

NETWORKING AND INNOVATION IN THE UK:

A Systematic Review of the Literature



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1. Executive Summary

“Overall in the UK we do a lot of networking when trying to innovate, perhaps we don’t do enough to capitalise on it and our general infrastructure is not quite adequate to support it”.

(AIM Review on Networking and Innovation, 2003).

The major points discussed in the report are:

On the Systematic Literature Review

A team of nine UK scholars were selected to produce three evidence bases on separate themes relating to innovation by conducting three systematic reviews.

This systematic review was designed to explore innovation and networking in the UK.

It was undertaken over an eight-week period; identified 628 relevant citations and reviewed 174 of them and shows the key implications for networking in the UK. The empirical evidence on which this review is based should be considered comprehensive but not exhaustive.

About Networking and Innovation

- The evidence confirmed that networks and networking amongst firms plays a pivotal role in innovation and that this has become more relevant as technologies have become more complex.
- Networking should not be viewed as a panacea for innovation as there are many other factors that contribute to innovation performance (e.g. R&D investment).
- The review found that network forms can be complex and that there is little evidence to explain which forms of network most contribute to innovation.
- The use of networks was crucially important during venture creation and for small growing firms.
- When examining the formation of networks it was concluded that there are many factors that promote and prevent their formation.
- UK Government can develop policies and mechanisms that can create institutional mechanisms that support network infrastructures.

The Key Factors Contributing to Innovation

- Diversity in firms’ relationships with external organisations has a positive impact on innovation and performance.
- The integration of suppliers, co-suppliers and distributors in innovation projects has a positive impact on the productivity of individual firms and the likeness that the innovation will succeed.
- Third parties, science partners and institutional mechanisms (e.g. incubators) play an important role by creating a network infrastructure and can act as neutral network brokers between firms.
- Effective venture finance networks can enable better opportunities for commercial success when firms innovate.
- Firms need to actively manage their networking relationships and what they gain from such relationships depends on their experience and network management competencies.
- There are many different forms of network configuration and these differ depending on the form of innovation, industry and the purpose of the network.
- Some networks can prevent innovation and be anti-competitive.
- Networks fail for a variety of reasons.

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- Government intervention can act as both a positive and negative force affecting the sustainability of particular networks and network infrastructures.
 - Principally, personal and informal relations drive the effectiveness of networking between firms.

Innovation and Networks in the UK

- UK firms appear to have strong network relationships with suppliers and business customers; although there are variations between sectors. Particularly good sectoral examples in the UK are the biotechnology, automotive and chemical industries.
- The role of trade conventions in the UK as mechanisms for collaborative innovation could be improved.
- Some UK trade associations need to play a more active role encouraging the involvement of small firms in their activities.
- UK associations (both trade and professional) need to be more careful to protect their neutrality as network intermediaries.
- The role of science partners in radical innovation has been confirmed and some current mechanisms (e.g. placements) were well regarded and had worked.
- UK venture finance networks appeared to be less well developed than the US. The study found considerable value in promoting co-investment both in the informal and formal equity finance markets.
- The UK needs to continue and expand its regional incubation capacity and improve the amount of networking activities led from incubators.
- The value of existing collaborative programmes (SMART; TCS; PhD CASE) in the UK was found to be beneficial for innovation.
- Network relationships between UK firms tended to be intermittent and driven by short-term decision-making undermining stable relationships that are required for innovation to occur.
- Formal business support has been shown to be important for encouraging networks; however, the UK could do more to promote informal networks through the business support infrastructure.
- The study confirmed that large disparities between regions in the UK had an effect on the general quality of the UK's network infrastructure.
- There was no evidence that German firms perform better than their UK counter-parts while US firms do have more effective networking skills.

The UK's performance in networking for innovation is quite strong. In the key areas linked to innovation, such as, supplier and customer engagement and links with science partners the UK performs strongly. In other areas linked to our networking infrastructure and firms' management of networks there is some cause for concern. In the UK we need to help firms learn how to leverage networks more effectively and encourage the development of longer term more stable relationships between firms. Our networking infrastructure requires more neutral intermediaries, our institutional mechanisms while operating quite well are insufficient in number when compared to competitor countries and our business support infrastructure needs to become more supportive of informal networking behaviours.

The Policy Recommendations

- During the review a large number of policy recommendations were made as they relate to particular sections.
- The review has listed these policy recommendations and prioritised them according to criteria. The following tables outline these recommendations and their likely usefulness for promoting networking behaviour.

When considering how these policies might add value to the UK's current policy infrastructure the following recommendations are made:

- In order to guide the networking activity between industries, we recommend the establishment of centres for collaboration in priority areas (for example, biotechnology). Such centres should have a national role and include regional satellites that promote commercial collaboration.
- Such centres should lead collaborative projects based on technical problems and facilitate other methods of networking (e.g. trade fairs, symposiums etc.).
- They should also act as exchange brokers promoting and facilitating peer-to-peer exchanges between organisations enabling informal networking.
- The range of tax incentives promoting collaborative innovation should be continued and expanded (for example, R&D tax credits targeted specifically at collaborative projects) and tax incentives for co-investment should be improved.

Table 1.1 Policy Recommendations Section 1

<i>Policy Recommendation</i>	<i>Cost</i>	<i>Degree of Intervention</i>	<i>Appropriateness to Policy</i>	<i>Level of Impact</i>
<i>The DTI should have a national policy on networking</i>	<i>Very Low</i>	<i>Very Low</i>	<i>High</i>	<i>High</i>
<i>Provide seed funding for business clubs, venture networks and conventions</i>	<i>Low</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>
<i>*Create R&D tax credits for collaborative projects</i>	<i>High</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>Existing barriers to the formation of new networks should be audited</i>	<i>Low</i>	<i>Low</i>	<i>Medium</i>	<i>Low</i>
<i>*Create exchange brokers to assist peer-to-peer exchanges between firms</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>	<i>High</i>

Table 1.2 Policy Recommendations Section 2

<i>Policy Recommendation</i>	<i>Cost</i>	<i>Degree of Intervention</i>	<i>Appropriateness to Policy</i>	<i>Level of Impact</i>
<i>Promote the development of 'networks of networks' cross industry and sector networks</i>	<i>Medium</i>	<i>High</i>	<i>Medium</i>	<i>High</i>
<i>Create networks for start-ups in deprived areas that bring in important economic actors (e.g. Venture Capitalists)</i>	<i>Medium</i>	<i>High</i>	<i>Very High</i>	<i>Medium</i>
<i>Undertake a promotion campaign illustrating to firms the value of working with science partners</i>	<i>High</i>	<i>Low</i>	<i>Low</i>	<i>Medium</i>
<i>Create policy interventions to encourage firms to involve supplier representatives in R&D teams</i>	<i>Medium</i>	<i>Very High</i>	<i>Medium</i>	<i>Very High</i>
<i>Support the development of industry forums for customer involvement in innovation projects</i>	<i>High</i>	<i>High</i>	<i>Medium</i>	<i>Very High</i>

Table 1.3 Policy Recommendations Section 3

<i>Policy Recommendation</i>	<i>Cost</i>	<i>Degree of Intervention</i>	<i>Appropriateness to Policy</i>	<i>Level of Impact to Policy</i>
<i>Ask the RDAs to create a strategy to develop their region's network infrastructure</i>	<i>Very Low</i>	<i>Very Low</i>	<i>Medium</i>	<i>Medium</i>
<i>Establish more network intermediaries in Universities and Colleges</i>	<i>Medium</i>	<i>Low</i>	<i>Medium</i>	<i>High</i>
<i>*Create tax incentives for co-investment by Business Angels and Venture Capitalists</i>	<i>High</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>*Create industry focused national and regional centres for collaboration</i>	<i>Very High</i>	<i>High</i>	<i>Very High</i>	<i>Very High</i>
<i>Use UK Ministries current R&D spend to create national centres for collaboration</i>	<i>Very High</i>	<i>High</i>	<i>High</i>	<i>Very High</i>
<i>Assess Intellectual Property laws with reference to collaborative innovation</i>	<i>Very Low</i>	<i>Very Low</i>	<i>Low</i>	<i>Low</i>
<i>Ensure competition laws remain strongly enforced where networks act in an anti-competitive way</i>	<i>Low</i>	<i>Medium</i>	<i>Very High</i>	<i>High</i>
<i>Support UK technology firms that work internationally</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>
<i>Retain and expand current collaborative programmes (TCS/SMART)</i>	<i>Medium</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>*Create targeted assistance on the supply chains of particular industries funding 'problem-based' collaborative projects</i>	<i>High</i>	<i>High</i>	<i>Medium</i>	<i>Very High</i>
<i>Continue strategies promoting R&D investment in UK firms</i>	<i>Low</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>Consult with Trade and Professional Associations to encourage the development of a code of practice supporting neutrality and networking</i>	<i>Very Low</i>	<i>Medium</i>	<i>Very Low</i>	<i>Medium</i>
<i>Continue and expand incubation space</i>	<i>Very High</i>	<i>Medium</i>	<i>Very High</i>	<i>Very High</i>
<i>Offer funding for wider local business networks to be created in existing incubators</i>	<i>Medium</i>	<i>Medium</i>	<i>High</i>	<i>High</i>
<i>Assist the development of Corporate Venture Capital Funds</i>	<i>High</i>	<i>High</i>	<i>High</i>	<i>Very High</i>

The Research Recommendations

During the review a large number of research recommendations were identified. These are shown in detail in Section 9 but the general conclusions about the subject can be drawn.

The evidence found by the review was quite limited, covering a large number of subjects, in many disciplines without much critical mass amongst key contributors or journals. The study of networking and innovation was found to be overly weighted toward the high technology industries with only limited focus on other areas such as manufacturing and service industries. Overall it was concluded that considerable research effort is needed both in the UK and comparatively across other countries.

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3 Preface

3.1 The DTI Innovation Review

Policy makers, practitioners and academics in the UK are engaged in a national debate about how to improve the country's innovation and productivity performance. Fuelling this debate are two specific initiatives: the DTI's Innovation Review and the Porter Report. The Innovation Review, which will be published in the autumn of 2003, involves widespread consultation with key stakeholders and is seeking to identify how the DTI and wider Government might best act to increase innovation in the UK. Key issues to be covered in the Innovation Review include:

1. The drivers of innovation.
2. Current policies and actions.
3. The role of Government and other stakeholders.
4. The potential obstacles.
5. International comparisons and benchmarking.

For information on the DTI's Innovation review, see <http://www.innovation.project@DTI.dsi.gov.uk>

3.2 The Porter Report

In addition to the Innovation Review, the DTI and the Economic and Social Research Council commissioned Professor Michael Porter and his team to conduct a review of the existing evidence on UK competitiveness. The resulting "UK Competitiveness Report" was published in May 2003 and argued that the UK has made good progress in certain aspects of the economy over the past decade. Growth in labour force utilization in the UK has been stronger than in Continental Europe, the UK's growth rate of GDP per capita has shown a rapid increase and trade and Foreign Direct Investment levels have been good. However, there is still a worryingly large productivity gap between the UK and major competitors such as the U.S., France and Germany. The UK Competitiveness Report argues that the UK economy is now in a transitional stage and the productivity and prosperity gap will widen if certain shortcomings are not addressed. The authors of the UK Competitiveness Report conclude that one of the major levers for change is to enhance the currently weak innovation capability of the UK.

In summary, the Porter and Ketels Report suggest that the UK has made considerable progress but it now needs to make a transition to a high value economy. The key question to address is how the UK can make this change.

Key findings of the UK Competitiveness Report include:

- Significant improvements in the UK competitiveness.
- Demonstrable managerial abilities.
- UK's potential in comparison to other countries.

However

- Diminishing returns from current government and company strategies.
- Weak collaborative capacity.
- Inadequate innovation, investment, management training.

Porter, M.E. et al., (2003) "UK Competitiveness: Moving to the Next Stage".

[http://www.aim-research.org/AIM Management Research Forum: Summary Report 6.](http://www.aim-research.org/AIM%20Management%20Research%20Forum%20Summary%20Report%206)

3.3 The AIM Management Research Forum

On 29th April 2003, leading academics, practitioners and policy-makers attended the first AIM Management Research Forum titled 'Post Porter: Where Does The UK Go From Here?' Delegates were presented a number of questions that were pre-defined by AIM and the DTI.

Reactions to the Porter and Ketels Report.

Is the UK in a good position to make the transition to a high value innovative economy?

What should the UK do to make the transition?

What must UK firms do in order to become more innovative?

What role should management play?

What role should Government play?

Four AIM Scholars from some of the leading UK business schools were selected to facilitate the discussion groups and subsequently to produce a report under the direction of AIM Executive Director: Professor Andy Neely. The report recommended a thorough review of all existing research relating to innovation and competitiveness in the UK.

For a copy of the report see <http://www.aimresearch.org>.

3.4 How the report was devised

Following the Management Research Forum, nine AIM Scholars (Dr Giuliana Batista, Dr Kamal Birdi, Dr Luke Pittaway, Dr Joachim Bauer, Dr Kamal Munir, Dr Maxine Robertson, Dr Michel Leseure, Dr Timothy Edwards, Dr Wes McClendon) were selected to produce three 'evidence bases' on separate themes relating to of innovation by conducting three systematic reviews. The project was managed by Professor Andy Neely (Project Director) and Dr David Denyer (Project Coordinator).

3.5 What the report contains

The study was designed to find out the extent to which UK companies are engaged in networking activities when seeking to develop their innovative capacity.

The objective of this research was to:

Establish the nature of the relationship between networking and innovation.

Compare the degree and impact of networking behaviour in the UK with that of businesses in competing countries.

Explore examples and literature on the failure of business-to-business networks.

Identify insights informing policies aimed at fostering business-to-business networking leading to greater innovative capacity.

Identify areas for future research.

3.6 Who the report is for?

This report will be of interest to the academic, practitioner and policy communities, in particular the report will:

Present policy recommendations that may feed into the DTI's Innovation Review.

Identify gaps in the evidence base, which will provide areas for future research. The report will be submitted to the ESRC's research priorities board.



4 Introduction

4.1 Background

The Porter report for the DTI has established that inter-organisational networking is critical for the development of innovative ability in firms. The extent to which UK firms are involved in networking and how this activity translates into innovative outcomes is less clear. The report concluded that the UK underperforms key competitors in this area but provided little in the way of evidence to justify the claim. The purpose of the review is to systematically explore the veracity of this claim.

The DTI mandate following the Porter report asked the question: Are UK businesses effective in external networking with other businesses in support of innovation? Following consultation it was identified that the review should concentrate on business-to-business networking; the extent to which networking translates into innovative outcomes and should include some reference to examples of failure in the construction and maintenance of networks.

4.2 The need for the review

The complexity of the issues involved requires a systematic review exploring all aspects of the existing literature and empirical evidence. Such a review is required because networking behaviour has been researched extensively from the 1980s and many useful contributions have been made linking networking behaviour and innovation. Despite the significant number of studies that have been conducted little attempt has been made to systematically translate these findings into a comprehensive review of current knowledge and there have been few attempts to link such knowledge with UK Government policies.

4.3 The purpose of the review

The purpose of the review is to explore linkage between networking and innovation using existing evidence and research to describe the nature of the relationship.

The review explains where the UK stands internationally in terms of business-to-business networking and its contribution to innovation, with particular reference and comparisons to and between the UK, USA, France, Germany and Japan.

4.4 Overall objectives

The overall objective of this review is to explore business-to-business networking activity in the UK. This can be broken down into a number of themes:

Understand how formal institutional mechanisms aimed at promoting business to business networking activity may operate, for example: mediated by professional associations; incubators; clusters et cetera.

Explore informal channels of networking leading to innovation, for example: communities of practice; mentoring schemes; knowledge brokerage; and entrepreneurial networks et cetera.

Explore how networking behaviour can be successfully translated into tangible outcomes specifically related to innovation; including a focus on different forms of innovation, such as product and process innovation.

Provide examples of network failure and inertia militating against innovation occurring within networks and explore why networks fail.



5 Methodology

5.1 Evidence-based Policy and Practice

Evidence-based policy and practice (EBPP) has emerged as a response to the poor utilisation of academic research in practice, a phenomenon shared by many physical and social science disciplines (Muir Gray, 1997; Hamer and Collinson, 1999; Trinder and Reynolds, 2000). EBPP involves the collection, synthesis and application of all high quality research relevant to a problem being addressed. This research can be integrated with practitioner or policy-maker expertise to guide decision-making and action.

Evidence-based approaches can now be found in many physical and social science domains (Petticrew, 2001), such as healthcare (Cochrane collaboration 2001; NHS Centre for Reviews and Dissemination, 2001) and social policy (Campbell Collaboration 2001; Evidence Network, 2001).

In addition, the Department of Education and Skills (DfES) has established a Centre for Evidence Informed Policy and Practice in Education.

Furthermore, a 'What Works?' Programme was introduced in the probation service following the Crime Reduction Strategy published by the Home Office in July 1998 (HM Inspectorate of Probation, 1998; Home Office, 1998).

In 1999 the Department for the Environment, Transport and the Regions (DETR) commissioned a review of the evidence base as it relates to regeneration policy and practice (DETR, 1999).

Other disciplines such as nursing (Evans and Pearson, 2000), housing policy (Davies, Nutley and Tilley, 1999; MacLennan and More, 1999), social care (Macdonald, 1999) and criminal justice (Laycock, 2000) have also adjusted the approach with varying degrees of success.

As yet an evidence-based approach to business and management policy and practice has largely been ignored. Cranfield Innovative Manufacturing Research Centre (acting on behalf of the EPSRC) recently awarded grant IMRC19 'Developing a methodology for evidence-informed management knowledge using systematic review' to Professor David Tranfield and Dr David Denyer to develop a field-tested and grounded prototype methodology for generating research evidence in the manufacturing and management fields. This prototype methodology was used to produce the three systematic reviews.

5.2 Systematic Review

In order to create a knowledge base of the best available evidence, many disciplines have made significant strides in developing review methodologies to identify, acquire, extract and synthesise existing research studies. Systematic reviews have achieved a high profile as rigorous scientific investigations, with pre-planned methods and strategies that limit bias and random error (Cook, Greengold, Ellrodt and Weingarten, 1997). These strategies include a comprehensive search of all potentially relevant articles and the use of explicit, reproducible criteria in the selection of articles for review (Cook, Mulrow, and Haynes 1997: 379). Whilst differences between medical science and management research requires adaptation of the systematic review methodology, it can be applied to the management field in order to produce a reliable knowledge stock, which can inform policy and practice (Tranfield, Denyer and Smart, 2003). The process of systematic review is shown in Table 5.1.

Table 5.1 Systematic Review Stages and Phases - Source: Tranfield and Denyer (2003)

<i>Stage 1: Planning the review</i>
<i>Step 1 – Forming a review panel</i>
<i>Step 2 – Mapping the field of study</i>
<i>Step 3 – Producing a review protocol</i>
<i>Stage 2: Identifying and evaluating studies</i>
<i>Step 4 – Conducting a systematic search</i>
<i>Step 5 – Evaluating studies</i>
<i>Stage 3: Extracting and synthesising data</i>
<i>Step 6 – Conducting data extraction</i>
<i>Step 7 – Conducting data synthesis</i>
<i>Stage 4: Reporting</i>
<i>Step 8 – Reporting the findings</i>
<i>Step 9 – Informing research</i>
<i>Step 10 – Informing practice</i>

5.3 The Review Strategy

The review strategy had a number of stages designed to provide a systematic and explicit method for the review as outlined in Section 5.2. Much of the detailed explanation and results of the review can be found in the appendices. The following steps were taken in this particular study (Table 5.2):

Table 5.2: Key Stages in this Review on Innovation and Networking

1	<i>The review team identified key words on the subject based on their prior experience (see appendix 11.2).</i>
2	<i>The key words were constructed into search strings (see appendix 11.2).</i>
3	<i>An initial search of ABI Proquest was undertaken using the basic search string innovat? AND network? The results were analysed in Procite and used to identify further key words for the main search (see appendix 11.2. additional key words).</i>
4	<i>The basic search string innovat? AND network? was used in nine search engines to identify three key citation indexes for the review (see appendix 11.3.).</i>
5	<i>The citation databases chosen were reviewed using the search strings identified in step 2 (see appendix 11. 7).</i>
6	<i>The citations identified were reviewed according to the inclusion and exclusion criteria (see appendix 11. 4) Two stages were undertaken to reduce the number of citations, the first analysed titles according to the exclusion criteria and the second analysed abstracts according to the inclusion criteria (see appendices 11.6 and 11.7).</i>
7	<i>The existing citation abstracts were reviewed according to the quality criteria (see appendix 11. 5) and separated into an A, B and C lists (see appendix 11. 6). After steps 1 to 7 174 citations remained.</i>
8	<i>The A list articles were selected and their abstracts were imported from Proquest to Nvivo. The abstracts were coded according to their content and a report structure was identified based on the coding of abstracts.</i>
9	<i>Articles were reviewed according to their relevant subject theme as identified in the narrative coding in step 8.</i>
10	<i>Sections of the report were written as the articles relevant to particular themes were reviewed. Additional articles were added in a narrative review method according to professional recommendation and references from articles included in the A list (see appendix 11.6).</i>



6 Findings

In the following section evidence from the systematic review is presented in order to demonstrate the relationship between networking and firms' propensity to innovate. A more detailed analysis of empirical findings follows in Section 7. In Section 8 the UK situation is considered in-depth and compared to the situation in the US and Germany. Before exploring the relationship between networking and innovation Section 6.1. explains the evidence base used for this study.

6.1 Results of the Review – The Evidence Base

The systematic review was carried out according to the methodology presented in Section 5.3. In the first stage of the review 628 papers were found by searching ABI Proquest, Science Direct and Web of Science citation indexes using the search strings developed (see appendices 11.6 and 11.7). Table 6.1 highlights the number of citations relevant to the subject found according to stage of the review.

Table 6.1: The Number of Relevant Citations Found During Each Stage of the Review

<i>Stage</i>	<i>Name</i>	<i>Included</i>	<i>Excluded</i>	<i>Duplicates</i>
1	<i>DATABASE ANALYSIS:</i>	628	-	-
2	<i>TITLE ANALYSIS:</i>			
	375	157	96	
3	<i>ABSTRACT ANALYSIS:</i>	332	43	-
	<i>A ranked</i>	179	-	-
	<i>B ranked</i>	-	76	-
	<i>C ranked</i>	-	77	-
4	<i>POST ABSTRACT CODING:</i>	174	-	5
5	<i>NARRATIVE INCLUSIONS</i>			
	20	-	-	

Table 6.2: Top Ten Journals Contributing to the Review

<i>Rank</i>	<i>Journal</i>	<i>Field</i>	<i>A List Citations</i>	<i>First Stage Inclusion</i>
1	<i>Research Policy</i>	<i>Economic Geography</i>	20	43
2	<i>Journal of Business Venturing</i>	<i>Entrepreneurship and Small Business</i>	18	33
3	<i>Regional Studies</i>	<i>Regional and Economic Geography</i>	16	20
4	<i>Technovation</i>	<i>Technology Management</i>	12	29
5	<i>International Journal of Technology Management</i>	<i>Technology Management</i>	11	22
6	<i>Technology Analysis and Strategic Management</i>	<i>Strategic Management; Technology Management</i>	10	17
7	<i>Small Business Economics</i>	<i>Entrepreneurship</i>	7	11
8=	<i>Journal of Product Innovation Management</i>	<i>Operations Management</i>	6	9
8=	<i>Organisation Studies</i>	<i>Organisational Behaviour</i>	6	9
8=	<i>Strategic Management Journal</i>	<i>Strategic Management</i>	6	7

The results show that networking and innovation has been studied in a number of fields within social science. These include: economic and regional geography; organisational behaviour; sociology; operations management; political economy; entrepreneurship and small business; technology management; marketing; and, strategic management. The key journals contributing to the review illustrate the fields of study that have most to say about the subject. The top journals in the review are shown in Table 6.2.

In addition to these ten journals, which have published regularly on the subject, the review sourced articles from another 47 journals. Undertaking a key word analysis illustrates the nature of the papers reviewed for this study. Table 6.3 highlights the top 10 key words and the number of times they were cited.

Table 6.3: Top Ten Key Words Cited in the Review

<i>Rank</i>	<i>Key Word</i>	<i>No. of Citations</i>	<i>Rank</i>	<i>Key Word</i>	<i>No. of Citations</i>
1	<i>Innovations</i>	56	2	<i>Research and Development</i>	50
3	<i>Small Business</i>	26	4	<i>Alliances</i>	16
5=	<i>Regions</i>	13	5=	<i>Technology Change</i>	13
7	<i>Statistical Analysis</i>	12	8=	<i>Business Networking</i>	11
8=	<i>Organisation Theory</i>	11	10	<i>Product Development</i>	10

Table 6.4: Industrial Analysis of the Papers Reviewed

<i>Industry</i>	<i>No. of Papers (A List)</i>	<i>% of Sample</i>
<i>Primary Industries</i>	<i>4</i>	<i>5.7%</i>
<i>Energy Industry</i>	<i>1</i>	
<i>Agriculture</i>	<i>1</i>	
<i>Oil and Gas</i>		
<i>Manufacturing Industries</i>	<i>12</i>	<i>17.1%</i>
<i>Automobile Component Industry</i>	<i>3</i>	
<i>Ceramics Industry</i>	<i>1</i>	
<i>Mechanical Engineering Industry</i>	<i>2</i>	
<i>Medical Equipment Industry</i>	<i>3</i>	
<i>Clothing Industry</i>	<i>2</i>	
<i>Packaging Machine Industry</i>	<i>1</i>	
<i>Service Industries</i>	<i>2</i>	<i>2.9%</i>
<i>Food Industry</i>	<i>1</i>	
<i>Financial Services Industry</i>	<i>1</i>	
<i>High Technology Industries</i>	<i>52</i>	<i>74.3%</i>
<i>Chemicals Industry</i>	<i>6</i>	<i>8.6%</i>
<i>Plastics</i>	<i>1</i>	
<i>Petrochemicals</i>	<i>1</i>	
<i>Enzymes</i>	<i>1</i>	
<i>Defence Industries</i>	<i>3</i>	<i>4.3%</i>
<i>Electronics (and related)</i>	<i>23</i>	<i>32.9%</i>
<i>Software</i>	<i>3</i>	
<i>Semiconductors</i>	<i>7</i>	
<i>Robotics</i>	<i>2</i>	
<i>Home Automation</i>	<i>1</i>	
<i>Telecommunications</i>	<i>3</i>	
<i>Pharmaceutical Industries</i>	<i>20</i>	<i>28.6%</i>
<i>Biotechnology</i>	<i>11</i>	
<i>Embryonic</i>	<i>1</i>	

Table 6.3 shows that the review was somewhat dominated by research and development, technology and product forms of innovation and there were a large number of articles by researchers focusing on small businesses and innovation within regions. Within the review the technological focus of studies was particularly evident when the type of industries analysed is explored.

Table 6.4 highlights the industries studied and the number of papers relevant to each. The sample of papers in the review is consequently balanced toward the high technology and manufacturing industries. It is clear that some caution should be used when seeking to apply conclusions from this study to primary or service industries as they only represent 5.7% and 2.9% of the sample respectively despite the fact that they account for 70% of economic activity.

In Table 6.5 the papers reviewed are analysed according to countries featured. It is important to acknowledge that the review criteria are weighted toward the UK, USA, Japan, Germany and France. As a consequence studies concentrating solely on countries outside of these five were excluded before the final list of citations was confirmed. In the following table (Table 6.5) countries outside of the principle five were only included if they made major contributions to the empirical evidence or were undertaking comparative studies which included the UK.

Table 6.5: Country Analysis of the Papers Reviewed

Country	No. of Papers (A List)	% of Sample
<i>United Kingdom</i>	36	28.3%
<i>Wales</i>	2	
<i>Scotland</i>	2	
<i>North America</i>	35	27.6%
<i>USA</i>	30	
<i>Canada</i>	5	
<i>Europe</i>	42	33.1%
<i>Austria</i>	2	
<i>Belgium</i>	1	
<i>Denmark</i>	1	
<i>Finland</i>	3	
<i>France</i>	5	3.9%
<i>Germany</i>	14	11.0%
<i>Ireland</i>	2	
<i>Italy</i>	3	
<i>The Netherlands</i>	3	
<i>Spain</i>	2	
<i>Sweden</i>	4	
<i>Switzerland</i>	2	
<i>Asia</i>	11	8.7%
<i>Japan</i>	9	7.1%
<i>Korea</i>	1	
<i>Taiwan</i>	1	
<i>Other</i>	3	2.4%
<i>Australia</i>	1	
<i>Brazil</i>	1	
<i>Israel</i>	1	

A detailed country analysis of the citations shows a number of points. Firstly, the number of studies focusing on the UK is quite high this illustrates that UK academics have made an above average contribution to the subject. It should be noted, however, that the overall total of papers focusing on the UK, although filtered to a smaller number using quality criteria, remains low in terms of total numbers (only 36 papers). Secondly, the possible comparative evidence on the subject between the UK (28.3%), USA (23.6%) and Germany (11.0%) is reasonable; however, the number of papers focusing on Japan (7.1%) and France (3.9%) is too low to warrant detailed comparisons.

Following the analysis of the A-list citations using NVIVO (see Section 5.3. stage 8) a thematic review and conceptual framework (see Figure 1) were developed. The results of the thematic analysis are presented in Table 6.6.

Table 6.6: Thematic Analysis of the Papers Reviewed

<i>Coding</i>	<i>Theme</i>	<i>Description</i>	<i>No. of Papers</i>	<i>% of Themes</i>
1.	<i>Network Formation</i>	<i>Studies that focus on how networks form and what factors inhibit or assist their formation.</i>	8	4.9%
2.	<i>Diversity of Partners</i>	<i>These papers focus on the importance of diverse partners in networks.</i>	5	3.1%
2.2.	<i>Suppliers</i>	<i>Articles which focus on the importance of supply networks within the innovation process.</i>	12	7.4%
2.3.	<i>Institutional Factors</i>	<i>Research that explores the value and contribution of institutional mechanisms for promoting networking.</i>	6	3.7%
2.4.	<i>Customers</i>	<i>Studies which explore the important role of customer business-to-business networks in the innovation process.</i>	4	2.5%
2.5.	<i>Third Parties</i>	<i>These papers focus on the role of third party networks e.g. professional and trade associations and consultants.</i>	11	6.8%
2.6.	<i>Science Partners</i>	<i>Research papers focusing on science partners as network brokers within business networks.</i>	14	8.6%
2.7.	<i>Finance Partners</i>	<i>Focusing on studies which explain the important role of equity finance networks in the innovation process.</i>	9	5.5%
3.1.	<i>Network Behaviour</i>	<i>How different behaviours within networks lead to different forms of benefits.</i>	27	16.6%
3.2.	<i>Network Governance</i>	<i>Papers that explore the role of governance within networks.</i>	13	8.0%
3.3.	<i>Network Management</i>	<i>Studies that look at the effective management of networks by firms.</i>	37	22.7%
3.4.	<i>Network Configuration</i>	<i>Research examining the makeup of networks and how these can be formed to benefit strategic goals.</i>	17	10.4%

The thematic review outlined above illustrates that a large proportion of articles focused on the firm level (micro) factors exploring how networks are managed and work in practice (57.7%). A smaller proportion of the evidence examines the macro or networking infrastructure that can support networking activity (42.3%). When the year of publication is considered it becomes clear that this subject of study and the evidence base is relatively recent. Table 6.7 describes the papers reviewed according to year of publication.

From Table 6.7 the obvious point to draw is that there has been a discernible increase in academic interest in the study of networking and its impact on innovation within the last five years. Although it is possible that these results are a consequence of the method used the results do confirm anecdotal evidence supporting the view that the evidence base has grown in recent years. The data do, however, illustrate that it is both quite young and relatively small.

Table 6.7: Papers Reviewed According to Year of Publication

<i>Year</i>	<i>No. Publications</i>	<i>Year</i>	<i>No. Publications</i>
2003	16	1991	8
2002	25	1990	2
2001	12	1989	0
2000	23	1988	4
1999	17	1987	8
1998	11	1986	0
1997	13	1985	1
1996	9	1984	2
1995	10	1983	0
1994	8	1982	0
1993	6	1981	1
1992	3		

In summary of the overall sample of evidence used for the review a number of key points can be illustrated. Firstly, the evidence base used in this study is somewhat dominated by a focus on technology and new technology industries. Secondly, the evidence is mainly focused on the UK, USA and Germany; with some bias toward the period 1995-2003. Finally, it does lack some depth in terms of the number of studies carried out. Research is also limited being spread out across a large number of authors, journals and disciplines in social science. The main conclusion to draw from the sample used in this systematic literature review is that the subject area may require some prioritisation by the ESRC's research priorities board if the evidence base is to be improved and expanded.

In Section 6.2. an overview of innovation is introduced. Section 6.3. explains how the papers reviewed relate networking to innovation; showing why networks are important.

6.2 Overview of Innovation

The ongoing national debate in the UK about the country's innovation and productivity performance provides the principle rationale for this study. The debate has focused on two specific initiatives: the Department of Trade and Industry's (DTI) Innovation Review and the Porter Report. The Innovation Review, which will be published in the autumn of 2003 seeks to identify how the DTI and Government policy in general might improve the rate of innovation within firms in the UK. The study outlined in this report explores on behalf of the ESRC/EPSRC's Advanced Institute in Management (AIM) business-to-business networking behaviour and its impact on innovation. The study is designed to review the UK's position with regard to networking and its impact on innovation.

Innovation as defined by the DTI emphasises that innovation is the successful exploitation of new ideas. The successful exploitation of a new idea can relate to different forms of innovation - product, process or organisational innovations. For the purposes of the report we adopt the DTI's broad definition:

"Innovation is the successful exploitation of ideas, into new products, processes, services or business practices, and is a critical process for achieving the two complementary business goals of performance and growth, which in turn will help to close the productivity gap".

In the following section (6.2.1.) the nature of innovation as applied by studies in the review is explored in more detail (Table 6.8) and the need for networking during the innovation process is explained.

6.2.1 Innovation and the Need for Networks

As innovation processes become more complex and products more modular, knowledge tends to be scattered among a large number of organisations (Baldwin and Clark, 2000) and firms often need to collaborate when seeking to harness this knowledge. The innovation process today is more appropriately defined as an interactive innovation process involving many different actors, organisations and institutions. The need for firms and individuals to collaborate via networks for innovation is quite different from the stereotypical view of individuals or firms working independently, creating path-breaking inventions.

The locus for innovation is no longer considered to be the individual or the firm but increasingly the network in which a firm is embedded (Powell, Koput and Smith-Doerr, 1996).

Scientific and technological breakthroughs are now considered to result from numerous contributions of many actors working in networks (Bougrain and Haudeville, 2002).

As are the standards necessary for a technology to function across different markets (Munir, 2002).

Table 6.8: A Synopsis of Innovation and the Innovation Process

<i>Form of Innovation</i>	<i>Explanation</i>
<i>Product Innovation</i>	<i>A large number of studies in the review focused on product innovation. Much of this work focuses on individual companies and their research and development networks. The work shows that for Multinational Corporations their local and technical embeddedness in the region where they have sites has an important impact on their capacity to create new product innovations overall. Some of the work examining product innovation illustrates the important part played by customers, suppliers and third parties in the innovation process. Collaborative relationships and their impact on product innovation are also shown to be spatially linked or are more likely to occur where dense networks already exist. Studies in this area do illustrate that the nature of networks differ for product innovation when compared with other forms, while illustrating that they can reduce costs, improve quality and reduce product development time.</i>
<i>Process Innovation</i>	<i>Very little research has been conducted on the role of networks in the development of process innovation. Process innovations aim to improve services and therefore tend to be developed in the service sector. The systematic review did not identify relevant studies in this area. In some instances product and process innovation were discussed in combination. From the work that has been carried out it can be observed that collaborative relationships and social networks can assist the diffusion of process innovations and that diffusion tends to occur due to different network configurations.</i>
<i>Continuous / Incremental Innovation</i>	<i>Distinctions are made between incremental/continuous innovation and radical innovation. This distinction is rather crude. However, studies tend to focus more on radical, or at least the development of significant product innovations. The institutional context is considered to be an important variable promoting the development of radical or incremental innovations.</i>
<i>Organisational innovation</i>	<i>Managerial involvement in social (largely informal) networks together with involvement with consultants and vendors inside and outside organisations has been viewed to impact on the adoption of new organisational practices. This form of innovation is best illustrated by Continuous Improvement Networks.</i>
<i>Innovation Diffusion</i>	<i>Study on innovation diffusion tends to focus on both the diffusion of technologies and product innovations and the diffusion of ideas and practices. Some of the work argues that small firms are more important than others when questions about diffusion are asked and empirical study explores the value of larger firms in diffusing their innovations within a locality and how this impacts on cluster development. Again the studies largely point to the importance of individual behaviour and informal social networks in the diffusion of innovations.</i>
<i>Radical Technological Innovation</i>	<i>The sources of ideas embodied in successful technological innovation have been a subject of many studies since the 1950s. This review found that radical technological breakthroughs can still occur in firms that lack adequate resources where they use networks to collaborate. Such networks usually involve communication between individuals including scientists and engineers in different organisations. The spatial reach of these networks tends to be greater where innovations are relatively novel. Networks for radical innovation tend to differ from those associated with new product development. The UK would appear to have an environment that encourages this form of innovation (Section 7.2.1. – Network Governance).</i>

Table 6.9 Continued from 6.8: A Synopsis of Innovation and the Innovation Process

<i>Form of Innovation</i>	<i>Explanation</i>
<i>Regional Systems of Innovation</i>	<i>Concepts of innovation have changed in economic geography, they have moved away from a focus on company innovation to a focus on regional and national systems of innovation. Some of these studies use patent-to-patent and patent-to-science citations as a method to analyse regional networking and its impact on innovation. Regional systems of innovation can be viewed as providing access to networks within a region via the development of a regional innovation infrastructure. Much of the work has been conducted outside of the UK and illustrates the value of localisation or embeddedness within a region when exploring networking and innovation. Existing studies currently reflect on the inability of these concepts to impact on regional policy making.</i>
<i>Research and Development Capability</i>	<i>A number of the studies analysed specifically explored research and development networks. They examined how small firms create research capacities; R&D intensity and the extent to which internal capacities influence the management of R&D networks. These studies show that internal research capacities and competencies enable firms to exploit networks more effectively; helping subsequent design to be more market focused. The body of work however does not find much difference between well-resourced internal R&D and networked R&D in terms of innovation performance. Networked R&D, however, assists the development of knowledge spillovers, or indirect incremental innovations localised around the research activity.</i>

A UK sector that exemplifies the positive relationship between networking activity and innovation is the biotechnology sector. The value of collaboration for innovation is widely documented as a key feature of the biotechnology industry. A rapidly evolving, complex knowledge base underpins the industry and the competencies and capabilities needed to take a scientific breakthrough to the market are scattered across a host of different organisations. As described in Box 1 the development of relational skills is a key requirement for success.

While the biotech industry illustrates the importance of networking for innovation the need to network when seeking to innovate is a prerequisite across the majority of sectors.

BOX 1: The Case of the Biotechnology Industry

The biotechnology industry illustrates why networking is indispensable in situations where scientific and technological knowledge is developing at a rapid pace. From their foundation firms must translate scientific discoveries into commercial technologies and new medical products. Biotech firms need: large amounts of capital to fund costly research; assistance with management and clinical trials; and later on, experience with the regulatory approval process, manufacturing, marketing, distribution, and sales.

The technological and scientific knowledge required to stay on top of such a field is diverse and the industry is complex and changing rapidly. In this business, many new areas of science have become inextricably involved, ranging from genetics, biochemistry, cell biology, general medicine, computer science, to even physics and optical sciences. Modern biotechnology is not a discipline or industry but a set of technologies relevant to a wide range of disciplines and industries. Since all the necessary skills and organisational capabilities needed to compete in the industry are not readily available under one roof biotech firms have regularly entered into a wide array of alliances to gain access to different competencies and knowledge.

Many of these alliances are with pharmaceutical companies that provide a set of organisational capabilities that biotech firms are lacking. Others are with research institutes and other firms designed to help biotech firms stay abreast of the latest technological and market opportunities. Success in the biotech industry depends on a firm's ability to access knowledge and skills located beyond their boundaries. (Adapted from Powell, 1998).

Comment: *A key challenge for both small biotechnology firms and large global pharmaceutical corporations is to learn to collaborate and learning from collaborations with external parties by constructing a portfolio of collaborators. Many high-tech industries have a similar need to develop and benefit from network relationships when seeking to innovate.*

The management field has shown that networking significantly boosts the innovation output and competitiveness of firms in a diverse range of industries (Ahuja, 2000; Powell, Koput and Smith-Doerr, 1996). Industries where networking has had an identifiable impact on innovation include (see Section 6.1 and Table 6):

Service industries: financial services; food.

Primary industries: agriculture; energy; oil and gas.

Manufacturing industries: automobile components; ceramics manufacturing; clothing; mechanical engineering; packaging machine industry.

High-tech industries: aerospace and defence; biotechnology; electronics; embryonics; enzymes; home automation; petrochemicals; plastics; robotics; semiconductors; software; telecommunications.

Gemser, Leenders and Wijnberg (1996) show the impact of networking in the global pharmaceutical industry, the US computer industry and the Italian furniture industry. They demonstrated in their case studies that the annual growth rate of 18% in the pharmaceutical industry was largely linked to networked research and development. Likewise the development of clusters in the US computer industry was based on networking and proximity, which led to an increase in innovation and assisted rejuvenation of the industry during the 1980s. In the Italian furniture industry the international competitiveness of the industry is largely down to continuous improvements and product differentiation which has been supported by the presence of industrial districts consisting of a network of small loosely organised (family) firms which are geographically clustered.

BOX 2: The History of Networking in the Aircraft Industry (Europe)

Among other high-tech industries aviation has witnessed a rapid increase in transnational networks among firms that have co-developed high-risk innovations. The development of Concorde by Aerospatiale and BAE Systems was one of the first of these collaborations in the European context. This set the stage for new European networks, such as: Airbus, Avions de Transport Regional (ATR) and Aero International Regional. In military aircraft European collaboration dates back to Panavia, established in 1969 and has extended with Eurofighter and Europatrol.

Transnational innovation networks are usually focused on one technology, one market and two or more countries. Such networks happen where two countries are specialised in different technology-market combinations. They collaborate in two ways: one country can recombine the technology in which it is specialised, with the market in which the other country is specialised and vice versa. The recombination of specialisation allows parties to explore a new technology-market trajectory collectively.

Two examples:

The Concorde aircraft was developed by Aerospatiale (France) and BAE Systems (UK), it was an early jet engine passenger aircraft developed during the 1960s. At the time, France was specialised in jet technology and the UK had a long record in the passenger market. Concorde was the first passenger aircraft with delta wing construction, which had been used in several French fighters developed in the 1950s.

The European Airbus Consortium started developing aircraft in the 1970s. The consortium included Aerospatiale, BAE, the German firm DASA and the Spanish firm CASA. Airbus concentrated its product innovations exclusively on passenger aircraft using turbofan technology. At the time of the establishment of Airbus, France had switched its technology base to turbofans, while the UK was still specialised in passenger aircraft. Germany and Spain had less experience in aircraft technology, Airbus provided these countries with a way to leave their old specialisation and enter a new market of state-of-the-art technology. The entry of Airbus into the turbofan passenger market was, therefore, driven by a recombination of competencies for some countries and a development strategy for others'. (Adapted from: Frenken, 2000)

Comment: *Networks across national boundaries in certain leading edge technologies can lead to the discovery of new national innovation competencies and the recombination of existing ones. Industrial policy can promote such collaborations in particular industries; current examples where such networks might be more valuable include robotics, nanotechnology and biotechnology.*

As well as the discovery and recombination of competencies as shown in the aircraft industry there are other benefits. For example, Gemünden, Ritter and Heydebreck's (1996) study examine networking effects of innovation in six high-tech industries. The research demonstrates that firms using particular forms of networking categorised by their relationship with specific parties were likely to have nearly 20% more product improvements than firms who did not network. Likewise the development of new products was 7-10% higher in these firms. The degree of innovation success in the study also illustrated a much greater chance of the innovation being technically successful and more economically relevant where firms used networks (Gemünden, Ritter and Heydebreck's, 1996).

To summarise the innovation benefits of networking identified by the literature include:

Risk sharing (Grandori, 1997).

Obtaining access to new markets and technologies (Grandori and Soda, 1995).

Speeding products to market (Kogut, 1989).

Pooling complementary skills (Hagedoorn, 1993; Eisenhardt and Schoonhoven, 1996).

Safeguarding property rights when complete or contingent contracts are not possible (Leibeskind et al, 1998).

Acting as a key vehicle for obtaining access to external knowledge (Powell, Koput, and Smith-Doerr, 1996; Cooke and Morgan, 1993).

Firms which do not cooperate and which do not formally or informally exchange knowledge limit their knowledge base on a long-term basis and ultimately reduce their ability to enter into exchange relationships.

6.2.2 The Diffusion of Innovation

While networks play a crucial role promoting innovation within and across firms they also assist the diffusion of innovations across and within sectors. At an institutional level, national systems of innovation can play an important role in the diffusion of innovations (Nooteboom, 2000, Furtado, 1997). The UK system has important similarities to the US system of innovation and can be characterised as one which:

Encourages the mobility of labour.

Promotes the development of non-exclusive and short-term inter-firm relations.

Is supported by a strong legal infrastructure (Nooteboom, 2000).

On this basis the UK system potentially limits the diffusion of innovations because it does not encourage long-term embedding of complementary knowledge across contexts. This will only occur where close, durable co-operative relations between firms are maintained (see Section 7.2.1).

Instead Nooteboom's (2003) characterisation of the UK system suggests that it promotes the diffusion of more radical innovations that demand entrepreneurial activity cutting across sectors, rather than promoting the diffusion of innovation within sectors (see Section 8.2).

At an organisational level, the involvement of managers and lower level employees in professional, industry and cross-industry networks has been found to promote the diffusion of innovations (Robertson et al, 1996, Erickson and Jacoby, 2003). The more involvement individuals have in these forums the more likely it is that the firms in which they are employed will adopt new innovations. Networks are not only critical for accessing knowledge to create in-house innovations or for the diffusion of technological innovation but they are equally important for learning about innovative work practices that others have adopted (Erickson and Jacoby, 2003). They influence this by:

Enhancing access to knowledge, promoting awareness and early adoption of innovations.

Promoting social interaction, generating trust and reciprocity that is conducive to knowledge transfer.

Creating via reciprocity incentives to share information.

Enhancing trust and thereby improving the quality of information being shared.

Creating networking adeptness, assisting the diffusion of more complex information and know-how (Uzzi, 1997).

The majority of research on the diffusion of innovation highlights the role of individuals and more specifically the importance of interpersonal and informal networking for the diffusion of innovations. While the utility of networks for enhancing the development of innovations and innovation diffusion is well established there appears to be a need for more research on the impact of networking on the diffusion of different forms of innovation in the UK context. In the next section (6.3.) the nature of networks and their contribution to innovation is explored in further detail.

6.2.3 Overview of Networking

For the purposes of this study a network has been defined as: "a firm's set of relationships with other organisations" (Perez and Sanchez, 2002) while a relationship or linkage is defined as "inter-organisational interaction processes and bonds with economic targets, directed to a sequence of exchanges" (Germünden 1990). The literature on networking shows that firms collaborate in networks for different reasons the most common being to access new or complementary technologies and new markets.

6.2.4 The Nature of Networks

While the benefit of networks for learning and innovation is beyond dispute, the question of how firms should position themselves within networks, or what kinds of networks contribute more to innovation remains a little less clear (the diversity of network forms in this review is illustrated in Table 6.9). That trust is an important ingredient of a successful network is well established, but importantly, the structure of the network is debated widely in the literature (Ahuja, 2000), for instance:

Shan, Walker and Kogut (1994) suggest that the number of collaborative relationships that a firm is involved in is positively related to innovation output.

Closed networks seem to foster innovation more than open ones (Coleman, 1988).

Burt (1992) finds that rather than maximizing the number of ties, firms should strive to position themselves strategically in gaps between different nodes, so as to become intermediaries.

Brass and Burkhardt (1992) propose that the best position is one where all firms are tied only to the focal actor.

Ahuja's (2000) research shows that the benefits of increasing trust, developing and improving collaboration and reducing opportunism create cohesive interconnected partners.

This research currently highlights that there is no consensus on the optimal networking configuration. The nature of networks encountered in this review illustrates that the optimal design for a network is contingent on the actions that the structure seeks to facilitate.

For example:

A network composed of relationships with partners with few ties to others would enable control for the principle partner. Such a network might be the objective for a firm seeking power over its buyers or suppliers.

A network composed of partners with many interlocking and redundant ties would facilitate the development of trust and cooperation. Such a network may be useful when all partners are faced with common problems, for example, adverse legislative actions or new technological opportunities.

A network of many non-overlapping ties would provide information benefits. Such a network would be ideal for an organisation whose primary business entails the brokerage of information or technology.

Table 6.10: Forms of Network in Brief

<i>Form of Network</i>	<i>Explanation</i>
<i>Network Types</i>	<i>A few studies have attempted to identify network forms or types. More generally networks and network relationships are characterised by the development of direct ties, indirect ties, structural holes, intra and inter-organisational relationships.</i>
<i>Knowledge Networks</i>	<i>Study on knowledge networks focuses on how networks create and transfer knowledge. Studies show the importance of local knowledge in the networking capacity of small firms, the importance of regionalism and explain how knowledge networks are constructed. Much of the work examined explores issues associated with learning through networks and illustrates their importance for sharing tacit knowledge.</i>
<i>Investment Networks</i>	<i>The UK equity gap is generally well documented but the UK 'investment network gap' has been explored less. Studies in this area have focused on the importance of investment networks and have illustrated their value for early stage investment and for spreading the risk amongst equity investors. Joint investment networks have been shown to be crucial both in venture capital finance and for informal business angel investment. The sharing of information on investment portfolios has also facilitated more effective investment levels in promising businesses. Likewise informal investment referral networks between investors have shown their value for enabling prospective entrepreneurs to meet appropriate investors.</i>
<i>Network Clusters</i>	<i>Much research has been carried out on the spatial proximity of firms in clusters and the benefits of clustering for networking. Some studies consider this to be the distinguishing factor between innovative and less innovative regions. How firms relate to each other in clusters has been less well considered. It has been argued that the mere proximity of firms does not necessarily impact on networking or innovation. Some cluster studies do illustrate the importance of conglomerations for attracting venture finance.</i>
<i>Regional and National Networks</i>	<i>Some of the studies reviewed explore intra-regional, inter-regional and international networks. These studies typically draw on economic geography but also include studies of Multinational firms. Many of these identify the importance of region-to-region knowledge exchange via networks and its impact on innovation. In certain industries these studies illustrate the importance for international networking even for very small firms e.g. biotechnology</i>
<i>Science-industry Networks</i>	<i>Although the study focused primarily on business-to-business networks science-industry relationships appear to be important for network brokerage and frame-breaking change. For example, non-business systems were viewed to provide a different stimulation for innovation, which could not be found within normal business routines. These interactions were viewed to take place most effectively between individuals, where communicating networks of scientists and engineers work together. Science enterprise was also shown to enable the creation of networks around focal points promoting the development of clusters in the same way that large organizations can. Proximity to publicly funded research organisations was also shown to be instrumental in the innovative effort of the small firm sector.</i>
<i>Supply Chain Networks</i>	<i>There were a large number of studies examining the supply chain network and its impact on innovation; particularly product innovation. These studies illustrate that engaging suppliers and customers in networks enables information exchange leading to more effective innovation. Whilst these may seem to be in the main to be naturally occurring, firms that had adopted a strategic approach to the development and management of relationships with customers and suppliers were found to be more innovative.</i>
<i>Strategic Networks</i>	<i>The strategic network literature explores networks as a strategic resource for firms and seeks to explain how firms can manage them more effectively. Such work explores how organizations can exercise strategic control over their relationships and explains how concepts of network management can be included in the strategic planning process.</i>

6.2.5 Network Formation

There are two major reasons that explain how business-to-business networks form.

The first focuses on the resource requirements of firms where they are induced to form network relationships with other firms as a way of obtaining access to technical and/or commercial resources they lack (Ahuja, 2000). The availability of opportunities to form relationships tends not to be viewed as a constraint.

The second argues that opportunities to form links tend to reflect prior patterns of inter-firm relationships. A firm's ability to develop network relationships with other firms is consequently based on its existing relationships and network capability (Granovetter, 1983).

Research conducted in the global chemical industry between 1979 and 1991 (Ahuja, 2000) highlighted that firms were most keen to form linkages with other firms where those firms had a high level of commercial competence. Barriers to network formation occur for two reasons:

Firms with high levels of technical and commercial competence are less likely to see the value of forming network relationships with other firms.

While businesses with few existing relationships often lack the technical and commercial competences required when attracting partners (Ahuja, 2000).

Study of the UK/US defence industry has highlighted that dependency in relationships occur because of the breadth of links between partners, such dependency and breadth often leads to the emergence of more complex networks (Grandori and Soda, 1995; Coles et al. 2003).

Social institutions influence the relative effectiveness and ease within which business-to-business networks form. These institutions affect the cultural conditions and infrastructure for networking, as well as, acting as brokers and intermediaries in network formation. Such institutions as: the legal system; the banking and finance system; the structure of labour markets, the education system and the political system (Grandori and Soda, 1995) shape the development of the infrastructure required to assist the formation of business-to-business networks.

6.2.6 Networks and Entrepreneurs

Networking is not only valuable for established businesses but is also beneficial for entrepreneurs. Through networking the success rate of entrepreneurial initiatives can be significantly enhanced (Baum et al, 2000) because interpersonal and inter-organisational relationships enable actors to gain access to a variety of resources held by other actors. For example, network relations provide emotional support for entrepreneurial risk-taking, and this in turn is thought to enhance persistence to remain in business (Hoang and Antoncic 2003).

A number of studies show that successful entrepreneurs consistently use networks to get ideas and gather information and advice (Birley, 1985; Smeltzer et al, 1991; Hoang and Young, 2000). Ties to venture capitalists and professional service organizations are other means for tapping into key talent and market information (Freeman, 1999).

Alliances enable firms to gain access to resources, particularly when time is of the essence (Gulati, 1998; Teece, 1992).

Networks enable small business owners to link into R&D that is contracted out by larger firms; to engage in joint R&D ventures; and, to set-up marketing and manufacturing relationships (Rothwell and Dodgson, 1991).

BOX 3: Networking in Entrepreneurial Processes (Sri Lanka)

'Kodithuwakku and Rosa's study explored the role of the entrepreneurial process in the economic success of Sri Lankan villagers. The study provided a natural experiment because families with no previous assets were settled on two and half acres of land in 1984. From equal beginnings the village had polarised 10 years later into a majority of economically unsuccessful villagers and a small but influential entrepreneurial class. The economically unsuccessful villagers had entered a cycle of poverty, having to become workers. The successful entrepreneurs in contrast had accessed a range and combination of economic opportunities and had started multiple ventures. The study revealed that entrepreneurial processes were important in the successful entrepreneurs emergence. They were not much more innovative than the unsuccessful villagers but they were more creative and persistent in finding ways to mobilise scarce resources. In particular, their ability to extract value from their social networks and contacts was a vital element in their struggle to accumulate more capital'. [adapted from Kodithuwakku and Rosa, 2002].

Comment: *Social networking capability and the ability to extract economic value from networks may be more important than having innovative ideas in the business start-up context. Policies promoting the establishment of relationships between people trying to start businesses and other economic agents may assist general business formation, survival and growth; particularly where these are targeted on venture creation in relatively deprived areas.*

As Baum et al (2000) also found start-ups can enhance their early performance at the time of their founding through:

Establishing an alliance network.

Configuring the network to provide efficient access to diverse information and capabilities with minimum costs of redundancy, conflict and complexity.

Allying with potential rivals that provide more opportunity for learning and less risk of intra-alliance rivalry.

Although networking behaviour has been shown to help entrepreneurial endeavour it is not clear whether the UK's education system enables individuals to learn how to extract economic value from networks.

Section 6 In Summary:

Network forms are typically complex.

There is little evidence to explain which forms of networks most contribute to innovation.

Networks are also crucially important for venture creation, small businesses and business growth.

Research on formation concludes that there are a range of factors promoting and preventing the establishment of networks and those institutional mechanisms play an important role in this regard.

6.3 Stage 1: Policy and Research Recommendations

To conclude this overview of the relationship between networking and innovation the following policy recommendations and research priorities are highlighted.

Promoting Innovation through Networks – Policy Recommendations

Current research supports the view that networking significantly boosts innovation output and the competitiveness of firms in a diverse range of industries and networking does require an appropriate infrastructure. Likewise firms that do not cooperate have access to a limited knowledge base over the longer term. Consequently, it is appropriate for the UK government and the DTI in particular to develop a strategy for assisting the development of networking infrastructures in the UK.

Managerial networking across contexts impacts on the adoption of good practice.

Policies promoting management networking, such as, seed funding for business clubs, venture networks and industry conventions can promote diffusion.

Such networks range in focus but diffusion of practices may occur more effectively where networks are cross-functional, engaging actors from a range of contexts (See Section 7.4.2. Adopting Promising Practices Systematic Review).

Dense networks do impact on long-term innovation. Where close collaboration already exists, incentive policies can promote the continuance of long-term relationships. For example, R&D tax incentives for collaborative projects may promote the emergence of longer-term network relationships. This may be promoted above R&D credits for a firm's individual effort.

The formation of networks is directly linked to social institutions; therefore, existing infrastructures may inhibit network formation in the UK. It is considered worthwhile that existing barriers to network formation are audited from a policy point of view.

Region-to-region knowledge exchange via networks assists innovation. Policies that promote peer-to-peer exchanges and inter-regional networking within and outside the EU should be encouraged by the DTI. Policy initiatives might include the use of exchange brokerage for vetting partners and promoting peer-to-peer secondments led by British Councils.

Access to networks for prospective entrepreneurs is essential for a variety of reasons; however, in general networks in deprived areas are rare. Policies to promote community involvement by economically active actors (e.g. successful entrepreneurs; venture capitalists) in deprived areas should have a positive effect on business start-up rates in these locations.

Research Recommendations

There is only limited coverage of the impact networking has on process driven innovation and on organisational innovation. Future research could seek to explore this relationship by focusing on the evolution of different network configurations that occur when new processes are developed and implemented.

Further study could focus on the way in which social/informal networking impacts on the adoption of new practices (See Section 7.4.2. Adopting Promising Practices Systematic Review).

Work drawing on existing concepts of regional systems in economic geography could be reviewed systematically to provide valuable policy insights for Regional Development Agencies.

There appears to be a need for further research on how networks promote the diffusion of innovation, particularly in the UK context focusing on different forms of innovation.

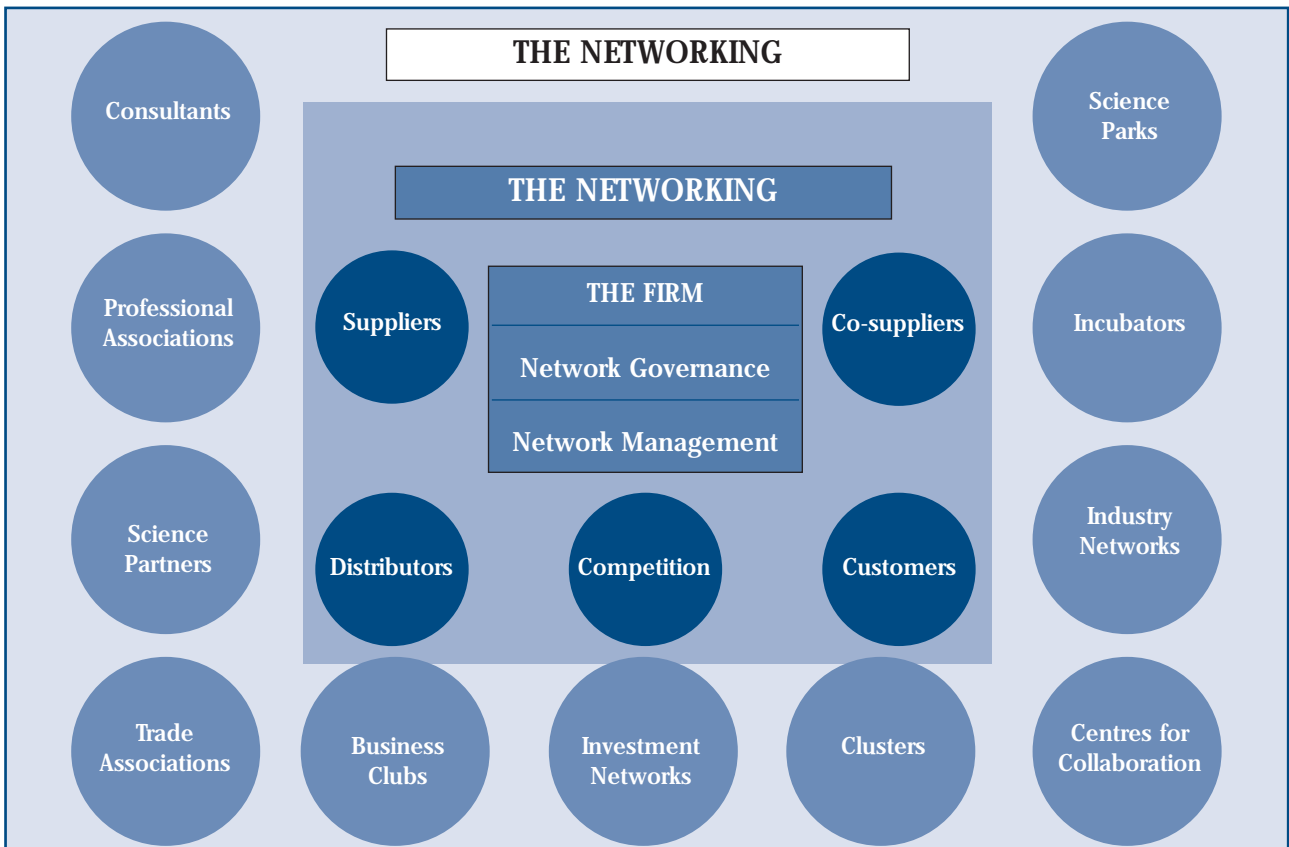
There are few studies focusing on the dynamics of network formation and very few of these are in the UK. Those studies that exist are beginning to touch on a relatively complex phenomenon. This review would encourage further research in this domain.

A key feature of networks is their capacity to promote learning and the transfer of tacit knowledge; such informal networking provides benefits for innovation. Although this has been highlighted well the mechanisms through which this occurs is an important area for future understanding.

Another important gap in the research is the extent to which networking promotes and supports entrepreneurial endeavour. Such effort can have a direct impact on wealth creation, innovation and productivity improvement. Consequently, further research in this subject would continue to add value.

A conceptual framework drawing together all of the key aspects of networking identified by this preliminary review (Section 6) is presented in Figure 1. The model will be used to guide discussion in Sections 7 and 8.

Figure 1: AIM Conceptual Framework: Networking and Innovation



7 Relationships between Networking and Innovation

In this section detailed empirical evidence from the systematic literature review is provided to more fully explore the process of network formation and the types of network relationships UK firms could engage in and the benefits in terms of innovation across sectors.

7.1 Diversity of Partners

Research on 'innovation systems' has recently illustrated that innovation occurs more effectively where there is exchange of knowledge between systems, for example: between different industries; between regions; or, between science and industry. Based on this work the importance of diversity of relationships in networks has been shown to have an impact on innovativeness (Kaufmann and Tödtling, 2000). In Figure 1 Ritter and Gemünden (2003) emphasise the different forms of partners a company can have and the contributions they make to innovation.

The value of diverse partners for innovation is further explored in Kaufmann and Tödtling's (2001) empirical research. The conclusions drawn are also supported by Perez and Sanchez's (2002) work on technology networks in the Spanish automobile industry and Romijn and Albu's (2002) work on small high technology firms in the UK.

They show that many actors both inside and outside the firm influence innovation.

That the most important partners are from the business sector, customers first (33.5% of firms) and suppliers second (21.9% of firms). This compares to 68% of firms working with customers and 50% with suppliers in the Spanish automobile industry (Perez and Sanchez, 2002).

That the willingness of firms to co-operate outside of these relationships was rather limited. For example, co-operation with Universities was 8.9% of firms in Kaufmann and Tödtling's work and 35% in Perez and Sanchez's study. Research in Germany however highlights significant national differences with respect to involvement with research institutes and universities (Gemünden et al. 2003).

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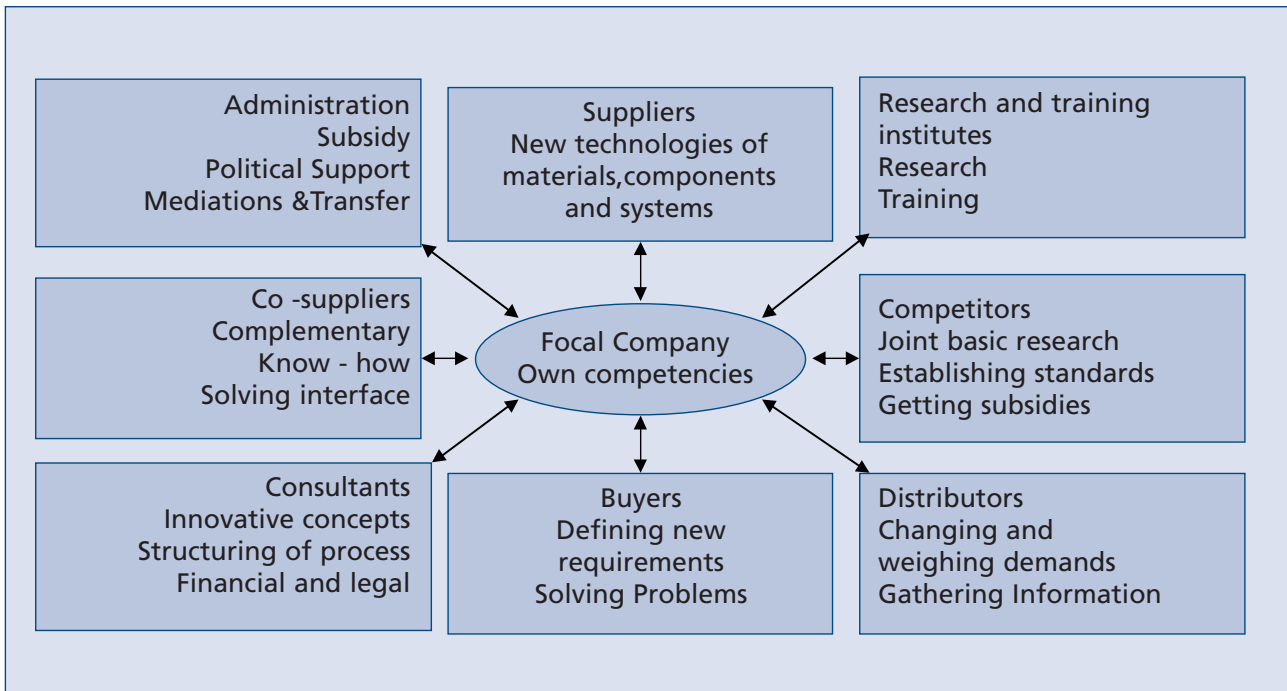
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Figure 2: Innovation Partners and their Contributions – Ritter’s and Germünden’s Model (2003)



When exploring different forms of innovation the studies showed that incremental innovators rely more frequently on their customers as innovation partners whereas firms that have products new to a market are more likely to collaborate with suppliers and consultants. More advanced innovators also interact more with Universities (12.6%). The conclusion of Gemünden, Heydebreck and Herden’s (1992) detailed survey of 4564 firms in the Lake Constance region (on the border between Austria, Germany and Switzerland) makes the point well based on good empirical evidence examining interactions between firms, customers, suppliers and university interactions: “Firms which do not supplement their internal resources and competence with complementary external resources and knowledge show a lower capability for realising innovations” (p. 373).

In conclusion the evidence shows that the innovation process, particularly complex innovation processes, benefit from the clash between different access to knowledge, behaviours and habits of thought. These lead to communication between people with different information, skills and values that increase the chance of unforeseen novel combinations of knowledge, which can lead to discovery. More risk-averse firms, however, link their innovation activities to customers because knowledge of clients’ demands reduces the risk of failure for the innovating firm. Innovation is no less valuable but is more incremental and productivity gains are more modest. Firms that do not network show much lower levels of competence in innovation.

Some of the key contributors to the innovation process as outlined by the model in Figure 1 are suppliers, co-suppliers and distributors working with or for an innovating firm. Section 7.1.1., highlights how suppliers and other firms in the supply network contribute to the innovation process.

7.1.1 Suppliers

The integration of suppliers during the process of innovation has been highlighted as one of the factors leading to frame-breaking innovation (Kaufmann and Tödtling's, 2001; Perez and Sanchez's, 2002; Romijn and Albu's, 2002). In Box 4 the relationship between Toyota and Denso provides one example.

Although the example provided shows a situation of decline in the relationship between Toyota and Denso, the value of including suppliers in new product development innovation has been widely documented in the supply chain literature (Ragatz et al., 1997). For example, firms having strong supplier networks report higher levels of productivity than those reporting weak alliances over time (Perez and Sanchez, 2002). It has been found that the effective integration of suppliers in new product development processes can:

Have a significant impact on cost, quality, technology, speed and responsiveness of buying companies.

Help manufacturers identify improvements that are necessary for them to remain competitive.

Enable firms to bring to bear wider expertise during the development process.

Help reduce concept-to-customer cycle time, costs and reduce quality problems.

Lead to higher levels of productivity and quality.

Assist with improvements in the overall design effort.

Lead to closer more open supplier relationships.

Create easier access to supplier knowledge and expertise in the longer-term.

Provide clearer focus on the projects that require joint development.

Lead to improved communication between the partners.

BOX 4: Change in Supply Networks the Case of Toyota and Denso (Japan)

When examining organisational learning and networks a good deal of attention has been paid to purchase-supply relations in Japanese manufacturing. A fascinating case is the evolving relationship between Toyota and Denso Corp, the car manufacturer's divested division and long-term Keiretsu supplier of automobile electronic components. It is a story of networks enabling companies to economise on knowledge by shifting production to parties with special capabilities.

The history of Toyota's effort to acquire competence in automobile electronics is one in which intra-firm learning has proceeded hand-in-hand with weakening of one of the oldest Keiretsu supply relationships. Toyota has been a specialist, with a highly focused core competence in the design and assembly of sedans. More recently it has worked with an array of partner firms to manufacture both the components for cars and has broadened its production to include trucks, mini-cars and other vehicles. Toyota has not had the expertise to manufacture in-house all of the relevant components for the cars it assembles. In particular electronic parts were outside its core skills and it entrusted the development of these to Denso. This has been a long-term relationship where Toyota reduced its need to invest in complex skills and electronic technology and Denso, although reliant on one customer used their Keiretsu bond as a governance structure to reduce the risks of reliance.

Toyota has now moved to producing four electrical engineering divisions that are in direct competition with Denso. The steep decline in Toyota's procurement from Denso is noteworthy and runs counter to the strategies applied by GM, VW and other Western automakers where they are aggressively diversifying internal parts divisions. Why then has Toyota pursued this strategy? Their rationale is that the contribution of electronics to the total value of a car has greatly increased and that Toyota can no longer stay ignorant of such technology. Electronic systems are so integrated into car design that they are no longer distinct from mechanical parts. Toyota desires the capability to produce these components so that it can evaluate what it is purchasing and recognise where future improvement and innovation is required. [adapted from Lincoln, Ahmadjian and Mason, 1998].

Comment: *Not all innovation strategies depend on networking. In some contexts the internalisation of innovation may be more important than external relationships. Public policy, therefore, needs to be careful not to view networking as a panacea for innovative activity. It can do so by creating an environment where networking can occur more easily but should leave engagement in networks open to the strategic choice of individual companies.*

The supply chain literature has illustrated the value of supplier interaction in innovation and has sought to explain how these interactions can be most effectively managed. Table 7.1 summaries the identified improvements for effective supplier integration in Ragatz's et al (1997) study while Table 7.2 summaries the management practices that encourage effective networking behaviour in the supply chain.

When examining management practices, including suppliers in the buyer's development team was the largest single differentiator between the least and most successful innovation efforts. The degree of involvement of suppliers tends to depend on the nature of projects; however, open and direct communication between companies has been identified as the critical success factor during supplier interactions in new product development processes (Harryson, 1997; Ragatz et al. 1997; Lincoln et al. 1998; Perez and Sanchez, 2002).

Table 7.1: Degree of Innovation Improvement Resulting from Supplier Integration –

	<i>Most Successful Cases of Integration</i>	<i>Least Successful Cases of Integration</i>
<i>Purchased material cost relative to historical costs</i>	15.0%+	(5.0%)
<i>Purchased material quality relative to historical quality</i>	40.0%+	(7.5%)
<i>Development cycle time</i>	25.0%+	(30.0%)

[Adapted from Ragatz et al. (1997)]

Interestingly companies that network effectively with suppliers also invest more in research and development because they require an infrastructure in which to frame collaborative behaviour (Perez and Sanchez, 2002). Network behaviour in the supply chain is intricately linked to research and development investment and has a direct impact on the productivity and competitiveness of individual firms.

The decisive factors that enable the engagement of suppliers in networks with buyers are the:

Strength of supplying firm’s top management commitment to their involvement.

Strength of the buying firm’s top management commitment to supplier integration.

Familiarity with the supplier’s capabilities prior to integration in the project.

Strength of consensus that the right supplier was selected.

Development team’s confidence to actively involve the supplier in the development effort.

Table 7.2: Management Practices Influencing Effective Networking Relationships with Suppliers – Adapted from Ragatz et al. (1997)

<i>Factor</i>
<i>Supplier membership/participation on buying company's project team</i>
<i>Direct cross-functional inter-company communication</i>
<i>Shared education and training</i>
<i>Common linked information systems (EDI, CAD/CAM, e-mail)</i>
<i>Co-location of buyer-seller personnel</i>
<i>Technology sharing</i>
<i>Formal trust development processes/practices</i>
<i>Customer requirements information sharing</i>
<i>Technology information sharing</i>
<i>Shared physical assets (plant and equipment)</i>
<i>Formalised risk/reward sharing agreements</i>
<i>Joint agreement on performance measurement</i>
<i>Confidentiality/nondisclosure agreements</i>
<i>Cost information sharing</i>
<i>Licensing agreements between buyer and supplier</i>
<i>Joint target setting</i>
<i>Formal assessment of supplier's capability</i>
<i>Cross-functional teams for supplier selection and planning</i>
<i>Formalised processes to select suppliers to be integrated</i>
<i>Supplier involvement in establishing the development project goals</i>
<i>Formalised processes to select purchased items for supplier integration</i>
<i>Buying firm focused specific assets on supplier</i>

In summary the supply chain literature on networking behaviour and innovation shows that supply relationships are one of the most important networking arrangements affecting innovation performance and productivity. Such relationships can be managed if firms are committed to collaboration, skilled in managing network relationships and are prepared to invest in research and development.

Although much of the evidence points toward the important role of suppliers, co-suppliers and distributors in the innovation process it is to customers that businesses most often turn when seeking network relationships on issues associated with innovation (Ragatz et al. 1997). Section 7.1.2. outlines the role of business customers within innovation networks.

7.1.2 Business Customers

Ragatz et al's (1997) work has shown that customers are considered to be the most important partners during incremental innovation. This view is supported in the work of von Hippel (1978) where he highlights two forms of approach to innovation and networks and argues that customer focused approaches are the most effective. The two approaches are highlighted in Figure 3.

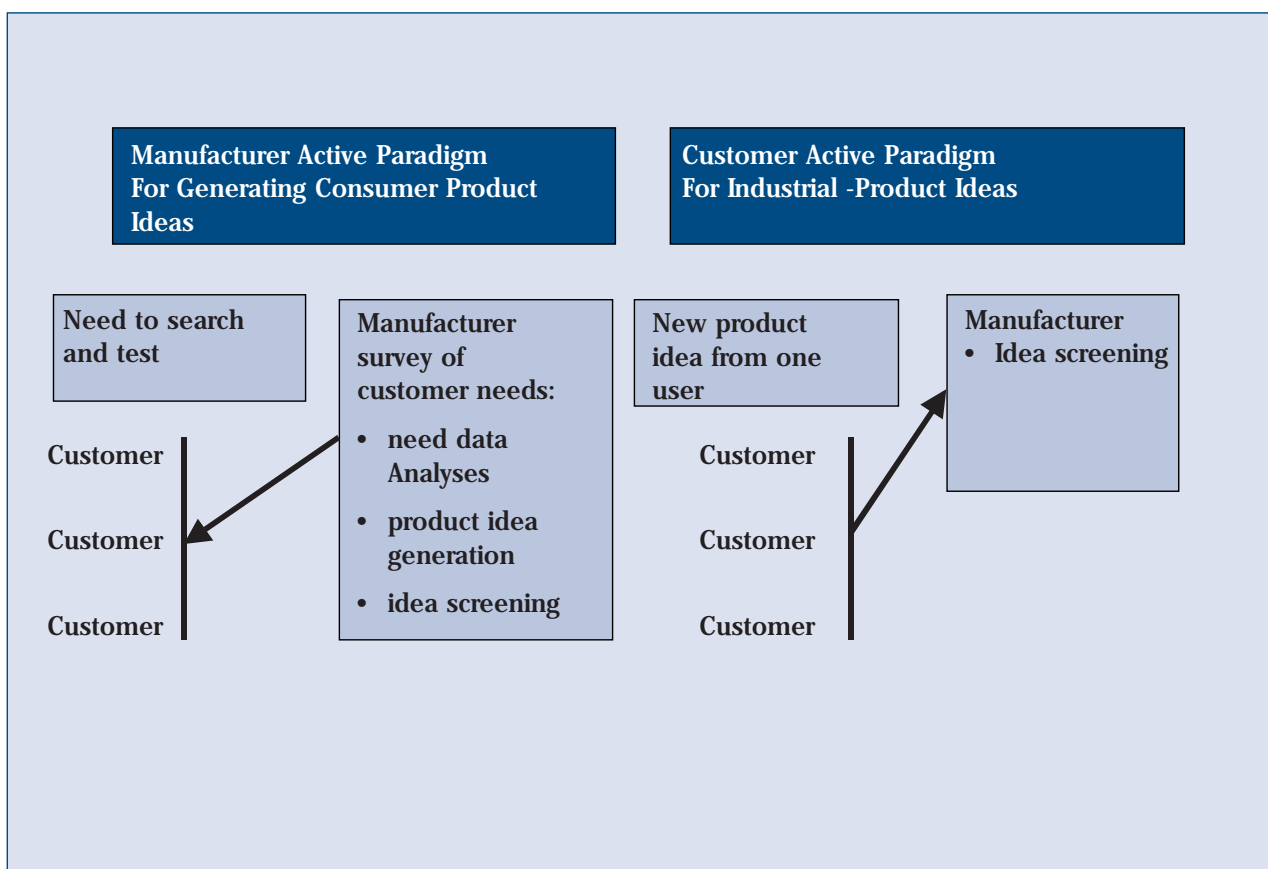
A systematic study of practices leading to commercial success in innovation also illustrated the important role of understanding users' needs and engaging them in the innovation process (Freeman, 1982). The implication being that marketing was the function most associated with understanding users' needs and was consequently crucial in the innovation process (Bruce and Rodgus, 1991). The point is illustrated effectively by Freeman (1982) "The product or process had to be redesigned, developed and freed of bugs to meet the specific requirements of future users, so the understanding of the market had to be present at a very early stage".

Subsequent study has highlighted that:

The linking of marketing and technical activities early in the innovation process enables products to be developed with full awareness of the customer's needs (Bruce and Rodgus, 1991).

Too much emphasis on technical excellence or marketing can lead to innovations that are too highly priced or over engineered (Walsh, Roy and Bruce, 1988).

Figure 3: Two Forms of Innovation and Networking Behaviour - Von Hippel's Model (1978)



The study of customer involvement in innovation through networks initially suggested that customers should play an active role in the innovation process and that they were capable of identifying novel ideas for development (Von Hippel, 1978). For example, when comparing West German and British Manufacturers Parkinson (1982) identified that the West German propensity to utilise the knowledge and ideas of customers was one of the major factors leading to their stronger competitive position in the machine tool industry in the 1980s. Such network relationships with customers are viewed to be important because:

Dialogue between key business customers and suppliers not only allows firms to learn of existing needs but also lead to the discovery of new needs in advance of the competition (Bruce, 1988; Araujo and Easton, 1986).

Customers who are actively engaged in the early stages of product innovation will assist the development of ideas (Biemans, 1989).

Customer involvement reduces the risks of innovation (Gemünden et al. 1992; Ragatz et al. 1997).

The innovator learns from the customer the likely market potential of the product idea (Gemünden et al. 1992).

In Gemünden et al's (1992) study of 4564 companies 75% of companies engaged customers in the innovation process and nearly 50% identified it as a precondition for innovation success. Conway (1995) also found in his study of 35 successful innovations that customers were crucially important at the idea generation stage of the innovation process. Companies that stated they received essential information from customers were more successful with technological innovation and had greater commercial success.

Despite this initial evidence of the value of business customers in the innovation process more detailed empirical study has shown that customer involvement tends to be useful at the beginning in terms of idea generation but is less so during the developmental process where the manufacturer tends to lead (Biemans, 1989; Bruce and Rodgus, 1991; Gemünden et al's 1992, Conway, 1995).

In summary the importance of networking with business customers is confirmed and is shown to offer many benefits. The nature of the value of networks with key customers needs to be treated with some caution. Such networking relationships appear to be ideal for promoting incremental innovation and customers can usefully help innovators identify market opportunities. The extent to which customers actively contribute to the innovation process is less clear as the evidence points to this being driven by the innovating firm balancing market awareness with technical feasibility.

Table 7.3 shows the key evidence on Theme 1 – the Networking Interface.

Author	Data used in the Study	Dates	Location of Study	Summary of empirical Findings
Ritter and Germünden	Survey of 308 mechanical and electrical engineering companies.	2003	Germany	Study focuses on medium sized companies. Data were analysed using LISREL 8 using a polychoric correlation matrix. They show important statistical links between network competence and innovation success. Managing key partners in the network interface is crucial for innovation.
Perez and Sanchez	Postal survey of 58 automotive suppliers.	2002	North Eastern Spain	Reasons for suppliers to engage in enterprise networks. Exchange of know-how and access to technologies (93%); Strengthening client-supplier relationships (79%); Use of comparative advantages (80%); Access to new markets (80%); benchmarking (90%). Used bi-variate correlations. Firms cooperating with customers (68%); with suppliers (50%); with Universities and Research Institutes (35%).
Romijn and Albu	Interviews with Small Electronics Firms (17 Software and 16 Electronics firms).	2002	South East of England	Used Spearman correlation coefficients to explore forms of innovation output with key partners in networks. Shows that firms interact with some partners for more radical innovation - suppliers 0.343* and Universities 0.353* while they work with other firms for more incremental forms of innovation - customers 0.437**. (**=0.01 level of significance *=0.05 level of significance).
Kaufmann and Tödtling	Postal survey of firms in the REGIS project.	2000	Styria, Wales, Tampere and the Basque Country	The distribution of innovation forms differs by region. Of 93 firms in Styria, 98 firms in Wales, 138 in Tampere and 54 in the Basque Country the majority of network relationships were with customers (approx 90% of firms) and with suppliers (approx 70%). Relationships with other partners were typically lower (e.g. Universities 30%). A more detailed analysis of means illustrates that customers were perceived to be the most important contributors in innovation networks.
Conway	Empirical case studies of 35 commercially successful innovations.	1995	UK	Suggests that prior research shows that networking contributes to between 34% and 65% of inputs to the development of successful product innovation. 23% of the innovations studied required critical informal networks for the key innovative solution. 54% employed inputs from external sources and a further 46% of the firms received useful inputs from informal sources. Even where these relationships were between suppliers or customers friendships were one of the most important aspects for informal inputs.

As outlined in the model applied in this review (Figure 1) networks in the market interface are the key relationships between a firm and their direct business associates. These networks typically include suppliers, co-suppliers, distributors, customers and firms offering business services (e.g. accountants and legal firms). The following section of the report (7.1.3.) will begin to look at networking infrastructures by examining the role of third parties within innovation networks.

7.1.3 Third Parties

In general the role of third parties, such as professional associations, trade associations and publicly funded bodies specifically aimed at promoting innovation such as technology transfer centres have a positive impact on the development of inter-organisational networks and innovation. There are a number of characteristics of third party involvement that need to be considered (Table 7.4).

Table 7.4: Theme 2: The Role of Third Parties

<i>Authors</i>	<i>Date</i>	<i>Summary</i>
<i>Hanna and Walsh</i>	<i>2002</i>	<i>Research comparing small firm networking facilitated by publicly funded bodies in Italy, Denmark and the US highlighted the need for third parties to remain 'neutral' in the facilitation process. Rather than encouraging the development of particular network relationships or innovations, publicly funded bodies should provide information and expertise but more importantly focus on promoting the development of trust and confidence among network members.</i>
<i>Grotz and Braun</i>	<i>1997</i>	<i>Research across 155 SMEs in Germany highlighted that formalised technology transfer does not have an impact on regional economies unless it is organised as an interconnected system with many entry points. Technology transfer centres cannot promote networking unless the skills, know-how and finance are already in place and a socio-cultural infrastructure exists. Again professional associations were found to be useful forums promoting the development of socio-cultural infrastructures.</i>
<i>Robertson et al.</i>	<i>1996</i>	<i>It is important to note that professional associations are not necessarily neutral conduits in the diffusion process. Research in the UK automotive sector highlighted that some professional associations have a pro-innovation bias and promote particular versions of 'best practice' that are not necessarily appropriate across all firms in a sector.</i>
<i>Conway</i>	<i>1995</i>	<i>Research across a sample of 35 UK innovations highlights the reliance on informal (in some cases ad hoc) third party involvement for successful innovation, particularly during the crucial idea generation phase. This can lead to over-dependence on key individuals who actually play no formal role in the process.</i>

Third parties have a dual role in promoting innovation. They act as neutral knowledge brokers but also conduits for the development of informal relationships that are the basis for the development of network relationships particularly between small firms. For policy makers to implement policies to encourage informal transfer of information, they need to have a clearer understanding of the mechanisms through which this process occurs.

Although professional associations, trade associations and consultants make some important contributions to the network infrastructure they are one of many network mechanisms that improve a region's general networking infrastructure. Science partners categorised as universities, technical colleges, research institutes, applied science consultancies and independent research and design laboratories all play an important role within the network infrastructure. The role of science partners is outlined in Section 7.1.4.

7.1.4 Science Partners

Although this study has sought to focus on business-to-business networks and not consider in any detail science-industry networks, science partners do play an important role as independent network brokers and intermediaries within business networks.

The relationship between science partners and business networks is most effectively illustrated by the experience of Canon when it sought to use networks to commercialise Ferroelectric Liquid Crystals for technology displays.

BOX 5: Canon's Commercialisation of Ferroelectric Liquid Crystals (USA)

Dr. Kanbe of Canon's Research Centre was asked to identify Canon's future key-technology for displays. He became aware of so called FLC (Ferroelectric Liquid Crystal) technology through an Applied Physics Letter that reported on the technology in 1980. Contacts were developed between Canon and the two scientists behind the innovation and Dr. Kanbe initiated a three-man task force to work on FLC technology. He had a lot of samples on FLC prepared by Canon's central research laboratory but it was through his close involvement of former colleagues in production that critical glass plate prototypes for FLC technology could be successfully prepared.

The FLC prototype was eventually presented to the R&D manager who championed it. Attempts had been made by the researchers to sell the technology to companies like Ericsson, ABB and Philips but it had proved impossible. Canon also hesitated at first but became aware that Seiko was working on a FLC prototype. To catch-up Canon sent people to the two universities where the invention was made and the two researchers were asked to make frequent visits to Canon. When the manufacturing potential was finally assessed and go ahead given the inventors signed an agreement with Canon and the firm set up a Display Business Operations Centre with the scientists and three FLC projects. The establishment of the Centre required cooperative contacts with leading suppliers and R&D cooperation with three local universities. A senior researcher concluded "We studied the technology together which was advantageous for all of us. The key suppliers could acquire more knowledge of our FLC technology and its development and we could build know-how with specialised production technology". (Adapted from Harryson, 1997).

Comment: *Science-industry interaction can be industry led and can depend on personal networking behaviour as well as formal relationships. Encouraging mechanisms to promote personal networks between industry and science may have beneficial effects on innovation.*

The important role of informal personal networks in networks outside of the market interface was also evident in the wider evidence on science partners. As well as direct benefits of interaction between science and industry; science partners provide an important role as intermediaries within networks, the evidence base is illustrated in Table 7.5.

Table 7.5: Theme 3: The Role of Science Partners

<i>Authors</i>	<i>Date</i>	<i>Summary</i>
<i>Bougrain and Haudeville</i>	<i>2002</i>	<i>In this sense science partners can act as network nodes facilitating the exchange of knowledge between different business systems, as well as, between science and industry.</i>
<i>Kaufmann and Todtling</i>	<i>2001</i>	<i>Show that innovativeness within business systems can often come from links with non-business systems that enable firms to step outside the routine activities of their market. They found that crossing the network border to science in particular increases the diversity of innovation partners, which in turn improves the capability of firms to produce more advanced innovations. Their evidence also showed that science partners were more important in radical innovation than business customers.</i>
<i>Fritsch</i>	<i>2001</i>	<i>The differences between regions regarding the propensity of firms to co-operate are mainly due to peculiarities of the small business sector. Spatial proximity is obviously of particular importance for horizontal co-operation and for relationships to publicly funded research institutions.</i>
<i>Verspagen</i>	<i>1999</i>	<i>A study of Philips' patent-to-patent citations illustrated that local science institutes were more important in the regional innovation system than local firms around Philips.</i>
<i>Oliver and Liebeskind</i>	<i>1998</i>	<i>The benefits of such relationships were most clearly demonstrated in the biotechnology industry.</i>
<i>Bower and Keogh</i>	<i>1996</i>	<i>Research on innovation in several industries has indicated that both radical and incremental innovations have involved contributions from communicating networks of scientists and engineers across different organisations; once again indicating the important role of personal networking behaviour.</i>
<i>Gemünden, Heydebreck and Herden</i>	<i>1996</i>	<i>The findings show that there are 3 kinds of technology-oriented external relationships that prove to be of special importance: 1. Close contacts with customers, 2. Linkages to universities and research institutes, and 3. Research and development co-operations with other companies.</i>
<i>Liyanage</i>	<i>1995</i>	<i>Collaborative research programs have a significant impact on the structure of national innovation systems by creating and strengthening networks, which are essential for breeding innovation clusters.</i>
<i>Hausler, Hohn and Lutz</i>	<i>1994</i>	<i>A case study of a successful cooperative research project reveals trust-building as a modular, cascade-like process where science partners play an important role. The wider scientific-technical network was established including all industrial and scientific actors who could be potentially interested in solving the technological problem at hand and this occurs before the commercialisation process.</i>
<i>Ebadi and Utterback</i>	<i>1984</i>	<i>Like large firms universities and science institutes can play an important role in creating spinout companies. Although the benefits of this activity is widely recognised it less known that the process can lead to the establishment of important networks between firms in a locality. Such clusters are unlikely to occur where large numbers of firms are started independently of each other.</i>

The evidence on science partners show that they contribute to innovation networks usually through informal-personal networks and that their contribution is important in enabling firms to develop thinking that steps outside of their particular business system. Science partners also act as brokers or intermediaries within networks enabling different business systems to communicate by creating trust in communication by acting as neutral agents. The evidence shows that science partners tend to be most important where the innovation is relatively radical in orientation.

Technology ventures that often arise out of radical innovations require investment and as a consequence venture finance partners are important contributors to the networking infrastructure surrounding a firm.

7.1.5 Venture Finance Partners

The importance of appropriate venture finance and loan finance for innovation has been widely documented and the UK's deficit in this regard was highlighted in the Porter Report. The importance of finance networks, however, has received less attention but is arguably of equal importance. Harding (2000), for example, highlights the UK's gaps:

There are inadequacies in the supply of UK investments into venture capital funds.

There is a lack of understanding about technology-based projects on the part of investors in the UK.

A second equity gap exists preventing small high growth firms from obtaining second round finance.

The dominance of the Management Buy Out/Buy In investments have led to an upward spiral in the size of average investments by most firms.

A lack of an effective equivalent to the US NASDAQ market continues to limit investment opportunities.

Harding's (2000) study of regional venture capital explains the need to have a 'system' of financial networks in each region that is coordinated and structured.

The role of venture finance networks has not been researched extensively and most of the research has been conducted in the US. The evidence on venture finance partners is presented in Tables 7.6 and 7.7.

The evidence base on venture capital networks and innovation shows a number of key conclusions. Co-investment between venture capital firms in entrepreneurial businesses has been shown to be both beneficial for venture capitalists and provides better quality and larger funds for entrepreneurial businesses. The quality of links between venture capital firms, therefore, provides an important networking infrastructure for the commercialisation of innovation.

The establishment of venture capital firms locally in established technology centres (e.g. Cambridge) enables firms to prosper via the higher concentration of good deals. Such finance networks when well developed, attract further start-up activity creating a self-reinforcing cycle. Venture capital firms can and do act as key brokers within technology and innovation networks, introducing key partners to prospective and current firms with whom they have invested.

Table 7.6: Theme 4a: The Role of Venture Finance Partners (Venture Capitalists)

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Florida and Kenney</i>	<i>Analysis of venture capital finance in the US economy.</i>	<i>1988a</i>	<i>USA</i>	<i>Venture capitalists actively develop networks made up of financial institutions, universities, large corporations, entrepreneurial companies, and other organisations. Venture capital establishes strong incentives for "breakthroughs" as opposed to other types of innovation.</i>
<i>Florida and Kenney</i>	<i>Venture capital complexes are investigated by examining finance-orientated (New York); technology orientated (San Francisco) and hybrids (Boston).</i>	<i>1988b</i>	<i>USA</i>	<i>Technology-oriented complexes contain large proportions of limited partnerships, favour local investment, and attract venture capital from other areas. Enormous incentives for venture capital firms to locate in established technology centres are created there by a high concentration of good deals. Technology- and finance-oriented venture capital complexes have a symbiotic relationship. Well-developed capital networks provide tremendous incentives for start-ups and help create a self-reinforcing cycle of new enterprise formation, innovation, and economic development.</i>
<i>Bygrave</i>	<i>Sample taken from Venture Economics database of 1501 portfolio companies and 464 venture capital investors.</i>	<i>1988</i>	<i>USA</i>	<i>Factors that influence degrees of networking include the innovativeness, technology, stage, and industry of the portfolio company. The top 61 venture capital firms were found to have extensive networks. Among these firms, sharing of information was shown to be a stronger reason for networking than spreading financial risk. The connectedness (one or more co-investments) was particularly high amongst Innovative Venture Capitalists (37%). Joint investments are shown to lead to better performance in the invested companies.</i>
<i>Bygrave</i>	<i>Database of 1501 venture capital companies and their portfolio companies and the first rounds of investment.</i>	<i>1987</i>	<i>USA</i>	<i>Bygrave's study shows the important role of co-investment and networks in venture capital. It was found that the High Innovative Venture Capitalists had a higher incidence of connectedness as measured by the percentage of pairs with one or more co-investments. The findings suggest that: links to other venture capital firms are extremely valuable and that this model of co-investment networks improves investment quality and success.</i>

Table 7.7: Theme 4b: The Role of Venture Finance Partners (Informal Investors)

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Harr, Starr and MacMillan</i>	<i>Postal survey to 2,898 investors in 17 states (response rate 320).</i>	<i>1996</i>	<i>USA</i>	<i>The results indicate the existence of an extensive informal investment community on the East Coast of the US, which can provide substantial resources to start-ups and young firms. Many of these so-called "angels" claim they have achieved higher returns via angel activity than through other investment options. Unlike capital firms, angels are not interested in competitive insulation, and they do not limit their investments to industries that are appealing or with which they are familiar. Their referral network is composed mainly of friends and business colleagues.</i>
<i>Harrison and Mason</i>	<i>Policy Review.</i>	<i>1996</i>	<i>UK</i>	<i>The study argues that the supply of informal venture capital in the UK is to be increased, there is a need for continued local intervention and support from the public sector to ensure that a complete network of local and regional business angel networks (BANs) exists to meet the needs of both companies and investors.</i>
<i>Harrison and Mason</i>	<i>Postal survey comparing UK with US informal investors.</i>	<i>1992</i>	<i>UK and USA</i>	<i>Although similar to their US counterparts in demographics, UK informal investors invest less, operate independently rather than in syndicated investments, have somewhat higher rate of return and capital gain expectations, and are less satisfied overall with the performance of their portfolios. Overall, in comparison to the US market, the UK venture capital market appears to operate less effectively, thereby reducing its potential contribution to venture financing.</i>
<i>Wetzel</i>	<i>The case of the Venture Capital Network Inc is described.</i>	<i>1987</i>	<i>USA</i>	<i>In spite of the apparent scale of the informal venture capital market, evidence indicates that the market is relatively inefficient. The market is characterized by a shortage of information about investors and investment opportunities. In addition, a number of entrepreneurs and private investors are unfamiliar with the techniques of successful venture financing.</i>

The evidence on informal investment networks although limited in depth highlights a number of key issues.

It shows that informal investment networks are particularly important for the networking infrastructure during firms' pre-start-up, start-up and early growth stages of development.

Most referral networks for informal finance are composed of mainly family and friends.

Studies show, similar to formal investment, that syndicated investments have a greater chance of success and often lead to higher investment levels in entrepreneurial firms.

The ways in which investments are made within the informal market are perceived to be less sophisticated and more inefficient than the formal venture capital market but more evidence is required.

Examining the evidence on finance networks shows that they are important within the networking infrastructure and that cooperative investment appears to be beneficial for both investing firms and entrepreneurial businesses. The evidence supports this point in both the formal and informal marketplace for venture funds.

There are number of mechanisms created by formal government policy that are designed to create such opportunities for investors and these are explored in the next section (7.1.6).

7.1.6 Institutional Mechanisms

Institutional mechanisms designed specifically to create and facilitate networks are the focus of this section. The most common forms are clusters, incubators and centres for cooperation.

Incubators: are generally a part of local development programmes and they offer a range of networking benefits to new firms including:

Providing space for new firms in proximity to other firms with the same industry focus or set of challenges (Smilor, 1987a).

Support services that engage the firm in cooperative learning (Smilor, 1987b).

Access to networks of entrepreneurial firms and investors.

Clusters: the OECD defines a cluster as "being networks of production of strongly interdependent firms (including specialised suppliers), knowledge production agents (universities, research institutes, engineering companies), bridging institutions (brokers, consultants) and customers, linked to each other in a value adding production chain". A cluster can consequently be considered to be one form of network. One where there is a strong collection of associated companies located in close geographic proximity or where there is a formal institutional framework (Perez and Sanchez, 2002).

Institutions for Collaboration: the Porter report shows that there is evidence that institutions for collaboration in the UK are less numerous and less effective than in comparable countries. Porter provides examples of the Australian Wine Cluster – in Box 6 an example of the NCMS provides an example of a collaborative institution in the US. It may be worth noting that the establishment of the Institute required the focusing of a government department's R & D expenditure and a change in the legal infrastructure.

The evidence in the study examining networking and innovation and the role of institutional mechanisms is considered insufficient to draw any useful conclusions. It is possible that the lack of coverage occurs due to the nature of the review, however, given the investment made in these institutional mechanisms within the innovation infrastructure one would have expected to have encountered more studies exploring the impact of this infrastructure on business-to-business networks. This clearly presents a priority for future research.

BOX 6: National and Regional Centres for Co-operation (USA)

'In 1986, the US Defence Department, the National Machine-Tool Builders' Association, The Manufacturing Studies Board, General Motors and 20 manufacturing companies formed the National Centre for Manufacturing Sciences (NCMS). As of 1995 the NCMS had 200 US, Canadian and Mexican corporate members. Those firms with similar interests form teams to work on R&D projects characterised as pre-competitive, or examine applied R & D where basic research has established and proven the process orientated technology concept. The strategy of such centres is to promote collaborations among industry, government and academic partners.

When Congress passed the National Cooperative Research Act in 1984 the US Government began to sanction joint R&D. Centre participants must, however, independently produce and sell the results of R&D collaborations. The NCMS receives \$30-40 million a year from federal government, \$3-5 million in state funds and another \$50-60 million in cash and resources from members, members' dues and competitive contracts. A typical NCMS project involves 15-20 companies, labs and vendors and industry co-funding is usually 67% of a project effort that ranges from \$1 million to \$50 million, usually two to four years in length. A technology review board chooses projects based on: relevance to long and short-term technical solutions; relevance to defence and commercial manufacturing; technical soundness and available funds'. (Pellerin 1995 – abridged version of case study).

Comment: National and Regional Centres for collaborative innovation if adequately resourced and managed can provide an excellent focus for collaborative effort during pre-competitive stages of innovation. Government policy and resources can play an important role in facilitating their formation.

Despite this insufficiency in the evidence it is possible that innovation policies and regional infrastructures can assist networking activities leading to innovation; how they do so and their degree of effectiveness in doing so is unclear. The detailed evidence in the review focusing on how institutional mechanisms can support and assist the development of business-to-business networks is shown in Table 7.8.

The evidence found in this review shows that clusters do not always contribute to business-to-business networking. Where clusters exist but networking does not happen there is evidence that innovation occurs less often and is less successful (see Table 19). The extent to which Science Parks promote business-to-business networks appears to be mixed with some evidence for and against their capacity to promote networking. The detailed evidence on how Science Parks might promote such networks also appears to be lacking.

The evidence on incubation tends not to focus specifically on the networking advantages of firms operating within incubators; however, it does illustrate some general benefits where networking is cited. Again the detailed evidence on incubators' role in creating and supporting business networks is inconsequential.

Although National and Regional Centres for collaboration are cited in the Porter report as valuable for networking (as highlighted in the Australian Wine Cluster) and good examples have been found (Box. 6) none of the evidence directly addresses their value in terms of networking and innovation. There is clearly some scope for these initiatives and anecdotal evidence supporting their formation but no current evidence explaining their value.

Table 7.8: Theme 5: The Role of Institutional Mechanisms

<i>Authors</i>	<i>Date</i>	<i>Institutional Mechanism</i>	<i>Summary</i>
<i>Rothschild and Darr</i>	<i>2003</i>	<i>Incubators</i>	<i>The study focuses on the construction and maintenance of informal networks of innovation in a technological incubator affiliated with a leading Israeli university. A wide array of exchange relationships (formal and informal), ranging from the use of library and laboratory services to an extensive and ongoing barter exchange of knowledge, know-how, and even shared practice is found and shown to impact on innovation.</i>
<i>Staber</i>	<i>2001</i>	<i>Clusters</i>	<i>Proportional hazard estimates show that location in clusters of firms in the same industry increased business failure rates and did not necessarily contribute to networking behaviour.</i>
<i>Phillimore</i>	<i>1999</i>	<i>Science Parks</i>	<i>The Western Australian Technology Park networks between WATP companies and universities were examined. It was found that there was more interaction than might be estimated and several different categories of company that existed at the Park are identified in terms of their interactive behaviour. An overview of the literature suggests that Science Parks do not assist networking a great deal but Phillimore's results disagree.</i>
<i>Smilor</i>	<i>1987b</i>	<i>Incubators</i>	<i>The study sought to understand how the incubator concept works in practice. In addition to a national survey, the research incorporated on-site review, case study analysis, and in-depth interviews with incubator managers and directors. 10 factors were identified as important to the effective management of the incubator system: 1. On-site business expertise, 2. Access to financing and capitalisation, 3. in-kind financial support, 4. Community support, 5. Entrepreneurial network, 6. Entrepreneurial education, 7. Perception of success, 8. Selection process for tenants, 9. tie to a university, and 10. Concise program milestones with clear policies and procedures.</i>
<i>Smilor</i>	<i>1987a</i>	<i>Incubators</i>	<i>In 1985, a national survey of new business incubators was conducted, and responses were received from 50 of 117 incubators. Extensive on-site analysis and in-depth interviews with incubator managers and directors were performed. Incubators were found to provide four benefits to tenants: 1. Development of credibility, 2. Shortening of the learning curve, 3. Quicker solution of problems, and 4. Access to an entrepreneurial network.</i>

Given the lack of evidence on this subject the review will be cautious with the type of policy recommendations it makes. Clearly, the UK Government has a role to play in the creation and development of infrastructures that support networking and innovation. The evidence base is, however, rather thin on how governments should do this and what methods work.

One area where considerable study has been carried out is on the nature of networks, network governance and how firms manage networks. These are explored in Section 7. 2.

7.2 Network Factors

7.2.1 Network Governance

In general network ties have been found to be much more conducive for the exchange of information and knowledge across partners than market mechanisms. Socialisation through networks engenders trust, which makes network ties a superior conduit for information flow. Due to its positive impact on information flows, trust based behaviour characterised by implicit open-ended contracts is cited as a crucial factor in enhancing innovation through interfirm collaboration (Hausler et al, 1994, Hoang and Antoncic, 2003) and an integral reason for interfirm networks' longevity (Lipparini and Lorenzoni, 1993).

Inclinations towards trust, opportunism, legal contracting and self-interest are all shaped by the institutional context in which firms operate. Distinctions have been made between the US/UK and Japanese/German systems of innovation, highlighting more reliance on legal contractual arrangements in network relationships in the UK and a system of innovation more conducive to the development of radical innovations (Table 7.9). Research in the biotechnology and semiconductor industries in the US, UK, Germany and Japan also support these findings (Bolton et al, 1994, Nooteboom, 2000).

Table 7.9: UK Innovation Systems – Adapted from Nooteboom (2000)

<i>US / UK Innovation systems – more conducive to the development of radical innovations.</i>	<i>Characterised by: Legal, extensive contractual agreements, multiple short relations.</i>	<i>Performance outcomes: – low prod'n costs, high transaction costs.</i>
<i>Japan/German Innovation systems – more conducive to the development of incremental innovations.</i>	<i>Characterised by: Implicit relational, lasting, exclusive contracts.</i>	<i>Performance outcomes: Higher prod'n costs and lower transaction costs.</i>

Table 7.10: Network Governance Mechanisms

<i>Pooled: Communication and decision procedures Implicit relational contracting – mutual monitoring. E.g. trade associations, horizontal consortia, production joint ventures in mature sectors.</i>	<i>Intensive: Group decision making Legal (property rights sharing) or implicit (mutual monitoring) contracting. E.g. Research consortia, joint ventures complex industrial project consortia.</i>
<i>Sequential: Hierarchical decision-making, legal contracting. E.g. Licenses, concessions, one-way subcontracting, profit-sharing ventures.</i>	<i>Reciprocal: Integration and liaison roles. Mix of legal and implicit relational contracting. E.g. Franchising, two way co-production subcontracting, capital ventures.</i>

The type of interdependence characterizing the network relationships between firms is an important mediating variable in terms of establishing the appropriate governance mechanisms that will promote innovation (Grandori, 1997). It is important therefore for firms in network relationships to establish what type of interdependence exists between themselves and other firms in the network in order to ascertain the appropriate form of governance. Under and over-formalisation of the network will both be detrimental to innovation (see Table 7.10).

How networks are governed plays an important role in their effectiveness and their capacity to assist the innovation process. In the next section the report will explore how a firm manages its networks and what part this can play in its innovative capacity.

7.2.2 Network Management

If networking is crucial for successful innovation firms need to become good at it. Not all firms are able to create and manage their collaborations to maximum advantage. Some of the research reviewed points out that both experience and ability to absorb new technologies and ideas (Cohen and Levinthal, 1990) are critical skills a firm requires when exploiting its relationships. Table 7.11 for instance highlights the key evidence exploring the management of networks. The research has shown the importance of network management, product champions and gatekeepers, the nature of networking practices and how decision-making behaviour impacts on network activity.

Table 7.11: Theme 6: Managing Networks (Sample of the Evidence)

<i>Authors</i>	<i>Date</i>	<i>Summary</i>
<i>Coles, Harris and Dickson</i>	<i>2003</i>	<i>This paper examines the development and management of networks in the defence industry. A key finding is that the effective functioning of the overall network is closely linked to the established processes within the two participating firms studied.</i>
<i>Ferrary</i>	<i>2003</i>	<i>Using Silicon Valley as an example the study points out that the most successful high-tech companies such as Cisco Systems, Intel, and Sun externalise their research by doing corporate venturing. These companies manage their portfolio of technologies by acquiring small businesses that have developed disruptive technologies. This kind of acquisitive strategy needs specific organisational and managerial practices to embed the large company in the industrial-network structure.</i>
<i>Ritter and Gemünden</i>	<i>2003</i>	<i>The model is empirically tested using a database of 308 German companies. The results show that both network competence and technological competence have a significant positive impact on a company's innovation success. The results suggest that a company's technological strategy supports the development of both network and technological competencies.</i>
<i>DeSanctis, Glass and Ensing</i>	<i>2002</i>	<i>A study of 14 leading technology-intensive companies in six industries illustrates how three organisational designs are being used to manage distributed R & D networks: 1. Decentralized, 2. Networked and 3. Integrated.</i>
<i>Lorenzoni and Lipparini</i>	<i>1999</i>	<i>A study of the structure of 3 lead firm-network relationships at 2 points in time is undertaken. Using data on companies in the packaging machine industry, the authors study the process of vertical disintegration and focus on the ability to coordinate competencies and combine knowledge across corporate boundaries. The study provides evidence that inter-firm networks can be shaped and deliberately designed.</i>
<i>Shaw</i>	<i>1998</i>	<i>The innovation process is examined for 34 UK medical equipment innovations developed by 11 companies, 26 through multiple and continuous interaction between the entrepreneurs and other actors in the networks. There were ten stages identified in the innovation cycle and effective management ensured opportunities for sustainable cost advantage and product or process differentiation at the different stages in the cycle. The networking enabled both external and internal product champions to flourish. For successful innovation, the integration of the activities of the actors in the network, the management of the sequential learning process, the adoption of an overlapping approach, the linking to knowledge in society, using complementary assets and creating credibility in the innovations was seen as essential.</i>

Table 7.12 Cont: Theme 6: Managing Networks (Sample of the Evidence)

<i>Authors</i>	<i>Date</i>	<i>Summary</i>
<i>Ragatz, Handfield and Scannell</i>	<i>1997</i>	<i>In a study of 60 member companies from the Michigan State University Global Procurement and Supply Chain Electronic Benchmarking Network, the management practices that relate most closely to successful integration of suppliers into the new product development (NPD) process are explored. The study identifies supplier membership on the NPD project team as the greatest differentiator between most and least successful integration efforts.</i>
<i>Gemünden, Heydebreck and Herden</i>	<i>1992</i>	<i>An empirical study of Europe's Lake Constance region covered a sample of 848 manufacturing companies. Based upon multivariate analyses the findings indicate that relationships must not be regarded in isolation, but that it is necessary to coordinate the relationships through network management.</i>
<i>Biemans</i>	<i>1991</i>	<i>In the study it was found that the firm should pay careful attention to the selection of collaboration partners and management of the individual relationships if they are to benefit from the development of technological innovations within networks.</i>
<i>Ebadi and Utterback</i>	<i>1984</i>	<i>Data were obtained from the principal investigators of 117 Sea Grant research projects, which represented a random sample. Bivariate correlation and partial correlation were used to analyse the data. The results show that at the individual level, the frequency, centrality, and diversity of communication all have positive effects on the success of technological innovation. On the aggregate level, network cohesiveness, centrality, and diversity of communications were found to be positively related to technological innovation.</i>

The evidence on the management of networks shows that managing informal and formal agreements, while establishing trust, means that the management of network relationships is inherently difficult. Firms need to learn core network competencies over time, for example, being able to identify when an agreement needs a contract or should be based on good faith; what role should friendship or reputation play in the identification of partners, and; what kinds of milestones or interventions are needed to ensure a project stays on course.

Knowledge of how to collaborate accumulates over time through experience, reflection, and interpretation. Learning from collaboration is a function of a firms' access to knowledge and its possession of the capabilities for utilizing the relationships and knowledge established. The evidence reported in Table 7.11 shows that firms' competence of managing networks can differ substantially and networks can be shaped and deliberately designed to meet the firm's innovation needs. The evidence reported links a firm's networking competence and management with its innovative capacity. The degree to which firms learn about new opportunities is a function of the extent of their existing participation in networks (Levinthal and March, 1994; Powell, Koput and Smith-Doerr, 1996).

In this section the evidence shows that firms can learn to be more effective at managing their networks and that developing competence will impact on innovation and productivity. The study shows that certain forms of network behaviour, such as, corporate venturing lead to the development of more effective industrial networks. The following section will explore how the configuration of networks assists or inhibits their capacity to promote innovation.

7.2.3 Network Configuration

The evidence on network configuration shows that the nature of a network is dependent on its industrial context and on what a firm is seeking to use its network for. The case of biotechnology companies in the US illustrates the point particularly well.

BOX 7: Collaboration in Biotechnology Companies (USA)

'Amgen a large biotech firm located in Los Angeles developed extensive R & D and marketing collaborations with many smaller biotech companies including: ARRIS, Envirogen, Glycomex, Guildford, Interneuron, Regeneron and Zynaxis. These relationships were based on a division of labour in the technology development process. The smaller firms develop promising technologies with Amgen's financial and scientific assistance while Amgen licenses and markets the product. Biogen in contrast adopted a strategy of licensing initial discoveries to established firms, for example Lilly and Merck.

Chiron had a different strategy to networks by developing extensive collaborations including R&D ties with smaller biotechs, universities, licensing agreements with large pharmaceutical and animal health companies, partnerships with large biotechs and manufacturing and marketing alliances with other firms. In 1997 Chiron had 1,400 informal arrangements and 64 formal collaborations. These different collaborative profiles reflect different strategies and circumstances behind the firm's original business formation. These different collaborative profiles have all worked for the respective firms. Amegen gains by working with entrepreneurial high growth companies gaining from novel technologies. Biogen licensed some of its initial research discoveries and the royalties it now receives funded the development, sales and distribution of its most recent products. Chiron's comprehensive network has created a universe of affiliations between basic scientists and private R & D, which has created a situation of critical mass in product development terms' (Powell 1998 - abridged version of case study).

Comment: *Within any sector diverse strategies for business-to-business networks serve industrial innovation as a whole. Encouraging one form of network configuration above another may have adverse consequences. Government policy needs to focus on the development of a networking infrastructure while avoiding the promotion of any particular form of network configuration.*

Government policy needs to ensure that it does not promote one form networking activity or configuration over another. For example Table 7.12 highlights the key evidence of network configuration.

Table 7.13: Theme 7: Network Configuration

<i>Authors</i>	<i>Date</i>	<i>Summary</i>
<i>Koch</i>	<i>2003</i>	<i>Intensive field studies in two constellations of enterprises were carried out. One is a segment-collaboration between a few manufacturing companies and a software house, the other a complex and extensive innovation network. These studies show how negotiations, shifting positions of players, mobilising stable elements of the network, when developing new ones, and interplays between internal and external collaboration are integral and inevitable in the product development process.</i>
<i>Kash and Rycroft</i>	<i>2002</i>	<i>Case studies of the innovation pathways traced by six complex technologies indicate that innovations can be grouped into three quite distinct patterns. Transformation: the launching of a new trajectory by a new network and technology. Normal: the evolution of an established network and technology along an established trajectory. Transition: the movement to a new trajectory by an established network and technology.</i>
<i>Baum, Calabrese and Silverman</i>	<i>2000</i>	<i>New firm alliance networks are studied to investigate the impact of variation in start-ups' alliance network composition on their early performance. An analysis of Canadian biotech start-ups' performance shows how variation in the alliance networks start-ups configure at the time of their founding produces significant differences in their early performance.</i>
<i>Gemünden, Ritter and Heydebreck</i>	<i>1996</i>	<i>Based on the assumption that intensity and structure are the most important dimensions of a firm's technological network the study identifies 7 different types of technology-oriented network configurations. Drawing upon a database of 321 high-tech companies, it is shown that innovation success is significantly correlated with a firm's technological network. Product and process innovations are shown to demand different types of network configurations.</i>
<i>Ostgaard and Birley</i>	<i>1994</i>	<i>Show that entrepreneurs use networks differently depending on the strategic orientation of their business.</i>
<i>Burt</i>	<i>1992</i>	<i>Illustrates that an actor's informational advantage will be maximised when network ties are diverse and loosely inter-connected. Participating in closed networks increases reliability of information, while participating in many is consistent with an information searching strategy.</i>
<i>Larson</i>	<i>1991</i>	<i>This paper examines the conditions under which successful partnership networks were formed by four entrepreneurial companies. This research suggests that a network organisational form can be cultivated by smaller companies and the data gathered indicate that these alliances do not form by chance. They are patterned, predictable exchange structures that can be replicated and used to improve a firm's competitive position.</i>
<i>Coleman</i>	<i>1988</i>	<i>Illustrates that information diffusion is enhanced when a network is tightly inter-connected and closed. Closure ensures that those who do not observe reciprocity norms or who transmit faulty information will be ostracised.</i>

The evidence on networking presented in Table 7.12 shows a number of key points.

The nature of network configuration and its utility for innovation and competitiveness depends on the strategic requirements of individual firms.

Firms will use networks in different ways and will reconfigure them if necessary.

Network configuration often differs between different forms of innovation required by actors; networks for product innovation are quite different from networks for process innovations.

The nature of a firms' alliance network during business formation can have important ramifications for future business performance.

All types of network configuration constantly change and adapt depending on the requirements of partners and the context within which the network operates.

The evidence reviewed shows that network configurations are dynamic and principally guided by the choices of partners and are beyond the direct influence of Government intervention. Network infrastructures, however, can have an indirect positive or negative impact on network configurations and can consequently encourage or hinder the development of certain forms of network relationships. In the following Section (7.2.4.) the study explores how some of these barriers become established leading to different forms of network failure.

7.2.4 Network Failure

The evidence overall has been extremely positive about the value of business-to-business networks and their impact on the innovation process. No study would be complete, however, without some focus on why networks fail or the factors that prevent the effective operation of networking behaviour. Box 9 provides one example from the UK financial services industry where networks did not work in the way that was anticipated.

Networks encounter problems for a variety of reasons and are discussed below.

7.2.5 Enduring Conflicts

Networks can endure and evolve over many years; as a consequence they go through periods of conflict between partners and such conflicts can and do lead to the failure of the network (Coles, Harris and Dickson, 2003).

7.2.6 Displacement Effects

Although networks can go through internal strife they also encounter displacement and conflict with other alternative networks. Izushi (1997), for example, examines the technological adaptation by small and medium sized firms in a Japanese district of traditional ceramics manufacturing, which has moved into high technology applications. He explains how external ties to networks prevailing in new Japanese industries have endangered the existence of innovative networks in an old industrial region.

7.3 Network Constraints

All networks have rules of engagement that constrain the partners' behaviour (Boter and Holmquist, 1996). These rules are governed by the network's governance mechanisms and the infrastructure (particularly industrial culture) within which the network is embedded (Section 7.2.1).

7.3.1 Networks Lack Scale

Although the impact of networking on innovation performance seems conclusive some studies show that innovation can occur more effectively within large organisations. Evidence from Hobday's (1994) study shows that failure in Silicon Valley is linked to networks of small firms being unable to capitalise on the profits that can be made during the maturity stage of innovations (Hobday, 1994).

BOX 8: The Problematic Nature of Networks – The UK Financial Services Industry

In 1990 an ambitious plan to introduce electronic trading into the UK life insurance industry was formulated by 20 of the UK's large and medium-sized insurance companies. The pseudonym Switchco has been given to this initiative. The purpose of the network of actors was to create a new electronically mediated inter-organisational network designed to displace paper-based methods of trading between insurance companies and their distributors. The insurance companies that formed the network hoped to improve their commercial trading position by: i) controlling a technology that had been controlled by technology suppliers; ii) becoming in command of what they thought would become the industry standard; and, iii) using the technology to raise the profile of independent advisers whose commercial survival was threatened by direct sales and tied agents.

The emergence of Switchco was an organisational innovation for the insurance industry, which had been relatively conservative. The insurance industry had a history of government support and protection that had led to the development of a tight community. In the last 20 years the cosy world of insurance was disrupted by new-entrants, a new regulatory regime and competition from banks and building societies. The emergence of Switchco was linked to the response of insurance companies to changes in their established position in the marketplace. Switchco offered the established companies an opportunity to lead and dominate new a machinery of transactions. If successful it would have enable the companies to reassert control over the market and manage their relationships with independent advisers. The network struggled to work because: i) it could not retain the support of these companies competitors; ii) it found it difficult to provide a more effective system; and, iii) found it difficult to persuade independent advisers to use the new technology as they found it was not designed with their interests in mind. (Adapted from Knights, Murray and Willmott, 1993).

Comment: *Networks breakdown for a variety of reasons and their establishment may not always be positive in terms of innovation and competitiveness. In the case of Switchco it was the desire to react to competition by creating more power for the established players that led to network formation. Networks can be anti-competitive and do not always promote innovation and productivity.*

7.3.2 Lack of Infrastructure

Walcott (1999) studying high technology firms in the deep south of the US shows that clustering of related industries is fostered by a shortage of appropriately configured laboratory and office space at the intermediate stage of the business growth, which encouraged information sharing and cooperative behaviour by necessity. The lack of key networking mediating organisations critically retarded the development of these firms in the study.

7.3.3 External Disruption

A number of studies show that events outside of an industry, particularly government policy, can have a disproportionate effect leading to network failure (Bower, Crabtree and Keogh, 1997). These failures, however, tend to be of existing networks and sometimes can lead to more innovative solutions not less. Sectoral patterns associated with technological change can also create disruption by displacing previously accepted boundaries between industries (Furtado, 1997).

Glasmeier (1991) for example shows in a study the Swiss Watch Industry that the current emphasis on technological innovation realised through cooperation lacks a detailed appreciation of historic networks. While networks can and do promote innovation within an existing technological framework they are subject to disorganisation and disintegration during periods of technological change.

7.3.4 Implantation

Study by Rychen and Zimmermann (2002) on the microelectronics cluster in the Marseilles area of France shows that decisions guided by national policy that seek to implant clusters or networks into areas, which do not take into consideration local conditions are likely to fail. They show that localised (regional) policy is more appropriate for the formation of infrastructures that tend to depend somewhat on existing networks in a locality.

The view is confirmed by a study of 85 semi-conductor firms in Silicon Valley that showed how the existence of dense social networks led to industrial collaboration and reciprocal innovation; which in turn led to the establishment of formal institutions for collaboration (Saxenian, 1990).

Although the evidence base on implantation is limited it does show that government policy on the creation of formal institutions for collaboration should be led by the existence of established networks.

Where new networks are sought UK government needs to be careful not to artificially implant these without reference to local conditions; attempts where local conditions are not considered in detail are more likely to fail.

7.3.5 Weak Ties

The evidence on weak ties shows that networks can exist but not work effectively because of weak relationships between partners or because firms are unable to extract value from their networks (Gales and Boynton, 1992).

In a qualitative study of eight space research innovation projects Gales and Boynton (1992) show that increasing uncertainty in the network's role or conditions can lead to weak ties. In their study projects with the greatest uncertainty had the smallest networks. Ahuja (2000) using a longitudinal study of the chemicals industry shows that 'structural holes', where important partners are missing within networks has a negative effect on innovation.

The evidence shows that if particular aspects of the UK's networking infrastructure are weak (e.g. Science-Industry links or supplier interactions) it can have a significant effect on the total networking infrastructure and therefore innovation.

7.3.6 Failure of Finance Networks

The evidence on finance networks shows that they are important for ensuring co-investment; such investment enables risk to be spread and usually leads to better quality investments and larger levels of investment for individual firms. If the investment infrastructure (venture finance networks) is weak it would appear that it can lead to the failure of new technologies or practices to enter markets and the premature failure of entrepreneurial firms (Harrison and Mason, 1996; Bygrave, 1987;1988).

7.3.7 The Limits of Networking

Although networks have been shown to contribute to innovation and competitiveness this report has already demonstrated that they can also inhibit innovation (Box. 9) by encouraging anti-competitive behaviour – ultimately the value of a network depends on what it is used for. The use of networking has also been shown to be against the strategic interests of particular companies at certain times (Box. 4). From the review a number of other limitations of networking have been demonstrated.

Love and Roper (2001) when modelling UK, German and Irish investment in research and development in manufacturing find no link between external networking and innovation performance. Instead they find that innovation is more dependent on internal organisational networks. This is also supported in the work of Fischer and Varga (2002) in their study of manufacturing firms in Vienna. As most of the evidence in this review concentrates on high technology industries it is possible that these studies show a different need for external business networks in the manufacturing sector.

Harris, Coles and Dickson (2000) find that inter-firm networking can facilitate innovation but it will not necessarily lead to innovation success.

Likewise Meyer-Stamer (1995) suggests caution when applying the idea of inter-firm networks in developing nations. The study of network infrastructures in Brazil concluded that even after improvements in the network infrastructure had led to better competitive performance a large competitiveness gap remained. This indicates that networking may be an important facilitator in the innovation process but that something more fundamental drives innovation and competitiveness more generally.

Tomas and Gomez (1995) also point out that closely connected networks also entail drawbacks for example, increasing the complexity of the innovation process; losing ownership control of the innovation; and, information lopsidedness where partners have very different understandings about agreements.

7.3.8 Creating Barriers

Oakey's (1993) study of the UK biotechnology sector illustrates that networks are not always beneficial in entrepreneurial contexts. In their study it was found that close networking relationships were important in the early stages of business formation but that they had an inhibiting effect when the business entered the growth phase.

Table 7.13 summarises the key evidence on network failure.

<i>Authors</i>	<i>Date</i>	<i>Evidence Base</i>	<i>Summary</i>
<i>Coles, Harris and Dickson</i>	<i>2003</i>	<i>Historical analysis of networks in the Defence industry.</i>	<i>Network conflicts can lead to the failure of networks.</i>
<i>Rychen and Zimmermann</i>	<i>2002</i>	<i>Historical case study of Eurotechnique in the microelectronics industry in Marseilles.</i>	<i>Policies that seek to implant clusters or networks into areas, which do not take into consideration local conditions are likely to fail.</i>
<i>Fischer and Varga</i>	<i>2002</i>	<i>Explores five types of networking used by manufacturing firms in Vienna.</i>	<i>Study shows a different need for external business networks in the manufacturing sector.</i>
<i>Love and Roper</i>	<i>2001</i>	<i>Modelling investment patterns in UK, German and Irish Plant Infrastructure.</i>	<i>Finds no link between external networking and innovation performance.</i>
<i>Ahuja</i>	<i>2000</i>	<i>Longitudinal study of firms in the international chemicals industry.</i>	<i>'Structural holes' where important partners are missing have a negative effect on innovation.</i>
<i>Walcott</i>	<i>1999</i>	<i>Survey and interviews with high technology firms seeking real estate.</i>	<i>The lack of key networking mediating organisations critically retards the development of firms.</i>
<i>Izushi</i>	<i>1997</i>	<i>Survey of Japanese traditional ceramics manufacturing.</i>	<i>Displacement occurs because of conflict with other networks.</i>
<i>Bower, Crabtree and Keogh</i>	<i>1997</i>	<i>Case studies of firms in the North-Sea Oil and Gas-related industries.</i>	<i>Events outside of an industry, particularly government policy, can have a disproportionate effect leading to network failure.</i>
<i>Furtado</i>	<i>1997</i>	<i>Case study of the French Oil industry.</i>	<i>Sectoral patterns associated with technological change create disruption between industries.</i>
<i>Boter and Holmquist</i>	<i>1996</i>	<i>Case studies of 6 Nordic small firms.</i>	<i>If breached rules of engagement within networks can lead to their break-up.</i>
<i>Meyer-Stamer</i>	<i>1995</i>	<i>Analysis of inter-firm reorganisation in Brazil.</i>	<i>Concluded that networks improvements led to better performance, but a large competitiveness gap remained.</i>

Table 7.13 summarises the key evidence on network failure.

<i>Authors</i>	<i>Date</i>	<i>Evidence Base</i>	<i>Summary</i>
<i>Tomas and Gomez</i>	<i>1995</i>	<i>Analysis of network formation new technologies.</i>	<i>Point out drawbacks like increasing the complexity; loss of autonomy; and, information lop-sidedness.</i>
<i>Hobday</i>	<i>1994</i>	<i>Analysis of networks in Silicon Valley.</i>	<i>Networks lack the benefits of scale when compared to large firms.</i>
<i>Oakey</i>	<i>1993</i>	<i>Explores the effects of networking on new firms in the UK biotech sector.</i>	<i>The study found that close networking relationships had an inhibiting effect when businesses entered the growth phase.</i>
<i>Gales and Boynton</i>	<i>1992</i>	<i>Case study of 8 space innovation projects.</i>	<i>Greater project uncertainty leads to weaker ties.</i>
<i>Glasmeier</i>	<i>1991</i>	<i>Historical analysis of the Swiss watch industry.</i>	<i>Networks are subject to disorganisation and disintegration during periods of technological change.</i>
<i>Saxenian</i>	<i>1990</i>	<i>Survey of 85 semiconductor firms in Silicon Valley.</i>	<i>Dense social networks led to industrial collaboration and reciprocal innovation; which in turn led to formal collaboration.</i>

The summary in Table 7.13 shows that networks can fail for variety of reasons, that government can have an effect on the failure of networks (both in a positive and negative sense) and that networks are not always supportive of wider innovation and economic performance because they can act to protect the interests of resident network participants.

In the next section (7.4.) factors exploring the local embeddedness of networking will be explored to explain how firms might avoid some of the problems associated with network failure.

7.4 The Regional and Local Embeddedness of Networks

In the previous section the review explored the evidence on network failure. Some problems associated with failure can be avoided if institutional arrangements fully recognise the important part played by regional and local policy.

Table 7.14 highlights the key evidence linking networking activities to local embeddedness.

Table 7.15: The Local Embeddedness of Networks

<i>Authors</i>	<i>Date</i>	<i>Summary</i>
<i>Freel</i>	<i>2003</i>	<i>The data indicates the need for caution when developing network strategies or policies. The spatial reach of innovation-related linkages is likely to be greater for firms reporting the introduction of relatively novel innovations while smaller firms and firms engaged in incremental product innovations appear more likely to be locally embedded.</i>
<i>Nijkamp</i>	<i>2003</i>	<i>The paper deals with co-operative relationships of manufacturing firms in three German regions. The differences between regions regarding co-operation are mainly due to peculiarities of the small business sector. Spatial proximity is of particular importance for horizontal co-operation and for relationships to publicly funded research institutions. The link between the co-operative behaviour of firms and the performance of the regional innovation system remains, however, unclear.</i>
<i>Andersson, Forsgren, and Holm</i>	<i>2002</i>	<i>This study explores the importance of relational embeddedness in external networks as a strategic resource for performance and competence development in multinational corporations (MNCs). Using data on 97 Swedish MNC subsidiaries, 5 hypotheses are tested in a LISREL model analysis. The results suggest that technical embeddedness has a positive impact on both the subsidiary expected performance and its role in the development of products and production processes in the MNC.</i>
<i>Odile</i>	<i>2002</i>	<i>The main finding is that the technological specialisation of foreign-owned affiliates in each region will become more closely related to the regional indigenous specialisation pattern the higher the position of their parent firms' country of origin in the national hierarchy of the multinational corporation.</i>
<i>Arndt and Sternberg</i>	<i>2000</i>	<i>The paper sets out to answer the question, whether manufacturing businesses with strong intraregional ties are more successful with respect to growth rates and innovative activities than those firms with little connection to their region. From a survey carried out in 10 European regions, the results verify that in spite of numerous network relationships on the national and international level small businesses are most likely to co-operate with others in their vicinity.</i>
<i>Hendry, Brown and Defillippi.</i>	<i>2000</i>	<i>This paper draws on an international study into the opto-electronics industry to examine the extent and significance of localised inter-company trading and network relationships in six regions. National and international relationships are found to be much stronger than local ones. This is a function of customer and supplier markets, which derive from the technological characteristics of the industry and the way its markets have been created.</i>
<i>Keeble, Lawson, Moore and Wilkinson.</i>	<i>1999</i>	<i>The nature and extent of regional collective learning processes and networking by innovative, technology-based, small and medium sized enterprises in the Cambridge region are investigated. The importance of socio-cultural preconditions for learning involving the University of Cambridge is highlighted, and the significance of firm spin-offs, inter-firm and organisation networking, and local scientific and managerial recruitment, as dynamic collective learning processes, are documented.</i>

The evidence on the regional embeddedness of networks is relatively inconclusive despite the wide use of the industrial districts and clusters concepts. Most researchers are able to see some linkage between regional innovation propensity and the quality of networks although there is some contradictory evidence. The requirement of firms to be embedded in local networks appears to depend on the industry, the nature of the firm and the nature of the innovation effort. Successful networking activity in regions is highly context dependent.

There is some evidence that shows the importance of local embeddedness for subsidiaries of Multinational Corporations (MNC) and this illustrates that the value of such networks to a locality depend to some extent on the MNCs strategic choice. This illustrates that Foreign Direct Investment does have a role to play when facilitating the establishment of new network infrastructures within regions.

Section 7 in Summary

The effectiveness of networking between firms appears to be dominated by the role of personal and informal networks.

The degree of diversity of a firm's relationships can have a positive impact on innovation.

Integrating suppliers, co-suppliers and distributors in innovation projects has a positive impact on firm productivity and the chance of successful innovation.

Business customers play an important role in innovation efforts by helping firms identify opportunities for innovation.

Third parties, science partners and institutional mechanisms play an important role in creating a network infrastructure. They can act as neutral network brokers and enable actors to step outside their current 'frame of reference'.

Effective venture finance networks enable better opportunities for commercial success when firms innovate.

Firms can manage their networks and what they gain from such relationships depends on their experience and network management competencies.

There are many different forms of network configuration. These differ depending on the form of innovation and industry and the purpose of the network. Some networks can prevent innovation and can be anti-competitive.

Networks fail for a variety of reasons – government intervention can act as both a positive and negative force affecting the sustainability of particular networks and network infrastructures.

To conclude the evidence on the relationship between networking and innovation the following policy recommendations and research priorities are highlighted.

7.5 Stage 2: Policy and Research Recommendations

Policy Recommendations

The evidence supports the view that innovation occurs where individuals from different business systems meet (e.g. different industries or science-industry). It is, therefore, sensible for policy to promote the establishment of 'networks of networks', which encourage the foundation of cross-industry/cross-system relationships. Possible intervention might include the sponsoring of 'problem-based' cross-industry foundations that encourage discussions on technical problems pre-commercialisation. Current government policy should avoid an overemphasis on the encouragement of networks along narrow industry perspectives.

The willingness of firms to work with science partners is low even where there is an identifiable but latent demand. While the Lambert Review addresses supply-side issues the DTI could have some impact on raising demand – translating latent requirements into actual relationships. A focused awareness raising campaign illustrating the benefits of collaborations with science partners could provide one approach. Further, tax incentives for such collaborations would provide another avenue for promoting relationships.

The involvement of suppliers in innovation efforts would appear to have an important role when assisting firms to innovate and this has been directly linked to productivity performance. It is suggested that policy interventions, which encourage firms to include supplier representatives in research and development teams could be valuable. How this could be achieved in practice or what policies might be created to do this needs further consideration.

The engagement of customers is essential during incremental innovation. Once again although policy interventions promoting such behaviour seem difficult there may be some role for assisting the continuance and establishment of industry forums and conventions or the establishment of customer think-tanks.

Where inward investment from large Multinationals occurs it can have a profound impact on local innovation. Policies supporting inward investment should be supported but reviewed to ensure that features are included that impels or encourages these businesses to work closely with local firms. Current study illustrates that this is both in the interests of the firm and the locality.

Regions can build regional systems of innovation based on the creation of network infrastructures; these naturally differ between regions. Such infrastructures often require regional policy and intervention. The Regional Development Agencies and local Business Links could be tasked with improving their strategies for promoting network infrastructures, particularly with regard to informal networking behaviour.

The value of different forms of networks is not yet established. Policy decisions should be careful to avoid the encouragement of one form of network or network configuration over another.

The importance of trust in networks is now widely accepted. Non-profit making intermediaries play an important role in promoting trust in networks. The DTI Innovation Review could consider assisting the establishment of network brokers, for example, in universities; research institutes and further education colleges. It is essential that these network brokers are trusted, neutral third-parties.

Although little evidence currently exists on venture finance networks some studies do show their importance in spreading risk, for referrals, and for the scale and quality of equity investment. Some further support by the DTI to encourage the establishment of investment networks, such as, business angel networks and greater collaboration between venture capitalists will promote the development of the investment infrastructure. This might be achieved by encouraging collaborative investments via RDAs' venture funds or by introducing tax incentives for venture capital co-investment.

Institutional mechanisms for collaboration have been considered important for innovation in a number of studies. Although the evidence base is thin, there is evidence to support the establishment of such centres in the UK but a more detailed feasibility study and pilot is recommended.

There is evidence to suggest that the R&D spend of UK Ministries if linked to National Centres for Collaboration can be used to leverage increases in pre-competitive innovation and relationships for new technologies.

Achieving the balance between the protection of intellectual property rights and open access to certain technologies is essential for promoting collaborative innovation.

Not all network arrangements are good for innovation. UK policy should continue to be harsh against networks that encourage anti-competitive behaviour.

The current evidence supports the view that the clash between different behaviours and habits of thought across industries and between science and industry lead to frame-breaking innovation. How this occurs, what facilitates it and the nature of the impact on innovation has not been explored to any significant degree.

Supply chains play a key role in networks for innovation. The extent to which firms manage these networks has been investigated but more effort is required to draw together the findings of this work and to identify how such networks promote different forms of innovation.

Further work in the UK exploring how Multinational companies situated here engage in networking behaviour and how such engagement leads to local innovation and embeddedness might help explain further the value of inward investment for innovation.

Management research has illustrated the value of networks for firms; however, more work is required to explain how firms can manage their networks to promote innovation and how UK firms perform in this regard.

The development and evolution of networks and how different structures contribute to innovation remains particularly unclear. Future research could explore this relationship in further depth.

Further work exploring the different types and/or typologies of networks with a focus on their innovative qualities could be beneficial.

Very little work has focused on investment networks in the UK and their impact on innovation. The review has found that these may be a crucial weakness in the UK and further evidence is required to explore the issue.

Much is written about clusters and their impact on innovation. The review found that little of this focused on whether or not clusters actually facilitate networking or how different clusters might differ in this regard.

Institutional mechanisms play an important role in developing the network infrastructure but little evidence was found specifically addressing their role in promoting network activity and effectiveness. Work on business incubation should be continued but some focus should be given to their role in network infrastructures.

National and Regional Centres for Collaboration, on anecdotal evidence, appear to play an important role in raising a country's general networking capacity for innovation. The role of such centres and how they contribute to national competitiveness is in urgent need of further research.

This section (Section 7) explored the detailed empirical evidence from the systematic literature review in order to identify the nature of network relationships and how the UK could use this general evidence on networking and innovation. In the next section (Section 8) the UK situation regarding networking and innovation is considered in depth and compared to the situation in the US and Germany.



8 Evidence on Networking and Innovation in the UK

In this section of the report detailed evidence on the UK situation regarding innovation and networking is explored. It will explain the evidence base on the UK; making policy recommendations and highlighting suggested research priorities.

8.1 Results of the Review – The UK Evidence Base

The evidence base on the UK from the systematic literature review consisted of 36 empirical papers. The evidence was supplemented by a further 15 articles that were introduced according to a narrative review method during writing up and introduced based on expert comment. The overall picture of this data set provides a useful way to assess the gaps in the UK evidence before introducing the detail³.

The key journals contributing to the UK evidence were:

Regional Studies (4); Journal of Business Venturing (3); Research Policy (3) and Technovation (3).

The main key words were:

Innovations (10); Small Business (5); Research and Development (4); and Technology Change (3).

The base data highlighted here correspond with the evidence overall. The top four journals are the same as those included in the total evidence base and only one key word is different (Technology Change). The industries focused on by the studies are outlined in Table 8.1. The distribution of papers show that manufacturing industries have been studied more in the UK and high tech industries slightly less – neither difference is particularly profound and the high technology industries continue to dominate the report. There is some difference in the degree of study focusing on electronics in the UK but this can be explained by the lower interest in the semi-conductor industry, which is perhaps less important in the UK than it is in Japan, Germany and the USA.

The UK evidence, similar to the evidence on networking and innovation overall, tends to be spread thinly across a large number of industries and lacks critical mass. It is important; therefore, that any intervention based on the evidence presented is considered cautiously. In the following sections the UK evidence is reviewed according to the themes identified in Section 7. The detailed implications for the UK from the evidence are also highlighted in this part of the report.

³ The analysis of the data set only applies to those studies found in the systematic literature review

Table 8.1: Industrial Analysis of the Papers Reviewed (UK Analysis)

<i>Industry Papers</i>	<i>No. of Sample</i>	<i>% of Papers UK</i>	<i>No. of Sample</i>	<i>% of UK</i>	<i>Change</i>
<i>Primary Industries</i>	4	5.7%	1	4.6%	-1.1
<i>Energy Industry</i>	1		0		
<i>Agriculture</i>	1		0		
<i>Oil and Gas</i>	2		1		
<i>Manufacturing Industries</i>	12	17.1%	5	22.7%	+5.6
<i>Automobile Components</i>	3		0		
<i>Ceramics</i>	1		0		
<i>Mechanical Engineering</i>	2		0		
<i>Medical Equipment</i>	3		2		
<i>Clothing</i>	2		1		
<i>Packaging Machine</i>	1		0		
<i>Service Industries</i>	2	2.9%	1	4.6%	+1.7
<i>Food Industry</i>	1		0		
<i>Financial Services</i>	1		1		
<i>High Technology Industries</i>	52	74.3%	15	68.2%	-6.1
<i>Chemicals</i>					
<i>Plastics</i>	6	8.6%	3	13.6%	+5.0
<i>Petrochemicals</i>	1		0		
<i>Enzymes</i>	1		0		
<i>Defence Industries</i>	1		1		
<i>Electronics & Software</i>	3	4.3%	2	9.1%	+4.8
<i>Semiconductors</i>	23	32.9%	5	22.7%	-10.2
<i>Robotics</i>	3		3		
<i>Home Automation</i>	7		0		
<i>Telecommunications</i>	2		0		
<i>Pharmaceutical</i>	1		0		
<i>Biotechnology</i>	3		0		
<i>Embryonic</i>	20	28.6%	5	22.7%	-5.9
	44		2		
	1		0		

8.2 UK Theme 1: Networks in the Market Interface

The general evidence on networks in the market interface is shown in Sections 7.1.1 and 7.1.2 as well as Table 16. The evidence shows that the involvement of suppliers in innovation efforts improves their chance of success, while including customers enables firms to identify opportunities for innovation. The evidence on the performance of UK firms and their effectiveness at engaging suppliers and customers in innovation is outlined in this section. The gaps in the evidence base are also outlined. Table 27 summarises the evidence.

Table 8.2: The UK Evidence on Networks in the Market Interface

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Romijn and Albaladejo</i>	<i>Detailed empirical model of internal innovation used to asses 33 companies in small electronics and software firms.</i>	<i>2002</i>	<i>South East England</i>	<i>Analysed in detail the innovation performance of firms. Found that suppliers played a key role in product innovation in the UK. Used Spearman correlation co-efficients and found significant relationships (at 0.05 and 0.01 levels) with suppliers. Proximity of suppliers to the innovating firm had a direct impact on the incidence of product innovation (0.343) and with the product innovation index (0.412).</i>
<i>Bruce and Moger</i>	<i>Semi-structured interviews with 10 senior managers in retail multiples including manufacturers and fibre suppliers.</i>	<i>1999</i>	<i>UK</i>	<i>An empirical study exploring innovation supporting and blocking factors in the UK clothing industry supply chain. Three types of supply relationships identified co-partnerships; ad-hoc relationships; and, small networks of independents. Found that networks of independents had difficulty engaging in existing co-partnerships and that the other two forms limited innovation to an incremental process. UK clothing manufacture was relatively lacking in innovation capacity as a consequence.</i>
<i>Conway</i>	<i>Studied firms who received the Queens Award for Technological Achievement and the British Design Award using a sample of 35 interviews.</i>	<i>1995</i>	<i>UK</i>	<i>External inputs sourced informally played a critical role in 8 (23%) of the innovations. 19 (54%) of the projects drew on important inputs from external sources only 11 (33%) of the projects were considered not to have benefited (or to a minor extent) from external networks. The establishment of a project supported by the Ministry of Defence to work on Liquid Crystal Display is highlighted. Although the consortium was formal the informal friendships guided innovation, e.g. "We have very close relationships with the groups we collaborate with... It is important. It develops a level of understanding you wouldn't get otherwise". 9 (26%) projects were stimulated by a formal need; 4 (11%) from a science-technology project; 22 (63%) from various internal processes. The innovation concept was defined by external sources in only 5 (14%) of the cases. External inputs were less important during problem-solving than field testing.</i>

Table 8.3 Continued from Table 8.2: The UK Evidence on Networks in the Market Interface

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Oakey</i>	<i>Survey interview with 43 new biotechnology firms.</i>	<i>1993</i>	<i>UK</i>	<i>In common with many high technology industries biotechnology firms rely heavily on one single large customer in their customer networks. Incidence of single customer purchasing in South East (67%) – Rest of UK (33%). The high South East total was seen as a precursor to acquisition.</i>
<i>Bruce and Rodgus</i>	<i>Survey to senior marketing personnel of 48 suppliers in the Enzyme Industry.</i>	<i>1991</i>	<i>UK</i>	<i>The main factors for competitiveness were 'effective product marketing' 7.28; 'maintaining links with customers' 7.00; and, new product R&D 6.92 (on a 1-10 scale). A majority of firms involved customers (73%) and customers were involved in idea generation and problem solving (73%) and product testing (64%). The survey showed that manufacturers dominated the innovation process but used customer involvement and this was a significant competitive issue in the Enzyme Industry.</i>
<i>Rothwell</i>	<i>Survey of 400 small manufacturing firms.</i>	<i>1991</i>	<i>UK</i>	<i>69% of firms had marketing links with other firms; 47.5% had a technical link; 39% of firms had contracted out R&D; 26% engaged in some form of collaborative R&D; 37% of firms were engaged in collaborative marketing. A large proportion of firms subcontracted some of their manufacturing (68%) but only a small number manufactured under license (16%).</i>

8.2.1 Diversity of Partners

The importance of diverse partners within networks for innovation was shown in Section 7.1. Keeble et al's (1998) study shows how different types of technology-based firms network in the Oxford and Cambridge regions and the part that internationalisation plays on firm's propensity to use network relationships (Table 28).

Table 8.4: Internationalisation and Local Networking by Technology Intensive Firms in the Cambridge and Oxford Regions (Adapted from Keeble et al. 1998).

<i>Nature of the relationship</i>	<i>Internationalist Firms % Sample</i>	<i>Nationalist Firms % Sample</i>
<i>Customers</i>	17.6	29.4
<i>Research collaborators</i>	23.5	11.8
<i>Suppliers or subcontractors</i>	37.1	44.1
<i>Firms providing services</i>	33.3	32.4
<i>Firms in same line of business</i>	20.6	2.9
<i>Firms reporting research links with Cambridge or Oxford Universities since formation</i>	59.6	45.7
<i>Firms reporting research links with Cambridge or Oxford Universities as of some or major importance for the firm's development</i>	40.3	21.7
<i>Firms reporting close links with other firms</i>	59.6	58.7
<i>Firms reporting research links with other local firms or organizations as of some or major importance for the firm's development</i>	34.0	34.8

Keeble et al's (1998) work illustrates that UK technology intensive firms that internationalise are particularly important in local regional networks and for the diffusion of innovation in the UK. Based on the study they make recommendations for UK policy makers:

Business Links and other support agencies (including Science Park and Incubator management companies) need to be aware of the importance of technology intensive firms that internationalise for local and global relationships.

Support should be offered, for example: help with foreign skills; pump-priming funding for foreign research collaboration or marketing visits; more sympathetic local authority planning; active promotion of local SME networking.

The evidence exploring the use of diverse partners in innovation networks (Tables 27 and 28) shows that UK firms' networking capacity is as good, if not better, than many of our competitors. UK firms have been shown to engage customers in a variety of different forms including marketing and R&D collaborations (Bruce and Rodgus, 1991; Oakey, 1993). They have drawn in external contributors in key award-winning innovations (Conway, 1995) and have worked with suppliers extensively (Rothwell, 1991; Bruce and Moger, 1999; Romijn and Albaladejo, 2002). The evidence supports the view that the networking capacity of firms within the market interface is relatively strong in the UK but that there are some variations between sectors. A detailed overview of the performance of UK firms when working within particular forms of relationship is explained in Sections 8.2.3 and 8.2.4.

In the following sections the report explores how UK firms work with suppliers and customers in more detail.

8.2.2 Supplier Involvement

In Section 7.1.1 the importance of networks with suppliers has been shown. The involvement of suppliers has a direct impact on the likely technical success and market appropriateness of product innovations and it has been directly linked to firm's productivity performance. The UK evidence on supplier involvement in networks is now explored.

Rothwell's (1991) study, for example, illustrates that innovative small manufacturing firms in the UK have in the past obtained many technical inputs from other usually small companies (in addition to links with science partners – see Section 8.4). Many of these firms have collaborated through joint R&D ventures and sub-contracted R&D. Other innovations and links have occurred that do not have any overt technical content. In the study firms gain access to market know-how via marketing links and collaborations. Small firms in UK manufacturing were also shown in this study to lessen the risks of product innovation by collaborating with other co-suppliers. The evidence in Rothwell's study is supported by Conway (1995); and Romijn and Albaladejo (2002) who both show evidence of UK firms working extensively with suppliers when seeking to innovate.

Bruce and Moger's (1999) study of the clothing industry does, however, suggest that the effective integration of suppliers in innovation in the UK might be lower in some industries. The evidence, therefore, supports the view that suppliers are effectively integrated into innovation efforts in UK high technology industries but the evidence is insufficient to draw conclusions about other industries.

The importance of customer networks in the UK (Table 27) is also confirmed in the evidence on the UK market interface.

8.2.3 Customer Involvement

In Section 7.1.2 the value of customer involvement in incremental innovation was shown. Customer networks were seen to be important during the early stages of innovation effort when ideas and opportunities are first explored (see Box 9).

The empirical evidence supports the benefits of customer involvement during innovation in the UK and firms have engaged customers in their innovation efforts. In Bruce and Rodgus' (1991) study, for example, of 48 suppliers in the UK enzyme industry, 73% of companies involved the customer in idea generation and problem solving, while product testing (64%) was a close third-place. Conway (1995) also found in his study of 35 successful innovations that customers were crucially important at the idea generation stage of the innovation process. UK Companies that stated they received essential information from customers were more successful with technological innovation and had greater commercial success.

In Oakey's (1993) study the strong bonds between small UK biotechnology companies and a principle customer was considered to be beneficial and supportive of innovation but there were also risks identified. It was shown that a strong contribution to innovation and growth from small firms in this industry was unlikely due to its sophistication and cost base. The strong relationship between small and large firms in this industry in the UK was viewed to have a number of benefits and weaknesses.

BOX 9: UK Networking Success – The British Advertising Industry

In the 1980s the large US advertising networks dominated the global advertising industry but they were challenged by a new breed of London-based agency mainly based in and around Soho. Some of these agencies rose to global positions transforming themselves from international advertising networks into global communications groups. This localised cluster in the UK is a fine example of innovation success via networks in the UK. Two London firms, Saatchi and Saatchi and WPP came to the forefront of the cluster. The rise of Saatchi and Saatchi elevated them to second position in the US billings table in 1987 and Martin Sorrell's WPP in 1987 became one of the first of the new cluster to takeover one of the largest and oldest US agencies Ogilvy and Mather in a hostile takeover. The key change that led to the rise of the Soho cluster was a new organizational form that led to the introduction of a process innovation 'account planning'. Account planning effectively involves the customer's perspective in the production process, which until that point had been confined to the perspectives of 'creatives' on the one hand, and 'account managers' on the other. The introduction of account planning enable a more creative but market focused process in the advertising industry. Although it has caught on in the US and Europe account planning is still firmly established in the British Advertising industry. In British agencies the design process is a collaborative effort of specialised professions where in Europe the division of labour is less pronounced. Although cooperation is key the London agencies keep the logic of 'art', 'client', 'customer' separate. The creativity derives from the diversity of those collaborating. This innovation is even more remarkable when one considers its mutations, for example, more recently account planners in London have started independent account-planning agencies. The London approach has also boosted the environment for innovation by hosting agency networks that form loose federations, for example, the Advertising Marketing International Network which consists of independently owned agencies in North America and Europe but which is coordinated from Soho. The first employee-owned agency St. Lukes was also founded in London in 1995 and its success illustrates another form of organisational innovation. (Adapted from Grabher, 2001).

Comment: *There are examples of considerable innovation success via networks in the UK. These may illustrate some industries other than the obvious ones, such as, biotechnology where the UK does perform well and uses networks effectively. More effort could be spent on identifying these successes.*

Both small and large firm executives viewed the networking behaviour of large firms as a formal strategy for keeping and watching brief on their smaller suppliers for possible future acquisition. This was considered optimal for two reasons.

- 1) Strong patronage or a small equity stake allowed the small firm to develop in an independent state during formation and growth which enabled it to gain the advantages of small size.
- 2) If the enterprise eventually proved to be a success the technological and human assets could be obtained through acquisition at a lower cost than would be involved with developing the technology.

Such an approach is an established phenomenon that can lead to a diversity of approaches to innovation.

Oakey (1993) concluded that such an approach to avoidance in R&D investment in UK biotechnology by larger firms meant that Japanese and US conglomerates were likely to out-perform UK firms.

The data on the involvement of business customers in innovation, therefore, shows a mixed picture. UK high technology industries appear to be quite good at involving customers in their innovation efforts particularly at the crucial stages of idea generation and opportunity recognition. Such activity is positive in that it improves the innovative effort of smaller firms.

Where there may be weakness in the UK is if larger firm's as customers use collaboration and subsequent acquisition of small firms as a method to reduce their own internal R&D expenditure. The evidence on UK biotechnology firms suggests that such network relationships can lead to lower R&D investment levels in the larger firms. More evidence is required on this particular issue; however, if it were proven it should raise concern because low R&D investment by customers in collaborative efforts has been linked to lower levels of successful innovation (Table 7.2).

In the next section the review starts to examine the UK's networking infrastructure by exploring the role of third parties within networks.

8.3 UK Theme 2: The Role of Third Parties

The general evidence on the role of third parties in network infrastructures is shown in Sections 7.1.3 as well as Table 7.3. The evidence shows that third parties have a dual role in promoting innovation; they act as neutral knowledge brokers and conduits for the development of informal relationships. The evidence on the role and effectiveness of third parties in the UK is highlighted here. The gaps in the evidence base are also outlined. Table 8.4 summarises the evidence.

Table 8.5: Theme 2: The UK Evidence on the Effectiveness of Third Parties

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Swan, Newell and Robertson</i>	<i>A survey of 1846 firms, including 350 from the UK and including interviews.</i>	<i>1999</i>	<i>UK</i>	<i>UK firms tended to adopted more standardised packages than other nations but this did not link to adoption success. Adapting standard packages forced the UK firms to change there operational systems to fit the software, whereas other firms in Sweden tended to take more time in implementation to adapt the systems to their particular operational requirements.</i>
<i>Blackburn and Curran</i>	<i>Detailed interviews with 100, 60 members of trade bodies, 40 not.</i>	<i>1997</i>	<i>UK</i>	<i>Such associations were viewed to be much more successful in the promotion of support networks in the UK than their formal counterparts (in this study TECs). Trade associations have a varying degree of enthusiasm for the inclusion of small firms and do not always encourage networking benefits on behalf of these firms.</i>
<i>Bryson, Keeble and Wood</i>	<i>Detailed interviews with 120 small firms in business services.</i>	<i>1992</i>	<i>UK</i>	<i>The study shows that client choice in this industry is related to personal recommendation and consequently personal networks. Repeat business accounted for 61% while 22% receive most new business from client referrals. Personal contacts account for 61% of business for management consultants and 76% for market research firms. 74% of these firms regularly use outside researchers but their associate networks were small usually less than 10 people.</i>
<i>Curran and Blackburn</i>	<i>Interviewed owner-managers of printing and electronics firms.</i>	<i>1992</i>	<i>UK</i>	<i>The study showed that latent networks existed but firms put little effort into promoting and maintaining them. The study shows that small firms consider professional services (lawyers and accountants) as one of the main nodes in their business-to-business network relationships.</i>
<i>Smallbone, North and Leigh</i>	<i>Explored a panel of 306 firms in 8 industries between 1979-1990.</i>	<i>1992</i>	<i>UK</i>	<i>55% of firms had received some substantial form of external assistance; paid consultants were the main form used (52%) while 17% received help from banks. Trade associations (8%) had a relatively low use, while 21% of firms had received assistance from public agencies.</i>

The evidence confirms the general view that third parties are important intermediaries in the country's network infrastructure. The UK evidence suggests that firms offering business services to other firms (e.g. accountants) and trade associations play the most important roles (Bryson, Keeble and Wood, 1992; Blackburn and Curran, 1997; Curran and Blackburn, 1992). Consultants appear to be important where problems emerge requiring process innovations and professional associations have had both positive and negative effects on innovation diffusion in the UK study (Swan, Newell and Robertson, 1999).

The studies examined, focused on the perspective of business owners, suggest that intermediaries play a more important role in the UK's networking infrastructure than formal support mechanisms sponsored by Government intervention. It must also be acknowledge, however, that such intermediaries rarely play a neutral role in network infrastructures and they may be less effective at network brokerage than other publicly sponsored organisations.

In the following sections each of the key intermediaries in network infrastructures are explored in more detail.

8.3.1 Consultants

In the evidence base only one study examined the role of consultants as network participants effecting innovation in firms. It is expected other evidence on this subject exists but was not focusing on networking and was consequently not picked up by the systematic literature search. The study conducted by Bryson, Keeble and Wood (1992) examined business services in the UK exploring their success at encouraging the development of networks. Detailed interviews were carried out with 120 small business service firms including management consultancy and market research firms. These firms act as important brokers in networks and during the innovation process. In the study they analyse informal networks, including demand-related (those associated with clients and obtaining new business), supply-related (where firms are able to satisfy specific client demands) and networks associated with support functions (for example, links with the banks or business advisers). The findings of the study show that personal networking behaviour is essential in UK business services and these firms act as an important node in network infrastructures.

Clearly, consultants in the UK can have an important role as 'match-makers' because their business depends on personal networking skills, their access across businesses enables them to see collaborative opportunities and they can introduce clients for joint development projects. The value and current performance of consultants in the UK in this regard cannot be ascertained from the evidence in this review and the practicalities associated with such matchmaking from the consultants' point-of-view are unclear.

8.3.2 Trade Associations

Trade associations are also one of the key intermediaries in many industry sectors in the UK undertaking conventions, providing members with resources and organising meetings. The UK evidence on the value of these intermediaries within networks is perhaps a little limited. For example, in the US the role of trade associations in assisting the diffusion of innovation via trade conventions is a well-established phenomenon. Although such conventions do happen in the UK none of the evidence found highlights the number of such conventions when compared to other countries. The role of such conventions and their contribution to assisting collaborative innovation via networks is also unclear.

One study that examined the role of Trade Associations in the UK was conducted by Blackburn and Curran (1997). They looked at the important role of trade associations in UK networks for smaller firms. The study focused on printed circuit board manufacturers, computer services, tool hire, hotel and guesthouses and hairdressing. Overall 110 business owners were interviewed, 60 were members of trade bodies and 50 were not. From their study they were able to identify that:

Membership of trade associations was high in some sectors notably PCB manufacture and tool hire while low in others.

Trade associations have a varying degree of enthusiasm for the inclusion of small firms and do not always encourage networking benefits on behalf of these firms.

Trade associations were viewed to be important bodies for advice and support and were considered the most important following families and friends.

Such associations were viewed to be much more successful in the promotion of support networks in the UK than their formal counterparts (in this study TECs).

Clearly the evidence is limited and more study is needed on the role of trade associations on network infrastructures. The evidence from the one study that has been carried out indicates that the UK trade associations may need to consider a number of factors. What they do to involve and encourage the involvement of smaller firms and how they develop and support networking behaviour amongst their members.

8.3.3 Professional Associations

Like their trade equivalent professional associations can play an important role within the UK's network infrastructure. Much of the role played by such associations can be through the promotion of informal networking and the diffusion of innovation via events and continuous professional development. Once again the evidence on the role of professional associations in the UK regarding their contribution to networks is relatively small. The research was a useful comparative study but is only representative of one UK professional association.

The study by Swan, Newell and Robertson (1999) examined the UK's approach to networking in professional associations by exploring the diffusion of Computer Aided Production Management (CAPM) technologies and compared this activity to the approach of professional associations in France, The Netherlands and Sweden. The study used a survey that explored various aspects of the adoption of CAPM and the influence of professional associations on diffusion. The survey covered 1846 firms including 350 from the UK and the researchers conducted interviews in addition to the survey. The key results are presented in Table 8.5.

Table 8.6: National Differences in the Diffusion of CAPM – Adapted from Swan, Newell and Robertson (1999).

	<i>UK</i>	<i>France</i>	<i>The Netherlands</i>	<i>Sweden</i>
<i>CAPM Systems adopted</i>	<i>Moderate</i>	<i>High</i>	<i>Moderate</i>	<i>Very High</i>
<i>Integration</i>	<i>High</i>	<i>High</i>	<i>High</i>	<i>Low</i>
<i>Degree of customisation</i>	<i>Moderate</i>	<i>Moderate</i>	<i>High</i>	<i>Very high</i>
<i>Perceived success</i>	<i>Moderate</i>	<i>High</i>	<i>High</i>	<i>High</i>
<i>Using MRP2</i>	<i>Moderate</i>	<i>High</i>	<i>Moderate</i>	<i>Low</i>
<i>MRP2⁴ Push by: Professional Associations</i>	<i>Strong</i>	<i>Weak</i>	<i>Strong</i>	<i>Weak</i>
<i>MRP2 Push by: suppliers</i>	<i>Strong</i>	<i>Moderate</i>	<i>Moderate</i>	<i>Weak</i>

UK firms tended to adopt more standardised packages than other nations but this did not link to adoption success.

Adapting standard packages forced the UK firms to change there operational systems to fit the software, whereas other firms in Sweden tended to take more time in implementation to adapt the systems to their particular operational requirements.

⁴ Computer Aided Production Management is known more widely as MRP2

In the study this was explained by the different way in which the professional organisations in the countries operated.

In both the UK and France firms adopted standardised packages but the French firms had more success.

In France the professional association held formal events but invited fewer supplier-members and had more informal discussion and networking.

In the UK there was more uncritical technology push from suppliers and the professional association, formal events were held; MRP2 was promoted as the 'best practice' CAPM design.

The use of the professional association to push the interests of suppliers was not tempered by informal discussion over practical problems implementing the technology.

The UK professional association consequently tended to promote a 'fad or fashion' in 'best practice' without considering the difficulties associated with implementing the new technology.

The association did not actively facilitate informal networking and learning that could have led to more effective implementation of the technology.

In the study the UK professional association may also have played a key role in the moderate success of the technology in the UK when compared to other countries (Swan, Newell and Robertson, 1999).

The evidence shows that the one professional association studied in the UK was less effective at supporting the diffusion of innovation through networks than its counter-parts in other countries. It failed because it was dominated by the interests of suppliers; was too uncritical of the issues associated with implementing new technology; and, it did not assist firms with informal networking essential for them to learn about the experiences of other members with the new technology. Although one cannot draw conclusions about professional associations in general in the UK based on this study it does indicate that further analysis of professional associations in the UK and their impact on innovation is urgently required.

In conclusion the role of third parties in the networking infrastructure in the UK has been under-researched for any general conclusions to be made. For example, there is little evidence in the review on the role of Chambers of Commerce (see Section 8.10.1), which is surprising and not enough on associations, particularly on the role of trade conventions. The evidence that does exist shows that these intermediaries are considered to be more important to the network infrastructure by small firms than formal support mechanisms. The evidence also presents some concerns. Both UK trade and professional associations have been seen to be 'exclusive' in some way, either they have not been welcoming of smaller firms or they have pushed the particular interests of one type of technology above another. Given that neutrality and trust have been found to be the key requirements for successful network brokerage by intermediaries UK associations may need to be more careful about how they balance the interests of their members.

The next major group of organisations that are considered to be important in the UK's network infrastructure are science partners. These organisations include for example: universities; technical colleges; research institutes; applied science and engineering consultancies; independent research and design laboratories and Government departmental research institutes.

8.4 UK Theme 3: The Role of Science Partners

The general evidence on science partners and their role as intermediaries in networks is shown in Sections 7.1.4 as well as Table 7.5. The evidence shows that science partners contribute to innovation networks by assisting the development of informal-personal networks and by enabling firms to develop thinking that steps outside of their particular business system. The evidence on the performance of UK firms and their effectiveness at networking through science intermediaries is shown in the following evidence. The gaps in the evidence are also outlined. Table 8.6 summarises the evidence.

Table 8.7: Theme 3: The UK Evidence on Firms' use of Science Partners as Intermediaries

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Collinson and Gregson</i>	<i>Case studies of organisations set-up to promote start-ups (Connect Scotland in the UK).</i>	<i>2003</i>	<i>UK Canada USA</i>	<i>Showed some success in the Connect Scotland network (27 events in 1997 to 49 in 2000). Its greatest impact has been on social networking that precede exchanges and collaboration. It had assisted the transfer of information about key players (e.g. business angels) across sectors. The evidence of conversion of networking in outcomes was not evident.</i>
<i>Romijn and Albaladejo</i>	<i>Detailed empirical model of internal innovation used to assess 33 companies in small electronics and software firms.</i>	<i>2002</i>	<i>South East England</i>	<i>Analysed in detail the innovation performance of firms. Found that the science base played a key role in R&D propensity. Used Spearman correlation co-efficients and found significant relationships (at 0.05 and 0.01 levels) with science partners. Frequency of interaction: incidence of product innovation (0.406); No. Patents (0.389); product innovation index (0.621). With proximity to science partners they found significant relationships with incidence of product innovation (0.393); No. patents (0.305) and product innovation index (0.292).</i>
<i>Cantwell and lammarino</i>	<i>Analysis of patent data.</i>	<i>2000</i>	<i>UK Regions</i>	<i>Shows that R&D spend on research grants (1994-1997) is dominated by the South East of England (39.9%). Scotland (12.4%); North West (8.6%); East Anglia (8.4%); Yorkshire and Humberside (7.5%).</i>
<i>Phillimore</i>	<i>Survey of Western Australian Technology Park (WATP) and comparison to Surrey Technology Park.</i>	<i>1999</i>	<i>Western Australia and Surrey</i>	<i>The main focus of this paper is WATP, however, data from Surrey is used for comparison. 33% of Surrey Research (SRP) firms have informal links with Surrey University; 5% had no link; 34% had formal links. Links between WATP and local Universities tended to be lower than in the Surrey Research Park. Inter-firm links based on proximity were viewed to be an important advantage of Science Parks.</i>
<i>Autio</i>	<i>Surveyed 19 University spin-off firms from the University of Cambridge.</i>	<i>1997</i>	<i>Cambridge</i>	<i>In the study new technology-based firms are analysed in terms of knowledge conversion process – taking basic technologies and converting them into commercial opportunities. The study shows that where a combination of internal and external resources are exploited through collaboration such firms are more likely to grow and be highly profitable.</i>

Table 8.8 Cont: Theme 3: The UK Evidence on Firms' use of Science Partners as Intermediaries

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Shaw</i>	<i>Studied in-depth case studies of 34 medical equipment innovations.</i>	<i>1993</i>	<i>UK</i>	<i>In this sector because of the need for clinical trials continuous interaction between entrepreneurs and science partners is required. 74% of the innovations involved joint prototype testing; 56% required joint prototype development and marketing; 38% required joint product specification and marketing.</i>
<i>Rothwell</i>	<i>Survey of 400 small manufacturing firms.</i>	<i>1991</i>	<i>UK</i>	<i>55% of firms had regular contact with public sector institutes that provided technical inputs. 31% sponsored students at educational establishments. 39% provided placements for sandwich students. Sponsorship and placements were viewed as a means to gain access to state-of-the-art knowledge. 40% of firms took at least one government sponsored scheme to gain access to outside technical help; 33% took up two and 10% took up three.</i>

The evidence on the role of science partners in networks for innovation is more substantial than the evidence on other partners. All of the evidence on science partners points to the key role that they play in networks for innovation; especially where the innovation is more radical.

For example, Shaw's (1993) study shows that entrepreneurs have needed to link to a variety of science/public sector partners. As well as the 20 universities and hospital schools that were linked to the 34 innovations, the Medical Research Council (MRC), the Department of Health, the British Technology Group (BTG), the Department of Trade and Industry were all found to act as important intermediaries enabling the innovations to be commercialised. The MRC for example acted as an intermediary in twelve of these innovations (35%); the Department of Health in four (11%) and the Department of Trade and Industry acted as an intermediary in one, and funded in a variety of ways ten (29%). The evidence confirmed the important role of UK public sector organisations and science partners as intermediaries in networks for innovation and confirms that performance of these intermediaries in this industry (in 1993) was relatively strong.

Rothwell's (1991) study shows that UK small firms in manufacturing have benefited greatly from links to science and technical partners. The data shows that radical/major innovations in these firms have been derived from external sources, and these were often associated with the employment of graduate engineers and scientists and with greater interaction with public sector R&D laboratories. Incremental innovations in contrast arose more frequently from inside the firm. The great majority of UK firms studied were proactive in seeking networks; although often the catalyst was problem-based.

The evidence in Rothwell's study is also supported by Collinson and Gregson's (2003) where they compared Connect Scotland, The Austin Technology Incubator (USA) and the Canadian Environmental Technology Advancement Corporation (Canada) showing that science partners have been making important contributions as intermediaries in networks in the UK, USA and Canada (see Box 10).

BOX 10: Science Partners as Network Brokers – the Case of Connect Scotland at the University of Edinburgh

Connect Scotland was based on Scottish Enterprise's research showing that the development of high growth enterprises depended on good links between many partners including universities, large corporations, emerging businesses and support organisations. Connect was located at the Management School in the University of Edinburgh. Its core competency is designed to network individuals and organizations creating a networking infrastructure; facilitating technology transfer and enhancing entrepreneurial education. Connect has a total of 54 sponsors that pay £3000 per year to support the programme. These include all 14 Scottish universities, nine public sector companies, five private sector companies, nine consulting firms, eight law firms and nine financial firms. There are approximately 100 companies that are members and 35 individuals they pay £100 per year. Connect uses technology briefings; enterprise workshops; learning sets; springboard workshops; investment conferences and partnership conferences as part of its role. Its main objectives were to keep the events and audience mix correct and enabling investment for new technology start-ups.

Connect has been effective at its first role and has increased the degree of social networking, which is consistent with the current understanding that social interactions and acquaintances across domains tend to precede exchanges and collaborations involving specific knowledge and financial value. A survey of members shows that the events were facilitating the transfer of business-related information across sectors and local constituencies including more market awareness of key players, such as, business angels and venture capitalists. There was little evidence, however, that the network had been successful at translating activity into financial backing for new businesses (as yet). (Adapted from Collinson and Gregson, 2003).

Comment: *The experience of Connect Scotland shows that Universities can act as important neutral conduits and brokers of networks. It has been shown that social networking is one of the major contributors to innovation and such networks promote learning across industry boundaries. It is also evident from this example that understanding about 'network leverage' (extracting value from networks) might need more thought.*

The evidence from the USA and Canada reported in Collinson and Gregson's (2003) study suggests that such networks should be further encouraged and can develop more; both CETAC and ATI were more effective at nurturing new technology-based businesses than Connect – improving the performance of such networks needs development by:

Assisting regional incubators to be network brokers in the more expansive sense demonstrated by Connect Scotland.

Enable such brokered networks at Universities to link into financial institutions and informal finance more effectively.

Enable such brokered networks to engage in the assessment, hosting and development of promising new ventures.

Encourage the use of wider filtration techniques and cost-benefit analysis used in the US and Canada for identifying 'winners' and assisting them through the venture formation process.

The evidence on science partners as intermediaries in the network infrastructure is important in a number of ways. The review shows that science partners play a crucial role in product innovation particularly where innovations are radical and not incremental. The UK evidence supports this view and interactions between firms and science partners in the UK are relatively strong in the industries featured. The evidence highlights that interactions based on students (placements; projects; TCS) have also been beneficial to UK firms as a way of accessing the science base; as has informal mechanisms such as networking events.

All of the evidence viewed by this study highlights the key role of personal networking between science and industry and this is something that might be further supported. Finally, the review did find some evidence from other countries (Section 7.1.4) that even where the supply infrastructure is present (e.g. funded networks; science incubators) some intervention is required on the demand side, for example, by promoting the benefits to firms of working with science partners.

In the next section the systematic review will examine the evidence on the final set of partners who contribute to the innovation infrastructure – venture finance partners.

8.5 UK Theme 4: The Role of Venture Finance Partners

The general evidence on the role of financial networks in the innovation process is shown in Section 7.1.5 and Tables 7.8 and 7.9. The evidence shows that finance networks are important for the commercialisation of innovation and that co-investment provides better quality investments and larger funds for high growth businesses. The evidence on the performance of the UK venture finance networks is highlighted here. The gaps in the evidence base are also outlined. Table 8.7 summarises the evidence.

The current evidence does not show much support for the existence of coordination mechanisms and co-operation in UK finance networks. All regions have schemes to support informal venture capital, for example, through the National Business Angel Network, Business Links and business angel syndicates. The British Venture Capital Association figures illustrate that the existence of Business Angels is increasing in the UK and the Global Entrepreneurship Monitor confirms this. Currently there are about 18,000 business angels across the UK investing over £500 million in at least 3,500 companies.

The importance of networks amongst the business angel population cannot be overstated (Mason, Harrison and Chaloner, 1991). Informal investors obtain most of their information on investment opportunities from friends and business associates.

Table 8.9: Theme 4: The UK Evidence on Venture Finance Networks

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Harding</i>	<i>Review of regional investment networks.</i>	<i>2000</i>	<i>UK</i>	<i>There are inadequacies in the supply of UK investments into venture capital funds. There is a lack of understanding about technology-based projects on the part of investors in the UK. There is a second equity gap preventing small high growth firms from obtaining second round finance. The study of regional venture capital explains the need to have a 'system' of financial networks in each region that is co-ordinated and structured.</i>
<i>Mason and Harrison</i>	<i>Survey of UK Business Angel Networks.</i>	<i>1997</i>	<i>UK</i>	<i>Syndicated deals in the UK with other registered angels accounted for around 25% of total investments, while a further 10% were with other equity investors, which does not compare favourably with the US (Lengel and Gulliford, 1997). The increasing evidence of syndicated deals among business angels is increasing the amount of investment available to expanding businesses in the UK.</i>
<i>Harrison and Mason</i>	<i>Review of five publicly supported business angel networks making 64 investments.</i>	<i>1996</i>	<i>UK</i>	<i>The effect of the projects was to leverage other networks including finance from the banks. They encouraged business angel syndicates to make further investments.</i>
<i>Oakey</i>	<i>Survey interview with 43 new biotechnology firms.</i>	<i>1993</i>	<i>UK</i>	<i>Most entrepreneurs would like to launch and develop their firm on the basis of their own and informal finance. Main sources of investment in biotechnology were: Profits (26%); Venture Capital (24%); Other (50%). Many biotechnology firms survived by selling services and received less venture capital investment than expected. Firms selling equity by number of employees where there were under 15 employees 40% firms sold equity whilst where there were over 15 employees 86% sold equity.</i>
<i>Mason, Harrison and Chaloner</i>	<i>Review of the business angel population.</i>	<i>1991</i>	<i>UK</i>	<i>Informal investors obtain most of their information on investment opportunities from friends and business associates. Such investors can also choose to take a formal role in ventures and often bring with them important entrepreneurial skills.</i>

Business angel's networking opportunities can be raised by government agencies (Stevenson and Coveney, 1994) if they are prepared for engagement in network brokerage. Analysing the UK business angel networks Mason and Harrison (1997) conclude:

Syndicated deals in the UK with other registered angels accounted for around 25% of total investments, while a further 10% were with other equity investors, which does not compare favourably with the US (Lengel and Gulliford, 1997).

The increasing evidence of syndicated deals among business angels is increasing the amount of investment available to expanding businesses in the UK.

There is still a need for further support for local and regional Business Angel Networks in the UK as these are beginning to fill some of the equity gaps in UK finance networks.

A review of the DTI's projects on informal investment by Harrison and Mason (1996) did show that intervention in these networks could work. The study reviewed five informal investment demonstration projects undertaken by the DTI and found them to be successful.

The findings show that the five projects facilitated 64 investments worth £3.7million.

The effect of the projects was to leverage other networks including finance from the banks.

They encouraged business angel syndicates to make further investments.

Helped create additional networking opportunities between investors and entrepreneurs via clubs.

Enabled business angels to take hands-on roles in the ventures.

The key finding of the work on UK business angels when compared with US counterparts is that the UK can benefit by strengthening the role of business angel networks but that this must be done on a local (sub-regional) level. Further, that encouraging syndicated investments can improve the quality of the investment and the amount of funds available to entrepreneurial firms. Networks are viewed as essential for assisting syndicated approaches and therefore are essential in the investment infrastructure.

The UK evidence on the formal Venture Capital (VC) network infrastructure is limited. Harding (2000) indicates that this is one of the UK's many investment gaps. The US data suggests that relationships between venture capital companies are essential for encouraging co-investment (Bygrave, 1987) and that co-investment can be linked to greater success in entrepreneurial businesses and for VCs themselves. It is clear that networked approaches to investment: spread risk; engage more people around the venture assisting learning; encourage larger funds to be invested in appropriate ventures; create greater network opportunities; and, enable entrepreneurial firms to grow more quickly.

Clearly, this is a subject that requires further focus but based on the evidence the review suggests that some form of tax incentive should be considered for collaborative investments.

In the following section the review will begin to assess the UK's formal innovation infrastructure and examine how it contributes to business networking and innovation.

8.6 UK Theme 5: The Role of Institutional Mechanisms

The general evidence on how institutional mechanisms can assist the innovation process is shown in Section 7.1.6 and Table 7.10. The general evidence on institutional mechanisms is relatively inconclusive. It does show, however, that these mechanisms can assist innovation via networks but how they do so remains unclear. The evidence on the performance of UK institutional mechanisms is shown in this section. The gaps in the evidence base are also outlined. Table 8.8 summarises the evidence.

Table 8.10: Theme 5: The UK Evidence on the Impact of Institutional Mechanisms

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Albert, Bernasconi and Gaynor</i>	<i>EU Review of European Incubator Policies.</i>	<i>2002</i>	<i>UK Germany and France</i>	<i>The study shows that incubation does not contribute at the same level to the UK's regional networking infrastructure as it does in France (220) and Germany (270-300). It shows that UK's (80-100) incubation policy has some way to go if it is to create the development of sufficient incubation space.</i>
<i>Kitching and Blackburn</i>	<i>Survey of small mechanical engineering firms.</i>	<i>1999</i>	<i>Stuttgart, Germany Aarhus, Denmark and South London, England</i>	<i>Show that limited networking between small-business owners and training providers in South London can be explained by a lack of embeddedness of UK small engineering firms in the institutional framework supporting business. The absence of a critical mass of engineering businesses, the limited experiences of business owners and the weak business-support network in South London were mutually reinforcing.</i>
<i>Cooke and Wills</i>	<i>Postal survey of 153 firms taking part in EU FP2 and 3; CRAFT and SPRINT; SMART; LINK; SPUR.</i>	<i>1999</i>	<i>Wales Ireland Denmark</i>	<i>In Wales SMEs were asked to ascribe improved performance gains to collaborative innovation programmes they were involved in. In EU programmes – knowledge exploitation (13%); innovation (40%); business performance (38%) in domestic programmes – knowledge exploitation (50%); innovation (62%); business performance (78%). Showing that domestic programmes tended to perform better than EU programmes.</i>
<i>Shutt and Pellow</i>	<i>Case studies of three urban clusters.</i>	<i>1998</i>	<i>Tyneside Leeds and Sheffield</i>	<i>The evidence is unclear but it does show that specific clustering activities designed to promote networking are being attempted in Northern cities. The indications from the study illustrate that the British institutional structure is not predisposed to such initiatives but more evidence is required to support the conclusion.</i>
<i>Rothwell</i>	<i>Review paper reviewing existing empirical evidence.</i>	<i>1989</i>	<i>UK</i>	<i>Finds that public sector organisations do play an important role in brokering relationships. In the UK this does not happen particularly well.</i>

The evidence as presented in Table 8.8 once again presents a mixed picture and confirms the general data showing that institutional mechanisms designed to promote networking and innovation have not as yet been proven successful. The UK data shows that we have had successful attempts at creating clusters via networks in Tyneside but were less successful in Leeds, that we have about 50% fewer regional incubation units than France and Germany, that in South London our support infrastructure had failed to create links between engineering firms and that Welsh small firms were finding UK sponsored collaborative programmes (SMART; TCS; SPUR) to be a success.

By examining some of these studies in more detail it is possible to show evidence of the UK's areas of success and failure when seeking to support networks designed to promote innovation.

8.6.1 Industrial Districts and Clusters

The concept of industrial districts or clusters featured strongly in the Porter report and it was argued that the UK had a relatively weak set of clusters. None of the data in this study was designed to directly address this question, however, examples of UK attempts to create clusters via networking were found. Shutt and Pellow's (1998) study for example explores the developments of three urban regions in the north of England and the attempts of economic development agencies to promote business networking. In north Tyneside the study examined the work of the 'Real Service Centre' (a collaboration between local authorities, business links, TECs and Newcastle University) which was designed to create services for specific industries including over 70 companies. In Sheffield attention was focused on the 'cultural industries' where promotion of the sector brought together 140 businesses. In Leeds the study focused on the Leeds Financial Services Initiative, which in the 1990s brought together firms from engineering, printing and the media. The results of the study were mixed.

It showed that in north Tyneside some networking and innovation benefits had accrued to the marine technology sector. In Sheffield the clustering appears to have been successful but in Leeds clustering success in the engineering sector was disappointing.

The evidence is unclear but it does show that specific clustering activities designed to promote networking are being attempted in Northern cities.

The indications from the study illustrate that the British Institutional structure is not predisposed to such initiatives but more evidence is required to support the conclusion.

The work on industrial districts in the UK that directly examines the role of networks in their formation is insufficient to draw any general conclusions. Other than to highlight that attempts at using networks to create clusters are being tried in the UK regions.

In Box 11 another method for cluster creation is explained in the case of NTT in Japan. It shows that networks and new ventures linked to one large organisation in a location can lead to the development of a cluster via corporate venturing. If you compare this to Box 12 which explains the Phillips equivalent it is possible to illustrate that large organisations can have very different effects on their locality depending on the extent to which they engage in networking and corporate venturing. There were no UK studies found in this specific subject area and so the role of large firms in the creation of clusters via networks and corporate venturing should be considered a research priority.

BOX 11: NTT – The Creation of a Cluster (Japan)

'The video-conferencing system and multi-point connection service market represented by multimedia technology is a growth market in Japan. Behind the recent upturn in this market was a strategic alliance between NTT, Japan's largest telecommunications carrier and PictureTel of the US, followed by the birth of business communities centred around or outside NTT. In 1994 NTT's president announced that NTT would be transformed from a telephone company to a multimedia company. Initially a small-scale multimedia promotion unit was set up inside NTT's head office. It started by utilising existing useable network technology to offer multimedia services to its customers. It promoted the popularisation of ISDN-based videoconferencing systems and videophones, which required the establishment of a new business in video applications that were unknown in the Japanese market. There were many challenges initially but the key to moving forward was the establishment of a business community interested in the project that included members within and outside the company. The community leader in NTT utilised these relationships with other leaders to create various business communities which worked together simultaneously to create a series of new businesses in video multimedia, both internal ventures and external ones; this provided the catalyst for the development of a cluster' (Adapted from Kodama, 2001).

Comment: *Large organisations if led effectively with appropriate resources can create new business-to-business collaborations in such a fundamental way that they have the potential to create new clusters. Policy to support innovation through networks should have some focus on how large UK organisations might do this more effectively. It is, however, currently unclear how well UK organisations perform in this regard.*

In the next section the report will explore the role of incubators as institutional mechanisms that support the development of networks of firms.

8.6.2 Incubators

The UK in recent years has made some effort to improve the incubation infrastructure for start-up firms. The policy has been supported by the RDAs who have made considerable investment in incubation. The main role of incubators is as dedicated space and support services for start-ups particularly high-tech ones, however, they also play an important role in networks. The quality of an incubator, however, largely depends on the quality of the network it can mobilise and consequently offer to prospective clients (Albert, Bernasconi and Gaynor, 2002) and this has not been widely acknowledged or addressed by UK incubators. The estimated population of regional development incubators in the UK compared to Germany and France is shown in Table 8.9.

Table 8.11: Estimate of the Number of Local Economic Development Incubators

	UK	GERMANY	FRANCE
Number of Incubators	80-100	270-300	220
Average Size of Incubator	2,200m ²	6,500m ²	2,240m ²
Average Length of Stay	3 years	5+ years	3.5 years

[Source: Albert, Bernasconi and Gaynor, 2002]

When one takes into consideration University incubation, for-profit incubation and corporate incubation the disparity between the UK and other European countries is probably less than this data illustrates, however, the lack of regional development incubators relative to competitors should be a concern. The study carried out by Albert, Bernasconi and Gaynor (2002) shows that incubation does not contribute at the same level to the UK's networking infrastructure as it does in France and Germany. The report published by the UKBI – United Kingdom Business Incubation (UK Incubators – Identifying Best Practice) confirms this view and illustrates that the UK has some way to go if it is to create a policy that promotes the development of sufficient incubation space. Based on the current data the UK needs to continue and expand its incubation space if incubators are to contribute to the general quality of the networking infrastructure.

Studies on incubation (Section 7.1.6 and Table 7.10) show that the management of such space is essential – if an incubator does not utilise local networks and encourage the establishment of further networks, as well as, providing space and support services they may not be as effective as they could be for supporting innovation (Albert, Bernasconi and Gaynor, 2002). There is no evidence in this review about the role of incubators in the creation and maintenance of local networks and this needs further study. Based on the general evidence it is possible to recommend some form of intervention, grants being the most obvious, that encourage incubators to expand their role from providing space and support services to being proactive business-to-business network facilitators. It is expected that many good incubators already undertake this role; however, the formalisation of this activity as part of ‘best practice’ could increase the effect incubators have on the general prosperity of their locality.

In the next section this review will explore how formal programmes for collaboration are perceived to have performed in the UK.

8.6.3 Programmes Promoting Collaborative Innovation

There are many formal programmes that the DTI and the EU already run to promote collaboration between science and industry and between firms in different European regions. Examples include SMART awards designed to assist firms with developing new technologies and TCS, which place graduates into firms on projects linked to an academic supervisor. Once again the data found in the review on the performance of these programmes is relatively thin.

One study by Cooke and Wills (1999) exploring EU and domestic programmes designed to promote collaborative innovation in Wales, Ireland and Denmark does provide some optimistic evidence supporting the value of these programmes. They specifically examine the EU’s 3rd and 4th Framework Programmes, the Cooperative Research Action for Technology (CRAFT) programme and the Strategic Programme for Innovation and Technology Transfer (SPRINT). 43 firms in Wales were surveyed as part of the study and the sample was mainly of engineering firms. The firms were asked to compare performance of the EU programmes with domestic programmes. In the case of the UK LINK, SMART and SPUR were investigated.

The domestic programmes in Wales were much more successful than either the EU programmes or the domestic programmes in Ireland and Denmark.

The high valuation of the domestic programmes in Wales was linked to SMEs popularity of local schemes that were tailored to the firm’s needs but implied a greater than expected informal inter-firm networking.

Over half of the SMEs surveyed ascribed improvements in product, process and organisational innovation to the involvement in these collaborative programmes.

Many of the Welsh respondents linked the low synergy of EU programmes to domestic ones as the main reason for the failure of EU collaborative programmes.

The main rationale for involvement was not innovation but business growth

Skills development and access to R&D were the main benefits Welsh SMEs sought to gain from collaborative programmes.

Following engagement in collaborative programmes enthusiasm for external networking and its benefits was greatly improved (see Table 8.10)

There were very few firms who could not see the benefits of networking following collaborative programmes (see Table 8.11).

Table 8.12: Welsh Firms Expressing a Strong Future Preference for Networking Following Involvement in Collaborative Programmes

<i>Preferred Link</i>	<i>Domestic Programmes (e.g. SMART)</i>	<i>European Union Programmes (e.g. FP4)</i>
<i>SME formal</i>	46%	27%
<i>Large firm formal</i>	46%	27%
<i>SME informal</i>	31%	27%
<i>Large firm informal</i>	15%	13%

[Source: Cooke and Wills, 1999]

Table 8.13: Welsh Firms Preference for Continued Networking following Involvement in Collaborative Programmes

<i>Preference</i>	<i>Domestic Programmes (e.g. SMART)</i>	<i>European Union Programmes (e.g. FP4)</i>
<i>Firms discontinuing networking</i>	5%	0%
<i>Weak networking preference</i>	4%	6%
<i>Strong networking preference</i>	8%	14%

[Source: Cooke and Wills, 1999]

Although the data is based on one study and further evidence is required the review considers the evidence to show that collaborative programmes in the UK especially SMART and TCS have been successful in their aim and should be continued and expanded. Unfortunately, the data is not as supportive of the value of the EU collaborative programmes. As these programmes can be administered by national and regional organisations UK policy makers do have some influence over their effectiveness. Based on the review it is suggested that where influence can be bought to bear EU collaborative programmes should seek to become more tailored to the local needs of individual firms.

This study has so far examined interactions in the marketplace and the role of the networking infrastructure in promoting innovation. Whether or not these are effective mechanisms it is the role of firms to use networks and innovate where they deem it necessary for business performance. In the next section the ability of UK firms to manage networks will be explored.

8.7 UK Theme 6: Managing Networks

The general evidence on the role of network factors and how firms might manage them effectively is presented in Section 7.2 and Tables 7.11-7.13. The evidence shows that a firm's experience and competence when managing its networks can have a direct impact on its innovation and productivity performance. The evidence on the performance of firms in the UK is illustrated in this part of the report. The gaps in the evidence base are also outlined. Table 8.12 summarises the evidence.

Table 8.14: Theme 6: The UK Evidence on Firms' Capacity to Manage Networks

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Grabher</i>	<i>Historical case study of the advertising industry.</i>	<i>2001</i>	<i>London, Soho</i>	<i>Highlights the success of the advertising industry in London based on proximity. Shows that networks thrive on dynamic tension between integrative and disintegrative practices.</i>
<i>Conway</i>	<i>Studied firms who received the Queens Award and the British Design Award using a sample of 35.</i>	<i>1995</i>	<i>UK</i>	<i>Informal boundary spanning relationships are a valuable mechanism in the innovation process. Managers must manage the flow of information in informal relationships, as this may not always be in the economic interests of the company. Firms were shown to be taking risks by relying on too few boundary-spanning individuals. The nature of relationships is unpredictable and it is recommended that firms create 'think-tanks' or 'test teams' to manage the process.</i>
<i>Curran and Blackburn</i>	<i>Interviewed owner-managers of printing and electronics firms.</i>	<i>1992</i>	<i>UK</i>	<i>The study showed that contacts in the UK between small and large firms were relatively widespread but one-off and intermittent and there was a lack of long-term relationships. Although word-of-mouth was the most common way in which small firms obtained business from large firms in the UK such contacts tended to be haphazardly activated rather than by strong local networks. Latent networks existed but firms put little effort into promoting and maintaining them. UK owner-managers did not see the value in networks and only 20% saw any value in introductory services.</i>
<i>Rothwell</i>	<i>Review paper reviewing existing empirical evidence.</i>	<i>1989</i>	<i>UK</i>	<i>UK large and small firms play complementary roles in the innovation process. In the UK this does not happen particularly well with the exception of particular industries (e.g. medical equipment manufacturers).</i>

Given how the general evidence highlighted the role of network management in translating activity into innovation outcomes the lack of UK studies on the subject is disappointing (Sections 7.2 and 7.3). The evidence that was identified tended to focus on links between small and large firms than on the management of networks within firms. The evidence, to be considered cautiously, does show that UK firms have tended to rely on the networking capabilities of too few individuals in their relationships with other firms and that contacts were too short-term being one-off and intermittent. This is of concern because the general evidence supports the view that networks are more effective at leading to innovation where they are relatively stable and long-term.

8.7.1 The Management of the Small Firm – Large Firm Interface

Studies exploring the links between small and large firms confirm the general impression that collaboration between firms in the UK tend to lack stability and is driven by short-term decision-making. For example, an investigation into the economic and social networks of small firms, with a particular focus on their links with large firms and public sector organisations, was carried out by Curran and Blackburn (1992). Owner-managers from 60 small printing and electronics firms were interviewed, as well as, 8 representatives from local large organisations.

The study showed that contacts in the UK between small and large firms were relatively widespread but one-off and intermittent and there was a lack of long-term relationships.

Relations between firms depended on personal links and were often broken because of changes in personnel.

Although word-of-mouth was the most common way in which small firms obtained business from large firms in the UK such contacts tended to be haphazardly activated rather than by strong local networks.

Latent networks existed but firms put little effort into promoting and maintaining them. UK owner-managers did not often see the value in networks and only 20% saw any value in a business-to-business directory or introductory service.

Evidence from Rothwell's (1989) study of inter-firm relationships supports the findings. The author brings together international empirical study on the subject and applies it to the UK context. It shows:

That large and small firms play complementary roles in the innovation process in the UK.

There appears to be considerable sectoral variation in UK relationships between small and large firms.

That public sector organisations can play an important role in brokering relationships which are essential if innovation is to occur.

In the UK this does not happen particularly well with the exception of particular industries (e.g. medical equipment manufacturers).

Rothwell's (1991) study on the UK manufacturing industry finds the UK small firms collaborate with large firms in a variety of different ways that can contribute to innovation but that all of these need further development. Table 8.13 explains these in further detail.

Table 8.15: Modes of Large/Small Firm Interaction in the UK Manufacturing Industries – Adapted from Rothwell (1989; 1991)

<i>Mode of Interaction</i>	<i>Description</i>
<i>Manufacturing subcontracting relationships</i>	<i>SMEs supply components and sub-assemblies to large companies. As part of this process large companies frequently transfer technological, manufacturing and quality control know-how to their small suppliers. Stable relationships can develop which are mutually advantageous.</i>
<i>Producer-customer relationships</i>	<i>SMEs supply finished products to large companies. Large companies can transfer technological know-how and supply suggestions for improvements to small suppliers based on user experience.</i>
<i>Licensing Agreements</i>	<i>Large companies provide licenses to small firms for innovative new developments. This frequently involves technology that the large company does not wish to exploit in-house but which it wishes to gain a financial return on. In some cases it can involve technology the large company will subsequently purchase in the form of equipment for in-house use.</i>
<i>Contract-out R&D</i>	<i>Large companies fund targeted R&D in small specialist consultancy companies, e.g. automobile companies funding R&D in specialist engine developers.</i>
<i>Collaborative development</i>	<i>Large and small companies collaborate in the development of a new product for the large company, e.g. small software companies collaborating with software companies.</i>
<i>Large-small firm joint ventures</i>	<i>Large-small firms collaborate in the development of an innovative new product containing technology new to the large partner. The large firm provides financial, manufacturing and marketing resources; the small firm provides specialist technological know-how and entrepreneurial dynamism. Generally the new products are complementary to the large firms' product range. The small partners manufacture them.</i>
<i>Educational acquisitions</i>	<i>Large companies acquire new technology based firms to provide them with a window on new technology and an entrée to a new business area.</i>
<i>Sponsored spin-outs</i>	<i>The large company offers financial backing for entrepreneurial employees to spin-out to form a new small firm to exploit technology developed within the parent company, but which is deemed unsuitable for in-house exploitation.</i>
<i>Venture nurturing</i>	<i>The large company offers not only financial support to the sponsored spin-out, but also access to managerial, marketing and manufacturing expertise, and if appropriate, distribution channels.</i>
<i>Independent spin-out assistance</i>	<i>The large company offers technical assistance to an independent spin-out and sometimes acts as first customer for its products. Pre-payments can provide a crucial source of income to the new company.</i>
<i>Personnel secondment</i>	<i>A number of large European companies have developed schemes to 'loan' experienced managers to assist new and existing SMEs in their locality.</i>

The evidence needs to be developed further with study on all these forms of corporate venturing and the relationships they create, as well as, the impact on innovation they might have. If one compares the case of Philips (Box 12) with that of NTT (Box 11) it is clear that large firms can have very little or considerable impact on a locality through their relationships with other firms; specifically ones based on venturing. The UK's performance in this regard is unclear although current evidence does suggest it might be weak. Most of these forms of relationships can be promoted by the UK Government in some way (e.g. the corporate venturing tax credit already supports sponsored spinouts and large-small firm joint ventures).

BOX 12: The Local Effects of Spillover from Philips (The Netherlands)

Philips is a large diversified multinational company. In 1997 its worldwide sales were US \$39.2 billion. Generally Philips' activities include: electronics; mobile communications; medical instruments; computers; media; software; semiconductors; and chips. R&D activities of the company are partly bundled in the corporate research organisation Philips Research and partly carried out under the flag of product divisions. In 1999 Philips Research had laboratories in the Netherlands, France, Germany, the UK, the US and Taiwan; employing 3000 researchers. About 2000 employees are at the main R&D facility in Eindhoven where basic research is carried out.

The study examined Philips spill-over effects using patent citations and citations to scientific literature made by Philips and other organisations to explore certain aspects of innovation. Patent-to-patent citations are often used in this way to explore technology spillovers (the link between innovation and its diffusion). The study looked at the relative role of small and large companies in the citation network around Philips. Patent-to-patent citation links tended to be dominated by large companies. In terms of countries Japanese and US companies dominate the list, while non-business UK institutions only represent 4.6% of Philips citations; UK business citations is much lower. When exploring localised spillovers around Philips in the Netherlands the study illustrated that most occur between Philips and its subsidiaries (Polygram, Whirlpool and ASML).

Patent-to-patent links between Philips and other local companies similar to the networking relationships observed in Silicon Valley did not appear to exist. The number of citations was relatively small compared to the number of patents. The main exception was Optical Disk Manufacturing Equipment that was originally established by Philips and is now an independent company. Localised spillovers consequently do not play a large role in the Philips case, although a large player in the field it does not have a very large impact on the patented innovations of local small companies (Adapted from Verspagen, 1999).

Comment: *Large corporations may not always impact on local networks of innovation in patented technologies in a way that might be expected of them. Encouraging local spillover in regional policy by supporting collaborative activity via corporate venturing may have important influences over the local embeddedness of innovation.*

In summary the evidence that there is suggests that UK firms have networks but that perhaps they are not as effective as they could be in using them for the purpose of innovation.

8.8 UK Theme 7: Network Configuration

The general evidence on the impact of network configuration is shown in Section 7.2.3. and Table 7.8. The evidence shows that finance networks are important for the commercialisation of innovation and that co-investment provides better quality investments and larger funds for high growth businesses. The evidence on the performance of the UK venture finance networks is highlighted here. The gaps in the evidence base are also outlined. Table 8.14 summarises the evidence.

Once again the evidence on this subject is relatively limited, UK firms are equally involved in networks as their US counterparts but these tend to be more focused on fewer individuals and these relationships are perhaps not 'leveraged' for business purposes to the same extent.

Table 8.16: Theme 7: The UK Evidence on Network Configuration and Behaviour

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Drakopoulou Dodd</i>	<i>Analysis of the British Household Survey.</i>	<i>1997</i>	<i>UK</i>	<i>The data show that membership of social groups is higher for business owners (8.19) than for wage and salary earners (7.8). The study further illustrates that 8 out of 10 owner-managers have high levels of involvement in social networks in the UK. They also exhibit higher levels of participation (7.93) than the employed (6.72).</i>
<i>Ostgaard and Birley</i>	<i>Survey of 317 firms in three industries: manufacturing, engineering and software.</i>	<i>1994</i>	<i>Cambridge shire and Avon</i>	<i>The study found a number of different networking strategies in UK small firms. These are shown in Table 44.</i>
<i>Birley, Cromie and Myers</i>	<i>Survey analysis of the size of personal contact networks in small firms.</i>	<i>1991</i>	<i>Northern Ireland and USA</i>	<i>The evidence suggests that the more informal approach to decision-making in businesses in the USA have contributed to the creation of more extensive personal contact networks. Although personal contact networks were smaller in Northern Ireland entrepreneurs tended to spend equal amounts of time maintaining the contact network as US entrepreneurs. Networking activity did, however, occupy a significant place in the working lives of Northern Ireland entrepreneurs. Entrepreneurs made contact with each of their 5 most widely used contacts about 11 times per month and had known them on average for about 8 years.</i>

The size of entrepreneurs' direct contact networks in Northern Ireland was found to be less broad than the USA (Birley, Cromie and Myers, 1991).

The evidence suggests that the more informal approach to decision-making in businesses in the USA have contributed to the creation of more extensive personal contact networks.

Although personal contact networks were smaller in Northern Ireland entrepreneurs tended to spend equal amounts of time maintaining the contact network as US entrepreneurs.

Networking activity did, however, occupy a significant place in the working lives of Northern Ireland entrepreneurs.

Entrepreneurs made contact with each of their 5 most widely used contacts about 11 times per month and had known them on average for about 8 years.

The study concluded that policy makers should aim to increase the size of contact networks in the UK and help improve the knowledge and skills of entrepreneurs in operating them (Birley, Cromie and Myers, 1991).

Ostgaard and Birley's (1994) study examined the personal networks of entrepreneurs and their links to the strategic makeup of the business. The study was carried out in two English Counties, Cambridgeshire and Avon and focused on three industries: manufacturing, engineering and software. It initially examined 317 firms in Cambridge and 232 in Avon but worked on a sample of 159 firms. The study showed a number of different networking strategies in UK small firms. These are highlighted in Table 8.15.

Table 8.17: The Personal Networking of UK Entrepreneurs – Adapted from Ostgaard and Birley (1994)

<i>Strategic Type</i>	<i>Description</i>
<i>Marketing Differentiation</i>	<i>UK entrepreneurs adopting this strategy use networking more than any other firm. They have a larger personal network they tend to seek assistance from business support organisations and spend more time contacting new customers, new suppliers and new investors.</i>
<i>Product Innovation</i>	<i>Those concerned with product innovation gain access to distribution channels and ideas for product development through their personal network. They spend less time with old suppliers and their frequency of interaction is low.</i>
<i>Market Segmentation</i>	<i>They tend to reach new contacts through their network and spend a significant amount of time developing their relationships. Supplier relationships are usually important.</i>
<i>Distribution</i>	<i>UK owner-managers who use this strategy tend to put emphasis on gaining access to distribution channels through their personal networks. They spend significant time maintaining and developing contacts.</i>
<i>Growth through Outside Capital</i>	<i>Owner-managers whose firms generate capital mainly through outside sources tend to receive general advice and assistance from their personal network. The network may act as investors or may introduce them to potential investors.</i>
<i>Differentiation through Quality</i>	<i>UK small firm owners using this approach use their personal networks to gain contact with new customers via word of mouth. This is usually reflected in the relatively large size of their personal network.</i>

Drakopoulou Dodd (1997) further explores the relationship between personal networks and entrepreneurial behaviour by examining data from the British Household Panel Survey.

The data show that membership of social groups is higher for business owners (8.19) than for wage and salary earners (7.8).

The study further illustrates that 8 out of 10 owner-managers have high levels of involvement in social networks in the UK

They also exhibit higher levels of participation (7.93) than the employed (6.72).

Although the reported data is not statistically significant it does show that social networking behaviour is major feature of entrepreneurial activity in the UK.

Overall the evidence on network configuration concentrates mainly on UK entrepreneurs and their personal networking strategies. As illustrated in Section 7.2.3 studies on network configuration can be more wide reaching examining: innovation pathways; alliance structures; information diffusion; network trajectories; and, structural issues associated with network change. There is consequently a need for further UK research on these issues. The UK evidence does suggest that entrepreneurs tend to have less wide and less dense personal networks than their US counterparts. Some studies do suggest that further educational support might be required, although how this could be practically achieved is unclear. It is just as likely that because there are fewer opportunities for useful commercially applicable networking UK entrepreneurs tend to engage less.

In the next section the review will focus on network failure.

8.9 UK Theme 8: Network Failure

The general evidence on how networks fail is shown in Section 7.3 and Table 7.13. The evidence shows that networks fail for a wide range of reasons and that government intervention can have an impact (often unintended) on network sustainability and failure; although this depends on the particular circumstances of the intervention. The evidence also illustrates that certain networks can also be detrimental for innovative capacity and can act in anti-competitive ways. The evidence on network failure in the UK is shown here. The gaps in the evidence base are also outlined. Table 8.16 summarises the evidence.

Table 8.18: Theme 8: The UK Evidence on Network Failure

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Collinson and Gregson</i>	<i>Case studies of organisations set-up to promote start-ups (Connect Scotland in the UK).</i>	<i>2003</i>	<i>UK Canada USA</i>	<i>Showed some success in the Connect Scotland network (27 events in 1997 to 49 in 2000). Its greatest impact has been on social networking that precedes exchanges and collaboration. The study showed, however, that Connect's failure to create new technology businesses (so far) could be explained by inadequate mechanisms for investing in small firms; a shortage of small firm management expertise in high-technology sectors; and a weak entrepreneurial culture in Scotland.</i>

As is often the case in research what is successful tends to be a more attractive field of study than what has failed; obviously access to situations where networks fail can also be difficult. There is insufficient research on this theme in the UK to make much comment other than to recommend all aspects of network failure (Section 7.3) as a research priority.

8.10 UK Theme 9: Local and Regional Embeddedness

The general evidence on the role of locality and regional embeddedness for the networking infrastructure is shown in Section 7.4 and Table 7.14. The evidence on regional embeddedness is relatively inconclusive. The embeddedness of networks in localities appears to be important for the establishment and maintenance of informal networking behaviour; which itself has been shown to be essential for innovation. There is little agreement about how regions might support such embeddedness, although inward investment has been identified as being an important factor. The evidence on the performance of UK regional networks is presented here. The gaps in the evidence base are also outlined. Table 8.17 summarises the evidence.

Table 8.19: Theme 9: The UK Evidence on the Effectiveness of Regional Networks

<i>Authors</i>	<i>Data used in the Study</i>	<i>Dates</i>	<i>Location of Study</i>	<i>Summary</i>
<i>Love and Roper</i>	<i>Analysis of plant-level data using the Product Development Survey of 1700 UK plants.</i>	<i>2001</i>	<i>UK Germany Ireland</i>	<i>Models UK, German and Irish plants' investment in R&D, technology transfer and networking and their effect on extent and success of a plants' innovation activity. Finds no support for the contention that external links (collaborative networks and technology transfer) develop greater innovation intensity.</i>
<i>Grabher</i>	<i>Historical case study of the advertising industry.</i>	<i>2001</i>	<i>London, Soho</i>	<i>Highlights the success of the advertising industry in London based on proximity. Shows that rich diversity in organisational form in local clusters benefit innovation overall by creating rivalry between forms. Shows that the location in London and proximity between firms benefited the advertising industry by enabling the diffusion of 'best practice'. The study shows that innovation occurs not because of the general acceptance of 'one best way' but because of the adoption, recombination and rejection of practices fuelled by rivalry.</i>
<i>Cantwell and lammarino</i>	<i>Analysis of patent data.</i>	<i>2000</i>	<i>UK Regions</i>	<i>Shows that Multinational corporations' R&D personnel are dominated by the South East (75,000) while the next major region the North West only had (22,000) R&D personnel. Shows that R&D expenditure in the South East also dominates (5,800m ECU) nearest rival is the North West (1,700m ECU). Likewise patent applications similarly dominate.</i>
<i>Kitching and Blackburn</i>	<i>Survey of small mechanical engineering firms.</i>	<i>1999</i>	<i>Stuttgart (Germany), Aarhus (Denmark), and South London (England)</i>	<i>Show that limited networking between small-business owners and training providers in South London can be explained by a lack of embeddedness of UK small engineering firms in the institutional framework supporting business. The absence of a critical mass of engineering businesses, the limited experiences of business owners and the weak business-support network in South London are mutually reinforcing.</i>
<i>Keeble, Lawson Lawton-Smith Moore and Wilkinson</i>	<i>Survey of 100 technology intensive small firms.</i>	<i>1998</i>	<i>Cambridge and Oxford</i>	<i>Demonstrates that technology-based firms have strong international networks and that these networks complement above average local networking behaviour. High-technology firms collaborative behaviour (over 50%) compares to low technology (29%) and they grow faster relatively.</i>

The evidence on local support and the local embeddedness of networking in the UK is reasonably extensive when compared with evidence on other themes. It shows that certain industries in the UK such as the advertising industry have had significant success as a consequence of innovation within networks. The evidence confirms the role of the formal support infrastructure for promoting and establishing networking behaviour; although some of the data show that it has not been particularly successful at supporting informal networking activity.

The evidence on the role of the business support infrastructure and regional factors are considered in some detail in the following sections of the report.

8.10.1 Business Support Infrastructure

Smallbone, North and Leigh (1992) investigate the business support infrastructure and its impact on networking between businesses. The study explored the development of a panel of firms from 1979-1990 in 8 manufacturing sectors; interviews were carried out with 306 firms. Work has also been carried out by Bennett and McGoshan (1993).

55% of firms had received some substantial form of external assistance; paid consultants were the main form used (52%) while 17% received help from banks (Smallbone et al. 1991).

Trade associations (8%) had a relatively low use, while 21% of firms had received assistance from public agencies (Smallbone et al. 1991).

The study highlighted the case for strengthening support networks. 25% of firms were able to point to examples of problems where external assistance would have been useful but was not available (Smallbone et al. 1991; Bennett and McGoshan, 1993).

Likewise Atkinson's (1994) study of 3,289 firms in Cornwall, Shrewsbury, Brighton, Manchester, Newport and Slough shows that that formal and informal support networks are used extensively by small firms when seeking information about employment-related concerns.

The importance of local business-to-business networks for business support in the UK is also highlighted by Gibb (1993) in his review of policy support for small businesses. The author places particular emphasis on networking between small businesses themselves and between the agencies supporting them and illustrates the UK's relative poor performance in this area.

Bennett and McGoshan (1993) examine national surveys conducted with 84 Chambers of Commerce and 244 enterprise agencies and suggest the gaps include:

An uneven distribution of support agents reflecting a wide range in the quality of support networks.

Considerable overlap between agents in the delivery of services whilst leaving strategic gaps.

The studies show that in the UK the public sector support infrastructure under-represents certain firms (especially those employing less than 10 employees) in networks and that the role of banks and accountants is essential because they act as a node of entry into some business-to-business networks.

Kitching and Blackburn (1999), for example, study small mechanical engineering firms in Stuttgart (Germany), Aarhus (Denmark), and South London (England) and show that the limited networking between small-business owners and training providers in South London can be explained by a lack of embeddedness of UK small engineering firms in the institutional framework supporting business. The absence of a critical mass of engineering businesses, the limited experiences of business owners and the weak business-support network in South London are mutually reinforcing.

In general the evidence on the formal business support infrastructure highlighted here is perhaps too out-of-date to draw any general conclusions on business support in 2003. A number of major changes have occurred including the foundation of the Small Business Service and the dissolution of TECs since these studies were undertaken. One point that can be made on the data is that business support in the UK has generally underperformed in the creation and support of informal networks and it could do more in this regard.

8.10.2 Business Links – Personal Business Advisers

Despite the lack of success within the business support organisations when trying to promote informal networking the base on which Business Links work is encouraging. For example, Sear and Agar (1996) review the role of Personal Business Advisers (PBAs) and their links to small firms via networks. The study undertook a postal survey to 333 PBAs in the UK and shows:

Each Business Link office employed approximately 5.9 PBAs, 63% were full-time and 72% had experience of running their own company.

A PBA has on average 62 businesses in their portfolio about one third of these are active at any time.

PBA clients often came through networks via direct contact with businesses, from referrals but only one in five came from proactive targeting.

The study illustrates the important role that PBAs might play in brokerage of introductions between businesses as intermediaries between existing firms in their portfolio; especially where they themselves network with other PBAs. Based on the existing work of PBAs Business Links could play a greater role assisting informal networking between businesses already working with them.

With the strengthening role of RDAs in the innovation and networking infrastructure some focus on regions seems appropriate.

8.10.3 The Performance of Regions

The UK's disparity in regional economic performance featured strongly in Michael Porter's report on UK competitiveness. He illustrated that the persistence of prosperity differentials across the UK indicated a failure to overcome the differences in the quality of the business environment across regions. The data in Table 8.17 confirms this perception. In terms of networking it appears that UK regions differ substantially and this can in part be explained by the effectiveness of networking infrastructures in regions and the part played by larger firms including the value of foreign inward investment.

Cantwell (1989; and Cantwell and Iammarino, 2000), for example, shows that the effects of foreign inward investment is positive at both the national and regional level but also shows it is dominated in the UK by one region. Table 8.18 shows the share of US patents attributable to research in UK regions and shows the important place of foreign firms in the South East.

Table 8.20: Share of US patents attributable to research in UK regions, as a per cent of UK total 1969-1995 - Cantwell (1998)

REGION	UK Firms	Foreign Firms	Total
North	4.0	2.3	3.4
Yorkshire and Humberside	4.4	3.9	4.3
East Midlands	6.3	4.5	5.7
East Anglia	1.5	5.3	2.7
South East	40.2	60.8	47.1
South West	5.7	4.2	5.2
West Midlands	16.4	3.6	12.1
North West	17.0	7.8	13.9
Wales	2.4	3.4	2.7
Scotland	2.0	4.0	2.7
Northern Ireland	0.1	0.3	0.1
Total UK (absolute nos.)	23404	11815	35219

Cantwell and lammarino (2000) examine the regional differentials affecting the networking infrastructure much further and find considerable disparities. For example:

Multinational R&D expenditure is dominated by the South East which is 3.4 times the nearest other UK region (North West).

Multinational R&D personnel are dominated in the South East which is 3.5 times the nearest other UK region (North West).

UK Government spend on research grants in higher education institutions by region (1994-1997) also indicates the dominance of the South East (39.9%) which is 3.2 times the nearest other UK region (Scotland).

Based on this data and further detailed statistical analysis Cantwell and lammarino (2000) concluded, in agreement with Porter, that UK policy needed to be rebalanced if strong regional concentration on the South East was not to be compounded further. They conclude that UK policy needs to:

Adjust regional and industrial policies to develop and improve local technological competence.

Attract and retain development efforts that contribute to locally specific innovation.

Create strategies that diffuse knowledge and innovation from the centre of strength (the South East) to other regions of the UK.

Create a more even distribution of publicly funded research and development across regions.

Love and Roper (2001) provide further evidence of problems for some UK regions. They show that structural weaknesses in regions particularly a preponderance of low value added industry and low productivity small firms are likely to lead to a low level of R&D, networking and technology transfer activity. Unfortunately these circumstances lead to low innovative activity and consequently limit the growth potential of firms preventing regional firms from creating positive local spillovers. Based on their study and that of Cantwell and lammarino (2000) many UK regions have already entered a downward spiral that is difficult for them to recover from.

From the UK evidence on regional disparities and business support the evidence in this review supports the proposed shift of economic development to the RDAs. In certain regions there may be a need to continue to develop regional strategies for inward investment, strategies for retaining talent through entrepreneurial activity and policies for building more effective regional network infrastructures. Based on this review these appear to be three of the most effective areas for regional policy where it is seeking to build sustainable patterns of innovation through networking.

The evidence from the UK regarding networking and innovation has been fully presented. In the following sections the study will explore some comparisons with Germany and the US.

8.11 UK Compared to Germany

Most of the research on the relationship between innovation and networking in Germany emphasises regional patterns of networking and innovation highlighting the federated nature of Germany in institutional terms and hence an emphasis on the development of distinctive regional policy which supports this. Baden in the Necker- Alb region of Germany is considered to be the most innovative and prosperous region in Germany and a number of studies have aimed to compare the networking relationships of firms in Baden with those in other regions of the country. A summary of the studies and major findings are shown in Table 8.19⁵.

⁵ Eight key papers of the eleven are reviewed in the summary

Table 8.21: A Summary of Studies on Business-to-Business Networks in Germany

<i>Authors</i>	<i>Date</i>	<i>Regions</i>	<i>N</i>	<i>Summary</i>
<i>Ritter and Gemunden</i>	2003	All	308	<i>Network competence i.e the ability to manage network relationships and technological competence has a positive impact on innovation success but no distinctions made between intra and interregional networking activity.</i>
<i>Streb</i>	2002	All	N/A	<i>German government encouraged cartelization and mergers following the 2nd world war, which were not limited to firms in the same industry. Chemical firms formed the integrated I.G. Farben concern that was important for the successful development of the plastics industry. Germany's distinctive background is considered to have led to an above average propensity to share innovative information with customers and competitors.</i>
<i>Love and Roper</i>	2001	East and West Germany	1300	<i>Comparisons made with Ireland and the UK. The study found that firms investment in R&D, technology transfer and networking was only weakly conditioned by the regional operating environment.</i>
<i>Zeller</i>	2001	Munich, Rhineland, Hamburg	N/A	<i>Federal state measures created gene centres in Berlin, Heidelberg, Cologne/Munich. The BioRegio Competition organised by the Federal Ministry for Education, Science, Research and Technology promoted and reinforced regional efforts to develop distinctive profiles in the biotech sector. All of the regions are highly innovative. Notably however, the most successful biotech firm was located in Hamburg where there was only relatively modest biotech development. Clustering was considered necessary for the transfer of tacit knowledge.</i>
<i>Fritsch</i>	2001	Baden, Hanover, Lower Saxony	1301 SMEs	<i>The link between networking and the performance of regional innovation systems is unclear. Propensity to network related to the number of small firms (<200 ee's) in a region but this does not equate to innovation success. Being spatially proximate to public research institutes and non-vertically integrated firms is particularly important for innovation.</i>
<i>Sternberg</i>	1999	Baden, Saxony, Lower Saxony	1301 SMEs	<i>Baden is distinctive in that it has a good R&D infrastructure. Small firms rely more on intraregional linkages whereas large firms rely more on interregional linkages. Personal contacts with research institutes were considered be very valuable linkages on an intraregional basis.</i>
<i>Grotz and Braun</i>	1997	Aachen Necker-Alb Luneburg-Celles	155 SMEs	<i>The majority of important weak ties and innovation-orientated linkages are based on traditional supplier-customer relationships. Intraregional exchange of information focuses on business rather than technological matters. Interregional linkages were more important for technology-orientated information particularly with research institutes.</i>
<i>Gemunden et al</i>	1996	All	321	<i>Many different patterns of networking relationships with successful high tech firms. It is the synergy of supplier and customer interaction that makes product innovation successful. Universities play an important role too. Process innovations success relies upon intensive interaction with universities and consultants.</i>

This research suggests that German policy measures aimed at developing distinctive regional innovation systems has had a very mixed impact on promoting the development of intraregional linkages for innovation; interregional linkages appeared to be equally important for innovation. Table 8.20 shows data on innovation and networking that compares the UK and Germany. The data show that the UK has marginally lower proportion of firms that undertake product innovations when compared to Germany but that these innovators are more active and much more likely to impact on the diffusion of innovation. Based on the data found by this review there is little or no evidence to justify the view that German industry is more effective at developing and using networks for the purposes of innovation.

Table 8.22: Innovation, Networking and Technology Transfer Indicators a Comparison of the UK and Germany – Adapted from Love and Roper (2001)

<i>Nature of Indicator</i>	<i>UK</i>	<i>Germany</i>
<i>Number of firms in survey (No.)</i>	1133	1186
<i>Product innovators (%)</i>	63.4%	71.4%
<i>INNOVATORS ONLY</i>		
<i>Number of product changes (No.)</i>	25.7	23.0
<i>Sales of new/improved products (%)</i>	52.8%	51.5%
<i>R&D intensity (%)</i>	4.0	4.1
<i>Technology transfer intensity (%)</i>	9.3	3.4
<i>Networking intensity (%)</i>	11.1	11.7
<i>Innovation intensity (No. per 100)</i>	0.429	0.201

Obviously UK regional policy is not as well developed as in Germany but these studies suggest that this is perhaps not the most appropriate strategy to adopt. What is distinctive about the German context is firms' propensity to collaborate both formally and informally through interpersonal relationships with research institutes for innovation. This activity appears to be far better developed in Germany compared to the UK (see Section 8.4).

8.12 UK Compared to the USA

Whilst there appears to be a significant number of studies focusing on innovation and networking in the US there is a lack of consistency across these studies. The papers have been conducted across sectors and regions of the US without much linkage between themes. Some of the evidence points out that in the US much of the support infrastructure is being developed piecemeal by industry groups and city and state governments (Kasarda and Rondinelli, 1998). Often government and industry investments are uncoordinated and the research findings reflect this. Silicon Valley is typically cited as a region characterized by networking resulting in high levels of innovation. The review found only two articles on the networking activity in Silicon Valley that are rather dated (Hobday, 1994, Saxenian, 1990). Both of these studies suggest that the region lacks complementary assets and a supporting infrastructure to leverage innovation in the growth and maturity stages of business development.

A distinctive feature of venture capital networks in the US when compared to the UK may be their joint investments in portfolio companies that encourage greater learning for firms within the network; more investment in entrepreneurial firms and more direct business support (Bygrave, 1988, Bygrave, 1987).

Table 8.23: Summary of Studies on Business-to-Business Networks in the US

<i>Authors</i>	<i>Date</i>	<i>Evidence Base</i>	<i>Summary</i>
<i>Bee</i>	<i>2003</i>	<i>Explores concentrations of patents in metropolitan areas, exploring the geographic concentration of technology.</i>	<i>Finds that different concentrations are based on urban areas.</i>
<i>Liao and Welsch</i>	<i>2003</i>	<i>Uses data from Panel Study of Entrepreneurial Dynamics (PSED). National panel study of US business start-ups.</i>	<i>Results suggest that technology-based entrepreneurs benefit more from the freer and greater exchange of non-redundant information. Non-technology-based entrepreneurs benefit more from the extensiveness of social networks.</i>
<i>Soh and Roberts</i>	<i>2003</i>	<i>Based on 150 firms and 319 alliances in the US data communications industry from 1985 to 1996.</i>	<i>They find that incumbents who are early advocates of standards in complex technological environments are more likely to survive via alliances.</i>
<i>Kadama</i>	<i>2002</i>	<i>Examines the NTT Phoenix a strategic alliance between US and Japanese companies.</i>	<i>This innovation community has created a new market known as Interactive Video Communication and has been doing much to promote it. This paper examines the world's largest multipoint connection video multimedia businesses.</i>
<i>Nooteboom</i>	<i>2000</i>	<i>Compares the US and German network infrastructures.</i>	<i>Concludes that the US is more flexible and market oriented and Germany is more oriented towards inter-organizational networks.</i>
<i>Carayannis, Kassicieh and Radosevich</i>	<i>2000</i>	<i>Uses a survey of embryonic firms in the Southwestern US to examine the characteristics of partnerships.</i>	<i>Empirical research findings identified key issues that are salient to small-firm/large-firm, technology-driven strategic alliances formed for seed capital investment purposes.</i>
<i>Almeida and Kogut</i>	<i>1999</i>	<i>Examines patent citations from semiconductor innovations in Silicon Valley.</i>	<i>It is found that knowledge localization is specific to only certain regions and that the degree of localization varies across regions. It is shown empirically that the inter-firm mobility of engineers influences the local transfer of knowledge.</i>
<i>Walcott</i>	<i>1999</i>	<i>The relation between biomedical firms and their metropolitan region location in Atlanta, Georgia, is examined.</i>	<i>Lack of a key networking individual or mediating organisation critically retards development of this potential growth engine.</i>
<i>Kasarda and Rondinelli</i>	<i>1998</i>	<i>A case study of Global TransPark experiment in North Carolina.</i>	<i>Identifies the components of the logistical support system that are needed to stimulate agile manufacturing, describes the reactive approaches of US industry groups, cities, and government agencies, and examines the strategic integration of the components into a unified business support system.</i>
<i>Autio</i>	<i>1997</i>	<i>Tests a model of new technology based firms using 3 empirical databases.</i>	<i>A model is developed and tested that classifies new, technology-based firms into science-based firms and engineering-based firms.</i>

Table 8.24 Cont: Summary of Studies on Business-to-Business Networks in the US

<i>Authors</i>	<i>Date</i>	<i>Evidence Base</i>	<i>Summary</i>
<i>MacPherson</i>	<i>1997</i>	<i>Looks at external technical services of New York State manufacturing firms. The results of a spatially and sectorally stratified postal survey of more than 400 manufacturing firms.</i>	<i>A major finding of the paper is that specialized technical services can support the product development efforts of innovative firms. The empirical results also point to significant spatial variations in technical service utilization. Some of these variations reflect different supply and accessibility conditions among the state's major regions and urban centres.</i>
<i>Ragatz, Handfield and Scannell</i>	<i>1997</i>	<i>Studies 60 member companies from the Michigan State University Global Procurement and Supply Chain Electronic Benchmarking Network.</i>	<i>The study identifies supplier membership on the NPD project team as the greatest differentiator between most and least successful integration efforts. Although respondents reported only moderate use of shared education and training, the study cites this management factor as another significant differentiator between most and least successful efforts.</i>
<i>Cooke</i>	<i>1996</i>	<i>Examines innovation systems in Pennsylvania.</i>	<i>The major findings are that business networking is an effective way of increasing company turnover; that not-for-profit organizations are excellent for setting up networks because they are trusted, and that innovation networks are perhaps the most difficult.</i>
<i>Pellerin</i>	<i>1995</i>	<i>Case study of the National Centre for Manufacturing Sciences.</i>	<i>Concludes that National Centres of collaboration have major impact on regional innovation.</i>
<i>Tidd</i>	<i>1995</i>	<i>Examines the US home automation industry as an example of the challenges involved in the development of complex product systems.</i>	<i>Finds that European firms tend to be more narrowly focused than American and Japanese firms. Japanese firms typically participate in open networks and overlapping consortia, which gives them an edge in the home automation industry.</i>
<i>Bolton, Malmrose and Ouchi</i>	<i>1994</i>	<i>Explores 46 new semi-conductor firms in US and 27 Japanese firms.</i>	<i>Compares kinyu keiretsu type of relational contracting between firms of unequal size and power in vertically related industries and compares contractual relations between the US and Japan. Finds that Japanese supplier ties work more effectively.</i>
<i>Hara and Toshihiro</i>	<i>1994</i>	<i>Examines case study of an international strategic alliance between the technology-based companies of Kinei in Japan and 3 companies in Silicon Valley.</i>	<i>The study concludes 1. International strategic alliances between small firms can be more symmetric than those between large and small firms. 2. Even if national cultures are starkly different, there are common features that characterize technology-based businesses regardless of their country of origin.</i>
<i>Hobday</i>	<i>1994</i>	<i>Examines network relationships in Silicon Valley.</i>	<i>An analysis is undertaken to show that the Silicon Valley network is incapable of realizing the main rewards from its innovations. Although the dynamic network may be appropriate for the early stage of the product life cycle, it lacks the necessary complementary assets to secure the profits generated during the growth and maturity stage.</i>

Table 8.25 Cont: Summary of Studies on Business-to-Business Networks in the US

<i>Authors</i>	<i>Date</i>	<i>Evidence Base</i>	<i>Summary</i>
<i>Harrison and Mason</i>	<i>1992</i>	<i>Examines postal survey and interviews comparing the investment behaviour of UK and US informal investors.</i>	<i>UK investors also receive more information on and seriously consider more investment opportunities than US investors, but they do not make any more investments than their US counterparts. Overall, in comparison to the US market, the UK venture capital market appears to operate less effectively, thereby reducing its potential contribution to venture financing.</i>
<i>Saxenian</i>	<i>1990</i>	<i>Looks at case studies of Cypress Semiconductor, Integrated Device Technology (IDT), and Weitek.</i>	<i>Examines partnerships with customers and suppliers in order to monitor changing markets Finds that the Silicon Valley economy remains vulnerable because firms have yet to recognize the social basis of their dynamism and create local institutions allowing them to respond systematically to shared challenges.</i>
<i>Bygrave</i>	<i>1988</i>	<i>Sample of venture capital portfolio companies taken from Venture Economics.</i>	<i>The findings suggest that: 1. Links to other venture capital firms are extremely valuable, 2. Entrepreneurs should submit proposals for funding to a limited number of firms.</i>
<i>Florida and Kenney</i>	<i>1988</i>	<i>Examines finance-oriented complexes (New York and Chicago). Technology-oriented complexes (San Francisco-Silicon Valley). Hybrids (Boston, Minneapolis, Connecticut and Texas).</i>	<i>Technology-oriented complexes contain large proportions of limited partnerships, favour local investment, and attract venture capital from other areas. Enormous incentives for venture capital firms to locate in established technology centres are created there by a high concentration of good deals.</i>
<i>Harr, Star and MacMillan</i>	<i>1988</i>	<i>Survey of 320 investors in 17 US states.</i>	<i>Finds that the referral network of informal investors is composed mainly of friends and business colleagues.</i>
<i>Bygrave</i>	<i>1987</i>	<i>Survey of 464 Venture Capital Firms and 1501 portfolio companies.</i>	<i>Factors that influence degrees of networking include the innovativeness, technology, stage, and industry of the portfolio company. The top 61 venture capital firms were found to have extensive networks.</i>
<i>Fusfeld and Haklisch</i>	<i>1987</i>	<i>Analyses collaborative R&D.</i>	<i>It is argued that collaborative research in the US continues to complement, and not replace or diminish, the competitive activity and independence of participating companies. Now more than ever, companies. Collaborative activity also has stimulated graduate activity at universities.</i>
<i>Birley</i>	<i>1985</i>	<i>A study of entrepreneurs in St. Joseph County, Indiana.</i>	<i>Finds that the choice of networks during the start-up process is key in understanding the nature of the subsequent firm. The entrepreneur is likely to recreate the elements of previous employment when using only business contacts and family, but in an efficient network, the system diagnoses needs and provides the necessary information and advice.</i>
<i>Leonard-Barton</i>	<i>1984</i>	<i>Examines personal networks in Sweden and Boston, Massachusetts.</i>	<i>Concludes Swedish entrepreneurs use less personal contacts as a source of business information than Americans.</i>

Significantly the US Congress passed the National Cooperative Research Act in 1984 and the US government began to sanction joint R&D - if participants independently produced and sold the results. They did this through Cooperative Research and Development Agreements, known government-wide as CRADAs. A CRADA is a government agreement to co-operate on research with an industry partner by contributing any kind of resource (expertise, equipment, technology) except money. Under a CRADA, the government research partner can give a private-sector partner intellectual property rights and exclusive patent licensing. Another model for collaborative research is the Small Business Innovative Research grant. The National Technology Transfer Centre is also the hub of a national network established to link private-sector companies with federal labs to turn research results into commercial technology. In line with this government policy national centres of cooperation have also been set up across the US that seem effective at promoting networking specifically for product innovation (Pellerin, 1995).

The evidence from the US shows that federal and state governments have invested heavily in networking infrastructure and many of these developments have had discernable impact on innovation. It is recommended that further primary research be commissioned to explore these developments in more detail.

Section 8 in Summary

The UK evidence base on business-to-business networks and innovation, while adequate for the purposes of the review, requires considerable further effort.

UK firms appear to have strong network relationships with suppliers and business customers; although there are variations between sectors.

Within the network infrastructure UK consultancies could play a wider role as 'match-makers' identifying opportunities for collaboration between their clients and brokering relationships.

The role of trade conventions in the UK as mechanisms for collaborative innovation could be improved.

Some UK trade associations need to play a more active role encouraging the involvement of small firms in their activities.

UK associations (both trade and professional) need to be more careful to protect their neutrality as network intermediaries.

The role of science partners in radical innovation has been confirmed and some current mechanisms (e.g. placements) were well regarded.

UK venture finance networks appeared to be less well developed than the US. The study found considerable value in promoting co-investment both in the informal and formal equity finance markets.

The UK needs to continue and expand its regional incubation capacity and improve the amount of networking activities led from incubators.

The value of existing collaborative programmes (SMART; TCS; PhD CASE) in the UK was demonstrated.

The network relationships between UK firms tended to be intermittent and driven by short-term decision-making undermining the stable relationships required for innovation.

Formal business support has been shown to be important for encouraging networks; however, in the UK it could do more to promote informal networks.

The study confirms that large disparities between regions in the UK and the effectiveness of their network infrastructure should be of concern.

There is no evidence that German firms perform better than their UK counter-parts when using networks to innovate.

To conclude the evidence in Section 8 on the networking capacity of UK firms and the UK's networking infrastructure the following policy and research recommendations are made. In Section 9 the final conclusions on networking and innovation in the UK will be presented and policy recommendations and research priorities suggested.

8.13 Stage 3: Policy and Research Recommendations

Promoting Innovation through Networks 3 – Policy Recommendations

Policy Recommendations:

The evidence suggests that UK technology intensive firms that network internationally make above average contributions to local innovation networks. Support for these firms via Business Links on: foreign language skills; for foreign research collaboration and marketing visits; and, active promotion within local networks may benefit local innovation propensity.

Supply networks are essential for innovation. Targeted assistance on priority industries and collaborations between firms in these networks on 'problem-based' projects may have valuable impacts on innovation.

In some industries larger firms have used collaboration as a way of reducing their own R&D expenditure through acquisition; this has proven to have a damaging effect on the success rate of innovations. General UK strategies to improve R&D investment in firms should continue and be expanded.

UK trade and professional associations act as important intermediaries in networks where their neutrality is essential. Government could consult with associations with the purpose of encouraging improvements to their codes of practices, which emphasise their neutrality and networking role.

The value of TCS and other schemes to promote partnerships between science and industry has been confirmed. These should be continued and expanded for example by sponsoring secondments.

Relationships between science and industry have been proven to be beneficial for firms but there is relatively low awareness amongst businesses. Some effort should be made to promote the value of network relationships with science partners perhaps through a promotional campaign.

Local networks around incubators in the UK are underdeveloped. The development of a grant scheme or other mechanism to assist the development of business-to-business venture clubs focused on existing incubators would be advantageous.

The evidence base suggests that the UK needs to continue and expand its investment in incubation space.

Existing schemes for collaboration (TCS) in R&D between science and industry have been successful. Further schemes based on the same principles could be applied to small firm-large firm collaborations.

The corporate venturing tax credit could be expanded and be more widely promoted. Other schemes to promote corporate venturing could be developed e.g. building on the work of the DTI's Corporate Venturing UK initiative and assisting the development of Corporate Venture Capital Organisations (for example, Adobe Ventures).

Facilitating Innovation through Networks 3 – Research Recommendations

Research Recommendations:

Overall more research is required on networking and innovation in the UK the evidence base is very limited and major aspects of the subject have little or no UK coverage.

More sector-focused studies on the role of different partners in networks would be useful. Currently studies are dominated by a focus on high technology industries. There is little or no UK focus on service and primary industries and only moderate study on manufacturing.

The role of third parties as intermediaries in networks has been confirmed. There is too little coverage of the subject in the UK. More focus needs to be given to all areas including: consultants; professional associations; trade associations; and, Chambers of Commerce. Within this work some focus could be given to power, trust and neutrality as these emerge as important issues.

The evidence base on cooperation in venture finance networks was insufficient to draw any conclusions it is, however, important for the effectiveness of the investment infrastructure. Further work needs to focus on syndicated and co-investment within the UK business angel and venture capital markets.

The role of large firm-small firm relationships for innovation needs more work. There are many forms of relationship (see Table 42) and each needs detailed consideration.

Although it is conceivable that this review has missed studies, it found no work specifically focusing on why networks fail that had a UK focus. Clearly this should be addressed.

Likewise the comparative evidence base on this subject between UK regions should be expanded.

9 Policy/Research Implications and Conclusions

9.1 Conclusions

This systematic review has been undertaken over an eight-week period; it has identified 628 relevant papers and reviewed 174 of them and has shown the key implications for networking in the UK. The empirical evidence on which this review is based should be considered comprehensive but not exhaustive.

The evidence derived from the review is considered to be fairly limited, covering a large number of subjects, in many disciplines. There is not a critical mass of research in any given area. The study of networking and innovation was identified as being overly weighted toward the high technology industries with only limited focus on other areas like manufacturing and service industries.

The evidence confirms that networks and networking amongst firms plays a pivotal role in innovation and that this has become more relevant as technologies have become more complex. Networking should not be viewed as a panacea for innovation, however, as there are many other factors that contribute to innovation performance (e.g. R&D investment). In Section 6 the review concludes that network forms are dynamic and can be complex. There is little evidence to explain which forms of network most contribute to innovation. It was highlighted that the use of networks was crucially important during venture creation and for small growing firms. When examining the formation of networks this study concludes that there are many factors that promote and prevent their formation and that the UK Government plays an important role creating institutional mechanisms that support the development of network infrastructures.

In Section 7 the study analyses in detail the AIM model (Figure 1) exploring different aspects that contribute to network performance and innovation. The review concludes:

Firms' informal and formal relationships with multiple diverse organisations have a positive impact on innovation and performance.

The integration of suppliers, co-suppliers and distributors in innovation projects has a positive impact on the productivity of individual firms and the likeness that the innovation will succeed.

Third parties, science partners and institutional mechanisms (e.g. incubators) play an important role by creating a network infrastructure and can act as neutral network brokers between firms.

That effective venture finance networks can enable better opportunities of commercial success when firms innovate.

Firms need to actively manage network relationships and what they gain from such relationships depends on their prior experience and network management competencies.

There are many different forms of network configuration and these differ depending on the form of innovation, industry and the purpose of the network. Some networks can prevent innovation and be anti-competitive.

Networks fail for a variety of reasons – government intervention can act as both a positive and negative force affecting the sustainability of particular networks and network infrastructures.

That personal and informal relations often drive the effectiveness of networking between firms.

Following analysis of the key evidence on networks and how networking can lead to innovation the review used the AIM model to explore the evidence on the UK. Similar to the general evidence, data for the UK was limited and spread across a number of subjects. The review is consequently cautious when drawing conclusions. Conclusions from Section 8 were:

UK firms appear to have strong network relationships with suppliers and business customers, although there are variations between sectors.

The role of trade conventions in the UK as mechanisms for collaborative innovation could be improved.

Some UK trade associations need to play a more active role encouraging the involvement of small firms in their activities.

UK associations (both trade and professional) need to be more careful to protect their neutrality as network intermediaries.

The role of science partners in radical innovation has been confirmed and some current mechanisms (e.g. placements) were well regarded and had worked.

UK venture finance networks appeared to be less well developed than the US. The study found considerable value in promoting co-investment both in the informal and formal equity finance markets.

The UK needs to continue and expand its regional incubation capacity and improve the amount of networking activities led from incubators.

The value of existing collaborative programmes (SMART; TCS; PhD CASE) in the UK was found to be beneficial for innovation.

The network relationships between UK firms tended to be intermittent and driven by short-term decision-making undermining the stable relationships required for innovation.

Formal business support has been shown to be important for encouraging networks; however, the UK could do more to promote informal networks within the business support mechanisms.

The study confirms that large disparities between regions in the UK and the effectiveness of their network infrastructure should be of concern.

There is no evidence that German firms perform better than their UK counter-parts when using networks to innovate.

Based on the conclusions of this report it can be demonstrated that the UK's performance in networking for innovation is quite strong. In the key areas linked to innovation, such as, supplier and customer engagement and links with science partners the UK performs strongly. In other areas, for example, the networking infrastructures and firms' management of networks there is some cause for concern. In the UK we need to help firms learn how to leverage networks more effectively and encourage the development of longer term more stable relationships between firms. Our networking infrastructure requires more neutral intermediaries. The network infrastructure whilst operating adequately has limited impact in promoting networking and innovation because of insufficient scale.

Overall in the UK we do a lot of networking, perhaps we don't do enough to capitalise on it and our general infrastructure is not quite adequate to support it.

The following policy recommendations are designed to explain how the UK might improve its networking infrastructure.

9.2 Policy Recommendations

In Sections 6, 7 and 8 policy recommendations have been made as they relate to particular sections. This has been undertaken as a brainstorming exercise without any reflection of the cost or appropriateness to the UK's current innovation policy. Given that implementation of any policy has an associated cost in this section we list the policy recommendations identified and prioritise them according to criteria. The criteria used are cost; degree of intervention; appropriateness to current UK policy and likely level of impact if implemented. The conclusion of this analysis is presented in Table 9.1.

Table 9.1: Analysis of the Policy Recommendations

<i>Policy Recommendation</i>	<i>Cost</i>	<i>Degree of Intervention</i>	<i>Appropriateness to Policy</i>	<i>Level of Impact</i>
<i>The DTI should have a national policy on networking</i>	<i>Very Low</i>	<i>Very Low</i>	<i>High</i>	<i>High</i>
<i>Provide seed funding for business clubs, venture networks and conventions</i>	<i>Low</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>
<i>*Create R&D tax credits for collaborative projects</i>	<i>High</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>Existing barriers to the formation of new networks should be audited</i>	<i>Low</i>	<i>Low</i>	<i>Medium</i>	<i>Low</i>
<i>*Create exchange brokers to assist peer-to-peer exchanges between firms</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>	<i>High</i>
<i>Promote the development of 'networks of networks' cross industry and sector networks</i>	<i>Medium</i>	<i>High</i>	<i>Medium</i>	<i>High</i>
<i>Create networks for start-ups in deprived areas that bring in important economic actors (e.g. Venture Capitalists)</i>	<i>Medium</i>	<i>High</i>	<i>Very High</i>	<i>Medium</i>
<i>Undertake a promotion campaign illustrating to firms the value of working with science partners</i>	<i>High</i>	<i>Low</i>	<i>Low</i>	<i>Medium</i>
<i>Create policy interventions to encourage firms to involve supplier representatives in R&D teams</i>	<i>Medium</i>	<i>Very High</i>	<i>Medium</i>	<i>Very High</i>
<i>Support the development of industry forums for customer involvement in innovation projects</i>	<i>High</i>	<i>High</i>	<i>Medium</i>	<i>Very High</i>
<i>Ask the RDAs to create a strategy to develop their region's network infrastructure</i>	<i>Very Low</i>	<i>Very Low</i>	<i>Medium</i>	<i>Medium</i>
<i>Establish more network intermediaries in Universities and Colleges</i>	<i>Medium</i>	<i>Low</i>	<i>Medium</i>	<i>High</i>
<i>*Create tax incentives for co-investment by Business Angels and Venture Capitalists</i>	<i>High</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>*Create industry focused national and regional centres for collaboration</i>	<i>Very High</i>	<i>High</i>	<i>Very High</i>	<i>Very High</i>
<i>Use UK Ministries current R&D spend to create national centres for collaboration</i>	<i>Very High</i>	<i>High</i>	<i>High</i>	<i>Very High</i>
<i>Assess Intellectual Property laws with reference to collaborative innovation</i>	<i>Very Low</i>	<i>Very Low</i>	<i>Low</i>	<i>Low</i>

Table 9.2 Continued: Analysis of the Policy Recommendations

<i>Policy Recommendation</i>	<i>Cost</i>	<i>Degree of Intervention</i>	<i>Appropriateness to Policy</i>	<i>Level of Impact</i>
<i>Ensure competition laws remain strongly enforced where networks act in an anti-competitive way</i>	<i>Low</i>	<i>Medium</i>	<i>Very High</i>	<i>High</i>
<i>Support UK technology firms that work internationally</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>	<i>Medium</i>
<i>Retain and expand current collaborative programmes (TCS/SMART)</i>	<i>Medium</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>*Create targeted assistance on the supply chains of particular industries funding 'problem-based' collaborative projects</i>	<i>High</i>	<i>High</i>	<i>Medium</i>	<i>Very High</i>
<i>Continue strategies promoting R&D investment in UK firms</i>	<i>Low</i>	<i>Low</i>	<i>High</i>	<i>High</i>
<i>Consult with Trade and Professional Associations to encourage the development of a code of practice supporting neutrality and networking</i>	<i>Very Low</i>	<i>Medium</i>	<i>Very Low</i>	<i>Medium</i>
<i>Continue and expand incubation space</i>	<i>Very High</i>	<i>Medium</i>	<i>Very High</i>	<i>Very High</i>
<i>Offer funding for wider local business networks to be created in existing incubators</i>	<i>Medium</i>	<i>Medium</i>	<i>High</i>	<i>High</i>
<i>Assist the development of Corporate Venture Capital Funds</i>	<i>High</i>	<i>High</i>	<i>High</i>	<i>Very High</i>

Based on this analysis if the review were forced to choose five options on a limited budget the following approach would be taken. They are considered to have the greatest impact on UK networking and innovation effectiveness if no other options are allowed.

The review would establish six major centres and regional satellites for national and regional commercial collaboration in particular priority industries with a significant public sector investment, and matched by the private sector, focusing on for example: biotechnology; nanotechnology; manufacturing sciences; computer sciences; environmental industries and space/defence industries. From these centres it would fund collaborative projects based on particular technical problems that engage industry suppliers and other participants. In addition to these centres it would seek to promote collaborative behaviour by introducing R&D tax credits and other tax incentives that promote collaborative innovation projects and tax incentives for co-investment within financial networks. Finally, it would support informal networking by creating exchange brokers across the UK promoting and facilitating peer-to-peer exchanges between individuals from a range of contexts (including public, private and voluntary sectors).

9.3 Research Implications

In Sections 6, 7 and 8 a large number of research recommendations were identified and these are highlighted below. Overall more research is required on networking and innovation in the UK the evidence base is very limited and major aspects of the subject have little or no UK evidence. Likewise comparative studies between industries in the UK and between countries need to be conducted urgently.

There is only limited coverage of the impact networking has on process driven innovation and on organisational innovation. Future research could seek to explore this relationship by focusing on the different network configurations when new processes are developed and implemented and by exploring how social networks impact on the adoption of new practices.

Work drawing on existing concepts of regional systems in economic geography could be reviewed systematically to provide valuable policy insights for Regional Development Agencies.

There appears to be a need for further research on how networks promote the diffusion of innovation, particularly in the UK context focusing on different forms of innovation.

There are few studies focusing on the dynamics of network formation and very few of these are in the UK. Those studies that exist are beginning to touch on a relatively complex phenomenon. This review would encourage further research in this domain.

A key feature of networks is their capacity to promote learning and the transfer of tacit knowledge; such informal networking provides benefits for innovation. Although this has been highlighted more extensive research is needed to develop further understanding.

Another important gap in the research is the extent to which networking promotes and supports entrepreneurial endeavour. Such effort can have a direct impact on wealth creation, innovation and productivity improvement. Consequently, further research in this subject would continue to add value.

The current evidence supports the view that the clash between different behaviours and habits of thought across industries and between science and industry lead to radical innovation. How this occurs, what facilitates it and the nature of the impact on innovation has not been explored to any significant degree.

Supply chains play a key role in networks for innovation. The extent to which firms manage these networks has been investigated but more effort is required to draw together the findings of this work and to identify how such networks assist different forms of innovation.

Further work in the UK exploring how Multinational companies situated here engage in networking behaviour and how such engagement leads to local innovation and embeddedness might help explain further the value of inward investment for innovation.

Management research has illustrated the value of networks for firms, however, more work is required to explain how firms can manage their networks to promote innovation and how UK firms perform in this regard.

The structure of networks and how different structures contribute to innovation remains particularly unclear. Future research could explore this relationship in further depth.

Further work exploring the different types and/or typologies of networks with a focus on their innovative qualities could be beneficial.

More sector-focused studies on the role of different partners in networks would be useful. Currently studies are dominated by a focus on high technology industries. There is little or no UK focus on service and primary industries and only moderate study on manufacturing.

The role of third parties as intermediaries in networks has been confirmed. There is too little coverage of the subject in the UK. More focus needs to be given to all areas including: consultants; professional associations; trade associations; and, Chambers of Commerce. Within this work some focus could be given to power, trust and neutrality as these emerge as an important theme.

The evidence base on cooperation in venture finance networks was insufficient to draw any conclusions it is, however, important for the effectiveness of the investment infrastructure. Further work needs to focus on syndicated and co-investment within the UK business angel and venture capital markets.

The role of large firm-small firm relationships for innovation needs more work. There are many forms of relationship and each needs detailed consideration.

The review found no work specifically focusing on why networks fail that had a UK focus. This should be considered an urgent priority for future research.

Likewise the comparative evidence base on networking and innovation between UK regions should be expanded.

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11 Appendices

11.1 The Authors

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Dr. Luke Pittaway, Institute for Entrepreneurship and Enterprise Development, Lancaster University Management School.

Luke Pittaway is a Lecturer in Entrepreneurship at Lancaster University. He was recently involved with securing a number of European Regional Development Fund (ERDF) projects at Lancaster which are supporting enterprise and developing working relationships between the University and its local business community. As part of his outreach activity Luke was the founder of a Venture Network Club for local high growth firms and has assisted a number of University spinouts including ventures from the engineering and computer sciences departments. Dr Pittaway's main research foci are entrepreneurial behaviour and enterprise in larger organisations, including corporate entrepreneurship and corporate venturing. He has several PhD students focusing on issues related to small business and entrepreneurship and has led a number of research projects. Dr. Pittaway teaches all aspects of entrepreneurship and is the course leader for the venture planning and franchising courses.

Dr. Maxine Robertson, AIM Advisory Scholar

Dr. Maxine Robertson, Warwick Business School.

Maxine Robertson is a lecturer in Organisational Behaviour at Warwick Business School. She is a core member of the IKON (Innovation, Knowledge and Organisational Networks) Research Unit based at Warwick Business School. She is also a principal investigator on a recently jointly funded (ESRC/EPRSC) project 'The Evolution of Biomedical Knowledge: Interactive Innovation in the UK and US'. Her main research interests include the management of knowledge workers, interactive innovation and knowledge management and she has published extensively in these areas. She is also co-author of 'Managing Knowledge Work', Palgrave, 2002.

Dr. Kamal Munir, AIM Advisory Scholar

Dr. Kamal Munir, Judge Institute of Management, University of Cambridge.

Kamal Munir is a University Lecturer at the University of Cambridge, the Judge Institute of Management. Kamal completed his PhD at McGill University in 2001. His research interests lie in institutional theory, technology evolution and product development. Kamal's research has previously been published in journals such as Organization Studies, Human Relations, Journal of High Technology Management Research, Journal of Engineering and Technology Management and he has chapters in several books.

Dr. David Denyer

Dr. David Denyer, Cranfield School of Management.

Dr David Denyer is a Senior Research Fellow in the Advanced Management Research Centre (AMRC) at Cranfield School of Management. David is a co-investigator on the EPSRC grant 'Developing a methodology for evidence-informed management knowledge using systematic review' (Cranfield IMRC 19). The aim of this groundbreaking work is to investigate whether, and to what extent, it is possible to develop and 'evidence-based' approach to management practice. He is a member of the research methods group of the Evidence Network. This group is accessed by invite only and has only two representatives from the management community in the UK. It is recognised to lead thinking on evidenced informed work in the medical and social sciences, and is located at Queen Mary College and is sponsored by ESRC and the Health Development Agency. David has authored several articles and has led several seminars on Evidence-based policy and practice, and is a regular speaker at international conferences.

Prof. Andy Neely, Project Director

Professor Andy Neely, Advance Institute in Management.

Professor Andy Neely is Executive Director of AIM, the Advanced Institute for Management, Chairman of the Centre for Business Performance at Cranfield School of Management and Managing Director of The Performance Practice. Previously he has held appointments at Cambridge University, where he was a Fellow of Churchill College, Nottingham University, where he completed his PhD and British Aerospace. Andy has been researching, teaching and consulting in the field of business performance measurement and management since the late 1980s and chairs the PMA, an international network for those interested in the performance measurement and management. He has authored over 100 books and articles, including "Measuring Business Performance", published by the Economist and "The Performance Prism", published by the Financial Times. He sits on the UK Government's Performance Information Panel and is widely recognised as one of the world's leading authorities on performance measurement.

11.2 Keywords used in the review

The following list of keywords captures essential concepts to conduct the review:

<i>Innovat*AND network*</i>	<i>Innovat*AND network*AND institutional (w) theory OR actor (w) network OR social (w) network</i>	<i>Diffusion AND knowledge AND network*</i>
<i>Innovat*AND network* AND UK</i>	<i>Innovat* AND network* AND incubators OR clusters communities (w) practice</i>	<i>Innovat*AND mentors OR knowledge (w) brokers OR</i>
<i>Innovat* AND network* AND learn* OR collaborat* OR trust OR absorptive (w) capacity</i>	<i>Innovat* AND network* AND ties OR dynamic* OR isomorphism OR knowledge (w) spill*</i>	<i>Innovat* AND collaborat* OR partner*</i>
<i>Network* AND innovat* AND fail*</i>	<i>Network* AND product (w) development OR invent* OR process (w) change</i>	<i>Network* AND innovat* OR effect* OR collapse OR dysfunction OR disintegrate</i>
<i>Other key words for search strings based on 2400 articles in SCI:</i>	<i>Complexity; embeddedness; entrepreneur*; knowledge; policy; research (w) development; social (w) capital</i>	<i>Relation*; co-operation; agglomeration; alliance*; proximity; intermediary; interaction</i>

11.3 Electronic Databases

The following databases were assessed for relevance and were selected for use in the study;

<i>DATABASE</i>	<i>Areas</i>	<i>Specifics</i>	<i>Comments</i>
<i>ABI – Proquest</i>	<i>This database includes details on virtually every aspect of business and management Coverage: from 1971</i>	<i>(?) as a right hand truncator only. To retrieve words with the same root. (*) in place of characters</i>	<i>Some full text available. Guided search mode is preferable.</i>
<i>Science direct</i>	<i>Experimental Sciences as well as Social Science. Coverage: from 1994</i>	<i>(!) to find a root word (*) to replace characters –one for each character</i>	
<i>Web of Science (Social Citation Index)</i>	<i>More than 5,700 major journals across 164 scientific disciplines.</i>	<i>- word* for all endings - sul*ur for alternative spelling Organi?ation to search both spellings</i>	<i>SAME for search for words in the same sentence () for combining operators No full text availability. Cited references functionality</i>

11.4 The Selection of studies

11.4.1 Exclusion criteria

Once a database has returned a list of results, the researcher manually selects the papers to include in the final list of papers to be reviewed according to the following criteria:

No.	Criteria	Reason for exclusion
1	Pre-1980	With very few exceptions contributions to networking theory started to be published after 1980.
2	Neural networks	These are not inter-organizational networks.
3	Network externalities	These are not inter-organizational networks.
4	Network effects	These are not inter-organizational networks.
5	Information systems	Exclude many articles on networking that focus on how IT systems are linked together.
6	Information technology	Exclude many articles on networking that focus on how IT systems are linked together.
7	Compatibility	Exclude many articles on networking that focus on how IT systems are linked together.

Additional automatic search strings:

<i>Exclusion Terms</i>
<i>AND NOT information technology</i>
<i>AND NOT information technology OR information systems</i>
<i>AND NOT information technology OR information systems OR neural networks</i>
<i>AND NOT information technology OR information systems OR neural networks OR Internet</i>
<i>AND NOT information technology OR information systems OR neural networks OR Internet</i>
<i>innovat? AND network? AND fail? OR collapse OR dysfunction OR disintegrate</i>
<i>innovat? AND network? AND incubat? OR cluster?</i>
<i>innovat? AND mentor? OR knowledge brokers OR communities (w) practice</i>

11.4.2 Inclusion Criteria

Once a database has returned a list of results, the researcher manually selects the papers to include in the final list of papers to be reviewed according to the following criteria:

<i>N</i>	<i>Criteria</i>	<i>Reason for inclusion</i>
1	<i>Theoretical papers – internal/ external validity</i>	<i>Provide the working assumptions to be used in the report.</i>
2	<i>Working papers</i>	<i>Ensure coverage the most current research.</i>
3	<i>All sectors</i>	<i>Examine how networking activities differ between sectors in the UK.</i>
4	<i>US/ Scandinavia/ France/ Germany/UK/ Japan</i>	<i>Ensure cross country comparisons.</i>
5	<i>Quantitative and qualitative empirical studies</i>	<i>Capture all empirical evidence.</i>
6	<i>Business to business networks</i>	<i>Focus on relationships between private sector organisations. Public sector will be included where they act as brokers in business to business networks.</i>

11.5 Studies quality assessment criteria

The following table details the assessment criteria applied to the relevant studies:

<i>Quality assessment criteria</i>					
<i>Element</i>	<i>Level</i>				
	<i>0- Absence</i>	<i>1- Low</i>	<i>2 – Medium</i>	<i>3 - High</i>	<i>Not applicable</i>
<i>1. Theory robustness</i>	<i>The article does not provide enough information to assess this criterion</i>	<i>Poor awareness of existing literature and debates. Under or over referenced. Low validity of theory</i>	<i>Basic understanding of the issues around the topic being discussed. The theory weakly is related to data</i>	<i>Deep and broad knowledge of relevant literature and theory relevant for addressing the research. Good relation theory-data</i>	<i>s element is not applicable to the document or study</i>
<i>2. Implication for practise</i>	<i>The article does not provide enough information to assess this criterion</i>	<i>Very difficult to implement the concepts and ideas presented. Not relevant for practitio-ners or professionals</i>	<i>There is a potential for implementing the proposed ideas, with minor revisions or adjustments</i>	<i>Significant benefit may be obtained if the ideas being discussed are put into practice.</i>	<i>This element is not applicable to the document or study</i>
<i>3. Methodology. Data supporting arguments.</i>	<i>The article does not provide enough information to assess this criterion</i>	<i>Data inaccuracy and not related to theory. Flawed research design</i>	<i>Data is related to the arguments, though there are some gaps. Research design may be improved</i>	<i>Data strongly supports arguments. Besides, the research design is robust: sampling, data gathering, data analyses is rigorous</i>	<i>This element is not applicable to the document or study</i>
<i>4. Generalisability</i>	<i>The article does not provide enough information to assess this criterion</i>	<i>Only to the population studied</i>	<i>Generalisable to organisations of similar characteristics</i>	<i>High level of generalisability</i>	<i>This element is not applicable to the document or study</i>
<i>5. Contribution Plus a short statement summarising the article's contribution</i>	<i>The article does not provide enough information to assess this criterion</i>	<i>Does not make an important contribution. It is not clear the advances it makes</i>	<i>Although using other's ideas, builds upon the existing theory</i>	<i>Further develops existing knowledge, expanding the way the issue was explained so far</i>	<i>This element is not applicable to the document or study</i>

11.6 Detailed Search Process and Results

Stage	Name	Results	Description
1	DATABASE ANALYSIS:	628 Citations	During the first stage of the review citations from ABI Proquest; Science Direct; the Web of Science were identified using the search strings outlined in Section 11.2. and applying the automatic exclusion search strings outlined in Section 11.4.1.
2	TITLE ANALYSIS:	375 citations included 157 excluded and 96 duplicates	During the second stage the review applied the manual inclusion and exclusion criteria identified in Sections 11.4.1. and 11.4.2. to the titles of the 628 citations found in stage one. During this stage the focus of the researchers was to remove duplicate items and any citations that obviously contravened the inclusion criteria set out prior to the database searches.
3	ABSTRACT ANALYSIS:	332 citations included 43 excluded	During the third stage the reviewers analysed in detail each of the abstracts. The inclusion and exclusion criteria were again applied and a more rigorous assessment of articles was undertaken. During this phase the citations were organised into an A, B and C list to reduce the number of articles to manageable level.
	A ranked 179	179 Citations	The A list of citations for the review included only articles which appeared to fully meet the inclusion criteria, which could contribute to understanding UK networks compared to key competing countries. Articles were only included in the A-list if it was clear that they had sound empirical contributions. The researcher's judgments on inclusion in the A list applied the quality criteria in Section 11.5. and was balanced to include quantitative, qualitative and ethnographic forms of primary research.
	B ranked	76 Citations	The B list of citations included articles that appeared to have some relevance to the inclusion criteria but where some ambiguity existed about how they would contribute to the subject. These articles also included studies that did not meet the higher order quality criteria for inclusion.
	C ranked	77 Citations	The C list included articles of two types. Firstly, there were a number of articles that were relevant to the subject and made sound theoretical contributions. These were excluded because they did not meet the criteria associated with providing empirical evidence on which policy could be based. The second category included articles where the contribution to the subject either appeared somewhat tenuous or the empirical evidence appeared to be relatively weak.
4	POST ABSTRACT CODING:	174 Citations 5 Duplicates	Following stage three 5 further duplicates were found when reviewing articles.
5	NARRATIVE INCLUSIONS	20	During the review phase and the report writing phase further citations were identified using a narrative approach which clearly contributed to the subject in discussion. Some of these came from expert recommendation and others from articles reference lists.

11.7 Citation Search Results

11.7.1 ABI Proquest

<i>Database: ABI Proquest Collections: Business and Management Dates: 1980-2003</i>			
<i>Field: Full text Date of Search: 30 June 2003</i>		<i>Total</i>	<i>Relevant</i>
1	<i>innovat? AND network?</i>	1282	268
2	<i>innovat? AND network? AND NOT information technology</i>	1159	268
3	<i>innovat? AND network? AND NOT information technology OR information systems</i>	1106	268
4	<i>innovat? AND network? AND NOT information technology OR information systems OR neural networks</i>	1065	268
5	<i>innovat? AND network? AND NOT information technology OR information systems OR neural networks OR Internet</i>	987	268
6	<i>innovat? AND network? AND UK AND NOT information technology OR information systems OR neural networks OR Internet</i>	100	18
7	<i>innovat? AND network? AND fail? OR collapse OR dysfunction OR disintegrate</i>	38	14
8	<i>innovat? AND network? AND incubat? OR cluster?</i>	38	23
9	<i>innovat? AND mentor? OR knowledge brokers OR communities (w) practice</i>	40	6
10	<i>network? AND UK AND invent? OR Product Development AND NOT information technology OR information systems</i>	21	6
11	<i>entrepreneur? AND network? AND UK</i>	29	12

11.7.2 Science Direct

<i>Database: Science Direct Collections: Social Sciences Dates: 1994-2003 Field: Full text Date of Search: 1st July 2003</i>	<i>Total</i>	<i>Relevant</i>
<i>innovat! AND network!</i>	<i>10,000+</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology</i>	<i>5496</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology OR information systems</i>	<i>4592</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology OR information systems OR neural networks</i>	<i>4526</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology OR information systems OR neural networks OR Internet</i>	<i>4023</i>	<i>189</i>
<i>innovat! AND network! AND UK AND NOT information technology OR information systems OR neural networks OR Internet</i>	<i>1311</i>	<i>4</i>
<i>innovat! AND network! AND fail! OR collapse OR dysfunction OR disintegrate AND NOT information technology (etc.)</i>	<i>80</i>	<i>64</i>
<i>innovat! AND network! AND incubat! OR cluster AND NOT information technology (etc.) 294</i>	<i>15</i>	
<i>innovat! AND network! AND ties OR dynamic! OR isomorphism OR knowledge</i>	<i>3180</i>	<i>25</i>
<i>innovat! AND collaborat! OR partner!</i>	<i>10,000+</i>	
<i>network! AND product development OR invent! OR process AND NOT information technology (etc.)</i>	<i>10,000+</i>	
<i>Title, Keyword and Abstract search</i>		
<i>innovat! AND network!</i>	<i>693</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology</i>	<i>647</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology OR information systems</i>	<i>631</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology OR information systems OR neural networks</i>	<i>575</i>	<i>189</i>
<i>innovat! AND network! AND NOT information technology OR information systems OR neural networks OR Internet</i>	<i>548</i>	<i>189</i>
<i>innovat! AND network! AND UK AND NOT information technology OR information systems OR neural networks OR Internet</i>	<i>13</i>	<i>4</i>
<i>innovat! AND network! AND business! AND NOT information technology OR information systems OR neural networks OR Internet</i>	<i>66</i>	<i>38</i>
<i>innovat! AND network! AND incubat! OR cluster!</i>	<i>30</i>	<i>15</i>
<i>innovat! AND network! AND ties OR dynamic! OR isomorphism OR knowledge spill AND NOT information technology etc.</i>	<i>64</i>	<i>25</i>
<i>diffusion AND knowledge AND network! AND NOT information technology (etc.)</i>	<i>44</i>	<i>10</i>
<i>innovat! AND mentor! OR knowledge brokers OR communities (w) practice AND NOT information technology etc.</i>	<i>13</i>	<i>3</i>
<i>innovat! AND network! AND professional associations</i>	<i>0</i>	<i>0</i>
<i>network! AND UK AND invent! OR Product Development AND NOT information technology OR information systems</i>	<i>4</i>	<i>0</i>
<i>entrepreneur! OR small business! AND network!</i>	<i>139</i>	<i>78</i>

11.7.3 Web of Science

<i>Database: Web of Science (Social Science Citations)</i> <i>Collections: Social Sciences</i> <i>Dates: 1980-2003</i> <i>Field: Full text</i> <i>Date of Search: 2nd July 2003</i>			<i>Total</i>	<i>Relevant</i>
<i>innovat* AND network*</i>	1543	145		
<i>innovat* AND network* NOT information technology</i>	1465	145		
<i>innovat* AND network* NOT information technology NOT information systems</i>	1441	145		
<i>innovat* AND network* NOT information technology NOT information systems NOT neural networks</i>	1428	145		
<i>innovat* AND network* NOT information technology NOT information systems NOT neural networks NOT Internet</i>	1357	145		
<i>innovat* AND network* AND business* NOT information technology NOT information systems NOT neural networks NOT Internet</i>	169	99		
<i>innovat* AND network* AND fail* OR collapse OR dysfunction OR disintegrate</i>	13352	32		
<i>innovat* AND network* AND incubat* OR cluster NOT information technology (etc.)</i>	4928	145		
<i>innovat* AND network* AND tie* OR dynamic* OR isomorphism OR knowledge</i>	32300	145		
<i>innovat! AND collaborat* OR partner*</i>	3400	99		
<i>network! AND product development OR invent! OR process AND NOT information technology (etc.)</i>	2000	145		

11.7.4 Descriptive Analysis Table

AUTHORS	ARTICLE TITLE	JOURNAL	DATE	VOL	NO	ABSTRACT	KEYWORDS
Ahuja, G.	<i>The Duality of Collaboration: Inducements and Opportunities in the Formation of Interfirm Linkages</i>	<i>Strategic Management Journal</i>	2000 Mar	21	3	<i>It is argued that the linkage-formation propensity of firms is explained by simultaneously examining both inducement and opportunity factors. Drawing upon resource-based and social network theory literatures, three forms of accumulated capital - technical, commercial, and social - that can affect a firm's inducements and opportunities to form linkages, are identified. Firms possessing these capital stocks enjoy advantages in linkages formation. However, firms lacking these accumulated resources can still form linkages if they generate a radical technological breakthrough. Thus, paths to linkage formation for leading as well as peripheral firms are identified. These arguments are tested with longitudinal data on technical collaborative linkages in the global chemicals industry.</i>	<i>Linkage-formation/ Social Network theory/ Technical collaboration/ Chemicals industry</i>
Ahuja, Gautam	<i>Collaboration networks, structural holes, and innovation: A longitudinal study</i>	<i>Administrative Science Quarterly</i>	Sep-00	45	3	<i>To assess the effects of a firm's network of relations on innovation, this paper elaborates a theoretical framework that relates 3 aspects of a firm's ego network - direct ties, indirect ties, and structural holes - to theory. The firm's subsequent innovation output. Results from a longitudinal study of firms in the international chemicals industry indicate support for the predictions on direct and indirect ties, but in the inter-firm collaboration network, increasing structural holes has a negative effect on innovation.</i>	<i>Innovations/ Business networking/ Organization to theory/ International</i>
Alasoini, Tuomo	<i>Promoting network-based organizational innovations: A new approach in Finnish labour and technology policies</i>	<i>International Journal of Technology Management</i>	2001	22	1,2,3	<i>During the 1990s, many European companies successfully renewed their work organizations. Many recent commentators have nevertheless seen the slow spread of organizational process innovations among European companies as one of the key reasons for the poor performance of European countries in global competition. A problem identified in a number of countries is the weakness of the development infrastructure in this grey area lying between the traditional areas of labour and technology policy. This paper examines the Finnish National Workplace Development Program (1996), one of the aims of which is to promote the development, experimentation and spread of organizational innovations in working life. The program pursues this objective by supporting networking between companies and reinforcing the infrastructure for the development of work organization. The paper looks at the program strategy and provides an introduction to project activity within the program, while also examining the role of government in the development of work organization.</i>	<i>Studies/ Organization development/ Innovations/ Business-government relations/ Technological planning/ Systems development</i>

Almeida Paul & Kogut Bruce	The exploration of technological diversity and the geographic localization of innovation	Small Business Economics	Feb-97	9	1	The innovative ability of small firms in the semiconductor industry regarding their exploration of technological diversity and their integration within local knowledge networks are examined. Through the analysis of patent data, the innovative activity of start-up firms and larger firms are compared. It is found that small firms explore new technological areas by innovating in less crowded areas. The analysis of patent citation data reveals that small firms are tied into regional knowledge networks to a greater extent than large firms. These findings point to the role of entrepreneurial firms in the diffusion of their accumulated knowledge through local small firm networks.	Small business/ Innovations/ Comparative studies/ Semiconductors
Almeida, Paul & Kogut, Bruce	Localization of knowledge and the mobility of engineers in regional networks	Management Science	Jul-99	45	7	Knowledge, once generated, spills only imperfectly among firms and nations. It is posited that since institutions and labour networks vary by region, there should be regional variations in the localization of spillovers. The relationship between the mobility of major patent holders and the localization of technological knowledge is investigated through the analysis of patent citations of important semiconductor innovations. It is found that knowledge localization is specific to only certain regions (particularly Silicon Valley) and that the degree of localization varies across regions. By analyzing data on the inter-firm mobility of patent holders, it is empirically shown that the inter-firm mobility of engineers influences the local transfer of knowledge. The flow of knowledge is embedded in regional labour networks.	Studies/ Engineers/ Technology transfer/ Regions/ Innovations/ Patents/ Semiconductors
Andersson, U., Forsgren, M. & Holm, U.	The Strategic Impact of External Networks: Subsidiary Performance and Competence Development in the Multinational Corporation	Strategic Management Journal	2002 Nov	23	11	This study explores the importance of relational embeddedness in external networks as a strategic resource for performance and competence development in multinational corporations (MNCs). Two different types of relational embeddedness at the subsidiary level - business embeddedness and technical embeddedness - are proposed to have an influence on the subsidiary's market performance as well as its importance for competence development in the MNC. Using data on 97 Swedish MNC subsidiaries, 5 hypotheses are tested in a LISREL model analysis. The results suggest that technical embeddedness has a positive impact on both the subsidiary expected performance and its role in the development of products and production processes in the MNC. Indirectly, through external technical embeddedness, external business embeddedness also influences the sister units' product and process development and subsidiary market performance.	External networks/ Swedish/ Multi-national/ MNC/ Embeddedness/ Product development/ Process development

Amdt, O. & Stemberg, R.	Do Manufacturing Firms Profit From Intra-regional Innovation Linkages? An Empirical Based Answer	European Planning Studies	2000 Aug	8	4	<p>Abstract Nowadays, inter-firm linkages in the form of regional networks are seen as growth-promoting and important prerequisites for successful innovation activities in firms. Beginning with this hypothesis, the paper sets out to answer the question, whether manufacturing businesses with strong intraregional ties are more successful with respect to growth rates and innovative activities than those firms with little connection to their region. From a survey carried out in 10 European regions, the results verify that in spite of numerous network relationships on the national and international level small businesses are most likely to cooperate with others in their vicinity. In addition, the more knowledge-intensive innovation activities of businesses are, the more important is the relevance of spatial proximity in particular and networking in general.</p>	Inter-firm linkage/ Innovation/ Regional networks/ Growth/ European nations/ Cooperation/ Knowledge
Auto, E.	New, technology-based firms in innovation networks symplectic and generative impacts	Research Policy	1997/10	26	3	<p>The systemic view of the technological innovation process largely remains to be implemented in research on new, technology-based firms. An attempt is made to bridge this gap, by applying a systemic approach to research on new, technology-based firms. A model is developed and tested that classifies new, technology-based firms into science-based firms and engineering-based firms. The two categories are defined in terms of the functional relationship between the new, technology-based firm and the articulation process of basic technologies. In the model, new, technology-based firms are analyzed in terms of the systemic knowledge conversion process to which they are attached. The model receives support in 3 empirical databases, compiled among new, technology-based firms in Finland, the UK, and Silicon Valley.</p>	Technological innovation/ Systemic approach/ Basic technologies/ Conversion/ Finland/ UK/ Silicon Valley
Baiman, Stanley, Rajan, Madhav V & Kanodia, Chandra	The role of information and opportunism in the choice of buyer-supplier relationships / Discussion	Journal of Accounting Research	May-02	40	2	<p>An important characteristic of any buyer-supplier relationship is the amount and type of information that is exchanged between the contracting parties. Buyer-supplier networks are characterized by greater information exchange than arm's-length transactions. This enhanced information exchange allows for greater production efficiency but increases the potential for information misappropriation. In this paper the set of innovations for which each of these forms of exchange relationships is efficient is characterized. The effect of an initial information linkage between the buyer and supplier is then explored. Such linkages increase the set of innovations for which networks are efficient. However, such linkages have a negative effect on the buyer's incentive to innovate and an ambiguous effect on the supplier's incentive to invest in flexible production techniques. Finally, settings in which the buyer-supplier surplus is greater with such linkages are identified.</p>	Information sharing/ Buyers/ Suppliers/ Research & development/ R&D/ Mathematical models/ Studies/ Intellectual property

Baptista, Rui	<i>The diffusion of process innovations: A selective review</i>	<i>International Journal of the Economics of Business</i>	Feb-99	6	1	Some of the most noteworthy literature on the diffusion of process technologies are reviewed from the point of view of economics. The main theoretical approaches to the diffusion phenomenon are examined: epidemic and learning effects, equilibrium models associated with firm characteristics and strategic interaction. Also discussed is the role of the supply side. Empirical work modelling inter-firm diffusion is reviewed, and special attention is given to the role of geography and inter-firm networking in the process of knowledge transfer and diffusion. Some suggestions for further research are presented.	Studies/ Economic theory/ Innovations/ Information dissemination/ Economic models
Baum, Joel A C, Calabrese, Tony & Silverman, Brian S	<i>Don't go it alone: Alliance network composition and start-ups' performance in Canadian biotechnology</i>	<i>Strategic Management Journal</i>	Mar-00	21	3	Theory and research on alliance networks and on new firms are combined to investigate the impact of variation in start-ups' alliance network composition on their early performance. It is hypothesized that start-ups can enhance their early performance by: 1. Establishing alliances, 2. Configuring them into an efficient network that provides access to diverse information and capabilities with minimum costs of redundancy, conflict, and complexity, and 3. Judiciously allying with potential rivals that provide more opportunity for learning and less risk of intra-alliance rivalry. An analysis of Canadian biotech start-ups' performance provides broad support for the hypotheses, especially as they relate to innovative performance. Overall, the findings show how variation in the alliance networks start-ups configure at the time of their founding produces significant differences in their early performance, contributing directly to an explanation of how and why firm age and size affect firm performance. Some clear, but challenging, implications for managers of start-ups are discussed.	Studies/ Strategic management/ Start-ups/ Alliances/ Agricultural biotechnology/ Statistical analysis
Bee, E	<i>.Knowledge Networks and Technical Innovation in America's Metropolitan Areas: a Paradigm for High-Technology Economic Development</i>	<i>Economic Development Quarterly</i>	2003 May	17	2	Presents a study that discussed the composition of knowledge networks and technical innovation in U.S. metropolitan areas. Principal distinction among innovative regions and less innovative regions; Function of the U.S. Patent and Trademark Office; Concentrations of patents in metropolitan areas; Geographic concentrations of technology.	Knowledge networks/ Composition/ Regions/ US/ Patents
Bernardy, Michel De	<i>Reactive and proactive local territory: Co-operation and community in Grenoble</i>	<i>Regional Studies</i>	Jun-99	33	4	Despite the pressure of globalization and hypercompetition, local embeddedness and proximity appear to be decisive factors in the competitive advantage of successful local economies. The recent evolution of high technology firms and industries in the Grenoble region is reviewed in considering why and how particular localities have over time been able to successfully renew and adapt their economies and competencies while others have collapsed. After examining the logic of firms' or individuals' appropriate space, the way in which particular agents have been able to renew knowledge and enhance cooperation through various learning processes depending on their personal network of relationships is highlighted.	Organizational learning/ Start-ups/ Spin-offs/ Innovations/ High tech industries/ Cooperation/ Business networking/ Organizational learning/

Biemans, Wim G	User and third-party involvement in developing medical equipment innovations	Technovation	1991/4	11	3	<p>Empirical data from the Dutch medical equipment industry are used to describe the distribution of innovation across manufacturers, users, and third parties. Although the development of innovations within complex networks consisting of several different organizations has various advantages, important disadvantages also exist. Potential users were found to participate in all but one stage of the product development process. However, the manufacturer-user interaction was not always intensive. Various third parties also contributed substantially to the process of product development, and important differences were found between manufacturer-user and manufacturer-third party interaction. The manufacturer should pay careful attention to the selection of collaboration partners and management of the individual interactive relationships in order to realize the full benefits of developing technological innovations within networks.</p>	Medical equipment industry/ Manufacturers/ Innovations/ Complex networks/ Product development/ Collaboration
Birley, Sue	New ventures and employment growth	Journal of Business Venturing	1987/0	2	2	<p>A study presents the results of a survey of 159 owner-managed companies in England. The research question explores the effectiveness of personal networks in terms of firm performance and growth. Multiple regression confirmed the importance of networks for company performance and development. The research establishes a link between the entrepreneur's networking behaviour and the growth of the firm.</p>	Personal networks/ Growth/ Firm performance/ Entrepreneur/ Networking behaviour
Birley, Sue	The role of networks in the entrepreneurial process	Journal of Business Venturing	1985/0	1	1	<p>Entrepreneurs often depend on building contacts and developing formal and informal networks. A study in St. Joseph County, Indiana – a county that had suffered severe economic decline – showed that firms tend to be started by local people using their own informal networks. Since the firm's elements are set during the start-up process, the choice of networks is key in understanding the nature of the subsequent firm. The entrepreneur is likely to recreate the elements of previous employment when using only business contacts and family, but in an efficient network, the system diagnoses needs and provides the necessary information and advice. Therefore, strategies are needed to increase community awareness to formal sources of help. Those in the formal system could exchange information on the various schemes and services they offer, perhaps in the context of a central clearing house. The enterprise office (clearing house) could also monitor new firms and help develop strategies for finding new customers and new markets.</p>	Entrepreneur/ Informal networks/ Formal networks/ US/ Formal system

<p>Bolton, Michele Kremen, Malmrose, Roger & Ouchi William G.</p>	<p>The organization of innovation in the United States and Japan: Neoclassical and relational contracting</p>	<p>The Journal of Management Studies</p>	<p>Sep-94</p>	<p>31</p>	<p>5</p>	<p>The role of intermediate governance structures between vertically related industries in the specific context of technological innovation is discussed. In the US, relations between firms in vertically related industries correspond closely to the neoclassical contracting model, characterized by arms-length, spot contracting on the open market. In Japan, inter-firm relations are more likely to involve relational contracting, characterized by stable bonding mechanisms and a dense historical network of economic ties between the parties to the exchange. The kinyu keiretsu type of relational contracting between firms of unequal size and power in vertically related industries is the focus. The contractual arrangements used to manage the development of new technology by 46 US and 27 Japanese semiconductor equipment firms are compared. It is speculated that the organisation of innovation in the Japanese semiconductor equipment industry has accelerated their development of new technology and led to their extraordinarily rapid worldwide market penetration.</p>	<p>Vertical markets/ Technological change/ Studies/ Statistical data/ Many companies/ Electronics industry/ Alliances</p>
<p>Boter Hakan & Holmquist Carin</p>	<p>Industry characteristics and internationalization processes in small firms</p>	<p>Journal of Business Venturing</p>	<p>Nov-96</p>	<p>11</p>	<p>6</p>	<p>A study of small firms compares the process of internationalization in traditional manufacturing companies with corresponding processes in companies oriented toward innovation. Case studies were conducted in 6 small Nordic companies: 3 conventional and 3 innovative. The conventional companies are incorporated into a multidimensional industrial system of suppliers, competitors, and other companies, and the individual companies within these industries are constrained by the rules dictated by these networks. The innovative companies all have a concentrated product scope, which implies that it is relatively easy to achieve efficiency in various functions such as R&D, production, and marketing activities. This clear distinction between functions has been advantageous to the process of internationalization. The results from the 6 case studies indicate that the internationalization process must be understood in the context of the industry, company, and people involved. International trade and cooperation will most certainly increase. Therefore, it is important to observe that the conditions for industries and single companies are different.</p>	<p>Studies/ Small business/ Manufacturers/ Globalization/ Comparative analysis</p>

Bougrain, Frederic & Haudeville, Bernard	Innovation, collaboration and SMEs internal research capacities	Research Policy	Jul-02	31	5	<p>The aim of this research paper is to assess how SMEs' internal research capacities help them to exploit external scientific and technical knowledge and to use networks of innovators. The empirical analysis draws upon case studies made of projects, which were partly financed by ANVAR, a French national agency responsible for the development of innovation projects in industry. The results of this study are three-fold: 1. Technological co-operation does not seem to increase the chance of success of innovative projects. 2. R&D intensity does not lead to discriminate between success and failure. 3. Internal R&D capacities, such as a design office, enhance the firm's ability to co-operate and to carry its project to success.</p>	Studies/ Innovations/ Statistical analysis/ Research & development/ R&D/ Alliances/ Small business/ Many industries
Bower D J & Keogh W	Changing patterns of innovation in a process-dominated industry	International Journal of Technology Management	1996	12	2	<p>Research on innovation in several industries has indicated that individual radical and incremental innovations have involved contributions from communicating networks of scientists and engineers in different organizations. The record of innovation within the downstream (refining and organic chemical production) and upstream (exploration and extraction of oil and gas) sectors of the petrochemical industry is analyzed. In the downstream industry, a varied group of organizations have mediated innovation, following the cyclical pattern of the Abernathy-Utterback (1978) model. On the other hand, while evidence about the upstream petroleum industry indicates a diversity of contributors similar to those found in other industries, the tempo of innovation does not appear to fit cyclical models derived from a number of manufacturing industries. A continuous innovation pattern, which has emerged since 1980 in the pharmaceutical industry, is discussed as offering a possible model for other industries that must innovate continuously.</p>	Studies/ R&D/ Petroleum industry/ Petrochemicals industry/ Many countries/ International/ Innovations
Bower, D Jane, Crabtree, Elisabeth & Keogh, William	Rhetorics and realities in new product development in the subsea oil industry	International Journal of Project Management	1997/12	15	6	<p>In any context people draw on an abstract, generative structure of rules and resources in order to act. While some of the rules are open and accessible to everyone in an industrial network, there are also hidden rules, which can be derived using data that may come from several sources - such as informal communications, and individual perceptions of past actions of participants within the network. One situation in which researchers have an unusual opportunity to uncover the hidden rules governing collaborative new product development, and the process by which they are inferred, is when major changes are disrupting hitherto smooth business relationships, provoking highly vocal self-examination of industry network functions. North Sea oil and gas-related industry reports are presented to elucidate the process of inference of the hidden rules, the varied construction of these by different actors within the industry network, and the impact of the abstract thus generated on decisions about product and service innovation by the actors. The new products developed are productive oilfield infrastructures and their diverse product technical service components.</p>	Rules/ Governance/ Industrial network/ Collaboration/ North Sea/ Oil/ Gas/ Hidden rules/ Product innovation/ Service innovation

Bower, Jane	New product development in the pharmaceutical industry: Pooling network resources <i>The Journal of Product Innovation Management</i>	European Planning Studies	Nov-93	10	5	Pharmaceutical innovation increasingly involves some degree of pooling of resources of finance, equity, technology, information, and intellectual property between pharmaceutical companies and other organizations. The organizations and their exchanges constitute a network that can be regarded as a growing store of varied resources preferentially accessible to network members. An examination is made of network effects in management decision-making in Ciba-Geigy (Switzerland) and Elan Corp. (Ireland). It is concluded that participation in a common network has enabled these firms to access a pool of resources of knowledge, experience, and finance. This pool has been generated by past exchanges among network members, including providers of finance, and has increased the network's collective reservoir of knowledge.	Studies/ Resources/ Product development/ Pool/ Pharmaceutical industry/ Partnering/ Management decisions
Bruce Margaret, & Rodgus, Gary	Innovation Strategies in the Enzyme Industry	R & D Management	Oct-91	21	4	Questionnaires were sent to 43 enzyme suppliers in the UK in order to investigate their approaches to management of innovation. The response rate was only 33%, but the sample does provide some indication of suppliers' strategies. Semi-structured interviews were also conducted with a small sample of firms. The analysis highlights a fairly continuous market orientation by the suppliers, but not at the expense of investment and research and development (R&D). Managing the supplier-customer interface, utilizing customer contacts and the information generated via these contacts, is a significant competitive issue in the enzyme industry. The firms in the sample follow the recommendations found in the innovation management literature - some firms involve the customer, some firms couple marketing and R&D activities, and other firms draw on a network of customers and third parties for information.	Surveys/ Roles/ R&D/ Questionnaires/ Market strategy/ Innovations/ Customer feedback/ Chemical industry
Bruce Margaret & Moger, Susan T	Dangerous liaisons: An application of supply chain modelling for studying innovation within the UK clothing industry	Technology Analysis & Strategic Management	Mar-99	11	1	An empirical study into innovation supporting and blocking factors has been conducted of the strategic perceptions of stakeholders within the supply chain of a mature industry sector, based on interview analysis. The data revealed strategic intentions and assumptions that support the emergence of 2 distinct trajectories of change in the industry based on co-partnership and ad-hoc relationships respectively. A model of the trajectories using current partnership theories of lean supply indicated that the co-partnership trend offers some scope for incremental innovation; the ad-hoc relationship trend offered rather less scope for incremental innovation. Both trends seem to be reducing the scope for development of entrepreneurial networks within which independent design innovators can flourish. The strategic assumptions identified point to an environment that is not supportive of radical innovation. The absence of in-house R&D capabilities may be an important factor in the industry's difficulties in innovating.	Clothing industry/ Supply chains/ Models/ Trends/ Innovations/ Strategic planning/ Studies/ Partnerships

Bygrave, William	The Structure of the Investment Networks of Venture Capital Firms	Journal of Business Venturing	Spring 1988	3	2	<p>The joint investment networks of venture capital firms are examined. A sample of portfolio companies was taken randomly from the Venture Economics database of all companies known to have received first rounds of venture capital. The venture capital firms were classified into 3 categories: 1. The top 61 firms in terms of the most investments, 2. The top 21 high innovative venture companies (HIVC), and 3. The top 21 low innovative venture companies (LIVC). It was found that the HIVCs had a higher incidence of connectedness as measured by the percentage of pairs with one or more co-investments. The findings suggest that: 1. Links to other venture capital firms are extremely valuable, 2. Entrepreneurs should submit proposals for funding to a limited number of firms, 3. HIVCs concentrate in the high-technology firms in California and the Northeast whereas LIVCs are evenly spread throughout the US, and 4. The model for co-investment networks also will apply to investors and lenders in general.</p>	Venture capital companies/ Studies/ Portfolio investments/ Organizational structure/ Networks/ Institutional investments/ Economic models
Bygrave, William	Syndicated investments by venture capital firms: A networking perspective	Journal of Business Venturing	1987/0	2	2	<p>Venture capital firms have networks through which they share information on the portfolio companies in which they invest. An analysis of the networking of 464 venture capital firms was conducted by assessing the firms' joint investments in 1,501 portfolio companies during the period 1966-1982. Factors that influence degrees of networking include the innovativeness, technology, stage, and industry of the portfolio company. Use of the resource exchange model showed that the amount of a firm's networking was related to the degree of uncertainty associated with an investment rather than the amount of money invested. The top 61 venture capital firms were found to have extensive networks. Among these firms, sharing of information was shown to be a stronger reason for networking than spreading financial risk.</p>	Venture capital/ Investments/ Innovation/ Technology stage/ Exchange model/ Uncertainty/ Networks
Cantwell, John & Iammarino, Simona	Multinational corporations and the location of technological innovation in the UK regions	Regional Studies	Jun-00	34	4	<p>In a rapidly globalizing economy and particularly in the face of a process of economic integration such as that occurring in the European Union, regions forge an increasing number of linkages with other locations within and across national boundaries through the local technological development efforts of multinational corporations (MNCs). By using patents granted to the largest industrial firms - arranged by the region host to the research facility responsible - the paper explores the location of innovative activities in MNCs, and the relationship between the profiles of technological specialization of foreign-owned and indigenous companies in the UK regions. The results are consistent with the hypothesis that the pattern of MNC networks for innovation conforms to a hierarchy of regional centres, and that the pattern of technological specialization of foreign-owned affiliates in different regional locations depends upon the position of the region in the locational hierarchy.</p>	Global economy/ Multinational corporations/ European Monetary Union/ Patents/ Innovations

<p>Cantwell, John & Iammarino, Simona</p>	<p>MNCs, technological innovation and regional systems in the EU: Some evidence in the Italian case</p>	<p>International Journal of Business Economics</p>	<p>Nov-98</p>	<p>5</p>	<p>3</p>	<p>Innovations/ Multinational corporations/ Many industries/ Regions/ Regression analysis/ Studies</p>
<p>The increasing appreciation of the role of multinational corporations (MNCs) in the generation of technology across boundaries has been facilitated by the recent trend for MNCs to establish internal and external networks for innovations. The development of cross-border corporate integration and intra-border inter-company sectoral integration makes it increasingly important to examine where and how innovative activity by MNCs is internationally dispersed and regionally concentrated. By using patents granted to the largest industrial firms for innovation located abroad - arranged by the host region - the nature of the relationship between the foreign-owned and the indigenous company profiles of technological specialization in the Italian regions is tested. It is argued that the MNC networks for innovation in Europe conform to a geographical hierarchy of regional centres. Accordingly, the technological specialization of foreign-owned affiliates in different regional locations depends upon the position of the region in the hierarchy.</p>						
<p>Carayannis, Elias C., Kassioch, Suleiman K. & Radosevich, Raymond</p>	<p>Strategic alliances as a source of early-stage seed capital in new technology-based firms</p>	<p>Technovation</p>	<p>2000/11</p>	<p>20</p>	<p>11</p>	<p>Seed capital/ New ventures/ Technology/ Strategic partners/ Partnerships/ Science/ Entrepreneurial networking</p>
<p>A significant gap exists in early-stage seed capital for technology-based new ventures. This article reports the results of a survey of embryonic firms in the south-western US that received significant amounts of their initial capital from strategic partners. Through this survey of firms, an examination is made of various characteristics of the partnerships. The firms were identified through extensive research of multiple sources (at least 30) such as universities, federal laboratories, state and local economic development agencies, incubator centres, technology parks, venture capital funds, NASA Regional Technology Transfer Centres, corporate alliance partners, entrepreneurial networking organizations and by word-of-mouth from other entrepreneurs. Empirical research findings identified key issues that are salient to small-firm/large-firm, technology-driven strategic alliances formed for seed capital investment purposes.</p>						
<p>Coles, Anne-Marie, Harris, Lisa & Dickson, Keith</p>	<p>Testing goodwill: Conflict and cooperation in new product development networks</p>	<p>International Journal of Technology Management</p>	<p>2003</p>	<p>25</p>	<p>1,2</p>	<p>Studies/ Innovations/ Product development/ Business networking/ Organizational behaviour/ Goodwill/ Defence industry/ Conflict</p>
<p>Networks are often seen as models of organizational flexibility, promoting the building of trust and exchange of information between different business functions while offering both cost savings and reductions in the uncertainties usually associated with innovation. Both internal and external networks have been identified as key elements in the collaborative development of new products. The actual process of network building and ongoing network management is not well researched, although the existing literature highlights difficulties for organizations attempting to maintain active product development networks. This paper examines the development and management of such a network in the defence industry and focuses on network building processes in terms of the interactions between the individuals involved. This network has endured and evolved over many years despite a series of conflicts. One of the key findings is that the effective functioning of the overall network is closely allied to established processes within the two participating firms.</p>						

Collinson, Simon & Gregson, Geoff	Knowledge networks for new technology-based firms: An international comparison for local entrepreneurship promotion	R & D Management	Mar-03	33	2	<p>A knowledge-based approach is adopted to examine how networks of would-be entrepreneurs interact with networks of experienced entrepreneurs and managers, venture capitalists, technical experts, consultants, IPR lawyers and other specialists. This interaction is promoted and mediated at the local level by the three organizations at the centre the study: the Austin Technology Incubator, Texas; Connect, Edinburg; and the Canadian Environmental Technology Advancement Corporation in Canada. These act as local network nodes or knowledge integrators, as well as incubating new ventures to increase the new business birth rate in their respective regions. Findings stress the importance of the regional context as a source of particular kinds of knowledge and expertise that may promote or inhibit new technology-based business start-ups. In particular: 1. the scale, scope and quality of ideas and business proposals in local networks, 2. the availability of relevant expertise and experience for intelligent selection and for successful mentoring, 3. the nature of rewards and incentives for all players, and 4. the importance of local champions or figureheads, are all factors that help explain differences across the example regions.</p>	Studies/ Research & development/ R&D/ Comparative analysis/ Start-ups/ Business networking/ Professional relationships
Conway, Steve	Informal boundary-spanning communication in the innovation process: An empirical study	Technology Analysis & Strategic Management	1995	7	3	<p>The sources of ideas embodied within successful technological innovation have been a subject of interest in many studies since the 1950s. This research suggests that sources external to the innovating organisation account for between 34% and 65% of the inputs important to the development of successful innovation. In addition, studies have long highlighted personal boundary-spanning communication as an important mechanism for the transference of such ideas. Despite this recognition, there has been little systematic evaluation of the role and importance of informal boundary-spanning communication in the innovation process. The results are provided of an empirical study of the role and source of informally derived inputs into the development process of 35 commercially successful innovations. It was found that informal mechanisms were often employed to transfer ideas and information, as well as other resources, during the idea-generation, problem-solving, and field-testing phases of these innovation projects. Indeed, the research indicates that the mobilization of informal boundary-spanning contacts and networks may often be an important, and sometimes critical, factor in successful innovation.</p>	Technological change/ Success/ Studies/ R&D/ Problem solving/ Innovations

Cooke, P.	The New Wave of Regional Innovation Networks: Analysis, Characteristics and Strategy	Small Business Economics	1996 Apr 8	2	<p>Today, the number one priority for competitive advantage is innovation. A new approach to regional business development has been pioneered in Europe and the US. This involves building a regional innovation infrastructure. Learning through networking has proven to be a successful approach in some of Europe's more dynamic regional economies such as Baden-Württemberg and Emilia-Romagna. This involves maximizing the complete range of regional innovation assets. Pennsylvania and other older industry centres are showing that such an approach is transferable from Europe to the US. Knowledge-transfer at the regional level is assessed and the key elements for successful regional innovation networking practices are outlined. The major findings are that business networking is an effective way of increasing company turnover; that not-for-profit organizations are excellent for setting up networks because they are trusted, and that innovation networks are perhaps the most difficult, thought-requiring but important of the types of business network conceivable.</p>	Innovation/ Regional business development/ Networking/ Regional economics/ US/ Europe/ Networking practices/ Business network
Cooke, Philip & Wills, David	Small firms, social capital and the enhancement of business performance through innovation programmes	Small Business Economics	Nov-99	3	<p>The paper explores the extent to which social capital is advantageous to small and medium enterprise (SME) growth. Social capital is a communal property involving civic engagement, associational membership, high trust, reliability and reciprocity in social networks. It is capable of being identified in social, political and economic contexts, often associated with strong communities. However, not all strong communities exert the effects of social capital in respect of business activities. This paper assesses government programs to promote collaboration amongst SMEs for improving innovation capacity by increasing social capital through networking. It shows that, for a sizeable proportion of program-funded firms in Denmark, Ireland and Wales (UK), social capital building was associated with enhanced business, knowledge and innovation performance. Of particular importance was the opportunity afforded to firms for linkage with external innovation networks, and the build-up of embeddedness, or the institutional basis for the enhancement of social capital. As a consequence of discovering the advantages of social capital, over a third of respondents planned to continue to develop it in future, in many cases funding such activities privately rather than calling on the public purse.</p>	Small business/ Capital/ Innovations/ Community/ Social services/ Studies

D'Cruz, Joseph R. & Rugman, Alan M.	Business network theory and the Canadian telecommunications industry	International Business Review	1994/9	3	3	<p>Introduces the five partners model of the "business network". Argument that the cooperative, inter-industry and inter-firm relationships of the business network can ameliorate some of the costs found in markets and hierarchies; How the business network is distinguished by a multinational enterprise's asymmetric strategic control over the network; Proposal that it is this asymmetry which facilitates the establishment of credible commitments among the network partners; Information on the business network, as a governance structure, embodies the findings of current research on inter-organizational learning and the embeddedness of economic action in social relations; How, as a case study the authors apply their business network theory to the Canadian telecommunications industry; Challenges faced by the industry in terms of the pace of technological innovation and exposure to global competition; Organisation of Canadian industry participants into the Stentor alliance is evaluated as a nascent business network.</p>	Business networks/ Inter-industry/ Inter-firm/ Credibility/ Embeddedness/ Case study
DeSanctis, Gerardine, Glass, Jeffrey T & Morris Ensing, Ingrid	Organizational designs for R&D	The Academy of Management Executive	Aug-02	16	3	<p>Research and development is becoming increasingly business-oriented, and corporate reliance on new technology and innovation is greater than ever. A study of 14 leading technology-intensive companies in six industries illustrates how three organisational designs are being used to manage distributed, flexible R&D organisations: 1. Decentralized, 2. Networked, and 3. Integrated. Decentralized designs limit the role of a central R&D group; they direct R&D resources more toward products and markets rather than basic scientific activities. Networked designs push the boundaries of R&D outside the confines of a central R&D group and the firm as a whole. Integrated models use sophisticated communication linkages to tie centralized, science-based activities with the business needs of the corporation. Within the three design approaches, there are design variants, each with its positive and negative tradeoffs. Some designs for R&D are more effective than others. Suggestions are provided for how companies in search of an ideal organisation design can select among possible configurations to promote adaptive, value-oriented R&D organizations.</p>	Research & development/ R&D/ Organizational structure/ Studies/ Models/ Statistical analysis
Drakopoulou Dodd, Sarah	Social network membership and activity rates: Some comparative data	International Small Business Journal	Jul/Sep 1997	15	4	<p>Data from the British Household Panel Survey are used to compare levels of social networking as reported by samples of business owners, self-employed and employed respondents. The findings show weak support for Birley et al.'s (1991) argument that the self-employed in general, and business owners in particular, are likely to exhibit higher levels of social networking than their employed counterparts. In terms of both membership and participation rates, the self-employed report very similar patterns and levels of involving in social networks to wage and salary earners.</p>	Studies/ Entrepreneurs/ Employees/ Differences

Ebadi, Yar M & Utterback James M	The Effects of Communication on Technological Innovation	Management Science	May-84	30	5	<p>An examination was conducted of the relationship between communication and technological innovation. Emphasis was placed on the patterns of technical communication among researchers and organizations to determine if these patterns had any effect on the success of technological innovation. The objectives of the study were to: 1. Investigate the effects of communication on technological innovation at an individual level, and 2. Examine the effects of inter-organisational communication on technological innovation. Data were obtained from the principal investigators of 117 Sea Grant research projects, which represented a random sample. Bivariate correlation and partial correlation were used to analyze the data. The results show that at the individual level, the frequency, centrality, and diversity of communication all have positive effects on the success of technological innovation. On the aggregate level, network cohesiveness, centrality, and diversity of communications were found to be positively related to technological innovation.</p>	Technological change/ Scientists/ Researchers/ Problem solving/ Innovations/ Correlation analysis/ Communication
Ebers, M. & Janillo, J. C.	The construction, forms, and consequences of industry networks	International Studies of Management & Organization	1997 Winter 1998 Winter	27	3	<p>Industry networks are a currently popular variation on the old idea of industrial districts. An industry network is a set of organizations that have developed recurring ties when serving a particular market. While industry networks are by no means a new phenomenon, several observers have argued that since the 1980s they have become more prevalent and more important for the strategic management and organisation of firms. Three questions are addressed that relate to inter-organisational networking relations in a number of different industries: 1. Why and how organizations do construct and reshape industry networks? 2. How and with which outcomes do they structure and govern their networking relationships in different ways? 3. How and why membership can in an industry network foster learning and motivation?</p>	Organizational behaviour/ Motivation/ Organizational learning/ Strategic management
Elg, Ulf & Johansson, Ulf	Decision making in inter-firm networks as a political process	Organization Studies	1997	18	3	<p>A political-process-oriented approach to decision making is applied to an asymmetric network of firms, based on the notion of resource interdependencies as the prime motivator of inter-firm exchange, and on a multi-dimensional view of power. Empirically, a paper draws upon a case study of the introduction of a computer-based decision aid in the Swedish food industry. A theoretical model is developed, demonstrating how motives, structural conditions and moves made by powerful as well as more dependent firms interact in shaping the decision process. A central theme is that structural change as well as the adoption of innovations within inter-firm networks is influenced by political activities during the decision process.</p>	Studies/ Decision making/ Food processing industry/ Organizational behaviour/ Inter-company transactions

<p>Erickson, Christopher L & Jacoby, Sanford M</p> <p>The effects of employer networks on workplace innovation and training</p>	<p>Industrial & Labor Relations Review</p>	<p>Jan-03</p>	<p>56</p>	<p>2</p>	<p>If innovative work practices improve performance, why does the intensity of their adoption vary substantially across establishments? Following a lead suggested by some sociological studies, this paper empirically investigates the role of social networks (ties to other organizations) in the organizational learning associated with diffusion of innovative work practices. Using establishment data on formal affiliation and other network measures, it finds that managerial participation in networks - specifically, in industry and cross-industry associations, civic organizations, and the internal networks of multi-unit firms - positively affected both the probability that high-performance work practices and employee training programs would be adopted and, where they were adopted, the intensity of their adoption. Furthermore, multiple affiliations raised the likelihood that an establishment would pursue an intensive approach to work reorganisation and training.</p>	<p>Studies/ Training/ Work environment/ Organizational learning/ Business networking/ Multivariate analysis</p>
<p>Farrow, Paul H., Johnson, Richard R & Larson, Andrea L</p> <p>Entrepreneurship, innovation, and sustainability strategies at Walden Paddlers, Inc.</p>	<p>Interfaces</p>	<p>May/Jun 2000</p>	<p>30</p>	<p>3</p>	<p>Walden Paddlers, a market leader in popularly priced recreational kayaks, used a simple, inexpensive guide to evaluate decisions against a parameter of environmental responsibility. This guide was applied across Walden's virtual corporation structure to yield quick innovations and economic, strategic, and environmental advantages. The guide enabled Walden and its network of partners to produce light, strong, inexpensive kayaks with superior performance characteristics made from 100% recycled plastic, the only such kayaks on the market. Walden also employed the guide to create a nearly waste-free product-packaging-and-shipping system. Walden's decision guide succeeded within a network of collaborative alliances because it was applied comprehensively, it helped to clarify common goals, it created benefits for all participants, and it was implemented by a skilled entrepreneur-leader who coordinated decision making in the network.</p>	<p>Sustainable development/ Case studies/ Kayaking</p>
<p>Ferrary, Michel</p> <p>Managing the disruptive technologies life cycle by externalising the research: Social network and corporate venturing in the Silicon Valley</p>	<p>International Journal of Technology Management</p>	<p>2003</p>	<p>25</p>	<p>1,2</p>	<p>The capability to generate and develop disruptive technologies drives the market in the high-tech sector. Traditional strategic theory recommends internalization of R&D to keep a competitive advantage. The Silicon Valley example points out that the most successful high-tech companies such as Cisco Systems, Intel, and Sun externalize their research by doing corporate venturing. These companies manage their portfolio of technologies by acquiring small businesses that have developed disruptive technologies. This kind of acquisitive strategy needs specific organizational and managerial practices to embed the large company in the industrial-network structure of the Silicon Valley. Thus, managers of innovation have to get a large social capital to gather information inside business networks.</p>	<p>Studies/ Venture capital/ Research & development/ R&D/ Acquisitions & mergers/ High tech industries/ Competitive advantage</p>

Fischer, Manfred M & Varga, Attila	Technological innovation and interfirm cooperation: An exploratory analysis using survey data from the metropolitan region of Vienna	International Journal of Technology Management	2002	24	7,8	This paper centres round two research questions: first, the identification of five types of networks that manufacturing firms located in the metropolitan region of Vienna may have created for different purposes and second, the question to what extent the likelihood of inter firm cooperation is conditioned by the general profile of manufacturing establishments and their technological resources. Although this paper focuses on the manufacturing sector, a special emphasis is placed on the electronics industry. The studies utilize a recent postal survey providing data on size and organization, products and markets, research and development, innovation and inter firm relationships. It appears that metropolitan networking is less common than has been thought. For technical advance spatial proximity does not seem to be very important.	Studies/ Electronics industry/ Business networking/ Regions/ Research & development/ R&D
Florida, Richard & Kenney Martin	Venture Capital and High Technology Entrepreneurship	Journal of Business Venturing	Fall 1988	3	4	Significant differences that exist among the major venture capital complexes, are explained through a typology in which venture capital is concentrated in 3 distinct types of areas. These are: 1. Finance-oriented complexes, such as New York and Chicago, 2. Technology-oriented complexes, such as San Francisco-Silicon Valley, and 3. Hybrids that exist in Boston, Minneapolis, Connecticut, and Texas. The first type of complex has a relatively high proportion of venture capital subsidiaries of financial institutions, and it exports their funds. Technology-oriented complexes contain large proportions of limited partnerships, favour local investment, and attract venture capital from other areas. Enormous incentives for venture capital firms to locate in established technology centres are created there by a high concentration of good deals. Technology- and finance-oriented venture capital complexes have a symbiotic relationship. Well-developed capital networks provide tremendous incentives for start-ups and help create a self-reinforcing cycle of new enterprise formation, innovation, and economic development.	Venture capital companies/ Trends/ Technology/ Regional/ Entrepreneurs/ Differences/ Business conditions
Florida, Richard L. & Kenney, Martin	Venture capital-financed innovation and technological change in the USA	Research Policy	1988/6	17	3	The importance of venture capital-financed innovation to the US economy is reflected in fast-growing, high-technology areas where venture-backed firms have risen to prominence. Venture capitalists actively develop networks made up of financial institutions, universities, large corporations, entrepreneurial companies, and other organizations. This, along with their access to information, allows them to reduce many of the risks associated with new enterprise formation and overcome many of the obstacles that stifle innovation. Venture capitalists also create important links among a variety of organizations that are significant to the innovation process and speed up the process of technological change. The venture capital industry is established in a series of fairly self-contained complexes -- technology-oriented, financial-oriented, and hybrid -- that play distinct parts in the process of venture capital-financed innovation. Venture capital establishes strong incentives for "breakthroughs" as opposed to other types of innovation.	Venture capital/ Growth/ Networks/ Innovation process/ Complexes

Free, Mark S	Sectoral patterns of small firm innovation, networking and proximity	Research Policy	May-03	32	5	<p>Drawing upon a sample of 597 small and medium-sized manufacturing firms, this paper investigates the extent to which cooperation for innovation is associated with firm-level product and process innovativeness and, where collaborative relationships are reported, the factors which influence their spatial distribution. With respect to the former issue, the data suggests considerable variety of association across Pavitt's (1994) sectoral taxonomy and innovation type. However, the data also indicates the need for caution when developing network strategies or policies: the evidence presented here is unequivocal in noting that innovation is neither a necessary nor less a sufficient condition for innovation. Moreover, internal resources often act as complements to, or indeed appears to negate the need for, external resources. With regards to the spatial distribution of firm linkages, it appears that increasing firms size and export propensity are positively associated with external linkages at a higher spatial level. Moreover, the spatial reach of innovation-related linkages is also likely to be greater for firms reporting the introduction of relatively novel innovations (i.e. products or processes which are new to the industry). In contrast, smaller firms and firms engaged in incremental product innovations appear more likely to be locally embedded.</p>	Studies/ Small business/ Manufacturers/ Research & development/ R&D/ Organizational behaviour/ Product development
Frenken, Koen	A complexity approach to innovation networks. The case of the aircraft industry (1909-1997)	Research Policy	Feb-00	29	2	<p>Successful innovation depends on complementary competencies in networks of producers, users, and governmental bodies. The effects of complementarities within innovation networks are modelled using Kauffman's NK-model. From the model, the hypothesis is derived that producers, users, and governments self-organize in specialized innovation networks: producers of particular technologies increasingly focus on particular user markets in particular countries. Data on 863 aircraft models (1909-1997) show these strong specialization patterns in the post-war period. Policy implications are indicated emphasizing the recent rise in transnational collaborations, which can be understood as a means of escaping historical specialization patterns.</p>	Mathematical models/ Aircraft industry/ Research & development/ R&D/ Studies
Fritsch, M.	Co-Operation in Regional Innovation Systems	Regional Studies	2001 Jun	35	4	<p>The paper deals with co-operative relationships of manufacturing firms in three German regions. By applying a hurdle-count data model, differences between regions as well as between smaller and larger firms are analysed. The differences between regions regarding the propensity of firms to co-operate are mainly due to peculiarities of the small business sector. Spatial proximity is obviously of particular importance for horizontal co-operation and for relationships to publicly funded research institutions. The link between the cooperative behaviour of firms and the performance of the regional innovation system remains, however, unclear.</p>	Cooperative relationships/ Regions/ Small businesses/ Spatial proximity/ Innovation system

Furtado, Andre	The French system of innovation in the oil industry some lessons about the role of public policies and sectoral patterns of technological change in innovation networking	Research Policy	Jan-97	25	8	<p>The central issue is to show the importance of public policies and sectoral patterns of technological change for institutional interaction in National Systems of Innovation (NSI), from the illustrative case study of French oil industry. This case is a relevant example of the French style of public policy, more well known as Colbertism. In the oil industry, Colbertism has demonstrated a greater ability to overcome some of its main challenges related to a weaker diffusion propensity and to a excessive concentration of R&D funds in some strategic sectors. The study of this industry demonstrates that sectoral patterns of technological change are very important to explain institutional interaction. Differences in the degree of appropriability between up and downstream of the oil industry had a great influence in this interaction and in public policies effectiveness. However, the technological diffusion success was not only due to some favourable technological factor but also to the nature of decision making, which was the outcome of a cooperative process.</p>	Studies/ R&D/ Innovations/ Industrial research/ Petroleum industry/ Public policy/ Technological change/ Decision making
Fusfeld, Herbert I & Haklisch Carmela S	Collaborative Industrial Research in the U.S.	Technovation	Feb-87	5	4	<p>Both the private research and development (R&D) within individual firms and collaborative R&D among firms contribute to the competitive position of the firm. It is argued that collaborative research in the US continues to complement, and not replace or diminish, the competitive activity and independence of participating companies. Now more than ever, companies are prepared to accept collaborative activities for the earlier, more generic, parts of the R&D spectrum. They are supplementary to the dominant corporate R&D. Although they add only marginally to the total level of R&D for the industries involved, they serve to strengthen networks for access to external activity. Collaborative activity also has stimulated graduate activity at universities. Finally, it is shown that the perception of science policymakers in the late 1970s concerning the slipping of technical status created a political climate favourable to these activities.</p>	R&D/ Joint/ Innovations/ Industrial research/ History/ Competition
Gales, Lawrence M. & Boynton, Andrew C.	Information ties and innovation management: A qualitative assessment of information processing and the strength of weak ties	The Journal of High Technology Management Research	1992/0	3	2	<p>In a qualitative study of eight space research innovation projects, we find support for using Granovetter's (1973, 1982) conceptualization of the strength of weak ties to assess the information-processing capacities of networks of relationships. We find that with increasing uncertainty networks are more likely to be weak tie networks. However, the most uncertain and equivocal projects tend to have small networks of relationships due to the lack of cohesiveness of the research domain.</p>	Space industry/ Networks/ Relationships/ Uncertainty/ Cohesiveness

Garofoli, G & Musyck, B.	Innovation policies for SMEs in Europe: Towards an interactive model?	Regional Studies	Dec-01	35	9	A typology of policy tools for the promotion of innovation in European small and medium enterprises (SMEs) is proposed. The different categories of schemes reflect the main weaknesses of SMEs in the fields of finance, information, advice and human resources. Most policy tools can be labelled as relatively conventional, i.e. they do not take into foster learning processes, additionality and networking. While the literature emphasizes the necessity to strengthen external economies to foster innovation and competitiveness, through the construction of a local and regional system of innovation, it seems that relatively few regional policy makers have taken on board these theoretical reflections. The article argues for a systematic approach to introduce strategic innovation planning at the local level.	Studies/ Policy making/ Small business/ Innovations
Gemser Gerda, Leenders Mark A A & Wijnberg Nachoem M	The dynamics of inter-firm networks in the course of the industrial life cycle: The role of appropriability	Technology Analysis & Strategic Management	Dec-96	8	4	A paper examines the dynamics of inter-firm networks and introduces a conceptual framework for explaining why inter-firm networks change over time. The framework is based on the idea that patterns of inter-firm linkages are lined to the lifecycle development of an industry. Special emphasis is placed on the role of appropriability, i.e., a firm's ability to capture the profits generated by its innovations. The (trans)formation of inter-firm networks in 3 industries is examined and used to illustrate the relevance of the framework. One important inference from the study is that public policy makers and managers should take into account the phase of industry development before implementing policies to create and/or change inter-firm networks.	Studies/ Affiliates/ Business cycles/ Trends/ Competitive advantage/ Policy making/ Organization theory/ Innovations
Gemunden H G, Heydebreck P & Herden R	Technological Interweavement: A Means of Achieving Innovation Success	R & D Management	Oct-92	22	4	An empirical study of Europe's Lake Constance region covered a sample of 848 manufacturing companies. Based upon multivariate analyses, it is documented that the mobilization of external resources and know-how is a critical factor for a firm's technological innovation success, which in turn is the main determinant of commercial innovation success. These findings show that there are 3 kinds of technology-oriented external relationships that prove to be of special importance: 1. Close contacts with customers, 2. Linkages to universities and research institutes, and 3. Research and development co-operations with other companies. The findings indicate that relationships must not be regarded in isolation, but that it is necessary to coordinate the relationships through network management. Seventy-five percent of the companies in the sample believe that dialogues with their customers had been at least helpful for the development of technically improved or new products or production processes.	Studies/ R&D/ Multivariate analysis/ Manufacturers/ Innovations/ Hypotheses

Gemunden Hans Georg, Ritter Thomas & Heydebreck Peter	Network configuration and innovation success: An empirical analysis in German high-tech industries	International Journal of Research in Marketing	Dec-96	13	5	Based on the assumption that intensity and structure are the most important dimensions of a firm's technological network, a study identifies 7 different types of technology-oriented network configurations. Drawing upon a database of 321 high-tech companies, it is shown that innovation success is significantly correlated with a firm's technological network. Product and process innovations are shown to demand different types of network configurations.	Network topologies/ Innovations/ Market strategy/ High technology
Glasmeyer, Amy	Technological discontinuities and flexible production networks: The case of Switzerland and the world watch industry	Research Policy	1991/10	20	5	The 20th-century history of Switzerland's watch industry illustrates how cultures and industrial production systems experience great difficulty adapting to external change at different points in time. The current emphasis on production networks - unique reservoirs of potential technological innovation realized through cooperation rather than competition among firms - lacks a detailed appreciation of historic networks and, in particular, their fragile character in times of economic turmoil. While networks can and do promote innovation within an existing technological framework, historical experience suggests that their fragmented, atomistic structure is subject to disorganisation and disintegration during periods of technological change. The Swiss loss of control of the world watch industry must be understood from the standpoint of how technological change challenges previous ways of organizing production, industry, culture, and society.	Switzerland/ Watch industry/ Production systems/ Production networks/ Historic networks/ Organizing production
Grabber, G.	Ecologies of Creativity: the Village, the Group, and the Heterarchic Organisation of the British Advertising Industry	Environment and Planning a	2001 Feb	33	2	In the 1980s, the hegemony of the large US advertising networks has been challenged by a new breed of London-based agencies who pioneered what is known in the trade as 'second wave'. On the one hand, second wave implied the emancipation of Soho from an 'outpost of Madison Avenue' to the 'advertising village' on the basis of momentous product and process innovations. On the other hand, a few London agencies rose to global top positions on the crest of the second wave by transforming themselves from international advertising networks into global communication groups. This paper starts from the assumption that both, the localised cluster of advertising agencies in the advertising village (the 'Village') and the global communications group (the 'Group'), share basic principles of social organisation. It aims at demonstrating that the organisational logic of both the Village and the Group can be conceptualised in terms of a heterarchy. By drawing on case-study evidence from Soho on the one hand and from the world leading communications business, WPP, on the other, the five basic features of heterarchies - diversity, rivalry, tags, projects, and reflexivity - will provide the conceptual tools for the investigation into the social organisation of the Village and the Group.	Advertising networks/ Second wave/ Product innovation/ Process Communication groups

Grandori Anna & Soda Giuseppe	Inter-firm networks: Antecedents, mechanisms and forms	Organization Studies	1995	16	2	A discussion reviews and organizes the now vast literature on inter-firm networks, with the aim of assessing the important current forms of network, the organizational mechanisms supporting them, and the main variables that have been shown to influence network emergence and shape. A literature review is undertaken encompassing a number of approaches across the social sciences. The discussion can therefore be used as a typological state-of-art on inter-firm networks, and as a basis for developing hypotheses of relationship between network antecedents and forms.	Social sciences/ Organizational structure/ Organizational behaviour/ Organization theory
Grandori, Anna	An organizational assessment of interfirm coordination modes	Organization Studies	1997	18	6	Inter-firm relationships are coordinated to a large extent by non-market mechanisms. The purpose of a study is to identify which of these mechanisms are the most relevant, and how they can be theoretically and empirically combined into discrete alternative modes of organizational coordination between firms. By analyzing network forms as mixes of coordination mechanisms, a framework offers a typology of inter-firm organisation forms that is much more fine-grained and conducive to network organisation design than those previously available. The predictive power of the framework is demonstrated by using the vast empirical research available on various types of networks, showing its capacity to explain the main findings on the use of different network forms for governing different types of relations.	Organisation theory/ Studies/ Models/ Business networking
Grotz, Reinhold & Braun, Boris	Territorial or trans-territorial networking: Spatial aspects of technology-oriented co-operation within the German mechanical engineering industry	Regional Studies	Aug-97	31	6	Grotz and Braun examine the relevance and viability of innovation-oriented networks of small and medium sized enterprises in three differently structured industrial environments in Germany based on in-depth interviews of the mechanical engineering industry and with regional innovation consultants.	Industry-wide conditions/ Mechanical engineering/ Regions/ Innovations
Gulati, R.	Alliances and networks	Strategic Management Journal	1998 Apr	19	4	A paper introduces a social network perspective to the study of strategic alliances. Five key issues for the study of strategic alliances are identified: 1. the formation of alliances, 2. the choice of governance structure, 3. the dynamic evolution of alliances, 4. the performance of alliances, and 5. the performance consequences for firms entering alliances. Some of the new insights that result from introducing the network perspective are discussed	Studies/ Strategic management/ Alliances/ Research/ Social psychology

<p>Gulati, R.</p> <p>Network location and learning: The influence of network resources and firm capabilities on alliance formation</p> <p>Strategic Management Journal</p> <p>1999 May</p> <p>20</p> <p>5</p> <p>Alliances/ Resource management/ Management science/ Correlation analysis/ Studies</p>	<p>A dynamic, firm-level study of the role of network resources in determining alliance formation is presented. Such resources inhere not so much within the firm but reside in the inter-firm networks in which firms are placed. Data from extensive fieldwork show that by influencing the extent to which firms have access to information about potential partners, such resources are an important catalyst for new alliances, especially because alliances entail considerable hazards. The importance of firms' capabilities with alliance formation and material resources as determinants of their alliance decisions is assessed. This dynamic framework and its hypotheses about the role of time-varying network resources and firm capabilities is tested with comprehensive longitudinal multi-industry data on the formation of strategic alliances by a panel of firms between 1970 and 1989. The results confirm field observations that accumulated network resources arising from firm participation in the network of accumulated prior alliances are influential in firm's decisions to enter into new alliances.</p>
<p>Haar, Nancy E., Starr, Jennifer & MacMillan, Ian C.</p> <p>Informal risk capital investors: Investment patterns on the East Coast of the U.S.A.</p> <p>Journal of Business Venturing</p> <p>1988/0</p> <p>3</p> <p>1</p> <p>Investors/ Referral networks/ Informal investors/ US/ Business angels</p>	<p>An attempt is made to profile a group of informal investors, their investment criteria, and the nature of their referral network. Data are from 320 responses to a mailing of some 2,989 questionnaires, and the sample includes informal investors identifiable from 17 states. The results indicate the existence of an extensive informal investment community on the East Coast of the US, which can provide substantial resources to start-ups and young firms. Many of these so-called "angels" claim they have achieved higher returns via angel activity than through other investment options. Unlike capital firms, angels are not interested in competitive insulation, and they do not limit their investments to industries that are appealing or with which they are familiar. Their referral network is composed mainly of friends and business colleagues. Discriminant analysis reveals that informal investors should select only ventures in which the entrepreneur can evaluate and manage the risks of the venture.</p>
<p>Hanna, Victoria & Walsh, Kathryn</p> <p>Small firm networks: A successful approach to innovation?</p> <p>R & D Management</p> <p>Jun-02</p> <p>32</p> <p>3</p> <p>Partnering/ Small business/ Research & development/ R&D/ Cooperation/ Many countries</p>	<p>This paper considers the increasing trend of inter-working among small firms. Networks of small firms co-operate in certain activities, such as marketing, purchasing, R&D, training or manufacturing. But does co-operation lead to innovation? To answer this question published evaluations of small firms co-operating for mutual benefit are reappraised. Inter-working among small firms is then investigated further by interviewing 3 network brokers. Regional governments funded the brokers and they facilitated co-operation between small firms. These semi-structured discussions explored the key characteristics of successful networks, the responsibilities of the broker and the level of innovation occurring. Networking is primarily a competitive response. It needs to evolve into a mechanism to enable small firms to develop innovative products and processes jointly. Small firms may have to rethink their approach to cooperation, and their motives for initiating inter-working if they are to benefit fully from co-operation.</p>

Hara, George & Kanai, Toshihiro	Entrepreneurial networks across oceans to promote international strategic alliances for small businesses	Journal of Business Venturing	1994/11	9	6	For small independent firms, the creation of alliances across national boundaries is a social event that relies upon the building and nurturing of a series of entrepreneurial networks. In countries as culturally diverse as Japan and the US, this may be realized through the use of gatekeepers who facilitate the creation of a network-of-networks. The creation of a successful international strategic alliance between the technology-based companies of Kinei in Japan and 3 companies in Silicon Valley, US is analyzed. From the case study several conclusions are made, including: 1. International strategic alliances between small firms can be more symmetric than those between large and small firms. 2. Even if national cultures are starkly different, there are common features that characterize technology-based businesses regardless of their country of origin.	Small firms/ Alliances/ Entrepreneurial networks/ Gatekeepers/ Japan/ US/ Culture
Harding, Rebecca	Venture capital and regional development: towards a venture capital 'system'	Venture Capital	2000	2	4	This paper provides a critical review of UK government proposals to develop venture capital funds in the English regions to address the 'equity gap'. It argues that there is currently an adequate supply of equity-type funding under £250,000. The real equity gap is between the more informal, packaged finance structures and the formal venture capital market that is dominated by MBOs and MBIs. It is argued that the creation of strong venture capital markets in the regions requires close co-ordination between all the various actors in the system at regional and national levels. Regional Development Agencies have the tools to enable them to perform this co-ordinating task.	Venture capital/ Equity gap/ Regional Development Agencies/ Regional policy/ Business Angels
Hargadon, A & Sutton, R. I.	Technology Brokering and Innovation in a Product Development Firm	Administrative Science Quarterly	1997	42	4	We blend network and organizational memory perspectives in a model of technology brokering that explains how an organisation develops innovative products. The model is grounded in observations, interviews, informal conversations, and archived data gathered during an ethnography IDEO, a product design firm. This firm exploits its network position, working for clients in at least 40 industries.	Network/ Organisational memory/ Network exploitation/ New products
Harris, Lisa, Coles, Anne-Marie & Dickson, Keith	Building innovation networks: Issues of strategy and expertise	Technology Analysis & Strategic Management	Jun-00	12	2	This paper investigates the role of networks in new product development by reporting on a contemporary case study of a firm in the defence electronics sector. A specific focus is the development and ongoing management of a network that comprises a number of formal inter-firm strategic alliances. The paper begins by reviewing earlier literature on technology strategies for innovation that has identified a key role for inter-firm networking in the organisation and management of new product development. It is concluded that while inter-firm networking can facilitate new product development across firm boundaries, it is not a panacea for success.	Studies/ Innovations/ Strategic management/ Product development/ Defence industry/ Alliances

<p>Harrison Richard & Mason, Colin</p>	<p>Developments in the promotion of informal venture capital in the UK</p>	<p>International Journal of Entrepreneurial Behaviour & Research</p>	<p>1996</p>	<p>2</p>	<p>2</p>	<p>The majority of small to medium-sized enterprises (SMEs) in the UK rely on self-financing supplemented in most cases by bank overdrafts and loans and trade credit. There is a widespread perception among SME owner-managers that there is a shortage of external capital, particularly equity capital. Harrison and Mason offer a brief review of the equity gap debate in the UK and summarize some of the major private and public sector initiatives designed to stimulate the supply of equity finance as a context for their main objective, which is critically to review initiatives in the UK to promote informal venture capital. If the supply of informal venture capital in the UK is to be increased, there is a need for continued local intervention and support from the public sector to ensure that a complete network of local and regional business angel networks (BANs) exists to meet the needs of both companies and investors.</p>	<p>Venture capital/ Economic development</p>
<p>Harrison, Richard T. & Mason, Colin M.</p>	<p>International perspectives on the supply of informal venture capital</p>	<p>Journal of Business Venturing</p>	<p>1992/11</p>	<p>7</p>	<p>6</p>	<p>Using data obtained from a combination of postal survey and snowball sample techniques, a recent study examined the informal venture capital market in the UK and compared the characteristics and behaviour of informal investors in the UK and North America. Although similar to their US counterparts in demographics (with the exception of age), UK informal investors invest less, operate independently rather than in syndicated investments, have somewhat higher rate of return and capital gain expectations, and are less satisfied overall with the performance of their portfolios. UK investors also receive more information on and seriously consider more investment opportunities than US investors, but they do not make any more investments than their US counterparts. Overall, in comparison to the US market, the UK venture capital market appears to operate less effectively thereby reducing its potential contribution to venture financing.</p>	<p>Venture capital/ UK/ USA/ North America/ Informal investors/ Business angel</p>
<p>Hausler Jurgen, Hohn Hans-Willy & Lutz Susanne</p>	<p>Contingencies of innovative networks: A case study of successful R & D collaboration</p>	<p>Research Policy</p>	<p>Jan-94</p>	<p>23</p>	<p>1</p>	<p>Trust among partners is an essential prerequisite in inter-firm R & D collaboration. An analysis considers this issue and examines the preconditions under which the establishment of trust among companies becomes possible. A case study of a successful cooperative research project reveals trust-building as a modular, cascade-like process. Initially a wider scientific-technical network was established including all industrial and scientific actors who could be potentially interested in solving the technological problem at hand. The process ended with a smaller group of researchers from a few companies and scientific institutes cooperating in a government-sponsored R & D project. At each stage of this highly contingent process, the intervention of public officials helped rendering cooperation successful.</p>	<p>Studies/ R&D/ Industrial research/ Factors/ Cooperation/ Alliances</p>

Hendry, Chris Brown, James & DeFillippi, Robert	Regional clustering of high technology-based firms: Opto-electronics in three countries	Regional Studies	Apr-00	34	2	Industrial districts are seen as generating significant advantages in production and innovation. However, the way concentrations of firms actually relate to one another is often assumed. This paper draws on an international study into the opto-electronics industry to examine the extent and significance of localized inter-company trading and network relationships in six regions. National and international relationships are found to be much stronger than local ones. This is a function of customer and supplier markets, which derive from the technological characteristics of the industry and the way its markets have been created. Such factors are important for understanding the potential for the development of industrial districts in high technology sectors.	Studies/ Economic development/ High tech industries/ Regions/ Cluster analysis
Hislop, Donald, Newell, Sue, Scarborough, Harry & Swan, Jacky	Networks, Knowledge and Power: Decision Making, Politics and the Process of Innovation.	Technology Analysis & Strategic Management	Sep-00	12	3	Examines the political nature of innovation appropriation processes. Role of networks, networking and knowledge in these processes; Implementation of the Enterprise Resource Planning systems in Pharma-co and Cast-co; Conclusions.	TECHNOLOGICAL innovations; APPROPRIATE technology
Hoang, Ha & Antonci, Bostjan	Network-based research in entrepreneurship: A critical review	Journal of Business Venturing	2003/3	18	2	Network-based research in entrepreneurship is reviewed and critically examined in 3 areas: content of network relationships, governance, and structure. Research on the impact of network structure on venture performance has yielded a number of important findings. In contrast, fewer process-oriented studies have been conducted and only partial empirical confirmation exists for a theory of network development. In order to address unanswered questions on how network content, governance, and structure emerge over time, more longitudinal and qualitative work is needed. Theory building in this field would benefit also from a greater integration between process- and outcome-oriented research.	Network/ Entrepreneurship/ Governance/ Relationships
Hobday, Mike	The limits of Silicon Valley: A critique of network theory	Technology Analysis & Strategic Management	1994	6	2	During the 1980s, the idea of the dynamic network was put forward as a new model of flexible production and applied to Silicon Valley, the home of the US semiconductor industry. An analysis is undertaken to show that the Silicon Valley network, a collaborative group of high-technology firms, is incapable of realizing the main rewards from its innovations. Although the dynamic network may be appropriate for the early stage of the product life cycle, it lacks the necessary complementary assets to secure the profits generated during the growth and maturity stage. The network lacks the scale-intensive process capabilities, the global marketing outlets, and the large financial resources needed to capture the rewards from mass-market innovations. These assets, by necessity, tend to be embodied in large integrated corporations. A simple model is offered to show the limits of the network form compared with the integrated corporation. During the 1990s, large firms will continue to capture the profits from innovation.	Technological change/ Studies/ Semiconductors/ R&D/ Product life cycle/ Innovations/ Industry-wide conditions/ Critiques

Holbrook, Daniel	Government support of the semiconductor industry: Diverse approaches and information flows	Business and Economic History	Winter 1995	24	2	Government funding of industrial R&D has received a great deal of attention from scholars in a number of disciplines. The microelectronics industry in particular has attracted a considerable amount of investigative effort. Government support for the microelectronics industry in the 1950s consisted of more than simply providing a market for the industry's output and building a trained personnel pool. The government established an atmosphere conducive to innovation on a wider base than the lure of large procurements and R&D contracts. The actions of various government agencies served to expand and reinforce existing information exchange networks. Diverse information moved over these channels. Urgent economic and competitiveness problems do exist, and technology resides at the centre of many of them. Furthering diversity and dissemination seems only prudent.	Semiconductors/ Industrial research/ History/ Government spending/ Electronics industry
Huggins, R.	Local Business Co-Operation and Training Councils: the Development of Inter-Firm Networks	Regional Studies	1998 Dec	32	9	Awareness among Training and Enterprise Councils (TEC) and firms in the UK of inter-firm networking, and the effectiveness of the instruments used by TECs to generate networking are investigated. The consequential outputs of and barriers to networking, the level of involvement encountered, and existing regional disparities are evaluated. An attempt is made to obtain the opinions and views of as wide range of the 81 TECs in England and Wales as possible; therefore a postal survey approach was adopted which yielded 63 replies. Evidence is found that, despite TECs being committed toward the development of inter-firm networking, this commitment does not equate with the perceived success of those networks that have been facilitated. The analysis suggests that the performance of TECs as network generators has been low by their own expectancy criteria. The most common and important output of networks was their role in aiding collaborative learning among businesses, and process developments involving the dissemination of best practice and benchmarking through programs such as manufacturing and management development initiatives.	TEC/ UK/ Inter-firm networks/ Barriers/ Regional/ Performance/ Failure
Hung-bin Ding & Lois S Peters	Inter-firm knowledge management practices for technology and new product development in discontinuous innovation	International Journal of Technology Management	2000	20	5,6,7,8	By reviewing the literature on knowledge management practices, this article suggests that knowledge management practices vary from one organisation to another. The variety of corporate knowledge management practices attribute to distinct organizational settings, and technology domains in the context of technology and new product development. It is proposed that the different types of inter-firm collaborative networks are established to fulfil specific knowledge management requirements for divergent technology and new product development in discontinuous innovation.	Studies/ Knowledge management/ Product development/ Innovations

Hyun, J. H.	Buyer Supplier Relations in the European Automobile Component Industry	Long Range Planning	1994 Apr 27	2	Dramatic changes in the business environment are demanding flexibility and innovativeness. These capabilities can often be achieved more effectively through external networks, rather than by internal arrangements, in the company that assembles the final product. In the automobile industry, where a large number of parts are assembled and many suppliers are involved, the role of suppliers is important in developing competitive advantages. Consequently, the development and operation of a world-class industry network needs to be incorporated into the strategic planning process. Supplier relationships in the European automobile components industry are investigated to determine what the key factors are in developing a supply network. How supplier networks are likely to develop in the future is also discussed.	Flexibility/ Innovativeness/ External networks/ Automobile industry/ Supplier relationships	
Ivarsson, I.	Transnational Corporations and the Geographical Transfer of Localised Technology: a Multi-Industry Study of Foreign Affiliates in Sweden	Journal of Economic Geography	2002 Apr 1	2	Presents a study that analyzed the extent to which foreign-owned affiliates of transnational corporations in Sweden generate technological competencies both internally as well as through cooperation with external business partners. Role of services and technological integration; Determinants for technological integration; Extent of technological competencies being transferred back to parent corporations; Analysis of some important determinants for technological integration.	Sweden/ Transnational corporations/ Technological integration/ Networking	
Izushi Hiro	Conflict between two industrial networks: Technological adaptation and inter-firm relationships in the ceramics industry in Seto, Japan	Regional Studies	Apr-97	31	Izushi examines the technological adaptation by small and medium sized firms in a Japanese district of traditional ceramics manufacturing, which has moved into high technology applications. Izushi suggests that external ties to semi-vertically integrated networks prevailing in Japanese industries endanger the existence of innovative networks in an old industrial region asserted by traditional literature on industrial districts.	Technology/ Traditions/ Regions/ Ceramics industry	
Jacquier-Roux Virginie & Bourgeois, Bernard	New networks of technological creation in energy industries: Reassessment of the roles of equipment suppliers and operators	Technology Analysis & Strategic Management	Dec-02	14	4	Energy industry companies have succeeded in maintaining and even increasing their production of knowledge during the last 15 years (1985/1990) within a financial context of reducing their in-house R&D expenditures. To understand these apparently paradoxical changes, elements of analysis are sought within an evolutionary framework, and especially referring to the related developments to network-firms, user-supplier relationships, and interactive nature of innovation processes. Empirical data are provided on patents granted to a sample of the top 15 world largest companies, both operators and equipment suppliers, and for the oil production and power generation industries. Interpretation of the results suggests that 2 dynamics ought to be distinguished. On the one side, dynamics of the networks of technological creation are characterized by a movement upstream of the head of the network towards suppliers. On the other side networks of creation of competitive advantages and bargaining power continue to be based on the operators and their strategies of adaptation to the constraints and opportunists of their institutional, financial and competitive environment.	Knowledge management/ Energy industry/ Research & development/ R&D/ Studies/ Competitive advantage

<p>Janne, Odile E. M.</p> <p>The emergence of corporate integrated innovation systems across regions: The case of the chemical and pharmaceutical industry in Germany, the UK and Belgium</p>	<p>Journal of International Management</p>	<p>2002</p>	<p>8</p>	<p>1</p>	<p>This paper examines the sub-national, regional, aspects of the multinational corporations' (MNCs) increasingly global innovative networks in the chemical and pharmaceutical industry. Using patents granted in the US to the largest industrial firms, attention is restricted to the main European MNCs and their research activities established in German, British and Belgian regions. The position of national groups of firms in a geographical hierarchy has been argued to affect the technological strategy and specialisation of those groups in foreign countries [Res. Policy 28 (1999) 119]. This paper extends the argument at the regional level, allowing for a hierarchy of regional host centres and investigating where and how MNCs of different nationality organise their networks for innovation in those regions. The main proposal is that the technological specialisation of foreign-owned affiliates in each region will become more closely related to the regional indigenous specialisation pattern the higher the position of their parent firms' country of origin in the national hierarchy is, and the lower the position of the regional host location in the regional hierarchy is. Conversely, when MNCs originating from a lower-order country locate research facilities in a higher-order country and regional centre, their affiliates are expected to show a tendency to replicate their domestic established lines of specialisation. This paper highlights the potential impact of the dynamic interactions between MNCs and their home and host locations on the technological performance of both the firm and its local environment.</p>	<p>MNC/ Multinational/ Networks/ Chemical industry/ Pharmaceutical industry/ Patents/ US/ German/ UK/ Belgian/ Regions/ Technological strategy</p>
<p>Juniper, Christopher, Moore, Maggie</p> <p>Synergies and Best Practices of Corporate Partnerships for Sustainability</p>	<p>Corporate Environmental Strategy</p>	<p>2002/8</p>	<p>9</p>	<p>3</p>	<p>Sustainability requires that problems be solved in a whole systems context. Corporations are increasingly finding that local/regional/state level partnerships provide whole systems solutions and unexpected benefits. Partnerships generally support four sustainability strategies: (1) Environmental Restoration of natural capital; (2) Community Development of human and social capital; (3) Regulatory/Standards Development; and (4) Learning Communities. Partnerships tend to become forms of learning communities if the efforts move beyond the corporate environmental staff. The partnerships consistently lead to unexpected benefits, whether it be international sales leads from a totally locally-focused network, innovative practices such as home ownership support programs, or analysis tools leading to cooperative solutions for contentious issues. Corporations are consistently pleased with results of partnerships. Best practices include utilization of self-organizing whole systems approaches, transparency, and business-sector leadership. Specific partnership stories of Steelcase Inc., Wacker Siltronic, Stonyfield Farm, Starbucks, BC Hydro and Suncor are described.</p>	<p>Sustainability/ Regional systems/ Partnerships/ Local networks/ Innovative practices/ Cooperation</p>

<p>Jurgen Peters & Wolfgang Becker</p>	<p>Vertical corporate networks in the German automotive industry: Structure, Efficiency, and R&D spillovers</p>	<p>International Studies of Management & Organization</p>	<p>Winter 1997/1998</p>	<p>27</p>	<p>4</p>	<p>Lead-time as well as high quality are very important factors in the automobile industry. Being the first to innovate with a new product with a high technological standard requires intensive R&D competition not only between independent automakers but also between vertical corporate networks. These networks are based on the level of manufacturer-supplier relationships and are strategically led by core automakers. A paper aims to analyze the role of R&D spillovers between automakers and suppliers in vertical corporate networks, both theoretically and empirically. The effects of R&D competition are formalized between 2 vertical corporate networks. A 2-industry model is used in which higher R&D activities lead to an earlier expected introduction of a given innovation and are distributed across manufacturer and supplier firms within vertical corporate networks. The empirical analysis focuses on the importance and effects of R&D spillovers in vertical corporate networks, based on data from a sample survey carried out in the German automobile industry in 1995. It is shown that R&D spillovers, strategically transferred from the manufacturers to the suppliers, have higher impacts on the innovative activities and success of suppliers belonging to corporate networks than in the case of non-members.</p>	<p>Vertical integration/ Automobile industry/ R&D/ Vendor supplier relations/ Competition/ Studies/ Discriminate analysis</p>
<p>Kadama, M.</p>	<p>Creating new businesses through a strategic innovation community - Case study of a new interactive video service in Japan</p>	<p>International Journal of Project Management</p>	<p>May-02</p>	<p>20</p>	<p>4</p>	<p>In the past few years, the market for video terminals such as videoconferencing systems and video phones typified by multimedia and the market for multipoint connection services that use these devices have been growing rapidly in Japan. In the background to this growth is an innovation community with Nippon Telegraph and Telephone Corporation (NTT), Japan's largest telecommunications company, and NTT Phoenix Network Communications, Inc. (NTT Phoenix), a joint venture established by a strategic alliance between the US and Japan. This innovation community has created a new market known as Interactive Video Communication and has been doing much to promote it. This paper examines the world's largest multipoint connection video multimedia businesses.</p>	<p>Video teleconferencing/ Video equipment/ Telecommunications industry/ Project management/ Innovations/ Interactive media/ Studies</p>
<p>Kasarda, J. D. & Rondinelli, D. A.</p>	<p>Innovative Infrastructure for Agile Manufacturers</p>	<p>Sloan Management Review</p>	<p>1998 Winter</p>	<p>39</p>	<p>2</p>	<p>Increased global competition means that industry and government must work together to ensure that manufacturers have support networks of transportation, telecommunications, services, and knowledge centres. Speed-to-market, agile manufacturing, and the virtual corporation reflect an increasing awareness that competing successfully in the global economy will require extensive changes in the way US corporations operate. An article identifies the components of the logistical support system that are needed to stimulate agile manufacturing, describes the reactive approaches of US industry groups, cities, and government agencies, and examines the strategic integration of the components into a unified business support system, such as the Global TransPark experiment in North Carolina.</p>	<p>Manufacturing/ Support networks/ Knowledge centres</p>

Kash, D. E.& Rycroft, R.	Emerging Patterns of Complex Technological Innovation	Technological Forecasting and Social Change	2002 Jul 69	6	<p>Technological innovation is increasingly concerned with complex products and processes. The trend toward greater complexity is suggested by the fact that in 1970 complex technologies comprised 43% of the 30 most valuable world goods exports, but by 1996 complex technologies represented 84% of those goods. These technologies are innovated by self-organizing networks. Networks are those linked organizations that create, acquire, and integrate the diverse knowledge and skills required to innovate complex technologies. Accessing tacit knowledge (i.e., experienced-based, unwritten know-how) and integrating it with codified knowledge is a particular strength of many networks. Self-organisation refers to the capacity networks have for reordering themselves into more complex structures (e.g., replacing individual managers with management teams), and for using more complex processes (e.g., evolving strategies) without centralized, detailed managerial guidance. Case studies of the innovation pathways traced by six complex technologies indicate that innovations can be grouped into three quite distinct patterns. Transformation: the launching of a new trajectory by a new coevolving network and technology. Normal: the co-evolution of an established network and technology along an established trajectory. Transition: the co-evolutionary movement to a new trajectory by an established network and technology. Policy makers and managers face the greatest challenge during those periods of movement from one innovation trajectory to another. These are periods of turbulence; they are the embodiment of Schumpeter's "gales of creative destruction." This paper investigates how, in six case studies, core capabilities, complementary assets, organizational learning, path dependencies, and the selection environment varied among the innovation patterns. The paper builds on work reported in a recent book by the authors entitled: <i>The Complexity Challenge: Technological Innovation for the 21st Century</i>, Pinter, London, 1999.</p>	Technological innovation/ Complexity/ Self-organizing networks/ Tacit knowledge/ Case studies
Kash, Don E & Rycroft, Robert W	Patterns of innovating complex technologies: A framework for adaptive network strategies	Research Policy	Aug-00 29	7,8	<p>Self-organizing networks have become the dominant innovators of complex technologies. This paper presents a framework that offers insight into the 3 distinctive patterns of innovation that are evident in the evolution of six technologies. It is at those points that networks must change from one pattern to another and that major adaptations in company strategies and public policy are required. Four indicators of pattern changes are discussed. Effective strategies and policy would benefit from the development of a different set of concepts and the science of complexity offers some of those concepts.</p>	Studies/ Innovations/ Technological change/ Computer networks

Kaufmann, Alexander & Todtling, Franz	Science-industry interaction in the process of innovation: The importance of boundary-crossing between systems	Research Policy	May-01	30	5	Applying recent theoretical concepts of social systems to innovation networks of firms leads to the presumption that linking firms to non-business systems stimulates innovativeness more than remaining within the business system's set of routines. Crossing the border to science, in particular, increases the diversity of firms' innovation partners and respective innovation stimuli, which in turn, improves the capability of firms to introduce more advanced innovations. This contention is supported by a statistical analysis using data from a research project on innovation systems in several European regions. The results demonstrate that partners from science are more important than the firms' customers for the introduction of products that are new to the market.	Studies/ Science/ Technology/ Innovations/ Product development
Kaufmann, Alexander & Todtling, Franz	System of innovation in traditional industrial regions: The case of Styria in a comparative perspective	Regional Studies	Feb-00	34	1	Concepts of innovation have changed considerably in the past years, the focus shifting from a company perspective to regional and national systems of innovation. An investigation is conducted into to what extent an innovation system can also be observed in an old industrial region like Styria in Austria, a region undergoing considerable restructuring in the past years. The results for Styria are compared with those for other old industrial regions such as Wales, the Tampere region and the Basque country. The findings show that firms rely only partly on innovation partners within the region; to a considerable extent they are integrated in national and European networks.	Innovations/ Research & development/ R&D/ Regions/ Studies/ Comparative analysis
Keeble David, Lawson Clive, Smith Helen, Lawton, Moore Barry & Wilkinson Frank	Internationalisation processes, networking and local embeddedness in technology-intensive small firms	Small Business Economics	Dec-98	11	4	It is argued that technology-intensive small firms often need to internationalize their activities, and especially sales, at a very early stage of their development because of the limited and global nature of the technological market niche which they have been set up to exploit. From a survey of 100 such firms in the Cambridge and Oxford regions, it is demonstrated that many technology-based smaller firms are engaged in a range of international networks and internationalization processes, including internationalization of markets, research collaboration, labour recruitment, ownership and facilities location. Technology-intensive firms reporting high levels of internationalization also differ significantly from those which are more nationally-oriented, for example in terms of size, age, research intensity, university links, and innovativeness. There are also differences with respect to recent growth rates.	Small business/ Globalization/ International markets/ High technology/ Industrial economics/ Studies

<p>Keeble, David & Wilkinson, Frank</p>	<p>Collective learning and knowledge development in the evolution of regional clusters of high technology SMEs in Europe</p>	<p>Regional Studies Jun-99</p>	<p>33</p>	<p>4</p>	<p>The aims and objectives of the TSER Network on Networks, Collective Learning and Research and Technology Development in Regionally Clustered High Technology Small and Medium Sized Enterprises, are outlined. Evolutionary trajectories of European regional clusters of such SMEs in the 1990s are considered. The development of ideas concerning regional clustering is reviewed, from Marshall's industrial districts, through innovative milieux, to notions of regional un-traded interdependencies, networks and collective learning. Particular attention is paid to how firms and regions develop competencies and new knowledge as the basis for successful innovation. The focus of individual papers is outlined.</p>	<p>Small business/ Organizational learning/ Regions/ High tech industries/ Studies/ Small business/ Organizational learning/ Regions/ High tech industries/ Studies</p>
<p>Keeble, David, Lawson, Clive, Moore, Barry & Wilkinson, Frank</p>	<p>Collective learning processes, networking and institutional thickness' in the Cambridge region</p>	<p>Regional Studies Jun-99</p>	<p>33</p>	<p>4</p>	<p>The nature and extent of regional collective learning processes and networking by innovative, technology-based, small and medium sized enterprises in the Cambridge region are investigated. The importance of socio-cultural preconditions for learning involving the University of Cambridge is highlighted, and the significance of firm spin-offs, inter-firm and organisation networking, and local scientific and managerial recruitment, as dynamic collective learning processes, are documented. The complementary importance of wider national and global networks for SME innovation inputs, research collaboration and professional staff recruitment is identified. The relevance of the concept of institutional thickness in evaluating firms' experience of regional support structures and services is assessed.</p>	<p>Organizational learning/ Regions/ Spin-offs/ Small business/ Business networking/ Innovations/ Studies/</p>
<p>Kitching, J. & Blackburn, R.</p>	<p>Management Training and Networking in Small and Medium-Sized Enterprises in Three European Regions: Implications for Business Support</p>	<p>1999 Oct</p>	<p>17</p>	<p>5</p>	<p>The authors aim to develop a better understanding of small-business owners' attitudes towards, and experiences of, management training through a study of small mechanical engineering firms and key support providers in three European regions: Stuttgart (Germany), Aarhus (Denmark), and South London (England). Important differences between the three regions in support networks are highlighted. The limited networking between small-business owners and training providers in South London is explained by a lack of embeddedness of UK small engineering firms in the institutional framework supporting business. The absence of a critical mass of engineering businesses, the limited experiences of business owners and the weak business-support network in South London are mutually reinforcing and perpetuate the isolation of small and medium-sized enterprises (SMEs) from external training providers. Drawing on experience in Stuttgart and Aarhus, some policy proposals are offered which are aimed at increasing the take-up of management training by UK SMEs.</p>	<p>Small business/ SME/ Mechanical engineering/ Networking/ Critical mass/ Business support networks/ Policy</p>

<p>Knights, David, Murray Fergus & Willmont, Hugh</p> <p>Networking as knowledge work: A study of strategic inter-organisational development in the financial services industry</p> <p>The Journal of Management Studies</p> <p>Nov-93</p> <p>30</p> <p>6</p> <p>In 1990, an ambitious plan to introduce electronic trading into the UK life insurance industry was formulated by 20 of the UK's large and medium-sized insurance companies. As a means of promoting and developing this innovation, a company to which the pseudonym Switchco was given was established. Its purpose was to act as a focal point and facilitator of the new electronically mediated inter-organisational network designed to displace paper-based methods of trading between insurance companies and their distributors. A study examines the process of establishing and building the Switchco network as a form of knowledge work. It is argued that the emergence of this novel network provides an instructive example of knowledge work as networking. Informed by Michael Callon's sociology of translation, the genesis of networking as knowledge work is shown to be a complex, nonlinear process consisting of a broad range of actors and intermediaries.</p>	<p>Sociology/ Skills/ Organisational behaviour/ Organisation theory/ Implementations/ Financial services/ Experts/ Electronic trading</p>
<p>Koch, C.</p> <p>Innovation networking between stability and political dynamics</p> <p>Technovation</p> <p>In Press, Corrected Proof</p> <p>This contribution views innovation as a social activity of building networks, using software product development in multi company alliances and networks as example. Innovation networks are frequently understood as quite stable arrangements characterised by high trust among the participants. The aim of the contribution is to challenge and transcend these notions and develop an understanding of innovation networks as interplay between stable and dynamic elements, where political processes in innovation are much more than a disruptive and even a counterproductive feature. It reviews the growing number of studies that highlight the political aspect of innovation. The paper reports on a study of innovation processes conducted within the EU—TSER-programme and a study field studies in two constellations of enterprises were carried out. One is a segment-collaboration between a few manufacturing companies and a software house, the other a complex and extensive innovation network. These studies show how negotiations, shifting positions of players, mobilising stable elements of the network, when developing new ones, and interplays between internal and external collaboration are integral and inevitable in the product development process. This leads to an understanding of a networking paradox: in seeking to reduce political uncertainties of one type, actors engage with others and build collaborative relationships which themselves lead to other and new political issues that have to be tackled.</p>	<p>Innovation/ Networks/ Software products/ Trust/ Innovation networks/ Collaboration</p>

Kodama, M.	Creating New Business Through Strategic Community Management: Case Study of a Multimedia Business	International Journal of Human Resource Management	2001 Sep	12	6	<p>For the last few years, the videoconferencing system and multi-point connection service market represented by multimedia technology have enjoyed strong growth in Japan. Behind the recent upturn in this market was the strategic alliance of NTT, Japan's largest telecommunications carrier, and PictureTel of the US, followed by the birth of business communities centred around or outside NTT, thus intensively creating and boosting a new market referred to as interactive video communication. This article reviews the challenges that faced NTT, one of the big businesses in Japan, followed by PictureTel and other players within and outside NTT, all of which were lined up to create various strategic business communities. The article gives careful consideration to the measures taken by these players who achieved success in such a way as to alter employee consciousness, vitalize organizational morale, entrench the new NTT 'Phoenix' brand (videoconferencing system) in the Japanese market and create an emergent new video multi-point connection network service market. And it was under the innovative leadership of community leaders that communities' core competencies were elevated, and innovation of the multimedia business achieved, as a function of the creation and harmonization of new value outlooks within the business community, inside as well as outside the companies.</p>	Alliance/ Strategic alliance/ Interactive video/ Business communities
Kodithuwakku, Sarath S & Rosa, Peter	The entrepreneurial process and economic success in a constrained environment	Journal of Business Venturing	Sep-02	17	5	<p>This paper explores the role of the entrepreneurial process in the economic and business success of Sri Lankan villagers. Families with no previous assets were settled on 2 1/2 acres of land in 1984. From equal beginnings, the village had polarized 10 years later into a majority of economically unsuccessful villagers, and a small but influential and successful entrepreneurial class. An ethnographic and multiple-embedded case study approach was adopted to explore their success. The findings reveal that entrepreneurial processes were important in the successful entrepreneurs' emergence from an extremely unpromising and constrained environment. In achieving success, they were not much more innovative in identifying opportunities than the unsuccessful villagers. Rather, they were much more creative and persistent in finding ways to mobilize scarce resources. In particular, their ability to extract value from their social networks and contacts was a vital element in their struggle to accumulate more capital.</p>	Studies/ Entrepreneurs/ Success/ Economic conditions/ Hypotheses/ Social conditions & trends

Koschatzky, K. & Sternberg, R.	R&D Cooperation in Innovation Systems - Some Lessons From the European Regional Innovation Survey (Eris)	European Planning Studies	2000 Aug	8	4	<p>Abstract Our paper summarizes some of the main results of the European Regional Innovation Survey (ERIS) as far as they are discussed in this special issue of European Planning Studies. The overall target of the ERIS project is a quantitative and qualitative assessment of determinants crucial for the innovation potential of any region, i.e. innovative and non-innovative manufacturing firms, business services and research institutions, as well as the innovative linkages and networks between these actors. Empirical research is based upon almost 8600 questionnaires collected in 11 European regions. Results confirm some of the common hypotheses on the relationship between space and innovation networks but others are contrary to existing scientific knowledge. Obviously the impact of national innovation systems on the innovation activities of manufacturing firms in a given European region is--at least--as strong as the impact of the respective regional innovation system. The spatial range of innovative linkages significantly depends on the size, the type of the cooperation partner, the R&D intensity and the industry of the analysed manufacturing firm. For example, the higher the technology intensity of the industry, the greater is the need of each firm to use intraregional knowledge via innovation linkages. It is therefore an important task in regional innovation policy to promote network building among firms and other actors of a regional innovation system and to interlink these intraregional networks with national and international knowledge sources.</p>	Regional Innovation/ Manufacturing/ Innovative linkages/ Spatial range/ R&D/ Intensity
Kumaresan, Nageswaran & Miyazaki, Kumiko	Management and policy concerns over shifts in innovation trajectories: The case of the Japanese robotics industry	Technology Analysis & Strategic Management	Sep-01	13	3	<p>Innovation related network systems would need to be re-aligned and adapted within major technological shifts and their capability to re-align themselves determines the dynamic capabilities of a national innovation system. In this paper, a particular phenomenon in industrial evolution is presented, which is called a shift in the "innovation trajectory," taking the case of the Japanese robotics industry that now undergoes major shifts in many respects. Activities directly involved with innovation in the entire value chain from invention to commercialization are considered, and the structural changes in the national systems due to the shifts in innovation trajectory are identified. This paper analyzes six different structural shifts, which are related to product, technology, market, actor, competitive and socio-economic structures. A new set of approaches is needed to shape the emerging innovation shifts.</p>	Electronics industry/ Research & development/ R&D/ Technological change/ Strategic management/ Studies

<p>Lamming, Richard, Hajee, David Horrell, Mike, Kay, Graham & Staniforth, John.</p> <p>Lessons from co-development of a single vessel processor: Methodologies for managing innovation in customer-supplier networks</p>	<p>International Journal of Technology Management</p>	<p>2002</p>	<p>23</p>	<p>1,2,3</p>	<p>This article reports on the development of practical methodologies for managers seeking to deal with pre-competitive co-development of process technology, in networks that bring together customers and suppliers. Eschewing the simplistic notion of a simple linear supply chain, the research focuses on the case of a supply network comprising five firms and a university, examining the ways in which technological innovation was managed within it. Action research was employed to develop two novel applications of theories and practices, operationalising innovation theories and the techniques of sociometry. The implications for supply chain managers working in networks is discussed.</p>	<p>Studies/ Research & development/ R&D/ Management science/ Innovations/ Customer relations/ Supply chains</p>
<p>Larson, Andrea</p> <p>Partner networks: Leveraging external ties to improve entrepreneurial performance</p>	<p>Journal of Business Venturing</p>	<p>1991/5</p>	<p>6</p>	<p>3</p>	<p>This paper examines the conditions under which successful partnership networks were formed by four entrepreneurial companies. Seven alliance partnerships were studied. Both sides benefited through product advances, administrative process improvements, and rapid response times due to the greater levels of information exchange and coordination through computers. Key to understanding the partnerships were the development of trust between organizations. The value of these partnerships in terms of benefits to smaller companies has not received adequate attention in the literature. Yet forging such collaborative alliances seems crucial in explaining the ability of smaller firms to grow and to innovate. These networks should be seen as a competitive alternative to vertical integration. Smaller-scale entrepreneurial firms lack the financial resources to vertically integrate steps in the value added chain. This research suggests that a network organizational form can be cultivated by smaller companies to realize the benefits of vertically integrated functions while avoiding the bureaucratic inefficiencies of that organizational form. The network strategy of building close collaborative alliances with a limited set of suppliers and customers enables a firm to stabilize itself while remaining flexible and responsive to a changing market. An important aspect of strategic planning for the entrepreneurial firm is to identify prospective partners and consciously initiate and build partnerships with responsive firms. The data gathered indicate that these alliances do not form by chance but can be studied as patterned, predictable exchange structures that can be replicated and used to improve a firm's competitive position against larger players. The paper argues for an expansion of our concept of entrepreneurship to include the effective management of partnership networks. We should also expand our ideas about organizational forms to recognize the network structure as an effective governance arrangement for entrepreneurial companies. The findings strongly suggest that entrepreneurial firm's ability to identify, cultivate, and manage these network partnerships is critical to survival and success.</p>	<p>Partnership networks/ Entrepreneurial companies/ Alliance/ Information exchange/ Trust/ SMEs/ Small firms</p>

Lawton Smith, Helen, Dickson, Keith & Smith, Stephen Lloyd	There are two sides to every story: Innovation and collaboration within networks of large and small firms	Research Policy	1991/10	20	5	Inter-firm collaboration networks serve to externalize the innovation function through the transfer of technology between firms. This is always a 2-way process. Collaboration also extends firm networks through linkages into those of the partner, linking individuals, firms, and sectors. An analysis of 27 cases of collaborative partnerships shows that, although it is possible to identify particular rewards and hazards resulting from inter-firm collaboration, what is clear is that each collaborator was confronted by a more or less novel set of circumstances in terms of size, product markets, and organizational idiosyncrasies. Changing technological and commercial imperatives mean that new rules have to be learned. The very newness of this active form of interdependence conflicts with traditional ingrained attitudes toward smaller companies. The analysis shows that the existence of informal, personal networks among the scientific and engineering elite was the key factor in the establishment of collaborative links.	Inter-firm networks/ Collaboration/ Innovation/ Technology transfer/ Informal networks/ Personal networks
Leonard-Barton, Dorothy	Interpersonal communication patterns among Swedish and Boston-area entrepreneurs	Research Policy	1984/4	13	2	This paper investigates the uses of personal communication networks by entrepreneurs in Sweden and among "Route 128" companies around the Boston, Massachusetts area. Swedish entrepreneurs appear to use personal contacts as a source of relevant business information less than their American counterparts. Moreover, relatively more successful Swedish entrepreneurs are characterized by access to product development and other business information through experience in the industry, contacts with outside consultants, and extensive travel.	Personal networks/ Communication/ Entrepreneur/ Product development
Leoncini, Riccardo & Montresor, Sandro	Network analysis of eight technological systems	International Review of Applied Economics	May-00	14	2	This paper aims to measure and compare some key relationships relative to the technological systems of 8 OECD countries along 3 temporal spans (early 1980s, middle 1980s, early 1990s). For each technological system, a matrix for inter-sectoral innovation flows is constructed and network analysis is then performed to examine the density distributions of the innovative flows, and the degree of centrality/centralization of each of its nodes. The first kind of analysis allows a quantitative comparison of the intensity of the linkages among the systemic nodes considered, while the second allows us to examine qualitatively the different internal structures identified by cutting-off flows of a certain magnitude. The main results of the paper are a clear distinction among technological systems with different structural characteristics (e.g. size, technological intensity, and institutional arrangements suggesting the existence of different models of capitalism), and a clear pattern of convergence among the technological systems along time.	Technological change/ Input output analysis/ Many countries/ Economic theory/ Studies

<p>Liao, Jianwen & Welsch, Harold</p> <p>Social capital and entrepreneurial growth aspiration: a comparison of technology- and non-technology-based nascent entrepreneurs</p>	<p>The Journal of High Technology Management Research</p>	<p>2003/0</p>	<p>14</p>	<p>1</p>	<p>Social capital is broadly described by researchers as an asset embedded in relationships—of individuals, communities, networks or societies [Admin. Sci. Q. 42 (1997) 339; Acad. Manage. Rev. 23 (1998) 242; Organ. Sci. 8 (1997) 109]. This study will build upon Nahapiet and Ghoshal's [Acad. Manage. Rev. 23 (1998) 242] three dimensions of social capital, including the structural, the relational, and the cognitive. The purpose of this research is to investigate (1) how the three dimensions of social capital interact among themselves in technology-intensive new ventures, (2) to what extent the interactions are different from those in the context of non-technology-based new ventures, (3) how the three dimensions of social capital influence the growth aspiration of the technology-based new ventures in a way that is different from non-technology-based ventures. We examined these questions using a data set from Panel Study of Entrepreneurial Dynamics (PSED) [Reynolds, P. (2000). National panel study of US business start-ups: background and methodology. In Databases for the study of entrepreneurship Vol. 4 (153–227) Greenwich, CT: JAI Press/Elsevier]. Results from structural equation modelling suggest that technology-based entrepreneurs benefit more from relational embeddedness—the freer and greater exchange of non-redundant information. Non-technology-based entrepreneurs benefit more from structural embeddedness—the extensiveness of social networks. Each dimension of social capital reinforces the creation of the other, contributes to entrepreneurial growth aspiration. Our findings suggest that the closure [Am. J. Sociol. 94 (1988) S95] and hole arguments [Burt, R.S. (1992). Structural holes. Cambridge, MA: Harvard Business Press; Admin. Sci. Q. 42 (1997) 339] are not as contradictory as they might seem. Implications and future research directions are proposed.</p>	<p>Social capital/ Embedded relationships/ Communities/ Networks/ New ventures</p>
<p>Lincoln, James R, Ahmadjian, Christina L & Mason, Eliot</p> <p>Organizational learning and purchase-supply relations in Japan: Hitachi, Matsushita, and Toyota compared</p>	<p>California Management Review</p>	<p>Spring 1998</p>	<p>40</p>	<p>3</p>	<p>This article deals with the role of purchase-supply relations in organizational learning and knowledge-creation in Japan and how such relations are currently undergoing change. Drawing on interviews with managers, it presents case studies of the customer-supplier partnerships of 3 prominent Japanese manufacturing firms: Hitachi, Matsushita, and Toyota. The Hitachi case illustrates in a somewhat novel way the prevailing paradigm of how long-term high-trust supply relations in Japan enhance organizational knowledge creation, learning, and innovation. The Toyota and Matsushita cases demonstrate that the dynamics of learning are behind 2 very different kinds of change in keiretsu supply networks. Toyota's evolving relationship with long-term partner, Denso Corp., appears to fit the popular view that globalization and technological change are eroding Japanese keiretsu ties. The Matsushita case, by contrast, demonstrates that these same forces of change in other industrial settings may in fact be strengthening keiretsu-style partnerships.</p>	<p>Vendor supplier relations/ Organizational learning/ Changes/ Studies/ Comparative analysis</p>

Lipparini, Andrea & Sobrero, Maurizio	The glue and the pieces: Entrepreneurship and innovation in small-firm networks	Journal of Business Venturing	1994/3	9	2	A study provides insights into the role of suppliers in the new product development process and explores the role of the entrepreneur in promoting and managing a wide set of external-innovative ties. Attention is focused on 103 small- and medium-sized firms (SME) located within 2 Italian industrial networks where interdependencies are unusually large and complex. The empirical analysis confirms SME's structural recourse to suppliers. More important, the contribution of such resources is not necessarily limited to cost reductions and marginal improvements. An entrepreneurial explanation of SME's innovative performance is advanced. Findings show that: 1. when the entrepreneur is leading and managing the business, more suppliers are involved in the development of new products, and 2. the type of contribution given by suppliers differs by management typology.	Suppliers/ New product development/ External ties/ Innovation/ SME
Liyanae, Shantha	Technovation	Journal of Business Venturing	1995/11	15	9	Collaborative research programs have a significant impact on the structure of national innovation systems by creating and strengthening networks which are essential for breeding innovation clusters. These networks involve both technology and market stakeholders and are extended to include industry, research and technology producers. Network activities have resulted in setting priority in research and linking research fields that have high potential to coalesce into distinct technological clusters. The process by which innovation clusters are formed in research collaborations are examined by analyzing the work programs of 51 Australian Cooperative Research Centres (CRCs). An analytical framework is provided to determine the direction of national research setting through cluster analysis. A methodology called "co-occurrence of words" is employed in cluster construction.	Collaborative research/ innovation/ Networks/ Clusters/ Cluster construction
Lorenzoni, Gianni & Lipparini, Andrea	The leveraging of interfirm relationships as a distinctive organizational capability: A longitudinal study	Strategic Management Journal	Apr-99	20	4	A study of the structure of 3 lead firm-network relationships at 2 points in time is presented. Using data on companies in the packaging machine industry, the authors study the process of vertical disintegration and focus on the ability to coordinate competencies and combine knowledge across corporate boundaries. It is argued that the capability to interact with other companies - which is called relational capability - accelerates the lead firm's knowledge access and transfer with relevant effects on company growth and innovativeness. This study provides evidence that inter-firm networks can be shaped and deliberately designed. The ability to integrate knowledge residing both inside and outside the firm's boundaries emerges as a distinctive organizational capability. The main goal is to contribute to the current discussion of cooperative ties and dynamic aspects of inter-firm networks, adding new dimensions to resource-based and knowledge-based interpretations of company performance.	Organizational behaviour/ Packaging industry/ Core competencies/ Strategic planning/ Alliances

<p>Love, James H & Roper, Stephen</p>	<p>Location and network effects on innovation success: Evidence for UK, German and Irish manufacturing plants</p>	<p>Research Policy</p>	<p>Apr-01</p>	<p>30</p>	<p>4</p>	<p>Recent developments in the new economic geography and the literature on regional innovation systems have emphasized the potentially important role of networking and the characteristics of firms' local operating environment in shaping their innovative activity. Modelling UK, German and Irish plants' investments in R&D, technology transfer and networking, and their effect on the extent and success of plants' innovation activities, casts some doubt on the importance of both of these relationships. In particular, this analysis provides no support for the contention that firms or plants with more strongly developed external links develop greater innovation intensity. However, intra-group links are important in terms of achieving commercial success. Evidence was also found that R&D, technology transfer and networking inputs are substitutes rather than complements in the innovation process, and that there are systematic sectoral and regional influences in the efficiency with which such inputs are translated into innovation outputs.</p>	<p>Studies/ Innovations/ Manufacturing/ Corporate culture/ Regions</p>
<p>Macpherson, A.</p>	<p>The Role of Producer Service Outsourcing in the Innovation Performance of New York State Manufacturing Firms</p>	<p>Annals of the Association of American Geographers</p>	<p>1997 Mar</p>	<p>87</p>	<p>1</p>	<p>This paper assesses the contribution of external technical services to the innovation initiatives of New York State manufacturing firms. The results of a spatially and sectorally stratified postal survey of more than 400 manufacturing firms are presented. A major finding of the paper is that specialized technical services can support the product development efforts of innovative firms. The empirical results also point to significant spatial variations in technical service utilization. Same of these variations reflect different supply and accessibility conditions among the state's major regions and urban centres. The survey results are discussed in the context of recent empirical and theoretical findings on the role of producer services in urban and regional development. Particular attention is given to the empirical connection between producer service accessibility and industrial innovation.</p>	<p>Innovation/ Manufacturing/ Product development/ Regional development</p>

<p>Martin, R. & Sunley, P.</p>	<p>Deconstructing Clusters: Chaotic Concept or Policy Panacea?</p>	<p>Journal of Economic Geography</p>	<p>2003 Jan 1</p>	<p>1</p>	<p>Over the past decade, there has been growing interest in local industrial agglomeration and specialization, not only by economic geographers but also by economists and by policy-makers. Of the many ideas and concepts to emerge from this newfound focus, Michael Porter's work on clusters has proved by far the most influential. His cluster theory has become the standard concept in the field, and policy-makers the world over have seized upon Porter's cluster model as a tool for promoting national, regional, and local competitiveness, innovation and growth. But the mere popularity of a construct is by no means a guarantee of its profundity. Seductive though the cluster concept is, there is much about it that is problematic, and the rush to employ cluster ideas has run ahead of many fundamental conceptual, theoretical and empirical questions. Our aim is to deconstruct the cluster concept in order to reveal and highlight these issues. Our concerns relate to the definition of the cluster concept, its theorization, its empirics, the claims made for its benefits and advantages, and its use in policy-making. Whilst we do not wish to debunk the cluster idea outright, we do argue for a much more cautious and circumspect use of the notion, especially within a policy context: the cluster concept should carry a public policy health warning.</p>	<p>Agglomeration/ Local/ Regional/ Clusters/ Policy/ Cluster weaknesses</p>
<p>Meyer-Stamer, Jorg</p>	<p>Micro-level innovations and competitiveness</p>	<p>World Development</p>	<p>Jan-95</p>	<p>1</p>	<p>The reorganisation of production within firms and the development of inter-firm networks are currently much in fashion as elements of competitiveness. An analysis of developing-country experiences suggests that caution is required. Studies of intra-firm reorganisation focus unduly on production and tend to assume that rapid improvements will lead to the attainment of international competitiveness. Evidence from Brazil suggests that, even after improving performance, the competitiveness gap remains large. Further, an examination of the basis of the success of the East Asian newly industrialized countries shows that Taiwan and Korea diverge in important respects from the new orthodoxy of just-in-time and inter-firm networking.</p>	<p>Studies/ Production planning/ LDCs/ Innovations/ Corporate reorganization/ Competition/ Business networking/ Alliances/ Reorganization/ Productivity/ Manufacturing</p>

Momma, Stefan & Sharp, Margaret	Developments in new biotechnology firms in Germany	Technovation	1999/2	19	5	Germany now has a substantial number of new biotechnology firms, with the number steadily increasing. The institutional framework has been slow to develop for this novel form of company, but many are now emerging and will certainly play an important part in the dynamics of the system. The essential questions that arise from these recent developments are: 1. What prevented these new biotechnology firms from growing earlier and what is the current situation? 2. What changes have occurred which have stimulated this growth? 3. How are biotechnology companies going to develop further and what are the implications for Germany's pharmaceutical industry and wider economy? A database for biotechnology firms in Germany was set up of which a subset was used to analyze the current state of development. The following conclusions were reached: 1. Germany now has a substantial number of new biotechnology firms and the numbers are steadily increasing. 2. Their collaborations with and proximity to academic centres of excellence suggests they are well embedded in the German research system: However, there is greater bias towards instrumentation and environmental biotechnology. 3. Since the mid-1980s there has been a continuous, if slow, adaptation to the institutional framework supporting biotechnology.	Biotechnology/ Institutional framework/ Germany/ Academic Proximity
Newell, S. & Clark, P.	The Importance of Extra-Organizational Networks in the Diffusion and Appropriation of New Technologies - the Role of Professionals- Associations in the United-States and Britain	Knowledge-Creation Diffusion Utilization	1990 Dec	12	2		
Nieuwenhuis, Loek F M	Innovation and learning in agriculture	Journal of European Industrial Training	2002	26	6-Jul	Innovation is a complex process, based on interactive network learning and processes of trial and error on the shop floor. Small companies, such as in agriculture, are depending on external knowledge infrastructures for effective innovation. Within small companies, the entrepreneur has a pivotal role in the innovative process: the entrepreneur is the professional learner. Learning and innovation as major parts of entrepreneurship are central to this contribution. How do farmers learn and innovate within a market-led, high-tech agricultural sector and what should governmental policy look like to support and facilitate innovation, avoiding the pitfall of protectionism? Two case studies are presented: one on linear innovation policy and one on learning processes of farmers. Innovative learning is balancing between the chaos of uncertainty and the old grooves of experience. Knowing how to escape this paradox forms the core competence of innovative entrepreneurship.	Studies/ Innovations/ Agriculture/ Entrepreneurs/ Small business/ Organizational learning

Nijkamp, P.	Entrepreneurship in a Modern Network Economy	Regional Studies	2003 Jun	37	4	<p>In this survey paper the literature on entrepreneurship is summarized from the perspective of geographical seedbed conditions and network constellations. It is argued that in many cases urban areas offer favourable incubator conditions for innovative entrepreneurship, as a result of economies of density and the opportunities created by the city as a nucleus of a broader network, both local and global. Clearly, network participation by creative entrepreneurs does not necessarily need an urban base, although informal spatial networks among specific business segments may be favourable for economic performance. A modern entrepreneur tends to become increasingly a creative network operator and manager.</p>	Entrepreneurship/ Constellations/ Incubator/ Networks/ Spatial networks
Nooteboom, Bart	Institutions and forms of co-ordination in innovation systems	Organization Studies	2000	21	5	<p>This article shows how institutions enable and constrain forms of co-ordination for inter-organisational relations, and how these affect innovative performance. The analysis is based on a theory of learning and on a theory of relations that combines a social exchange perspective with elements from transaction cost economics. Performance is analyzed in terms of production costs, transaction costs, product differentiation, diffusion of innovations, incremental innovation, and radical innovation. The method is illustrated with a comparison between the US and Germany. The first is more flexible and market oriented; the second is more oriented towards inter-organizational networks. Policy recommendations focus on how flexibility and durability of relationships might be reconciled.</p>	Innovations/ Organizational behaviour/ Studies/ Comparative analysis
Norton, Edgar & Tenenbaum, Bernard H.	Specialization versus diversification as a venture capital investment strategy	Journal of Business Venturing	1993/9	8	5	<p>A study tested hypotheses based upon the finance and strategic management literature regarding certain venture capitalist investment practices. Data used to test the hypotheses were derived from responses to a survey of 98 venture capitalists. The hypothesis tests were usually resolved in favour of the information-sharing view. For example, venture capitalists that were heavily involved in seed round financing were diversified across fewer numbers of firms and industries. Further evidence in favour of information sharing was seen in investment patterns across different financing stages. The information sharing-specialization view argues that it is best to stay focused on a single stage or several "connected" stages. The data again favoured this perspective.</p>	Venture capital/ Venture capitalist practices/ Information sharing/ Connectedness

Oakey, R P	Predatory networking: The role of small firms in the development of the British biotechnology industry	International Small Business Journal	Jul-Sep 1993	11	4	The effects of networking in competitive conditions are examined, particularly the effects on new firms in the UK's biotechnology sector. It is found that a close networking relationship, while helpful in the initial stages of formation and growth, can become a major barrier to independent expansion once a certain level of success has been achieved. As larger firms have acquired an increasing minority of growing firms, it is suggested that a strong small firm contribution to innovation and growth in the emerging biotechnology sector is unlikely. In Britain, for example, government should ensure that medium- to long-term investment capital is available to viable small independent biotechnology firms that wish to remain independent. This is necessary because large-firm dominance leads to a slow rate of technological change, which in the long term, renders industry uncompetitive at an international level.	Technological change/ Studies/ Strategic planning/ Small business/ Roles/ R&D/ Networks/ Effects/ Business growth/ Biotechnology
Oliver, Amalya L & Ebers, Mark	Networking network studies: An analysis of conceptual configurations in the study of inter-organizational relationships	Organization Studies	1998	19	4	Given the recent accumulation of research on inter-organizational relations and networks and the current fragmentation of the field, it is time to take stock and explore the achievements of, and future challenges for, this field of study. On the basis of a network analysis of the 158 articles on inter-organizational relations and networks that were published in 4 leading journals from 1980 to 1996, this paper explores the linkages among, and configurations of, core theories and concepts underlying earlier empirical research on inter-organizational relations and networks. The analysis shows that the field segments into 4 substantive research perspectives: social network, power and control, institutional and institutional economics and strategy clusters.	Studies/ Organizational behaviour/ Research/ Organisation theory
Ostgaard, T. A. & Birley, S.	Personal Networks and Firm Competitive Strategy - a Strategic or Coincidental Match	Journal of Business Venturing	1994 Jul	9	4	A survey was conducted of 159 owner-managed companies in the UK in order to explore a different and new effectiveness measure of personal networks - the implementation of competitive strategies. Preliminary analysis identified 6 components that were consistent with previous literature: 1. Marketing differentiation, 2. Product innovation, 3. Market segmentation, 4. Distribution, 5. Growth through outside capital, and 6. Differentiation through quality. Correlation of these components with the networking characteristics of propensity to network, network activity, network density, network intensity, and content of network exchanges supports the proposition that entrepreneurs differ in their networking activities according to the competitive strategy pursued by the firm. Further classification reveals that most firms appear to follow multiple patterns of strategic behaviour.	UK/ Personal networks/ Networking characteristics/ Network activity/ Network density/ Strategic behaviour

Ostgaard, Tone A. & Birley, Sue	New Venture Growth and Personal Networks	Journal of Product Innovation Management	1996/11	13	6	A study presents the results of a survey of 159 owner-managed companies in England. The research question explores the effectiveness of personal networks in terms of firm performance and growth. Multiple regression confirmed the importance of networks for company performance and development. The research establishes a link between the entrepreneur's networking behaviour and the growth of the firm.	Personal networks/ SMEs/ Growth/ Networking behaviour
Oswald Jones & Craven, Martin	Expanding capabilities in a mature manufacturing firm: Absorptive capacity and the TCS	International Small Business Journal	Apr-Jun 2001	19	3	This paper's objective is to examine the process by which participation in the Teaching Company Scheme (TCS) helped develop managerial capabilities within a small manufacturing company. To do this, the concept of "absorptive capacity" is utilized which describes the organizational ability to assimilate new knowledge and new skills. The paper begins with a review of literature associated with innovation networks and absorptive capacity and this is followed by a discussion of the research methodology. The paper also presents the empirical data, which illustrate the way in which the creation of new organizational routines contributed to the expansion of the company, RSL's capacity to innovate new products. The implications of this case study are discussed for a broader understanding of absorptive capacity.	Manufacturing/ Studies/ Small business/ Innovations/ Alliances/ Organisation theory
Pammolli, Fabio & Riccaboni, Massimo	Technological regimes and the growth of networks: An empirical analysis	Small Business Economics	Nov-02	19	3	This paper shows how specific technological and relational regimes have shaped the growth of the network of R&Dcollaborative agreements in pharmaceuticals in the 1990s. Analysis reveals the existence of a complex set of regimes of firm growth within the network, providing additional evidence supporting prediction that both growth and innovative activities of large and small firms respond, even within a given industry, to considerably different technological and economic factors. It is shown, in the context of a specific industry and by means of a series of preliminary and explorative empirical analyses, that information on the topological properties of a given industrial settings and on roles/positions of organizations within it can be used to disentangle some fundamental generative processes underlying observed processes of growth. This result contributes to the old stochastic approach to firm growth, in the direction of building parsimonious and, at the same time, more realistic, representations of processes of industrial growth.	Studies/ Economic theory/ Pharmaceutical industry/ Agreements/ Research & development/ R&D/ Technology

<p>Patrucco, Pier Paolo</p>	<p>Institutional variety, networking and knowledge exchange: Communication and innovation in the case of the Brianza technological district</p>	<p>Regional Studies</p>	<p>Apr-03</p>	<p>37</p>	<p>2</p>	<p>Elaborating on the literature on innovation systems and technological districts, this paper suggests that localization is conducive to a multilateral exchange of interdependent and external knowledge bases but requires explicit communication efforts in order to lead to innovation. In particular, the case of the Brianza technological district shows that different and yet complementary knowledge bases are built upon the institutional variety characterizing the local economic system. Moreover, this case provides empirical evidence for the fact that the construction of an inter-organisational network of dissimilar but complementary cooperative relations - in contrast to one dominant kind of interaction - is the key source of innovation and growth of local firms.</p>	<p>Studies/ Regions/ Innovations/ Telecommunications/ Technology/ Research parks/ Economic theory</p>
<p>Pellerin, Cheryl</p>	<p>Consortia: Free enterprise meets co-operation and the results can be good for robotics</p>	<p>The Industrial Robot</p>	<p>1995</p>	<p>22</p>	<p>1</p>	<p>In 1986, the Defence Department, the National Machine-Tool Builders' Association, the Manufacturing Studies Board, General Motors, and 20 manufacturing companies formed the National Centre for Manufacturing Sciences (NCMS). Today, the NCMS has 200 US, Canadian, and Mexican corporate members. Those with similar interests form teams to work on R&D projects characterized as pre-competitive, or applied R&D where a basic research phase has established and proven the process-oriented technology concept. The strategy is to promote collaborations among industry, government, and academic partners. When Congress passed the National Cooperative Research Act in 1984, the US government began to sanction joint R&D - if participants independently produced and sold the results. Another model for collaborative research is the Small Business Innovative Research grant. The National Technology Transfer Centre is the hub of a national network established to link private-sector companies with federal labs to turn research results into commercial technology.</p>	<p>Technological change/ Robots/ R&D/ Manufacturers/ Cooperation/ Consortia/ Antitrust/ Advantages</p>
<p>Perez Perez, Manuela & Sanchez, Angel Martinez</p>	<p>Lean production and technology networks in the Spanish automotive supplier industry</p>	<p>Management International Review</p>	<p>Third Quarter 2002</p>	<p>42</p>	<p>3</p>	<p>The automotive industry has undergone tremendous transformation during the 1990s. One of them is the importance of knowledge-sharing networks to access to technology, innovation and training. Firms having a strong supplier network report higher levels of productivity and quality than those reporting weak alliances over time. However, very few empirical studies exist on the relationship between networking and production and process innovation. This paper tests the underlying relationship between lean production and networking.</p>	<p>Automotive supplies/ Studies/ Hypotheses/ Regression analysis/ Production management</p>

Phillimore, John	Beyond the linear view of innovation in science park evaluation - An analysis of Western Australian Technology Park	Technovation	Nov-99	19	11	Science and technology parks have been viewed sceptically in much of the academic literature when judged in terms of technology development or urban renewal. Interaction and networking within Western Australian Technology Park, as well as between WATP companies and universities, are examined. The situation in WATP is compared with the findings from a study by Vedovello of Surrey Research Park. It is found that there is more interaction occurring than might be estimated using the traditional evaluative model and several different categories of company that exist at the Park are identified in terms of their interactive behaviour.	Studies/ Innovations/ Research parks/ Information dissemination
Podolny, J. M & Stuart, T. E.	A Role-Based Ecology of Technological Change	American Journal of Sociology	Mar-95	100	5	This article considers what factors determine whether an innovation becomes a foundation for future technological developments rather than a 'dead end'. The authors introduce the concept of the technological niche, which includes focal innovation, the innovations on which the focal innovation builds, the innovations that build on the focal innovation and the technological ties among the firms within the niche. Using patents and patent citations to measure characteristics of innovation niches within the semiconductor industry, the authors show that size of the niche and the status of the actors within the niche have a positive effect on the likelihood that subsequent innovations will build upon the focal innovation. Competitive intensity within the niche has a negative effect on this likelihood.	Innovation/ Focal innovation/ Technological ties/ Patents/ Patent Citations
Post, G. J. J., Hop, L. & Van Aken, J. E.	Indicators for Establishing Sme Product Development Networks	Journal of Scientific & Industrial Research	2001 Mar	60	3	The results of research into SME product development networks are presented. The paper provides insight to the process of establishing such networks and the use of indicators in the design and monitoring of this process. It is based on five extensive case studies and in addition on several in-depth interviews with SME entrepreneurs and business managers. The practical experiences in these case studies and the indicators used by practitioners in network development are briefly described. These experiences together with theoretical insights were combined into a comprehensive set of indicators, describing the progress and effectiveness of the network formation and operation process. The discussion closed with more generic conclusions about establishing inter-organisational networks and monitoring network development processes in practice. Implications for further research have also been put forward.	SME/ Product development/ Networks/ Case Studies/ Network development/ Network formation

<p>Powell, Walter W, Koput, Kenneth W, & Smith-Doerr, Laurel</p>	<p>Inter-organisational collaboration and the locus of innovation: Networks of learning in biotechnology</p>	<p>Administrative Science Quarterly</p>	<p>Mar-96</p>	<p>41</p>	<p>1</p>	<p>It is argued that when the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than in individual firms. The large-scale reliance on inter-organisational collaborations in the biotechnology industry reflects a fundamental and pervasive concern with access to knowledge. A network approach to organizational learning is developed, and a firm-level, longitudinal hypotheses are derived that link research and development alliances, experience with managing inter-firm relationships, network position, rates of growth and portfolios of collaborative activities. These hypotheses are tested on a sample of dedicated biotechnology firms in the years 1990-1994. Results support a learning view and have broad implications for future theoretical and empirical research.</p>	<p>Studies/ Statistical analysis/ Learning/ Innovations/ Industrial research/ Biotechnology/ Alliances/ Organisation theory/ Innovation/ Biotechnology</p>
<p>Powell, Walter W</p>	<p>Learning from collaboration: Knowledge and networks in the biotechnology and pharmaceutical industries</p>	<p>California Management Review</p>	<p>Spring 1998</p>	<p>40</p>	<p>3</p>	<p>The biotechnology and pharmaceutical fields are rife with a wide range of collaborative relationships intended to access knowledge, skills, and resources that cannot be produced by organizations internally in a timely fashion. As more firms rely on external relationships for knowledge, the ability to process, transfer, and transmit knowledge gained in one context to other activities becomes critical. This article examines the capability for learning both how and what to learn in the context of these inter-organizational relations, and it surveys various practices developed by companies for accessing and distributing knowledge. The key challenge in innovation-intensive fields is to develop organizational routines for learning that are robust, flexible, and durable.</p>	<p>Biotechnology/ Pharmaceutical industry/ Alliances/ Cooperation/ Organizational learning/ Information dissemination/ Organisation theory</p>
<p>Ragatz, Gary L., Handfield Robert B & Scannell Thomas V</p>	<p>Success factors for integrating suppliers into new product development</p>	<p>The Journal of Product Innovation Management</p>	<p>May-97</p>	<p>14</p>	<p>3</p>	<p>Effective integration of suppliers into new product development (NPD) can yield such benefits as reduced cost and improved quality of purchased materials, reduced product development time, and improved access to and application of technology. However, those benefits do not automatically accrue to any NPD team that includes representatives from a supplier's company. In a study of 60 member companies from the Michigan State University Global Procurement and Supply Chain Electronic Benchmarking Network, the management practices and environmental factors that relate most closely to successful integration of suppliers into the NPD process are explored. The study identifies supplier membership on the NPD project team as the greatest differentiator between most and least successful integration efforts. Although respondents reported only moderate use of shared education and training, the study cites this management factor as another significant differentiator between most and least successful efforts.</p>	<p>Studies/ Product development/ Success/ Suppliers/ Integrated approach/ Statistical analysis</p>

Reed, Fiona M & Walsh, Kathryn	Enhancing technological capability through supplier development: A study of the U.K. aerospace industry	IEEE Transactions on Engineering Management	Aug-02	49	3	<p>The current trend in the manufacturing industry is for large companies to focus on core competencies and to outsource more design and manufacture. Combined with the rationalization of the supplier base, this has meant that companies are increasingly dependent on key suppliers to continue providing advanced product subsystems and subassemblies that incorporate advanced product and process technology. Suppliers in turn are reliant on their customers for information for innovation. This paper discusses the potential to enhance the technological capability of the supply network through supplier development (SD) schemes. Case studies of SD in the UK aerospace and defence sectors are presented in order to establish whether SD is enhancing technological capability in small companies in the UK supply base. The formal processes of SD are found to have little direct impact on supplier technological capability, but instead have an important indirect effect - primarily through strengthening relevant communication channels. There remains an opportunity for large companies to utilize SD to promote better technology management practices.</p>	Studies/ Aerospace industry/ Vendor supplier relations/ Technological change/ Strategic management
Riccaboni, Massimo & Pammolli, Fabio	Technological regimes and the evolution of networks of innovators. Lessons from biotechnology and pharmaceuticals	2003	Aug-02	25	3,4	<p>This paper analyzes the relationships between technological regimes, regimes of local interaction, and the global structure of an industrial network. Given the complexity of the task, it follows a semi-inductivist approach, combining quantitative empirical analyses and simulative exercises. It shows that the topological properties of the R&D network in pharmaceuticals are the result of neither a purely random nor of a cumulative process of growth. Instead, they emerge from a mixture of the two generative processes, under a regime of intense and stable entry. This paper should be considered only as a first step towards the understanding of some general determinants of industry networks growth. Despite its limitations, it provides a parsimonious and general framework to reverse engineer the growth of networks in different industries. Some of the current limitations of the analysis could be overcome, in the future, based on a higher availability of data on real systems and, in particular, of detailed topological and economic information on real-world networks.</p>	Studies/ Pharmaceutical industry/ Biotechnology/ Systems development/ Research & development/ R&D

Ritter, Thomas & Gemunden, Hans Georg	The impact of a company's business strategy on its technological competence, network competence and innovation success	Journal of Business Research	This paper discusses the dual nature of the key to competitiveness in the network economy: On the one hand, a company needs technological competence in order to add value to products and processes. On the other hand, companies need to develop network competence in order to link their organisation to other players in the market to allow interactions beyond organizational boundaries. In this paper, a basic framework for the successful implementation of a technology-oriented business strategy is developed, consisting of four elements: business strategy, network competence, technological competence and innovation success. The model is empirically tested using a database of 308 German companies. The results show that both network competence and technological competence have a significant positive impact on a company's innovation success. Furthermore, the results suggest that a company's technological strategy supports the development of both network and technological competencies.	Network economy/ Technological competence/ Network competence/ Business strategy/ Innovation success/ Technological strategy
Ritter, Thomas & Gemunden, Hans Georg	Network competence: Its impact on innovation success and its antecedents	Journal of Business Research	In Press, Corrected Proof Past research has consistently shown that companies, which have close relationships with customers, suppliers, research institutions, and competitors, are more likely to have higher product and process innovation success. But why and how are these firms able to build up and use technology-oriented inter-organisational relationships, which give them a competitive advantage? The authors postulate that the underlying reason is a company-specific ability to handle, use, and exploit inter-organisational relationships. We call this skill network competence. Drawing upon a sample of 308 German mechanical and electrical engineering companies, results of a LISREL analysis reveal that network competence has a strong positive influence on the extent of inter-organisational technological collaborations and on a firm's product and process innovation success. Furthermore, four organizational antecedents have an impact on a company's network competence: access to resources, network orientation of human resource management, integration of intra-organisational communication, and openness of corporate culture.	Product innovation/ Process innovation/ Inter-organisational networks/ Network competence

Robertson Maxine, Swan Jacky & Newell Sue	The role of networks in the diffusion of technological innovation	The Journal of Management Studies	May-96	33	3	The diffusion of computer-aided production management (CAPM) technology in the UK manufacturing sector during the mid to late 1980s is examined. Using 3 case companies where the introduction of CAPM occurred at approximately the same time, decisions regarding adoption, design and subsequent implementation, are explored in order to establish the influence of inter-organizational networks on the diffusion and subsequent appropriation of CAPM technologies. These cases revealed that potential adopters engaged in a range of inter-organizational networks through which they learned about new technologies. However, technology suppliers who were promoting similar ideas about best practice shaped the knowledge diffused through many of these networks.	Technology transfer/ Studies/ Knowledge/ Information dissemination/ CAM
Romijn, Henry & Albu, Mike	Innovation, networking and proximity: Lessons from small high technology firms in the UK	Regional Studies	Feb-02	36	1	The article explores how the innovative performance of small high-tech firms relates to their external networking activities, and whether geographical proximity in their network relations matters. Data from a small sample of electronics firms and software developers in South East England are used to construct indicators of innovativeness, which are correlated with variables capturing intensity of external interactions and proximity benefits. The regional science base is found to have played a key role in nurturing new high-tech ventures, but science parks had not contributed to this. Interaction with parties with complementary capabilities such as suppliers and service providers is also associated with high innovative performance. However, the findings do not support the current policy fashion of encouraging regional networks revolving around firms in similar business activities and close customer relations.	Studies/ High tech industries/ Innovations/ Small business/ Cluster analysis
Romijn, Henry & Albaladejo, Manuel	Determinants of innovation capability in small electronics and software firms in southeast England	Research Policy	Sep-02	31	7	The paper explores determinants of innovation capability in small UK electronics and software firms. An experimental innovation index is used alongside conventional proxies of innovative performance. These indicators are correlated with variables capturing a range of potentially important internal sources - such as education, prior work experience and R&D effort - as well as measures of intensity of external interactions and proximity in network relations. The findings support the importance of R&D, the key role played by the regional science base in nurturing high-tech spin-offs, and proximity to suppliers. However, no support is found for the current policy fashion of encouraging regional networks revolving around firms in similar business activities and close customer relations.	Studies/ Innovations/ Electronics industry/ Software industry/ Small business/ Cluster analysis/ Correlation analysis/ Research & development/ R&D

Rothschild, Leora & Darr, Asaf	Technological incubators and the social construction of innovation networks: An Israeli case study	Technovation	Mar-91	11	2	In Press, Corrected Proof	Based on a field study at a technological incubator affiliated with a leading Israeli university, this paper focuses on the construction and maintenance of informal networks of innovation, composed of entrepreneurs within the incubator, Technion staff and industry. A linear model of the development of emergent technology is set aside, while a cyclical model based on social networks is suggested. A wide array of exchange relationships (formal and informal), ranging from the use of library and laboratory services to an extensive and ongoing barter exchange of knowledge, know-how, and even shared practice is presented and discussed.	Technological incubation/ Informal networks/ Innovation/ Social networks
Rothwell, Roy	External Networking and Innovation in Small and Medium-Sized Manufacturing Firms in Europe	Technovation	Mar-91	11	2		The relative roles of large and small companies in industrial innovation has long been debated. Small and medium-sized firms (SMF) can be at a disadvantage relative to larger companies in establishing communication with external sources of scientific and technological expertise. The disadvantages are related to the SMFs' relatively low levels of in-house technical expertise and to the managerial opportunity costs associated with seeking out appropriate external sources of technical advice. The external technological needs of SMFs vary between and among sectors, depending on the type of innovation under development. UK data indicate that innovative SMFs generally have dense external networks involving other companies, usually SMFs, in a variety of technical, marketing, and manufacturing relationships. These relationships involve infrastructural institutions, such as universities and private sector research institutes. Small and large companies can benefit mutually from a growing pattern of relationships.	Studies/ Statistical analysis/ Small business/ Relations/ Innovations/ Experts/ Disadvantages/ Advantages
Rychen, Frederic & Zimmermann, Jean-Benoit	Birth of a cluster: The microelectronics industry in the Marseilles metropolitan area	International Journal of Technology Management	2002	24	7,8		The emergence and the build-up of an industrial and technological fabric in the microelectronics field, in the Marseilles metropolitan area, in the south of France is described. The origin of the process is the location of a new enterprise, called Eurotechnique, in 1979, as a joint venture of the French industrial and financial group Saint-Gobain and the US National Semiconductors. This implantation has been done in the framework of a national industrial policy, without any consideration or relationship to local scientific and technological potential. This enterprise was integrated in 1983 into the structure of Thomson-Composants, eventually giving rise to SGS-Thomson in 1987. After a period characterized by the creation of new small enterprises through spin-off operations, a serious crisis at the end of the 1980s led local actors to realize the weak territorial anchoring of the activity. The mobilization of new institutional initiatives aimed at fostering cooperation between complementary competencies and the success of Gemplus, in the field of smart cards, have initiated the emergence of innovation networks on a territorial basis.	Case studies/ Microelectronics/ Regions/ Metropolitan areas/ Economic development/ Area planning & development

Saxenian, AnndLee	Regional Networks and the Resurgence of Silicon Valley	California Management Review	Fall 1990	33	1	<p>When Japanese competition forced the US semiconductor industry into crisis during the 1980s, most observers predicted the demise of Silicon Valley. Yet, the region's economy is once again flourishing. More than 85 new semiconductor firms were started in Silicon Valley during the 1980s. By building on the dense networks of social relationships that were created and then abandoned by the established semiconductor firms, this new wave of semiconductor start-ups is creating a new Silicon Valley - one that fosters collaboration and reciprocal innovation among networks of specialist producers. Firms such as Cypress Semiconductor, Integrated Device Technology (IDT), and Weitek are building partnerships with customers and suppliers in order to monitor changing markets and jointly redefine products and processes. However, the Silicon Valley economy remains vulnerable. While today's producers are better organized to respond to volatile markets and technologies than their predecessors, they have yet to recognize the social basis of their dynamism and create local institutions that allow them to respond systematically to shared challenges.</p>	Start-ups/ Semiconductors/ Entrepreneurs/ Electronics industry/ Effects/ Business growth/ Alliances
Shaw, Brian	Innovation and new product development in the UK medical equipment industry	International Journal of Technology Management	1998	15	3,4,5	<p>The innovation process is examined for 34 UK medical equipment innovations developed by 11 companies, 26 through multiple and continuous interaction between the entrepreneurs and other actors in the networks. There were ten stages identified in the innovation cycle and the effective management ensured opportunities for sustainable cost advantage and product or process differentiation at the different stages in the cycle. The networking enabled both outside and inside product champions to flourish. For successful innovation, the integration of the activities of the actors in the network, the management of the sequential learning process, the adoption of an overlapping approach, the linking to knowledge in society, using complementary assets and creating credibility in the innovations was seen as essential.</p>	Innovations/ Product development/ Medical equipment/ Information dissemination/ Studies/ Product life cycle
Shaw, Brian	Formal and informal networks in the UK medical equipment industry	Technovation	1993/9	13	6	<p>Networking by entrepreneurs in the creation, development, design, manufacture, marketing, and re-innovation of 34 medical equipment innovations in the UK is examined. The networks created by the entrepreneurs facilitated the process of learning by doing, learning by using, and learning by interaction. During this learning process, capital and human resources were created that enabled the organisation to adapt and take advantage of techno-economic circumstances. Through outside linkages, the entrepreneurs accumulated the knowledge embedded in society and developed research with outside product champions. Collaboration with the users and other actors in the networks in prototype development, testing, and evaluation, marketing research, joint specification, user feedback, and the use of users as reference points in the marketing of the equipment facilitated the diffusion of costs throughout the innovation process and created differential advantages for the entrepreneurs.</p>	Entrepreneurial networking/ Medical equipment innovations/ UK/ Outside linkages/ Collaboration

Shepherd, Jonathan	Entrepreneurial growth through constellations	Journal of Business Venturing	1991/9	6	5	Constellations are particular types of networks in which particular roles in marketing and production are divided between leading and external firms. This division of roles and the coordination of the group through the links that connect leading and external firms within the constellation are examined. Constellation-style growth not only allows the firm to grow with a reduction of investment risk, but adds to competitive advantage by fostering personal entrepreneurship through the use of coordinated partnerships of external firms with a leading firm. Several cases are cited to demonstrate how the constellation functions in practice in Italy, and, from the mechanisms explained, it should be clear that the model can be adapted for international use.	Constellations/ Networks/ External firms/ Firm growth/ Partnerships
Sigvald J, Harryson	How Canon and Sony drive product innovation through networking and application-focused R&D	The Journal of Product Innovation Management	Jul-97	14	4	Using case studies of R&D efforts at Canon and Sony, the key mechanisms that these companies use to foster product innovation are identified and illustrated. Examples show how Canon and Sony use a combination of external and internal networking mechanisms to identify and acquire key technologies and related skills, gain market knowledge, improve the results of internal R&D efforts and ensure the successful transfer of these results to efficient production processes. There are 4 key mechanisms underlying successful production innovation at Sony and Canon: 1. Strategy training and job rotation for engineers, 2. Application-driven R&D, 3. Direct transfer of development teams from R&D to production, and 4. Extensive networking with external centres of excellence and key suppliers.	Electronics industry/ R&D/ Product development/ Organizational behaviour/ Training/ Production planning
Smilor, Raymond	Commercializing Technology Through New Business Incubators	Research Management	Sep/Oct 1987	30	5	A new business incubator is a facility for aiding the development of new companies. It provides a variety of services and support to start-up and emerging firms, with a definite preference for those in high technology and light manufacturing. Incubator models include: 1. University-related, 2. Private, 3. Community, and 4. Corporate-franchise. In 1985, a national survey of new business incubators was conducted, and responses were received from 50 of 117 incubators. Extensive on-site analysis and in-depth interviews with incubator managers and directors were performed. Business services that respondents considered most important for incubator management to provide to tenants included: 1. Business planning, 2. Marketing, 3. Accounting, and 4. Management. Annual sales were reported for 42 tenant firms, with 7% having no sales and 22% having \$1 million in sales. Incubators were found to provide 4 benefits to tenants: 1. Development of credibility, 2. Shortening of the learning curve, 3. Quicker solution of problems, and 4. Access to an entrepreneurial network.	Tenants/ Technology/ Surveys/ Start-ups/ R&D/ Projects/ Models/ Leverage/ Innovations/ High technology/ Companies/ Business growth

Smilor, Raymond	Managing the Incubator System: Critical Success Factors to Accelerate New Company Development	IEEE Transactions on Engineering Management	Aug-87	EM34	3	The new business incubator is an innovative system that offers a variety of support systems to entrepreneurs to accelerate new company development, speed the commercialization of technology, and contribute to economic growth. A study was conducted to understand how the incubator concept works in practice. In addition to a national survey, the research incorporated on-site review, case study analysis, and in-depth interviews with incubator managers and directors. As a result, 10 factors emerged as important to the effective management of the incubator system: 1. On-site business expertise, 2. Access to financing and capitalization, 3. In-kind financial support, 4. Community support, 5. Entrepreneurial network, 6. Entrepreneurial education, 7. Perception of success, 8. Selection process for tenants, 9. Tie to a university, and 10. Concise program milestones with clear policies and procedures. The more extensively these factors are incorporated into the incubator, the greater the chance of success for the tenant firms and the incubator.	Venture capital/ Success/ Studies/ Start-ups/ Services/ Organisation costs/ Factors/ Facilities/ Entrepreneurs/ Economic Development/ stage enterprises
Smith, Helen Lawton, Dickson & Smith, Stephen Lloyd	There Are Two Sides to Every Story: Innovation and Collaboration Within Networks of Large and Small Firms	Research Policy	Oct-91	20	5	Inter-firm collaboration networks serve to externalize the innovation function through the transfer of technology between firms. This is always a 2-way process. Collaboration also extends firm networks through linkages into those of the partner, linking individuals, firms, and sectors. An analysis of 27 cases of collaborative partnerships shows that, although it is possible to identify particular rewards and hazards resulting from inter-firm collaboration, what is clear is that each collaborator was confronted by a more or less novel set of circumstances in terms of size, product markets, and organizational idiosyncrasies. Changing technological and commercial imperatives mean that new rules have to be learned. The very newness of this active form of interdependence conflicts with traditional ingrained attitudes toward smaller companies. The analysis shows that the existence of informal, personal networks among the scientific and engineering elite was the key factor in the establishment of collaborative links.	Technology transfer/ Size of enterprise/ R&D/ Innovations/ Electronics industry/ Disadvantages/ Cooperation/ Advantages
Soh, Pek-Hooi	The role of networking alliances in information acquisition and its implications for new product performance	Journal of Business Venturing	In Press, Corrected Proof			The premise of Austrian economics on entrepreneurial discovery suggests that mutual knowledge about market participants defines who will acquire potential information about opportunities to bring future products into existence. Building upon this argument, this research investigates the role of networking alliances in information acquisition and its lagged effect on the new product performance of the firm. By using a longitudinal analysis, the study shows that a firm improves its new product performance as it increases the number of repeated partners and its centrality position relative to others in the technology collaboration network.	Products/ Networking alliances/ New product performance/ Collaboration network

Soh, Pek-Hooi & Roberts, Edward B.	Networks of innovators: a longitudinal perspective	Research Policy	In Press, Corrected Proof	This paper investigates how evolutions of complex technologies and networks of innovators affect the development of emerging innovations. Building upon the theories of technological evolution and socio-organizational dynamics, we develop propositions to examine the stability and change of networks punctuated by successive technological changes. We argue that incumbents who are early advocates of standards in complex technological environments are more likely to survive via alliances. Based on 150 firms and 319 alliances in the US data communications industry from 1985 to 1996, we found support for our propositions and the characteristics of central-periphery structure best describe the patterns of industry networks.	Complex technologies/ Networks of innovators/ Alliances/ US/ Communications industry
Staber, Udo	Spatial proximity and firm survival in a declining industrial district: The case of knitwear firms in Baden-Württemberg	Regional Studies	Jun-01 35 4	The literature on small firm networks in industrial districts postulates the importance of territorial proximity for business innovation and regional development, but empirical research to test this proposition is sparse. While there is some research on the extent of inter-firm co-operation, little is known about the performance outcomes of co-operation. Competing hypotheses from institutional, ecological and random action theories concerning the survival chances of firms located in geographic proximity are developed, and they are tested with data on the complete population of knitwear firms in Baden-Württemberg, Germany, for the period from 1960 to 1998. Proportional hazard estimates show that location in clusters of firms in the same industry increased business failure rates, and location in diversified clusters of firms operating in clusters or firms in the same industry increased business failure rates, and location in diversified clusters of firms operating in competition in resource environments.	Studies/ Small business/ Textile industry/ Geography
Staropoli, Carine	Cooperation in R&D through a network, and organizational gamble? An empirical analysis of Rhone Poulenc Rorer-Gencell	Technology Analysis & Strategic Management	Dec-98 10 4	This study is based on the empirical analysis of innovation challenges to Rhone Poulenc Rorer-Gencell resulting from the development of biotechnology in the pharmaceutical industry. These are identified as an organizational innovation involving the development of a network of partners following and/or inducing a technological innovation. RPR-Gencell represents a style of innovation since it is based on various factors specific to the firm and corresponds to a new organizational form, the tight network of partners. It is argued that this organizational form, in the context of the development of biotechnology in the pharmaceutical industry, can be likened to an "organizational gamble" associated with a "technological gamble."	Organizational structure/ Innovations/ Studies/ Pharmaceutical industry/ Biotechnology/ Partnering/ R&D

Sternberg, R.	Innovation Networks and Regional Development - Evidence From the European Regional Innovation Survey (ERIS): Theoretical Concepts; Methodological Approach, Empirical Basis and Introduction to the Theme Issue	European Planning Studies	2000 Aug	8	4	<p>A general consensus exists in the debate on innovation-oriented regional development, in which cooperation in innovation between manufacturing firms, service firms and research institutions continues to grow in importance with respect to business success and the economic performance of a region—at least for some region types. The academic discussion, thus far, has been shaped by a large number of outstanding theoretical studies focusing on this topic from the perspective of the innovative milieu concept, the network theory (spatial version), the regional innovation systems approach or the transaction cost theory. Up to now, comparative empirical studies have not been performed evaluating the significance of innovation networks over a sufficiently large and statistically representative data set for the various types of regions. This is the goal of this issue of European Planning Studies, which is introduced in this article. Briefly, the basic concepts for explaining network oriented regional development are described and the essential features of the European Regional Innovation Survey (ERIS) are presented—developed by a research team of German economic geographers and regional economists. Between 1995 and 1999 ERIS carded out three extensive surveys in 11 European regions with a total return of 8635 questionnaires, in an effort to identify, systematize, and quantify linkages between innovative players. The question of the range of such innovative linkages plays a central role in this analysis.</p>	Regional development/ Innovation/ Manufacturing firms/ Network theory
Sternberg, Rolf	Innovative linkages and proximity: Empirical results from recent surveys of small and medium sized firms in German regions	Regional Studies	Aug-99	33	6	<p>Recent theoretical discussion about modern approaches to explaining knowledge-based regional development in terms of industrial district, innovative milieu and network hypotheses emphasizes the importance of intraregional linkages between innovative actors. Among these, innovative firms and research institutions are regarded as most important for influencing regional economic development by intraregional linkages. Database research is supplied by analyzing several comprehensive surveys in three German regions. The focus is on the role that spatial proximity of partners plays in the establishment of innovative linkages between manufacturing SMEs and other actors, such as research institutions, customers and suppliers. The results in general confirm the hypothesis of strong and increasing intraregional linkages between innovative actors. However, some of the empirical findings regarding industrial districts like Baden do surprise.</p>	Studies/ Innovations/ Regions/ Small business/ Economic development/ Manufacturing/ Statistical analysis/ Studies/ Innovations/ Regions/ Small business/ Economic development/ Manufacturing/ Statistical analysis

Streb, Jochen	Shaping the national system of inter-industry knowledge exchange: Vertical integration, licensing and repeated knowledge transfer in the German plastics industry	Research Policy	2003/6	32	6	<p>We will claim in this paper that it was in particular the above-average propensity to share innovative information with customers and competitors which caused the exceptional international competitiveness of the West German plastics industry including chemical firms, plastics fabricators and machine makers. The system of knowledge exchange of this national cluster was shaped in two main steps. In the first half of the 20th century, cartelization and mergers were first tolerated and then even supported by the German government. It was in this period when German chemical firms formed the vertically integrated I.G. Farben concern which provided an optimal organisational framework to explore the new technological path of plastics. After the breaking up of I.G. Farben the firms of the West German chemical firms had to find new ways to maintain inter-industry technological co-operation in the second half of the 20th century. It turned out that they became aware of both contractual and non-contractual solutions of bundling standard good and information which were often placed somewhere between "market" and "hierarchy".</p>	Knowledge sharing/ International competitiveness/ Germany/ National cluster/ Chemical firms/ Plastics/ Cooperation
Swan Jacky, Newell Sue & Robertson Maxine	National differences in the diffusion and design of technological innovation: The role of inter-organizational networks	British Journal of Management	Sep-99	10	10	<p>Results from a study of the design and diffusion of computer-aided production management (CAPM) technologies across 4 European countries (UK, France, The Netherlands, and Sweden) are reported. The study combined surveys of members of professional operations management associations in each of these 4 countries and interviews with operations managers and technology suppliers. The findings revealed significant differences across countries in the design and diffusion of CAPM. This paper explains these findings in terms of differences in the structure and operation of these 4 professional association networks. These differences in inter-organisation networking encouraged different types of knowledge sharing related to the design of CAPM in the 4 countries.</p>	Comparative studies/ Production management/ Technological change/ Associations/ Business networking/ Many countries
Swan, Jacky A & Newell, Sue	The role of professional associations in technology diffusion	Organization Studies	1995	16	5	<p>A study investigates a professional production and inventory control (PIC) association in Canada. A survey of members revealed that this association was perceived to be an important network for learning about new developments in PIC. Predictors of technological innovation in PIC included involvement in the professional development activities of this professional association, as well as firm size and members' communication within their firm. The findings support the idea that professional associations impart knowledge that is important for the diffusion of technology. However, the influence of this professional association was limited by its rather small size and its lack of penetration into small firms. The results from the Canadian association are compared with earlier work conducted with similar associations in Britain and the US and suggest that there are national differences in the roles of these associations in the knowledge diffusion process.</p>	Technological change/ Studies/ Regression analysis/ Inventory management/ Innovations/ Information dissemination/ Associations

Swan, Jacky, Newell, Sue, Scarbrough, Harry & Hislop, Donald	Knowledge management and innovation: networks and networking	Journal of Knowledge Management	1999	3	4	Two cases of interactive innovation are contrasted. One focused almost entirely on using intranet for knowledge sharing, while the other recognized the importance of face-to-face interaction for sharing tacit knowledge.	Knowledge management/ Innovations/ Information sharing
Tarpey, Simon	Case study: The London Biotechnology Network - a people thing	Drug Discovery Today	15/5/2002	7	10	It all started in December 1999 after I had attended a meeting with numerous government officers to discuss setting up a biotechnology group for London. The need for a London-wide biotechnology organisation had been identified in a cluster report by Lord Sainsbury (UK Minister for Science) (http://www.dti.gov.uk/CB/biotechclusters/index.html), but had been talked about for some time before that. The current hotbeds of biotechnology around the UK in Cambridge, Oxford, Scotland and the northwest of England had developed regional biotechnology bodies, which had helped to promote the business in these areas. However, London, despite being a European centre for medical research, did not have such an organization. In fact, no one knew who was doing what, if anything, in commercial biotechnology in London.	Case study/ Biotechnology/ UK/ Cambridge
Tidd, Joe	Development of novel products through intra-organisational and inter-organisational networks: The case of home automation	The Journal of Product Innovation Management	Sep-95	12	4	Using the home automation industry as an example, the challenges involved in the development of complex product systems are examined. When products and services cut across traditional marketing and technological boundaries, radical innovation is difficult because different firms and industries are typically responsible for developing the various subsystems and components. Successful development efforts may require novel forms of innovation. Comparing organizational approaches and the networks of alliances for home automation in the US, Europe, and Japan, it appears that European firms tend to be more narrowly focused than American and Japanese firms. Because various technologies and industries are involved, open networks are more effective than closed networks or alliances. Japanese firms typically participate in open networks and overlapping consortia, which gives them an edge in the home automation industry.	Studies/ Statistical analysis/ Product development/ Organizational structure/ Innovations/ Consumer electronics/ Comparative analysis/ Alliances

Tomas, Jose & Arias Gomez	Do networks really foster innovation?	Management Decision	1995	33	9	<p>A warning is given that although technology and innovation are often the key drivers in the formation of business partnerships and networks, reflecting the parallel relationship between the institutional set and the technological set, the formation of tightly knit networks of relationships often entails drawbacks and hazards like increasing complexity, loss of autonomy and information asymmetry, all of which can hamper innovation and technological change. How networks simultaneously promote and block innovation in the partner companies involved are explored. An attempt is made to define the concept of the network and its multiple variations. Different attributes of networks as they related to innovation are analyzed: flexibility, speed and networks as learning systems. Ways to extract the maximum innovative potential from inter-firm networking are suggested.</p>	Technology/ Innovations/ Alliances
Tovstiga, G.& Fantner, E. J.	Implications of the Dynamics of the New Networked Economy for E-Business Start-Ups: the Case of Philips' Access Point	Internet Research- Electronic Networking Applications and Policy	2000	10	5	<p>This paper explores how the spread of connectivity and the introduction of new standards is driving the emergence of entirely new value constructs that deliver to multiple stakeholders. The new economics of network growth and the associated economics of increasing returns are examined. The dynamic trajectory of this function is looked at from the perspective of new business development at the various stages of the trajectory, and management implications for each stage are derived in terms of appropriate competitive and market strategies, organizational structure and management practices. The resulting framework is applied to discuss specific implications for the business start-up of Access Point, Philips' new multimedia, voice technology-based information and online services venture that has as its core a disruptive technology.</p>	Network growth/ New business development/ Management practices/ Philips
Tushman, Michael L & Scanlan, Thomas J	Boundary spanning individuals: Their role in information transfer and their antecedents	Academy of Management Journal (pre-1986)	Jun-81	24	2		
Udell, G. G., Bottin, R. & Glass, D. D.	Perspective - the Wal-Mart Innovation Network - an Experiment in Stimulating American Innovation	Journal of Product Innovation Management	1993 Jan	10	1	<p>The Wal-Mart Innovation Network (WIN) is a cooperative experiment designed to test an infrastructure for stimulating American innovations - new products invented and manufactured in the US. The WIN venture focuses on independent and small business inventors because it is here that WIN is likely to have the greatest impact. Rather than attempt to stimulate invention, the WIN strategy is simply to make it easier for existing ideas and inventions to reach the marketplace. In addition to other resources, WIN draws on the expertise of some 160 volunteer Wal-Mart executives, buyers, and marketing specialists who provide an assessment of marketability. Although innovation is the primary focus of the WIN venture, the bottom line objective is the creation of new, domestic manufacturing jobs.</p>	Innovation Network/ Case study/ Wal-Mart/ Small business/ Inventors/ Manufacturing

Verspagen, Bart	Large firms and knowledge flows in the Dutch R&D system: A case study of Philips Electronics	Technology Analysis & Strategic Management	Jun-99	11	2	This paper uses data on patent-to-patent citations and patent-to-science-literature citations to study the spill-over network of companies and research institutes around Philips Electronics. The theoretical section of the paper surveys the literature on innovation regimes and regional systems of innovation, and uses this to derive a number of testable hypotheses on the Philips network. The main findings of the paper are that the importance of local firms in the technology network around Philips is small, but the impact of local (semi-) public institutes is larger. It is also found that large firms generate a large part of the scientific literature that is referred to in Philips patents.	Case studies/ Consumer electronics/ R&D/ Size of enterprise/ Knowledge
Walcott, Susan M	High tech in the Deep South: Biomedical firm clusters in metropolitan Atlanta	Growth and Change	Winter 1999	30	1	The relation between biomedical firms and their metropolitan region location in Atlanta, Georgia, is examined as an empirical test of both innovative milieu agglomeration theory and place specific strategies for life science companies in the Deep South. This sectoral analysis utilizes questionnaires and targeted interviews to highlight the economic development role of real estate in suburban employment and residence sites (SEARS) and the intra-metropolitan directional migration of firms. Clustering of related industries is fostered by a shortage of appropriately configured laboratory and office space at the intermediate stage of the business growth cycle, encouraging information sharing and cooperative behaviour via proximity by necessity. Lack of a key networking individual or mediating organisation critically retards development of this potential growth engine.	Studies/ Business growth/ Biotechnology/ Cities/ Employment/ Office space/ Business cycles/ High tech industries/
Walsh, Vivien, Niosi, Jorge & Mustar, Philippe	Small-firm formation in biotechnology: A comparison of France, Britain and Canada	Technovation	1995/6	15	5	A comparison is made of the pattern of emergence, survival, and growth of small biotechnology firms in France, the UK, and Canada, using surveys in the 3 countries. These data are compared in turn with what is known about US biotechnology firms from the literature. Although the literature suggests that the appearance of new industries based on the emergence of new, small high-technology firms is a US phenomenon, evidence is presented of a nearly comparable pattern of small firm commercialization of biotechnology in the 3 countries studied, relative to the size of the countries. However, the Canadian, French, and British firms appeared 1-4 years later than the US firms, and are still somewhat weaker. While the US is generally held to have an entrepreneurial culture and a supportive private finance industry providing venture capital, which provides a stimulus to new high-technology firm formation, in the other 3 countries public policy - to a greater or lesser extent - made up for the relative lack of an entrepreneurial culture and private-sector finance.	Biotechnology/ France/ UK/ Canada/ Networking/ Business formation

Wetzel, Jr., William E.	The informal venture capital market: Aspects of scale and market efficiency	Journal of Business Venturing	1987/0	2	4	<p>The informal venture capital market in which entrepreneurs raise equity-type financing from private investors (business angels) is discussed. Private venture investors are usually self-made persons with substantial business and financial experience and with a net worth of \$1 million or more. These private investors manage a portfolio of venture investment aggregating in the area of \$50 billion, and by participating in smaller transactions, they finance over 5 times as many entrepreneurs as professional venture investors. In spite of the apparent scale of the informal venture capital market, evidence indicates that the market is relatively inefficient. The market is characterized by a shortage of information about investors and investment opportunities. In addition, a number of entrepreneurs and private investors are unfamiliar with the techniques of successful venture financing. The procedures and performance of the Venture Capital Network Inc., an experimental effort to enhance the efficiency of the informal venture capital market, are described.</p>	Informal venture capital/ Entrepreneur/ Business angel/ Venture capital networks
Yli-Renko Helena & Autio Erikko	The network embeddedness of new, technology-based firms: Developing a systemic evolution model	Small Business Economics	Nov-98	11	3	<p>The interactive relationship between new, technology-based firms and their network environment is presented. The mechanisms through which new, technology-based firms become immersed in innovation and manufacturing networks is analyzed. The concept of embeddedness is developed and used to depict such mechanisms. A systemic evolution model of new, technology-based firms is proposed; the model depicts the evolution of new, technology-based firms in manufacturing and innovation networks. The model emphasizes the catalyzing role of new, technology-based firms in national systems of innovation. Network embeddedness is empirically explored in five case studies of Finnish new, technology-based firms. The systemic evolution model serves as an interpretive scheme for the case studies. The analysis of the organic relationship between new, technology-based firms and their systemic environment also serve to reveal the implications of embeddedness for new, technology-based firms.</p>	Studies/ Small business/ High tech industries/ Innovations/ Evolution/ Mathematical models/ Manufacturing

Yoshio, Sugasawa & Shantha, Liyanage	Technology and business opportunities for small and medium enterprises in Japan: The role of research networks	International Journal of Technology Management	1999	18	3,4	The results of a survey conducted in 407 companies and 20 in-depth case studies are analyzed to assess the technology development needs of SMEs in Japan. The results show that capital and human resources are the major impediments to SMEs' efforts in new industrial technology development and the firms are increasingly relying on external knowledge sources to build up their technological competencies. The environment that influences the formation of such tie-ups for new products and technology development in SMEs. The results show that research links with external collaborators and knowledge networks are critical for the next phase of industry technology development in Japanese firms.	Studies/ Technological planning/ Innovations/ R&D/ Small business/ Roles
Zeller, C.	Clustering Biotech: a Recipe for Success? Spatial Patterns of Growth of Biotechnology in Munich, Rhineland and Hamburg	Small Business Economics	2001 Aug	17	1-Feb	This paper discusses the unequal spatial development elaborating perspectives that derive from recent debates about regional innovation systems. The biotech regions Munich and Rhineland, both winner regions of the BioRegion Competition are described and compared with the situation in Hamburg where biotechnology is much less important. The degree and relevance of locally integrated input-output relations of innovation systems are analyzed based on typologies of the wide range of firms within the biotechnological value chain and the forms of cooperation. Moreover, a qualitative estimate is given with respect to the significance of untraded relationships and regional knowledge spillovers. Factors favoring local integration are compared with those favoring input-output systems on a transatlantic scale. The paper discusses the question whether the biotech industries in the regions of Munich, Rhineland and Hamburg represent identifiable regional systems of innovation.	Spatial development/ Biotechnology/ Germany/ Value Chain/ Regions/ Innovation/ Regional systems

