration of the activities of MNCs. Certain authors in the field of economic geography have suggested that the process of globalisation, which relates to the increasing dominance of MNCs, has reduced the significance of regions and localities in theoretical terms (For example, Robins, 1989, Amin and Robins, 1991, Robins and Gillespie, 1992). On the other hand, the disproportionate concentration of innovations and economic growth in regions across Europe, Japan and the United States, still lend credence to the notion that the regional and local context is still significant. This apparent paradox has led economic geographers to the problem of developing a theoretical framework that is able to reconcile an increasingly internationalised economic system with the continued disproportional spatial concentration of innovation and economic growth. Those who lean towards the globalisation perspective contend that the region is getting too much emphasis in recent theoretical interpretations and that a more realistic interpretation of the interaction between global, regional and local factors needs to be adopted. Robins and Gillespie (1992, p.155) suggest that "it is not about a new pre-eminence of the local, but rather a new articulation of local, regional and global scales of activity." The globalisation argument therefore needs to be considered before dealing with further developments from the regional perspective.

There is strong a priori evidence to suggest that the globalisation of the economy has seen a decentralisation of activities in the production hierarchy. This is allowed by

> "the high technical divisibility of the labour process, the relative indifference of products to transportation costs, the extensive use of on-line information and communication systems, and the need for locational proximity to customised and volatile markets" (Amin and Robins 1991 p.114).

Castells argued that the basic organisational form of the global economy is the emergence of international networks of firms (Castells, 1996, p.191). He has also recently attempted to dispell the idea that the influence of small firms in the process of product development is in the ascendancy: "the informational / global economy is organised around command and control centres able to co-ordinate, innovate and manage the intertwined activities of networks

of firms" (Ibid., p.378). Castells (Ibid., p.156) asserts that "the renewed dynamism of SMEs comes under the control of large corporations that remain at the centre of the structure of economic power in the new global economy."

Castells (1988, quoted in Amin and Robins, 1991, p.114) had earlier identified four main types of node along the internationally decentralised network (see **figure 3.2**). Any theory which attempts to explain the role of the region needs to be made in the context of this network hierarchy. The small IC firms in the London Metropolitan Region being studied in this research do not fall neatly into any of the categories. They are closest to the third type - "skill-based manufacturing sites". However, they are not controlled externally in any formal sense. They can be described as intermediate producers but whether they are externally controlled in a more informal sense by the influence of the customer over the process of production is something which will be examined. Izushi (1997) showed that when technology flows are one way from customers, the customers do command some power over their suppliers. The evidence from this study shows that technology tends to flow in both directions between the small IC firms and their customers. The question of power will be revisited in section 3.8.

Castell's network hierarchy is concerned with the co-ordination of mobility and fixity. The reason for this is that while capital accumulation necessitates the organisation of flows of knowledge between the different elements of the hierarchy it also requires the territorial fix of social and physical infrastructure to make this possible (Robins and Gillespie, 1992, p.155). This is articulated by Castells (1996) as the interaction between the "space of flows" and the "space of places". The space of flows is linked to the space of places because while infrastructures become the function of electronic networks they also become embedded by place-specific factors in the form of social practices and dominant social structures (Ibid., p.412). This study will show that the space of flows is constrained by the need to co-ordinate the process of knowledge conversion. Despite the spatial dispersal of sources of information, the firms remain fixed to their location by their internal social practices and labour requirements which enable them to co-ordinate knowledge conversion as well as the transport infrastructure that allows the firms to access information from beyond the region. These arguments are developed in section 3.6 after the consideration of theories which seek to explain the role of the region in the context of globalisation.

Figure 3.2: The internationally decentralised network hierarchy

1) "Secondary milieux of innovation": linked to the seedbed milieux through research and sales contacts;

2) "Technical branch plants": generate their own production networks but still technologically and organisationally dependent on parent firm;

3) "Skill-based manufacturing sites": located near the metropolitan centres of large or growing markets, externally controlled intermediary centres of production with a combination of international and local linkages;

4) Assembly factories relying on cheap labour in peripheral locations.

3.4 Recent developments in response to globalisation

Towards the end of the 1980s a distinct paradox emerged in the literature on the spatial dynamics of innovation and product development. This was centred on the problem of how to reconcile regional approaches to innovation and learning with the globalisation perspective which was based on the assertion that MNCs were becoming the key shapers of the world economy. The development of capitalism is the key to understanding the interaction between the globalisation of the economy and the different natures of local factors that contribute to the development of products and innovation. The increasing importance of knowledge is a key factor in these developments, but our understanding of the role of proximity in relation to the process of knowledge conversion still remains unclear. The following theories have been developed in the context of globalisation.

3.4.1 The innovative milieu

The term, "innovative milieu", coined by Aydalot (1986) of the European School,[3] is used to describe the complex set of relationships behind the development of innovative potential in a spatially defined context. The economic elements that characterise the innovative milieu were summarised by Camagni (1995, p.319). These are first, district economies that are "capable of reducing the cost disadvantage of small local firms with respect to large firms"

[3] Aydalot was the leading researcher in the Group de Recherche Europeen sur les Mileux Innovateurs (GREMI). This is a network of European researchers whose publications include Aydalot (1986) and Camagni (1991).

(agglomeration approach). Second, proximity economies that reduce transaction costs (neo-institutionalist approach). Finally, drawing on the work of Aydalot (1986), Camagni points to the synergy elements that facilitate innovation activity through interaction between local agents (embeddedness approach).[4] Camagni (1991, p.4) had earlier argued that spatial proximity matters in terms of easy information exchange, similarity of cultural and psychological attitudes and the frequency of interpersonal contacts. These approaches are explained in more detail in later sections of the chapter but initially the importance of the milieu will be considered in the context of the spatial diffusion of innovation. According to Ratti (1991, pp.79-81), the importance of the milieu relates to a product's degree of innovativeness, which in turn relates to the innovation's spatial diffusion process. The three different models of the spatial diffusion process are listed in **figure 3.3**, below.

Figure 3.3: Spatial diffusion processes

1.Epidemic-hierarchic model: In this model the adoption of innovations is a decreasing function of distance. Diffusion is therefore more likely to take place in the large town than the smaller town, that is from the top towards the bottom of the urban hierarchy.

2.Spatial division of labour model: Here the process of diffusion is determined by the functional hierarchy belonging to large MNCs and the diffusion of technology is therefore dependent on the internal strategy of the large enterprises.

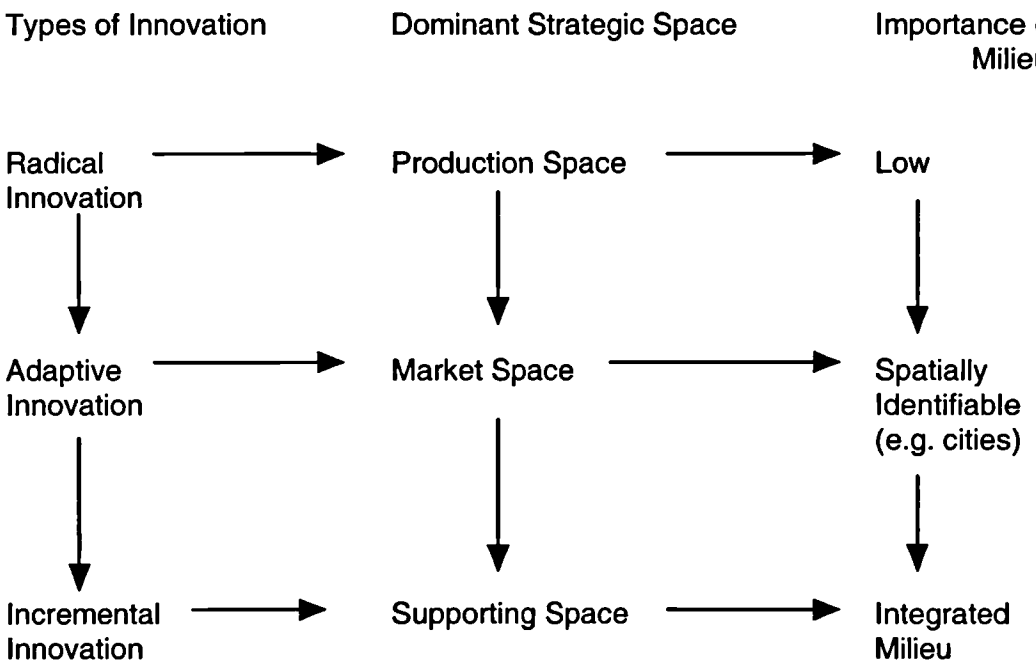
3.Net-like model: Innovation is a interactive process, that is, it is product of exchange among different agents. Innovation depends on networks which are open to external dynamics.

Ratti argued that the future of a group of enterprises belonging to a region will depend not only upon its strength or content but also on its relative space of positions. Three strategic spaces form the basis of his model (Ibid., p.72). The first of these is the production space of the firm which is determined by the spatial division of work. The second is the market space which is determined by the relationships of the SME facing the market. Thirdly, there is the supporting space which describes the relationships outside the market such as specific human ties and the interaction between private and public institutions. Ratti suggests that each spatial

[4] Harrison (1992) argued that the social embeddedness approach, which is closely related to the concept of the innovative milieu, has been incorporated into a neo-Marshallian theory of industrial districts. This is considered later in the chapter.

diffusion process of innovation is dominated by a certain strategic focus. In the epidemic-hierarchic model the strategic behaviour of the SME is strongly determined by the market space where the strategic adaptation of the firm will be dominated by the evolving forces of supply and demand. In the spatial division of labour model the SME's supporting space is determined by the internal strategies of the large MNC. In this case the dominant strategic space would therefore be the production space. Finally, in the net-like model the supporting space will have a strongly spatial character and will be the important determinant of strategic behaviour. According to Ratti, the support space has a key significance in facilitating the firm's capacity to improve product performance: "In fact, the necessity to define and manage some modes of co-operation becomes vital for an incremental innovation" (Ibid., p.84). Camagni (1991, p.4) went on to argue that creativity and continuous innovation are the result of such "collective learning processes". **Figure 3.4** depicts the complex expression of relationships in Ratti's model.

Figure 3.4: Dynamic analysis of the linkages between 'innovation, strategic space and milieu'



Source: Ratti (1991, pp.79-81)

The model used by the European School provides an insight into the complexity of relationships underpinning the small firm's place in the production hierarchy in relation to the spatial diffusion of innovation. Empirical evidence strongly supports the notion that innovations change during the process of diffusion and this is now generally accepted in neo-Schumpeterian theoretical frameworks. The declining significance of the epidemic-hierarchic model in neo-Schumpeterian economics follows the general acceptance of the interactive vision of innovation. The model used by authors from the European School nevertheless leads to questions concerning the importance of local milieux of production, within the context of globalisation. Its underlying argument is that the importance of the local milieu increases as innovations become more incremental in nature.

Three criticisms can be directed at the concept of the innovative milieu in the context of Ratti's model. Firstly, the model concentrates on different degrees of innovation without saying anything about their specific technological and market characteristics. Secondly, Ratti's model would also need to be developed to show how the milieu gives rise to radical innovations. For example, Saxenian (1994, p.161) later explained the importance of collective learning to the regional example of Silicon Valley, the pioneer of the computer industry, which will be considered later in the chapter. Finally, the model needs to be extended to show how proximity relates to different types of information linkages. The following section shows how recent theories attempt to address these issues.

3.4.2 External linkages

In explaining the regional concentration of certain industries, Porter (1990) argues that external pressures on firm dynamics are at least as important as the neo-classical agglomeration factors. Traditional agglomeration theory uses the neo-classical concept of externalities to explain the attraction of certain areas in business location decisions. The limitation of the neo-classical framework, however, is that it focuses on a given spatial context for location. By ignoring the relationship between typologies of industrial structures and their spatial context or the dynamics of firm organisation, it fails to offer a comprehensive explanation of why certain regions are more successful than others. According to Vaessen and Keeble (1995, p.491) environmental advantages or agglomeration factors must be juxtaposed with Porter's selective external linkages. The starting point for Porter's analysis is the value chain where suppliers and buyers are linked together in the process of product development. This was outlined in chapter two in section 2.4.1. Porter identifies four determinants of

national competitive advantage that affect the value chain of firm or industrial activities (Ibid., pp.69-130), in what he refers to as the "international battleground" of the knowledge-based industries. This is known as the "competitiveness diamond". The four determinants are listed in **figure 3.5**, below:

Figure 3.5: The four points of Porter's competitiveness diamond

1. factor conditions
2. the nature of home demand for the industry's product or service;
3. the related and supporting industries;
4. the firm's strategy, structure and rivalry.

Porter argues that each of the four factors has a significant effect on the ability of a domestic firm to achieve success in the global economy (Ibid., pp.71-72). It is also argued that government, through different types of regulation, can advance or impair the performance of home-based firms. For example, the increasing need for environmental protection is creating new technological trajectories for environmentally friendly production techniques and products, providing an important source of competitive advantage. The potential importance of this advantage depends on the nature of environmental regulation at the national level.

The first of Porter's determinants is factor conditions such as skilled labour or infrastructure. Here he emphasises higher-order advantages such as highly skilled labour or modern digital data communications that are important in the generation of cost-cutting production procedures. Factors such as these provide more sustainable competitiveness because pure cost advantages such as natural resources are less sustainable in terms of competitiveness than factors which create product differentiation. As well as highlighting the distinction between basic and advanced factors, Porter argues that the key to more sustainable competitiveness lies in the specificity of factor inputs. Generalised factors, such as transport linkages and the general standard of education, are applicable to a wide range of sectors. Specialised factors, on the other hand, such as narrowly skilled personnel and knowledge bases in particular fields of technology, are relevant to a narrower, but more innovative, range of activities. This is reiterated by Storper (1995) who suggests that localised institutions and rules become more

important when the production system evolves from a position of generality to specificity: "The elaboration of the technology over time, its differentiation into many different products and using more and more differentiated inputs, make the assets of the industry often highly specific to its firms and products" (Ibid., p.208). These assets are said to have a specific local or regional dimension.

Home demand can determine the success of a domestic firm by its influence on economies of scale. The quality and mix of home consumption patterns are seen as more important than the size of the home market. Products which succeed at the international level require demanding and sophisticated buyers. Porter (1990, pp.71-72) argues that proximity between firms and their customers plays an important role in the communication of ideas at the early stage of product development. Proximity also plays an important part in the relationship between the firm and its related and supporting industries. Clearer communication between suppliers and their users facilitates faster and more efficient solutions to problem solving. Inter-firm linkages at the regional level are said to be particularly important to the process of innovation in terms of up-grading.

Porter's fourth determinant of competitive advantage is the firm's strategy, structure and rivalry. These are the industry-specific conditions in the home nation that determine the organisational structure of companies and the nature of domestic rivalry. It is reckoned that the geographic concentration of rival firms enhances the innovative potential of the industry through four specific mechanisms (Simmie and Kirby, 1995, p.31). First, it stimulates a fast diffusion of technologies, second, it helps upgrading suppliers, third, it puts pressure on political support in creating specialised assets for production and finally, it stimulates firms to fund local training and research centres themselves. The industry structure and the positioning within the industry determine the scope for opportunity and competition (Porter, 1990, p.36). Certain market segments within the industry are more profitable than the average profitability within the industry.

Porter's model provides a general insight into the factors that make certain regions and nations more successful than others in global competition. It has wider empirical justification than the flexible specialisation models. However, it does not explain how the different factors relate to the innovation characteristics of the firms, in terms of technology and markets. While Porter acknowledges the importance of cultural accessibility to inter-firm linkages (Ibid., p.129), other authors have been more effective at linking the question of culture to specific

resources of proximity. The model is essentially a static depiction of different types of linkages. It does not throw much light on how firms use their regional environments in acquiring the specific information that enables them to respond to technological and organisational change along trajectories of development.

3.4.3 The resources of proximity: trust and social capital

The spatial context of economic development is said to be important because it leads to specific resources of proximity which can facilitate the innovation process (Maillat et al,1995, p.252). Before considering proximity in the context of technological development we need to consider what the resources of proximity actually are. The issue of proximity, revisited in the flexible specialisation thesis, has led to a reassessment of the theory of industrial districts. The recent elaboration of the theory of industrial districts (Marshall, 1890) again uses the example of NEC Italy to illustrate the importance of social embeddedness in economic relations:

> "What holds together the firms which make up the industrial district . . . is a complex and tangled web of external economies and diseconomies, of joint and associated costs, of historical and cultural vestiges, which envelops both inter-firm and interpersonal relationships . . . a localised thickening . . . which is usually stable over time" (Becattini, 1989, p.132, quoted in Harrison,1992).

The nexus of transactions or "localised thickening", which are seen by some authors as fundamental to the development of a region's innovative potential, presents a more sociological view of the concept of industrial district than the interpretation put forward by the Californian school which incorporates the ideas of Williamson (1975, 1985). The Californian school (see Scott, 1987, Scott, 1988, Storper and Christopherson, 1987), argues that agglomeration economies are caused by the need to reduce the transaction costs associated with inter-firm linkages. This need is heightened by the greater complexity and diversification of the productive environment. It is suggested that linkages between economic actors at the regional level, through face-to-face contact and free and open information flows, can effectively institutionalise trust and by doing so, reduce the transaction costs associated with production. Williamson (1975, 1985), elaborating on Coase (1937), had used this argument to explain why firms do not perform all necessary tasks in-house.

A criticism of neo-institutionalism, adopted by the sociologists, is that it assumes economic agents are still atomised and rational. It therefore overlooks the importance of embedded personalised relationships, trust and the sociology of association. In the Williamsonian framework, however, "externalised relations between economic actors are assumed to be constituted only on impersonal, contingent and impermanent exchanges between buyers and sellers" (Gordon, 1991 p.177). According to Hodgson (1988, p.156),

> "the basis of agreements is not simply the rational calculation of abstract individuals with a view to the perceived costs and benefits, it is a combination of both formal legislation and legitimation of inherited customs and traditions of a less formal kind."

Advocates of the social embeddedness argument, incorporating the ideas of Granovetter (1985), suggest that long-term personal relationships, where trust is the basis for interaction, provide a substitute for vertical integration. The social embeddedness argument therefore goes beyond the neo-institutionalist school by emphasising the importance of long term relationships between economic actors and networks built on experience which do not necessarily lead to optimal economic outcomes in the neo-classical sense. The case of NEC Italy has been used to demonstrate the importance of common cultural characteristics in facilitating these relationships.

According to Fukuyama (1995) the specific economic resource of cultural accessibility is a greater degree of trust in economic relations. His basic argument is that economic life cannot be understood separately from the "customs, morals and habits of the society in which it occurs" (Ibid. p.13). In other words economic relations cannot be divorced from culture. Fukuyama suggests that the neo-classical model is eighty percent correct in its explanation of economic behaviour. However, the neo-classical model gives "a poor account" of the other 20%. To Fukuyama "social capital" or culture is the "twenty per cent solution" to the problem of explaining how neo-classical economics fails fully to account for the complexities of economic relationships. He makes an important distinction between high-trust societies, such as Germany and NEC Italy, and low-trust societies and suggests that economic prosperity has a positive relationship with the degree of "social capital" apparent in any society. In his observation of Italy Fukuyama was indebted to the work of Putnam (1993). Putnam had painted a stark contrast between the nature of social interaction in North and South Italy. The Italy of the north is characterised by individuals that are more willing to trust

their fellow citizens by taking part in clubs and associations that go beyond the family while familism continues to characterise the southern part of Italy.

Powell (1990) argued that networks, supported by social ties and mutually supportive actions, as opposed to markets and hierarchies were becoming a more important mode of resource allocation. DiMaggio and Louch (1998) went on to argue that transacting with social contacts tends to embed commercial exchanges in a web of obligations. Their data supported the view that within network exchanges will be more common in riskier transactions. Uncertainty about product and product performance leads to close relationships with customers. This research will show that where firms tend to rely on specific customers for the purposes of product development close relationships do develop. The relationships may develop from market-based transactions but social ties develop from these transactions and the relationships become embedded. However, these customers are not necessarily based in the home region or even the home nation. The problem of the using the level of the region as the conceptual basis for policy action on networks is discussed in section 3.7

According to Castells and Hall (1994, p.19), the early development of the computer industry in Silicon Valley was supported by established social networks. The now famous Home Brew Computer Club, formed by young electronics engineers and computer lovers in the early 1970s, met regularly to exchange information and discuss developments in the field. Twenty-two members of the group would go on to start new companies including Apple and Microsoft (Ibid.). According to Castells and Hall, drawing on Saxenian (1990), informal social networks became the material basis for the formation of a culture that emphasised the value of technological excellence and free market entrepreneurship (Ibid.). This enabled Silicon Valley to emerge as the pioneer of the new computing and software industry and to continually re-invent itself in the 1980s and 1990s (Saxenian, 1994).

In section 2.4 it was explained why the exchange of specific information requires close personalised relationships. Networking, collaboration, shared socialisation and even friendship are an important basis for the excahnge of specific information. Examples such as Silicon Valley and NEC Italy show how "shared socialisation", through proximity and face-to-face contact within different communities, facilitates the exchange of specific information. In NEC Italy this social cohesion is based on firmly established ties between workers and entrepreneurs who have known each other from school (Ibid.). An important attribute of NEC Italy's industrial culture is what Porter (1990, p.437) calls the "out of school learning

process" in particular industries. Against a background of informal family and social networks the regional governments in NEC Italy have been able to encourage co-operation between small firms. The establishment of trust in user-producer relations along with fierce competition within the industries has helped to fuel the generation of new ideas and innovative products. The geographic concentration of these industries is said to speed up the process of knowledge conversion (Ibid.). "Shared socialisation" is important because it reduces the search period for potential collaborators because the degree of trust that is needed for the collaboration to work effectively is already established. The underlying argument of Fukuyama's (1995) celebrated book on trust was that making network models seen in places such as NEC Italy generalisable would be problematic in low trust societies.

3.4.4 Regional learning processes and the movement of labour

A further way in which proximity facilitates the process of information transfer is when individuals move more easily between organisations. Drawing mainly on the research of Saxenian (1990), Castells and Hall (1994) observed how the process of spin-off and recruitment in Silicon Valley created the twin processes of competition and cross-fertilisation between organisations. The movement of labour is also based on high degrees of social capital because informal networks were able to facilitate the recruitment process (Ibid., p.18). The constant circulation of talent from one firm to another made it extremely difficult to maintain proprietary rights over each innovation (Ibid.). Experience gained within the region can be utilised in spin-off activity, creating a dynamic process of information transfer. The fluidity of the labour market therefore enables regional learning processes to occur.

Keeble et al (1997, p.14) argued that innovations in the specific examples of Oxford and Cambridge have been characterised by the local recruitment of highly-qualified research and managerial staff, within the regional scientific and labour markets. An example of an industry where this has been prevalent in the UK is the motor racing industry in what has become known as Motor Racing Valley in the SE of England (Henry, forthcoming). The special characteristics of Motor Racing Valley in the SE of Engand have seen it move above NEC Italy to the status of pioneering region in the industry. The movement of personnel within the region enables ideas about the ways things are done in other firms to be implemented in the new firm's production ventures (Ibid.). In other words ideas diffuse and are then adapted within the industry as individuals apply their knowledge of information, acquired from past experience, to the product development process in their new place of work.

3.4.5 Information flows and the role of distance

The idea of the innovative milieu was based on the premise that local or regional flows of information are becoming more significant to the process of innovation. Other authors had earlier drawn attention to information flows and the role of distance. Thorngren (1970) had previously drawn attention to the importance of contact systems to the provision of information in city regions. Thorngren (Ibid.) argued that different regions offering different possibilities of utilising and combining many kinds of contact systems to capture information was becoming more and more important in economic development. Changes in communicational structures has locational implications because location is not a once and for all decision. Firms must respond to the their changing information requirements over space. However, he went on to suggest that the need for rapid random exchange of information will put a heavy restriction on the choice of location.

Pred (1975) called for the development of methodologies aimed at evaluating the relationships of linkages to inter-metropolitan flows of specialised information. He called for more accurate insights into the process of city system development of information linkages in advanced economies and the spatial distribution of information amongst multifunctional organisations. He had argued that economic interdependencies channel the flows of special information which affects the location of subsequent innovation decisions thereby affecting spatial innovation performance in the future. Contact with large metropolitan centres is considered to be vital to innovation capacity. Other authors such as Allen (1977) and Taylor (1975) have also drawn our attention to information flows and the role of distance and Von Hippel's (1998) arguments on "sticky" information also have implications for analysing information flows in a spatial setting. The stickiness of the information is said to be down to the distant relationship between the information source and its recipient. The writings of each of these authors do not necessarily support the view that intra-regional flows of information are becoming more important. They are more inclined to suggest that information capture is becoming more important to the choice of location. These arguments are elaborated in section 3.6.

3.5 The meeting of evolutionary economics and spatial perspectives

The importance of trust and the movement of labour locally have been highlighted in the literature as the two essential facets to a region's innovative performance. However, the way in which these factors contribute to information transfer needs to be understood in the context of technological change. The European School, which emphasised the importance of relationships between public and private institutions and local interaction, had little regard to the relationship between the nature of technological change and the precise factors within the region that facilitate it. As Storper (1995, p.203) observed, the European School had never explained "why localisation and territorial specificity should make technological and organisational dynamics better." The analytical tools which underpin the dynamic logic of the relationship between "territorial specificity" and technological development have recently been developed from evolutionary economics and the idea of technological trajectories, which was introduced in chapter two.

Storper (Ibid.) sought to provide an expression of the integration of theories of technological change with spatial perspectives on the innovation process. He turned to the theory of evolutionary economics to understand how the interactions between firms and institutions, in relation to space, facilitates technological development. Chapter two showed how evolutionary theories emphasise the relationships underlying the development of technology. The industrial structure behind the development of technology is a system of interconnected actors. Production is effectively taking place through the operation of a network which is an element of the heuristic-problem solving routines and procedures that are designed to shorten the average search to solutions of innovation-related problems. Relationships within the network are continually evolving and any attempt to explain the evolution of the system must be founded upon an understanding of the interaction over time between the evolution of the parts and the evolution of the whole system (Lundgren, 1991, pp.43-44). Technological change is path dependent because it involves interdependencies between choices made over time. These choices have an important spatial dimension. The evolution of the whole system is too vast to study in one research project. However, we do need to consider how small, innovative firms operate as part of an evolving spatial system.

The characteristics of the path of technological development and its networking attributes are relevant to the study of small firms and the importance of space for two important reasons.

First, as established in the chapter two, the relative importance of the roles of large and small firms in the innovation process depends on the innovation characteristics of the trajectory of a new technology and its networking attributes. Second, the importance of information acquisition occurring at different spatial levels in relation to the firm's home region depends on the properties of information and knowledge along the newly established trajectories. According to Storper, "untraded interdependencies" that generate region-specific material assets such as skilled labour and non-material assets such as the exchange of specific information become more important when trajectories of technology are relatively open. It is argued that more open and complex technological trajectories are characterised by a greater need for the resources of proximity discussed in the previous section. It is reckoned that the barriers to the transfer of more specialised information are overcome by geographical and social accessibility (Lundvall, 1994, Morgan, 1995, Storper, 1995). These industrial geographers point to the examples of regional growth, based on high-tech industry, to advance the idea that locally generated learning processes become more significant as technology becomes more open to adaptation. Storper (1995, p.209), suggests that geographically constrained untraded interdependencies become more important when there is potential for high levels of technological or organisational learning, in basic or incremental form:

> ". . . untraded interdependencies would be territorialised where the technological trajectories were particularly open, that is had wide margins of potential variation thus increasing the uncodifiability and tacitness of knowledge development and the importance of communicational clarity" (Ibid., p.206).

The idea of untraded interdependencies becoming more important at different phases along the path of technological development presents a more realistic theoretical framework for understanding the spatial dimensions of sources of information in the context of innovation. Storper contends that the importance of region-specific factors such as "localised rules and conventions" increases as the exchange of knowledge becomes more tacit and less articulable. If this is also applied to the exchange of specific information the limitation of this argument is that there is no a priori reasoning for asserting that the most important elements of information associated with the development of technology are spatially constrained to the region where the development is taking place. The argument infers that the most important and specific aspects of information are spatially constrained to the home region. In fact the globalisation of economic activity can only mean that this is less likely to be the case. During the development of specific technologies firms draw on forms of information that are

becoming more, not less spatially dispersed in relation to their home regions. Closer, personalised relationships do facilitate the exchange of specific information. The problem with applying this to reality is that in an era of globalisation, aspects of information which are most important to local technological development are sometimes acquired from other regions and other nations. This study will show that the most important information flows for small IC firms transcend regional and national boundaries. This is related to the firms' innovation characteristics, which tend to be small-scale, incremental in nature and driven by market necessity.

Emphasis on the idea of region-specific non-material assets also tends to underplay the role of tangible factors such as transport and communications infrastructure in the location behaviour of innovative firms. In the UK innovative firms tend to locate in regions where the transport and communications infrastructure is more advanced than other UK regions. One issue to address therefore is the extent to which this infrastructure facilitates communicational clarity beyond the region as well as within the region. The relationship between distance and information can be viewed in terms of cost optimisation. As Nelson and Winter argued, "the question is whether the costs associated with the obstacles to the articulations are sufficiently high so that the knowledge in fact remains tacit" (Nelson and Winter, 1982, p.82). The reduction in the relative costs of communication and transportation can only mean that the obstacles to the acquisition of specific information from beyond the region are lowered. However, obstacles such as the need to co-ordinate other aspects of knowledge conversion internally and externally to the firm still remain. This is not to suggest that region-specific social capital is not important to the process of innovation in general terms. The question that needs to be addressed is how we place the importance of region-specific social capital in the context of certain types of innovative activity and performance.

3.6 Towards a new interpretation of innovation, information flows and space

The paradox of globalisation and spatial concentrations of innovative activity led McCann (1995, p.564) to ask why clustering should take place when such spatial clustering often takes place in industries in which the innovation rate and the spread of technological change are not high or alternatively in industries which co-ordinate activities on a global scale. McCann went

on to suggest that the underlying spatial economic question in traditional location theory had been the co-ordination of production hierarchies (Ibid.). As empirical evidence from this study will show, the co-ordination of activities on production hierarchies can have a significant interrelationship with the co-ordination of information flows. However, production hierarchies are not the only consideration in the question of why innovative firms in the same industry co-locate in certain regions. The importance of production hierarchies to information capture for the innovative firm interrelates with the nature of the innovation characteristics of the products in question. In other words production hierarchies will be important to information capture with certain innovations but not with others. The most important factor that directs the process of innovation is knowledge of information on technology and markets. The co-ordination of information flows is therefore the underlying spatial question of this study.

The acquisition of information for the purposes of innovation is a continuing trade off between the costs of overcoming the problems of distance associated with access and the value placed on the acquired information. Ceteris paribus, a firm will tend to remain in the same location to avoid the loss of benefits of being able to co-ordinate information flows. McCann argued that this would need to be weighed against the costs incurred in being located at a point is space (Ibid., p.569). These are the cost of local capital, land and labour inputs. The benefits of location in terms of information acquisition are relatively important for an innovative firm compared to a firm dealing with standardised products. The main benefit is the greater ease of access for face-to-face contact. This is vital to the firms' ability to acquire specific information. McCann attempted to incorporate face-to-face contact into a location framework to explain why similar firms locate in similar places:

> "If the perceived opportunity costs of not being able to maintain continuous face-to-face contact with other firms and / or customers in order to allow the maximum level of negotiation and co-ordination, always outweigh the benefits of lower factor price at alternative locations which would allow less intensive face-to-face contact due to distance, then any consideration of alternative location for firms in such industries, other than at location next to other firms performing similar activities, is completely ruled out" (Ibid., p.570).

Hall (1997, p.20) called for the development of traditional location theory to incorporate the costs of access to information. Hall suggested that the model would need to be weighted to produce alternative measures of attractiveness to different kinds of informational activity.

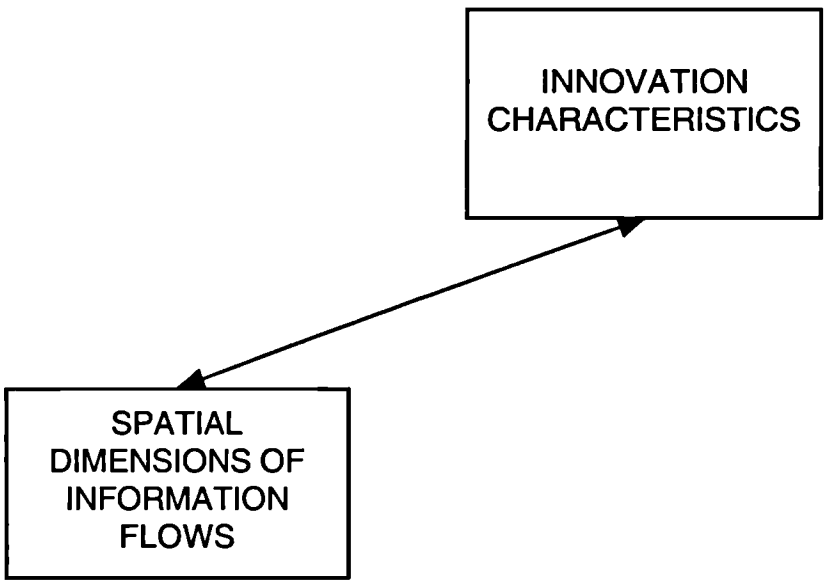
Accordingly, for the purposes of this study the different forms of information are valued in terms of their effect on the development of different functions within the firm. The measures of attractiveness relate to the importance of these functions to the process of innovation. It is assumed that more specific, technological information is more important to the process of innovation whereas more generalised, organisational information is less important. The costs incurred by being located at a particular point in space are weighed against the benefits of being able to access the most important, specific information that leads to innovation. The benefits of location therefore include an ease of access to the pool of specialised labour, which allows for the co-ordination of information internally and externally, and access to transport links that allow for the degree of face-to-face contact which is required beyond the firm's region. In studying the spatial dimensions of information flows these other location factors need to be considered. By taking into account access to information Hall believed that the outcome of the new location theory would be a new urban hierarchy of centres and sub-centres, based on positions within a set of global information flows (Ibid.).

McCann (1995, p.568) argued that the factors which influence the location behaviour of particular types of firms producing particular types of products need to be related to the qualitative characteristics of those products: "if we cannot indicate what is produced, then we cannot discuss either markets or hierarchies." Similarly, if we do not appreciate the innovation characteristics of products then we cannot understand how information is acquired in spatial terms. The structural basis of this study is therefore the relationship between the spatial dimensions of information flows and the nature of the firms' innovation characteristics. The innovation characteristics of the products interrelate with the routines that enable the firms to access sources of information. Firms depend on certain sources of information associated with the type of innovation that they are dealing with. Accordingly, the factors that influence the location behaviour of firms are based on their experience of the innovation process because this determines how they perceive the value of sources of information in the future. In the case of small IC firms, sources which are valued more highly are predominately located beyond the region and the nation. Faced with uncertainty over markets and technological scope the firms draw on their past experience of innovation in their decision to remain located in close proximity to good transport links that allows them to access this highly valued information.

Figure 3.6 provides a simple illustration of the interrelationships between the different theoretical components of the research. At this stage the diagram is general in nature. Its purpose, however is to provide a basis for unpacking the operational relationships in the

following chapter. Despite the complexity of these relationships, a simple explanatory framework is useful for isolating the main conceptual components of the study. From this simple framework a complex interaction of explanatory hypotheses emerges. The main explanatory hypothesis of the study is that innovation characteristics interrelate with the spatial dimensions of information flows. The different forms of information, and their source of acquisition, are valued in terms of their importance to the innovation process in the firm. The values signify the extent to which information is more specific to the process of innovation. The spatial dimensions are defined in terms of the location of the source of its acquisition and the importance of other location factors in comparison to intra-regional flows of information. This explanatory framework leads to three hypotheses set out in the section 4.1 of chapter four.

Figure 3.6: Explanatory framework



The key theoretical component of this study is the innovation characteristics of the products which depend on the firm's position along the trajectory of technological development. This is the central theoretical element of the theoretical framework because it determines the point of reference for the study - small firms dealing with the adaptation of particular types of technologies. The spatial dimensions of information are analysed in the context of these innovation characteristics.

This study will show that the factors which attract small innovative firms to the LMR are based on the powerful force of path-dependency. Agglomeration factors attract like-minded firms to particular areas and encourage them to stay. In this context regional and local policy-makers are encouraged to foster the development of indigenous innovation capacity. In the following section the learning region policy framework will be examined to provide the basis for considering the issue of policy response.

3.7 The learning region

As the spatial dispersal of information accompanying the process of globalisation becomes ever more apparent, the role of regional policy in facilitating the development of innovative industry comes under closer scrutiny. Storper's idea of untraded interdependencies has been utilised by authors in their attempts to move towards the slippery concept of the "learning region", a framework which has been used to inform economic development policy. The "learning region" (Morgan 1995, Asheim, 1996), emerged from debates that were considering the significance of non-firm institutions to the development of innovation capacity. Non-firm institutions cover non-tangible assets such as trust, as well as the more conventional idea of non-firm institutions as tangible assets, such as trade associations and other support services.

The concept of the learning region is closely connected to the idea of regional innovation systems (see Braczyk et al, 1998). Amin and Thrift (1994) had earlier argued that the local economy and local institutions are becoming more not less important in enabling firms to adapt and survive. It is suggested that the local and regional scale rather than that of the nation state is the most appropriate spatial level at which to nurture interactions that give rise to the sorts of activity that enable firms to compete in the global economy. Drawing on Amin and Thrift and the work of the institutional sociologists, discussed in section 3.4.3, Braczyk et al (1998, p.416) argue that regional innovation systems depend on regionally developed assets which maybe embedded in woven networks of interactive and exchange relationships. The problem with the regional approach, as Lovering (1999, p.383) points out, is that it is not clear how the abstract region posited by proponents of the 'new regionalism' relates to the actual region in which people live and work. In analysing regional learning processes we therefore need to be clear on the nature of the learning we are measuring and the definition of the region where the learning is taking place. A further complaint from Lovering (1999) is

that the regional innovation system concept overlooks the role of macro-economic redistribution at the national level.

Despite the learning region concept often being associated with the institutional structures of regions and their importance to the innovation processes in firms, there still seems to be confusion in the literature over the exact nature of the factors that give rise to a learning region. On the one hand there are authors emphasising the softer factors such as mutual support and flows of information and knowledge within the region. This view of the learning region was exemplified by Morgan (1997) and Asheim (1996). Whilst accepting that globalisation caused the role and function of industrial districts to be problematic,[5] Asheim argued that the future of these districts would depend on the "collective learning capacity of SMEs".

On the other hand, authors such as Florida (1995) have highlighted the importance of tangible factors such as human capital and transport and communications infrastructure in attracting firms which learn most effectively to a particular region. According to Florida (Ibid., p.528), "learning regions function as collectors and repositories of knowledge and ideas, and provide an underlying environment or infrastructure which facilitates the flow of knowledge, ideas and learning." We cannot say that Florida is necessarily referring to the importance of intra-regional flows of knowledge. The different emphasis in definitions of the learning region means that the development of the concept in policy terms becomes more confusing and less meaningful. This study argues that in the current policy context of the UK, it is more useful to think of the learning region in terms of increasing the efficiency of information flows between firms and organisations. By examining the relationship between innovation and the spatial dimensions of information flows, this study will show that the learning region is more useful as a policy framework than it is in explaining existing innovative performance in small firms. However, it is essential to consider policy responses which aim to develop mechanisms for collaboration and information exchange in the context of how small, innovative firms acquire information both at the regional level and beyond. We need to know more about the extent to which regional policy mechanisms can facilitate access to information for small firms with innovative potential.

[5] In line with the globalisation perspective some observers had raised questions about the long-term stability of industrial districts because of MNCs taking over the most successful SMEs and the most successful firms inside the districts forming hierarchies.

In the UK policy context the idea of the learning region has usually been associated with the reconversion of regional economies traditionally dependent on the older manufacturing industries such as South Wales or the North-East of England. The term "learning region" is most often applied within the context of strategies that are aiming to rebuild regional economies in response to the contraction of large-scale manufacturing industry. For example, Morgan (1997) has used the concept of the learning region in expressing the objectives of the Welsh RTP plan. The aims of the plan had centred on the development of support programmes to generate innovation capacity as spin-offs from foreign direct investment. This innovation capacity is said to be dependent on non-firm innovation networks strategically focused on technological support, learning and economic development. According to Lovering (1999), however, policies such as these which encourage innovation are indiscriminate and vague and can hardly be called an economic development strategy. Issues of power in the development of such policies will be considered in the following section.

The learning region policy framework draws implicitly on examples of government intervention and support mechanisms from other countries. For example, the purpose of the Japanese national technopolis program has been to create an entire series of new science cities in the country's peripheral areas, in order to fulfil the twin objectives of promoting new technologies and developing lagging regions (Castells and Hall, 1994, p.112). There has been an emphasis on soft infrastructure of trained people, the diffusion of new technologies, information sources, venture capital and telecommunication services (Ibid., p.116). A prime example is the 130,000-hectare Shinanogawa technopolis, centred in and around the city of Nagaoka (Ibid., p.126). In order to develop new attitudes in older firms, the prefectural government has established an Industrial Technology Centre and a Technological Co-ordination Centre within the technopolis. The research core centre, which opened in 1984, provides companies with an access to new technologies, trains people to train others and serves as a key source of information (Ibid., p.128).

The technopolis programme in Japan is part of national strategy to reduce the country's regional imbalance in economic development. This has been integrated with a land-use strategy of new town designation. According to Castells and Hall (Ibid.), the population growth in Nagaoka has been slow (5,000 by 1990 against a target of 40,000) but the technopolis planners view the development of high-tech industry in this region as a long-term project. In the UK the national government is keen to foster innovation potential in all regions but up to now innovation strategies have been separated from strategic land use planning.

Learning region policy initiatives are currently being implemented at the county level. Hertfordshire County Council is an example of a local authority who are keen to develop the concept of the learning region through a number of European funded ADAPT initiatives within the county.[6] Unlike South Wales, this is in a relatively successful region in UK terms, albeit one which has been affected by reductions in defence expenditure and a severe contraction of large-scale industry. The aim of the Hertfordshire initiative has been to develop long-lasting mutual support relationships where firms can learn about new organisational techniques and practices. Hertfordshire's pursuit of the learning region concept is the subject of chapter six.

The framework for studying the learning region in the context of policy development is a synthesis of interpretations of the meaning of the learning region. This is mainly from recent developments in the literature. In section 3.8 it will be shown why this framework needs to be considered in the context of the spatial dimensions of information flows in regionally-based firms. A political, economic, and cultural dimension to the learning region policy framework can be extracted from the literature. The social dimension is underdeveloped so will be only touched on using the author's own interpretation. The summary of these different dimensions is presented in **figure 3.7**.

In economic terms, the idea of learning region is usually applied in the context of enabling firms to become more competitive in a learning economy where the ability to cope with change by adapting to technological and organisational change is vital to survival and success. The problem of coping with innovation, in terms of product performance, therefore tends to inform the economic perspective on the learning region. Learning in this sense relates to the knowledge that firms need to acquire to enable them to compete at the global level. Surviving in the globalised economy depends on innovation because innovation is viewed as the key to competitiveness. According to Florida (1995, p.532), a learning region possesses a culture where continuous improvement, new ideas, knowledge creation and organisational learning are the maxims for a sustainable support infrastructure. The economic dimension of the learning region suggests that a support infrastructure should be developed that gears firms to organisational, process and product innovation.

[6] Hertfordshire have explicitly stated that they are developing the learning region concept by encouraging small firms to access information and knowledge from universities and large companies and through the development of mutual support mechanisms for the same small companies (Hertfordshire CC, 1995).

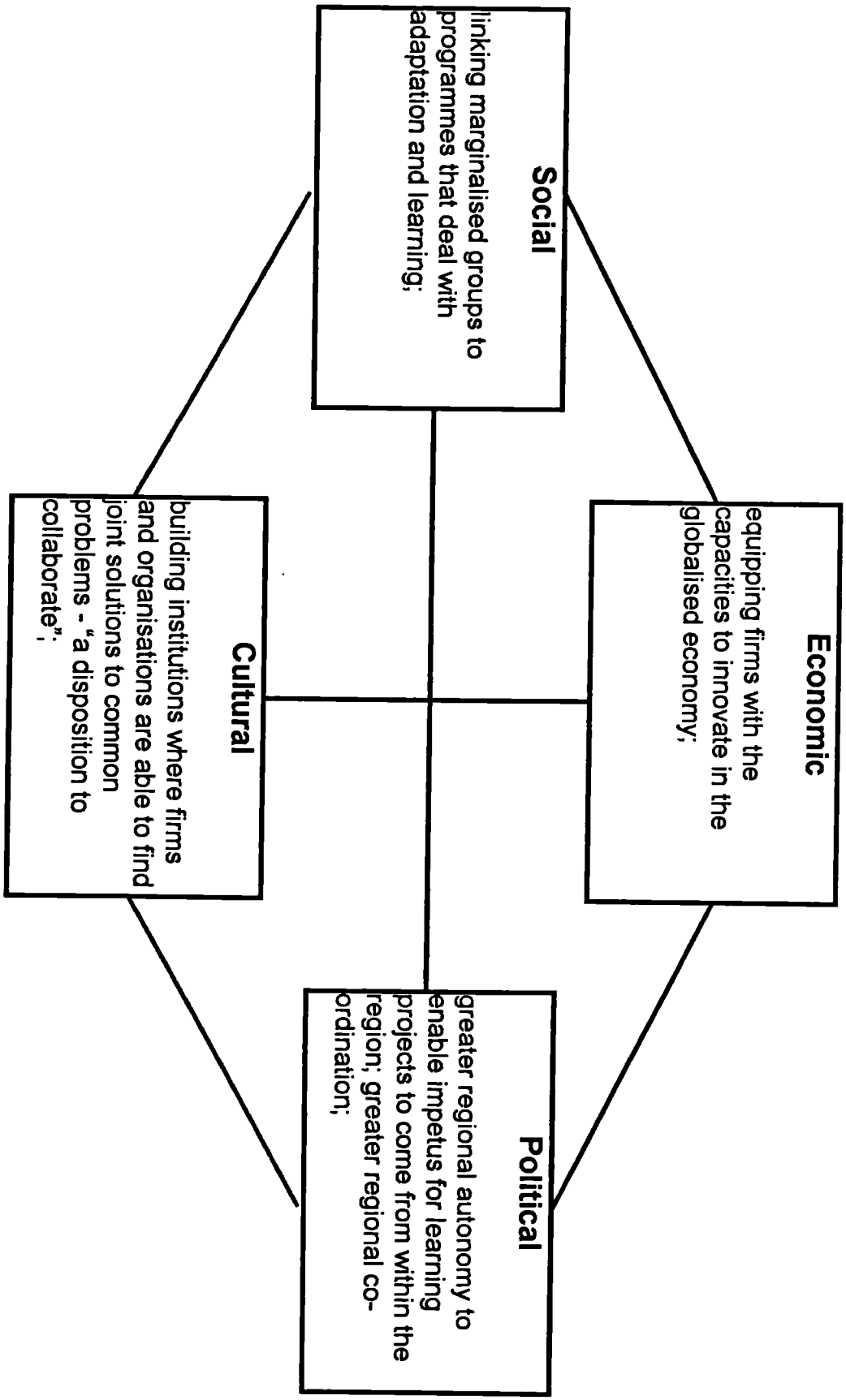


Figure 3.7: The learning region policy framework

In political terms the learning region framework suggests that there is definite role for governance in the delivery of policies for learning at the regional level. This involves the devolution of responsibilities for action to regionally autonomous bodies to direct regional economic development policy. It is argued that learning processes depend on the empowerment of decision-makers at the regional level through the devolution of responsibility for economic development policies to regional authorities (Morgan, 1997, p.497). Regional economic strategies are now the responsibility of the RDAs in England. However, the extent to which the RDAs have the autonomy to formulate a Regional Economic Strategy, in accordance with the own perceived needs of the region is yet to be decided (Benneworth, 1999, p.20). This will depend on the degree to which policies for the development of learning capacity at the regional level behave to national logic (Ibid.). This study will aim to develop arguments on the importance of autonomy and co-ordination in the development of policies for learning at the regional level.

The social dimension relates to the ability of regional institutions to link marginalised communities into programmes for learning. As the power of MNCs becomes more concentrated in certain core regions, the social dimension of the learning region becomes more important, especially for peripheral regions. This study will consider whether support mechanisms that aim to develop learning capacities, have the potential to alleviate the problem of long-term unemployment and social exclusion.

Culturally, the learning region framework is concerned with the ability of institutions to create a "disposition to collaborate" amongst firms in the region. This concerns the ability of institutions and firms to work together by finding common solutions to common problems. In this context learning region initiatives would have to take account of the ability of firms to know who they can work together with so that learning processes can occur. The previous chapter discussed how learning is not only the process of knowing what to do and why to do it. An actor can learn of the importance of particular organisational practice, but they would then need to know who to consult with if they had problems with the implementation of the new organisational method. This can be helped by a "disposition to collaborate" that Morgan refers to. He describes this as:

> " . . . working with what exists, however inauspicious, in an effort to break the traditional institutional inertia in the public and private sectors, fostering inter-firm networks which engage in interactive learning, nurturing trust and voice-based

> mechanisms which help to lubricate these networks and promoting a cultural disposition which sets a premium on finding joint solutions to common problems" (Ibid., p.501).

It is difficult to be critical of Morgan's sentiments but the important issue is whether the idea of collaboration alone can be practical in facilitating new innovations in an area such as Hertfordshire. The learning region policy framework also needs to be considered within the broader context of economic development in the region, land use policy and whether, in an era of globalisation, the idea of creating a disposition to collaborate for indigenous industry is the most effective and cohesive way of generating innovative performances. We also need to consider whether promoting the cultural disposition leads to genuine learning processes within the region or if new forms of collaboration are just the responses of regional agents to influences from beyond the region that do not improve the innovation potential of firms independently of outside firms. Here we need to consider the role of power.

3.8 The importance of power

While those who wanted to develop the idea of the learning region were viewing the region as an autonomous entity, Pratt (1997) was drawing our attention to the role of power in limiting the development of such a policy framework. The importance of power is implicit in Castell's depiction of the internationally decentralised network hierarchy, set out in section 3.3. Drawing on Murdoch (1995), touched on in section 2.6, Pratt considered whether institutions at the regional level could change the locational attributes of branch plant economies from one of subordination to pro-active innovators (Pratt, 1997, p.129). Pratt considered the nature of scientific work and the ability of powerful actors to encourage the rest of the science community to believe in their projects. This view, underpinned by ideas from the sociology of knowledge (Latour 1987), suggests that the power of individuals rests on their ability to enroll other actors behind the process of knowledge accumulation. This is without them acquiring the necessary empirical evidence on the validity of the projects. Agents are enrolled on to projects by more powerful actors who direct the process of innovation and product development. In the case of reconversion economies, where inward investors play an important role in economic development strategies, these key actors are usually the senior managers of the large inward investing MNCs. Their power is measured by their ability to coerce others into following their path by a process of translation and transformation.

According to Pratt a power / institutions account of regional innovation systems would consider the ability of inward-investing companies and

> "their attempts to create a new modality of economic organisation, to stabilise their production techniques and technologies, and their workers. The managers seek to enrol the potential workers, the local sub-contractors and existing government agencies into their particular task" (Pratt, 1997, p.131).

When an economy is in a reconversion period, as in the case of South Wales, agencies are more likely to be subservient to the aims and objectives of large, powerful multi-national companies. According to Pratt the problem with the concept of the learning region is that it overlooks these institutional / power arguments. Pratt accepts that generalised models of institutional / power relations remain elusive. We therefore have to understand the qualitative characteristics of relationships by getting inside networks of information accumulation: "power is an effect or an outcome; as such it cannot be ascribed in the abstract or generalised, it will be particular to and occasioned by, specific situations" (Ibid.). In analysing the innovativeness of firms and institutions we therefore need to consider the role of power and influence between the firm and its source of information.

The implementation of a project for a microelectronics centre connected to the Siemens plant in the north-east of England demonstrated the difficulty of applying the learning region concept to branch-plant economies. Siemens were successful in acquiring funding from the UK's EC funding stream for a microelectronics training centre located near to their production plant in Sunderland. In this sense the inward-investor had been successful in getting local actors, in the form of the local business link, involved in their plans to create support infrastructures for their production process. The issue in question was whether this could lead to innovation-oriented infrastructure within the region and the generation of regional learning processes that would enhance the innovation potential of the local production base. It is unlikely that the learning region attributes of Tyneside, in terms of its existing institutional structures, had attracted the branch plant there in the first place. As Glasmeier and Leichenko (1996) pointed out, foreign firms tend to choose locations on the basis of labour availability and cost reasons. It was therefore more likely that the inward-investor had chosen the area where there is a plentiful supply of low-paid, reliable labour - workers that they could trust to fulfil their production requirements. The Siemens project therefore presented a good example of the learning region / power paradox. Once the new modality of

production is created, policy-makers need to address whether institutions can nurture and develop independent learning processes in the region.

In terms of policy the conceptualisation of learning also needs to be separated from entrepreneurial ability that is innate and difficult to nurture. Entrepreneurship is only one aspect of learning. Successful entrepreneurs have the ability to learn quicker than others because they are able to cope with difficult situations when they arise. This is why 'intelligent region' is a more appropriate term than 'learning region' to describe a region where a spirit of entrepreneurship already thrives such as the Silicon Valley of the mid-to-late 1970s:

> " . . . the capacity of a region to generate a set of innovative and economically dynamic small firms may be conditioned therefore by entrepreneurial talents within the set of existing entrepreneurs in the region and the wider culture of enterprise that surrounds them" (Wynarczyk et al, 1997, p.36).

The ability of regional institutions to generate new learning processes that lead to innovation is constrained by the existing culture and capacity of local production systems. This is largely dependent on existing entrepreneurial capacity within the region and the influence of actors from beyond the region in directing the economic development process. In considering the learning region as a policy framework we therefore need to consider existing innovation processes in the region as well as the qualitative characteristics of indigenous firms' relationships with actors from beyond the region.

3.9 Summary and conclusions

The aim of this chapter has been to present a detailed synthesis of theoretical debates on the relationship between innovation, knowledge conversion and information flows in a spatial setting. The chapter showed that contemporary spatial perspectives on the role of small firms in the process of product development have developed from the thesis of flexible specialisation. However, the flexible specialisation thesis has been criticised because it offers a static depiction of firm arrangements, with its basic models only applying to specific sectoral and geographical circumstances. The theory of flexible specialisation has also been criticised from the global perspective where authors have suggested that the increasing dominance of MNCs has reduced the significance of the locality. But despite its limitations,

the flexible specialisation thesis has led economic geographers to confront the vexing issue of why we are seeing disproportional concentrations of innovation in a seemingly globalised economy.

Recent elaborations of the theory of industrial districts have developed from the work of the neo-institutionalist school which explains the importance of local and regional space by the way in which proximity reduces the transaction costs associated with innovation. It is said that proximity institutionalises trust and in doing so reduces the risk associated with more complex transactions. This is elaborated by the social embeddedness argument which suggests that personal interaction and experience, which relies on "social and cultural accessibility", is vital to the innovation process. The idea of an "embedded" institutional structure that generates knowledge and information flows underpins the concept of a "milieu" of innovation, put forward by the European school.

A more sophisticated explanation of learning and the role of space was put forward by Storper (1995) who stressed that the researcher needs to identify cases where "region-specific assets", such as conventions and rules and pools of skilled labour, are important to the generation of technological and organisational learning. Researchers must also recognise how public sector governance can influence the development of these assets. Storper accepts that the concept of untraded interdependencies is extremely complex and difficult to unravel but he maintains that it is a necessary conceptual foundation for any regional development policy today, as are those of technological and organisational trajectories (Ibid., p.214). It is reckoned that in certain industrial sectors, at certain phases on the path of development of new technologies, region-specific factors, in the form of untraded interdependencies, facilitate the development of innovation capacity in small firms. This led Storper (Ibid., p.211) to suggest that,

> "the task of researching untraded interdependencies as the basis of the ongoing resurgence of regional economies, pattern of regional growth, regional differentiation in development, trade and technology accumulation, is an enormous and exciting multi-disciplinary project."

While Storper's work has been effective at linking spatial perspectives on knowledge conversion to the nature of technological development, it still emphasises the importance of regional institutions at a time when the economy is becoming increasingly globalised. The

emphasis on region-specific untraded interdependencies tends to overlook the role of tangible infrastructure factors in the location behaviour of firms and the value of region-specific sources of information in comparison to the value of sources beyond the region. However, this study accords with recent developments in industrial geography, by attempting to disentangle the relationship between information transfer and space. The approach which is adopted is to weigh up the factors which influence the location behaviour of a group of firms in terms of the innovation characteristics of the products. It is argued that the way in which information is acquired in relation to space, based on path-dependent properties, influences the location behaviour of the firms.

The learning region, which developed from the idea of untraded interdependencies, has so far proved to be unhelpful in the development of a conceptual framework that explains why certain firms tend to co-locate with other like-minded firms in certain regions. It is more helpful to consider the learning region as a policy framework. The four dimensions of this framework are based on economic, political, cultural and social interpretations of the learning region. The economic dimension is concerned with how actors adapt to the globalisation of the economy. Culturally, the learning region relates to the disposition to share solutions to common problems. Politically, the learning region is about autonomy for the region in the coordination of economic development activities. Finally, the social dimension is concerned with involving marginal groups in programmes for learning and adaptation. In any attempt to conceptualise the role of the region the importance of power cannot be overlooked. The relationship between power and institutions at the regional level takes into account the influence of actors beyond the region who enrol others behind the process of development. It is argued that evaluation of the learning region policy framework needs to be carried out in the context of the spatial dimensions of information flows in indigenous firms.

4

Bridging Explanation and Findings: Operationalisation and methodology

4.1 Introduction

The analysis of theoretical developments in the literature suggests that more attention needs to be paid to the relationship between the innovation characteristics of products and the spatial dimensions of information flows. The conclusion to the previous chapter showed that the explanatory framework adopted for this study is based on these two theoretical components. The bridge between this explanatory framework and empirical observation is now constructed through the operationalisation of the hypotheses that emerge from the framework, a description of the measurables involved and justification of the instruments that were used to investigate them.

The specific hypotheses are derived from a more detailed operationalisation of the spatial dimensions of information flows. The innovation characteristics in question are operationalised by the choice of sector and the size of firms within that sector. A qualitative appreciation of the innovativeness of products within that sector, and the role of small firms within it, is vital to understanding the innovation characteristics of the products. This is an important caveat of the research because it was argued in chapter three that the spatial dimensions of information flows need to be analysed in the context of the types of firms being studied. The spatial dimensions of information flows, the second main conceptual component which underpins the hypotheses is also broken-down into a number of operational sub-components.

The basis of the empirical work is a case study of innovative firms from the chosen sector and size-band of firms as well as a smaller-scale research exercise on policy implementation in the "Western Crescent" area of the London Metropolitan Region (LMR) (see **figure 1.1**). The survey of small firms was supplemented by smaller-scale research on policy developments in

the County of Hertfordshire which is situated within the case study area. The aim of the policy evaluation was to develop understanding on the application of the learning region policy framework in response to the three hypotheses. The evaluation of policy initiatives was carried out in response to the development of the explanatory framework.

The operationalisation was constructed as a basis for developing the broader research objectives and the more detailed questions for the fieldwork. These two broad research objectives, which were listed in section 1.3, are now repeated below:

1. How do we explain the spatial dimensions of learning processes in small, innovative firms?

2. What is the relevance of the learning region policy framework to product development in small, innovative firms?

The hypotheses to emerge from the explanatory framework developed in chapters two and three are listed below.

1. External sources of specific information make a more important contribution to innovation beyond the region than from within the region.

2. Generalised sources of information are relatively more important to innovation within the region than specific sources of information.

3. Tangible factors such as access to skilled labour and access to transport links are more important to location decisions than access to regional sources of information.

The proxy for specific sources of information is their contribution to areas of development within the firms which are considered to be more important to innovation. The measurement of the direct relationship between the source of information, the development areas and innovation is dependent on the perceptions of the respondents to the questionnaire. The problem of the use of language in questionnaires is discussed in section 4.7.3.1. Generalised sources are measured by their relative contribution to less important areas of development within the firms. The different forms of information are considered in section 4.6.1. The sources are described in section 4.6.2. The rationale for the definition of the region is

elaborated in section 4.6.3 and the location factors which are the measurables of the third hypothesis are elaborated in section 4.6.4.

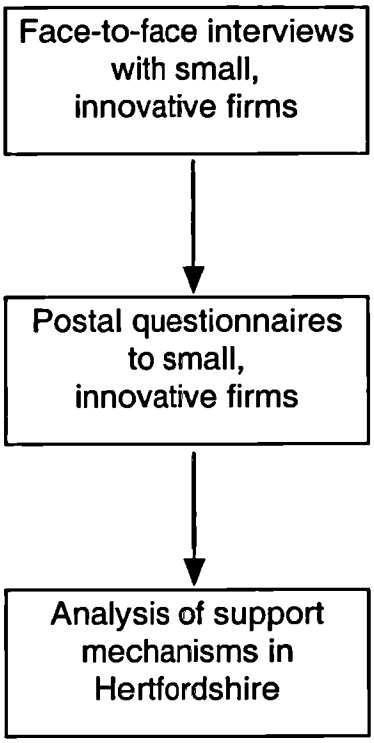
4.2 The case study

The case study of the "Western Crescent" area of the London Metropolitan Region (LMR) formed the primary focus of a three stage methodology. The background to the selection of this area as the case study area and its working definition is set out in section 4.6.3. The research process is shown in the form of a flow diagram in **figure 4.1**, below. The first stage was a set of face-to-face interviews with managing directors or senior managers of small IC firms in the county of Hertfordshire. The identified firms were investigated with in-depth interviews based on semi-structured questionnaires with open-ended questions. This first few interviews were effectively a pilot study for the development of a more tightly structured questionnaire which was used for a wider postal survey on small, innovative firms from within the same sector. The purpose of the postal questionnaire was to gather coded responses to support the qualitative information from the interviews. The operationalisation of the research was an iterative process whereby evidence from the first few interviews was used in its development. The final research questions and hypotheses were developed from these interviews to enable a better account of the facts to be put forward. Yin (1984) argued that exploratory research allows the investigator to examine phenomenon thus allowing a better description of patterns to be developed for empirical generalisations while Kaplon (1964) claimed that our ability to measure something depends on how we have conceptualised it and on our knowledge of it. It was decided that face-to-face interviews were the most effective way of empathising with the subjects of the research. This enabled the operationalisation to be developed.

The theoretical background to the research raises questions concerning the role of policy in the development of learning processes at the regional level. The final stage of the research process contributed to the evaluation of the implementation of the learning region policy framework, which was discussed in chapter three. In particular, this focused on the implementation of a European ADAPT project that was aiming, through the development of networks, to equip workers in small firms with the skills to adapt to innovation and technical change. The final stage of the research attempted to observe the development of the new

networks, which have emerged from the programmes, and their capacity to create new rules and conventions within the small firm community that facilitate the development of learning processes. Action research and in-depth interviews with the co-ordinators of the programme were used to examine the processes behind the implementation of policies designed to develop the learning networks. The research process is considered in more detail in section 4.7.

Figure 4.1: The research process



4.3 Justifying the methodological approach

The complexity of innovation and the heterogeneity of different types of innovation makes the formulation of an "average" model of innovation and the spatial dimensions of information flows an unrealistic endeavour. However, the purpose of social science research should still be to move towards a generalised methodology which can overcome the constraints born by different cultural settings. This methodology can then be applied to other regions and sectors in further research. The methodology can also be used to test the nature and importance of

regional policy support mechanisms in other regions and localities. The utility of social science in dealing with the complexity of reality across cultural boundaries was one of the principal motivations for Max Weber's work on the formulation of an appropriate methodology for the social sciences (Weber, 1949). According to Weber, the ideal type describes the type of methodology most appropriate to social science objectives. Weber's contribution is widely recognised as one of the most important in the development of a value-free methodology for comparative research. Weber's original definition of the ideal-type is still the most concise:

> "An ideal type is formed by the one-sided accentuation of one or more points of view and by the synthesis of a great many diffuse, discrete, more or less present and occasionally absent concrete individual phenomenon, which are arranged according to those one-sided emphasised viewpoints into a unified analytical construct" (Ibid.).

Weber believed that the ideal social science methodology should not be averages of human behaviour but "heuristic constructions" (Ibid.). The "heuristic" method is adopted in this study to shorten the search to an understanding of the complex relationships and categories that underpin the process of innovation. As Parkhe (1993, p.243) remarked, complex relationships may always remain beyond the researcher's grasp,

> "but the gap between the known and knowable can be removed by breaking down complexity into its essential components and linking these components to related variables in rigorous theory development."

The analytical construct, which was adopted to explain how firms acquire information in spatial terms, is based on five development areas within the firms and a number of different sources of information acquisition. This was considered to be the most appropriate way of measuring the spatial dimensions of information flows. The purpose of the analytical construct is to explain how the spatial dimensions of information flows vary according to the nature of information and the source of its acquisition. The problem of operationalising the different forms of information is elaborated in section 4.6.1.

One way of categorising types of methodologies for studying the spatial dimensions of information flows is the bottom-up and top-down distinction. The bottom-up approach analyses information flows from the perspective of individuals, firms or industrial sectors

within a particular region. The spatial unit of analysis is decided before the research is carried out. The importance of the pre-defined spatial unit is then placed within the context of the processes of information acquisition undertaken by these individuals or groups in comparison to other spatial units. The top-down approach attempts to evaluate the ability of institutions to pursue policies that attempt to develop learning processes within a particular spatial unit. One way of doing this is to take a specific economic development project and to analyse its effects on the development of new learning processes within the particular area under focus.

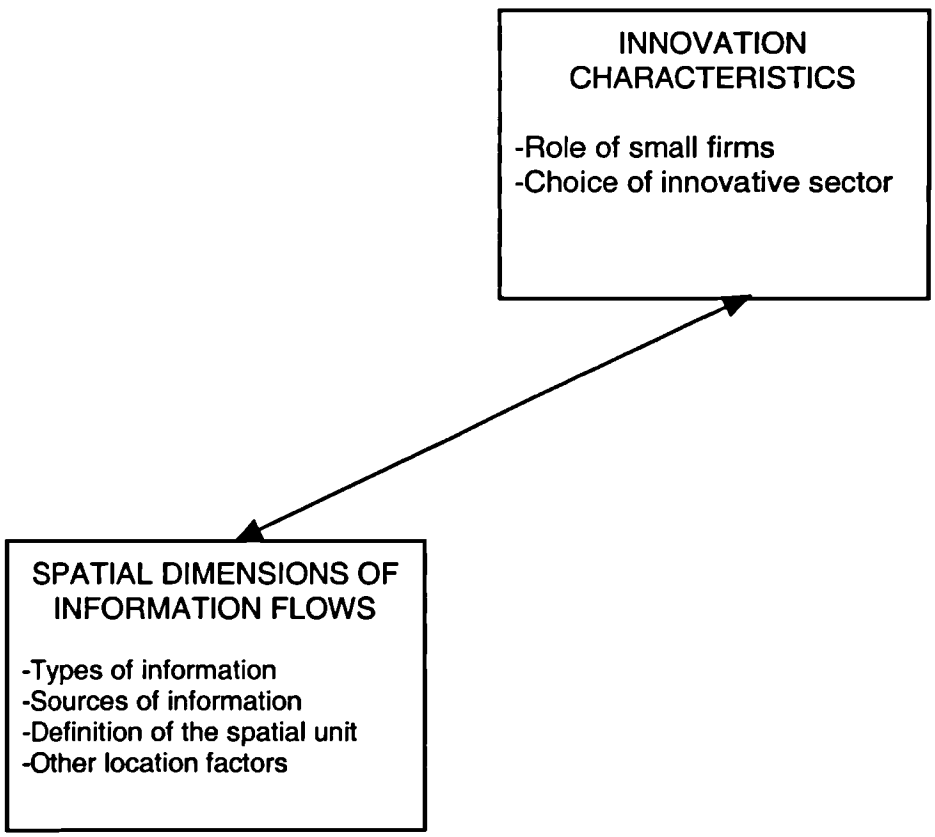
This study will attempt to utilise a combination of these approaches. However, greater emphasis is placed on the bottom-up approach whereby a specific case study of innovative firms is chosen. An examination of the role of the region in the generation of learning processes raises questions about the scope and potential effectiveness of regional public and quasi-public sector support mechanisms in enabling small firms to acquire information on organisational and technological change. Analysis of a specific sector will demonstrate the limitations and opportunities for involving innovative firms in policy projects that aim to move towards this ideal. The analysis will lead to questions concerning the conditions for the efficient operation of such policies and whether these conditions suit the needs of small, innovative firms.

4.4 The basis of the operationalisation of the research

The explanatory hypotheses of the research listed in section 4.1, above, emerged from the two main conceptual components. The two components are firstly, the innovation characteristics of the products and secondly, the spatial dimensions of information flows. The sub-components of the two main conceptual components are presented in **figure 4.2**, below. The innovation characteristics are defined in terms of the chosen sector - instrumentation and control and the role of small, innovative firms within that sector. Overcoming the problems of innovation is facilitated by acquiring information on the types of organisational and technological functions that lead to the commercial exploitation of new and improved products. These development functions are therefore associated with different forms of information.

There are four aspects to the spatial dimensions of information flows. These are the measurables for the three specific hypotheses listed in section 4.1. The first is the different types of information. Certain types of information are more specific and therefore valued more highly than others. Identifying the sources of information is important because they all have a specific spatial dimension. The region is the spatial unit of analysis. The spatial dimensions are measured by the distinction between the nature and importance of information that was acquired from within the region against that which was acquired from beyond the region. Finally, location factors are relevant because information acquisition is being considered in the context of other factors that tie a firm to a particular region. The operationalisation of the two main conceptual components of the study are elaborated in the following two sections.

Figure 4.2: Operational components of the explanatory framework



4.5 Innovation characteristics

4.5.1 Definition of small, innovative firms

The complexity in analysing paths of technological change, is reflected in the heterogeneity of the small firm sector where it is difficult to make conceptual distinctions between the technologically backward firms and those with the potential for innovation. The conceptualisation of the firms being studied is vital because the types of conclusions which are drawn from the research depend on the way in which it was approached. This is principally a study of information capture from the perspective of the firm. More specifically, this is a study of small, innovative firms. The justification for concentrating on small firms only is based on qualitative and quantitative assumptions on the behavioural and performance characteristics of the small firm sector with respect to the population of all firms from all size categories. In the case of this research the performance characteristics are analysed in terms of innovation.

Small firms have been the subject of a number of extensive research studies in recent years (see for example, Curren and Blackburn, 1994, Cosh and Hughes, 1998). The size and complexity of the small firm sector opens up a wide range of possible avenues for research, each with their own unique problems of definition and conceptualisation. Methodological approaches to the study of small firms are usually based on the distinction between grounded definitions and statistical definitions (Storey, 1994, pp.14-15). Definitions range from the simple, one dimensional, usually based on a statistical indicator such as the number of employees, to grounded, multi-functional or qualitative definitions based on a combination of defining characteristics. The statistical definition is used as a baseline for comparative analyses over time and between countries. The definition recommended by the European Community, which led to the coining of the term 'SME', is one example of the statistical version. This is based on three different categories of firm size, as shown in **figure 4.3**, below.

The EC definition has been criticised because certain industrial sectors consist of only firms with under 500 employees. This makes the distinction between large and medium firms largely redundant and creates problems for policy implementation (Ibid.). More qualitative definitions have been put forward in response to this criticism. One of the original qualitative definitions

of small firms was adopted by the Bolton Committee in the last large-scale government inquiry on the role of small firms in the economy:

"First, in economic terms a small firm is one that has a relatively small share of its market. Secondly, an essential characteristic of a small firm is that it is managed by its owners or part-owners in a personalised way, and not through the medium of a formalised management structure. Thirdly, it also independent in the sense that it does not form part of a larger enterprise and that its owner managers should be free from outside control in taking their principal decisions" (Bolton Report, 1971, p.1).

Figure 4.3: Size-bands of firms defined by the EC

Micro-enterprises	0-9 employees
Small-enterprises	10-99 employees
Medium-enterprises	100-499 employees

The problems associated with this definition, such as the definition of "market" and the somewhat ambiguous definition of ownership structures, have made it difficult to use in practice. The problem of finding appropriate size bands for different research purposes has therefore remained. According to Storey (1994, p.16) the researcher must be able to show that size is a factor that contributes to the performance of firms. For example, one performance characteristic which is often associated with small firms is a high failure rate. This is demonstrated by the fact that firms with an annual turnover of less than £13,000 in 1980 were six times more likely to de-register for VAT than firms with a turnover in excess of £2m (Ganguly, 1985, quoted in Storey, 1994, p.79). Empirical evidence strongly points to the fact that business failure rates are inversely related to firm size, with lower failure rates associated with increasing size. However, concentrating on only one characteristic is not necessarily helpful in terms of policy and research objectives. Some experts in the field of small firms policy have even suggested that the size categories with particularly high failure rates should be avoided in policy initiatives (for example, Storey, quoted in the Financial Times, 1990).

Wynarczyk et al, (1993, quoted in Storey, 1994, p.10-11) suggested three ways of characterising small firms with respect to the entire firm population - uncertainty, evolution and innovation. Their definition of uncertainty relates to the market environment in which the

firm operates. Three dimensions of uncertainty are identified. The first is the uncertainty associated with being a price taker. This followed the Bolton definition which emphasised the small share of the market-place. A criticism of this is that being a price taker is not always relevant to small firms. This is because small firms can have some monopoly power in niche markets with only one or two potential competitors but still display characteristics that one would usually associate with being small, such as low turnover and employment.

The second dimension of Wynarczyk et al's definition of uncertainty relates to the limited customer and product base of small firms. The is true of products but small firms do not necessarily rely on one or two customers. Small firms have been known to produce specialised goods for large numbers of customers. Partnership with a selected number of buyers is important in the process of product development but these goods can then be sold to a much wider market of buyers.

Wynarczyk et al's third dimension relates to the much greater diversity of owners' objectives, compared with the owners of large firms. The demands of the shareholders are usually less relevant to the case of small firms. However, firms which are fairly autonomous in their production activities may still be constrained by the controlling influence of their parent companies.

Uncertainty is a useful parameter for characterising small firms but Wynarczyk et al's definition is only partly relevant to this study. Another way of looking at uncertainty is by considering the information and knowledge at the small firm's disposal. Uncertainty can be related to the small firm's control over the important information and knowledge that enables it to innovate. As chapter two demonstrated, certain types of information and knowledge are more "person-embodied" than others and the more specialised and specific knowledge becomes, the more important social interaction becomes to its exchange. The size of the firm influences its propensity to draw on external sources of information and knowledge to overcome the problem of uncertainty. Working together with other firms and institutions reduces the level of uncertainty facing small firms. The OECD (1993, p.55) report on SMEs, technology and competitiveness, for example, highlighted networking as being vital to competitiveness in small firms, describing networks as "implicit or explicit partnerships which reduce the cost of information, thus reducing the uncertainties of the market in both the short and the longer term." Uncertainty is therefore related to the relative reliance of the firm on external sources of information, which in turn relates to the its number of employees.

Accordingly, small firms are not defined by number of employees per se but by uncertainty which in turn depends the ability of individuals to capture important information. The number of employees is an important indicator of the firm's ability to capture specific information and knowledge.

The second way in which Wynarczyk at el distinguish small firms from large is by the assumption that small firms are more likely to need to evolve to survive. Evolution does not necessarily refer to the firm's ability to grow. The structure and organisation of the firm changes as it expands but it is also common for a firm to be static in terms of the usual size indicators such as employment and still require the evolutionary capacity to adapt to the changing requirements of the market environment. We will now see how the characteristic of evolution is related to innovation

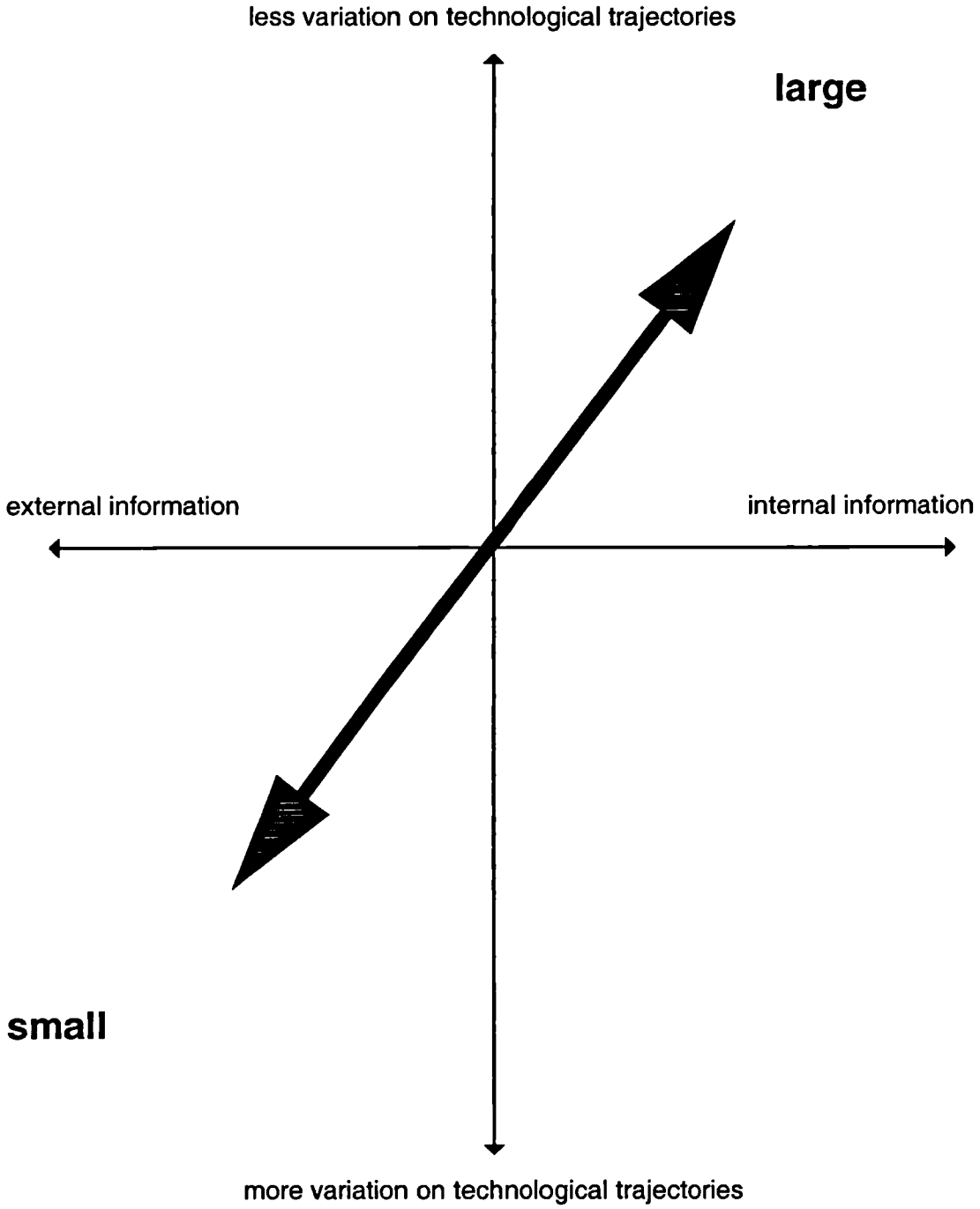
The specific methodology which the individual researcher adopts for studying certain problems associated with the small firm sector depends on the aims and objectives of the individual project (Ibid., p.16). The most appropriate way of characterising small firms in terms of the aims and objectives of this study is to consider their role in the process of innovation. Innovation is one of the major sources of evolution, enabling the firm to meet the changing requirements of the market. Theoretical perspectives and empirical evidence, described in chapter two, suggest that small firms have more innovative potential in niche markets where they can introduce incremental innovations. These markets depend on technologies which have relatively open trajectories. The ability to adapt technology is therefore important. The innovative role of small firms can therefore be interrelated with the characteristic of evolution. To survive in niche markets characterised by incremental innovations where the adaptation of technology is important, the small firm needs to overcome the problem of uncertainty. This can be achieved by developing the capacities that enable it to adapt to rapidly changing technology and market conditions. Small firms are therefore moving along trajectories which have greater variation.

In terms of this study the small firm's role in the process of innovation needs to be considered because innovation characteristics are one of the conceptual components of the study. The role of small firms in the process of technological development helps to define those characteristics. The complexity of defining small, innovative firms with respect to innovative firms from the population in general can be overcome by linking these two characteristics of uncertainty and evolution. This is presented in **figure 4.4**. The horizontal axis measures the

degree of certainty in the market environment facing small firms. Small innovative firms are relatively more dependent on external knowledge than large firms. This is related to the type of technology and the complexity of knowledge and information flows which the firm needs to access to stay ahead in the market. The vertical axis measures the variation on the technological trajectory that the firm is dealing with. Small firms are likely to have greater potential for innovation in niche markets where the adaptation of existing technologies is important.

Technology is the significant characteristic which sets the small firms in this study apart from the rest of the small firm population. Theoretical perspectives in chapter two explained how small firms can exploit the adaptation of technology when its future application goes beyond the corporate visions of larger companies. The characteristics of uncertainty and evolution which define the small firm in this study, interrelate with the nature of technological innovation and its path of development. Ideas from recent developments in industrial geography, discussed in chapter three, suggest that learning processes generated at the regional level are more important where trajectories of technology are relatively open. Accordingly, the small firm being surveyed in this research is operating in a market where the application and development of technology are vital to market success. As section 2.3.2 explained, the way in which technology evolves and its potential path of development has an important bearing on the organisational evolution of the industry. Small firms have a more important role in adapting technology for specific market niches. Increasing decentralisation within the industry, caused by more open technological trajectories, increases the relative importance of inter-firm networking because as the industry becomes more dispersed knowledge and information becomes relatively more externalised.

Figure 4.4: Characteristics of innovation in small, innovative firms and large, innovative firms



4.5.1.1 Parameters for identifying small firms

In conceptualising the study it was decided that the grounded definition of small firms, recommended by Curran and Blackburn (1994, p.53), would be the most appropriate for the purposes of this research. This is where the defining characteristics of the small firm are controlled by a number of qualitative and quantitative parameters. It is accepted that smallness can only be defined with respect to the industrial sector in which the firm operates, using multi-dimensional characteristics. The complexity of the small firm population makes it impossible to ensure that all the firms in the survey precisely fit the conceptual characteristics which the researcher has identified. However, a set of identified criteria can increase the likelihood of the appropriate firms being selected. Accordingly, it is assumed that small firms which are characterised by reliance on external information and dealing with products on open technological trajectories, have a greater probability of being autonomous, that is having an independent production function, of employing less than 50 workers, and of falling into SIC categories which are characterised by high rates of innovation. For the operational purposes of the project, firms are therefore selected within these tightly controlled parameters. The firms were discarded if they did not have a high degree of autonomy from their parent companies and were not be within a controlling relationship. These characteristics were verified before the firms were selected for the survey from the appropriate SIC categories.

4.5.2 Choice of sector

The operationalisation of innovation raises a number of problems. The taxonomy of innovation introduced in section 2.2 of chapter two demonstrates that the effects of innovation vary from the small, minor product changes to the effects which are so far-reaching that they impact on almost every aspect of economic life. Every study of innovation is different, depending on the social, economic and cultural effects of the goods and services being studied. In this study it was decided to take a specific sector that has been widely regarded as innovative. The innovation characteristics of the sector can then be considered in depth and the implications of the selection can be considered in the final conclusions. The innovation capacity of the IC sector is demonstrated by a number of studies and surveys and evidence gathered from fieldwork in this project, as presented in chapter five. It is almost impossible to analyse the potential effects of individual goods and services, but this sector is viewed as strategically important for the industrial and social benefits of developing efficient measurement and control techniques (DTI, 1996). The choice of the IC sector as a

conceptually valid object is based on the view that it is a sector where the development of product quality is vital to competitiveness. This is confirmed by the DTI's (1996) report on the sector.

The firms were therefore identified from the appropriate SIC categories and product types for firms in the IC sector, located in the Western Crescent counties. Section 4.6.3 justifies the selection of these counties for the case study area. The appropriate SIC categories for the IC sector are 33.2 and 33.3, as recommended in the DTI's recent report on the industry (Ibid.).[1] The 1992 SIC classifications used for statistical purposes are:

33200: Instruments and Appliances for Measuring, Checking, Testing, Navigating and other purposes.
33300: Industrial Process Control Equipment.

These superseded the SIC (1980) headings of SIC 3442 and 3710, which were two of the SIC categories included under Butchart's (1987) definition of high-tech industry.

There is an ongoing debate as to whether researchers should rely on acknowledged sectors in identifying innovations and innovative firms. Recently the object method has gathered momentum (see Kleinknecht and Bain, 1993). There are two main aspects to the object method. The first is the literature-based innovation output method (LBIO) where new products are identified from announcements in trade magazines and journals. The second is innovation award winners. The limitation of the LBIO approach is that it does not guarantee that innovations have been commercially exploited. It will also tend to overlook minor product improvements and process innovations within the firms because firms have an incentive to make public their product innovations (Kleinknecht, 1993, p.7). It is not guaranteed that the products are firsts on the market. This would require a thorough consultation process with experts in the industry or a rigorous verification exercise. Moreover, the LBIO method is likely to be more biased towards firms which use trade journals and magazines as a method of marketing. This study relies on secondary evidence on the IC sector's innovativeness which is now described.

[1] Product details are provided in the UK Markets Annual Report 70 of the new Office for National Statistics.

The small firm community within the sector is viewed as being appropriate to fulfil the criteria of characteristics for small, innovative, firms set out in the previous section. A recent report on the IC sector claims that innovation is its lifeblood (DTI, 1996, p.17). Thwaites and Wynarczyk (1996) identified "measuring, checking and precision instruments" as a sector where small enterprises were highly innovative in terms of product innovation. In an earlier study on innovation in the county of Hertfordshire, the STITES sector, which is closely related to the IC sector, was identified as being highly innovative (see Simmie, 1998). Simmie found that a high proportion of award-winning innovations[2] in the county of Hertfordshire were from the STITES sector. In terms of awards this was found to be the second most innovative sector in the county behind 'chemicals, pharmaceuticals and biological sciences'. The most conclusive evidence, however, on the innovativeness of the IC sector comes from the Community Innovation Survey (CIS) data which is scheduled to be published towards the end of 1999. The measure of innovative performance for each sector is based on the percentage of firms introducing new technological product and process innovations between 1994 and 1996. **Table 4.1** shows that the category of 33.2 came out as the third most innovative, with 81.6% of firms in this category introducing new products in this period.[3]

It needs to be recognised that a selected SIC category is not by itself, an indicator of innovation. The only way of ensuring that the firm fulfils the criteria of innovation that the researcher is interested in is by checking the nature of innovation(s) within the firm before the survey is carried out. The managing director was therefore approached before the questionnaire was sent to ensure that the firm was dealing with the design and development of products. The questionnaire focused on the sources of information that led to product innovation within the firm. This is an object method of sorts. However, initial pilot studies demonstrated the variety of processes and perceptions of innovations even within this very specific SIC category. This reflects the limitation of using SIC categories to identify innovative firms. SIC categories are nevertheless useful, as a starting-point for selecting the appropriate firms, particularly if the SIC categories identify a sector with a relatively strong innovative performance.

[2] This survey covered Queen's award to industry for Technology and Exports and the Small Firms Merit Awards for Research and Technology (SMART) because of their combined focuses on innovation and the export of technology.
[3] Only a small minority of firms in the IC industry are in the 33.3 category and not 33.2.

Table 4.1: Ten most innovative sectors in terms of the percentage of firms introducing new technological product and process innovations between 1994 and 1996

Rank	Sector	SIC (3 digit)	Percentage
1.	Television and radio receivers, sound or video recording or reproducing apparatus and associated goods	32.3	87.5
2.	Basic Chemicals	24.1	86.2
3.	Instruments and appliances for measuring, checking, testing, navigating and other purposes	33.2	81.6
4.	Machinery for the production and use of mechanical power, except vehicle, aircraft and cycle engines	29.1	78.7
5.	Office machinery and computers	30.0	76.1
6.	Basic precious and non-ferrous metals	27.4	73.7
7.	Production, processing and preserving of meat and meat products	15.1	67.0
8.	Medical and surgical equipment and orthopaedic appliances	33.1	66.7
9.	Electronic valves and tubes and other electronic components	32.1	65.7
10.	Other special purpose machinery	29.5	64.5

Note: From sectors where number of responses > 20
Source: CIS 2 (forthcoming)

4.5.2.1 Statistical dimensions of the instrumentation and control sector

The current standing of IC firms in the SE of England is not remarkable in world terms but its current performance and economic development potential still warrants investigation, particularly in the context of the UK. And as Howells (1997, p.46) acknowledges, because there are now fewer and fewer areas where Britain has a strong scientific and technical capacity, any decline or loss of such a sector would have serious implications for the development of the UK's long-term technological competitiveness.

In 1992 the UK produced 8.5% of the world's production of scientific instrumentation and process control. This amounted to 2,839 million ECU. At this time the UK had the 4th largest output of IC producing countries. Germany produced 3,554 million ECU and Japan 9,460 million ECU. The US had the largest level of output with 14,532 million ECU (DTI, 1996, p.7).

Table 4.2 shows the sales performance of the UK IC sector over the period 1988-1996. As shown in **table 4.3,** gross value added per head has been broadly in line with rises in the manufacturing sector as a whole. The turnover of firms in the 20-99 employee category in the UK in 1992 amounted to £1295m. This almost doubled the level of turnover amongst firms in the 100-199 category (£788m) and was almost three times the level of turnover in the 0-20 category (£501m) (Ibid., p.5).

Table 4.2: Development of UK sales in the IC sector

	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total Sales (£m)	3,297	3,573	3,736	3,753	3,783	5,142	4,789	4,869	4,965

Note: 1993 sales from SIC(92) 33200 + 33300 less radar
Source: Business Monitor

Table 4.3: Gross value added per head (£000s)

	1988	1989	1990	1991	1992	1993	1994	1995
group 33.2	19.2	19.3	21.3	21.3	23 3	24.3	28.7	28.2
manufacturing	20.6	22.3	23.5	23.2	25 1	26.8	29.0	30.1

Source: Business Monitor

Table 4.4 - Table 4.7 present data on establishment and employee information in the two SIC categories 33.2 and 33.3, the official SICs(92) for the IC industry. The dominant production group in terms of output, is clearly the 33.2 category. A significant feature of the 33.3 category, however, is the large increase in number of establishments between 1994 and 1995.

While the number of businesses in the product group 33200 grew from 2,561 in 1993 to 2,855 in 1994, the level of employment fell from 92,000 to 82,500 (census of production). In the same group the gross value added at factor cost grew from £24,334 to £28,656.

Table 4.4: Industry sales for product group 33200 (measuring, checking, testing etc.)

Value £000s	1993	1994	1995	1996
Total UK manufacturing sales of products in the group	4,346,856	4,370,456	4,403,947	4,355,781

Source: Annual Market Reports (1997)

Table 4.5: Industry sales for product group 33300 (industrial process control)

Value £000s	1993	1994	1995	1996
Total UK manufacturing sales of products in the group	397,819	418,774	466,246	610,778

Source: Annual Market Reports (1997)

Table 4.6: Establishment / employee information for product group 33200

	1994	1995
No. of establishments	2923	2766
No. of employees	99987	85623
Average no. of employees per establishment	34	31
Average turnover per employee	£49,343	£59,580
Average turnover per company	£1,687,890	£1,844,331

Source: UK Markets Annual Report 70, 1996, Measuring and Testing Apparatus

Table 4.7: Establishment / employee information for product group 33300

	1994	1995
No. of establishments	140	312
No. of employees	5354	7001
Average no. of employees per establishment	38	22
Average turnover per employee	£55,756	£44,372
Average turnover per company	£2,132,257	£995,673

Source: UK Markets Annual Report 70, 1996, Measuring and Testing Apparatus

Table 4.8, below provides information on the export performance of manufacturing in the larger product group 33200.[4] This is presented graphically in **figure 4.5**. It is shown that exports have become considerably more important to the competitiveness of firms in this group in the last five years. By the end of 1996 total exports accounted for 85% of manufacturer sales for the 33200 product group, compared to 64% in 1993. The figures show that firms in this sector have been successful at penetrating the EC market in recent years. This is probably due in some part to the devaluation of the pound since sterling left the European exchange rate mechanism in 1992. However, IC firms have also performed well in markets beyond the EC in this period.

Table 4.8: Exports as a % of UK manufacturer sales for product group 33200

	1993	1994	1995	1996
Intra EC Exports	24	29	36	36
Extra EC Exports	40	41	42	48
Total Exports	64	69	79	85

Source: National Office Statistics (1997)

[4] Export information is not available on group 33300 in the Annual Market Reports.

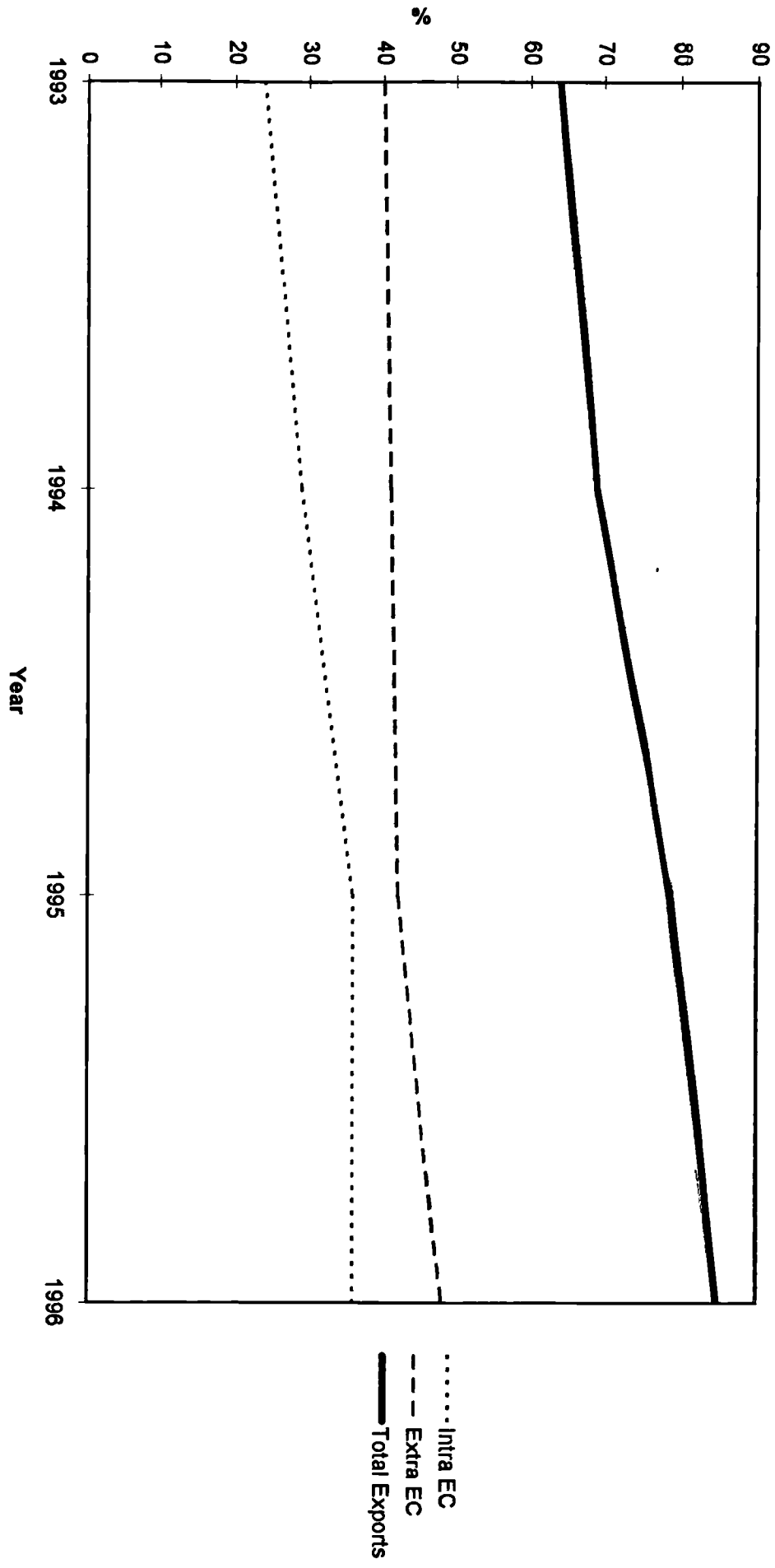


Figure 4.5. Exports as a % of UK manufacturer sales for product group 33200

4.6 Spatial dimensions of information flows

4.6.1 Forms of information

As chapter two explained, the heuristic value of information acquisition depends on the way in which it facilitates the innovation process through technological and organisational development. Accordingly, the use of sources of information must be such that they facilitate new ways of doing things in relation to production, organisational and marketing techniques (process / organisational innovations). In doing so, they allow firms to commercially exploit new innovations in order to increase their competitiveness (product innovations). The material basis of spatial networks in the context of this study is information acquisition that leads to innovation. For example, in the past, studies have depicted membership of an organisation as a network relationship. This has little value in terms of the process of innovation unless the firm uses the membership to form linkages that enable it to access important information. As Curran and Blackburn (1994, p.91) remark, membership of an organisation "may involve little more than paying a subscription and perusing a newsletter occasionally." This would have a limited impact on an organisation's ability to learn about organisational and technological development.

The forms of information are associated with different aspects of change within the firms that contribute to the process of innovation. The deconstruction of the innovation process into different areas of development raises questions about the nature of innovation in relation to the firm as the unit of analysis. In the past innovation has usually been analysed in terms of process innovation and product innovation. However, this distinction is sometimes difficult to detect. Macpherson's (1994) study of 34 innovative firms in New York state found that some innovative firms had been adopting new process methods because they innovate on the product side, whereas others have been launching new products because they have been able to innovate on the process side. He concluded, however, that many firms are situated between these two poles. The nature of the innovation process also raises questions about the importance of organisational change to the commercial exploitation of innovations. There is a tendency to emphasise the technological side when information on new organisational developments also facilitates the innovation process. Change is the key factor in the innovation process and technological and organisational innovation can be a cause and an effect of that change.

Figure 4.6, below, lists the forms of information that to varying degrees contribute to the firm's ability to commercially exploit new and improved products on the market. The conceptualisation of types of information breaks the analysis down by relating them to a number of areas of development within the firm. The spatial dimensions of information flows is operationalised by relating the spatial dispersal of sources of information to the different development areas.

Figure 4.6: Forms of information

1) Adaptation of new technology into the development of the product
2) Adoption of new technology for engineering / design purposes
3) Development of new management systems
4) Development of marketing / market research processes
5) Development of new processes and systems in relation to distribution / stock control / scheduling

The relevant forms of information are now considered in more detail. The adaptation of new technology is the application of new and existing technology to enhance the attributes of a product for customer application. The adoption of new technology for engineering / design enables the designer / developer to improve the quality of the product. This differs from the adaptation of new technology because it is distinctly a process innovation within the firm. A variety of advanced technologies such as computer-aided design / manufacturing (CAD / CAM) have now been widely adopted in manufacturing in the UK. Farrell and Oakey (1993, p.507) accept that the ability to use new technologies in the post-adoption phase, although sometimes overlooked, is critical and the lack of skills and inadequate training have led to production-related problems.

The improvement of management techniques usually relates to organisational change within the firms. In some cases firms have been innovative without consciously developing their management systems. In other cases the development of management systems is vital to the innovation process. For example, the findings showed that the adoption of the ISO 9000 quality system has taken on a more important role in the process of innovation in recent

years.[5] The improvement of organisational practices can also involve the adoption of new technology and software such as project management systems.

As section 2.4.1 of chapter two explained, the interactive theory of innovation means that the adaptation of technology is only one aspect of the innovation process. The small, innovative firm also needs to be able to access market information so that it can develop a quick responsiveness to changes in demand. In some cases marketing is not viewed as important because firms rely on one or two customers in very specific niche markets. Innovation can also be an experimental and risky process where actors are faced with great uncertainty over the market potential of a new product. In that case marketing becomes an important aspect of the innovation process because the new product needs to be marketed as widely as possible. The development of new processes and systems in relation to distribution / stock control / scheduling are those aspects of development that increase the speed of response to customers and improve the commercial exploitation of products. Technologies can offer shorter production-lead times and reduced production costs and inventories (Ibid.).

The importance of the different types of information in this study depends on their contribution to the process of innovation. It is assumed that the more specific information becomes the more important it is to the process of innovation. For example, generalised knowledge of information about potential suppliers for standard components is less important to the innovation process than knowledge acquired on the adaptation of specialised technology. In order to compete in global markets, specific market information and specific information of marketing techniques is important. However, this study also considers organisational change in the context of innovation The development of management techniques can allow firms to organise the innovation process more effectively and the development of scheduling / distribution techniques enables them to organise their production process in order to commercially exploit their innovations more effectively

4.6.2 Sources of information

As section 4.5.1 conceptualised, one characteristic of small, innovative firms is that they are relatively more reliant on external sources of information than large firms. This is because of their limited human capacity. The firms which will utilise external sources of information

[5] ISO 9000 is an international set of quality management standards that provide a common approach for documenting and maintaining a quality system.

most effectively are those which are constantly searching for new ideas and new processes. The innovation capacity of the small firm therefore depends on its ability to access information and ideas from across the global information system. Good practice, in terms of new management and production technologies transcend different regional and national cultures. The ability to access the international pool of information has become more important with recent developments in the global economy. For example, successful firms have become aware of how training for technological development is organised in other countries.

The theoretical context in which this research was carried out, particularly from the new school of industrial geography, suggests that recombinations of information and knowledge at the regional level are of increasing significance to the innovative firm. It was shown in section 3.4 of chapter three that the new industrial geographers contend that networking relationships have an important regional dimension because of the way in which proximity reduces the barriers to the transfer of more specific types of information. Consideration of networking structures is an appropriate starting point for analysing the spatial dimensions of information flows. According to Castells, (1996, p. 470) a network is a set of interconnected nodes where a node is a point at which a curve intersects itself. When two points are nodes in a network there is a greater intensity of exchange or interaction than if they do not belong to the same network. The subjects of this research, the small, innovative firms, are nodes in a global network of information flows. The networks of information flows in relation to the firm has a spatial dimension in terms of the location of the sources of information.

Nauwelaers and Reid (1995, p.115) recommended the use of matrices to show the binary encoding of relationships between actors and their external information resources, as one method of assessing the innovation potential of regions. This type of matrix is depicted in **Table 4.9**. The table is used to show relationships of interest between different actors in the innovation process (1-4). By way of illustration it can be assumed that information resources are controlled by actors on the vertical axis. The matrix in **Table 4.9** would then show that the actor, '1', is dependent on resources controlled by '3'. The zero in the cell (1,3) indicates that the relationship is not mutual. The use of matrices provides a "first glance" depiction of the "institutional thickness" of regional sources of information. However, a simple illustration of the existence of relationships in learning networks is not necessarily an adequate way of evaluating the importance of sources of knowledge to the innovation process. This is because the network focuses on relationships between actors within the region only. The importance of

these relationships needs to be given meaning by a convenient method of evaluation or benchmarking.

Table 4.9: Example of a matrix showing binary encoding of relationships

	1	2	3	4
1	0	1	0	0
2	1	0	0	0
3	1	1	0	1
4	0	0	1	0

Source: Pattison (1993, p.6)

Lundgren (1991) used EBLOC analysis to illustrate the historical development of networks in the image processing industry in Sweden. The EBLOC method is illustrated in **figure 4.7**. The actors, illustrated by the crosses, are blocked in the network according to their relationships with other actors. The purpose of the blocks is to show how some actors are more closely connected to each other than actors outside the block. This is a more useful way of depicting how networking relationships evolve over time as a critical mass of relationships develops but it is limited in the way it expresses the importance and value of the relationships which pass from outside the blocks. The EBLOC method does not represent the importance of the "b ock" in any meaningful way. However, the weaker ties from outside the block might have a greater impact on the process of technological development than the more intense personal contacts inside the block. Granovetter (1973, p.533) showed that weak ties can often be crucial to the ability of a network to adapt.

Accordingly, a more useful application of matrix algebra for networking relationships to depict the importance of sources of information is to illustrate the value of relationships using a numerical scale. This provides a better illustration of the importance of the learning relationships within the network. The value of the relationship in the context of this study depends on how it enables firms to acquire information to overcome the problems of innovation. **Figure 4.8** illustrates the valued network with values being used to show the significance of these relationships in the network.

Figure 4.7: The EBLOC method

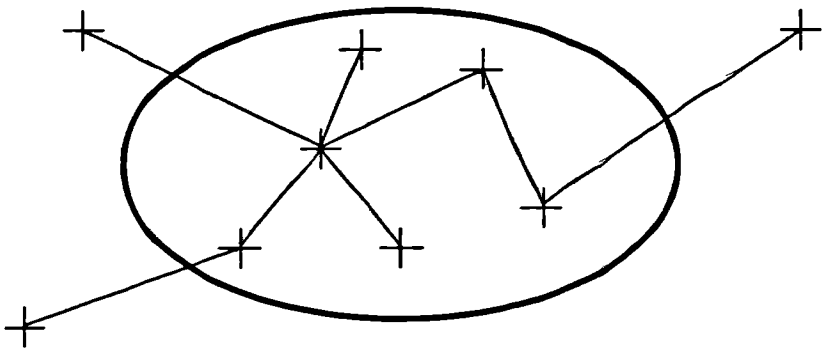
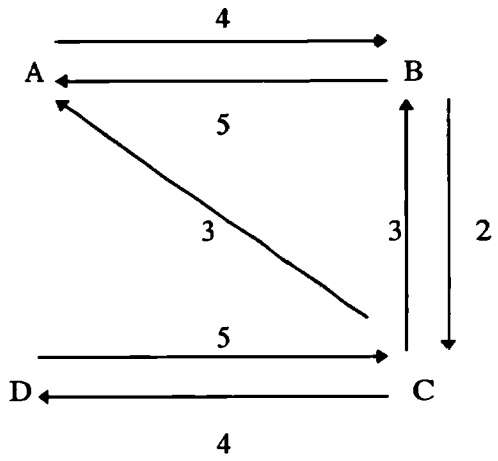


Figure 4.8: Representations for a valued network relation



0	4	1	1
5	0	2	1
3	3	0	4
1	1	5	0

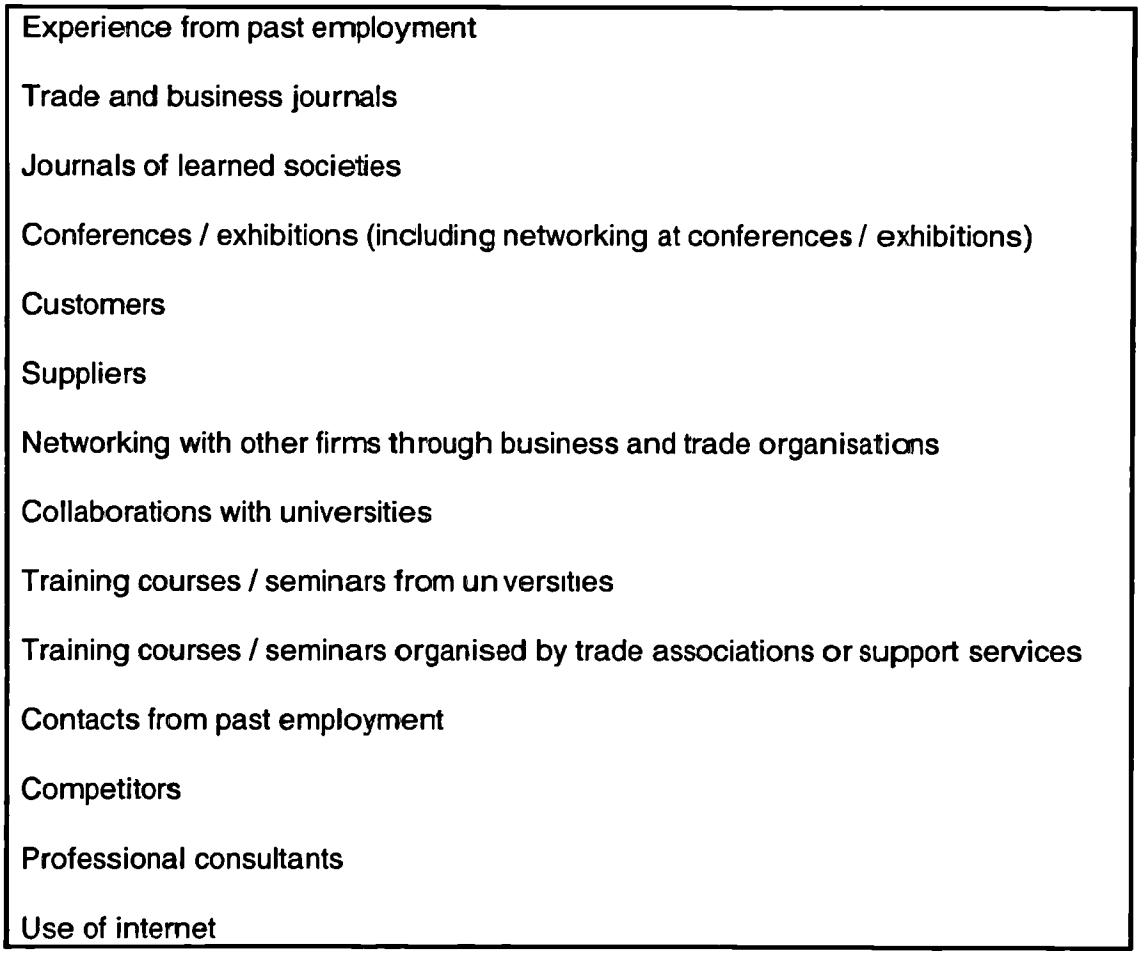
(a) **(b)**

(a) valued directed graph **(b)** valued matrix (adapted from Pattison, 1993, p.4)

This study is concentrating on the distinction between regional information flows and flows that emanate from beyond the region from the perspective of the firm. In learning networks the important actors are those that are capable of generating important information. These might be firms, institutions, consultants or public sector agencies. However, sources of information do not always refer to the way that firms utilise other firms and institutions located at a point in space. It needs to be stressed that the sources are not only nodes of access for firms to develop their information base. Chapter two showed that a firm's learning capacities can also be explained by its ability to recombine different types of information with information gained

from experience in past employment. This enters into the analysis by considering the importance of experience in past employment as a source of information This is a source of information for the company but not a point of access for information acquisition in location terms. Experience from past employment is naturally important to the knowledge-base of current development with the firms but measuring its spatial dimensions is problematic. The reason for this is that although the individual may have worked in the region when the information was acquired he / she may have initially learned from a source that was located beyond the region. In the context of this study it was taken as the location of the firm that the individual had previously worked for.

Figure 4.9: Sources of information



The use of sources of information as a conceptual device was considered to be the most appropriate way of placing the importance of the region in the context of the way in which small firms acquire information for the purposes of innovation. The sources of information which are considered in this study are listed in **figure 4.9**, below. The sources will sometimes overlap. They also lead on to other sources of information. It needs to be ackowledged, however, that the source from which the firm directly obtains the information is not necessarily the orginal producer of the information.

4.6.3 The spatial unit: definition of the region

In analysing the spatial dimensions of certain phenomena the spatial unit(s) need to be defined. For the purpose of this study the region is adopted as the spatial unit. It was decided that the region would be the most appropriate level of spatial analysis because the new regional development theories need to be evaluated against empirical evidence. Moreover, the region is getting increasing attention in policy debates. The Collins English Dictionary defines 'region' as an area which is considered as a unit for geographical, functional, social or cultural reasons. According to Markusen (1987, pp.16-17),

> "a region is an historically evolved, contiguous territorial society that possesses a physical environment, a socioeconomic, political and cultural milieu and a spatial structure distinct from other regions and from other major territorial units, cities and nations."

Malecki (1991, p.8) points to three defining aspects of a region. First, regions may be homogeneous with respect to some physical, social or economic characteristic. Second, modality or polarisation around a central urban place has the advantage of focusing attention on economic attributes of cities and their dominance over surrounding space, especially on labour markets. Finally, policy-oriented regions adhere to administrative boundaries that correlate with political or state institutions and their well-defined sphere of influence. The operationalisation of the region for the purposes of this study is based on a combination of these three defining characteristics.

As Markusen suggests in the definition above, political, cultural, social and economic factors need to be considered in deciding on the definition of the region. In this study there is an emphasis on the economic factors in terms of innovation activity and performance in the

London Metropolitan Region (LMR) compared to the rest of the UK. It was decided that the LMR should be the regional focus for the research with the subjects of the research being drawn specifically from the Western Crescent area, one part of the LMR where there is a relatively high concentration of IC firms.

While accepting that the definition of the LMR is usually based on labour market areas and journey to work patterns, Mogridge and Parr (1997) address the issue of whether the SER[6] is the appropriate representation of the contemporary LMR. It is argued that one way of assessing this is to consider the population increases beyond the SER (Ibid.). On the one hand, this might be interpreted as a reflection of the locational advantages associated with these areas that have emerged independently of the proximity of London. On the other hand, authors have suggested that the zone of maximum growth has moved steadily away from the metropolis. Mogridge and Parr (Ibid., p.112) contend that

> "the present position beyond the SER is a logical consequence of the negative externalities of the metropolis, combined with the locational advantages stemming from the metropolis centred on transport and communications improvements."

For this reason the SER may no longer be an appropriate definition because areas beyond this region probably also contribute to the function of the LMR and vice versa. The negative externalities which Mogridge and Parr refer to have seen businesses and households decentralise away from the centre of London. This is not necessarily an urban-rural shift of companies away from London but there is a propensity for firms to locate in areas further away from the centre than they would have done thirty years ago. This is made evident by the high post-war growth rates of the free-standing towns and cities in close proximity to London (Ibid.). **Table 4.10**, below, shows the dominance of such towns in terms of employment growth in the UK in the 1980s.

4.6.3.1 Regional characterisation

While economic history tells us that the manufacturing sector was an important base for the development of the large conurbations in the UK, the concentration of new knowledge-

[6] SER: (standard definition of the South-East region) consists of the following counties: Bedfordshire, Berkshire, Buckinghamshire, Essex, Greater London, Hampshire, Hertfordshire, Kent, Oxfordshire, Surrey, East Sussex, West Sussex.

intensive industries have been growing in areas away from the cities. The decentralisation of knowledge-intensive manufacturing industry is reflected in the growth of employment in the traditional classification of the high-tech sector in the outer areas of the LMR. This is particularly true of the area immediately north, north-west south-west and west of London, which has become commonly known as the "Western Crescent". According to Castells and Hall (1994, p.145), this is "outstandingly the high-technology core of the British Economy". Hall et al's research on the Western Crescent raised its profile as an area of relatively strong innovative performance, particularly in the context of the UK. "it seems more appropriate, if labels are necessary, to refer to the Western Crescent, this pattern of high-tech industry as not so much a corridor as an arc around west London" (Hall et al, 1987, p.47). The innovative performance of the area has seen the Western Crescent develop its own regional identity because it is one of the few areas in the UK where manufacturing and R&D employment is increasing. According to Castells and Hall (1994, p.147), this is something which makes it important to study.

Table 4.10: Local areas with largest absolute increases in employment, 1981-87

Local Area	employment change (000s)	%change
Reading	+20.0	+14.6
Milton Keynes	+18.5	+29.9
Northampton	+18.4	+17.4
Cambridge	+15.7	+15.0
Oxford	+15.6	+10.5
Bournemouth	+15.0	+9 9
Aldershot / Farnborough	+14.6	+15.6
Swindon	+14.0	+15.7
Norwich	+12.4	+8 4
High Wycombe	+11.9	+13.0
Great Britain	+178.8	+0 9

Source: Champion et al (1987)

Table 4.11, below, shows the strong performance of the study area in terms of R&D employment. Although London has by far the most R&D employees in absolute terms, its performance is not so good in relative terms. Hertfordshire has the highest location quotient of any county - 4.20, compared to London's 1.07.

Table 4.11: Top ten research counties in Britain, employment Levels 1991-93

Rank 1993	County	R&D Employment	1991-1993: Change		Location Quotient	
		1993	1991	Numbers	Index	
1.	Greater London	14,655	14,649	6	100	1.07
2.	Hertfordshire	6,939	6,381	558	109	4.20
3.	Avon	6,149	520	5,629	1182	3.41
4.	Essex	5,317	2,206	3,111	241	2.55
5.	Berkshire	4,744	3,622	1,122	131	3.14
6.	Cambridgeshire	4,703	5,236	-533	90	3.93
7.	Surrey	3,649	5,481	-1,832	67	2.14
8.	Oxfordshire	3,065	8,162	-5097	38	2.88
9.	Tyne and Wear	2,414	1,453	961	166	1.30
10.	West Sussex	2,302	1,203	1,099	191	1.92
	Great Britain	93,240	89,572	3,668	104	1.00

Notes: Location Quotients: a value of 1.00 is what would be expected if the county had the same proportion of R&D employees to that of average for the Great Britain as a whole, given the county's total employment.
Source: Howells (1997, table 5.2)

The changing nature of production in the Western Crescent area is an important factor in its characterisation as a leading innovative performer Areas to the west, particularly Avon and Wiltshire had shown no particular dynamism up to the 1980s Hall et al, 1987, p.47), whilst towns such as Hemel Hempstead, Bracknell, Reading and Portsmouth have been the major centres of growth in terms of the so-called high-technology sectors (Ibid., p.48). The expansion of employment in the service sectors and advanced manufacturing industries in the

Western Crescent is indeed reflected in the growth of employment in the free-standing towns and cities situated to the north, north-west, west and south-west of London (see **table 4.10**).

The idea of the Western Crescent being the most successful innovative area in the UK has been reiterated by other authors. For example, Fingleton (1994, p.48) found that

> "around London, the Thames Valley and the M4 corridor, stretching into the west country and the region to the north of London through Hertfordshire as far as Cambridgeshire, stand out as areas with a higher then average share of the workforce employed in high-technology manufacturing." [7]

Table 4.12 shows how local labour market areas in the Western Crescent dominate the league table of highest relative levels of R&D employment in the UK.

Table 4.12: Top ten local labour market areas with highest relative levels of R&D employment activity in 1991

Rank: 1991	Local Labour Market Area	1991		1981	1991-81: Change
		Employment	LQ	Employment	
1.	Didcot	4,960	46.0	7,244	-2,284
2.	Thurso	1,742	20.5	2,392	-650
3.	Hertford and Ware	1,794	17.6	835	959
4.	Welwyn	2,642	12.3	701	1,941
5.	Huntingdon	1,274	9 9	1,343	-71
6.	Bracknell	1,602	9 6	946	656
7.	Salisbury	1,846	9.3	2,441	-595
8.	Weymouth	1,388	7.7	2,547	-1 159
9.	Malvern	557	7 6	859	302
10.	Cambridge	3,900	7 6	3,511	389

Notes: LQ - Location Quotient
Source: Howells (1997, table 3 3)

[7] This study used Butchart's (1987) definition of high-tech manufacturing industry.

Recently there have been attempts to move away from R&D input measures of innovation to the use of measurements on the output side. When the output measure is applied, the relatively strong performance of the counties to the north, north-west, south-west and west of London still stands out. **Table 4.13**, below shows the most innovative counties in terms of the percentage of manufacturing firms that introduced new technological product and process innovations in the period between 1994 and 1996. Six of the top ten counties in the table are part of the geographical area of the case study in this research. Counties which lie to the north-east of London such as Essex or the south-east such as Kent do not feature in the table.

As Fingleton (1994) suggested and as the table above confirms, the growth of innovative firms in the area to the north of the SER means that it would now be appropriate to add Cambridge to the list of fast growth centres. Cambridge exemplifies the emergence of innovative industry in the area to the north and north-west of the SER but the "Cambridge phenomenon", as it has become known, is more dependent on spin-offs from the university than innovative industry in the rest of the region. The university has been instrumental in actively encouraging the exploitation of its own R&D through technological transfer (Segal Quince Wicksteed, 1985).

Moreover, the image of Cambridge has attracted firms and skilled labour to the area and encouraged them to stay. The growth-hampering policies of the 1950s had conserved the historical value of the old town and in conjunction with other soft locational factors made the region a magnet for small, innovative firms (Sternberg, 1996, p.215). Keeble et al' s (1997, p.23) study showed that the "attractive local living environment for staff and directors" was perceived to be the single most important "region-specific" advantage for firms in the Cambridge area The census of employment from 1995 shows that the IC sector now provides 2,586 jobs in Cambridgeshire.

Table 4.13: Counties with over 60% of firms introducing new technological product and process innovations in the period between 1994-96

Rank:	County	Percentage
1.	Berkshire	80 6
2.	Buckinghamshire	76 0
3.	Warwick	73.7
4.	Bedfordshire	73 3
5.	Cambridgeshire	72.7
6.	Oxfordshire	70.6
7.	Wiltshire	70.0
8.	Surrey	68.2
9.	Grampian	67.9
10=.	Durham	66.7
10=.	Cheshire	66.7
12.	Hampshire	63.8
13.	Hertfordshire	63.0
14=.	West Yorkshire	62.5
14=.	Lincolnshire	62 5
14=.	Lothian	62.5
15	Devon	61.9
16	Northants	60.0
	London	51.0

Note: Counties where number of responses from the survey is > 15.
Source: CIS 2 Data (forthcoming

4.6.3.2 Regional distribution of IC firms

The pie chart in **figure 4.10** shows that there is a relatively high concentration of IC employees in the SE of England compared to the rest of England. 55% of all employees in the IC sector in England are located in the SE (Source: business monitor various editions). In terms of the UK nearly one-half of the IC firms are located in the SE and East Anglia (Business Monitor). The SE produces 41% of all UK output. The second largest producing region in the UK is the north-west of England, which produces 9% of overall UK production. In 1996 43.69% of all employees in product group 33.2 in the UK were located in the SE of England. This compares with only 23.55% of all employees in the manufacturing sector as a whole.[8] **Table 4.14** shows the top ten Nuts regions, out of twenty-eight in England, with the highest relative concentrations of IC employees in 1996.

Table 4.15 shows the five counties with the highest concentrations of IC employees. This provides further justification for concentrating on the Western Crescent counties because the cluster of IC firms spreads from Cambridge in the north to West Sussex on the south coast, passing through Hampshire.

4.6.3.3 Historical background

The growth of employment in small, innovative firms in the Western Crescent area of the LMR relates to the proximity of this area to London's urban core and a movement in the relative concentration of knowledge-intensive manufacturing employment away from the centre. Although the South of England is still dominant in terms of high technology employment, the level of high-tech employment in London has declined significantly. Between 1984 and 1989 London's share of employees in high-tech manufacturing fell by 20% (Fingleton, 1994, p.48). The decline of London's share of advanced manufacturing employment is reflected by its relative level of employment in the IC sector (location quotient of 0.41), as shown in **table 4.14**.

[8] Calculated by taking SIC 92) divisions 15-37 as representing manufacturing sector as a whole in various editions of the business monitor.

Table 4.14: Top ten Nuts 2 regions with highest relative concentrations of IC employees, 1996

Rank:	Nuts area	LQ
1.	Hampshire, Isle of Wight	2.59
2.	Dorset, Somerset	2.39
3.	Bedfordshire, Hertfordshire	1.97
4.	Essex	1.94
5.	Kent	1.92
6.	Cornwall, Devon	1.88
8.	East Sussex, Surrey, West Sussex	1.77
7.	Berkshire, Buckinghamshire, Oxfordshire	1.57
8.	Borders, Central, Fife, Tayside	1.47
9.	Cambridgeshire Norfolk, Suffolk	1.46
10.	Avon, Gloucestershire, Wiltshire	1.28
	London	0.41

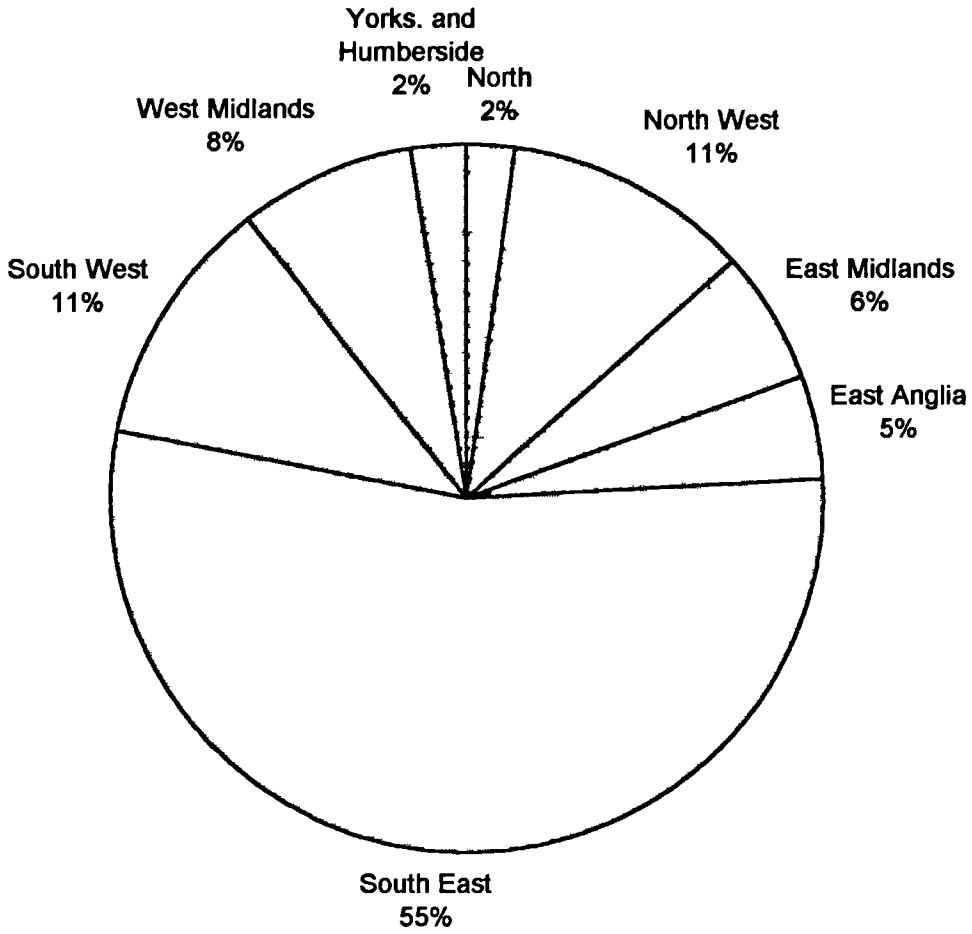
Note: Location Quotients: a value of 1.00 would occur if the NUTS area had the same proportion of IC employees out of total employment to that of Great Britain as a whole.
Source: Annual Employment Survey

Table 4.15: Top five counties with highest relative concentrations of IC employees, 1996

Rank:	County:	LQ
1.	West Sussex	2.96
2	Buckinghamshire	2.55
3.	Bedfordshire	2.31
4.	Hampshire	2.23
5	Cambridgeshire	2.07

Note: Location Quotients: a value of 1.00 would occur if the county had the same proportion of IC employees out of total employment to that of Great Britain as a whole.
Source: Annual Employment Survey

Figure 4.10: Regional distribution of employment in the instrumentation and control sector



The growth in the number of innovative manufacturing firms in areas away from the urban centre is based on a complex evolutionary process involving an important interaction with the locational attractiveness emanating from London's urban core. The history of the development of this relatively strong innovation performance therefore matters. The regional dynamism depends on positive feedback which occurs as a result of the initial (perhaps chance) presence of a cluster of firms at the start of the period. Other related firms are subsequently attracted into the area (Ibid., p.49). A priori evidence suggests that this has been the pattern of development in terms of innovative companies in the Western Crescent area, but it is important to go back in history to attempt to understand how this positive feedback was initially generated.

In discussing the definition of the region in section 4.6.3, it was noted that Malecki (1991) referred to the modality or polarisation around a central urban place which allows attention to be focused on economic attributes of cities and their dominance over surrounding space, especially on labour markets. The critical factor in explaining the initial growth of the high-tech industries in the Western Crescent area was the combination of a pool of specialised labour supplies and access to international labour markets afforded by London's airports and motorway connections (Hall et al, 1987, p.73).[9] The generation of small, innovative companies in this area resulted from the growth of large high-tech companies around major centres of government financed R&D (Ibid., p.88). Smaller companies had spun off from larger companies to operate in niche markets through the application of knowledge acquired from experience in larger companies. Although few firms had been founded in London it was the spin offs from larger firms, "some of which had a London origin," which has been accepted as an important factor in the Western Crescent's innovative performance (Hall et al, 1987, p.73). These spin-offs have been gradually decentralising away from London's urban centre.

The industrial-military complex in the Western Crescent began to develop in the 1950s when linkages between government research establishments (GREs) and major electronics firms like English Electric, Edison Swan, General Electric, and Mullard became established. There was a tendency for these firms to cluster around the GREs and the Ministry of Supply (later, Ministry of Defence) headquarters in London (Castells and Hall, 1994, p.150). In recent years, however, the end of the cold war has led to the reduction of defence expenditure as a

[9] The importance of these factors was based on results from 44 interviews with high-tech companies in the Western Crescent.

share of GDP. The reduction in defence expenditure, the "peace dividend", has seen counties such as Hertfordshire in the Western Crescent experience a substantial reduction in their large-scale manufacturing base (Hooper et al, 1995). The table, below shows how expenditure on defence as a proportion of GDP has fallen. This has resulted in severe job losses in the Hertfordshire economy. In the early 1990s the county went from being one of the most prosperous in the UK to around average in terms of unemployment. Hertfordshire CC have nevertheless been keen to take a less pessimistic view of the "peace dividend" and promote this as an opportunity for the development of the small business sector (Hart et al, 1994).

Table 4.16: UK defence expenditure as a share of GDP

1986-87	4.5
1987-88	4.3
1988-89	4.1
1989-90	4.0
1990-91	4.0
1991-92	4.2
1992-93	4.0
1993-94	3.7
1994-95	3.5
1995-96	3.2

Source: Hooper et al (1995)

4.6.3.4 Operationalisation of the region

The Western Crescent area of the LMR was chosen as the most appropriate geographical area for the case study because of its homogeneous economic characteristics. As we have seen, the area is characterised by strong innovative performance in manufacturing in the context of the UK. Moreover, there is a high concentration of IC firms in the area. This sets this area apart from the rest of the UK and justifies it being singled out as a particular region. However, the dependence of firms within these counties on proximity to London's infrastructure assets

means that Greater London should not be excluded from the definition of the region. For the purposes of this research the Western Crescent counties are defined as Bedfordshire, Berkshire, Buckinghamshire, Cambridgeshire, Hampshire, Hertfordshire, Northamptonshire, Oxfordshire, Surrey and West Sussex. Accordingly, the spatial unit of analysis is operationalised as Greater London and a fuzzy regional boundary which circles the firms with a 50 mile radius. The firms are drawn from the Western Crescent counties because of the high concentration of firms in the area.

4.6.4 Location factors

The final operational sub-component of the spatial dimensions of information flows is the location factors that keep the firms tied to their regions. Section 3.6 in chapter three explained why it is important to consider factors such as tranport links in the location behaviour of firms. The operationalisation therefore takes account of the relative importance of different types of location factors in keeping the firms tied to their region. Accordingly, intra-regional flows of information are analysed against other reasons for firms being tied to their region. In accordance with the theoretical perspectives developed in chapter three, these factors were considered in the context of how they enable firms to co-ordinate information capture.

4.7 The research process

4.7.1 First stage: face-to-face interviews

The qualitative study consisted of face-to-face interviews with 27 firms from the IC sector based in the County of Hertfordshire to the north of London.[10] The interviews were based on semi-structured questionnaires with open ended questions. The complexity of innovation processes within the small firm sector does not lend itself to rigorous quantitative analysis. A qualitative analysis, combined with descriptive data on the importance attached to certain experiences, was therefore considered to be the most effective way of analysing information flows. In recent years there has been a reaction to the failings of more quantitative methods in capturing some of the complexities of human behaviour. In making the case for qualitative research Morgan and Smircich (1980, quoted in Parkhe, 1993) assert:

[10] The interview schedule is shown in appendix 1.

> "Once one relaxes the ontological assumption that the world is a concrete structure and admits that human beings, far from merely responding to the social world may contribute to its creation, the dominate methods become increasingly unsatisfactory and indeed, inappropriate . . . scientists can no longer remain as external observers, measuring what they see, they must move to investigate from within the subject of study."

The advantage of open-ended face-to-face interviews in the field of economic geography is well-documented (see for example, Schoenberger, 1993). They permit a deeper understanding of softer variables and key relationships: "Small sample research will bring order to the array of soft variables in question" (Parkhe, 1993, p.253). According to Eisenhardt (1989), the constant juxtaposition of conflicting realities forces individuals to reframe perceptions into a new gestalt and tends to unfreeze thinking, and so the process has the potential to generate theory with less researcher bias than theory built from incremental studies or armchair axiomatic deduction (quoted in Parkhe, 1993, p.258). Face-to-face interviews allow the interviewer to elaborate on complex issues and probe deeper on the more intangible areas of the study. The gathering of qualitative information was therefore preferred to the mail questionnaire in the first instance.

4.7.2 Lessons from the initial pilot studies

The purpose of undertaking a small number of pilot interviews was to build up empathy with the managing directors by obtaining a large amount of qualitative data on which to draw some conclusions on the nature of product innovation and information capture in the IC sector. Moreover, it was important that the final postal questionnaire was comprehensive, as well as comprehensible, to the typical managing director or senior manager in this sector. Following Curran and Blackburn's (1994) study on small firms it was decided that an initial qualitative approach would be an effective exploratory device. The interviews were a useful way of testing the fieldwork process and finalising the conceptualisation of the project. In summary there were three reasons for doing an extensive qualitative study. Firstly, there was a need to develop the conceptualisation and final questionnaire by probing deeper on the complex areas of the study. The second reason was to obtain a large amount of qualitative data to support the descriptive statistics from the final survey. Thirdly, the face-to-face interviews were used

to test respondents attitudes towards the idea of developing local learning networks for small firms within the Hertfordshire area.

The experience gained in the initial pilot studies was important to the development of questionnaire techniques for the final study. There was a sense in some of the early cases that the interviewees were finding the questions vague. The pilot interviews therefore highlighted the importance of being able to explain technical terms in an unambiguous way so that the respondent was able to understand the question. For example, it was important to be absolutely clear on the spatial dimensions of the different types of collaboration and networking that were being considered. Moreover, the pilot studies were useful because they enabled me to translate concepts and terms developed in the conceptual background into a language that the respondents were able to understand. The use of appropriate language in the delivery of the questions was also important to the quality and reliability of responses. Again, the experience of the pilot studies was vital in developing this ability. The use of a tape recorder in the interviews was useful, not only in terms of extracting a great deal of information and being able to sift out the relevant responses, but also in being self-critical in the use of language for the final questionnaire.

4.7.2.1 Types of products

The original results demonstrated the heterogeneity of the types of products found even within a very specific industrial sector such as this and following on from this, the heterogeneity of types of collaborative and networking relationships that generate sources of information for the firms. This emphasised the need for being very careful in checking the product attributes of each company in the final postal survey. The pilot studies demonstrated the need to be certain that the firms were dealing with the design and development of new products. Certain firms were only involved with sub-contracted assembling work or distribution despite being listed under the Instrumentation and Control SIC codes.

4.7.2.2 Independent firms

The pilot studies demonstrated that there was a need to find autonomous companies who were not reliant on the parent company for knowledge and information. For example, one of the companies from the original pilot study was bought out of receivership by a US company in 1991. The subsidiary company were producing a standard range of electronic instruments,

primarily used for dimensional measurements of fixtures, especially those made for aeroplanes. Its parent company were expanding a range of electronic gauging systems in the United States. The development of the product in the UK had an important integration with the development of software which had been written by the parent company in the United States. The MD viewed the adaptation of this software as vital to the competitiveness of the company. However, the company relied on its US parent to keep up with published research and any pure research that was funded from the United States. The company was "investing heavily in CAD" through funding from its parent company and training workers in the US to move over to new management software packages.

4.7.2.3 Coding

The pilot studies were very useful for coding the questions for the final studies. Some of the factors in this section in the original questionnaire were found to be irrelevant. A number of factors were included to reflect the qualitative responses in the pilot interviews. These reflected the importance of being able to interpret the importance of different types of collaboration and networking from the viewpoint of the respondent. For example, the importance of networking at conferences was included in the final questionnaire. The final questionnaire was effectively a coding frame for the qualitative information gathered in the interviews.

4.7.2.4 Social desirability bias

In questionnaires of this kind it is important to avoid what Oppenheim (1992, pp 128-129) calls "social desirability or prestige bias". In approaching the pilot interviews one of the main concerns was that the respondent would be too keen to promote an "innovative and proactive" image for his / her firm. The questions which promoted these sort of biased responses were either omitted for the final questionnaire or their wording was changed to promote less biased responses. For example, companies might be inclined to pretend that they carry out lots of R&D. In the section on development areas, for example, (see **appendix 3**) there was some concern that the respondent would answer all the questions very positively to promote an innovative and proactive image for his / her company. The mixture of negative and positive responses from the pilot studies suggested that this was not going to be a problem. In the final questionnaire the respondents were asked to discuss the nature of R&D within the company.

4.7.3 Second stage: postal questionnaire

The small IC firms were identified from the Dun and Bradsheet database held at the London Chamber of Commerce.[11] The firms were identified by the recommended SICs for the IC sector (DTI, 1996). The grounded definition of small firms described in section 4.5.1 explained why the firms needed to be independent with under 50 employees. Archibugi et al (1994, p.77-99) made a distinction between gross samples, net samples and realised samples. In total 186 firms with under 50 employees were identified from the IC SIC(80) equivalent categories 3442 and 3710 in the case study area. This was the gross sample. This number whittled down significantly to 84 firms after omitting firms who, after initial telephone contact, were not considered to be innovative and those that were not considered to be independent. Certain firms, despite being in these manufacturing categories, were only distributors, whereas others were assembly subcontractors. A number of firms from the gross sample had also gone out of business. In total these are what Archibugi at al (Ibid.) refer to as the unreal non-responses. The remaining set of 84 firms became the net sample. 50 out of these 84 companies responded - a response rate of 60%.

The following procedure adopted for the administration of the questionnaires was a vital factor in ensuring a good response rate. In the first instance the managing director of the firm was contacted by telephone. This provided an opportunity to promote the project and answer any questions about the objectives of the research and to check the firm's characteristics. Building up a rapport with the potential respondent was considered to be an effective way of ensuring that the completion of the questionnaire was made more compulsory. Because the circumstances of firms are changing constantly, it was necessary to check that the firms still fell within the operational boundaries of the study. The initial telephone conversation therefore provided an opportunity to ensure that the companies were predominately dealing with the design and development of products. The potential respondents were also questioned on their employee numbers and ownership structure and relationship with parent companies. If the managing director agreed to participate the questionnaire was then posted. If the questionnaire was not returned after two weeks the MD was contacted again as a reminder. At least two further phone calls were made to encourage response. After three phone calls to the firms I then wrote to them again enclosing the questionnaire as a final reminder.

[11] Having written to all economic development officers and TECs in counties in the South-East this database was found to be the only one with standardised data and addresses by SIC cataegory.

4.7.3.1 Structure of the postal questionnaire[12]

The first section of the questionnaire dealt with the innovation characteristics of the firms. The firms were asked a number of questions relating to innovation, the product development process and the importance of innovation to their firm's competitiveness. Any firms who responded that were not innovative in terms of the development of new products were discarded. The following section focused on the importance of the different internal development functions to innovation. These are associated with the different forms of information described in section 4.6.1. The development areas were valued by how important the respondents perceived them to be the innovation process in the past and how important they perceived them as being in the future. The sources of information , listed in section 4.6.2 were then listed in the postal questionnaire and the respondents were asked to state how important they had been to each area of development within the company. The respondents were asked whether the sources had originated from within the region or beyond, as operationalised in section 4.6.3. The questions on the sources of information would generate findings on the relationship between the sources and the different forms of information, associated with the different development functions and whether the sources were located within or beyond the region.

The subjects were also asked about the attributes of the development of relationships where they had gained important knowledge and information from other firms. These questions focused on the importance of experience in past employment, face-to-face contact, importance of market-based relationships, technological relationships, information on the firms, networking, cost of travelling and use of electronic mail. The purpose of this question was to gain some further insight into the spatial dimensions of relationships with the most important knowledge sources. In the final section of the questionnaire there was a question on location factors. This asked the respondents to compare the importance of regional sources of information and knowledge to other more tangible factors in keeping them tied to their region.

The questionnaire form stressed that respondents should leave the boxes blank if they were uncertain about any questions. To purpose of this was to avoid the situation where respondents would be forced into a response on issues where there is too much uncertainty. This was recommended by Oppenheim (1992). This led to a number of missing responses in

[12] see appendix 3

the questionnaires but it was decided that it was better to encourage the respondents to leave the boxes blank if they were uncertain rather than make them feel obliged to answer questions that they were unsure of. Respondents answering on behalf of larger firms were more likely to keep some of the boxes blank because of the greater complexity of information acquisition with a larger staff base.

The mail questionnaire is a more commonly used way of collecting data in the small firm sector, but it has limitations and these had to taken into account in the way it was administered. There were two important limitations of the mail questionnaire. First, the mail questionnaire is usually characterised by poor response rates. A poor response rate was considered to be a potential problem in a survey which is concentrating on a specific sector in a confined geographical area. Approaching the firms by telephone and encouraging response was considered to be the most effective way of overcoming this problem. This certainly pushed the response rate up. The second reason is that mail questionnaires do not allow for the sort of probing which is required for a survey of this type. The questionnaire had been derived from in-depth interviews where probing was necessary to find the right language to use in the final questionnaires. However, the limitations of using language to gauge individual attitudes and perceptions needs to be recognised. Oppenheim (Ibid., p.148), has articulated the frustrations of the social scientists at their methods for dealing with the measurement of people's experiences and attitudes:

> "When we sometimes despair about the use of language as a tool for measuring or at least uncovering awareness, attitudes, precepts and belief systems, it is mainly because we do not yet know why questions that look so similar produce such very different sets of answers, or how can we predict contextual effects on a question, or in what ways we can ensure that respondents will all use the same frame of reference in answering an attitude question . . . we lack strong theories about attitudinal constructs in people's minds, theories that might help us to understand what happens when we use language to trigger or actuate such constructs in order to reach and measure them."

The combination of face-to-face interviews and mail questionnaires was considered to be the most appropriate method for the purposes of this research. The face-to-face interviews were important in limiting some of the problems of language that Oppenheim highlighted.

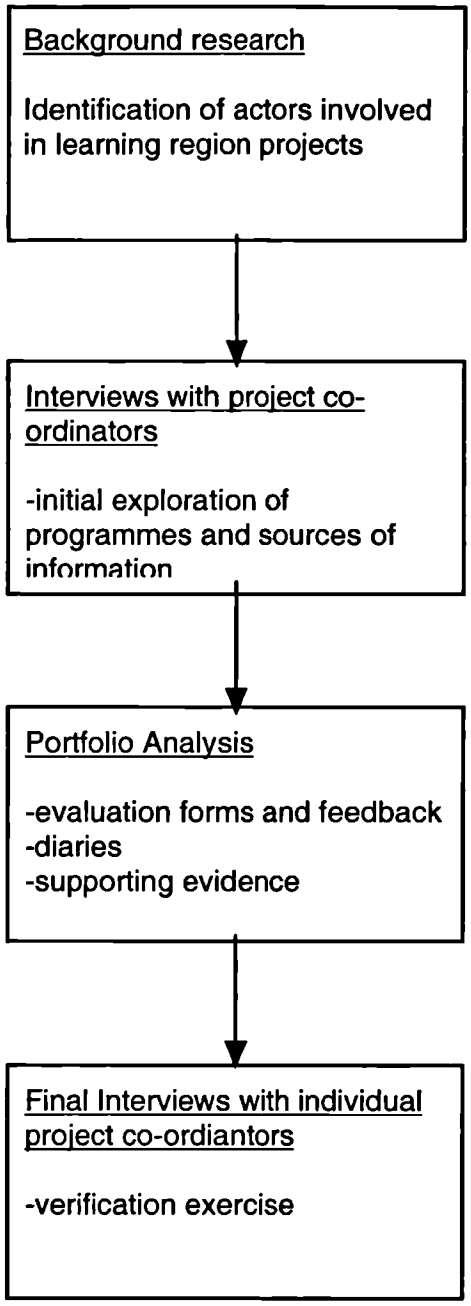
4.7.4 Third stage: policy analysis

The results of the survey on small firms were used as a basis for analysing the relevance of policies which aim to develop learning capacities for small firms within specific spatial administrative boundaries. Accordingly, the final stage of the fieldwork was an in-depth examination of a specific aspect of the implementation of a 'learning region' project in the county of Hertfordshire, situated to the north of Greater London. The policy research was used to analyse the relationships and processes underpinning policies in a county where the expressed objective had been the development of "learning cultures" within the small firm community (Hertfordshire CC, 1995).

It was decided to consider one particular programme in depth for two reasons. Firstly, the resource constraints of the project only allowed for this. The second reason was that these types of initiatives are at an early stage in their development. It is therefore important to take lessons forward from the evaluation of learning region projects to test the potential relevance of the learning region policy framework to innovative performance. The findings of the third stage of the research are effectively a bridge between the analysis of the spatial dimensions of information flows for small innovative firms and the final policy conclusions and recommendations. The findings from this stage also support the underlying hypothesis of the research on the role of generalised sources of information within the region. The policy study will show how the learning region project gives rise to generalised sources of information which may be of benefit to small firms with innovation potential. The findings will also be able to compare Hertfordshire's project with the learning region policy framework set out in section 3.7.

The action research on the implementation of the policy framework was based on the stages in **figure 4.11**, below. The background study involved identifying the appropriate people to interview by studies of policy documents, preliminary interviews with policy officers and attendance at meetings on the ADAPT projects. The project co-ordinators were then interviewed to gain initial insights into the programmes and identify sources of information for the portfolio analysis. The portfolio analysis involved searching for the required information on the progress of the programmes. Final interviews were then held to verify certain issues that arose in the portfolio analysis.

Figure 4.11: Policy methodology



4.8 Summary and conclusions

This chapter has operationalised the conceptual background of the research developed in chapters two and three for empirical observation on the relationship between innovation and the spatial dimensions of information flows. The findings of this empirical observation are described and explained in the following chapter. The innovation characteristics relate to the chosen sector - instrumentation and control and the size of firms - those with less than fifty employees. The justification for the use of these two units of analysis was set out. The small firms are conceptualised firstly, by the characteristic of uncertainty, through their limited control over important information resources and secondly, by evolution, which relates to their requirement to move along technological trajectories to maintain and improve their market position. The properties of networks conceptualise the spatial dimensions of information acquisition taking place within the region measured against that taking place beyond the region. The region is conceptualised as Greater London as well as a area of regional proportions that circumscribes the individual firms in the Western Crescent counties.

This chapter has also set out the main issues involved in the formulation of the research process for the project. It has attempted to throw light on some of the logistical problems of the research process and the ways and means by which they have been overcome. The research process follows a three-stage methodology. The first and second stages of the case study concentrates on the experiences of firms in relation to the spatial dimensions of information flows. The more in-depth research on the small firm sector involves a sector-specific study of the "cluster" of small firms in the instrumentation and control sector in the "Western Crescent" area of the London Metropolitan Region. The final stage concentrates on the policy initiatives in Hertfordshire in relation to small firms, innovation and the implementation of support mechanisms for learning.

5

The Case of Small-Scale Innovation in the Instrumentation and Control Sector

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> ". . . but all this can be prevented by a few thousandths of an inch fit which precision instruments give, and this is their classical beauty - not what you see, but what they mean - what they are capable of in terms of control of underlying form" (Robert M. Pirsig - Zen and the Art of Motorcycle Maintenance).

5.1 Introduction

The central argument of this study is that the spatial dimensions of information flows should be understood in the context of the types of technological and organisational change that the firms being analysed are dealing with. The methods that small firms utilise in acquiring information on technological and organisational change are analysed in the context of the nature of the firms' innovation characteristics. An important aspect of these methods for small firms is the way in which the key actors involved in the innovation process acquire information externally to their firm before combining it with other aspects of information for the means of development. The theoretical background to this study, developed in chapters two and three, informed the development of an explanatory framework for understanding the relationship between the innovation characteristics of products and spatial dimensions of information flows. Chapter four operationalised these conceptual components and went on to justify the methods that were used to investigate them. This chapter will explain how the different conceptual components interrelate through the description of empirical findings from the research.

The structure of this chapter is based on the three explanatory hypotheses set out in section 4.1 of chapter four. These are restated below:

1. External sources of specific information make a more important contribution to innovation beyond the region than from within the region.

2. Generalised sources of information are relatively more important to innovation within the region than specific sources of information.

3. Tangible factors such as access to skilled labour and access to transport links are more important to location decisions than access to regional sources of information.

The first part of the chapter concentrates on the innovation characteristics of the products. The analysis shows how the type of firm being studied tends to be locked into path-dependent technological development. In other words the firms are generally dealing with products that they improve incrementally by adapting technologies developed elsewhere. The findings show that, for these firms, the adaptation of technologies developed elsewhere is of vital importance to product development. Their attempts to speed up along the trajectories of existing technologies, by utilising their current heuristic search operations, reduce the level of resources devoted to the introduction of radical new technologies. However, the firms do not necessarily have a choice in the innovation path that they follow. One of the reasons for this is that the financial risk in pursuing more radical technological ventures is too great for the size of firm being studied. The first part of the chapter goes on to consider the sources of innovation, categorised in terms of the effects of market pull and technology push. This part of the chapter draws mainly on primary evidence from the fieldwork with limited reference to secondary information from publications on the IC sector.

The second part of the chapter focuses on the spatial dimensions of information sources that contribute to innovations within the firms. Initially, the relative importance of different sources of information for the whole process of innovation within the firms is examined. These are considered in aspatial and spatial terms. This analysis incorporates the use of technology, marketing and the organisational change that is needed for innovation. The following section goes on to consider the different aspects of development and their associated forms of information seperately. This will analyse the spatial dimensions of sources of information acquisition with respect to the different forms of information at different stages of the innovation process. The following section will consider the attributes of the firms' most important relationships of information acquisition in order to provide further insights into the spatial dimensions of these relationships. Finally, the location behaviour of the firms will be

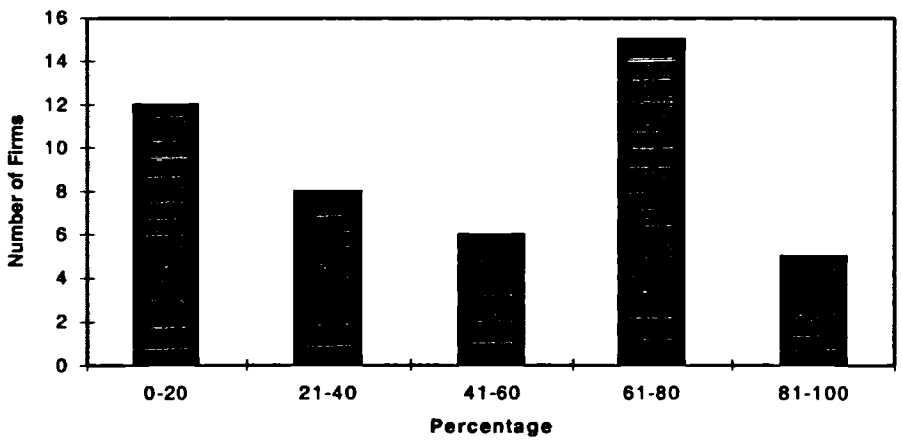
examined by analysing the importance of intra-regional flows of information against other reasons for firms being tied to their region. The purpose of this section is to compare the importance of more tangible factors as regional assets with softer inter-organisational flows of information and knowledge. It is argued, using this analysis, that the location behaviour of the firms is explained by the need to co-ordinate the process of information acquisition by accessing sources from beyond the region as well as within.

5.2 Innovation characteristics of the surveyed firms

5.2.1 Competitiveness as a driver of innovation

The firms which are analysed in this research are those where developments in product quality are important to their export performance and hence their competitiveness. Their products need to be improved at regular intervals to enable the firms to meet the changing requirements of global markets. The reliance of the surveyed firms on export markets is confirmed by **Figure 5.1** which displays the proportion of each firm's export sales from the realised sample of 50 firms from the postal questionnaire stage of the research.

Figure 5.1: Percentage export sales of surveyed firms (*Source*: Responses to survey)



On the question of how innovation is important to market success the MD of company E said, "the quality of products is substantially different than compared with five years ago - five

years is a long time in electronics." Referring to the introduction of two new laser ranges, high-speed imaging systems and micro-machinery systems, a questionnaire respondent commented that "ninety percent of sales of our products have been introduced in the last five years." Further comments in the questionnaires emphasised the importance of innovation to the firms' competitiveness. For example one MD commented that innovation was vital to "to maintain our position in the market and profitability" and allowed "market leadership by cost reduction and improved technical features," while another MD stated, "if we don't (innovate) we decline rapidly, we would be dead in five years." Other respondents stated that innovation was "vital - to keep the product fresh in the market and make the product more cost efficient" and "in this business with short product life cycles, innovation must be constant." These responses from the questionnaires provide a general reflection of the importance of innovation to the firms' survival and how the problem of innovation is a constant issue facing these types of firms.

As Castells (1996, p.81) reminds us, profitability and competitiveness are normally the actual determinants of technological innovation. This is not always true of the innovation process. In reality the degree to which innovation is a response to market necessity varies depending on the specific situation. However, it was unusual to find firms that were innovating solely as a personal endeavour or for the betterment of humankind. The evidence suggests that small-scale innovation in the IC sector is essentially a competitive process and a means to profitability and survival. When managing directors were asked how important innovation had been to their firm's performance, a typical response was "to maintain the competitive edge". One MD commented that innovation was vital to "profit, unique selling points, cost reduction, increased value perception of customers." Common responses were that innovation was "vital" and "essential" to the firm's market success. One MD commented, in a matter of fact way, that innovation enabled his firm "to produce better products than our competitors, which means products which give our customers technical or other advantages over their competitors." The importance of innovative products to the survival of the firms means that the process of product innovation is a dominant aspect of their day-to-day business.

5.2.2 The scale of innovation

An important aspect of the routine functioning of the firms is the continuous search for ways of improving the quality of their products. However, key actors involved in the innovation process are not usually pure R&D experts who experiment with basic science and radical new

technologies. Moreover, innovation involves a number of different functions within the firm because firms would like to exploit their innovations as widely as possible in the market. The importance of the interaction between the acquisition of information on the scope of technology and market position means that the role of different functions within the firms can overlap and be blurred.

Incremental improvements to existing products rather than the introduction of radical new products is the dominant form of innovation for the firms surveyed. As one interviewee remarked, "the introduction of new products is not as important as producing high quality, reliable, and accurate instruments" (interview, company G). This was reiterated by a questionnaire respondent who commented,

> "we seek to design and manufacture products which provide better price / performance than all our competitors by incorporating features that save operating costs and increase reliability with minimum component costs."

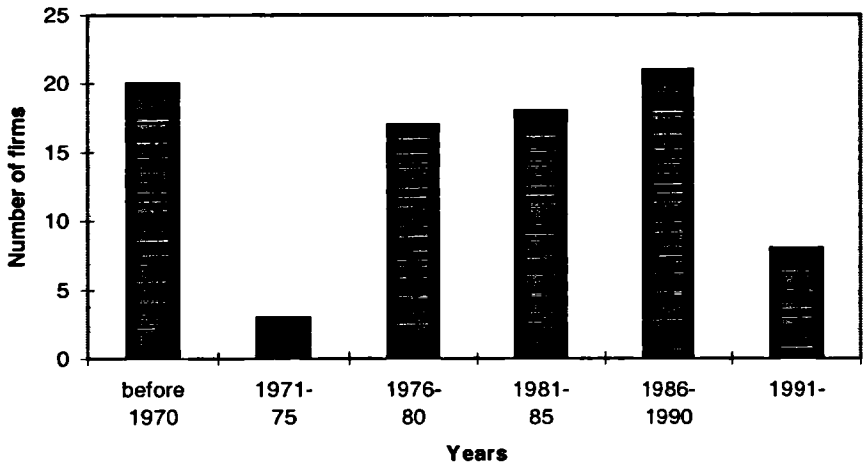
The representative of company A commented, "products developed today are based on patents taken out 20 years ago. Small incremental improvements in resolution and design are important."

It was rare to find firms whose day-to-day functioning predominately involved basic research and scientific experimentation for the introduction of new products. A commonly held view was that the introduction of radical innovations was very expensive. For small firms such as these accessing the required venture capital to pay for the development of such innovations is extremely problematic. A well-recognized problem for smaller companies is access to venture capital for R&D projects. Small IC firms have to contend with the fact that most venture capital companies will not even consider loans of over £250,000. The MD of company K, a firm with ten employees, said that his company "just cannot show the sort of returns over two or three years that the venture capitalists want to see."

Limited access to venture capital is a significant reason why the dominant type of innovation for the small firms in this sector is incremental product improvement through the adaptation and recombination of existing technologies. The need to access venture capital for a small-scale innovation such as this is less important. The firms were tending to deal with innovation in existing product ranges. As one MD remarked, "innovation is very important to us but only

in terms of improving the design of products we already have" (interview, company O). **Figure 5.2**, which shows the distribution of the years of birth of the firms, demonstrates that the typical small IC firm is well established in its field. Small firms in the IC sector are not usually in the process of undergoing rapid growth from the introduction of radical new products.

Figure 5.2: Distribution of years of birth of firms from the net sample (*Source*: Dun and Bradsheet database)



The most effective way for any firm to enhance its knowledge-base is usually by the means of recruiting the appropriate skilled labour. However, 60% of interviewees said that skilled labour was their biggest constraint on innovation. This was by far the biggest constraint reported. The availability of skilled engineers and software specialists is a particular problem facing these firms. For example, the MD of company I said that they had been advertising for c++ programmers for months and had not been successful in recruiting an appropriate person. However, in some cases it is not the availability but the cost of the labour that constrains the recruitment process. 26% of the firms that were interviewed said that the availability of finance was the biggest constraint on innovation. This was considered to be the second most important constraint after the availability of skilled labour. The availability of skilled labour is probably a nation-specific constraint that relates to educational and training practices as well as available experience. The constraints on access to risk capital and skilled labour mean that the firms are forced to be more risk averse and rely on the experience of their existing

staff base. This goes some way to explaining why the firms are path-dependent in the choice of innovative product to pursue.

5.2.3 Sources of innovation

Section 2.4.1 of chapter two explained why innovation is now recognised an interactive process involving feedback loops between the user and producer rather than a linear process where the innovation develops in a uni-directional manner from the R&D stage to the marketing stage. The recognition that the process of innovation is more of an interactive process than a linear one points to the need for analysis of the forces on the demand and supply sides of product development. These sources of innovation are usually expressed in terms of market pull and technology push. Section 2.4.4 of chapter two went on to explain that the process of information acquisition in relation to innovation goes beyond the simple exchange of technological know-how between the user and producer. The process of innovation involves a number of different levels of interaction between different types of information capture. The forces of market pull and technology push are the environmental stimuli that compel the firm to adapt internally through the interaction of different forms of information associated with the firms' development functions.

5.2.3.1 Market pull

The strong market pull effects on product development within the IC sector emanate from the need to find accurate measurement and fast processing of information in the production environment. New measuring techniques are usually developed in response to the implementation of new regulations or for the development of more efficient control of industrial processes to meet the demands of other businesses. Small IC firms are therefore usually producing for other firms rather than final household consumers. The significance of the customer has important implications in terms of the methods that firms adopt in acquiring new information. The important role of the customer as a provider of information for the small IC firm is described and explained in depth in section 5.3.1.2.

-Regulations

Where regulations are important to the development of products in the IC sector, they were usually specific to the domestic market. For example, quality accreditation procedures, which

are the result of national legislation, require more sophisticated measurement techniques. Company D produced test equipment for the inspection and testing of electrical installations to comply with wiring regulations. This firm was founded in 1980 and had 38 employees with a turnover of £5.5m. It had export sales of 10% mostly to Ireland, Middle East and Scandinavia. The firm's export levels were relatively low because the development of the product was based on a response to changes in domestic regulations. Product development within the company had been dependent on the need for greater precision in measurement following the introduction of more sophisticated UK regulations. The definitive regulations applying to the majority of electrical installations, the current 16th Edition of the IEE wiring regulations were published in May 1991. These regulations stipulate the requirements for the inspection and testing of electrical installations. They also provide recommendations on reliable methods to ensure that the installation complies with the requirements of the 16th Edition. However, the MD viewed British regulations as an important constraint on the commercial exploitation of their products. The reason for this is that European standards tend to be more advanced than UK thus allowing German and French companies to become more competitive in terms of the global market for this type of product.

Increasingly sophisticated environmental regulations which have been adopted in response to growing awareness of environmental damage caused by production processes, continue to push the limits of detection in the measurement industry. Moreover, the important interplay between process and product innovation, as a response to changing environmental regulations was exemplified by company E, one of the larger companies from the interviews. This company was founded in 1954 and had 45 employees. The company's main activity was making cleaning systems for hydraulic valves where cleanliness is a vital consideration. Export sales were 18%, with the main export markets being situated in the Far East electronics sector. The company had been operating with a "very stable and mature" product range up to the end of the 1980s. This had been largely based on CFC chemistry but due to the general growth in environmental awareness the company was forced to rethink its product range. By moving away from CFC based to hydro-carbon based chemistry the company achieved the Queen's award for environmental innovations.

-Industrial process measurement

An example of a company dealing with industrial process control began as general engineers around 90 years ago working for local companies before developing a range of machines for

the confectionery and food canning industries.[1] In the 1930s the company initiated joint development projects with the rubber and plastics research association and undertook the design and manufacture of test equipment to evaluate the physical properties of rubber and other polymeric materials. In the early 1950s the company started looking for export markets in the rubber growing regions and in industrialised countries where rubber processing takes place. Export business has grown rapidly since then and now accounts for nearly 80% of the product (65-70% of turnover) which is sold to over 60 countries worldwide. Through close contacts with customers, research associations and its international standards committees, the company has been active in devising new world standards for particular types of rubber testing. According to the MD, this helped to give the company a competitive edge in introducing new test equipment on to the market.

-Ease of use

Continuous improvements in design and resolution, resulting in a greater ease of use and cost-savings in production are an important source of value added for customers of small IC firms. The importance of a greater ease of use for the customer was emphasised by one interviewee who said, "we aim to introduce new products which are easier to use yet provide the customer with more information." The MD of company K, referring to the nature of product development said, "equipment needs to be more automated so people who use it can be dummer." The importance of ease of use reflects one of the major implications of changing technology in society - the deskilling of potential users. The MD of company Z said that "smart instruments" is the buzzword that drives the innovation process. He believed that equipment needs to be more intelligent so that people with less skills and know how can use them. The MD went on to say, "there is a requirement for more and more processing power but the principles of the instruments do not change to any great degree." To this firm the innovation process was essentially about reducing the level of complexity in operation for potential users. Again, this suggests that incremental improvement is more typical of the firms.

One company who provided extra information with the questionnaire responses was specialising in a sorting system called an 'autosort' and a visual inspection system called a 'qualisizer'. A feature of the 'autosort' was its capability in processing several tonnes of dry,

[1] Extra information provided with the questionnaire responses.

fresh or frozen products per hour to very high specification. The machine is able to grade and sort by colour, shade, size or defect. The qualisizer measures each particle passing its camera and allocates it to a specific size and colour category. All the data is processed in a spreadsheet and the sorting systems have recently been interfaced with a touch screen operator. The MD commented that the aim of the company was "to produce high-technology equipment that is easy to use". The adaptation of new technology into the development of the product and the adoption of new technology for engineering and design purposes were both seen as being vital to the firm's innovativeness and competitiveness.

-Miniaturisation

Miniaturisation of equipment is another facet of product quality which is important in the penetration of new markets. More and more companies are seeking smaller equipment for portable use or greater efficiency in the use of current space. In discussing the nature of innovation, the MD of company L said that "electronics is generally becoming smaller and more densely packed. We must innovate to ensure that our capability meets the changing technology." The MD of company Z remarked, "people want to use smaller, lighter instruments and so miniturisation is vital." This was exemplified by the MD of company R describing the multi-faceted nature of his company's innovation process. He said that "innovation is about reliability through process investment, miniaturization in terms of product introductions and processing power to increase functionality per unit value." Miniaturisation is closely tied in with the convenience for the user. This provides another example of why the interaction between the adaptation of new technology and the acquisition of knowledge on market position is not easy to detect. The importance of the customer in providing the firm with information on both of these development functions is elaborated in sections 5.2.4 and 5.3.1.2.

5.2.3.2 Technology push

The importance of the interaction between market pull and technology push is evident in the IC sector through the integration of software, microelectronics and the greater ease of use. While customers are continuing to look for a greater ease of use and more portable products, the adaptation of new technologies is allowing this to happen. In terms of technology push, developments in methods of measurement and the ways in which results are analysed have

become significant drivers of innovation in the industry. The interface between technology and software is becoming increasingly important to the development of measurement techniques.

Company Z was specialising in fault location products where export sales amounted to 70% of its overall output. The products were being designed to detect where faults have occurred on underground cables or overhead lines. The MD said that this was a niche market product where price has never been a critical factor. According to the MD, the important competitiveness factors had been the quality function and the speed of response. Ideas had often been postulated a long time before they were implemented because of the length of time it had taken to adapt the technology which becomes available. For example the availability of a technology called GPS provides accurate signals to get tiny measurements. According to the MD, this enabled the firm to implement ideas that were theoretically proposed in the 1950s.

According to the DTI (1996, pp.18-19), "the innovation profile of instrumentation and systems is characterised by the nature of technology involved as defined by software, microelectronics and sensors and which may be present singly or in combination." The industry has been transformed by the application of microelectronics and information technology (Ibid., p.4). The key to innovation is the development of software to interface with the product function. Software used in instrumentation and control is characterised by rapid change. Up to date information and know-how on the latest developments in computing technology therefore becomes vital. The MD of company F remarked, "we are constantly trying to get to grips with the power of computers."

There were numerous examples of firms developing new software in order to improve the accuracy of their measurement techniques. Comapny P was particularly keen to interface software with driving engines. They had recently designed a new tool that tested engines to meet standards. The MD of company I said, "it is software rather than hardware which is becoming more important," whilst the MD of company O commented, "we have improved networking capability of the product and the interface with software is becoming more and more important." R&D activities in the firms were strongly orientated towards software development. Comapny D's major innovation in the previous five years had been a series of digital insulation / continuity testers, which are controlled by on-board microprocessors with high performance integrated circuits and software to provide high speed data processing and a rapid display of readings.

A growing R&D activity within the sector in recent years has been the search for new sensing devices:

> "Advances in selectivity, sensitivity, speed of response, ruggedness, compatibility with particularly physiological and other 'bio' environments and cost reductions are continuously sought. These may emanate from many scientific disciplines, for example, material sciences, life sciences, electronics, optics and chemistry" (DTI, 1996, p.33).

The role of sensing devices as a driver of technological change has particular relevance for the role of small firms. The reason for this is that the final application of sensing devices is not always obvious to the corporate visions of large companies. This provides small firms with the opportunity to exploit niches in the market. There is a great deal of scope for adapting sensing devices for niche markets and many of the important innovations in the industries are the result of the specialised knowledge within small companies. As the DTI report on the sector pointed out, there are very few techniques within the field of instrumentation and control that command very large markets. This accounts for the high proportion of small firms in the sector (DTI, 1996).

A further source of innovation increasingly apparent in the IC sector is digital electronics. Microelectronics and digital communications are of particular importance to the development of portable and high specification equipment. Again, this shows the importance of the interaction between technological development and market scope within the industry. One MD suggested that portability of the equipment is not necessarily important per se. It was more "to improve the product's capabilities within its existing parameters" (interview, company Z), while the MD of company F commented, "innovation helps us to pack more capability into the same area and therefore keeps the costs of production down." This enables the firm to maintain its competitiveness.

5.2.4 The R&D process

To reiterate an earlier point, basic research is of limited importance to the innovation process within these firms. The R&D process is more the result of interaction with other firms than those industries where basic scientific development plays a key role. In the final questionnaire, the respondents were asked whether they employed workers who carry out design-based

activities and whether they were involved in pure research or if they worked closely with the customer on the development of the product. They were then asked to state how many workers worked on these activities. One firm employed "approximately 12 scientific and engineering staff who carry out mostly pure research and development" but it was rare to find departments that were as large as this doing pure R&D. The following response was more exemplary of the firms surveyed:

> "We have one design engineer developing new products, currently working on a precision digital thermometer who works closely with the customers and one software engineer producing application software."

Many of the companies employed workers in a formalised design or development capacity. However, they were a few who said that workers performed development work more informally amongst other functions. As one respondent stated, "number varies but is no more than two. It is usually 0.5 men." This was reiterated by another MD who commented, "five are involved in design work but it's not our main job," while another commented, "all project engineers are involved in the field of research and development whilst maintaining close contact with customers to obtain feedback."

For these firms it was usual to find small R&D departments where employees within the departments are working closely with customers. One MD stated, "we have two workers who both work on software and hardware developments and are responsible for interpretating customer requirements." Another company MD commented,

> "we currently employ three staff on research and development. This is the development of new products and software both of which are closely linked to customers requirements. Continuous research and development is vital to the survival of our business."

One MD commented, "yes - we have two PhD physicists working on instrument development, one electronics designer working on electronics controls for the instruments and one mechanical designer" while another remarked, "(we have) seven staff on R&D and design, mainly working with customers to fulfil design briefs." Software development is a vital component of R&D. The MD of company F said, "we have two engineers working on the development of a computer-based test system."

Those individuals who were not necessarily working in formalised R&D departments but were working on product development were usually working closely with customers. One MD stated, "we currently employ three staff on research and development. This is development of new products and software both of which are closely linked to customer requirements." One MD stated, "in the engineering department we have 10 people working in response to changes in customer demand", while another commented, "most of the products we sell are designed to meet each customer's specific requirements. We have three design engineers and an engineering manager plus a technician." Another firm representaive commented,

> "we currently employ two part-time engineers one for software the other for hardware with contract work issued to associated companies as and when required for concept development derived from customer requirements."

There were a few examples of research being subcontracted. As one MD commented, "no pure research is carried out. Design ideas are sourced externally and developed in partnership with the design source." The complex nature of the product development process within the small firms demonstrates the limitations of input measures of innovation such as the number of R&D employees. It is important to understand the nature of the R&D process within the firms because this tells us something about the way in which the firms access important sources of information. However, the complexity of product development within the firms justifies the use of the output approach in measuring innovative performance.

5.2.5 Development functions

It was argued in section 2.4.3 of chapter two that in order to create the right conditions for innovation a firm must combine various forms of information. It was therefore important to develop a realistic conceptualisation of the internal functions of the firm in relation to their contribution to product development. These different functions are associated with different forms of information. Having considered innovation in terms of market pull and technological effects the analysis now goes on to consider how firms respond to the problem of coping with these external forces. Analysis of the internal functions shows how the firms adapt to the external forces emanating from the changing environment. This is not a study of the internal dynamics of firms but a brief insight into the nature of change within the firms allows us to understand how external sources of information relate to different areas of development within the firms.

The firms were asked how important each area of development had been to the market exploitation of new products and improvements in goods and services. **Tables 5.1 (a) and 5.1 (b)** show the mean levels of importance of the different development areas to the process of product innovation within the firms surveyed. The findings displayed in the tables clearly demonstrate that the firms perceive all of the development areas to be more important in the future than they had been in the past. The mean level of importance for adapting new technology to develop the quality of the product is 4.41 in the future compared to 3.96 in the past. This is the most important aspect of product innovation and reflects the importance of adapting new software and microelectronics to improve the performance of products. There is a distinction between the adoption of new technology for the purposes of innovation and its adaptation to improve product quality. The adoption of technology improves product performance by facilitating the design and engineering process. This is a process innovation within the firms. Company P, for example, was keen to upgrade its CAD system because it was less interested in developing new products and more concerned with improvements in its design capacity its existing products. The MD of company Y said, "the main changes have been the advent of computers to optimise design for lens so has become more cost effective - the spin-off of optics into electronics is becoming more important." There were a number of companies from the interviews where the adoption of design capacity was considered to be vital to the innovation process. This was usually backed up by CAD. The adoption of new technology was considered to be the second most important area of development with a mean level of importance of 3.54 in the past and 4.02 in the future.

The largest differential between the past and the future was for the development of the marketing function where there was a mean score of 3 48 in the future compared to 2.56 in the past. This is because the firms see the improvement of their marketing capacity to be important even though they have been relying on a stable customer base in the past. As one interviewee said, "we tend to stay with a few customers but (developing our marketing techniques) might be important in the future" (interview, company R). There was evidence to suggest that firms were beginning to appreciate the value of increased marketing capacity. For example, one MD said, "marketing research has become more important with the increasing customer-led approach, reflecting increasingly rapid changes in technology and increasing competition" (interview, company V). For one firm marketing had not been an important issue in recent years because it had "found a niche and knows its customers very well" (interview, company F). The interviewee did say, however, that the company is always open to new ideas on marketing, especially if it goes into markets abroad: "we are currently dipping our toes into

the waters of the international market but only on a sales basis." Another firm representative explained how his company's management team had grown in recent years and recruited a new sales and marketing manger who has been able "change style and customer perceptions" (interview company D), for example by writing articles in what the interviewee referred to as "posh" magazines. There were numerous examples of firms being relatively advanced in the marketing field. A large part of one company's export business was processed through distributors and agencies and marketing was vital in keeping the product at the core of their agencies' activities. The company had been involved in a series of roadshows in Europe and a major exhibition in the United States. They regularly advertised in international magazines that specialised in their field of measurement. In certain cases marketing and distributing the good more widely had become more important than the development of the product: "we are a reasonably sized player in a fairly small market, it is therefore more important that we are good at selling the product" (interview, company E).

When the firms believed that the development of new marketing techniques was not of immediate importance this was usually because they had already developed close relationships with existing customers. These firms were not looking to increase the market scope of their product(s). As one managing director remarked,

> "it is not a case of them looking into a catalogue and saying one of those and one of those, we are an extension of our customers, you need to be there, we are rarely phoned up out of the blue" (interview, company P).

There were some examples of attitudes that might lead to complacency in the development of marketing capacity. For example, one MD said, "we have good market intelligence so it is therefore not a problem." This shows how firms rely on existing routines to sustain their market position even when they are producing innovative products. A common concern expressed by managing directors, however, was that they would require assistance with marketing processes if they were forced to diversify their production base. The mean level of importance of marketing is far greater than management and scheduling / distribution as a future development priority. The rankings are summarised in **tables 5.1 (a) (b)**, below.

The firms were not necessarily complacent on organisational aspects of development such as managment and scheduling / distribution, but they did view these as being less important in

terms of the process of innovation. The need for some limited improvements in their internal organisational capacity was nevertheless recognised. One interviewee said,

> "(innovation to us) is not so much new products but we want to improve our design capacity and we are applying for the ISO 9000. This is two pronged, we need to file information better and handle information to help us in the next job" (interview, company P).

Table 5.1 (a): Importance of different devlopment areas to innovation in the past

	Mean level of importance	% of firms reporting development area as ranking of 4 or 5 importance
Adapting new technology into the development of the product	3.96	66.7
Adoption of new technology for engineering and design purposes	3.54	58.7
Development of new management systems	2.46	10.9
Development of marketing / market research processes	2.56	18.8
Development of new processes and systems for distribution / stock control / scheduling	2.27	16.7

Note: All means in the tables derive from a scale of 1 to 5 for the level of importance given to to the contribution of each type of development area to innovation.
Source: Responses to survey.
N=50 (realised sample from questionnaire responses)

The evidence showed that once a new management system is adopted it can facilitate the innovation process in the future. The MD of company R whose quality systems had become certified to ISO 9000 said, "this constitutes the backbone of everything we do from an innovation point of view." In certain cases it was difficult for the firms to decide how important the adoption of new management techniques had been to the process of innovation. Company Y had recently adopted ISO 9000 but the MD considered it to be too early to say if

it had made a significant contribution to the innovation process. The MD believed that it would take time for his staff to adapt to the changing culture of its implementation.

Table 5.1 (b): Perceived importance of different development areas to innovation in the future

	Mean level of importance	% of firms reporting development area as ranking of 4 or 5 importance
Adapting new technology into the development of the product	4.41	85.7
Adoption of new technology for engineering and design purposes	4.02	74.5
Development of new management systems	3.11	44.5
Development of marketing / market research processes	3.48	54.2
Development of new processes and systems for distribution / stock control / scheduling	2.94	37.5

Note: All means in the tables derive from a scale of 1 to 5 for the level of importance given to the contribution of each type of development area to innovation.
Source: Responses to survey
N=50

The development of new processes and systems for scheduling and distribution are important to innovation because it allows firms to exploit new products more effectively in the market. The respondents also perceived this area of development to be more important in the future than it had been in the past. As one MD remarked, "just-in-time production has become very important, we are working on very low stocks and we are looking to continually improve" (interview, company V). The MD of company L said, "all the buying is on the computer system; we want to keep stocks up to date and this has worked very well. We will be moving into scheduling capacity in the future." The MD of company N said that his firm was "investigating possible solutions to stock control at the moment," while the MD of company M commented, "we are running computerised stock control but it's been an effort to get it working and it still is not right for finished stock for the customers." The MD of company P

remarked, "the control of stocks and processes is very important, we are very keen to learn about that." One company that was in the process of launching a transceiver product range for telecoms applications said that the production process was of utmost importance to the commercial exploitation of the product: "we are offering advantages over competitors particularly in development of a high volume manufacturing process to save costs" (interview, company O). Overall the firms were very keen to improve their distribution channels to improve the commercial exploitation of their products. The MD of company G said, "we need to improve our distribution to increase the volume of sales."

The qualitative and factual responses show how innovation is more than just the development and application of technology. For these firms the commercial exploitation of new and improved products involves a complex interaction of functions that highlight the limitations of measures of innovation that emphasise R&D expenditure. Internal organisational change, often overlooked in the literature on regional learning, has an important impact on the ability of firms to exploit their new products and improvements in the domestic and international markets. These types of knowledge and information bases are given low values compared to information on technological functions. Added together, however, they are considered to be more important to the process of innovation than is sometimes acknowledged. The functions which are less important such as management techniques are more generalised in that they are less specific to the firms' innovation processes. They are nevertheless important in aggregate. Section 5.3.3 will show that the spatial dimensions of the sources of information depend on their relationships with the firms' development functions.

5.3 The spatial dimensions of sources of information

5.3.1 Sources of information and the general innovation process

In this section the sources of information are ranked according to their importance to the whole process of innovation within the firms. This incorporates the importance of different sources of information for all aspects of development within the firms that have contributed to the product innovation process. This was reached by taking the mean importance of each source's contribution to all types of development areas within each of the firms.

This section will also compare the importance of specific sources of information within the region to beyond the region. The spatial analysis only includes sources of information where it is possible to make a comparison from the questionnaire responses. Learning from journals and the internet does not lend itself to spatial analysis in terms of flows of information. However, they are internal sources of information that can be used as a benchmark in measuring the importance of other sources.

Table 5.2 displays the rankings for all the sources of information. The table clearly show that experience from past employment and customers are the most important sources of information. In-house information sources such as trade, electronic, scientific and business journals are the second most important source. The internet, another in-house information source, was considered to be the third most important source of information while conference / exhibitions was the fourth highest. Suppliers were the fifth most important source. **Table 5.3** provides a summary of the spatial differentiation of external sources of information. The value of the paired sample t-test indicates the significance of the difference between the importance of sources within the region and beyond. The higher t-values indicate a more significant spatial differential. The following sub-sections consider these findings in more detail by linking them to the explanatory framework and providing qualitative illustrations from the face-to-face interviews.

5.3.1.1 Experience and contacts from past employment

In interviewing the firms in the first stage of the research it was apparent that one of the most important sources of knowledge of information is experience gained in past employment. When it was difficult for interviewees to articulate precisely what their important sources of information for technology and markets had been, a typical response was that "the single most important thing is experience." Chapter three showed that recent literature has emphasised the importance of regional learning processes generated by experience in past employment. As chapter two showed, analysis of how information from existing sources is recombined with knowledge of information from past experience provides us with a better understanding of the learning process. Theoretical perspectives on learning explain how know-how in recombining different sources of information comes from experience in past employment which itself is an important source of information. This is therefore regarded as a separate source with an explicit a spatial dimension.

Table 5.2: Importance of sources of information[2]

Source	Mean level of importance	Rank
Customers	2.86	1
Trade, Electronic, Scientific and Business Journals	2.74	2
Internet	2.57	3
Conferences / exhibitions	2.54	4
Suppliers	2.48	5
Journals of learned societies	2.35	6
Networking through other institutions[1]	2.16	7
Universities: Collaborations	2.09	8
Contacts from past employment	2.06	9=
Consultants	2.06	9=
Other training / seminars[2]	1.87	11
Universities: Training / seminars	1.72	12
Competitors	1.67	13

Notes: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each source's provision of information for each development area.
[1] usually business and trade bodies such as chamber of commerce, business link or trade associations;
[2] organised by trade associations and other business support services.
Source: Responses to survey
N=50 (realised sample from questionnaire responses)

[2] Where there was a spatial differential for the sources in the questionnaire the mean of the differential was taken.

Table 5.3: Spatial differential of sources

Source	Mean level of importance	Spatial differential	Paired sample t-test
Experience from past employment			
-region	2.88		
-beyond the region	3.03	-0.15	-1.28
Customers			
-region	2.61		
-beyond the region	3.11	-0.50	-2.04
Suppliers			
-region	2.22		
-beyond the region	2.73	-0.51	-3.21
Networking through other institutions[1]			
-region	2.27		
-beyond the region	2.05	+0.22	2 5
Universities: Collaborations			
-region	2.08		
-beyond the region	2.11	-0.03	-0.36
Universities: Training / seminars			
-region	1.69		
-beyond the region	1.75	-0.06	-0.75
Conferences / exhibitions			
-region	2.28		
-beyond the region	2.8	-0.52	-3.28
Other training / seminars[2]			
-region	1.88		
-beyond the region	1.86	+0.02	0.25
Contacts from past employment			
-region	2.51		
-beyond the region	2.33	+0.18	0.61
Competitors			
-region	1.47		
-beyond the region	1.87	-0.40	-1.78
Consultants			
-region	2.17		
-beyond the region	1.95	+0.22	1.5

Notes: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each source's provision of information for each development area.
[1] usually business and trade bodies such as chamber of commerce, business link or trade associations;[2] organised by trade associations and other business support services.
Source: Responses to survey N=50

Experience from past employment is important to these firms because in many cases they are spin-offs from larger companies. However, because of the nature of the products that they are dealing with, experience of markets and technology acquired in places from beyond the region becomes more important to innovation. Moreover, considering the high concentration of IC firms in the LMR, the acquisition of experience from recruitment within the region is not as important as might have been expected. The respondents said that experience from beyond the region was more important than within the region, with a mean of 3.03 compared to 2.88. The reasons for this will be explained after we have considered some examples of the importance of experience in past employment.

For these firms information about markets and technological change is usually drawn from experience in past employment. This is usually employment in larger companies. Company P from the interviews had started out as a small group of employees who had been made redundant from a local Rolls Royce plant. The senior researcher being interviewed commented, "the pool of knowledge was already here, a good number of us are ex- Rolls-Royce from the plant in Watford which closed just over five years ago. Our contacts with Rolls-Royce are still very important" (interview, company P). The knowledge gained from this experience was utilised in the new company's operations that specialised in the development of instrumentation for measuring fluid flows to save fuel and transducers for measuring low pressure on air flows. The importance of spinning-off from regionally based firms was reflected by another interviewee who said, "I enhanced and made improvements to a product from a company I worked for before in the area" (interview, company K). The recruitment of labour from large companies enables the small firms to emulate them on certain aspects of the innovation process.

Two further responses from the interviews suggested that the region was of vital importance to experience. The MD of company U said, "we are always looking for people from the big companies, we've recently recruited a couple from a large company in Hertfordshire" while the MD of company M said, "because we recruited two people from a large company based in Hertfordshire we were able to pinch their approach to control." The MD of company Z was keen to highlight the importance of employing the ex-staff of a competitor that was based in the same town as them - "just down the road." Qualitative examples such as these suggest that the spatial dimensions of experience from past employment are closely tied in with the ability to recruit specialised labour from within the region. However, this is not necessarily the case because an individual recruited from within the region may have acquired more valuable

information in experience gained beyond the region. The difference between recruitment and experience is also reflected in section 5.3.5 which shows that the need to hold on to specialised labour is of considerably higher importance than the availability of skilled labour in keeping the firms in the region. These findings also suggest that experience had been drawn from workers who had worked in companies all over the UK. The representative of company A remarked, "we can pull workers in from anywhere in the UK." This suggests that the labour market is more nation-specific than region-specific.

The data from the questionnaire responses suggests that key decision-makers were more inclined to draw on knowledge of information gained in employment beyond the region and even the nation in developing their technological and organisational capability. This does not necessarily mean that they had worked outside the LMR for longer than they had worked within the region. Although labour markets in the LMR are probably more important in terms of the turnover of labour, they are not more important in qualitative terms. In other words the knowledge the workers had gained in experience working beyond the region or abroad was considered to be more valuable. The MD of company C who had spent five years working in the United States said that this experience had been vital to his knowledge of information on the scope of technology, as well as managerial techniques that had been implemented in the small firm that he was now directing in Hertfordshire. This demonstrates the importance of being able to consider experience in qualitative terms. The firms are dealing in international markets. Their workers therefore need to have an international outlook.

Experience from past employment was considered to be the most important source of information originating from within the region. However, this may reflect the importance of experience from past employment generally compared to the other sources. The specialisation of regional sources of information is considered in section 5.3.2 with the ranking of importance of sources within the region shown in **table 5.4**.

As the example of company P shows, experience from past employment is also important in generating contacts that lead on to further sources of information. Contacts from past employment can be an important source of information in current employment, thereby making an important contribution to the learning capacities of the firm. In referring to his experience in the job, the MD of company Z said, "it is a very close-knit field and you get to know people." Another remarked, "there are no particular linkages in the area but I do know a lot of customers from the company that I worked for before in the area" (interview, company

M). In this particular instance the individual had learned about the function of markets from his experience working in his previous company.

In contrast to experience from past employment in general, contacts, which are one aspect of this experience, were more important within the region. The mean level of importance within the region for contacts was 2.51, compared to a mean of 2.33 beyond the region (see **table 5.4**). Contacts from past employment is a more important source than suppliers, universities and consultants within the region and ranked third out of all regional sources. This is an important finding because it shows that networks of contacts from past employment can be more easily sustained at a closer distance. As ties from past employment become weaker beyond the region they also become less important as a source of information for the firms. However, as **table 5.2** shows, the importance of contacts from past employment is relatively low compared to other sources, in aspatial terms. The reason for this, as section 5.3.3 shows, is that contacts from past employment are more important for less valued types of information such as management and distribution, where information is relatively more accessible at the regional level.

5.3.1.2 Customers

Although the firms draw on experience in past employment in identifying potential customers, the customer then becomes the single most important source of information that is recombined with knowledge from past experience and other sources of information. In terms of the commercial exploitation of new products, information gained from the customer about the path of product development becomes more important than the information that workers had gained in previous employment. **Table 5.2** shows that, the customer is the second most important source of information for the firms (after experience from past employment) with a mean level of importance of 2.86. Section 5.3.4, later in this chapter on the attributes of important relationships of information acquisition, shows that experience in past employment was considered to be of some significance to the development of their relationships with suppliers or customers, two of the most important sources of information for the firms in the survey.

The reason that customers are so important reflects the nature of the innovation process that the firms are undertaking. The firms are usually producing for other firms where customer

specification is vital. Contact with the customer by telephone, email or personal interaction to exchange information on the development of the product is a predominate aspect of the routine functioning of the firms. The MD of company P said, "we talk to customers on a daily basis." Section 5.2.4, earlier in this chapter, showed that the R&D process within the firms relies heavily on regular contact with customers.

An understanding of the qualitative characteristics of the relationship between the firms and their customers allows us to appreciate the methods by which information. Information flows in both directions, from the firm to its customer and back again in the opposite direction. This two-way flow of information enables both the firm and its customer to move in the right direction towards the goal of technological development. Section 2.6 in chapter two referred to the importance of power in analysing relationships of information exchange. The direction of information flows between the firm and its customer and where the balance of power in the relationship lies is sometimes not easy to detect. It is very difficult to generalise even within a very specific sector such as this. The findings from this research suggest that the customer provides information to the small firm that can help it with the exploitation of its product in the market. Customers pass on information that enables the small firms to learn about market requirements. This allows the small firms to widen their markets both in geographical and volume terms. As one interviewee said, "we would develop a product to a specific customer requirement and then try and sell it to as many customers as we can" (interview, company V). On the other hand the firm is passing on specific information to the customer about the scope of the technology that they are applying to the process of production. This enables the customer to learn about development opportunities for their own product(s) in the future. In terms of information flows it is therefore usually a two way relationship. As one interviewee remarked,

> "the majority of our work is designing and manufacturing equipment for new R&D projects. This equipment is customised for projects and invariably requires new innovations that when proven become standard. In many cases our development is customer requested. For example electron microscope manufacturers increase the resolution of their machines, we are then required to produce machines that will give films of very fine grain size to allow the benefits of higher resolution to be used" (interview, company U).

This type of response was reiterated by other interviewees. For example, the MD of company X said, "we have to work very closely with customers as they all have different requirements," while a questionnaire respondent commented,

> "(we innovate) by integrating functions of small controllers into one simple box, most innovations are software driven. We have two designers who work closely with customers. Innovation is very important - each customer specifies different priorities and aims."

Company Y's main function was to supply a wide range of detectors to scientific instrument manufacturers around the world. Its main production functions were the development of scintillators used in mass spectrometers, fluoroscopic screens used in the provision of radiotherapy imaging systems and x-ray screens for security and machinery processes. According to the MD, the company was dedicated to providing innovative solutions to current and future problems in the application of phosphor technology. The company had export sales of 52% with its main customers based in the United States, Belgium, France, Germany and Israel. The detectors were supplied as a standard product or developed in collaboration with the customer to meet their specification. Products were being differentiated for particular customers. According to the MD, there is almost continuous innovation in the sense that the quality of the product is improving through its customisation. The company had one R&D manager and one technician who was spending around 70% of his time on R&D, but everybody in the production department was working on R&D for approximately 10% of their time. These activities predominately involved interactive development to meet the specifications of particular customer needs. According to the MD, the company was dealing with different types of innovation because the technology used in the production process was very old and the development workers who were working closely with customers were refining it and bringing it up to date.

The suggestion that the relationship with the customer is not necessarily a learning relationship for the small firm because the customer has a strong influence over the firm's direction in setting the specifications for developing the product needs to be addressed. What the firm learns from one customer in terms of that particular customer's specifications is effectively information that might be applied in developing the technology to wider market application and indeed to increase its innovativeness. The customer requirements provide the firm with a specific insight into the scope of technological adaptation and the future

requirements of the market. The relationship with the customer is of course based on the imperatives of the market but it has spin-offs for the smaller firm in terms of the development of learning capacities for dealing with market position. The findings from the research suggest that it would be a sweeping generalisation to think that these firms are simply subservient to their customers' requirements. As one MD said, "I would say that we collaborate with customers, its important for them and ourselves, it's a two way process" (interview, company F). The complexity of analysing power and influence in the relationships was exemplified by the MD of company O who said,

> "although we build to a customers design we have recently decided that we can have more of a say in the design by providing prototypes free of charge. We hoping to collaborate more with this customer in the future."

The following example of a company who provided extra information with their questionnaire responses also demonstrates how a firm which relies on specifications from the customer in developing its product should still be regarded as innovative in its own right and not necessarily subservient to the customer's technological requirements. The company, established in 1990, had 7 employees with export sales of 50%. Despite its small size the company was still a leading international supplier of piezo-electric axle detectors which are used to measure vehicle speed and trigger law enforcement cameras. The MD was mostly responsible for designing the products, having designed, proto-typed and built the first rubber piezo-electric axle detector in the world. He had previously spent two years as sales manager at a company producing axle detectors. This company was located in the firm's region. The firm had also developed a pedestrian sensitive tile, which detects pedestrians waiting to cross the roads and activates the traffic signals accordingly. This allowed the MD and his colleagues to develop electronics that would allow vehicles to come to rest or travel very slowly across the sensors. They also developed electronics that is able to cope with minuscule piezo electric outputs from pedestrians waiting to cross the road.

The company worked very closely with its customers because they all had different requirements but the technology that goes into the development of the product was a result of the firm's knowledge-base. The innovation performance of the company had been demonstrated by the number of prizes it had won. These included a £500 prize from the Chamber of Commerce for being the best small business in the area that had started in the previous two years. It had also won a £5000 prize from the BBC Radio Times for again,

being the best small business in Britain established for less than two years. The criteria for the award was innovation and export achievement. It was also successful in the Business Breakfast award in 1993 for export achievement.

The importance of the customer reflects the position of these firms on the value chain of production. They are usually intermediate producers, who are producing for other firms rather than final consumers. Moreover, the qualitative findings clearly suggest that because of this, the firms have very close relationships with their customers. As one MD remarked,

> "we work extremely closely with our buyers, there is a lot of discussion before we enter into a contract, if we don't see them often, misunderstandings arise, you need to be there . . . we are really an extension of our customers, so we need to be there as often as possible" (interview, company P).

Because the relationship with the customer is very close it becomes important to the small firm in terms of acquiring knowledge on other aspects of development apart from technology. The firms become reliant on their customers for information of organisational development, as well as developments on the technological and marketing side. This is particularly true for small companies with growth aspirations. They look to their customers, usually larger firms, as benchmarks for dealing with the organisational problems of growth. The research findings therefore suggest that the customer is not only important as a source of information for the adaptation of technologies but also through its ability to provide information for the firm on internal organisational change. This is made evident by the analysis on the importance of sources of information from the customer to the different types of development within the firms in section 5.3.3 of this chapter.

Table 5.3 shows that there was a significant difference in comparing of the importance of customers as a source of information beyond the region against the importance of those inside. The mean level of importance for inside was 2.61, whereas beyond the region it was 3.11. The example of company F shows how being near to a customer can be important but not vital to the firm's acquisition of information. This was a company of 40 employees, formed in 1984 with export markets situated all over the world. The company was producing test equipment for PCBs and electronic assemblies. Having become accepted that static can do a great deal of damage to integrated circuits, the company had developed a range of anti-static testing equipment. The adaptation of computerised measurement systems was viewed as being vital

to the development of the product. In the words of the MD, "customers' boards are getting smaller and smaller with more on them. With us the object is getting more facilities into the same space." The company was continually reviewing its operations and dealing with customers on a regular basis. The company had three large customers in the UK, with one based locally in Hemel Hempstead. The company worked very closely with this customer and the relationship was considered to be very important to the adaptation of new technology. The MD said that "when we work with (the local customer) we pop along to each others factories when we want. This is a great asset to the relationship." Despite the importance of this local relationship the MD also said that his company worked very closely with a customer based in Scotland, a relationship that was also said to be vital to the firm's innovation process.

This example shows that customers being nearer does not necessarily mean that they are more important in terms of the firms' ability to access information. This was also exemplified by another interviewee who said, "we have one major customer in Croydon and one at Luton and various others around the South-East but we also learn from customers in the Far East, Middle East and Europe" (interview, company P). The MD of company S said, "there is one company we are trying to work with in the US. I'm not sure if distance would matter." But a close relationship with a local customer can be important on more general requirements that are less important to the firm's development process. As one MD said, "to meet a legal technological requirement one of our customers based at Sunbury allows us to use their lab which is a great help" (interview, company M). The MD of company L said, "our local customers help us to produce on time but I wouldn't say this was particularly important to innovation." Being closer to certain customers does not necessarily mean that the value of information from those customers will be higher. This was implied by the MD of company D who said, "we work more closely with customers in the UK because of the language, but we've also worked extremely well with customers in Denmark."

5.3.1.3 Suppliers

Such is the nature of innovation in the firms being analysed that suppliers were viewed as being of lower importance as a source of information than customers. The mean level of importance for suppliers was 2.48 overall, compared to the customer's 2.86. It was common for the firms from the interviews to have networks of suppliers within the LMR but relationships that had given rise to important information flows were rare. This is confirmed by the differential between the importance of suppliers within the region and their importance

beyond. Suppliers beyond the region were considered to be more important with a mean of 2.67 compared to 2.19 inside the region for the innovation process as a whole. As one interviewee explained, "it is convenient to be near subcontractors but you could easily say the same about other areas" (interview, company V). One MD said,

> "we buy from all over the place but Hertfordshire and Buckinghamshire mainly but if we were in Birmingham I'm sure there would be suppliers there as well . . . we utilise sub-contract labour for installation and assembly in the SE but these are not important to the process of innovation" (interview, company P).

The MD of company Q said, "we have networks of suppliers in Herts but they are all very low-tech." The findings therefore suggest that relationships with suppliers that deal with specific aspects of technology are spatially dispersed from the home region.

5.3.1.4 In house sources: journals and the internet

Journals are included in the analysis because, as well as providing technical information, the managing directors in the interviews often saw them as a useful link on to other sources such as suppliers and conferences. It was widely reported that systematic searches of all newspapers and trade press are carried out continuously. Technical journals seem to be the most important in-house information source. The MD of company Z commented, "I continuously read journals from the learned societies," while the MD of company K remarked,

> "good engineers learn as they go along - they are constantly checking magazines looking for new ideas, this is more important to us than formalised training . . . trade journals are our key information source."

The MD of company M commented, "we read large numbers of trade magazines and technical journals." Electronic, scientific and trade journals were considered to be more important than journals of learned societies such as the institute of electronic engineering. Electronic, scientific and trade journals had a mean level of importance of 2.74, while journals of learned societies were less important with a mean of 2.35. This shows that the firms are much less reliant on the results of basic research from academia than other types of innovative firms.

The findings suggest that the internet is becoming more important as a source of information in small firms but it was rare to find firms carrying out routine systematic searches for information on the internet. As one MD said, the internet is scanned but only as "secondary follow-up" from other information sources. Nevertheless the internet makes an important contribution to the firms' ability to access new knowledge and information, with a relatively high mean of 2.57. This was ranked third in importance out of all of the sources that were surveyed. As well as use of the world-wide-web, the high mean for the internet probably reflects the increasing use of email to contact other important sources of information, such as customers. Section 5.3.4 shows that 18.7% of the firms gave a score of 4 or 5 for the level of importance attached to the use of email in relationships with their most important sources of information. The increasing importance of the internet does suggest that proximity is becoming less important to the small firm's ability to access certain forms of information.

5.3.1.5 Conferences / exhibitions

It was evident from the interviews that conferences and exhibitions play a key role for these firms in enabling them to access useful sources of information. Firms use the conferences to establish contacts that become sources of information in their own right. Conferences are important in allowing firms to glean information on their market position. This is reflected in the factual responses where conferences are ranked fourth as a source of information with a mean level of importance of 2.54. The only sources that were considered to be more important than conferences were customers, in-house sources and the internet.

Considering the high concentration of small IC firms in the Western Crescent, the LMR is not viewed by the respondents as being more important for conferences than elsewhere. Conferences / exhibitions were considered to be more important beyond the region. This was one of the largest spatial differentials of any source - a mean of 2.8 beyond the region compared to 2.28 for conferences within the region. This relatively large difference reflected a common response in the interviews, which was usually along the line of "I go to conferences all over the world." This suggests that the LMR is not particularly specialised in conferences and exhibitions for the IC sector, despite the relatively high concentration of firms from this sector in the region. It might suggest, however, that there is a role for regional policy in developing a capacity to provide conferences on measuring and controlling devices. These issues shall be returned to in the following chapters.

5.3.1.6 Competitors

The firms being surveyed tended to operate in close-knit niche markets. For example, one company said that it knew all of its competitors, of which there were three based in the UK. Even though the firms tend to know exactly who and where their competitors are, it was rare to find them collaborating and sharing information with them. The results in this analysis strongly suggest that competitors are not particularly important as a source of information for these types of firms. This dispels to some degree the myth that innovative firms rely on a fusion of ideas that are generated by clustering with competitors and like-minded companies. The firms do acquire information from competitors on market position. One MD said that he read about a competitor's product to "see how he could improve it." However, knowledge such as this was not considered to be important to the innovation process. Generally, competitors are more important as a source of information from beyond the region than within (a significant differential of 1.87 - 1.47). However, competitors are lowest in importance of all the sources that were considered with a mean of 1.67 in aspatial terms.

5.3.1.7 Consultants

It is widely acknowledged that the use of external consultants has grown and become more important to the process of innovation in general terms (see for example Wood, 1999). However, consideration of whether they contribute to the learning capacities of small innovative firms is a separate issue. The mean level of importance for consultants as a source of information was 2.09. This was the ninth most important source out of the twelve sources, with the same overall mean as contacts from past employment. The interviews in the first stage suggested that consultants were widely used. The MD of company D said that he employed two workers specifically to look for appropriate engineering consultants in the south. However, this was one of the few firms from the research who had employed consultants to carry out high value design work. A probable reason for this was suggested by the MD of the same company who commented, "work is too specialised for in-house development, making the cost of innovation very expensive." This was exemplified by another response which typified the attitude of the firms towards consultants:

> "we haven't collaborated with pure research companies because the cost of innovation would be huge, we tend to deal with small companies who are or can become small suppliers of ours. They have a vested interest with lowering their product development

> costs, but it is in our best interests to ensure that suppliers know nothing about our markets" (interview, company E).

Consultants are often used as inputs into the design process where specific expertise is lacking within the production or marketing departments of organisations. They are often used to carry out a specific job for the company. But this is not the same as saying that linkages with consultants are necessarily important information sources. They do not necessarily provide information to the workers in the small firm for the purposes of innovation. The majority of firms seemed to be suspicious of consultants, preferring to do their work in-house. Usually if consultants were employed it was for small-scale lower level work or specific jobs that would not contribute to the firms' learning capacities.

Generally, the firms were sceptical about the use of consultants but they realised that they may have some potential for the development of their products in the future. Moreover, because of financial constraints, the firms' use of consultants at best, can only be described as circumspect. The MD of company I said, "a consultant took me over to a local company to watch them install a system which might be important in the future and we have just started using management consultants who are based at the University of Hertfordshire." It seemed that the majority of work that the firms were doing with consultants was speculative and it was difficult for the interviewees to talk in terms of tangible benefits.

Unlike the findings on other firms, the information that the firms acquired from consultants within the region was more important than beyond. The mean level of importance inside the region was 2.17 compared to 1.95 beyond. This reflects the high spatial concentration of consultancy firms in the LMR in the context of the UK. The importance of consultants within the region is only a relative figure, however, because other firms are still more important as sources of information within the region. There is certainly potential for consultants inside the region to become more important to the learning capacities of these types of firms. This suggests that there is potentially a role for support mechanisms in enabling small firms to overcome the financial and information hurdles of using consultants.

5.3.1.8 Universities

In small IC firms basic research is usually less important and innovation is very much dependent on the responsiveness of firms in terms of their ability to adapt technology to changes in market specification. The link between academia and the IC industry in general is vital to technological development because fundamental scientific work is usually beyond the scope of manufacturing companies. However, this does not necessarily mean that linkages between the small firms in the sector and academia are strong because small firms tend to adapt technology developed elsewhere, usually in larger companies, for their own market ends. Universities only rarely make an important contribution to the small firm's ability to learn about the application of new technology. The reason for this was summed up by one MD of a firm developing a measuring device for wiring efficiency who said, "our work is fairly downstream from advances in academia." The MD of company D dealing with the regulation of power supply said that it did not have links with academia because academia tends to look at the "scope of electricity not control." Only one firm from the interviews (company A) had grown as a spin-off from research carried out in a university. This was Imperial College in London.

The firms were tending to deal with universities on very specific aspects of technology. Collaborative relationships with universities in terms of the joint development of products were rare and firms were more inclined to deal with universities on a commercial basis for training on the organisational side of development and more general aspects of product development. For example the MD of company L said that "training at University of Hertfordshire on production engineering has been very useful," while the MD of company O said, "we have worked with University College London, Cambridge and Brunel on new training for new manufacturing processes." Collaborations with universities were ranked eighth with a mean of 2.09 while training / seminars at universities were ranked eleventh with a mean of 1.72. This reflects the fact that information gained from collaborations is valued much higher than the more generalised information from training and seminars. This does not necessarily mean that universities are used more frequently for collaborations than seminars and training.

There was no significant differential between the importance of collaborations with universities within and beyond the region (a mean of 2.08 for within against 2.11 beyond). This reflected the responses from the interviews, where it seemed that universities were used

more on a national basis than at the regional level. Spatially, a similar result followed for seminars and training courses organised by universities and colleges. Here the mean inside the region was 1.69 compared to 1.75 beyond.

Collaborative relationships with universities are not especially region-specific but the results do not preclude the fact that national universities are significant. However, we need to bear in mind that it has already been demonstrated that universities are generally not important to the process of innovation for small IC firms. The use of universities nationally was exemplified by one interviewee who said,

> "we have used University of Hertfordshire occasionally and we have contacts there. We got involved with them on computational fluid dynamics with a couple of students doing final year projects although this did not lead to the resolution of the problem. We have also used Manchester university to test acoustic panels to meet local environmental standards" (interview company P).

When regional linkages with universities were found, they were not necessarily fundamental to the process of innovation. The MD of company F remarked, "we have worked with Surrey University, looking at a particular aspect of optics," The firm had also worked on projects at Loughborough University which it viewed as being moderately important to the process of innovation. Another interviewee commented,

> "most of the collaborative activity is in the UK, we have important connections with University of Salford, one of only two centres in the UK who have the know-how that we require, whether this is in Manchester or Hertfordshire makes no difference to the effectiveness of the collaboration, it is essential to our production process" (interview, company U).

Although collaborations with universities are more important as a source of information beyond the region they could not happen anywhere. As the MD of company M said, "when we've used universities it can be a day trip." With the sort of speculative development that the firm looks for from universities, it is unlikely that they would look further than the nation in accessing the required information, except in very exceptional circumstances.

5.3.1.9 Networking and training through institutions

For networking with other firms / individuals through business and trade bodies such as chamber of commerce, business link and trade associations, the respondents said that sources within the region were more important with mean level of importance of 2.27 compared to 2.05 beyond. Overall this source of information was ranked seventh, with a higher mean than collaboration with universities, consultants and contacts from past employment. This type of networking would seem to be one area where the region plays a relatively important role, with a ranking of fifth of all the regional sources of information (see **table 5.4**, below). A possible reason for this is the tendency for trade associations to be located in the capital. For example, the MD of company D said that the trade association in London had helped them to identify potential suppliers and public funding opportunities. There was a very limited number of examples of firms viewing the local Business Links as a valuable source of information. For example, one MD said, "Business link gave us a contact for venture capital, that got us off the ground and kept me under their wing for two years" (interview, company Q).

There was no significant difference to be found between the importance of training courses / seminars organised by trade associations and support services held within the region and those held beyond. These types of training and seminars had a mean of 1.87 in aspatial terms with a ranking of ten. As part of the evaluation of Hertfordshire's learning region project section 6.4.4 of chapter six will provide, through the findings of the attitudinal survey, some insights on why these firms do not generally perceive the types of networking and training courses offered by local support services to be of value.

5.3.2 The importance of regional sources of information

The importance of regional sources of information acquisition is now considered to see if there are any particular specialisations in the LMR. Experience from past employment was considered to be the most important source within the region with a mean of 2.88 compared to a mean of 2.61 for customers. The importance of such sources within the region and conferences / exhibitions which are the fourth most important, do not necessarily reflect a regional specialisation. The sources are important within the region because they are important as information sources for innovation generally. In other words, they are also very important in terms of information which is acquired from beyond the region. The regional specialisation of sources can only be analysed by comparing their ranking within the region

with that beyond the region. This is displayed in **table 5.4**, below. The table shows that the sources which are relatively more important inside the region are experience and contacts from past employment, networking and training through other institutions, universities and consultants. Other firms (customers and suppliers) are relatively more important beyond the region. The spatial dispersal of sources of information, measured by the spatial differential, is shown diagrammatically in **figure 5.3**.

Table 5.4: Regional specialisation of sources

Source	Mean level of importance (within the region)	Rank	Mean level of importance (beyond the region)	Rank
Experience from past employment	2.88	1	3.03	2
Customers	2.61	2	3.11	1
Contacts from past employment	2.51	3	2.33	5
Conferences / exhibitions	2.28	4	2.80	3
Networking through other institutions[1]	2.27	5	2.05	7
Suppliers	2.22	6	2.73	4
Consultants	2.17	7	1.95	8
Universities: Collaborations	2.08	8	2.11	6
Other training / seminars[2]	1.88	9	1.86	10
Universities: Training / seminars	1.69	10	1.75	11
Competitors	1.47	11	1.87	9

Notes: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each source's provision of information for each development area.
[1] Usually business and trade bodies such as chamber of commerce, business link or trade associations;
[2] Organised by trade associations and other business support services.
Source: Responses to survey
N=50

In assessing the importance of intra-regional flows of information, **Table 5.5** takes into account the contribution of all sources of information to all aspects of development within the

firms. Overall the region is less important in terms of the value of information acquired within the region than that which is acquired from beyond the region. This shows in very broad terms that the home region is not as important to small innovative firms as recent theories on innovation and space suggest. Again, it needs to be reiterated that this should be considered in the context of the innovation characteristics being analysed. The table shows that more important specific information, is spatially dispersed from the home region for these firms. To understand regional specialisations of information acquisition in more detail, however, the product development process needs to be broken down into the different aspects of development within the firms that contribute to innovation. The different areas of development associated with different forms of information then need to be analysed against the different sources of information.

Table 5.5: Spatial origin of all sources

Location of sources	Mean level of importance
Within the region	2.05
Beyond the region	2.15

Note: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each source's provision of information for each development area.
Source: Responses to survey
N=50

5.3.3 Information acquisition and the different development functions

This section provides a multi-level analysis of the spatial dimensions of information flows by considering different areas of development within the firms. The conceptualisation of the different types of information associated with the development functions was set out in section 4.6.1 of chapter four. The way in which they relate to the firms' innovation processes was analysed in section 5.2.5 of this chapter. The development areas are defined in terms of the information requirements that firms perceive as being important in moving them along the appropriate organisational and technological trajectories that lead to innovation and competitiveness. The respondents were asked to take into consideration how important each development area had been to product development. The respondents were then asked how

important the different sources of information had been to each respective development area, and whether the information had been acquired from within or beyond the region.

Figure 5.3: Spatial dispersal of sources of information

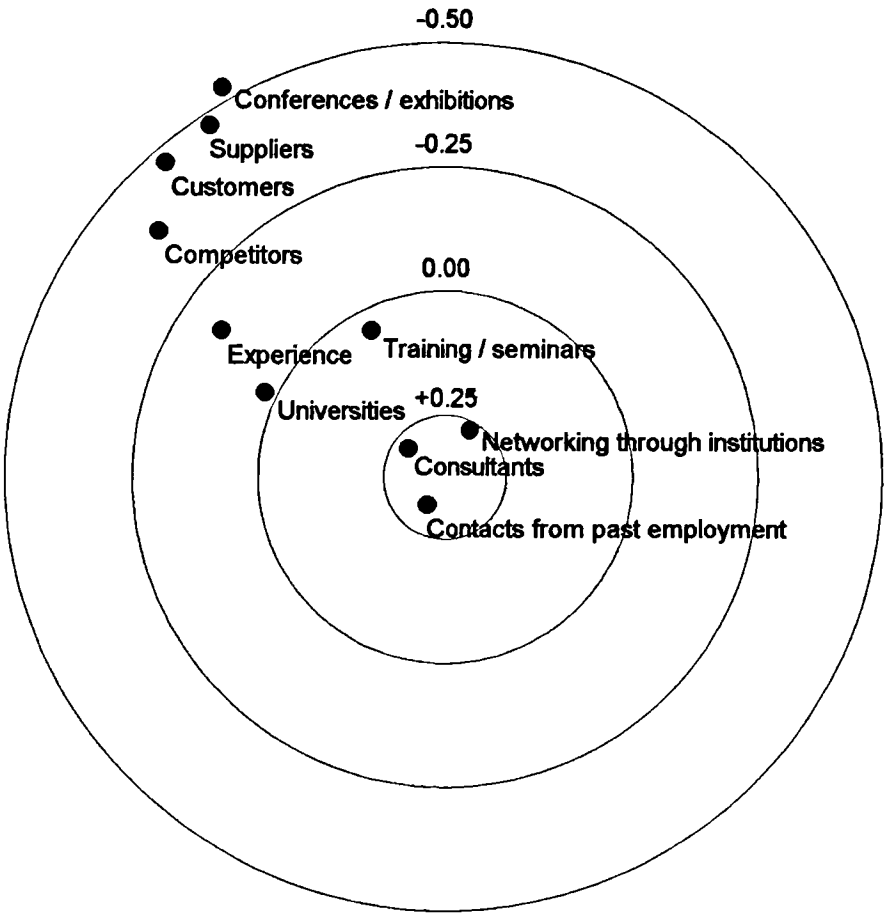


Table 5.6 shows the spatial differential between the mean level of importance for all sources of information in relation to each development area. This shows that the spatial differential between sources of information is lower on more general organisational aspects of development, those which are less important to the product development process in general. For example the differential for adapting technology for product development is (2.68 - 2.40), whereas for management systems it is much lower - (1.83 - 1.79). This shows that the more generalised information, which is valued less, is relatively more accessible at the regional level. Specific information, which is valued more highly, is more spatially dispersed from the home region confirming the first hypothesis.

Table 5.6: Multi-level analysis of the importance of all sources to each development area

Development area	Mean importance to product innovation	Mean importance of sources inside the region	Mean importance of sources beyond the region
Adapting new technology into the development of the product	3.96	2.40	2.68
Adoption of new technology for engineering and design purposes	3.54	2.31	2.58
Development of new management systems	2.46	1.79	1.83
Development of marketing / market research processes	2.56	1.98	2.06
Development of new processes and systems for distribution / stock control / scheduling	2.27	1 89	1.92

Note: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each source's provision of knowledge for each development area.
Source: Responses to survey
N=50

5.3.3.1 Analysis of sources in relation to the development functions

This section will show how the overall importance of sources relates to their contribution to different areas of development within the firms. The findings show that the customer is the vital source of information in enabling the firm to adapt technology for the purposes of

product development. We have already seen that the the adaptation of new technology was the most important development area. 51% of respondents stated that the adaptation of new technology was very important (a score of 5) to the product innovation process. 50% of these cases said the customer was a very important source of information. The interaction between the importance of adapting technology and the firms' access to information on market position was reflected by the fact that the customer was also considered to be an important source of information for marketing. For example, the MD of company D said, "we tend to build up our intelligence on the market by talking to our customers." This is reflected in the fact that the customer was viewed as being considerably more important in relation to marketing than other non-technological areas of development. As **table 5.7** shows, the mean importance for the customer as a source of information for marketing was 2.64. For scheduling and distribution techniques it was 2.18 and for the development of management techniques it was 2.1.

These findings confirm that the relationship with the customer develops into an important relationship for the small firm in terms of information acquisition on more organisational aspects of development. The findings show that of those firms that gave a score of four or five for the customers' level of importance as a source of information for the adaptation of technology beyond the region, one-third also gave these customers a score of four or five as a source of information for the development of their managerial techniques. One quarter of firms who gave customers beyond the region a score of four or five as a source of information for the adaptation of technology also gave a score of four or five to customers as source of information for their distribution and scheduling techniques.

The closeness of the relationship with the customer, which stems from the need to develop technology in collaboration, allows the small firm to emulate their customers on other aspects of development. Customers are viewed as important sources of information for the development of organisational functions because these firms have a propensity to emulate their customers. For example, the MD of company E said that they had emulated one of their customer's project management systems. The MD of company D said that his firm had learned a lot on the organisational side of business from a larger company in France. Although this relationship had been based on a technology venture, it had allowed the smaller company, to emulate the larger company on organisational matters. The MD said that the relationship had allowed his firm to cope with some of the "growth pains of business". According to the MD, this was one of the reasons why the company was relatively advanced for a small firm in terms of organisational development. For example, the closeness of this

relationship had encouraged the firm to adopt an ISO 9001 quality system relatively early, compared to the other firms that were interviewed.

Table 5.7: Multi-level analysis of the importance of sources

Development area	Adaptation of technology	Adoption of new technology	Management techniques	Marketing functions	Scheduling and distribution
	Mean level of importance				
Source					
Customers	3.36	3.16	2.1	2.64	2.18
Suppliers	2.72	2.62	1.76	1.86	2.41
Networking through other institutions[1]	2.35	2.30	1.92	2.32	1.89
Universities: Collaborations	2.68	2.45	1.39	1.44	1.57
Universities: Training / seminars	2.00	2.02	1.57	1.32	1.30
Conferences / exhibitions	3.02	2.79	1.92	2.15	2.09
Other training / seminars[2]	2.00	2.02	1.66	1.82	1.68
Contacts from past employment	2.61	2.55	1.95	2.29	2.11
Consultants	2.12	2.07	1.90	1.97	1.86
Competitors	1.73	1.73	1.37	1.74	1.54

Notes: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each source's provision of information for each development area.
[1] usually business and trade bodies such as chamber of commerce, business link or trade associations;
[2] organised by trade associations and other business support services.
Source: Responses to survey
N=50

Because firms have more important and closer relationships with customers beyond the region on technological issues, they also learn more from these customers on managerial issues and aspects of marketing and scheduling and distribution, than customers inside the region. This is reflected in **table 5.8** which shows that the mean levels of importance for all areas of development reflect the importance of the customer for information on technology beyond the region. While one interviewee said that "our relationship with our customers in the SE is vital because we have continual discussions with our buyers about future markets" (interview, company U), he also said that it was always vital to learn about future market needs from customers in Scotland. For marketing the mean importance for customers beyond the region was 2.86 compared to 2.42 inside the region. However, there was a smaller spatial differential on managerial issues where the mean for customers beyond the region was 2.26 compared to 1.94 inside the region. This was a differential of only 0.32 compared to 0.57 for the adaptation of technology. There was a similar finding for the supplier. In terms of the adaptation of technology the differential for the supplier was 0.87 (3.15 - 2.28) whereas on managerial issues the differential was much less at 0.37 (1.94 - 1.57). The relatively small spatial differential for the suppliers' contribution to information capture on scheduling and distribution (2.51 - 2.30) is in marked contrast to the customer's differential, which is much higher on the same development area.

Table 5.7 provides an insight into the relative importance of different sources of information in relation to different development functions in aspatial terms. We would expect the mean to be higher for each source on the technological side because these functions are more important to the process of innovation. The relative specialisation of each particular source becomes apparent when its relative contribution to each development area is considered. For example, as expected, collaborations with universities make a very limited contribution to the development of management techniques (a mean of 1.39) and marketing (1.44) in comparison to the contribution they make to the adaptation of technology (a mean of 2.68). In contrast, networking through institutions scores relatively highly on management (1.92) compared to other sources. Competitors score relatively highly on marketing (1.74) compared to the adaptation of technology (1.73) because they are more useful to the firms in terms of market position.

Suppliers were viewed as being relatively more important as a source of information for scheduling and distribution techniques than the customer. The mean level of importance of the supplier for scheduling and distribution was 2.41 compared to 1.86 for marketing and 1.76

for managerial techniques. This was higher than the customer's mean of 2.18 for scheduling and distribution whereas the supplier's mean for management techniques was relatively low compared to the customer's (2.1) and other sources. For example, in relation to management, the mean for networking through other institutions was 1.92, while for contacts from past employment it was 1.95. The relatively high importance of the supplier for scheduling and distribution reflects the fact that these firms can relate more easily to their suppliers on scheduling and distribution requirements than their customers. However, the firms tended to look to their customers rather than their suppliers when it came to acquiring information on the management side. Suppliers were considered to be less important on the technological side compared to customers. The mean for suppliers on the adaptation of technology was 2.72 compared to the customer's 3.36. Again, this needs to be observed in the context of the innovation characteristics being analysed. These firms are generally working much more closely with their customers than their suppliers, in relation to the adaptation of technology.

Table 5.8 provides a summary of the multi-level analysis on the spatial dimensions of information flows. The table confirms that where information is less valuable to the firms in terms of the process of innovation and more generalised, the region becomes relatively more important. For example, in relation to organisational functions, contacts from past employment within the region were considered to be more important than those beyond. On average firms acquired more valuable information from contacts from past employment on scheduling and distribution techniques within the region (a mean of 2.25) than contacts from past employment beyond the region (1.97). A similar finding followed for managerial techniques where the mean level of importance for contacts was 2.04 within the region compared to 1.85 beyond. With the development of scheduling and distribution techniques, 25% of firms gave contacts from past employment inside the region a score of four or five for importance whereas only 9% did for contacts beyond the region. This shows that the firms emulate ideas from their contacts from past employment more within the region than beyond in terms of the less valuable organisational functions. However, information gained on these functions is still more important from customers beyond the region.

As **table 5.8** shows, the importance of the supplier for scheduling and distribution was viewed as being higher inside the region than suppliers were considered to be for the adaptation of new technologies and the adoption of new technologies. In fact one of the largest spatial differentials for any source was information acquired on the adaptation of technology from suppliers. This was a differential of (3.15 - 2.28). There was a similar differential for the

adoption of technology - (3.08 - 2.16). This confirms that where suppliers are important as a source of knowledge for the adaptation of technology they have a high degree of spatial dispersal relative to the home firm. This also confirms that relationships with suppliers were of limited importance in terms of technological development within the region.

Table 5.8: Multi-level analysis of the spatial dimensions of information flows

Development area	Adaptation of technology		Adoption of new technology		Management techniques		Marketing functions		Scheduling and distribution	
	Mean level of importance									
	I	O	I	O	I	O	I	O	I	O
Source										
Customers	3.08	3.65	2.89	3.43	1.94	2.26	2.42	2.86	1.91	2.44
Suppliers	2.28	3.15	2.16	3.08	1.57	1.94	1.72	2.00	2.30	2.51
Networking through other institutions[1]	2.37	2.32	2.32	2.27	2.03	1.82	2.45	2.18	1.84	1.74
Universities: Collaborations	2.61	2.74	2.43	2.47	1.36	1.41	1.39	1.48	1.62	1.52
Universities: Training / seminars	1.90	2.10	1.90	2.13	1.47	1.66	1.34	1.29	1.34	1.25
Conferences / exhibitions	2.65	3.39	2.32	3.29	1.81	2.03	2.11	2.38	2.00	2.18
Other training / seminars[2]	2.03	1.96	2.07	1.96	1.82	1.50	1.86	1.79	1.64	1.71
Contacts from past employment	2.63	2.59	2.62	2.48	2.04	1.85	2.33	2.25	2.25	1.97
Consultants	2.17	2.07	2.07	2.07	2.04	1.76	2.07	1.86	2.00	1.72
Competitors	1.59	1.97	1.52	1.93	1.31	1.42	1.52	1.96	1.38	1.70

Notes: I - inside the region; O - beyond the region;
All means in the tables derive from a scale of 1 to 5 for the level of importance given to each source's provision of information for each development area.
[1] usually business and trade bodies such as chamber of commerce, business link or trade associations;
[2] organised by trade associations and other business support services.
Source: Responses to survey
N=50

The nature of the relationship between information acquisition and space for these firms was exemplified by the MD of company D who said that distance is not a hindrance with the "big things" but being close is very helpful for the "little things" such as dealing with a supplier to "change a capacitor if it is at the wrong angle." The "little things" are naturally less important to the process of product development generally. Changing a capacitor is an example of the sort of information that diffuses more easily from region to region. This means that it is more likely to be available in the home region.

As we saw in section 5.3.2 on regional specialisation, examples of sources of information where the region is more important are networking and training through business and trade bodies and seminars, consultants and contacts from past employment. Where institutions and firms are more significant as sources of information on adapting new technology to their products companies also learn more from these organisations than from regional institutions on the organisational side. However, firms seem to learn more from institutions at the regional level where they are less important on the technological side. The importance of regional organisations to less valued functions explains why certain sources are specialised at the regional level.

For example, networking through business and trade bodies is more important to the firms' acquisition of information on organisational development within the region than beyond the region. Apart from competitors, this was the only source where information gained on a non-technological aspect of development was more important than technology. On the whole firms considered learning on marketing techniques from this type of networking within the region, a mean of 2.45, to be more important than on the adaptation of technology, a mean of 2.37. This was an unusual result in comparison to other sources. A possible explanation for this is the role played by business support services in introducing small firms to marketing consultants. As one MD said,

> "we are working with a marketing consultant to see what we can add to our products to make them more niche market, this includes more environmental monitoring, we are looking for more opportunities as standards get tightened, we were given this contact through Hertfordshire Business Link" (interview, compnay G).

The firms also acquired more information from this type of networking within the region on managerial techniques where the mean inside was 2.03 compared to 1.82 beyond the region.

There was also a significant difference between information from training courses / seminars organised by trade associations and business support services within the region compared to beyond - a differential of 1.82 compared to 1.5. This shows that firms are not willing to travel as far for training on general, less important aspects of development. These types of courses are made available by local branches of trade associations and business support services without being specifically tailored to the needs of local industry. However, it needs to be emphasised that in the context of innovation generally, these sources are considered to be of much lower importance than customers and suppliers beyond the region.

The firms' use of consultants also demonstrates that regional flows of information are relatively more important when they come from more generalised sources of information. Perhaps surprisingly, given their increasing role in recent years, consultants are relatively unimportant for technological development, both in terms of its adaptation for the product and its adoption for engineering and design purposes. As **table 5.7** showed, consultants were one of the lowest in importance of all the sources for the adaptation of technology. On average consultants scored 2.12 for this area of development, compared to 2.61 for contacts from past employment. The differential in favour of the region was relatively large for consultants - (2.04 - 1.76) for management and (2.00 - 1.72) for scheduling and distribution. The importance of consultants for management compared to technology was almost much higher than other sources. This confirms that consultants are relatively more important for lower level information or speculative aspects of development. They are probably too expensive for technological issues.

Table 5.9, below, shows that sources of information become relatively more important to organisational areas of development within the region when they are less important in terms of the acquisition of information on the adaptation of technology. The number in brackets in the right hand column shows the ranking of the sources in terms of their relative importance to organisational development beyond the region. For example, customers are the most important source of information for the adaptation of technology. They also have the highest relative importance beyond the region on organisational aspects of development. The Spearman's rank correlation coefficient for the relationship between the source's importance to the adaptation of technology for the firms and the important of the source to generalised areas beyond the region is 0.67 for the first nine sources.

Table 5.9: Relationship between source's importance to the adaptation of new technology and its regional importance to organisational development

Ranking of sources' importance for adaptation of new technology	Mean spatial differential for management / scheduling / distribution
1	-0.425 (1)
2	-0.2 (4)
3	-0.29 (2)
4	+0.025 (6)
5	+0.235 (9)
6	+0.155 (8)
7	+0.28 (10)
8	-0.05 (5)
9	+0.125 (7)
10	-0.215 (3)

Notes: Spatial differential is the difference between the mean importance of each source from within and beyond the region. Where the differential is positive the region is more important than beyond the region.
Source: Responses to survey
N=50

5.3.4 Attributes of the most important relationships of information acquisition

The managing directors of the firms were asked about the attributes that characterised the development of their most important relationships of information acquisition with other firms. Questions about these relationships were set in such a way that the answers would provide an insight into the spatial dimensions of the relationships. The respondents were asked to refer to earlier questions on the sources of information in answering the questions.

5.3.4.1 Type of firms

There was a large differential between the mean level of importance for market-based relationships in comparison to non-market based relationships with other firms. Market-based relationships were considered to be of much higher importance than horizontal collaborative

relationships. In the interviews there was only a few examples of firms taking part in joint ventures to share ideas on new technologies or new forms of organisational development. Company F from the interviews had worked together with other companies from Germany and France on a particular aspect of technology to see if there was a way forward on design. The MD said that the purpose of the relationship was "to get the benefits of each others knowledge." However, this type of relationship was rare. Being in a relationship where the other actor is dealing in a complementary area of technology was also considered to be important. This was the second most important factor. Again, this reflects the importance of certain sources to the interrelationship between the adaptation of new technology and information on market position. The findings suggest that where the firms were dealing with another firm in a complementary area of technology it was usually a customer.

5.3.4.2 Origin

The findings showed that experience from past employment was of some significance to the development of these relationships with a mean level of importance of 2.86. This reflects the earlier analysis which showed that experience from past employment was important in maintaining and establishing links with important sources of information, particularly customers. Networking in current employment was generally considered to be of lower importance in the development of these relationships than experience from past employment.

5.3.4.3 Contact

The nature of the product characteristics and their development determines the extent to which firms need to be close to their important sources of information. As we have seen, these firms are usually dealing with the adaptation of existing technologies for specific market niches. Regular face-to-face contact is necessary for the exchange of information but firms do not necessarily need to be located in close proximity to their important sources of information. The findings suggest that not even monthly contact is vital to the relationships. The MD of company E said, "we go to the far east three or four times a year so it is not a problem. We don't mind travelling when it's relevant." Moreover, a mean importance of 1.93 for the low cost of travelling shows that regular contact is not essential to the firms' most important learning relationships. The use of email (2.26) to maintain links with the important sources of information was considered to be of greater important than the low cost of travelling (1.93).

This suggests that the cost of travelling is of limited importance in acquiring high value, specific, spatially dispersed information.

Table 5.10: Attributes of important relationships of information acquisition

	Mean level of importance	% of firms reporting attribute as ranking of 4 or 5 importance
type of firm		
Market-based relationship with a customer / supplier	3.7	63. 4
Non-market based relationship with another firm	2.33	8.8
The firm dealing in a complementary area of technology or production	3.43	63.2
origins		
Knowledge of the firm's activities from experience in earlier employment	2.86	35.1
Information on the firm from networking at conferences / seminars or other events	2.46	25.0
Networking with the firm at conferences / seminars or other events	2.37	25.0
contact		
Low cost of travelling to source of knowledge	1.93	6.8
Regular face-to-face contact (approximately at least once a week)	1.76	10.3
Regular face-to-face contact (approximately at least once a month)	2.72	35.1
Regular contact through use of electronic mail	2.26	18.7

Note: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each factor in the development of the relationships.
Source: Responses to survey
N=50

One MD did remark that the "the whole relationship could be improved if we were closer to our customers" (interview, company C). However, with customers spatially dispersed it would not necessarily be practical for the firm to move closer to any particular customer so that it can manage its relationship more effectively. Evidence from the interviews showed that when senior managers did travel they were out of the region and the country for long periods. Long distance travel which is necessary for information acquisition is an important aspect of the routine functioning of these types of firms. There was a significant difference between the importance of face-to-face contact at least once a week which scored a very low mean of 1.76 and the importance of monthly face-to-face contact which had a mean of 2.72. The need to meet at least once a month with their important sources of information becomes more important to the relationship than the use of email. This provides a further indication that proximity in regional terms is not considered to be a vital factor in the most important relationships for firms with these innovation characteristics. The next section will show that being near to good transport links is more significant.

5.3.5 Access to information and location

The importance of external knowledge acquisition in explaining the location behaviour of firms is analysed in this study by comparing the importance of external sources of knowledge within the region, listed in **table 5.2** earlier in the chapter, against other factors that contribute to the firms' reason for being tied to their region. This raises questions about the importance of inter-organisational flows of information within the region in comparison to other more tangible factors in the location behaviour of firms. The firms were asked what the important factors were in keeping them located in the region. The mean levels of importance and rankings are displayed in the **table 5.11**. The empirical observations suggest that the firms do not re-locate because this would affect their ability to innovate. Access to good transport links is important because it enables the firms to co-ordinate aspects of information where sources originate from beyond the region.

In most cases it was very difficult for the interviewee to pin down the precise reason for the company being tied to the area. The qualitative responses showed how the firms became aware of the benefits of location after settling into the area. For example, one MD from the interviews said,

> "I started the company and I lived in the area but other factors were still important. There was an assumption that there was a high degree of skilled labour in the area. In terms of transport I became aware that Stansted and the M1 were vital. Holding on to my present staff is very important and we have formed important linkages in the area since we started" (interview, company R).

Another MD said,

> "The company would not move from its location in Hertfordsire because of the impressive surroundings that looks good to customers. The location, in national terms, is also very important. The need to hold on to specialised labour is important as there is a difficulty in getting replacements for specialised calibrating work. The managing director's contacts in London are vital to market success where a big percentage of business is done" (interview, company D).

Table 5.11: Reason for staying in the region

	Mean score	Ranking	% reporting reasons as 4,5
Need to hold on to specialised labour	4.44	1	87.6
Accessibility to good transport links	3.65	2	58.6
Availability of skilled labour in the area	3.53	3	57.7
Quality of the environment (in terms of the general amenity of the area)	3.28	4	52.2
Access to external sources of information in the region	2.23	5	15.4

Note: All means in the tables derive from a scale of 1 to 5 for the level of importance given to each factor.
Source: Responses to survey
N=50

The research findings suggest that the need to hold on to specialised labour is the most important reason for firms staying in the region. This had a very high mean level of importance of 4.44 (see **Table 5.11**). As one respondent from the questionnaires remarked,

> "the company has no requirement to remain tied to the current area other than the domestic requirements of key staff. We certainly receive no incentive to remain from local organisations."

The MD of company O responded by saying, "the reason we stay here now is for our staff and customers. Our main customer is situated in the SE of England," while the MD of company J said, "I work here because I live here, customers are not important."

The high mean importance for the need to hold on to specialised labour suggests that the quality of life in the outer area of the LMR is an important factor in attracting and keeping specialised workers. However, this does not necessarily give rise to a pool of specialised workers that match the requirements of the industry because the availability of skilled labour has a much lower mean of 3.53. This reiterates that the labour market is not necessarily a region-specific interdependency despite the high concentration of these firms in the region. The nature of the recruitment process in the firms suggests that availability of skilled labour at the regional level is not a particularly important issue in keeping firms in the region. This reflects the importance of experience gained within the region which was lower than experience gained beyond the region. Although there has been a contraction of large scale industry in some areas of the Western Crescent such as the defence-dependent sectors in Hertfordshire, the availability of skilled labour is viewed as being less important than one might have expected. Only one firm representative from the interviews mentioned that the pool of labour from the defence industry had been important. He said,

> "these days it is lot easier to recruit the skills we need. Towards the end of the 1980s it was a lot harder. Labour has become available because companies such as British Aerospace have shed labour" (interview, company E).

However, one interviewee specifically stated that the expected increase in the pool of local labour from the British Aerospace redundancies had not come to fruition. Another commented, "London (North) was traditionally an optics area so there was a lot of trained labour in the area initially" (interview, company X), but it was rare to find firms saying that they were attracted to the area by labour market traditions. Holding on to specialised labour is more important in terms of tying firms to a particular area. As the MD of company K said "the reason that we don't move is simply inertia." Once the workers are established in the area it becomes very difficult, because of family and other social ties, for the firms to relocate. As

one MD said, "I have lived here for 20 years; I wouldn't want to move" (interview, company J).

The mean value of importance attached to good transport links was 3.65. This was the second highest mean for any factor contributing to the reasons for firms being tied to the area. The airports are of particular importance. As the MD of company C said, "being close to Gatwick, Heathrow and increasingly Stansted are vital to us saying in the area." In certain cases the good motorway links were considered to be important for intra-regional travel: "we have been doing a lot of work at Farnborough, the M25 makes this very accessible" (interview, company Q). Good transport links were considered to be vital to the firm's selling ability: "Good transport access for sales staff is more important than access to universities etc. sales are a day-to-day activity whilst development of new techniques etc is not" (interview, company J). The importance of good transport links is nevertheless important in enabling the firms to acquire information from beyond the region, both in national terms and international terms. Good transport links enable the firms to co-ordinate a complex network of information flows, the most important of which, as we have seen in previous sections are spatially dispersed to their own location. There were numerous examples of firms relying on good access to the international airports.

The factor which was considered to have the lowest level of importance was access to external sources of information in the region. The mean for this factor was only 2.23. There were only a few examples of firms being tied to the area because of the need to maintain an ease of access to sources of information. It is difficult to identify any particular spatial dynamic behind relationships of information acquisition with regionally-based customers. This is because the interviews did not display any qualitative distinctions between the firms' relationships with customers inside the region and those from beyond the region. The region can be more important when the relationship is based on home regulations but this is more of a nation-specific factor. There were a few firms who dealt with central government offices in developing regulations. In these cases being located in the LMR would have been of some benefit but it does not necessarily suggest that being near to London was vital to the relationship. Often linkages with customers, despite being important learning relationships both in terms of technology and the market, are not particularly important in keeping firms in the area. This was exemplified by one interviewee, who said, "we have customers and suppliers nearby but they do not keep us in this area" (interview, company P).

In one of the smaller firms from the interviews the development of its main product revolved around the managing director and a colleague who assisted him. Although it was considered to very important to adapt the product to the needs of the customer, the adaptation of technology developed in partnership with a local supplier was also considered to be vital to the firm's process of product development. The technology being adapted was an embedded personal computer. In terms of information acquisition the MD of company Z considered the most important relationship to be with a supplier in a nearby town who produced the embedded PCs. The MD said, "we recognise the application and we try to implement solutions on PCs that the supplier produces." Despite the importance of this relationship the MD could only say that it was "jolly nice" that the supplier was based just down the road but he did not consider this relationship as being vital to the firm staying in the area as he said, "I doubt it would tie us to the area."

In certain cases the information linkages within the region might be more appropriately described as local or town-specific rather than region-specific. This is particularly true of relationships with the two big universities in the areas surrounding Cambridge and Oxford. As one respondent from the questionnaires commented, "the company has a strong relationship with the Institute of Biotechnology at the University of Cambridge, moving away from Cambridge would make communication (with this institute) more difficult." However, in general terms, long-term relationships with universities are the exception rather than the rule for these firms. One MD said that Imperial college had been a natural feeder for his firm and that they spoke to them on regular occasions. However, this was only one firm from the interviews that had grown by the process of spin off from a university. This was a product which was based on the findings of a doctoral research degree at the University of London.

Earlier in this chapter a spatial distinction was made between the region and nation-specific assets. However, we also need to recognise the difference between the region and the locality and the arbitrariness of regional boundaries when we come to consider the learning region as an explanatory framework. This demonstrates why it was important to operationalise the region in relation to the firm as well as including Greater London. As one MD remarked in the questionnaire, "Milton Keynes has an excellent business infrastructure, great location, good transport links and we benefit by links with Cranfield and De Monfort Universities."

The linkages with local support services only generally became more important after firms had become established in the area. The MD of company Z said that linkages with Business

Link and the University of Hertfordshire had become very important in the development of cellular manufacturing and would definitely be an important factor in their reason for staying. However, a common response to the question about business links was that they could be found anywhere. The MD of company Y commented, "Business Link is extremely useful but you can find them all over." The region-specificity of the programmes offered by business support services would depend on the input to the programmes by local businesses and whether this input was specific to the region. It was extremely rare to find firms talking about programmes that were specifically designed for local industry.

5.4 Summary of findings

The findings show how the spatial dimensions of the information flows can be related to the innovation characteristics of the products. For these firms the interaction between information acquired on market position and the adaptation of technologies are vital resources for innovation. For this reason the customer is the most important source of information that is recombined with information gained in past experience. The relationship with the customer is vital for experimentation with the scope of technology as well as its market application. The importance of the customer also reflects the position of the firms on the value chain where they are usually producing for other firms rather than final consumers. Although the firms have many linkages with local suppliers these are not as important as suppliers beyond the region and customers.

Generalising about the power implications of the firms' relationships with their customers is problematic. However, it was rare to find firms relying on one customer and being a responsive servant of that customer rather than a pro-active entity with a knowledge-base that is vital to the product's development. The firms and their customers are learning from each other about the scope of technological adaptation and market application. The relationship with the customer can therefore be described as a collaborative relationship. This means it is an important learning relationship.

The findings suggest that the customer is not only important as a source of information to the development of technologies but also because this relationship allows the smaller firm to acquire information on other aspects of technological and organisational development.

Customers were viewed by many firms as mentors on aspects of organisational development such as management and scheduling and distribution. The firms look to their customers, usually larger firms, as a benchmark for dealing with organisational development. Suppliers are an important source of information for scheduling and distribution techniques because the firms were able to relate more effectively to their suppliers on these aspects of development.

There was little evidence to suggest that competitors or other forms of horizontal collaboration were generally important to the innovation process. Collaboration on technological development at the regional level is of limited importance, with universities rarely being used for R&D purposes. Developing instruments and control devices in collaboration with universities is the exception for small firms in this sector. The adaptation of technologies that are relevant to these firms is usually far removed from scientific and technological development in universities. Universities were marginally important for more general training requirements on the adoption of technology for process development and managerial techniques. Dealings with universities on specialised technological aspects and general training requirements could not necessarily be described as region-specific and are probably more specific to the nation.

Those sources where the region was relatively important were also those sources where more specific information on technology was less important overall. The region becomes more important where sources are viewed as being less important generally to the process of product development. This can be explained by the spatial dimensions of different types of information acquisition, both in terms of the type of development area within the firms and the source of acquisition of the information. Higher valued, specific information is more spatially dispersed while generalised information is more accessible to the firms at the regional level.

Analysis of the attributes of the most important relationships of information acquisition for the firms confirmed that market-based relationships dealing with the development of technology were most significant. This also confirmed that horizontal collaborations with other firms were of limited importance. Weekly face-to-face contact and the low cost of travelling were not considered to be important. However, there was a much higher mean rating of importance for monthly face-to-face contact.

In terms of the factors that keep firms in the area the importance of external sources of information was viewed as limited. The need to hold on to specialised labour, which in turn

relates to quality of life factors and access to good transport links were of greater importance to the firms in keeping them located in the LMR. An important reason for firms staying the region is the good transport links associated with London which enable them to access information from beyond the region.

The idea of a learning region where inter-organisational flows of information are important to the process of innovation within the region therefore appears to have limited explanatory value in terms of the experiences of small, innovative IC firms. This demonstrates why the learning region is not a location theory and why it is a policy framework that needs to be evaluated. The question that needs to be addressed is whether the application of the learning region as a policy framework can lead to innovation through the more efficient use of generalised sources of information. This is the theme of the following chapter.

6

The Learning Region Policy Framework in Practice: Lessons from Hertfordshire

6.1 Introduction

The previous chapter showed that market-orientated networks were the most important sources of information acquisition for small, innovative firms in the IC sector. The nature of information flows externally to the firms was related to the innovation characteristics of the products in question. The findings showed that customers were important, not only to technological adaptation and market position but also to more generalised aspects of information such as management techniques. A pertinent issue, therefore, at the time of the introduction of the English Regional Development Agencies (RDAs), particularly because there is ambiguity over how they will relate to existing business support infrastructures, is the potential role of regional support mechanisms (RSMs) in enabling small, innovative firms to acquire information more effectively from other organisations.

Section 5.3 in chapter five showed that, despite exhibiting a regional specialisation, existing networking and training support mechanisms are of low importance to small, innovative firms. There are three possible reasons for this which need to be examined. The first is that current training and networking ventures at the regional level are not particularly relevant to the needs of the firms. Secondly, they are under-utilised. The third possible reason is that existing support mechanisms are not exploiting the existing knowledge-base of the region to maximum effect. The firms were moving in the right direction along the appropriate trajectories of development but this does not necessarily negate the importance of RSMs in enabling them to move more effectively in the future or in enabling them to move on to new technological and organisational trajectories.

This chapter therefore focuses on Hertfordshire County Council's recent attempts to foster learning capacities amongst its small firm community. The context for the development of its

learning programmes is provided by the county's Bright Green Industrial Strategy (Hart et al, 1994). This strategy highlights the importance of the small firm sector and the lessons learned from the role of public sector support mechanisms in other countries. The main part of the chapter is a description of Hertfordshire's learning networks programme. An evaluation of the impact of the programmes in terms of firm behaviour would require a longitudinal study. This has not been possible because of the time limitations of this project. This evaluation will therefore also aim to identify gaps in the data and provide suggestions on how further evaluations might be carried out. These will be discussed in the concluding chapter. The methodology for this stage of the research is set out in section 4.7.4 of chapter five.

The major caveat of this analysis is that it is focusing on one particular economic development project. It provides a case study example of how policy programmes within certain administrative boundaries are attempting to encourage small firms to capture information through dissemination and collaboration. We have seen in the previous chapter that the participation of small innovative firms in such programmes is likely to be constrained by reliance on existing information networks that transcend local and regional administrative boundaries. However, a particular case study provides us with lessons on how such policies might be developed at different spatial levels, taking into account these existing constraints. The case of Hertfordshire also conforms to the second hypothesis of the research which postulates that generalised sources of information are more accessible at the regional level. In terms of the policy conclusions we need to consider how policy mechanisms might be able to provide more specific sources information to small innovative firms using various spatial levels of implementation.

The analytical basis of the chapter is the extent to which Hertfordshire's programme conforms to the elements of the learning region policy framework set out in section 3.7. Following on from this we need to consider its relevance to the development of innovation potential in small, innovative firms. A useful way of evaluating the programme is to consider why there was such a low rate of participation from innovative firms in the county. The final section in the chapter therefore focuses on the reasons why the small, innovative firms analysed in the previous chapter were largely sceptical of the learning region concept.

6.2 The potential role of regional support mechanisms

The regulatory forms that underpin the relationship between central and regional support mechanisms have a bearing on the ability of the latter to generate new learning processes for businesses at the regional level. In the UK local authorities have operated within regulations and budgetary guidelines which, in comparison to countries such as France, Italy and Germany, are relatively subordinate to the overall direction of national policy. Regional and local policy initiatives, particularly in the UK, have come to depend on funding mechanisms decided by negotiations at the national and supranational level. ADAPT projects that deal with the adaptation of workers in SMEs to industrial change and KONVER that deals with the economic reconversion of defence dependent areas are two examples of EC funding programmes, where money is allocated through central government departments. In this context recent UK government have viewed the region as a receptacle for funding rather than a more dynamic and proactive entity in the formulation of economic development strategies (Boland, 1998).

The restructuring of industry in recent years is nevertheless one of the reasons why there has been a universal re-evaluation of the relationships between local, regional and national governments in the field of economic development. The increasing diversity of regional economic structures and the disproportionate spatial concentration of innovative industry and growth has brought to the fore debates on the role of regional governance in the development of innovative activity. Proponents of the learning region ideal, which is underpinned by the idea of region-specific untraded interdependencies and regional innovation systems, outlined in chapter three, contend that the region should have a more prominent role in the direction of economic development policy. They would argue that RSMs are in a better position to provide training programmes, which can cater specifically for industry at the regional level and encourage a local culture of networking relationships, business conventions and rules, that take into consideration the specific characteristics of the regional economy.

Advocates of a more regionalist approach to economic development policy have argued that while certain institutions at the regional and local levels are either beginning to take on "greater responsibility for the prosperity and trajectory of their regional economies" (Di Giovanna, 1996, p.374) others should be given greater autonomy in the future (Morgan, 1997). Section 3.7 argued that the political dimension of the learning region is based on

greater responsibility being given to the region in deciding the direction of policy. In the light of the findings from the previous chapter, this chapter will provide some further evidence on the potential for RSMs to take on greater responsibility for the trajectories of their economies in the future.

6.3 From technopoles to learning regions

In the conclusion to their wide-ranging exposition on the *Technopoles of the World*, Castells and Hall (1994) called for vision and imagination in areas of policy that attempt to develop more advanced forms of economic development:

> "Though there are general frameworks for policy, which are ignored at their peril, these are broad in nature: they allow, and even compel, a great deal of local variation depending on the specific national and regional circumstances. It is for each nation, each region, each city, to work out an appropriate strategy, with as much vision and as much imagination as it can conjure up" (Ibid., p.250).

By describing the historical routes of the most successful growth poles, such as Silicon Valley, and, comparing them with the failures, such as Akademgorodok in Russia, and looking at the varying degrees and types of intervention, the authors came to the conclusion that there is no single all-embracing policy prescription. The nature and degree of planning involved in the development of "technopoles", the term used to describe the phenomenon of knowledge-based industrial development within spatially defined areas such as regions and cities, has varied according to the specific socio-political and economic characteristics of the areas concerned. Castells and Hall showed that support mechanisms for high-tech industry must be adaptable to an area's specific circumstances.

Castells and Hall therefore concluded their study by highlighting the need for vision and imagination in regional and national strategies of high-tech growth. This is something which the county of Hertfordshire, situated to the North of London, has alluded to in publishing its "Bright Green" strategy for industrial development up to the year 2011. 'Bright Green' is a long-term strategy aimed at facilitating knowledge-based industrial development (see Hart et al, 1994).

6.4 The case of Hertfordshire

6.4.1 Background

The underlying theme throughout the "Bright Green" report, Hertfordshire CC's industrial strategy, is to reconcile the objectives of economic development and environmental quality. By analysing the recent history of Hertfordshire's economy, evaluating its current climate, and then considering alternative scenarios for the future, the strategy attempted to set a realistic vision of Hertfordshire's potential for future development. It acknowledged the long-term rise of an economy from one based on mass production to one which, as well as being dependent on the provision of services, is dominated by a knowledge-based, post-mass production sector. This is reflected in one of the conclusions from the report which stated that

> "one particularly important - and appropriate - way for an area like Herts. to compete in economic terms is to add value to goods and services by means of the deliberate and systematic application of knowledge" (Ibid., p.108).

The emphasis on the application of knowledge showed that the council is keen to present Hertfordshire as a county where businesses are able to learn and adapt more effectively.

As part of the background analysis to the Bright Green strategy the authors carried out a study on the strengths, weaknesses, opportunities and threats (SWOT analysis) of Hertfordshire's economy (Ibid., p.29-31). In the section on opportunities the authors pointed to the potential for growth in the small business sector as an economic recompense for the contraction of large-scale industry. Much of the increased unemployment in the county in recent years has been a result of the redundancies from large companies. This is reflected in the unemployment rate for the county, which rose from 2.1% in 1989 to around the national average of 9% in 1993 (Annamanthodo et Geddes, 1995, p.5). The Bright Green report described how the 1990s' recession had accelerated underlying changes in the structure of the Hertfordshire economy that were already taking place. The most far-reaching of these changes was the rundown of defence-dependent industry. In 1995 Hooper et al wrote,

> "recently, Hertfordshire has experienced a substantial reduction in the size of its traditionally strong manufacturing base. Many of the local job losses have been in the defence-related and aerospace industries. These job losses are the result of cuts in

> defence spending under Options for Change, the recession in the economy and in the civil aerospace industry, industrial restructuring and relocation to lower cost areas" (Hooper et al, 1995, p.13).

Under weaknesses, the Bright Green strategy singled out the skill mismatch in the labour market and the inflexible workforce in the small firm sector as areas which need to be addressed in future policy. Both of these claims about the state of the Hertfordshire economy have emphasised the importance of the small firm sector as a source of future knowledge-based growth. Moreover, the report accepted that the most effective way of nurturing growth in the small firm sector would be through public-private partnerships. This argument was underlined by examples of public-private partnership in well-documented European regions such as Emilia-Romagna in Italy and Baden Württemberg in Germany.

These ideas were reiterated by Annamanthodo and Geddes' (1995) report to the County's Planning and Environment Department on trends, issues and strategies in the Hertfordshire economy:

> "although large firms are still important in the local economy, Hertfordshire needs to strengthen its small firm sector as its significance increases. A successful business strategy aimed at developing the knowledge economy would include this size of firms as a priority group" (Ibid. p.13).

Annamanthodo and Geddes went on to suggest that "support must be targeted at knowledge-intensive industries, where there is innovation and a higher proportion of added value" (Ibid.). The importance which Hertfordshire CC attaches to its small firm sector reflects the decline of its large-scale defence-dependent manufacturing.

The Bright Green report commented on the effects of deindustrialisation and the possibility of nurturing new sources of employment in the county. The changing structure of the British economy, from one based on manufacturing to one where services are the predominate source of economic development, has been well-documented (see for example, Champion et al, 1987). There is a danger that the British economy has become too dependent on its service sector as a source of employment, and there is a strong case for believing that the application of information technologies in manufacturing should be given greater policy focus. It was suggested that the way in which a county such as Hertfordshire could respond effectively to

the problems of globalisation was not only through the development of its service sector but also by facilitating newer industries producing high-quality, specialised products (Hart et al, 1994, p.108). The report rightly acknowledged that innovation is not only dependent on large-scale systematic R&D, but also small scale innovation in niche markets where the adaptation of new technologies is vital. These are the types of firms that were the main research focus of this study.

6.4.2 Support mechanisms: experience from other countries

Case studies of successful regional economies, such as Emilia-Romagna and Baden Württemberg, have shown that public or quasi-public sector agencies can act as providers of information to facilitate the process of product development. A potentially important role for RSMs is to identify potential opportunities for the exchange of information and to raise awareness of the possibilities of collaboration. The previous chapter showed that local and regional agencies have had a limited role in performing this task for small IC firms in the LMR. The thinking behind the learning region policy framework, as discussed in chapter three, is that there is potential for RSMs to encourage collaboration by exploiting any critical mass of firms where common interests exist.

Experiences from regions in Europe have shown that the public sector's role must be laid by a strong partnership with representatives from the private sector. A successful partnership involves the public sector adapting to and understanding the needs of local industry. Long-term partnership between the private and public sector is recognised as central to the development of support mechanisms. The nature of the private-public relationship found in areas such as Baden-Württemberg and NEC Italy was described in Hertfordshire's industrial strategy (Hart et al 1994, p.92):

> "A partnership is not a short-term, intermittent meeting of public organisations and private firms largely proceeding in isolation from each other but occasionally agreeing - it is much more about fashioning a common purpose and systematically pursuing it, often over a period of decades."

For example, the relationship between the higher education sector and industry works more effectively if it is reciprocal. In Grenôble, an area renowned for its advanced engineering sector, one of the foundations of innovative performance is said to be the strong links between

universities and business. The universities have been able to meet the needs of local industry by being more responsive and evolving with its development. A recent demonstration of this evolution was the creation of the School of Industrial Engineering in Grenôble in 1991 (Bernardy, 1993, p.118). The school was established in response to the development of the engineering sector in the area.

Another region where the relationship between the HE sector and industry has been crucial is the Swiss Jura Arc which has recently seen its industrial base convert from watchmaking to microtechnology. The introduction of microtechnological engineering courses at the region's five technical colleges has helped local engineers to adapt their engineering skills from watchmaking to the new more high-tech applications. Maillat et al (1995, p.255) put the introduction of the new courses down to "growing awareness and collective actions" in the region. These institutions do not necessarily provide the advanced, high value knowledge that is needed to make firms internationally competitive. They do, however, support the process of innovation. The Grenôble and Swiss Jura Arc cases demonstrate the importance of institutions that are able to respond to the needs of local industry through strategic awareness.

Recent UK governments have been eager to promote the use of local support mechanisms. According to the DTI (1994) firms need make full use of local TECs, trade associations and employers' organisations to increase their awareness of training options. However, as well as being responsive to the needs of local industry, local institutions must also be able to market their services effectively so that firms can be aware of their functions. The government in Denmark has been particularly successful at promoting an awareness amongst the small firm community of the possibilities of collaboration (Huggins, 1996, p.525). The aim of the Denmark government has been to establish synergy between local authorities and the business community. Here, the development of local networks for small firms has been actively encouraged by the national government. The networks have been developed by training 40 experienced industry advisors to act as network brokers to find areas of common need within the small firm community. Early evidence suggests that the network programmes in Denmark have worked successfully. As well as 3,000 companies submitting proposals for grants from the programme, 1,000 have entered "spontaneously" without applying for grants (Ibid., p.523). The "growth-group" concept is one dimension of the programmes that has worked particularly effectively. The groups consist of 10-15 firms working on a particular aspect of the innovation process which is beneficial to all participant firms. The groups met approximately 10 times over 18 months (Ibid., p.525).

The inter-firm networks in the well-documented regions of Baden-Württemberg and NEC Italy, have been supported by firmly established institutional support mechanisms. An institution of particular importance in the region of Baden-Württemberg in Southern Germany is the Steinbeis Foundation (Cooke and Morgan, 1991, p.28). The foundation facilitates the dissemination of state-of-the-art technical knowledge to small firms through colleges, universities and polytechnics on a for-profit basis. The trade associations and the chamber of commerce, which fall into the category of quasi-public institutions, also play an important role in disseminating industry-wide analyses for small firms (Morgan, 1992, p.162). In contrast to the UK, however, the German chambers of commerce are part of a nation-wide network with all firms being legally obliged to join. With plentiful resources at their disposal the German chambers are in a position to provide sophisticated commercial and technical service, including technology transfer and training. According to Hassink (1993) Baden-Württemberg's high degree of political autonomy has enabled it to create a technology transfer network that is transparent to the business community. This contrasts sharply with the UK's record of co-ordination at the regional level where different agencies have competed with each other for funding. It remains to be seen whether the new RDAs will be able to co-ordinate support mechanisms more effectively.

The Chambers in Baden-Württemberg have assisted in the integration of small firms into wider networks of information sharing, making high quality information both "accessible and affordable" (Morgan, 1992, p.162). According to Sabel et al (1987, quoted in Morgan, 1991, p.161), the success of Baden-Württemberg is based on a collaborative approach to innovation, achieved through a number of different mechanisms such as:

- horizontal collaboration among firms in complimentary product markets, through for example, collectively sponsored facilities for research, marketing and training;
- vertical collaboration among buyer-supplier networks;
- an innovative support infrastructure consisting of a wide range of private and public bodies which specialise in technology transfer, business information and technical consultancy.
- a robust regional innovation policy on the part of the land government.

A problem that a county such as Hertfordshire has had to contend with in terms of policy transfer is isolating the role of support mechanisms in other nations and regions. As Porter (1990) argues, the problem with learning from successful regions is that they are the most

difficult to duplicate. The success of Baden-Württemberg and NEC Italy, the two examples cited in Bright Green, is based on a complex interaction of sociological, cultural and economic factors. The extent to which innovative support mechanisms have influenced these factors is difficult to determine. Attempts to isolate the scope for possible policy transfer from Baden-Württemberg and NEC Italy is made even more complicated by the fact that these two regions are characterised by very different industrial structures. One can begin to disentangle the complexities of policy transfer by looking at the socio-institutional context of policy in the region as well as the cultural disposition of indigenous firms towards participation in collaborative projects.

Culturally, the single most important factor in the success of Baden-Württemberg is the population's strong orientation towards science and technology. German industry has a cultural disposition towards the production of sophisticated machinery and complex production processes. This is supported by a skill base geared to the production of these types of products. The structure of the companies is often hierarchical, reflecting characteristics of the German family. The owner has a "close and enduring" relationship with employees and tends to be involved in all aspects of the work. The hierarchical structure of German companies supports the technical orientation of the industries (Porter, 1990, p.107). The reason for this is that, like NEC Italy, there is also a strong tradition of generations of families working in the same industry. Technical knowledge therefore tends to be passed on from generation to generation. Closely related to this is the strong and sustained commitment by workers and managers to their industry.

All of these factors tend to encourage a culture of collaboration but as Hassink (1996, p.300) points out, many authors have stressed that the role of support mechanisms in Baden-Wurttemberg should not be overestimated. Hassink suggests that the role of RSMs is more as reactors to the production capability within the region than as pro-active agents in developing strategic awareness of organisational and technological development. But as the Hertfordshire industrial strategy demonstrates, they have nevertheless, been viewed as regions where lessons can be learned for public policy on small firms and innovation.

According to Hertfordshire's Bright Green report (Hart et al, 1994, p.92), the Emilian Regional Government in part of NEC Italy has been an important catalyst in the development of inter-firm relationships and growth. NEC Italy is distinguished by the political culture of 'clientelism' (Storper, 1993, p.436). This has its roots in church, class, and family-based

political institutions. The conventional wisdom is that secure political stability slows down economic development by impeding market adjustments and factor mobility. However, in NEC Italy, extremely rapid growth and political stability tend to go hand in hand (Ibid.). The political stability in different sub-regions of NEC Italy has facilitated open negotiations on economic matters. The long history of technical schools in the region and its egalitarian traditions have also been important factors in the cultivation of an entrepreneurial culture in the region (Ibid.). Although the region is distinguished by clusters of very small firms, the production systems have been described as "something akin to multi-product organisations" (Ibid., p.437). As we saw in chapter three, the internal institutional arrangements of these multi-product organisations are based on deep-seated social relationships. As Storper goes on to contend, "work, entrepreneurship and participation in NEC Italy cannot be understood by looking at the individual in the labour market, but must be analysed in terms of the individual within the family unit, in relation to labour and product markets" (Ibid., p.438).

6.4.3 Learning networks in Hertfordshire

Section 3.8 showed that one of the ideas at the core of the learning region policy framework is the development of collaborative mechanisms between firms as well as between firms and policy actors. The importance of collaboration on technological know-how was acknowledged by the last Conservative government towards the end of their term of office. This was highlighted in their white paper on employment and growth which stated that "the exchange of technological know-how and best practice between firms raises the general level of performance and prosperity" (DTI, 1995a, para.11.10). This was also underlined by the "winning" report on the top 100 companies in the UK, which stressed the importance of firms being able to learn from others (DTI, 1995b). Up until then the Conservative government had tended to emphasise the importance of atomistic competitive practices. Policy-makers began to take note of the fact that where firms do not realise the benefits of collaboration the public sector has a role in specifying particular projects which bring firms with common interests together. The 'learning networks' project in Hertfordshire, which exemplifies this idea being put into practice, will now be examined.

Hertfordshire County's TEC has been implementing programmes that are designed to develop "learning cultures" within the county's small firm community. In their successful application for funding from the ADAPT 1995-1997 programme Hertfordshire stated that they will aim to develop "flexible training programmes" which meet the needs of small firms, thus enabling

them to adapt their management methods and working patterns, and the development of networking and mutual support mechanisms amongst small firms to promote the "learning region" concept. It was reported in the County's Economic Development Policy Panel, held in March 1996, that the EC ADAPT programme would aim to develop a system of learning networks whereby SMEs would be able to share expertise and experience and assist each other in the development of shared solutions to shared problems. Hertfordshire TEC launched the Learning Organisation Network (LON) programme in August 1996. The programme consisted of a series of events designed to disseminate new ideas about the value of continual transformation within organisations to enable the firm to develop its ability to cope with global change.

This research is examining the "learning region" from the perspective of small, innovative firms. Drawing on ideas from the literature on the learning region, section 3.8 of chapter three described an interpretation of the main components of a learning region policy framework. The final stage of the research, consisting of interviews and action research on the implementation of a "learning region" project, was completed in order to understand whether "learning region" projects, which encourage collaboration, can contribute to the learning capacities of small, innovative firms. The assessment of Hertfordshire's project will therefore be combined with an assessment of attitudes towards its learning region initiative from the small IC firms interviewed in the first stage of the research process.

At the start of the project Hertfordshire TEC agreed a number of outcomes with the ADAPT unit at the Department for Education and Employment (DFEE). The outputs were listed on the Project Scope Document which resulted from the meeting with the DFEE. A description of these outcomes was considered to be the most appropriate starting-point for the evaluation. The mentoring programme is considered on top of the LON programme because it was a major spin-off from the LON seminars and became a programme in its own right. The outcomes are listed below.

- Learning Organisation Network (LON)

- Participation from 40 managers, 20 from SMEs.
- Innovative new support mechanisms
- 15 SMEs under threat from rapid change committed to the learning organisation concept

- **Mentoring**
- Approved / accredited mentor development programme
- 20 trained mentors with appropriate certification
- 80 mentees matched to appropriate mentors

There are two ways of assessing whether new networks have been created by the programmes. The first is to consider whether support mechanisms have continued beyond the funded period of the project. The second is to analyse the pay-off to participant firms in terms of whether collaborative relationships between firms have been initiated.

6.4.3.1 Learning organisation network (LON)

The overriding objective of the LON was the establishment of five learning networks for SMEs and trainers. According to the project co-ordinator, the aim of the five networks was to provide mechanisms for the dissemination of best practice and mutual support mechanisms, aimed at developing the concept of life-time learning amongst SMEs. By the end of the funded period of the project in December 1997 five networks had been established. According to the project co-ordinator, the networks attempted to answer the three fundamental questions that need to be answered when approaching new learning processes. First, the question of "why change?". This would be particularly important for firms that are already successful, such as the ones that were considered in the previous chapter. The co-ordinator said that this is what participants need to ask when looking at a new topic like mentoring. The "what's in it for me?" question was answered through a number of learning forums with trained facilitators. The "how?" question was approached through a range of practical workshops. The events, forums and workshops are demonstrated by the diary of events held at the TEC. However, not all of the networks lasted beyond the funded period of the ADAPT project. Details of the five networks are now provided.

The 'LON' is Hertfordshire TEC's principal network developed for the purpose of knowledge and information exchange. By the end of 1997 35 separate learning activities, aimed at developing the concept of the LON, had been organised. This is demonstrated by the diary of events and evidence of attendance held in the portfolio folders at the TEC. Because there was no industry-specific context to the programmes, the early seminars were focused on general organisational issues relating to the meaning of the learning organisation and its potential implementation. One of the speakers at the launch of the LON was a management consultant

with an international reputation in the field of learning within business. This is an example of how international best practice on more generalised aspects of production were being disseminated at the local level.

The 35 events attracted 62 members to join Hertfordshire's LON, the records of which are kept on a database at the TEC. The database consists of company and contact information and details of meetings and evidence of the company's specific interest in developing their learning capabilities. The database also has details of members' useful experience that might be utilised in further LON events and sessions.

The 'learning forums' grew from the LON and developed around a number of group meetings where participants could come together to discuss areas of mutual interest. Key themes discussed included team learning, career planning, performance competencies and benchmarking. Again, this provides an example of how forums were being set up on generalised areas of development. This shows that there was lack of networks specific to particular sectors.

In the 'learning action set' a well known international writer and practitioner on learning in the workplace led a practical workshop on the subject of how to benchmark an organisation's progress in becoming a learning organisation. Following positive feedback from participants, further networking events were held on this particular subject. Although it did not last for the duration of the project the network served its purpose in responding to particular demands raised in the early LON meetings.

There was no defined target for the number of private sector firm participants, let alone what would usually be described as innovative firms. This was demonstrated by the 'learning schools' network where the TEC were working alongside an international author and management consultant, to promote the development of a learning culture within schools. Alongside these network events a number of meetings were held with representatives from local schools on 'Investors in People in Hertfordshire Schools'. Following these meetings the document 'Special Quality in Schools' was published in April 1998.

The 'mentors' forum' developed as a monthly meeting place for mentors to come together to share ideas. The details of this network are set out in the section on mentoring below.

The database of subscribers held at the TEC showed that 270 people had attended LON events until the 'Investors in People and the Learning Organisation' event held in July 1997. Estimates from July onwards suggest that at least a further 40 individuals attended the events. The database showed that the majority attending were managers or directors. A large proportion of those listed in the database attended more than one event. At the time of writing information on the size of firms was not available. However, it is reasonable to assume that more than 20 came from organisations with less than 50 employees which was the original target for the TEC. The private sector, particularly high-tech firms, was underrepresented at the events with most firms coming from the public sector and voluntary organisations. From the database of firms that had attended only one firm was found that could be described as innovative using the conventional definition of acknowledged high-tech sectors. One of the concerns expressed in the customer impact survey[1] was that many of the events had a 70% / 30% balance in favour of public over private sector participants. There were a number of firms who considered this to be a disincentive to attend future events. Section 6.4.4 provides a number of insights into why it was so difficult for the TEC to attract more innovative firms to the events.

Feedback from the initial events in the LON suggested that emphasis on organisational needs rather than the network itself discouraged some individuals from further involvement. The original idea to set up a learning organisation network therefore evolved into the concept of the learning network. This showed that the participants were willing to work together as well as attend seminars that aimed to disseminate new ideas. According to the co-ordinator of the programme, the aim of Hertfordshire's network was to develop a platform for individuals in local businesses to come and try at low cost some new ideas in the ways that they can develop themselves and their people. The feedback from the events, made evident from the summary of evaluation forms, indicated that participants had been highly satisfied that new ideas were being displayed in the network sessions.[2] After the network was set up it became apparent, through feedback from the participants, that there would be a need for different levels of learning, not only group activities and events but also self-managed learning and one-to-one support.[3] Accordingly, two levels of support mechanisms have been organised.

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[1] This was an in-depth survey of outcomes for client organisations who had participated in the LON up to May 1997. The 15 firms were a representative sample of organisations participating in the programmes.

[2] Level of satisfaction with new ideas scored consistently between 7 and 10 with an average of approximately 8 in the evaluation forms for all the events.

[3] Interview with project co-ordinator.

The first of these is the resource centre situated at Hertfordshire Business Link. The resource centre accommodates learning at the self-managed level by offering email, internet, CD rom facilities and IT support. For those who prefer physical information there are books, magazines and press cuttings and a stock of video tapes and multi-media elements that is building up on a gradual basis. The resource centre was set up because evidence from feedback forms to the initial events found that about 18% of participants preferred learning through the self-managed route. Although it is too early to assess the impact of the resource centre on its users it does demonstrate that tangible support mechanisms can be developed from feedback generated at the initial networking sessions.

The second mechanism is individual support for all LON users. TEC / accredited advisors have been appointed to help clients when problems arise in the implementation of organisational techniques. This shows that the TEC are aiming to develop sustainable support mechanisms. Their aim is to maintain contact with local businesses beyond the funded period. There is also the potential for the TEC to act as facilitator by introducing participants to other firms who have managed to overcome similar problems.

One of the aims of the network had been to encourage 15 SMEs under threat from rapid change to become committed to the learning organisation concept. There is some evidence in the form of qualitative statements from the Customer Impact Survey and event feedback on the question of whether companies are under threat. However, this is a very difficult to measure unless workers are right at the point of redundancy. Anecdotal evidence from the interviews with project co-ordinators indicated that there are one or two examples of participant firms facing imminent closure but there was no written evidence of this.

If Hertfordshire are to be successful at moving towards the concept of the learning region, as they stated in the original bid for funding for the programmes, it is important that institutions involved in the projects develop collaborative relationships with other organisations. The main examples of collaboration involved organisations from the public sector and in particular the TEC at the level of policy development. There was very little evidence of practical collaboration in the private sector. In 1996 the TEC joined the European Consortium of Learning Organisations (ECLO). One of the co-ordinators of the project from the TEC was invited to their annual conference in the south of France. This was attended by 100 individuals interested in developing the concepts of learning organisations and learning networks. A number of outcomes came out of the ECLO conference, two of which were specific for the

next round of bidding for the ADAPT 2 programme. Hertfordshire TEC now have transnational partners in Portugal at EGOR a management consultancy, and relationships and an agreement with Guinness in Ireland with whom the TEC are working on team learning.

The co-ordinator of the network project had meetings with a Professor from Leiden University in Holland who according to the co-ordinator is a "major thinker on knowledge productivity." Along with the professor, the TEC worked with two academics from Durham University Business School to put together a Knowledge Productivity Seminar. This took place in November 1997. The TEC has developed further outcomes for the next ADAPT bidding round from this seminar as well as what was referred to as an Open Space Dialogue on the subject of Employability. This was held at the TEC in February 1998.

Representatives from Hertfordshire TEC also met with transnational partners from the Canaries and East Germany. The co-ordinator of the projects at Hertfordshire TEC made a number of presentations to them while they were in England in September 1996. As a result of these meetings the East Germans are now setting up a learning network and are seeking support from Hertfordshire TEC to help them to implement this under a future ADAPT programme. In December 1996 the co-ordinator went to the Canaries to attend an event on sustainability in their local economy and to present views on how learning networks could be set up.

In terms of the development of learning capacities the programmes need to be evaluated on the basis of individuals and/or organisations' experience of implementing new ideas gained from the events and activities and the TEC's support mechanisms. A Customer Impact Survey on the LON programmes was carried out in May 1997 to assess, through a qualitative evaluation, the effect of the events and activities on job and organisation behaviour. The survey showed strong support for the LON to go on developing its portfolio of learning activities and services. The survey showed that 50% of participants were intending to establish a Learning Organisation framework with their employees. However, a common response in the survey of 15 organisations was that it was too early to identify specific outcomes. Also, with a limited number of organisations taking part in the survey it was difficult to be conclusive on the pay-offs from the networking events. There was some evidence from the survey that the participants used each other to gain ideas but this was only on a very limited basis. For example one said that "I have been able to apply an idea back in my organisation gained from a like-minded participant, namely how to use suppliers to

identify market opportunities" (Customer Impact Survey). There was a general acceptance in the survey that the firms had been able to gain useful feedback from established organisations who had led the seminars.

6.4.3.2. Mentoring

The Mentoring programme which developed as a spin-off from the LON activities provides a good example of how a programme can develop as the result of a reciprocal process between local business and the TEC. This also provides a good example of how firms can work together on a specific aspect of knowledge. Mentoring was originally set up as a separate event from the LON, through a number of breakfast seminars held at Hertfordshire TEC, but it only took off because the LON events were used to promote the benefits of mentoring. Mentoring has been defined as "off-line help by one person to another in making significant transitions in knowledge work or thinking" (Megginson and Clutterbuck, 1995). The Mentoring programme grew to be a major contributor to the LON activities. The principal objective of the mentoring programme in the original project scope document was the development of a mentoring service, with 20 trained mentors, for 80 individuals under possible threat of redundancy.

The initial research on the professional backgrounds of the mentors suggested that it was unlikely that there would be a great uptake of NVQ units. Hertfordshire TEC therefore decided to run a mentoring course in conjunction with the European Mentoring Centre, a leading authority on mentoring. The mentors' directory at Hertfordshire TEC shows that 48 mentors have completed the Mentor Training Programme. In view of the fact that 48 mentors now have certificates of attendance at the mentoring sessions, it is reasonable to assume that there are at least 80 mentees attached to mentors which was the original objective of the TEC. The number of mentees is difficult to monitor due to the complexity of multiplier effects in companies with trained mentors. However, anecdotal evidence and evidence from the Customer Impact Survey showed that companies are keen to implement mentoring programmes. For example, through the training of two mentors, one company have been able to train 13 more mentors who are now attached to 1 or 2 mentees. This demonstrates how knowledge diffuses through the organisations.

The Customer Impact Survey had indicated that mentoring formed a key skill area to be developed with 75% of participants requesting further assistance from the LON and in

particular through learning forums. A Mentors Forum has since been set up by the TEC. This now forms part of the ongoing support provided by the TEC and runs on a monthly basis. The purpose of the forums is to enable mentors to come together to exchange ideas, experience and best practice in keeping with the learning region ideal. Mentors attending the monthly forums had attended at least one of the mentoring programmes. The forums had been attended by an average of approximately ten mentors in the first year of the project. A web site on mentoring was also created by the TEC.

In December 1997 Hertfordshire TEC held an event called "Celebrating Mentoring" attended by 32 people from the Mentors Directory. The purpose of the event was to shape strategies for the future. A leading authority on mentoring, from the European Mentoring centre spoke at the event. The TEC has also been involved in a number of transnational activities in relation to mentoring. They have exchanged know-how with ITC of the Canaries through a number of seminars at the TEC. The co-ordinator of the mentoring programme at Hertfordshire TEC spoke at the European Mentoring Conference in November 1997. Hertfordshire TEC also participated in a Steering Group with the European Mentoring Centre and other academic partners to formulate an NVQ for mentoring.

The Customer Impact Survey showed that customers saw mentoring as a key skill area to be developed with 75% of participants requiring further assistance from the LON. Although 2 of the 15 survey respondents said that they had implemented a mentoring programme it was too early to provide any more information on specific outcomes. This was confirmed by the responses on the outcomes of the programmes which suggested that more time would be needed to assess the impact of the progammes on job behaviour.

The LO and mentors programmes showed how more generalised, organisational aspects of information were being made available to the small firm community. This information could benefit the small firms that were analysed in the previous chapter although they would certainly perceive it as being of lower value than the information that they acquire from their existing networks. The following section attempts to explain why these types of firms were not attracted to Hertfordshire's programmes.

6.4.4. Explaining the low level of participation from innovative firms

The case example of Hertfordshire shows how the learning region policy framework is being developed in practice. In the light of the findings from the case study, we also need to consider why these types of programmes did not attract small, innovative firms from the area. The face-to-face interviews in the first stage of the fieldwork provided an opportunity to obtain some initial insights into the potential value of such networking ventures for small, innovative firms in the Hertfordshire County. After the launch of Hertfordshire's programme I asked the managing directors of the IC firms for their opinions on the aims and objectives of the Hertfordshire learning region project. The potentiality of networking ventures for these small, innovative firms was tested by asking them to draw on their own experiences of mutual support mechanisms and networking. Hertfordshire TEC's concept of the learning region was put to the interviewees and they were then asked a number of questions relating to governance issues surrounding the development of learning networks.

The findings suggested that the constraint of time is a very important factor in explaining why the MDs would not send their staff to networking seminars. The MD of company M remarked, "time is always important for small businesses so it would need to be focused." The interviews suggested that there is an important trade-off between the time that the company would commit itself to such programmes and the quality of the information that they perceive as being available. The MD of company L said, "it's good idea as long as companies have the time to get involved." Overall 75% of the interviewees said that the question of time would be an important factor in their decision to participate in such a scheme.

Many of the managing directors said that the networks would need to be focussed from the beginning. The Hertfordshire networks were certainly not focused on the specific needs of groups of firms in the early stages. The MD of company L commented, "if it's going to work firms need to know that it works." It was highlighted in the examination of the networks in section 6.4.3 that there had been no industry-specific context to the programmes. It was apparent that most of the interviewees would need to convinced at the onset of the programmes that the networks would lead to tangible benefits for their companies.

68% of the interviewees from the first stage of the research said that it would be important for the networks to be relevant to current training needs rather than long-term needs. The MD of company M said that there would be a danger of seeing it as "a pie in the sky" project if it

focused too much on long-term issues. The MD of company Y said, "a lot of the management guru stuff comes out as being very irrelevant but if its distilled in the right way some of it can be quite good." The MD of company I said, "it sounds like a good idea if not a bit utopian." The evidence did, however, suggest that being able to communicate with other firms when they experience day to day problems would be of some benefit. For example, the MD of company X said his company was experiencing day-to-day problems with software for scheduling purposes and would be very willing to exchange ideas with other firms who had successfully implemented the adoption of the software. An example such as this suggests that the potential for local inter-firm learning certainly exists on lower level issues.

The interviewees were more optimistic in their appraisal of the potential of local networking on more general organisational aspects of production. However, there would still need to be a clear project focus. The MD of company N remarked, "it might be helpful to talk to other companies about ISO 9000 but I can't see it being vital." The MD of company Y said it would be helpful to talk to other companies on the question of space and the problem of obtaining relocation grants: "if other people had space problems like us it would be useful to talk to them about the availability of grants and assistance to relocate." The MD had said that he was continually looking for information on grants and money. The same MD also agreed that it would be helpful to learn about the implementation of ISO 9000 from companies who had been successful in its adaptation. The MD of a small firm with seven employees (company P) said that his firm could learn a lot from other firms on marketing image, admitting that their premises were "a bit of a mess." This again demonstrates the potential for firms to learn from each other on areas of development that are not necessarily viewed as being vital to the innovation process. The potential for cross-fertilisation is therefore apparent but the low participation rate of these firms in the Hertfordshire projects still suggests that the implementation of such projects for small, innovative firms remains problematic.

A common theme in the interviews was the need for workers in small innovative businesses to become more versatile. The availability of greater support for small firms through networking might help to alleviate the common 'chicken and egg' problem where small firms such as these cannot grow without skilled staff but cannot afford to pay for the staff without growing. As the MD of company D remarked, "it would be a tremendous asset to get my sales manager in with six other sales managers in front of a top trainer."

The interviewees were asked about the type of partners they would prefer to network with in such seminars. A number of respondents stated specifically that they would not want to work with workers from other sectors. 81% of the interviewees said that the success of the network would depend on the firms dealing in broadly the same technological field. The MD of company G said that a club was being set up for businesses in the local area but the list of members had mainly consisted of small service businesses. This was seen as being irrelevant to his needs. It would seem that cross-fertilisation between firms within a shared culture of industry might be a useful way of utilising current labour particularly where firms have financial problems with the recruitment of more specialised staff.

The interviewees were asked whether a financial inducement would encourage them to participate. There were mixed responses to this question. For example, the MD of company L said that a 40% grant for completing a BSI standard was vital to their decision to go ahead. This was a subsidy of £2000 out of the total cost of £5000. However, the MD of company N said, "subsidies can water-down the whole impetus of the thing." Overall 60% of the interviewees said that subsidies would be a important factor in encouraging them to participate.

The potential for developing more informal networking relationships that develop beyond the formalised networking seminars appears to be, as the MD of company J suggested, "a long shot". Another admitted in candid terms that "we're very anti-social, the only closely related thing we belong to is the BSIA (trade association) which we tend to use for information rather than meetings" (interview, company Q). The MD of company I suggested that a local network would only work with a clear project focus and a finite life-span and that there would be little chance of informal relationships being developed from the sort of networks that Hertfordshire were encouraging.

There were only a few firms who said that they would be prepared to collaborate with potential competitors. The extent to which firms would be willing to share experiences is certainly constrained by competitive secrecy. The interviewees' responses displayed a general scepticism towards the idea of sharing experiences and ideas with firms that might be potential competitors. On the question of collaborating with competitors, the MD of company D looked astonished when I asked him about the possibility: "we want to put them out of business, why would we network with them." He went on to say that seminars with potential competitors "would inhibit open-talking". When asked if they would be prepared to share

information on the development of processes with potential competitors only 16% said that they certainly would. However, in a small area like Hertfordshire it is unlikely that firms would be asked to share ideas with firms who are in direct competition. Most of the small firms in the IC sector were dealing in niche-type markets with very few, if any potential competitors in the region. The findings presented in section 5.3.1.6 of chapter five showed that the competitors which the firms did acquire knowledge from were mostly located beyond the region.

Although there was enthusiasm towards the idea of learning networks, the interviewees displayed a general scepticism towards the concept of learning networks actually working for small firms in Hertfordshire. In certain cases this scepticism was based on experience. The MD of company R said, "I did a lot of this sort of thing in the United States but there was not much common ground between the firms taking part." In Hertfordshire's case the programmes were evolving over time because the development of the programmes was a response to feedback from the original seminars. In other words they were demand-led. The lack of a clear project focus at the beginning therefore partly explains why the TEC had not been successful in encouraging small, innovative firms to participate. This is despite most of the firms seeming to like the idea in principle. The MD of company P said, "there is an important need for more access to best practice and ideas from academia." On the question of mentoring the MD of company X said, "there is a real potential for small firms to be mothered by large firms but not too big as they might bully us."

The MD of company V said that he had had lots of experience with business clubs. He said that when firms are dealing with similar technology they never give anything away and that he preferred things to have an immediate use rather than being long-term. He said that he was a member of the M25 group of instrumentation firms where there was "a reasonable flow of information and knowledge on current research and development work." He went on to say that it was difficult to measure the effects but that those type of clubs lead to a general increase in awareness and experience. The club consisted of monthly meetings throughout the academic year for two and half hours each. This sort of view was reflected by the findings in chapter five where networking through intermediate institutions within the region was shown to have some value although it was very rarely seen as being vital.

The same MD said that he had been to many clubs. However, networking events in the region and the development of personal relationships beyond the networks had never happened to him

yet. He went on to say that he had never travelled further than 20 / 30 miles for one of these sorts of clubs. On the question of developing long-term relationships he said that it can be rewarding transferring information and said he "would not have a problem with anyone phoning him about the use of the internet, for example." Another MD said,

> "there is always some value in the cross-fertilisation of ideas. If we were affiliated to some industry association which involved cross-fertilisation of ideas I'm sure that would be useful but if it was not based in the region I'm sure we wouldn't be interested" (interview, company E)

71% of the interviewees said that it would be important to have these types of networks in the region rather than elsewhere. This suggests that any experience of clubs and associations had usually been locally-based. The MD of company E said that if it was not in the region his firm would not be interested.

The responses suggest that a clear understanding of firms' needs and objectives is crucial as well as a good marketing strategy to communicate the benefits of networking to potential participants. This is likely to depend on the abilities of networking brokers and the need to develop relationships with the firms who might benefit from participating. For example, the MD of company I said that the network would be of value if it led to collectively sponsored research within the industry. He believed that it would work only if the firms were involved from an early stage so that they could contribute to the design of the projects. This suggest that an industry expert would have to take the lead in the early stages to raise awareness. A number of respondents said that there should be a great deal of common ground within the IC sector but there was also a large number of firms who said that they were too specialised. The MD of company E said, "the area we're in is very unique in terms of technology so it would be hard to find areas of common ground."

Overall, the interviews suggested that the creation of formalised networking processes for innovative firms is a possibility. The governance issues surrounding the network would have to be thoroughly examined. The success of the programmes would appear to depend on targeting specific areas of common interest on technology and processes. There is also the problem of encouraging already successful firms to embark on new projects. The MD of company C said that his firm was already "leader in a specific market niche so it is unlikely that a mentor can come in and teach us in any technological or market sense." In certain cases

firms were already initiating the types of projects that Hertfordshire TEC were involved with. As the MD of company C said, "we already have mentors from the US". This raises questions about the role of both national and regional policy in implementing training programmes when firms are already looking abroad to acquire new skills.

6.5 Conclusions

The learning region policy framework which emerged from debates that were considering the importance of region-specific untraded interdependencies in regions of strong innovative performance, has paradoxically been implemented in Hertfordshire with little involvement from innovative firms. In moving towards the concept of the learning region Hertfordshire County Council, through the local TEC have been implementing a learning network programme in order to develop their strategy for knowledge-based industrial development. The learning network has been successfully implemented in terms of the TEC's own objectives with over 300 people attending 35 learning network events. 62 individuals have subsequently joined the learning network register. A number of innovative support mechanisms have been established including forums, self-learning facilities and individual support. Customer surveys suggest that the participants were highly satisfied that new ideas were being displayed at the network sessions.

Through dissemination to transnational partners and contacts with experts established during the projects, the TEC have been able to develop a number of outcomes for the second round of bids from the European Social Fund ADAPT initiative. This has demonstrated the continuance of the projects through the development of collaborative relationships beyond the funded period of the project. To this end, the ADAPT programme has been a learning process in itself for the TEC by helping them in the delivery of further programmes as well as future bidding rounds. The Mentoring programme grew from the LON activities and has subsequently become a major contributor to the Learning Network projects. There are now 47 trained mentors on the TEC's mentors' directory and the Mentors Forum has grown into a network in its own right. The projects focus on organisational aspects of learning. There was little evidence of firms collaborating and sharing information that was subsequently utilised in the workplace but relationships with the TEC have been developed and support mechanisms set in place.

The enthusiasm shown towards the LON by organisations responding to the Customer Impact Survey, the number of LON members and the transnational outcomes demonstrate that the projects have been sustainable for the funded period. However, it is too early to assess the long-term effects of the projects on job behaviour. It is too early to tell whether networks, which were established in the first year of the project, will be sustainable in the long-term and how well the information transferred in the programmes will diffuse through the companies involved. This would require a long-term research project which is not possible in the time-span of this study.

The findings from this chapter and the previous chapter show that there is potential for RSMs to increase the learning capacities of innovative firms by making information available in the region. There are two reasons for this. Firstly, the findings from chapter five suggest that more generalised sources of information are more accessible to firms at the regional level. Secondly, the findings on the Hertfordshire project showed how new ideas and best practice can be distilled to local firms. However, the findings also suggest that developing the social capital for such programmes to succeed can only happen in the long-term. The development of effective regional learning networks will undoubtedly take time. The evidence also confirmed what Lorenz (1992, p.198) had observed where firms usually "prefer co-operation for reasons of long-term self-interest, but co-operation nonetheless flounders on lack of information and distrust about the intentions of others."

A revealing factor is the very low level of involvement of firms from the acknowledged high-tech sectors, particularly small, innovative firms. Insights into the reason for this came in the second part of the chapter where small, innovative IC firms displayed a general scepticism towards the implementation of Hertfordshire's learning programmes. The evidence demonstrated the problem of making network models from other countries generalisable, particularly when there is a low degree of spontaneous networking from firms already locked on to existing paths of development. Most of the firms were unaware of the TEC's work on the learning region framework. Even if they were aware of the programmes their participation would be constrained by time as well as uncertainty over the direction of the programmes. Moreover, there was no evidence to suggest that a general disposition to collaborate exists between innovative firms in the region. This is the case even when there is potential for the most successful export-orientated firms to learn about aspects of organisational and development that can ultimately lead to improved innovative performance.

The 'learning region' programmes being developed in Hertfordshire have so far fallen short of the types of programmes that might result from the implementation of the learning region policy framework developed in chapter three. There was little evidence of collaboration in the private sector leading to the exchange of information that would enable firms to survive by being innovative in the global economy. Moreover, the programmes were not based on any strategic awareness of particular sectoral needs which are spatially concentrated in the Hertfordshire county. This is reflected in the generalised nature of the information being made available and the low rate of participation of innovative firms. In terms of responding to the needs of innovative firms the 'learning region' initiatives demonstrate the limitations of programmes based in a confined geographical area such as Hertfordshire. These issues will be addressed in the following chapter.

7

Conclusions and Challenges for Policy

". . . power does not disappear, but becomes a matter for negotiation through a whole set of interactions - between global flows, cultural identities, and institutions and firms, now operating as networks. In such a society, we need a counterbalance to all these abstract flows of money, knowledge and culture, so dominant over our everyday existences . . . And that counterbalance will come from the solid anchoring of identities and human values in the institution of civil society" (Castells, 1997).

7.1 Introduction

The overall aim of this study has been to evaluate the proposition that region-specific untraded interdependencies, in the form of shared conventions and rules that lead to inter-organisational information flows, are an important asset for innovative firms and an important factor in their location behaviour. The research has focused on the methods and routines that small, innovative firms utilise in acquiring information from external sources to combine with information acquired from other sources for their means of development. The findings of the research have shown that the learning region, which adopts the concept of untraded interdependencies, is limited when being used in the context of explaining innovation processes in small firms in the London Metropolitan Region. However, it is recognised that this does not preclude the role of learning region policy initiatives being examined further in the future. The research has highlighted an important distinction between learning based on path-dependent technological development and the potential role of regional support mechanisms in providing information that might lead on to new paths of organisational development for indigenous firms.

A review of theoretical developments, presented in chapters two and three, showed that more attention needs to be paid to the relationship between innovation characteristics and performance and the spatial dimensions of how different forms of information are acquired

from external sources. The role of the region in relation to information flows was analysed by adopting two broad approaches. Firstly, the study considered the spatial dimensions of information flows in relation to small innovative firms in the IC sector. The case study was used to analyse the nature and importance of external sources of information within the region compared to sources beyond the region. The spatial attributes of the firms' most important relationships of information acquisition were considered as well as the role of regional sources of information in relation to the location behaviour of firms. To illustrate the application of the learning region ideal, the study has also considered the development of a learning region project, using the county of Hertfordshire as a case study. The purpose of doing a policy study was to examine current initiatives on learning networks in response to the analysis of how small, innovative firms acquire information over space.

This concluding chapter will synthesise the main arguments of the study and offer challenges for future policy development. The first section returns to the hypotheses that underpinned the research process, that were described in section 4.1 of chapter four. The next section draws on the findings of the research from chapter five and chapter six to consider the implications for policy development. This takes into account the changing institutional context of regional economic development policy and in particular the potential role of the new Regional Development Agencies (RDAs) that have recently been introduced in England.

7.2 Theoretical implications

The first section of this concluding chapter addresses the three hypotheses that underpinned the first two stages of the research. These were concerned with explaining the spatial dimensions of information flows in small, innovative firms.

7.2.1 Caveats of the research

The types of external linkages that give rise to information capture depend on the nature of the innovations that firms are dealing with. However, this can be viewed as a circular or path-dependent process. While the sources of information that firms draw on depend on the type of innovation that they are dealing with, firms will innovate in different ways because they acquire information from certain types of sources in certain places. The selection of small,

innovative firms as the basis of the research has implications for the conclusions which arise from it. Taylor (1975) argued that small firms (less than 50 employees) in general have stronger local linkages than firms with larger numbers of employees. He went on to suggest that small firms with less local linkages, however, were more likely to grow and become publicly owned. In contrast, this research has found that while small IC firms are generally not growing, regional linkages are not particularly important. This shows why it is important to relate the linkages of firms to the products in question.

Small IC firms have linkages with a myriad of firms, institutions and actors which tend to be spatially dispersed in relation to the home region. The nature of innovation in the sector is such that the most important sources of information for these firms are other firms, particularly the customer. This is because the firms are dealing with products where the adaptation of technology for specific market niches is an important aspect of their development. The innovations are incremental in nature and developed in response to the imperatives of the market. This should be contrasted with firms where the supplier is a more important source of technological information and firms which are less responsive to customers and responding more to their own market vision. Small IC firms are also dealing with technologies that are international in their scope. Export markets are vital to the competitiveness of the innovations. For this reason customers beyond the region and nation are the most important providers of information. The nature of the firms and their innovations therefore need to be borne in mind in considering the three hypotheses of the research.

In analysing the spatial dimensions of information flows in general we also need take into account the importance of internal sources as well as external sources of information to firms. The conceptual basis of small firms in this study is that they are more reliant on external sources of information. This should be contrasted with large firms where internal sources are likely to be relatively more important to the process of product development. Gibbons and Johnston (1974) distinguished between internal and external sources of information and found that external information only accounted for 34% of all information utilised within the firms. While the customer is the most important source of external information to the firms, it is not necessarily more important than sources from within the firms.

7.2.2 Hypothesis 1

External sources of specific information make a more important contribution to innovation beyond the region than from within the region.

More specific information is acquired beyond the region because the firms develop close relationships with their customers to adapt technologies for specific niches. Suppliers beyond the region are also important to the provision of infomation on technological development but contrary to earlier suggestions (for example, Morgan, 1997), innovative firms do not necessarily place a high value on information from their competitors. They acquire information on market position from their competitors but this is not considered to be specific. The customer also provides information on organisational aspects of development that the firms still consider to be important to the innovation process. The findings showed that collaborations with firms apart from customers and suppliers were of limited significance to the firms' learning relationships. This does not mean that horizontal collaborations are not important to innovation generally. It means that they are likely to be less important to small firms dealing with innovation of an incremental nature in existing product ranges.

The findings from this research therefore highlight one of the paradoxes behind recent developments in regional development theories, namely that learning processes emanating from the movement of labour and flows of information between like-minded firms in regional 'clusters' are less important to small IC firms than is generally assumed for the small firm population. Although the firms are in the same industry and on a similar stage in the value chain of production, there is no evidence to suggest that collective learning behaviour with a strong regional dimension is taking place within the sector. The research findings therefore question the validity of neo-Marshallian theories in explaining the clustering of firms in specific industrial sectors. In particular they cast doubt on the significance of learning capacities dependent on "region-specific" untraded interdependencies within particular regional concentrations of firms in similar product groups. Paths of technological development in innovative industries are specific and partialised as Storper (1995) suggests. However, untraded interdependencies for small, innovative firms, do not necessarily have a dominant region-specific dimension. The findings of this research support work by other authors such as Grozt and Braun (1997), who have also asserted that innovation-orientated relationships are far less spatially restricted than generally assumed.

The analysis of small, innovative firms in the IC sector suggests that the role of the region generally in generating inter-organisational information flows has been over emphasised in recent theoretical perspectives. In the firms being studied here links that go beyond the region, which are sometimes described as weaker because of less frequent contact, are more important to information acquisition than intra-regional linkages. Murdoch (1995, p.743) had also suggested that organisations may be tied to particular places although "they often transcend these places and extend their networks over ever-increasing distances." Section 3.5.1 of chapter three considered the importance of trust within particular societies in the development of innovative industry. The evidence from this research suggests that what Fukuyama (1995) would refer to as the low-trust society is indicative of the Western Crescent area of the LMR. In acquiring information small IC firms tend to rely on production hierarchies that transcend the region.

Using a mix of qualitative information and coded responses this study has also highlighted the limitation of simple proxies of innovative performance such as the introduction of new products and R&D expenditure. The findings suggest that these measures can throw a veil over the innovative performance and innovative potential of certain regions. The vast amount of literature on the forces shaping the most successful innovative regions tends to highlight factors such as personal networks, the availability of venture capital and the fluidity of labour markets. The region-specificity of these factors in the LMR was not as apparent in the firms being studied. However, these firms are still regarded as innovative in the context of the UK using all the available measures. It therefore needs to be emphasised again that the firms being considered in this study are dealing with small-scale innovations, which are incremental in nature and usually driven by market necessity. This research has also shown why it is important to consider the role of power and influence from beyond the region in considering the innovative performance of firms and regions. Accordingly, as well as distinguishing between different scales of innovative activity in analysing the spatial dimensions of networks of informal information flows we also need to consider the power relationships between the firm and its source.

7.2.3 Hypothesis 2

Generalised sources of information are relatively more important to innovation within the region than specific sources of information.

Demonstrating that the acquisition of more specific information takes place beyond the region does not imply that the region is not significant, or that we should ignore the nature and characteristics of information flows within its boundaries. The findings do point to some conceptual significance for the region as an environment that enables firms to acquire information on more general areas of development that are perceived to have less value for innovation and competitiveness. The findings of the research indicate that information acquired from sources within the region become relatively more important when the form of information is less specific in technological and market terms. The findings have shown that there are certain sources of less valued information where the region was considered to be more important. Sources such as networking through institutions, contacts from past employment and the use of consultancies are relatively more important to more generalised, organisational knowledge. This information makes an important difference to the competitiveness of firms within the region but the fact that it is more general suggests that it is not specific to the home region's socio-cultural context.

The evidence suggests that generalised sources of information are more likely to be available in the LMR than other regions. For example, the use of contacts from past employment as a source of information is more region-specific because historically there has been a high concentration of these types of firms in the LMR. However, these sources still tend to be useful only for lower level information. As Gordon and Cheshire (1998) point out questionnaires that use ordinary language do not readily recognise the availability of the various services, information sources and opportunities for collaboration as a general feature of the urban economy. Information acquired from these sources individually is perceived to be much lower in significance than information from other firms beyond the region. In aggregate, however, it is still crucial to the process of product development, particularly in terms of how organisational change affects innovation. This is an important finding because it shows that the regional support mechanisms have the potential to deliver more effectively on more generalised information that can still have an important impact on competitiveness. These findings do suggest, however, that we should take a more circumspect view of the role of regional support mechanisms. They may be able to allow firms to innovate more effectively rather than being able to provide them with the advanced, specific information that leads to innovation.

The process of information capture within small IC firms is the outcome of actors' perceptions about how they should move towards product development and competitiveness.

It involves a complex interaction of sources of information that tend to transcend the regional context. Because these innovators live in a particular region and have the desire to stay in a particular region does not mean that the region becomes significant in itself for the firms' learning processes. For this reason it would be more appropriate to refer the Western Crescent of the LMR as a competitive region because there is a disproportional concentration of innovative firms within it. However, it is not necessarily a learning region in the sense of it being the dominant spatial level at which specific information is being exchanged between organisations. The reason for the location of their businesses within the LMR relates to a different set of forces based on agglomeration and historical factors. These have little to do with learning capacities developed through factors that are specific to the region's socio-cultural context. Growing awareness through experience is gained by individuals working for firms which are located at a fixed point in space. However, there is no evidence to suggest that the culture of the LMR is particularly important in facilitating the development of this awareness except that these firms have chosen to locate there. However, we can still say, somewhat paradoxically, that the process of information capture is an important issue in explaining the location behaviour of the surveyed firms. This is now explained through consideration of location factors.

7.2.4 Hypothesis 3

Tangible factors such as access to skilled labour and access to transport links are more important to location decisions than access to regional sources of information

Chapter three described the dichotomy in the recent literature over the exact nature of the factors that give rise to a cluster of innovative firms. Certain authors emphasise the infrastructure factors that attract and embed those that learn most effectively within the region whereas others pay particular attention to intra-regional flows of knowledge. The analysis in this study has shown that the Western Crescent area of the LMR provides an underlying environment that allows small, innovative firms to sustain competitiveness. As Porter (1990) points out, more specialised knowledge is more important to sustainable competitiveness. The Western Crescent area attracts and embeds specialised labour and has good transport links that enable firms to acquire the information they need from both within and beyond the region. As the research findings in chapter five showed, the importance of external information sources within the region is of very limited significance compared to these other factors in keeping firms in the region. Access to good transport links, that allow firms to access

information beyond the region, however, is an important factor in keeping the firms in the region.

The firm is faced with an economic decision about the cost of travelling that is incurred in gleaning more information about the technological scope and market requirements of the particular product that it is dealing with. With transportation costs falling and the returns on specific innovations becoming more important to the competitive success of the firm, the cost of travelling compared to the gains from external sources of information are becoming relatively lower. The firm becomes more selective about the number of foreign trips it can make when the cost of travelling approaches the benefits of accessing external sources of information beyond the region. To use the economic jargon, the individual will travel up to the point at which the marginal returns on accessing information no longer outweigh the marginal costs of travelling. Part of the explanation for the clustering of innovative activity is of course found in sociological and cultural factors but we cannot ignore the economics of information acquisition in studying the location patterns of firms.

The findings from this research have shown that the benefits of re-locating in terms of lower factor price would not outweigh the losses from not being able to co-ordinate the various aspects of information capture that lead to innovation. This includes information that is accessed by specialised labour within the firm. The findings suggest that the need to hold on to specialised labour is a vital factor in keeping firms in the area. This is the result of the shared aspirations of workers to live and work in the Western Crescent area of the LMR rather than being the result of the shared industrial culture of the IC sector. The labour chooses to live and work in the Western Crescent area but its experience from the beyond the region and its ability to access sources of information are key factors. These are firms who are performing similar activities and therefore acquiring information in similar ways. This goes some way to explaining why there is a high relative concentration of small IC firms in the Western Crescent area.

A surprising finding of the study is experience in past employment within the firms' region being found to be less important than experience gained beyond the region. The knowledge of information gained in past experience within the region was, however, is considered to be the most important source from within the region compared to other regional sources. This indicates that the historical context of production in the LMR is still significant in the analysis of how firms acquire information. Chapter two showed why it is important to consider how

individuals learned in the past when considering how they learn in the present. We therefore cannot ignore the experience of individual workers in explaining the spatial dimensions of information flows.

As we have seen accessibility to good transport links is rated much more highly in importance than intra-regional flows of information in keeping firm located in the LMR. Small IC firms acquire information from other firms that are spatially dispersed and make careful decisions when they weigh up the value of acquiring important information against the cost of travelling to access that information. As information becomes more dispersed globally in a sector such as IC, proximity to global transport nodes becomes vital for the degree of face-to-face contact that is required for firms to access information abroad. The regularity of face-to-face contact depends on the nature of the information that the individual is acquiring, which relates in turn to the nature of the innovation. The nature of the products that the firms were dealing with in this research is such that interaction with existing and potential customers is vital to the process of innovation. Analysis of firm location suggests that the importance of communications infrastructure rather than intra-regional flows of information explains the co-location of IC firms. McCann's (1995) assertion that location factors need to be weighed up in terms of the product characteristics, highlighted in chapter three, is therefore pertinent to the explanation of why similar types of firms tend to locate in similar places.

With these powerful forces in mind the creation of conditions for effective acquisition of knowledge for indigenous firms by regional support mechanisms would seem to be highly constrained. As one author remarked:

> "There is no doubt that innovation and learning can be important concepts in understanding why some firms and regions are economically successful and others are not. Nevertheless it would be as well to recognise the limits that learning entails, both as an explanatory concept and as a guide to territorial development policies . . . learning is by no means a universal panacea to the problems of socio-spatial inequality and is in some respects a cloak behind which the harsher realities of capitalism can be hidden" (Hudson, 1998, p.10).

The findings from this research lend weight to the argument that learning is not the universal panacea to the problems of socio-spatial inequality. However, in an era when regional redistribution by national state intervention is not on the agenda, lower cost economic

development projects need to be fully tested. The learning region, which was described in chapter three is one such policy framework.

7.3 Policy implications

Finding a systematic role for local and regional policy is problematic when we take into account the powerful agglomeration factors that explain why there is a high relative concentration of small IC firms in the Western Crescent area of the LMR. The findings of this study indicate that regional support mechanisms nevertheless have the potential to enable firms to either innovate more effectively or develop innovation potential rather than provide them with the more advanced forms of information on technology and markets, which this study has found to be spatially dispersed. The findings from chapter five and six suggest that it has been more feasible for regional support mechanisms to orientate themselves to the provision of more generalised forms of information for small firms. The case example of Hertfordshire TEC shows how more generalised activities are being encouraged at the local level. Regional support mechanisms do have the potential to shorten the search of firms to the final innovative solution, that is the commercial exploitation of new ideas in the market. This is true of both core and peripheral regions. However, the public sector can respond to the more specific information needs of small firms more effectively by increasing its understanding of the types of technology and organisational change that the firms are dealing with.

The question that needs to be addressed in considering the policy conclusions is the extent to which national, regional and local agencies can develop mechanisms to make information at the regional and local level more specific to particular industries. While recognising that there are empirical problems in defining the boundaries of particular sectors Geddes (1992, p.2) argued that the objectives of local and regional economic development policy should be determined by the particular characteristics and requirements of particular sectors.

7.3.1 The potential role of strategic agencies

The findings of the policy study on the usefulness of the learning region framework show that it is still underdeveloped, and indeed constrained by the administrative context of economic

development policy in England. This raises questions about the role of the new Regional Development Agencies (RDAs) in enabling the learning region policy framework to implemented more effectively in the future. Although there is much ambiguity over how the RDAs will relate to existing business infrastructures, there is reason to believe that they should be better equipped to respond to the dynamics of technological change in regional sectors or clusters. If the RDAs facilitate the co-ordination of institutional support for business and provide greater transparency for support mechanisms they should present a significant opportunity to utilise the information base within particular regions. Moreover, there is potential for support mechanisms to be more responsive to the specific needs of innovative firms by being more strategically aware.

Best (1990) highlights the importance of strategy as opposed to planning in developing policies to deal with continuous improvement in the business environment. He goes on to emphasise the importance of strategic sector-specific forums. These are referred to here as cluster organisations in the sense of a cluster being a co-located group of firms with similar market and technological characteristics. It is argued in this study that small, innovative IC firms do share similar characteristics and therefore constitute a sector, as well as being spatially concentrated. Moreover, the findings on their innovative behaviour do not preclude a role for forums or cluster organisations in supporting their development in the future. Although the firms are currently moving successfully along technological trajectories there is always the danger that they will become too reliant on their customers for specific information about the application of technology. This could lead to them taking a narrow perspective on the scope of technology and hinder them from moving on to related technological trajectories.

The issues that need to be addressed are at what level the cluster organisations and their programmes might be situated and who might direct or 'own' them. Pratt and Totterdill (1992) argue, albeit in the context of inward investment, that the issue of the distribution of skills within the institutions of policy formation and delivery needs to be addressed. The cluster organisations could be directed by partnerships between representatives of central government ministries such as the DTI and DFEE, regional and local agencies such as the TECs, LED functions, RDAs and representatives from the sector itself. The clusters would need to be identified by strategists from the regional and local agencies such as the TECs or LEDs or the new RDAs when they become established. The ability to influence the development of industry-specific programmes presents an important challenge in defining the role of the new RDAs. The spatial concentration of innovative industry is such that regional agencies should

have a role in promoting the existence and interests of groups of co-located firms within their regions. These interests then need to be recognised by central government ministries.

Representatives from central government departments should aid the direction of the cluster organisations because the geographical scope of clusters is not necessarily confined to particular regions at the administrative level. Moreover, the needs of spatially-concentrated groups of firms goes beyond the capacities of agencies based at the level of the region. According to Best (1990) forums would need to link to macro-economic policy, the banking system and education policy. These are the main aspects of what is referred to in the literature as the national system of innovation and are usually neglected in the literature on regional innovation systems and the learning region. Where sectors are a strategic priority, shortfalls in specific aptitudes such as computing programming and technological know-how need to be assessed and then addressed in terms of education at all levels. However, it is only worth pursuing education policies in relation to particular sectors once their strategic importance has been established by local and regional agencies. Representatives of trade associations of the sectors would then need to be consulted as well as the firms themselves on shortfalls in skills. The cluster organisations should also initiate programmes on sector-specific inter-firm networks or clubs to be based at the level of the region. If the clubs were to work effectively further needs could be identified.

Chapter six showed that one of the limitations of the learning region programmes on inter-firm networking in Hertfordshire was the lack of a specific industry focus with a high proportion of participant firms from the public sector. This indicates that either innovative firms were generally not aware of the programmes or they were simply not interested because as the findings of the attitudinal survey in chapter six suggest, they were uncertain about the potential benefits of the programmes. This provides an example of why programmes need to be more transparent and more specific to innovative firms. For this to happen cluster organisations need to develop a strong awareness of industry-specific issues so that programmes which encourage inter-firm networking can be tailored to the specific industries. In certain cases this can be facilitated by collaboration between local authorities and the TECs. Hertfordshire, for example, finds itself in the Eastern region, when in terms of the sort of products considered in this study, the county has more in common with the county of Berkshire, situated in the SE, than it does with say, Norfolk, in the north of the Eastern region area. A strategic awareness of opportunities for the development of learning processes within innovative sectors such as IC goes beyond the arbitrary regional boundaries defined by the old

government office regions. If a shared industrial culture is the way to promote learning networks, as the findings from chapter six suggest, the RDAs will need to work together across administrative boundaries and possibly at the national level to develop programmes around geographical clusters of like-minded firms. The spatial extent of the regional concentration of small IC firms, from Sussex in the south to Cambridge in the Eastern region, shows the tension between spatial policy based on administrative boundaries and sectoral policies.

Lundvall and Borras (1997, p.83) remarked that, "strong industrial and innovation networks in the territory might condition negatively the position of individual firms to re-orient themselves towards new technological directions." This would, of course, be the same for strong innovation networks that go beyond the region. This study has shown that there is a particular problem to overcome in encouraging existing innovative firms to experiment with new methods of inter-firm networking when the senior managers perceive that they are already moving in the right direction to sustained competitiveness. As Pratt points out, "building a network, a science park or a better mouse trap, is not sufficient unless others can be convinced of its value and be enrolled into its promotion and use" (Pratt, 1997, p.134). However, the fact that intra-regional flows of information and knowledge are not as important as those that go beyond the region for small IC firms does not necessarily preclude a role for cluster organisations in raising awareness amongst these firms of the opportunities for information capture from other like-minded firms.

The propensity for small firms to collaborate and share information depends on the market relationships between the firms. Naturally, competitive secrecy is an important consideration in any decision to collaborate. However, the attitudes of the managing directors of the IC firms suggested that a shared industrial culture, where firms are closely related in terms of technology, certainly has the potential to generate the right conditions for increased personal contacts and the possibility of increased information sharing. This research has demonstrated that industrial networks usually emanate from common technological and market problems where a single firm or set of firms has a degree of control over the innovation process. However, the learning region as a theoretical conception is not based on market-based interactions. Firms are said to be linked together by certain aims and objectives, by the pursuit of common goals, and the networking relationships are governed by trust and the tacit observance of certain rules, not necessarily formal contractual agreements. Conceptually, the network might have developed from market relationships or it might lead to market

transactions and innovations, but the factors which bind the players together are a convergence of interest in the development of new trajectories for their businesses.

The need to encourage the participation of firms in the programmes of cluster organisations means suggests that 'brokers' have a key role to play in their development. Brokers could be a mixture of representatives of specific industries and market research specialists, who could identify common needs within particular product groups. A disposition to participate in networking ventures could also be instilled by an action-orientated approach such as interviews with firms that focus on specific technological issues or seminar, group work and conferences. This could lead to a more targeted training programmes. Further programmes can develop as spin-offs from the more specific programmes as common needs are further identified. However, this can only be achieved if strategic agencies develop more effective market research capacities than those that currently exist for business support infrastructures.

It can therefore be argued that there is the potential for strategic agencies to enable small, innovative firms, to learn about coping with technological and organisational change, even though these firms have the appearance of being locked into path-dependent development. This can be achieved through a better understanding of the needs of small firms in relation to the nature of the technological change that they are dealing with. Long-term relationships need to be developed between the representatives of the strategic agencies and representatives from small, innovative firms so that programmes can be adapted to the needs of small firms as technology changes. However, this study has also shown that we need to be circumspect about the policy implications of the learning region framework where collaboration is encouraged at the regional level only. Regional agencies such as the TECs, LED functions and possibly the RDAs in the future need to work together with government departments at the national level to improve the innovation potential of spatially-concentrated groups of small firms.

7.3.2 The potential role of the LPA

The findings of the research have shown that we need to be sceptical about the possibility of newly established small IC firms learning from existing firms already located in the region. However, analysis of location behaviour can still inform the planning system. Ceteris paribus, if past experience shows that a particular type of innovative firm benefits from being located at a particular locus then a similar firm should be given an easier opportunity to find suitable premises in that area over an area where there is less potential benefit. This would then lead to

a greater specialisation for particular regions and the possibility of more targeted learning programmes through the development of local and regional strategies with strategic agencies working together to encourage collaboration. The LPAs would need to work together with cluster organisations for this to occur. Notwithstanding the issues that this argument raises in terms of regional inequality, policy programmes which encourage collaboration and learning still need to be examined in more depth before 'location near to similar types of innovative firms' for the purposes of cross-fertilisation' becomes a material consideration in the planning process.

7.4 Future directions for research

7.4.1 Innovation characteristics

One of the reasons why small IC firms were chosen as the focus of the study was that it was more appropriate with the resource constraints of the project to do an in-depth study of one specific area of innovation. It was earlier suggested that this is an important caveat of the research. It would therefore be interesting to take the research further by considering firms from a wider selection of size-bands, sectors and regions. A much larger sampling frame would be needed to compare the spatial dimensions of external sources of information in relation to a wide spectrum of different sub-categories of innovation characteristics and performance in different regions. This should enable researchers to identify products where region-specific social capital is relatively important to the innovation process. In such regions we would expect to find the region being more important in terms of external sources of information than is the case with small IC firms in the LMR. This study has shown that flows of information within the region are not as important as is sometimes assumed in the literature. In an increasingly globalised society it is probable this observation applies to most types of innovation in most regions. However, more comparative work is needed to test the relative importance of the region in relation to innovative performance and characteristics. The relative importance of the region, in terms of external information flows, would also need to be related to the different types of business support infrastructures within the different regions as well as the innovation characteristics and performance of the products in question.

7.4.2 Policy studies

There has been a reluctance in the past to carry out rigorous evaluations of economic development programmes (Henderson, 1998). In the future research needs to focus on the impact of learning region type initiatives on the innovation potential of firms. This research would have to be longitudinal in nature and if possible contain an ethnographic component so that the researcher can experience at first hand, changes taking place within the firms as a result of their participation in learning region projects. As well as assessing the impact of such programmes on job behaviour, a methodology such as the one adopted for this study would be able to show whether intra-regional flows of information have become more important to the firms as a result of their participation in the programmes. The methodology would also be able to show the forms of information that are exchanged more effectively by the implementation of policies that encourage increased collaboration at the regional level. Policy effects could be measured by a matched-pairs sampling frame of firms. This would allow a comparison between those who participated in the programmes and firms from the same product group and size-band who did not. The study would be able to firstly, whether networking through local institutions had increased in importance as a source of information and furthermore, what types of operations within the firms had benefitted from the programmes. A further study would find out whether greater awareness of networking opportunities within the region had impacted on the innovation process within the firms over time. This would add a temporal dimension to the analysis.

It is realised that the definitive account of the spatial dimensions of information flows is not possible in one research project. However, by understanding how small, innovative firms acquire information in relation to space, it can take us forward on the path to a greater understanding of how economic development policy can affect the ability of small businesses to cope with change in the world economy. To paraphrase Castells from the quote at the beginning of this chapter, if the new RDAs can "anchor identities" by identifying common goals of development in particular product groups and sectors, they will go some way to counteracting the ascendancy of the global cultures that "dominate our everyday lives". This would seem to be the most progressive way for economic development policy in the UK at this juncture. Whether it is a viable way of generating more successful innovative performance in UK firms remains to be seen.

Appendix 1: Interview schedule

What are the main reasons for your company locating and staying in Hertfordshire?

Are there are any linkages or relationships with private and public institutions which give your company particular reason for staying in the county of Hertfordshire?

Describe any product innovations which have been introduced by your company in recent years.

Do you employ any workers in a formalised research and development department?

If so how many and can you describe their current activities?

In what ways do you see innovation as being important to the future market success of your company?

In view of your company's recent experience, in what specific areas do you think your company needs to improve to allow it to continue to innovate and improve product quality?

What do you think, if any, are the major constraints on your firm's ability to improve product performance and compete successfully in world and domestic markets?

Describe any major improvements in aspects of the innovation process which have been adopted by your company in recent years.

What would you describe as your major information searches geared at improving innovative performance?

What type of firms or institution are you currently sharing information and knowledge with?

Are these institutions located in the region or beyond the region?

(Introduce Hertfordshire's concept of the learning region here)

What would be the most important constraints on you taking part in these programmes?

How important would it be that they are subsidised?

How important would it be that the firms are dealing in similar areas of technology?

How important would it be that the programmes are relevant to your current needs?

Would you network with fellow competitors?

Would you hope to develop personal relationships beyond the networks?

How important would it be that the programmes are based in the region?

Appendix 2: List of face-to-face interviews

Number	Company	Date
1	A	02-12-96
2	B	10-12-96
3	C	17-12-96
4	D	03-01-97
5	E	10-01-97
6	F	17-01-97
7	G	31-01-97
8	H	14-02-97
9	I	28-02-97
10	J	21-03-97
11	K	25-03-97
12	L	01-04-97
13	M	02-04-97
14	N	15-04-97
15	O	17-04-97
16	P	21-04-97
17	Q	22-04-97
18	R	28-04-97
19	S	30-04-97
20	T	01-05-97
21	U	02-05-97
22	V	13-05-97
23	W	14-05-97

24	X	15-05-97
25	Y	19-05-97
26	Z	27-05-97
27	AA	02-06-97

Appendix 3: Postal questionnaire

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J.Sennett@ucl.ac.uk

Survey of Innovation and Learning in the Instrumentation and Control Sector

(All answers will be treated in the strictest confidence Your company will not be mentioned in the final analysis.)

A. COMPANY DETAILS

1) Name of company: 2) Address:_____
_____ _____
_____ _____
_____ _____

3) Name of respondent: _____
4) Position in company:_____
5) Main product type(s): 6) % Export sales:

B. INNOVATION

Innovations: new products or improvements in the quality and efficiency of your company's product(s) which have been commercially exploited. These are your company's inputs into the process of production.

7) Describe, briefly, any innovations introduced by your company in the last five years.

8) Do you employ any workers who carry out design-based or research and development activities on the development of the product? If so, can you state how many and describe their current activities? Is this pure research or do they work closely with customers?

9) In terms of the general characteristics of your product(s), in what ways do you see the process of innovation as being important to the future success of your company?

C. "DEVELOPMENT AREAS" FOR INNOVATION

10) How important have the following development areas within your company been to the process of innovation in the past five years?
How important do you think these areas of development are likely to be in the immediate future?

(see definition of innovation in section B)

ranked by the importance of each area of development (1-5): **1-less, 5-more**

If you are uncertain or the question is not relevant you can leave the boxes blank.

Development areas	**Importance**									
	past					**future**				
	1	2	3	4	5	1	2	3	4	5
a. adapting new technology into the development of the product(s):										
b. adoption of new technology for engineering / design purposes:										
c. development of new management systems:										
d. development of marketing / market research processes:										
e. development of new processes and systems in relation to distribution / stock control / scheduling:										

11) Would you like to elaborate on any important improvements from above or other "ways of doing things" which have been adopted in the last five years and contributed to the innovation process.

D. SOURCES OF KNOWLEDGE AND INFORMATION

Knowledge: skills and techniques acquired through experience and learning or knowledge of important information.

Information: usually words or data that can be written down on paper or in books.

12) In view of your important "development areas" of innovation above (q.10), what do you think have been your company's important sources of knowledge and information?

N.B. Sources can overlap and information from one source can be a lead on to other sources.

You can elaborate or make more specific comments by writing in each box under the relevant source.

"Your region" refers to the area within a radius of approx. 50 miles of your company.

If you are uncertain or the question is not relevant you can leave the boxes blank.
Ranking: 1-Less 5-More

Source of Knowledge and Information	**Development area (see Q.10)**	**Rank of Importance**				
		1	2	3	4	5
a. experience in past employment in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
b. experience in past employment outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
c. up-to-date trade, electronic, scientific and business journals:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
d. journals of learned societies (e.g. institute of electronic engineering):	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					

Source of Knowledge and Information	Development area (see Q.10)	Rank of Importance				
		1	2	3	4	5
e. conferences / exhibitions (including by networking at the events) based in London or your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
f. conferences / exhibitions (including by networking at the events) based outside London or your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
g. relationships with customers in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
h. relationships with customers outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
i. relationships with suppliers in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
j. relationships with suppliers outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
k. networking with other firms / individuals through business and trade bodies in London or your region such as chamber of commerce, business link and trade associations:	a. adapt. new tech.					
	b. adopt new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					

Source of Knowledge and Information	Development area (see Q.10)	Rank of Importance				
		1	2	3	4	5
l. networking with other firms / individuals through business and trade bodies outside your London or your region such as chamber of commerce, business link and trade associations:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
m. collaborative research with universities in London / your region:	a. adapt. new tech.					
	b. adopt new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
n. collaborative research with universities outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
o. training courses / seminars organised by universities in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
p. training courses / seminars organised by universities outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
q. training courses / seminars organised by trade associations, local business support services in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					

Source of Knowledge and Information	Development area (see Q.10)	Rank of Importance				
		1	2	3	4	5
r. training courses / seminars organised by trade associations, local business support services outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
s. contacts from past employment in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
t. contacts from past employment outside London / your region.	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
u. networking with competitors in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
v. networking with competitors outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e manufact. processes					
w. parent companies in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
x. parent companies outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					

Source of Knowledge and Information	Development area (see Q.10)	Rank of Importance				
		1	2	3	4	5
y. professional consultants in London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
z. professional consultants outside London / your region:	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					
aa. use of information technology (e.g. internet):	a. adapt. new tech.					
	b. adopt. new tech.					
	c. m'ment systems					
	d. marketing processes					
	e. manufact. processes					

13) What are the more typical attributes of the development of any relationships where your company has successfully managed to learn from other firms by gaining important knowledge and information?

If you are uncertain or the question is not relevant you can leave the boxes blank.

Attribute	less				more
	1	2	3	4	5
a. market-based relationship with a customer / supplier:					
b. non-market based relationship with another firm:					
c. the firm dealing in a complementary area of technology or production:					
d. knowledge of the firm's activities from experience in earlier employment:					
e. information on the firm from networking at conferences / seminars or other events:					
f. networking with the firm at conferences / seminars or other events:					
g. low cost of travelling between your company and its collaborator:					
h. regular face-to-face contact (approximately at least once a week):					
i. regular face-to-face contact (approximately at least once a month):					
j. regular contact through use of electronic mail:					

14) Would you like to elaborate on any points from q.13?

E. COMPANY LOCATION

15) If you were faced with the choice of relocating what would be the important reasons for your company to stay in your locality?

If you are uncertain or the question is not relevant you can leave the boxes blank.

	Importance				
	1	2	3	4	5
a. the need to hold on to specialised labour:					
b. availability of skilled labour in the area:					
c. quality of the environment (in terms of the general amenity of the area):					
d. accessibility to good transport links:					
e. access to important external sources of information and knowledge for your company (from q. 12):					

16) Would you like to elaborate on any of the answers to question 15 or make any further comments on any local sources of knowledge and information that provide particular reasons for your company being tied to the area?

Thank you for your co-operation.

Appendix 4: Results data

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
10AF		1	2	3	4	5	Missing
	Frequency	1	2	4	12	31	0
	Percent	2.0	4.0	8.0	24.0	62.0	0
	Valid %	2.0	4.0	8.0	24.0	62.0	
	Cum %	2.0	6.0	14.0	38.0	100.0	
10AP		1	2	3	4	5	Missing
	Frequency	1	7	8	9	24	1
	Percent	2.0	14.0	16.0	18.0	48.0	2.0
	Valid %	2.0	14.3	16.3	18.4	49.0	
	Cum %	2	16.3	32.7	51.0	100.0	
10BF		1	2	3	4	5	Missing
	Frequency	2	1	9	18	18	2
	Percent	4.0	2.0	18.0	36.0	36.0	4.0
	Valid %	4.2	2.1	18.8	37.5	37.5	
	Cum %	4.2	6.3	25.0	62.5	100.0	
10BP		1	2	3	4	5	Missing
	Frequency	3	5	12	19	9	2
	Percent	6.0	10.0	24.0	38.0	18.0	4.0
	Valid %	6.3	10.4	25.0	39.6	18.8	
	Cum %	6.3	16.7	41.7	81.3	100.0	
10CF		1	2	3	4	5	Missing
	Frequency	7	6	13	16	4	4
	Percent	14.0	12.0	26.0	32.0	8.0	8.0
	Valid %	15.2	13.0	28.3	34.8	8.7	
	Cum %	15.2	28.3	56.5	91.3	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
10CP		1	2	3	4	5	Missing
	Frequency	7	16	20	5		2
	Percent	14	32	40	10		4.0
	Valid %	14.6	33.3	41.7	10.4		
	Cum %	14.6	47.9	89.6	100.0		
10DF		1	2	3	4	5	Missing
	Frequency	4	4	14	17	9	2
	Percent	8.0	8.0	28.0	34.0	18.0	4.0
	Valid %	8.3	8.3	29.2	35.4	18.8	
	Cum %	8.3	16.7	45.8	81.3	100.0	
10DP		1	2	3	4	5	Missing
	Frequency	7	18	14	7	2	2
	Percent	14.0	36.0	28.0	14.0	4.0	4.0
	Valid %	14.6	37.5	29.2	14.6	4.2	
	Cum %	14.6	52.1	81.3	95.8	100.0	
10EF		1	2	3	4	5	Missing
	Frequency	12	6	13	11	7	1
	Percent	24 0	12.0	26.0	22.0	14.0	2.0
	Valid %	24.5	12.2	26.5	22.4	14.3	
	Cum %	24.5	36.7	63.3	85.7	100.0	
10EP		1	2	3	4	5	Missing
	Frequency	16	14	11	7	1	1
	Percent	32.0	28.0	22.0	14.0	2.0	2.0
	Valid %	32.0	28.6	22.4	14.3	2.0	
	Cum %	32.7	61.2	83.7	98.0	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12AA		1	2	3	4	5	Missing
	Frequency	6	7	10	7	8	12
	Percent	12.0	14.0	20.0	14.0	16.0	24.0
	Valid %	15.8	18.4	26.3	18.4	21.1	
	Cum %	15.8	34.2	60.5	78.9	100.0	
12AB		1	2	3	4	5	Missing
	Frequency	6	5	12	8	9	10
	Percent	12.0	10.0	24.0	16.0	18.0	20.0
	Valid %	15.0	12.5	30.0	20.0	22.5	
	Cum %	15.0	27.5	57.5	77.5	100.0	
12AC		1	2	3	4	5	Missing
	Frequency	10	13	7	7	1	12
	Percent	20.0	26.0	14.0	14.0	2.0	24.0
	Valid %	26.3	34.2	18.4	18.4	2.6	
	Cum %	26.3	60.5	78.9	97.4	100.0	
12AD		1	2	3	4	5	Missing
	Frequency	7	10	16	3	2	12
	Percent	14.0	20 0	32.0	6.0	4.0	24.0
	Valid %	18.4	26.3	42.1	7.9	5.3	
	Cum %	18.4	44.7	86.8	94.7	100.0	
12AE		1	2	3	4	5	Missing
	Frequency	9	12	9	8	1	11
	Percent	18.0	24.0	18.0	16.0	2.0	22.0
	Valid %	23.1	30.8	23.1	20.5	2.6	
	Cum %	23.1	53.8	76.9	97.4	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12BA		1	2	3	4	5	Missing
	Frequency	3	4	9	12	7	15
	Percent	6.0	8.0	18.0	24.0	14.0	30.0
	Valid %	8.6	11.4	25.7	34.3	20.0	
	Cum %	8.6	20.0	45.7	80.0	100.0	
12BB		1	2	3	4	5	Missing
	Frequency	4	2	12	12	3	17
	Percent	8.0	4.0	24.0	24.0	6.0	34.0
	Valid %	12.1	6.1	36.4	36.4	9.1	
	Cum %	12.1	18.2	54.5	90.9	100.0	
12BC		1	2	3	4	5	Missing
	Frequency	8	5	11	6	1	19
	Percent	16.0	10.0	22.0	12.0	2.0	38.0
	Valid %	25.8	16.1	35.5	19.4	3.2	
	Cum %	25.8	41.9	77.4	96.8	100.0	
12BD		1	2	3	4	5	Missing
	Frequency	6	8	9	5	3	19
	Percent	12.0	16.0	18.0	10.0	6.0	38.0
	Valid %	19.4	25.8	29.0	16 1	9.7	
	Cum %	19.4	45.2	74.2	90.3	100.0	
12BE		1	2	3	4	5	Missing
	Frequency	9	10	5	6	2	18
	Percent	18.0	20.0	10.0	12.0	4.0	36.0
	Valid %	28.1	31.3	15.6	18.8	6.3	
	Cum %	28.1	59.4	75.0	93.8	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12CA		1	2	3	4	5	Missing
	Frequency	5	5	9	17	11	3
	Percent	10.0	10.0	18.0	34.0	22.0	6.0
	Valid %	10.6	10.6	19.1	36.2	23.4	
	Cum %	10.6	21.3	40.4	76.6	100.0	
12CB		1	2	3	4	5	Missing
	Frequency	4	5	10	15	10	6
	Percent	8.0	10.0	20.0	30.0	20.0	12.0
	Valid %	9.1	11.4	22.7	34.1	22.7	
	Cum %	9.1	20.5	43.2	77.3	100.0	
12CC		1	2	3	4	5	Missing
	Frequency	11	11	13	3	4	8
	Percent	22.0	22.0	26.0	6.0	8.0	16.0
	Valid %	26.2	26.2	31.0	7.1	9.5	
	Cum %	26.2	52.4	83.3	90.5	100.0	
12CD		1	2	3	4	5	Missing
	Frequency	11	7	15	7	2	6
	Percent	22.0	14 0	30.0	14.0	4.0	16.0
	Valid %	26.2	16.7	35.7	16.7	4.8	
	Cum %	26.2	42.9	78.6	95.2	100.0	
12CE		1	2	3	4	5	Missing
	Frequency	8	11	17	8	2	4
	Percent	16.0	22.0	34.0	16.0	4.0	8.0
	Valid %	17.4	23.9	37.0	17.4	4.3	
	Cum %	17.4	41.3	78.3	95.7	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12DA		1	2	3	4	5	Missing
	Frequency	9	7	9	8	9	8
	Percent	18.0	14.0	18.0	16.0	18.0	16.0
	Valid %	21.4	16.7	21.4	19.0	21.4	
	Cum %	21.4	38.1	59.5	78.6	100.0	
12DB		1	2	3	4	5	Missing
	Frequency	12	6	7	9	7	9
	Percent	24.0	12.0	14.0	18.0	14.0	18.0
	Valid %	29.3	14.6	17.1	22.0	17.1	
	Cum %	29.3	43.9	61.0	82.9	100.0	
12DC		1	2	3	4	5	Missing
	Frequency	19	10	6	3	1	11
	Percent	38.0	20.0	12.0	6.0	2.0	22.0
	Valid %	48.7	25.6	15.4	7.7	2.6	
	Cum %	48.7	74.4	89.7	97.4	100.0	
12DD		1	2	3	4	5	Missing
	Frequency	19	5	10	2	1	13
	Percent	38.0	10.0	20.0	4.0	2.0	26.0
	Valid %	51.4	13.5	27.0	5.4	2.7	
	Cum %	51.4	64.9	91.9	97.3	100.0	
12DE		1	2	3	4	5	Missing
	Frequency	18	9	11		3	9
	Percent	36.0	18.0	22.0		6.0	18.0
	Valid %	43.9	22.0	26.8		7.3	
	Cum %	43.9	65.9	92.7		100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12EA		1	2	3	4	5	Missing
	Frequency	10	9	8	11	2	10
	Percent	20.0	18.0	16.0	22.0	4.0	20.0
	Valid %	25.0	18.0	16.0	22.0	4.0	
	Cum %	25.0	47.5	67.5	95.0	100.0	
12EB		1	2	3	4	5	Missing
	Frequency	12	9	8	8		13
	Percent	24.0	18.0	16.0	16.0		26.0
	Valid %	32.4	24.3	21.6	21.6		
	Cum %	32.4	56.8	78.4	100.0		
12EC		1	2	3	4	5	Missing
	Frequency	18	10	5	3		14
	Percent	36.0	20.0	10.0	6.0		28.0
	Valid %	50.0	27.8	13.9	8.3		
	Cum %	50.0	77.8	91.7	100.0		
12ED		1	2	3	4	5	Missing
	Frequency	14	10	9	3	1	13
	Percent	28.0	20 0	18.0	6.0	2.0	26.0
	Valid %	37.8	27.0	24.3	8.1	2.7	
	Cum %	37.8	64.9	89.2	97.3	100.0	
12EE		1	2	3	4	5	Missing
	Frequency	13	14	9	2		12
	Percent	26.0	28.0	18.0	4.0		24.0
	Valid %	34.2	36.8	23.7	5.3		
	Cum %	34.2	36.8	23.7	5.3		

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12FA		1	2	3	4	5	Missing
	Frequency	3	9	6	20	6	6
	Percent	6.0	18.0	12.0	40.0	12.0	12.0
	Valid %	6.8	20.5	13.6	45.5	13.6	
	Cum %	6.8	27.3	40.9	86.4	100.0	
12FB		1	2	3	4	5	Missing
	Frequency	4	6	10	18	4	8
	Percent	8.0	12.0	20.0	36.0	8.0	16.0
	Valid %	9.5	14.3	23.8	42.9	9.5	
	Cum %	9.5	23.8	47.6	90.5	100.0	
12FC		1	2	3	4	5	Missing
	Frequency	15	11	3	5	1	15
	Percent	30.0	22.0	6.0	10.0	2.0	30.0
	Valid %	42.9	31.4	8.6	14.3	2.9	
	Cum %	42.9	74.3	82.9	97.1	100.0	
12FD		1	2	3	4	5	Missing
	Frequency	15	7	8	5	4	11
	Percent	30.0	14 0	16.0	10.0	8.0	22.0
	Valid %	38.5	17.9	20.5	12 8	10.3	
	Cum %	38.5	56.4	76.9	89.7	100.0	
12FE		1	2	3	4	5	Missing
	Frequency	15	9	9	5	1	11
	Percent	30.0	18.0	18.0	10.0	2.0	22.0
	Valid %	38.5	23.1	23.1	12.8	2.6	
	Cum %	38.5	61.5	84.6	97.4	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12GA		1	2	3	4	5	Missing
	Frequency	10	2	8	11	7	12
	Percent	20.0	4.0	16.0	22.0	14.0	24.0
	Valid %	26.3	5.3	21.1	28.9	18.4	
	Cum %	26.3	31.6	52.6	81.6	100.0	
12GB		1	2	3	4	5	Missing
	Frequency	9	5	9	9	5	13
	Percent	18.0	10.0	18.0	18.0	10.0	26.0
	Valid %	24.3	13.5	24.3	24.3	13.5	
	Cum %	24.3	37.8	62.2	86.5	100.0	
12GC		1	2	3	4	5	Missing
	Frequency	16	8	3	4	1	18
	Percent	32.0	16.0	6.0	8.0	2.0	36.0
	Valid %	50.0	25.0	9.4	12.5	3.1	
	Cum %	50.0	75.0	84.4	96.9	100.0	
12GD		1	2	3	4	5	Missing
	Frequency	14	6	2	7	4	17
	Percent	28.0	12.0	4.0	14.0	8.0	34.0
	Valid %	42.4	18.2	6.1	21.2	12.1	
	Cum %	42.4	60.6	66.7	87.9	100.0	
12GE		1	2	3	4	5	Missing
	Frequency	17	9	5	3	1	15
	Percent	34.0	18.0	10.0	6.0	2.0	30.0
	Valid %	48.6	25.7	14.3	8.6	2.0	
	Cum %	48.6	74.3	88 6	97.1	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12HA		1	2	3	4	5	Missing
	Frequency	3	4	11	12	13	7
	Percent	6.0	8.0	22.0	24.0	26.0	14.0
	Valid %	7.0	9.3	25.6	27.9	30.2	
	Cum %	7.0	16.3	41.9	69.8	100.0	
12HB		1	2	3	4	5	Missing
	Frequency	5	4	12	10	11	8
	Percent	10.0	8.0	24.0	20.0	22.0	16.0
	Valid %	11.9	9.5	28.6	23.8	26.2	
	Cum %	11.9	21.4	50.0	73.8	100.0	
12HC		1	2	3	4	5	Missing
	Frequency	13	8	6	5	2	16
	Percent	26.0	16.0	12.0	10.0	4.0	32.0
	Valid %	38.2	23.5	17.6	14.7	5.9	
	Cum %	38.2	61.8	79.4	94.1	100.0	
12HD		1	2	3	4	5	Missing
	Frequency	9	7	7	6	7	14
	Percent	18.0	14 0	14.0	12.0	14.0	28.0
	Valid %	25.0	19.4	19.4	16.7	19.4	
	Cum %	25.0	44.4	63.9	80.6	100.0	
12HE		1	2	3	4	5	Missing
	Frequency	13	9	8	5	4	11
	Percent	26.0	18.0	16.0	10.0	8.0	22.0
	Valid %	33.3	23.1	20.5	12.8	10.3	
	Cum %	33.3	56.4	76.9	89.7	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12IA		1	2	3	4	5	Missing
	Frequency	13	7	10	5	1	14
	Percent	26.0	14.0	20.0	10.0	2.0	28.0
	Valid %	36.1	19.4	27.8	13.9	2.8	
	Cum %	36.1	55.6	83.3	97.2	100.0	
12IB		1	2	3	4	5	Missing
	Frequency	15	7	9	6		13
	Percent	30.0	14.0	18.0	12.0		26.0
	Valid %	40.5	18.9	24.3	16.2		
	Cum %	40.5	59.5	83.8	100.0		
12IC		1	2	3	4	5	Missing
	Frequency	21	2	6	1		20
	Percent	42.0	4.0	12.0	2.0		40.0
	Valid %	70.0	6.7	20.0	3.3		
	Cum %	70.0	76.7	96.7	100.0		
12ID		1	2	3	4	5	Missing
	Frequency	21	4	3	3	1	18
	Percent	42.0	8.0	6.0	6.0	2.0	36.0
	Valid %	65.6	12.5	9.4	9.4	3.1	
	Cum %	65.6	78.1	87.5	96.9	100.0	
12IE		1	2	3	4	5	Missing
	Frequency	17	1	7	4	4	17
	Percent	34.0	2.0	14.0	8 0	8.0	34.0
	Valid %	51.5	3.0	21.2	12.1	12.1	
	Cum %	51.5	54.5	75.8	87.9	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12JA		1	2	3	4	5	Missing
	Frequency	5	6	11	12	5	11
	Percent	10.0	12.0	22.0	24.0	10.0	22.0
	Valid %	12.8	15.4	28.2	30.8	12.8	
	Cum %	12.8	28.2	56.4	87.2	100.0	
12JB		1	2	3	4	5	Missing
	Frequency	8	4	9	13	5	11
	Percent	16.0	8.0	18.0	26.0	10.0	22.0
	Valid %	20.5	10.3	23.1	33.3	12.8	
	Cum %	20.5	30.8	53.8	87.2	100.0	
12JC		1	2	3	4	5	Missing
	Frequency	15	6	9	2		18
	Percent	30.0	12.0	18.0	4.0		36.0
	Valid %	46.9	18.8	28.1	6.3		
	Cum %	46.9	65.6	93.8	100.0		
12JD		1	2	3	4	5	Missing
	Frequency	16	6	5	4	1	18
	Percent	32.0	12.0	10.0	8.0	2.0	36.0
	Valid %	50.0	68.8	84.4	96.9	100.0	
	Cum %						
12JE		1	2	3	4	5	Missing
	Frequency	15	2	7	7	4	15
	Percent	30.0	4.0	14.0	14.0	8.0	30.0
	Valid %	42.9	5.7	20.0	20.0	11.4	
	Cum %	42.9	48.6	68.6	88.6	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12KA		1	2	3	4	5	Missing
	Frequency	15	8	5	6	4	12
	Percent	30.0	16.0	10.0	12.0	8.0	24.0
	Valid %	39.5	21.1	13.2	15.8	10.5	
	Cum %	39.5	60.5	73.7	89.5	100.0	
12KB		1	2	3	4	5	Missing
	Frequency	15	6	8	5	3	13
	Percent	30.0	12.0	16.0	10.0	6.0	26.0
	Valid %	40.5	16.2	21.6	13.5	8.1	
	Cum %	40.5	56.8	78.4	91.9	100.0	
12KC		1	2	3	4	5	Missing
	Frequency	15	8	7	3	1	16
	Percent	30.0	16.0	14.0	6.0	2.0	32.0
	Valid %	44.1	23.5	20.6	8.8	2.9	
	Cum %	44.1	67.6	88.2	97.1	100.0	
12KD		1	2	3	4	5	Missing
	Frequency	12	8	9	7	2	12
	Percent	24.0	16 0	18.0	14.0	4.0	24.0
	Valid %	31.6	21.1	23.7	18.4	5.3	
	Cum %	31.6	52.6	76.3	94.7	100.0	
12KE		1	2	3	4	5	Missing
	Frequency	17	12	6	1	1	13
	Percent	34.0	24.0	12.0	2.0	2.0	26.0
	Valid %	45.9	32.4	16.2	2.7	2.7	
	Cum %	45.9	78.4	94.6	97.3	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12LA		1	2	3	4	5	Missing
	Frequency	12	7	7	3	4	17
	Percent	24.0	14.0	14.0	6.0	8.0	34.0
	Valid %	36.4	21.2	21.2	9.1	12.1	
	Cum %	36.4	57.6	78.8	87.9	100.0	
12LB		1	2	3	4	5	Missing
	Frequency	13	7	7	3	3	17
	Percent	26.0	14.0	14.0	6.0	6.0	34.0
	Valid %	39.4	21.2	21.2	9.1	9.1	
	Cum %	39.4	60.6	81.8	90.9	100.0	
12LC		1	2	3	4	5	Missing
	Frequency	18	6	7	1	1	17
	Percent	36.0	12.0	14.0	2.0	2.0	34.0
	Valid %	54.5	18.2	21.2	3.0	3.0	
	Cum %	54.5	72.7	93.9	97.0	100.0	
12LD		1	2	3	4	5	Missing
	Frequency	14	8	4	5	2	17
	Percent	28.0	16 0	8.0	10.0	4.0	34.0
	Valid %	42.4	24.2	12.1	15.2	6.1	
	Cum %	42.4	66.7	78.8	93.9	100.0	
12LE		1	2	3	4	5	Missing
	Frequency	16	9	4	2		19
	Percent	32.0	18.0	8.0	4.0		38.0
	Valid %	51.6	29.0	12.9	6.5		
	Cum %	51.6	80.6	93.5	100.0		

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12MA		1	2	3	4	5	Missing
	Frequency	13	4	3	4	7	19
	Percent	26.0	8.0	6.0	8.0	14.0	38.0
	Valid %	41.9	12.9	9.7	12.9	22.6	
	Cum %	41.9	54.8	64.5	77.4	100.0	
12MB		1	2	3	4	5	Missing
	Frequency	14	3	4	4	5	20
	Percent	28.0	6.0	8.0	8.0	10 0	40.0
	Valid %	46.7	10.0	13.3	13.3	16.7	
	Cum %	46.7	56.7	70.0	83.3	100.0	
12MC		1	2	3	4	5	Missing
	Frequency	22	3	2	1		22
	Percent	44.0	6.0	4.0	2.0		44.0
	Valid %	78.6	10.7	7.1	3.6		
	Cum %	78.6	10.7	7.1	3.6		
12MD		1	2	3	4	5	Missing
	Frequency	22	2	3	1		22
	Percent	44.0	4.0	6.0	2.0		44.0
	Valid %	78.6	7.1	10 7	3.6		
	Cum %	78.6	85.7	96 4	100.0		
12ME		1	2	3	4	5	Missing
	Frequency	21	3	2	1	2	21
	Percent	42.0	6.0	4.0	2.0	4.0	42.0
	Valid %	72.4	10.3	6.9	3.4	6.9	
	Cum %	72.4	82.8	89.7	93.1	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12NA		1	2	3	4	5	Missing
	Frequency	11	2	7	6	5	19
	Percent	22.0	4.0	14 0	12.0	10.0	38.0
	Valid %	35.5	6.5	22.6	19.4	16.1	
	Cum %	35.5	41.9	64.5	83.9	100.0	
12NB		1	2	3	4	5	Missing
	Frequency	15	1	7	4	5	18
	Percent	30.0	2.0	14.0	8.0	10.0	36.0
	Valid %	46.9	3.1	21.9	12.5	15.6	
	Cum %	46.9	50.0	71.9	84.4	100.0	
12NC		1	2	3	4	5	Missing
	Frequency	23	3	1	1	1	21
	Percent	46.0	6.0	2.0	2.0	2.0	42.0
	Valid %	79.3	10.3	3.4	3.4	3.4	
	Cum %	79.3	89.7	93 1	96.6	100.0	
12ND		1	2	3	4	5	Missing
	Frequency	22	3	2	1	1	21.0
	Percent	44 0	6 0	4.0	2.0	2.0	42.0
	Valid %	75.9	10.3	6.9	3.4	3.4	
	Cum %	75.9	86.2	93.1	96.6	100.0	
12NE		1	2	3	4	5	Missing
	Frequency	21	4	2	1	1	21
	Percent	42.0	8.0	4.0	2.0	2.0	42.0
	Valid %	72.4	13.8	6.9	3.4	3.4	
	Cum %	72.4	86.2	93.1	96.6	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12OA		1	2	3	4	5	Missing
	Frequency	19	3	5	1	3	19
	Percent	38.0	6.0	10.0	2.0	6.0	38.0
	Valid %	61.3	9.7	16.1	3.2	9.7	
	Cum %	61.3	71.0	87.1	90 3	100.0	
12OB		1	2	3	4	5	Missing
	Frequency	20	3	3	1	4	19
	Percent	40.0	6.0	6.0	2.0	8.0	38.0
	Valid %	64.5	9.7	9.7	3.2	12.9	
	Cum %	64.5	74.2	83.9	87.1	100.0	
12OC		1	2	3	4	5	Missing
	Frequency	23	2	3	2		20
	Percent	46.0	4.0	6.0	4.0		40.0
	Valid %	76.7	6.7	10.0	6.7		
	Cum %	76.7	83.3	93.3	100.0		
12OD		1	2	3	4	5	Missing
	Frequency	24	1	3	1		21
	Percent	48.0	2.0	6 0	2 0		42.0
	Valid %	82.8	3.4	10.3	3.4		
	Cum %	82.8	86.2	96.6	100.0		
12OE		1	2	3	4	5	Missing
	Frequency	23	2	4			21
	Percent	46.0	4.0	8.0			42.0
	Valid %	79.3	6.9	13.8			
	Cum %	79.3	86 2	100.0			

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12PA		1	2	3	4	5	Missing
	Frequency	15	4	5	2	3	21
	Percent	30.0	8.0	10.0	4.0	6.0	42.0
	Valid %	51.7	13.8	17.2	6.9	10.3	
	Cum %	51.7	65.5	82.8	89.7	100.0	
12PB		1	2	3	4	5	Missing
	Frequency	16	4	4	2	4	20
	Percent	32.0	8.0	8.0	4.0	8.0	40.0
	Valid %	53.3	13.3	13.3	6.7	13.3	
	Cum %	53.3	13.3	13 3	6.7	13.3	
12PC		1	2	3	4	5	Missing
	Frequency	20	3	3	2	1	21
	Percent	40.0	6.0	6.0	4.0	2.0	42.0
	Valid %	69.0	10.3	10.3	6.9	3.4	
	Cum %	69.0	79.3	89.7	96.6	100.0	
12PD		1	2	3	4	5	Missing
	Frequency	22	4	2			22
	Percent	44.0	8 0	4.0			44.0
	Valid %	78.6	14.3	7.1			
	Cum %	78.6	92.9	100.0			
12PE		1	2	3	4	5	Missing
	Frequency	22	5	1			22
	Percent	44.0	10 0	2 0			44.0
	Valid %	78 6	17.9	3.6			
	Cum %	78 6	96.4	100.0			

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12QA		1	2	3	4	5	Missing
	Frequency	14	7	4	4	1	20
	Percent	28.0	14.0	8.0	8.0	2.0	40.0
	Valid %	46.7	23.3	13.3	13.3	3.3	
	Cum %	46.7	70.0	83.3	96.7	100.0	
12QB		1	2	3	4	5	Missing
	Frequency	14	6	4	6		20
	Percent	28.0	12.0	8.0	12.0		40.0
	Valid %	46.7	20.0	13.3	20.0		
	Cum %	46.7	66.7	80 0	100.0		
12QC		1	2	3	4	5	Missing
	Frequency	19	2	1	5	1	22
	Percent	38.0	4.0	2.0	10.0	2.0	44.0
	Valid %	67.9	7.1	3.6	17.9	3.6	
	Cum %	67.9	75.0	78.6	96.4	100.0	
12QD		1	2	3	4	5	Missing
	Frequency	17	3	5	4		21
	Percent	34.0	6 0	10.0	8.0		42.0
	Valid %	58.6	10.3	17.2	13.8		
	Cum %	58.6	69.0	86.2	100.0		
12QE		1	2	3	4	5	Missing
	Frequency	19	4	1	4		22
	Percent	38.0	8.0	2 0	8 0		44 0
	Valid %	67.9	14.3	3.6	14.3		
	Cum %	67.9	82.1	85.7	100.0		

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12RA		1	2	3	4	5	Missing
	Frequency	14	7	3	2	2	22
	Percent	28.0	14.0	6.0	4.0	4 0	44.0
	Valid %	50.0	25.0	10.7	7.1	7 1	
	Cum %	50.0	75.0	85.7	92.9	100.0	
12RB		1	2	3	4	5	Missing
	Frequency	14	7	2	4	1	22
	Percent	28.0	14.0	4.0	8.0	2.0	44.0
	Valid %	50.0	25.0	7.1	14.3	3.6	
	Cum %	50.0	75.0	82.1	96.4	100.0	
12RC		1	2	3	4	5	Missing
	Frequency	21	2	3	2		22
	Percent	42.0	4.0	6.0	4.0		44.0
	Valid %	75.0	7.1	10.7	7.1		
	Cum %	75.0	82.1	92.9	100.0		
12RD		1	2	3	4	5	Missing
	Frequency	17	5	3	4		21
	Percent	34.0	10 0	6.0	8 0		42.0
	Valid %	58.6	17.2	10.3	13.8		
	Cum %	58.6	75.9	86.2	100.0		
12RE		1	2	3	4	5	Missing
	Frequency	18	5	1	3	1	22
	Percent	36.0	10.0	2.0	6.0	2.0	44.0
	Valid %	64.3	17.9	3.6	10.7	3.6	
	Cum %	64.3	82 1	85.7	96.4	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12SA		1	2	3	4	5	Missing
	Frequency	11	5	8	8	3	15
	Percent	22.0	10.0	16.0	16.0	6 0	30.0
	Valid %	31.4	14.3	22.9	22.9	8 6	
	Cum %	31.4	45.7	68.6	91.4	100.0	
12SB		1	2	3	4	5	Missing
	Frequency	11	5	8	6	4	16
	Percent	22 0	10 0	16 0	12.0	8.0	32.0
	Valid %	32.4	14 7	23.5	17.6	11.8	
	Cum %	32.4	47 1	70.6	88.2	100.0	
12SC		1	2	3	4	5	Missing
	Frequency	14	4	7	1	2	22
	Percent	28.0	8.0	14.0	2.0	4.0	44.0
	Valid %	50.0	14.3	25.0	3.6	7.1	
	Cum %	50.0	64.3	89.3	92.9	100.0	
12SD		1	2	3	4	5	Missing
	Frequency	12	6	6	2	4	20
	Percent	24.0	12.0	12 0	4.0	8.0	40.0
	Valid %	40.0	20.0	20 0	6.7	13.3	
	Cum %	40.0	60.0	80 0	86.7	100.0	
12SE		1	2	3	4	5	Missing
	Frequency	15	5	4	5	3	18
	Percent	30.0	10.0	8.0	10.0	6.0	36.0
	Valid %	46.9	15.6	12.5	15.6	9.4	
	Cum %	46.9	62.5	75.0	90.6	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12TA		1	2	3	4	5	Missing
	Frequency	10	5	8	6	3	18
	Percent	20.0	10.0	16 0	12 0	6.0	36.0
	Valid %	31.3	15.6	25.0	18 8	9.4	
	Cum %	31.3	15.6	25 0	18 8	9.4	
12TB		1	2	3	4	5	Missing
	Frequency	10	6	8	4	3	19
	Percent	20.0	12.0	16.0	8.0	6.0	38.0
	Valid %	32.3	19.4	25.8	12.9	9.7	
	Cum %	32 3	19.4	25.8	12.9	9.7	
12TC		1	2	3	4	5	Missing
	Frequency	14	4	8	1		23
	Percent	28.0	8.0	16.0	2.0		46.0
	Valid %	51.9	14.8	29.6	3.7		
	Cum %	51.9	66.7	96.3	100.0		
12TD		1	2	3	4	5	Missing
	Frequency	11	7	6		4	22
	Percent	22.0	14.0	12 0		8.0	44.0
	Valid %	39.3	25.0	21.4		14.3	
	Cum %	39.3	64.3	85.7		100.0	
12TE		1	2	3	4	5	Missing
	Frequency	14	7	6	2	1	20
	Percent	28.0	14.0	12.0	4.0	2.0	40.0
	Valid %	46.7	23.3	20.0	6.7	3.3	
	Cum %	46.7	70.0	90.0	96.7	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12UA		1	2	3	4	5	Missing
	Frequency	18	5	2	1	1	23
	Percent	36.0	10.0	4.0	2.0	2 0	46.0
	Valid %	66.7	18 5	7.4	3.7	3.7	
	Cum %	66.7	85.2	92.6	96 3	100.0	
12UB		1	2	3	4	5	Missing
	Frequency	19	4	2	2		23
	Percent	38.0	8.0	4 0	4.0		46.0
	Valid %	70.4	14.8	7.4	7.4		
	Cum %	70.4	85.2	92.6	100.0		
12UC		1	2	3	4	5	Missing
	Frequency	22	2	1	1		24
	Percent	44.0	4.0	2.0	2.0		48.0
	Valid %	84.6	7.7	3.8	3.8		
	Cum %	84.6	92.3	96.2	100.0		
12UD		1	2	3	4	5	Missing
	Frequency	17	3	5			25
	Percent	34.0	6.0	10.0			50.0
	Valid %	68.0	12.0	20.0			
	Cum %	68.0	80.0	100.0			
12UE		1	2	3	4	5	Missing
	Frequency	20	4	1		1	24
	Percent	40.0	8.0	2.0		2.0	48.0
	Valid %	76.9	15.4	3.8		3.8	
	Cum %	76.9	92.3	96.2		100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12VA		1	2	3	4	5	Missing
	Frequency	16	4	5	2	2	21
	Percent	32.0	8.0	10.0	4.0	4.0	42.0
	Valid %	55.2	13.8	17.2	6.9	6.9	
	Cum %	55.2	69.0	86.2	93.1	100.0	
12VB		1	2	3	4	5	Missing
	Frequency	16	4	5	3	1	21
	Percent	32.0	8.0	10 0	6 0	2.0	42.0
	Valid %	55.2	13 8	17.2	10.3	3.4	
	Cum %	55.2	69 0	86 2	96.6	100.0	
12VC		1	2	3	4	5	Missing
	Frequency	20	3	2		1	24
	Percent	40.0	6.0	4.0		2.0	48.0
	Valid %	76.9	11.5	7.7		3.8	
	Cum %	76.9	88.5	96.2		100.0	
12VD		1	2	3	4	5	Missing
	Frequency	14	3	6	2	1	23
	Percent	28.0	6.0	12.0	4.0	2.0	46.0
	Valid %	53.8	11.5	23.1	7 7	3.8	
	Cum %	53.8	65.4	88.5	96.2	100.0	
12VE		1	2	3	4	5	Missing
	Frequency	17	4	4	1	1	23
	Percent	34.0	8.0	8.0	2.0	2.0	46.0
	Valid %	63.0	14.8	14.8	3.7	3.7	
	Cum %	63.0	77 8	92.6	96.3	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12WA		1	2	3	4	5	Missing
	Frequency	15			1		34
	Percent	30.0			2.0		68.0
	Valid %	93.8			6.3		
	Cum %	93.8			100.0		
12WB		1	2	3	4	5	Missing
	Frequency	15		1			34
	Percent	30.0		2.0			68.0
	Valid %	93.8		6.3			
	Cum %	93.8		100.0			
12WC		1	2	3	4	5	Missing
	Frequency	14			1		35
	Percent	28.0			2.0		70.0
	Valid %	93.3			6.7		
	Cum %	93.3			100.0		
12WD		1	2	3	4	5	Missing
	Frequency	14		1			35
	Percent	28.0		2.0			70.0
	Valid %	93.3		6.7			
	Cum %	93.3		100.0			
12WE		1	2	3	4	5	Missing
	Frequency	14			1		35
	Percent	28.0			2.0		70.0
	Valid %	93.3			6.7		
	Cum %	93.3			100.0		

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12XA		1	2	3	4	5	Missing
	Frequency	15	1		1		33
	Percent	30.0	2 0		2.0		66.0
	Valid %	88.2	5.9		5.9		
	Cum %	88.2	94.1		100.0		
12XB		1	2	3	4	5	Missing
	Frequency	15	1	1	1		32
	Percent	30.0	2.0	2.0	2.0		64.0
	Valid %	83.3	5.6	5.6	5.6		
	Cum %	83.3	88 9	94.4	100.0		
12XC		1	2	3	4	5	Missing
	Frequency	14		1	2		33
	Percent	28.0		2.0	4.0		66.0
	Valid %	82.4		5.9	11.8		
	Cum %	82.4		88.2	100.0		
12XD		1	2	3	4	5	Missing
	Frequency	15		1			34
	Percent	30.0		2.0			68.0
	Valid %	93.8		6.3			
	Cum %	93.8		100.0			
12XE		1	2	3	4	5	Missing
	Frequency	14			1		35
	Percent	28.0			2 0		70.0
	Valid %	93.3			6 7		
	Cum %	93 3			100.0		

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12YA		1	2	3	4	5	Missing
	Frequency	12	8	5	3	2	20
	Percent	24.0	16.0	10.0	6.0	4.0	40.0
	Valid %	40 0	26.7	16.7	10.0	6.7	
	Cum %	40.0	66.7	83.3	93.3	100.0	
12YB		1	2	3	4	5	Missing
	Frequency	11	7	8	1	1	22
	Percent	22.0	14.0	16.0	2.0	2.0	44.0
	Valid %	39.3	25.0	28.6	3.6	3.6	
	Cum %	39.3	64.3	92.9	96.4	100.0	
12YC		1	2	3	4	5	Missing
	Frequency	16	4	2	3	3	22
	Percent	32.0	8.0	4.0	6.0	6.0	44.0
	Valid %	57.1	14.3	7.1	10.7	10.7	
	Cum %	57.1	71.4	78.6	89.3	100.0	
12YD		1	2	3	4	5	Missing
	Frequency	14	4	4	3	2	23
	Percent	28 0	8 0	8.0	6.0	4.0	46.0
	Valid %	51 9	14.8	14 8	11.1	7.4	
	Cum %	51.9	66.7	81.5	92.6	100.0	
12YE		1	2	3	4	5	Missing
	Frequency	13	5	6	2	1	23
	Percent	26.0	10.0	12.0	4 0	2.0	46.0
	Valid %	48.1	18.5	22.2	7 4	3.7	
	Cum %	48.1	66.7	88.9	96.3	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12ZA		1	2	3	4	5	Missing
	Frequency	16	5	3	3	3	20
	Percent	32.0	10.0	6.0	6.0	6.0	40.0
	Valid %	53.3	16.7	10 0	10.0	10.0	
	Cum %	53.3	70 0	80 0	90.0	100.0	
12ZB		1	2	3	4	5	Missing
	Frequency	16	4	5	2	3	20
	Percent	32.0	8 0	10.0	4.0	6.0	40.0
	Valid %	53.3	13.3	16.7	6.7	10.0	
	Cum %	53.3	66.7	83.3	90.0	100.0	
12ZC		1	2	3	4	5	Missing
	Frequency	18	4	4	2	1	21
	Percent	36.0	8.0	8.0	4.0	2.0	42.0
	Valid %	62.1	13.8	13.8	6.9	3.4	
	Cum %	62.1	75.9	89.7	96.6	100.0	
12ZD		1	2	3	4	5	Missing
	Frequency	18	1	6	1	2	22
	Percent	36.0	2 0	12.0	2.0	4.0	44.0
	Valid %	64.3	3.6	21.4	3.6	7.1	
	Cum %	64.3	67.9	89.3	92.9	100.0	
12ZE		1	2	3	4	5	Missing
	Frequency	18	3	6	2		21
	Percent	36.0	6.0	12.0	4.0		42.0
	Valid %	62.1	10.3	20.7	6.9		
	Cum %	62.1	72.4	93.1	100.0		

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
12AAA		1	2	3	4	5	Missing
	Frequency	10	3	6	10	6	15
	Percent	20.0	6.0	12 0	20.0	12.0	30.0
	Valid %	28 6	8.6	17 1	28.6	17.1	
	Cum %	28 6	37.1	54.3	82.9	100.0	
12AAB		1	2	3	4	5	Missing
	Frequency	12	1	9	11	5	12
	Percent	24.0	2 0	18.0	22.0	10.0	24.0
	Valid %	31.6	2.6	23.7	28 9	13.2	
	Cum %	31.6	34.2	57.9	86.8	100.0	
12AAC		1	2	3	4	5	Missing
	Frequency	19	6	7	3	2	13
	Percent	38.0	12.0	14.0	6.0	4.0	26.0
	Valid %	51.4	16.2	18.9	8.1	5.4	
	Cum %	51.4	67.6	86 5	94.6	100.0	
12AAD		1	2	3	4	5	Missing
	Frequency	12	6	7	4	8	13
	Percent	24.0	12 0	14.0	8.0	16.0	26.0
	Valid %	32.4	16.2	18.9	10.8	21.6	
	Cum %	32.4	48.6	67.6	78.4	100 0	
12AAE		1	2	3	4	5	Missing
	Frequency	18	5	8	3	3	13
	Percent	36.0	10 0	16.0	6.0	6.0	26.0
	Valid %	48.6	13.5	21.6	8.1	8.1	
	Cum %	48.6	62 2	83.8	91 9	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
13A		1	2	3	4	5	Missing
	Frequency	3	3	9	13	13	9
	Percent	6.0	6.0	18 0	26.0	26.0	18.0
	Valid %	7.3	7.3	22 0	31.7	31.7	
	Cum %	7.3	14.6	36 6	68.3	100.0	
13B		1	2	3	4	5	Missing
	Frequency	9	9	13	3		16
	Percent	18.0	18.0	26.0	6.0		32.0
	Valid %	26.5	26.5	38.2	8.8		
	Cum %	26 5	52.9	91.2	100.0		
13C		1	2	3	4	5	Missing
	Frequency	5	3	6	17	7	12
	Percent	10.0	6.0	12.0	34.0	14.0	24.0
	Valid %	13.2	7.9	15.8	44.7	18.4	
	Cum %	13.2	21.1	36.8	81.6	100.0	
13D		1	2	3	4	5	Missing
	Frequency	7	9	8	10	3	13
	Percent	14.0	18.0	16 0	20.0	6.0	26.0
	Valid %	18.9	24.3	21 6	27.0	8.1	
	Cum %	18.9	43.2	64.9	91.9	100.0	
13E		1	2	3	4	5	Missing
	Frequency	12	9	6	6	3	14
	Percent	24.0	18.0	12.0	12.0	6 0	28.0
	Valid %	33.3	25.0	16.7	16.7	8 3	
	Cum %	33.3	58.3	75.0	91.7	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
13F		1	2	3	4	5	Missing
	Frequency	14	8	5	6	3	14
	Percent	28 0	16.0	10.0	12.0	6.0	28.0
	Valid %	38.9	22.2	13.9	16.7	8.3	
	Cum %	38.9	61.1	75.0	91.7	100.0	
13G		1	2	3	4	5	Missing
	Frequency	14	8	6	1	1	20
	Percent	28.0	16.0	12.0	2.0	2.0	40.0
	Valid %	46.7	26.7	20.0	3.3	3.3	
	Cum %	46.7	73.3	93.3	96.7	100.0	
13H		1	2	3	4	5	Missing
	Frequency	16	8	2	2	1	21
	Percent	32.0	16.0	4.0	4.0	2.0	42.0
	Valid %	55.2	27.6	6.9	6.9	3.4	
	Cum %	55.2	82.8	89.7	96.6	100.0	
13I		1	2	3	4	5	Missing
	Frequency	10	5	9	9	4	13
	Percent	20 0	10.0	18.0	18.0	8.0	26 0
	Valid %	27.0	13.5	24 3	24 3	10 8	
	Cum %	27.0	40.5	64.9	89.2	100.0	
13J		1	2	3	4	5	Missing
	Frequency	13	6	7	5	1	18
	Percent	26.0	12.0	14.0	10 0	2 0	36.0
	Valid %	40.6	18.8	21.9	15 6	3 1	
	Cum %	40.6	59.4	81.3	96 9	100.0	

QUESTION		VALUE (IMPORTANCE RATING - 1 Less 5 More)					
15A		1	2	3	4	5	Missing
	Frequency	2	2	2	9	33	2
	Percent	4.0	4.0	4.0	18 0	66.0	4.0
	Valid %	4.2	4.2	4.2	18.8	68.8	
	Cum %	4.2	8.3	12 5	31.3	100.0	
15B		1	2	3	4	5	Missing
	Frequency	5	4	10	14	12	5
	Percent	10.0	8.0	20 0	28.0	24.0	10.0
	Valid %	11.1	8.9	22.2	31.1	26.7	
	Cum %	11.1	20.0	42 2	73.3	100.0	
15C		1	2	3	4	5	Missing
	Frequency	8	6	8	13	11	4
	Percent	16.0	12.0	16.0	26.0	22.0	8 0
	Valid %	17.4	13.0	17.4	28.3	23.9	
	Cum %	17.4	30.4	47.8	76.1	100.0	
15D		1	2	3	4	5	Missing
	Frequency	1	6	11	14	11	7
	Percent	2.0	12.0	22.0	28.0	22.0	14.0
	Valid %	2.3	14.0	25.6	32.6	25.6	
	Cum %	2.3	16.3	41.9	74.4	100.0	
15E		1	2	3	4	5	Missing
	Frequency	16	5	12	5	1	11
	Percent	32.0	10.0	24 0	10.0	2.0	22.0
	Valid %	41.0	12.8	30.8	12.8	2.6	
	Cum %	41.0	53.8	84.6	97.4	100.0	

Appendix 5: Interviews and Meetings for Policy Study

Interviews with firms on attitudes to policy initiatives on learning networks: see appendix 1

Attendance at ADAPT meeting, Hertfordshire County Council, Economic Development Policy Panel, 11/03/96

Interviews on background to the ADAPT bid:

Simon Smith, Head of Economic Development, Hertfordshire County Council, various interviews and meetings.

John Rumble, Hertfordshire County Council, March 1996.

Stuart Walker, Hertfordshire TEC March 1996.

Rob Kemp, Hertfordshire Business Link, March 1996.

Interviews on the implementation of the programme:

Anthony Felstead, Hertfordshire TEC, 3 Interviews (March 1997 and November 1997).

Kim Langridge, Hertfordshire TEC, 2 Interviews (November 1997).

Ten days portfolio analysis of programmes

Appendix 6

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