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Networking and Innovation: A Systematic Review of the Evidence

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ABSTRACT

Porter and Ketels' (2003) study of British competitiveness emphasised the importance of business networking for innovativeness. Until recently insights into the dynamics of this relationship have been fragmented. This paper presents a systematic review of research linking the networking behaviour of firms with their innovative capacity.

We find that the principal benefits of networking as identified in the literature include, risk sharing; obtaining access to new markets and technologies; speeding products to market; pooling complementary skills; safeguarding property rights when complete or contingent contracts are not possible; and acting as a key vehicle for obtaining access to external knowledge. The evidence also illustrates that those 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.

At an institutional level, national systems of innovation play an important role in the diffusion of innovations in terms of the way in which they shape networking activity. The paper provides evidence suggesting that network relationships with suppliers, customers, and intermediaries such as professional and trade associations are important factors affecting innovation performance and productivity. Where networks fail it is due to inter-firm conflict, displacement, lack of scale, external disruption and lack of infrastructure.

The review identifies several gaps in the literature that need to be filled. For instance, there is a need for further exploration of the relationship between networking and different forms of innovation, such as, process and organisational innovation. Similarly, we need better understanding of network dynamics and network configurations, as well as the role of third parties such as professional and trade associations. Our study highlights the need for inter-disciplinary research in these areas.

INTRODUCTION

The systematic review from which the findings in this paper are presented was motivated by a quest to establish the extent to which UK companies are engaged in networking activities when seeking to develop their innovative capacity. Specifically, the objectives of the review were to:

i) Establish the nature of the relationship between networking and innovation

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

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

iv) Generate insights informing policies aimed at fostering business-to-business networking leading to greater innovative capacity.

v) Identify areas for future research for the Economic and Social Research Council's (ESRC) Research Priorities Board.

The Porter report had established that inter-organisational networking was 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 was, however, less clear in the report. For instance, Porter and Ketels' (2003) study 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 was therefore to systematically explore the evidence in view of the Department of Trade and Industry (DTI) mandate: *Are UK businesses effective in external networking with other businesses in support of innovation?* Following consultation it was agreed 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.* In this paper the authors present a sub-set of the findings from the systematic review and consider the *general* evidence base that has explored the relationship between innovation and networking across countries and sectors[1]. In the following section we outline the specific methodology we adopted to conduct this particular review.

METHODOLOGY

Despite the significant number of studies that have been conducted in this general area, since the 1980s, little attempt has been made to systematically translate these findings into a comprehensive review of current knowledge and there have been few

[1] For further information on the UK's performance please refer to the full report (add reference).

attempts to link such knowledge with policy decision-making. The complexity of the issues involved required a systematic review exploring all aspects of the existing literature and empirical evidence. The study aimed to fill this gap, thereby enhancing our understanding of the relationship between networking and innovation.

A number of themes were pursued. Firstly, the study sought to 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*. Secondly, it aimed to explore the relationship between informal networking and innovation, for example: communities of practice; mentoring schemes; knowledge brokerage; and entrepreneurial networks *et cetera*. Thirdly, it explored how networking behaviour can be successfully translated into tangible outcomes specifically related to innovation. Finally, the study looked for examples of network failure and inertia militating against innovation occurring. The review strategy had a number of stages designed to provide a systematic and explicit method for the review as outlined in the prologue to this special issue of the journal. The following steps were taken in this particular study; these steps were both guided by the general methodology as previously outlined and adapted to the particular requirements of the subject of study.

i) The review team identified key words on the subject based on their prior experience. These words were identified using a form of brainstorming. They included for example: innovation; networking; diffusion; collaboration; actor network theory; and brokers among others.

ii) The key words were constructed into search strings. For example, the search string [Network* AND innovat* OR effect* OR collapse OR dysfunction OR

disintegrate] was used as a secondary method for finding citations on the failure of innovation networks.

iii) 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. For example, additional words, such as: complexity; embeddedness; social capital; co-operation; alliance; and, proximity, were found to be important during this secondary analysis.

iv) The basic search string innovat? AND network? was used in seven search engines to identify three key citation indexes for the review. These were chosen based on the volume of citations relevant to the basic search string. The search engines reviewed included: ABI Proquest (1294); Business Source Premier (1088); Science Direct (1473); Web of Science - Social Science Citation Index (1543); EBSCO (390); PsycINFO (560); Emerald (904).

v) The citation databases (ABI Proquest, Science Direct and Web of Science) chosen were reviewed using the search strings identified in steps ii and iii. These search strings were progressively analysed from the most basic to the most complex. For example, the basic search string "Innovat* AND network*" added "AND ties OR dynamic* OR isomorphism OR knowledge (w) spill*" when the reviewers wanted to identify articles relevant to the dynamics of network relationships. A full protocol for the use of these search strings was devised and followed in the review process.

vi) The citations identified were reviewed according to the inclusion and exclusion criteria (Appendix 1 and 2). Two stages were undertaken to reduce the number of citations, the first analysed the titles of articles according to the

exclusion criteria and the second analysed the abstracts according to the inclusion criteria.

vii) The existing citation abstracts were reviewed according to the quality criteria (Appendix 3) and separated into an A, B and C lists. After steps i to vii 174 citations remained in the A list.

viii) 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.

ix) Articles were reviewed according to their relevant subject theme as identified in the narrative coding in step viii.

x) Sections were written as the articles relevant to particular themes were reviewed. Additional articles were added according to professional recommendation and references from articles included in the A list.

THE EVIDENCE BASE

In this paper a sub-set of the findings is presented exploring the relationship between networking and firms' propensity to innovate. Here we explain the precise nature of the total evidence base used for the study. The systematic review was carried out according to the methodology presented. 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. Table 1 highlights the number of citations relevant to the subject found according to stage of the review.

[Insert Table 1 here]

The results show that networking and innovation have 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 five journals in terms of their coverage of this topic in the review were Research Policy; Journal of Business Venturing; Regional Studies; Technovation; and, International Journal of Technology Management. In addition to these journals the review sourced articles from another 47 journals. Undertaking a key word analysis illustrates the nature of the papers reviewed for this study. The top ten key words (in order of importance) in the review were: Innovations; Research and Development; Small Business; Alliances; Regions; Technology Change; Statistical Analysis; Business Networking; Organisation Theory; and, Product Development. The review also analysed the industrial focus of the papers included and this is presented in Table 2.

[Insert Table 2 here]

Table 2 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 therefore be applied when seeking to generate conclusions from this study to primary or service industries as they only represent 5.7% and 2.9% of the sample respectively.

The papers reviewed were also analysed according to the countries that featured within studies. This analysis showed that 36 papers had empirical data based on the UK, 35 on the USA, 42 on other European Countries (Germany with 14 studies was the highest other European country included in the review), 11 were on Japan and 3 were on other countries (Australia; Brazil and Israel). The number of studies focusing on the UK is quite high illustrating 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 relatively low in terms of total numbers (36 out of 127 papers).

Following the analysis of the A-list citations using NVIVO (stage viii) a thematic review was developed. The results of the thematic analysis are presented in Table 3.

[Insert Table 3 here]

The thematic review illustrates that a large proportion of the articles reviewed 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. For example from 1999-2003 93 papers were published on the subject while from 1981-1986 4 papers were published. The analysis of the citations on networking and innovation also shows an upward trend between 1981 and 2003. 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 illustrates that it is a relatively new area of investigation and published work is therefore quite limited.

In summary, with regard to the overall sample of evidence used in this paper a number of key points can be made. 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, the research to date lacks some depth in terms of the very limited number of studies that have been carried out. The research is also fragmented as it is spread across a large number of authors, journals and disciplines in social science. The main conclusion drawn from the sample used in this systematic literature review was that

the subject area may require some prioritisation by a 'critical mass' of academics over a prolonged period if the evidence base is to be improved and expanded.

What follows is our analysis of the general relationship between innovation and networking based on a sub-set of the empirical evidence that was derived from the systematic literature review. The following section provides an overview of this relationship. We then present a schematic that illustrates this relationship. The framework serves to structure the analysis that follows where we consider the role of the parties that constitute the networking interface and infrastructure. We finish our analysis by considering evidence on the limitations of networks in innovation processes and network failure. To conclude the paper we consider important areas for future research and briefly highlight policy implications derived from the existing evidence base.

OVERVIEW OF THE RELATIONSHIP BETWEEN INNOVATION AND NETWORKING

Innovation in this study was mindful of the DTI's emphasis that innovation is the *successful* exploitation of new ideas. The successful exploitation of a new idea relates to different forms of innovation - product, process or organisational innovations. The study, therefore, adopted 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" DTI's Innovation Report (2003, p. 8).

The study consequently assumed that innovation was both about the generation and exploitation of new products, processes, services and business practices. As products become increasingly modular and knowledge is distributed across organisations (Baldwin and Clark, 2000) firms recognise an increasing requirement to collaborate with other

firms both formally and informally. Indeed, the locus of innovation is no longer the individual or the firm but increasingly the network in which a firm is embedded (Powell, Koput and Smith-Doerr, 1996). Many scientific and technological breakthroughs result from numerous contributions of many actors working in networks (Bougrain and Haudeville, 2002) and the standards necessary for a technology to function across different markets depend increasingly on networks of firms (Munir, 2002).

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 in biotechnology to the market are scattered across a host of different organisations both large and small. While the biotech industry illustrates the importance of networking for innovation the review highlighted the need to network when seeking to innovate as a prerequisite across the majority of sectors. Networking behaviour was identified as significantly boosting 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 included: service industries[2], primary industries[3], manufacturing industries[4] and high-tech industries[5].

Gemser, Leenders and Wijnberg (1996), for example, demonstrated the impact of networking in the global pharmaceutical industry, the US computer industry and the Italian furniture industry. They demonstrated that the annual growth rate of 18% in the

[2] Financial services and food
[3] Agriculture; energy; oil and gas
[4] Automobile components; ceramics manufacturing; clothing; mechanical engineering; packaging machine industry
[5] Aerospace and defense; biotechnology; electronics; embryonics; enzymes; home automation; petrochemicals; plastics; robotics; semiconductors; software; telecommunications.

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. Using the examples of Concorde and Airbus, Frenken's (2000) analysis of the history of the aircraft industry also shows the key role of transnational networks in the development of innovative aircraft. He explains how the recombination of national strengths / competencies via networks and projects can play an important role in the identification of new opportunities.

Gemünden, Ritter and Heydebreck's (1996) study also examined the networking effects of innovation in six high-tech industries. This study demonstrated 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 that 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.

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 (Almeida and Kogut, 1999); pooling complementary skills (Eisenhardt and Schoonhoven, 1996; Hagedoorn and Duysters, 2002); safeguarding property rights when complete or contingent contracts are not possible (Leibeskind, Porter, Zucker and Brewer, 1996); and, acting as a key vehicle

for obtaining access to external knowledge (Powell, Koput, and Smith-Doerr, 1996; Cooke, 1996). The evidence from the literature review also illustrates that those 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.

It is also important to recognise that while networks play a crucial role promoting the development of innovations within and across firms they also play a key role in the diffusion of innovations across and within sectors. For example, at an institutional level, national systems of innovation do play an important role in the diffusion of innovations in terms of the way in which they shape networking activity (Nooteboom, 2000, Furtardo, 1997). Nooteboom's study (2000), for example, characterises the UK innovation system as one that promotes the diffusion of more radical innovations which demand entrepreneurial activity cutting across sectors, rather than promoting the diffusion of innovation within sectors. This clearly has networking implications. 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 other organisations have developed or adopted (Erickson and Jacoby, 2003). They influence this in a number of ways: firstly, by enhancing access to knowledge - promoting awareness and early adoption of innovations - and secondly, by promoting social interaction, generating trust and

reciprocity that is conducive to knowledge transfer. To summarise, with regard to the relationship between networking and the diffusion of innovations, the majority of research highlights the role of individuals and more specifically the importance of interpersonal and informal networking for the diffusion of innovations. However more generally, 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 focussed research on the impact of networking on the development and diffusion of different forms of innovation (e.g. product, process and organisational).

OVERVIEW OF NETWORK FORMATION AND CONFIGURATION

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, p. 261). The literature provides two major reasons to explain why 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). From this perspective, 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, 1985).

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. However there exists at least two barriers to network formation. Firstly, firms with high levels of technical and commercial competence are less likely to see the value of forming network relationships with other firms. Secondly, businesses with few existing relationships often lack the

technical and commercial competences required when trying to attract partners (Ahuja, 2000). A study of the UK/US defence industry, for example, 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, Harris and Dickson, 2003).

The relative ease with which business-to-business networks form was also found to be influenced by social institutions. Empirical evidence shows that these institutions can shape the cultural conditions and infrastructure for networking, as well as, acting as brokers and intermediaries in network formation. Institutions such 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) all shape the development of the infrastructure that is required to assist the formation of business-to-business networks.

In terms of the types of firm engaged in networking activity the research suggests that it was not only found to be valuable for established businesses but is also beneficial for entrepreneurs. Through networking the success rate of entrepreneurial initiatives can be enhanced (Baum, Calabrese and Silverman, 2000) because interpersonal and inter-organisational relationships enable actors to gain access to a variety of resources held by other agents. 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 other studies also show that successful entrepreneurs consistently use networks to get ideas and gather information and advice (Birley, 1985; Smeltzer, Hook and Hutt, 1991). Ties to venture capitalists and professional service organisations 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 (Teece, 1986; Baum et al. 2000). 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). As Baum et al (2000) 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; and by allying with potential rivals that provide more opportunity for learning and less risk of intra-alliance rivalry.

The literature on network formation and networking activity therefore clearly demonstrates that whilst firms collaborate in networks for many different reasons the most common reason to do so is to gain access to new or complementary competencies, technologies and markets. The question of how firms should position themselves within networks or what kinds of network configurations facilitate innovation remains ambiguous. The literature highlights the important role that trust plays in developing and sustaining successful networking activities in terms of the creation, flow and integration of knowledge but importantly, the constituents of successful network structures is debated widely in the literature (Ahuja, 2000). For example, Shan, Walker and Kogut (1994) suggest that the number of collaborative relationships that a firm is involved in is positively related to innovation output, while conversely, closed networks have been found to foster innovation more than open ones (Coleman, 1988). In further disagreement 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. Contrary to this perspective, Brass and Burkhardt (1992) propose that the best position is one where all firms are tied only to the focal actor. Ahuja's (2000) empirical findings suggest that the benefits of increasing trust, developing and improving

collaboration and reducing opportunism shapes network structures creating cohesive interconnected partners. These studies consequently highlight that there is no consensus as to the optimal networking configuration. The nature of networks encountered in this review illustrate 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.

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 evidence on network configuration presented in Table 4 shows a number of key points:

i) The nature of network configuration and its utility for innovation and competitiveness depends on the strategic requirements of individual firms (Ostgaard and Birley, 1994; Koch, 2003).

ii) Firms will use networks in different ways and will reconfigure them if necessary (Kash and Rycroft, 2002).

iii) Network configuration often differs between different forms of innovation required by actors; networks for product innovation are quite different

from networks for process innovations (Gemünden, Ritter and Heydebreck, 1996)

iv) The nature of a firms' alliance network during business formation can have important ramifications for future business performance (Baum, Calabrese and Silverman, 2000).

v) All types of network configuration constantly change and adapt depending on the requirements of partners and the context within which the network operates (Larson, 1991).

[Insert Table 4 here]

The evidence reviewed shows that network configurations are dynamic and principally guided by the choices of partners and their network management capabilities and are beyond the direct influence of policy intervention. The evidence suggests that network infrastructures 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.

To summarise, regarding networking formation and network configurations for innovation a number of points can be established from the empirical data. Networking can have a positive impact on innovation in all organisational contexts (i.e within established large organisations, small businesses and new entrepreneurial start-ups). Network forms are, however, complex and research has not yet clearly demonstrated which configurations most impact on innovation in particular contexts. Furthermore, there are a range of identifiable factors promoting and preventing the establishment of business networks. Following this initial analysis of the evidence on the relationship between networking and innovation, network formation and network configuration a schematic was developed to structure the more detailed analysis presented in the next sections of the paper (see Figure 1).

[Insert Figure 1 here]

In the following section detailed empirical evidence from the systematic literature review is presented to more fully explore (i) the parties involved and the interrelationships between the networking infrastructure and networking interface and (ii) the importance of network management and network governance to network activity and relations (as presented in Figure 1).

INTER-RELATIONSHIPS BETWEEN THE NETWORKING INFRASTRUCTURE AND NETWORKING INTERFACE

The Importance of Partner Diversity

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; regions; or between science and industry (Kaufmann and Tödtling, 2001). Based on this work the importance of diversity of relationships in networks has been shown to have an impact on innovativeness (Kaufmann and Tödtling, 2001). The value of diverse partners for innovation is demonstrated in Kaufmann and Tödtling's (2001) empirical research and were 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. These studies show that innovation is influenced by many actors both inside and outside the firm and that the most important partners are from the business sector, customers first (33.5% of firms) and suppliers second (21.9% of firms). Studies on partnering have also shown that the willingness of firms to co-operate outside of these 'direct' relationships was rather limited. For example, co-operation with Universities was 8.9% of firms in Kaufmann and Tödtling's work. In contrast, however, research in Germany highlights significant national differences with respect to involvement with research institutes and universities

and illustrates the importance of scientific partners in some industry sectors (Ritter and Gemünden, 2003).

The types of partner firms engaged in networking appears to be related to the type of innovation occurring. For example, 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. Advanced innovators and the development of radical innovations tends to demand more interaction with universities. This point is supported by Gemünden, Heydebreck and Herden's (1992) survey of 4564 firms in the Lake Constance region (on the border between Austria, Germany and Switzerland). Examining interactions between firms, customers, suppliers and university interactions the suggest,

"Firms which do not supplement their internal resources and competence with complementary external resources and knowledge show a lower capability for realising innovations" (Germünden, Heydebreck and Herden, 1992, p. 373)

In conclusion, the evidence shows that the innovation process, particularly complex and radical innovations benefit from engagement with a diverse range of partners which allows for the integration of different knowledge bases, behaviours and habits of thought. Formal and informal communication between people with different information, skills and values increases the chance of unforeseen novel combinations of knowledge, which can lead to radical discoveries. More risk adverse firms, however, tend to link their innovation activities and networking relationships to customers because knowledge of clients' demands as the risk of failure for the innovating firm is perceived to be lower. Innovation is no less valuable but is more incremental and productivity gains are more modest. This suggests a direct relationship between type of networking activity and innovation type (e.g. radical or incremental). The studies highlighted (Germünden et

al. 1992; Ritter and Germünden, 2003) also show that firms that do not network possess much lower levels of competence in innovation.

The Role of Suppliers

The integration of suppliers in the innovation process 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). 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). Within the evidence reviewed it has been found that the effective integration of suppliers in new product development processes can:

i) Have a significant impact on cost, quality, technology, speed and responsiveness of buying companies (Ritter and Germünden, 2003).

ii) Help manufacturers identify improvements that are necessary for them to remain competitive (Perez and Sanchez, 2002).

iii) Enable firms to bring to bear wider expertise during the development process (Romijn and Albu, 2002).

iv) Help reduce concept-to-customer cycle time, costs and reduce quality problems (Ragatz et al. 1997).

v) Lead to higher levels of productivity and quality (Perez and Sanchez, 2002).

vi) Assist with improvements in the overall design effort (Conway, 1995).

vii) Lead to closer more open supplier relationships (Conway, 1995).

viii) Create easier access to supplier knowledge and expertise in the longer-term (Conway, 1995).

ix) Provide clearer focus on the projects that require joint development (Ragatz et al. 1997).

x) Lead to improved communication between the partners (Ritter and Germünden, 2003).

Consequently, 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 5 summaries the identified improvements for effective supplier integration in Ragatz's et al (1997) study.

[Insert Table 5 here]

When examining management practices, involving 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). Interestingly it was also noted that companies that networked effectively with suppliers also invested more in research and development because they required an infrastructure in which to frame collaborative behaviour (Perez and Sanchez, 2002).

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 are 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).

The Role of Customers

Von Hippel (1978) was one of the first researchers to highlight the pivotal role of customers or users in innovation processes. He highlights two forms of approach to innovation and networks and argues that customer focused approaches are the most effective as opposed to product focused ones. Customers should play an active role in the innovation process and are capable of identifying novel ideas for development (Von Hippel, 1978). 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). Ragatz et al's (1997) work has also shown that customers are considered to be the most important partners during incremental innovation.

Other studies have 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). Moreover 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). Such network relationships with customers are viewed to be important because:

i) Dialogue between key business customers and suppliers not only allows firms to learn of existing needs but also leads to the discovery of new needs in advance of the competition (Bruce and Rodgus, 1991).
ii) Customers who are actively engaged in the early stages of product innovation will assist the development of ideas (Biemans, 1989).

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

iv) 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, for example, 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 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 6 shows a sample of the evidence on the 'Networking Interface'.

[Insert Table 6 here]

As outlined, 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 paper will consider the broader networking infrastructure by examining the role of third parties within innovation networks.

The Role of 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 (see, Table 7).

[Insert Table 7 here]

Third parties have a dual role in promoting innovation. They ideally act as neutral knowledge brokers (though see Robertson et al, 1996) but also act as important conduits for the development of *informal relationships* which are the basis for the development of network relationships particularly between small firms. Although professional associations, trade associations and consultants make some important contributions to the network infrastructure there are 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, also all play an important role within the network infrastructure.

The Role of Science Partners

Whilst the review focused principally on business-to-business networks, science partners play an important role as independent network brokers and intermediaries within business networks and this was explored by the study. The important role of informal personal relationships in networks outside of the market interface was also evident in the wider research on science partners (Verspagen, 1999; Kaufmann and Todtling, 2001). As well as direct benefits of interaction between science and industry, science partners provide an important role as intermediaries within networks acting as network nodes where the exchange of knowledge can occur (Bougrain and Haudeville, 2002).

The evidence on science partners shows that they contribute to innovation networks usually through informal-personal networks (Bower and Keogh, 1996) and that their contribution is important in enabling firms to develop thinking that steps outside of their particular business system (Liyanage, 1995). Science partners also act as brokers, intermediaries or neutral agents within networks enabling different business systems to communicate by generating trust between different parties (Hausler, Hohn and Lutz, 1994). The evidence demonstrates that science partners tend to be most important where the innovation is relatively radical in orientation (Ebadi and Utterback, 1984; Verspagen, 1999; Fritsch, 2001).

The Role of Venture Finance Partners

The importance of appropriate venture finance and loan finance for innovation has been widely documented (Harding, 2000). The importance of finance networks, however, has received less attention but is arguably of equal importance. The evidence base on venture capital networks and innovation shows a number of key issues. 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 (Bygrave, 1987; 1988). The quality of links between venture capital firms, therefore, provides an important networking infrastructure for the commercialisation of innovation (Florida and Kenney, 1988a).

The establishment of venture capital firms locally in established technology centres (e.g. Cambridge in the UK) enables firms to prosper via the higher concentration of good deals (Florida and Kenney, 1988b). Such finance networks when well-developed attract further start-up activity creating a self-reinforcing cycle (Florida and Kenney, 1988b). 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 (Bygrave, 1988).

The evidence on informal investment networks (business angel networks) highlights similar issues. Haar et al.'s study (1988) shows that informal investment networks are particularly important during a firm's pre-start-up, start-up and early growth stages of development and that most referral networks for informal finance are composed of family and friends (Haar, Starr and MacMillan, 1988). Other 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 (Harrison and Mason, 1992; 1996). 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 (Wetzel, 1987).

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.

The Role of Institutional Mechanisms

Institutional mechanisms designed specifically to create and facilitate networks come in many forms, the most common forms are clusters, incubators and centres for cooperation. The evidence in this study examining networking and innovation and the role of institutional mechanisms was considered insufficient to draw any useful conclusions. It is possible that the lack of coverage occurs due to the nature of the methodology employed in this review, however, it appears that this area potentially presents a priority for future research. Despite the paucity of 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 8.

[Insert Table 8 here]

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 innovation occurs less often and is less successful (Staber, 2001). 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. Detailed evidence on how Science Parks might promote such networks also appears to be absent from the literature (Phillimore, 1999).

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 (Smilor, 1987a; 1987b; Rothschild and Darr, 2003). Again the detailed evidence on incubators' role in creating and supporting business networks is inconsequential. Likewise, although National and Regional Centres for

collaboration are cited in the Porter and Ketels (2003) report as valuable for networking (as highlighted in the Australian Wine Cluster) and good examples have been found by this study in the UK, none of the evidence directly addresses their value in terms of networking and innovation. There is some scope for these initiatives and anecdotal evidence supporting their formation but limited current evidence explaining their value. One finding from this study is an urgent need to examine in more detail the available evidence on institutional mechanisms and there usefulness when promoting innovation networks.

NETWORK GOVERNANCE AND MANAGEMENT

In general, network ties have been found to be much more conducive for the exchange of information and knowledge across partners than market mechanisms. The characteristics of network ties, however, are significantly shaped by modes of network governance and network management. In principal, the socialisation that starts to occur through networks that develop from weak to strong over time 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 inter-firm collaboration (Hausler et al, 1994, Hoang and Antoncic, 2003) and an integral reason for inter-firm networks' longevity (Lipparini and Sobrero, 1994).

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.

Research in the biotechnology and semiconductor industries in the US, UK, Germany and Japan also support this view (Bolton et al, 1994, Nooteboom, 2000).

The type of interdependence characterising the network relationships between firms was found to be an important mediating variable in terms of establishing the appropriate governance mechanisms that will promote innovation (Grandori, 1997). Grandori's review highlighted that firms clearly need to establish the type of interdependence that 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 were both recognised as being detrimental to innovation (Nooteboom, 2000). Consequently, how networks are governed plays an important role in their effectiveness and their capacity to assist the innovation process (Coles, Harris and Dickson, 2003).

Network management is also considered crucial for successful innovation and firms need to improve their proficiency (Ferrary, 2003). However, 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 knowledge embodied in new technologies and ideas (Cohen and Levinthal, 1990) are critical skills a firm requires when exploiting relationships. The research has shown the importance of network management generally (Coles et al. 2003; Ritter and Gemünden, 2003) and specifically, the role of product champions and gatekeepers (Shaw, 1998); the nature of networking practices (Biemans, 1991) and decision-making behaviour on network activity (Ebadi and Utterback, 1984). 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 (Biemans, 1991). Those responsible for managing network relationships 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; the role that friendship or reputation plays in the identification of partners and, the kinds of milestones or interventions are needed to ensure a project stays on course (Shaw, 1998).

Knowledge of how to collaborate accumulates over time through experience, reflection, and interpretation (Lorenzoni and Lipparini, 1999). Learning from collaboration was found in the empirical work reviewed to be a function of a firms' access to knowledge and its possession of the capabilities for utilising the relationships and knowledge established (DeSanctis, Glass and Ensing, 2002). The evidence found in the review shows that a firm's 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 (Powell, Koput and Smith-Doerr, 1996).

To conclude this section presented the empirical evidence on the relationship between networking and innovation. The next section focuses on the evidence relating to network failure and the limitations of networks in innovation processes.

NETWORK FAILURE AND NETWORK LIMITATIONS

The vast majority of the evidence analysed was extremely positive about the value of business-to-business networks and their impact on the innovation process. No systematic review on this subject would be complete, however, without some focus on why networks fail or the factors that prevent the effective operation of networking behaviour. Networks appear to encounter problems for a variety of reasons, for example: due to inter-firm conflict; as a consequence of displacement; lack of scale; external disruption; and, lack of infrastructure.

Networks can endure and evolve over many years and as a consequence they go through periods of conflict between partners, which can and do lead to the failure of the network (Coles, Harris and Dickson, 2003). Although networks may suffer internal strife they also encounter displacement and conflict with other alternative networks. Izushi (1997), for example, examines the technological adaptation encountered 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.

All networks have rules of engagement which 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. Although the positive impact of networking on innovation performance appears 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). 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 behavior by necessity. The lack of key networking mediating organisations critically retarded the development of these firms in the study.

A number of other studies reviewed 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 of the Swiss Watch Industry that the emphasis on technological innovation realised through cooperation lacked 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.

A study by Rychen and Zimmermann (2002) on the microelectronics cluster in the Marseilles area of France also highlighted that if decisions guided by national policy, that seek to implant clusters or networks into areas, do not take into consideration local conditions they 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 evidence was 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).

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 only the development of 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, also has a negative effect on innovation. Though, as previously discussed Burt's (1992) research demonstrated contrary findings.

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

Although networks have been shown to contribute to innovation and competitiveness, this study has already demonstrated that they can also inhibit innovation by encouraging anti-competitive behaviour, suggesting that the ultimate value of a network is dependent upon what it is used for. The use of networking has also been shown to conflict with the strategic interests of particular companies at certain times. From the review of the evidence a number of other limitations of networking have been demonstrated.

i) 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 by 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.

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

iii) 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 other things are more fundamental (e.g. skill base of labour markets and regulation) and drive innovation and competitiveness more generally.

iv) Tomas and Arias (1995) also point out that closely connected networks also encounter drawbacks for example, increasing the complexity of the innovation process; losing ownership control of the innovation; and, information lop-sidedness where partners have very different understandings about the nature of agreements.

CONCLUSIONS

This review of the evidence base concerning the relationship between networking and innovation has highlighted a number of areas in need of future research. The first obvious gap in the literature concerns the relationship between networking and different forms of innovation, such as, process and organisational innovation. To date the focus of research across disciplines has been primarily on product innovations. Whilst process and

organisational innovation may be, by their very nature, more difficult to study, the types of networking activity occurring in the development, diffusion and implementation of process and organisational innovation warrants serious attention. It may then be possible to compare networking activities and configurations across these different types of innovation and derive useful conclusions about the differences.

More generally, perhaps the most significant area for future research is in the area of network dynamics and network configurations. The evidence suggests that there is considerable ambiguity and contestation within the literature regarding appropriate network configurations for successful innovation. Whilst networking configurations are clearly contingent upon such factors as sector, type of innovation (radical vs. incremental; product vs. process), far more systematic research needs to be conducted in this area. By recognising that networks are inherently dynamic, research could benefit from adopting a longitudinal approach.

Related to this, it is clear that whilst considerable research has been conducted on the networking activities that occur between suppliers, customers and firms (operating within the networking interface) and this has been demonstrated to provide clear benefits, far more research is needed to explore and understand the ways in which diversity of partners facilitates innovation. In addition, the role of third parties operating within the networking infrastructure such as professional and trade associations is under-researched. The evidence base suggests that third parties are important for the development of informal relationships but the processes through which informal networking relationships develop and subsequently impact on innovation clearly needs to be investigated further.

A key feature of informal networking is the transfer of tacit knowledge promoting learning, which provides significant benefits for innovation. Although this has been

highlighted throughout much of the literature the mechanisms through which this occurs is an important area for future understanding.

What was surprising from this review was the very limited volume of published research located on institutional mechanisms for facilitating networking and their impact on innovation. What evidence exists is also mixed in terms of the impact identified. Given the policy implications it would seem to be an area requiring urgent attention.

The review also highlighted that study on innovation and networking attracts interest across many disciplines and it is useful to suggest here that funding be provided for more inter-disciplinary research in the areas that have been highlighted here. Different disciplines for example, may have very different approaches to conducting research on the role of informal networking activity in innovation versus formal networking activity. If funding were made available across disciplines in this one particular area it would be possible to develop a substantive evidence base relatively quickly.

Some broad policy implications can also be derived from this literature review. Current research supports the view that networking significantly boosts innovation output and the competitiveness of firms in a diverse range of industries. Likewise firms that do not cooperate have access to a limited knowledge base over the longer term. Consequently, governments should focus considerable attention on the development of strategies for assisting the development of networking infrastructures.

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 should, in principal, promote diffusion. Such networks range in focus but diffusion of practices may occur more effectively where networks are cross-functional, engaging actors from a diverse range of contexts. The

review has also highlighted that dense networks have a positive 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. Finally, 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 can have a positive effect on business start-up rates in these locations.

REFERENCES

Ahuja, G. (2000). The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal*, **21** (3), 317.

Almeida, P. and Kogut, B. (1999). Localization and knowledge and the mobility of engineers in regional networks. *Management Science,* **45** (7), 905.

Baldwin and Clark (2000). Design Rules, Volume 1, The Power of Modularity, Cambridge. MA: MIT Press.

Baum, J., Calabrese, T. and Silverman, B. (2000). Don't go it alone: Alliance network composition and start-ups performance in Canadian biotechnology. *Strategic Management Journal,* **21** (3), 267.

Biemans, W. (1991). User and third-party involvement in developing medical equipment innovations. *Technovation*, **11** (3), 163.

Birley, S. (1985). The role of networks in the entrepreneurial process. *Journal of Business Venturing*, **1** (1),107.

Bolton, M., Malmrose, R., and Ouchi, W. (1994). The organization of innovation in the United States and Japan: Neoclassical and relational contracting. *The Journal of Management Studies*, **31** (5), 653.

Bougrain, F. and Haudeville, B. (2002). Innovation, collaboration and SMEs internal research capacities. *Research Policy*, **31**(5), 735.

Boter, H. and Holmquist, C. (1996). Industry characteristics and internationalization processes in small firms. *Journal of Business Venturing*. **11** (6), 471.

Bower, D., Crabtree, E. and Keogh, W. (1997). Rhetorics and realities in new product development in the subsea oil industry. *International Journal of Project Management,* **15** (6), 345.

Bower, D. and Keogh, W. (1996). Changing patterns of innovation in a process-dominated industry. *International Journal of Technology Management*, **12** (2), p. 209.

Brass, D. and Burkhardt, M. (1992). Centrality and power in organizations. In Nohria, N. and Eccles, R. (eds.), *Networks and Organizations*, Boston: Harvard University Press, 191.

Bruce, M. and Rodgus, G. (1991). Innovation strategies in the enzyme industry. *R & D Management*, **21** (4), 319.
Burt, R. (1992). *Structural Holes: The Social Structure of Competition.* Cambridge, MA: Harvard University Press.
Bygrave, W. (1987). Syndicated investments by venture capital firms: A networking perspective. *Journal of Business Venturing,* **2** (2), 139.
Bygrave, W. (1988). The structure of investment networks of venture capital firms. *Journal of Business Venturing,* **3** (2), 137.
Cohen, B. and Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly,* **35**, 128.
Coleman, J. (1988). Social capital in the creation of human capital. *American Journal of Sociology,* **94**, 95.
Coles, A., Harris, L. and Dickson, K. (2003). Testing goodwill: Conflict and cooperation in new product development networks. *International Journal of Technology Management,* **25** (1), 51.
Cooke, P. (1996). The new wave of regional innovation networks: Analysis, characteristics and strategy. *Small Business Economics*, **8** (2), 159.
Conway, S. (1995). Informal boundary-spanning communication in the innovation process: An empirical study. *Technology Analysis & Strategic Management*, **7** (3), 327.
DeSanctis, G., Glass, J. and Ensing, I. (2002). Organizational designs for R&D. *The Academy of Management Executive,* **16** (3), 55.
DTI's Innovation Report (2003). Competing in the Global Economy: The Innovation Challenge. Department of Trade and Industry, *http://www.dti.gov.uk/innovationreport/index.htm*.
Ebadi, Y. M and Utterback, J. (1984). The effects of communication on technological innovation. *Management Science*, **30** (5), 572.
Eisenhardt, K. and Schoonhoven, C. (1996). Resource-based view of strategic alliance formation: strategic and social effects in entrepreneurial firms. *Organization Science,* **7**, 136.
Erickson, C. and Jacoby, S. (2003). The effects of employer networks on workplace innovation and training. *Industrial and Labor Relations Review,* **56** (2), 203.
Ferrary, M. (2003). Managing disruptive technologies life cycle by externalising the research: Social network and corporate venturing in the Silicon Valley. *International Journal of Technology Management,* **25** (1), 165.
Fischer, M. and Varga, A. (2002). Technological innovation and interfirm cooperation: An exploratory analysis using survey data from manufacturing firms in the metropolitan region of Vienna. *International Journal of Technology Management,* **24** (7), 724.
Florida, R. and Kenney, M. (1988a). Venture capital and high technology entrepreneurship. *Journal of Business Venturing*, **3** (4), 301.
Florida, R. and Kenney, M. (1988b). Venture capital-financed innovation and technological change in the USA. *Research Policy*. **17** (3), 119.
Freeman, C. (1982). *The Economics of Industrial Innovation.* Cambridge, MA: MIT Press.
Freeman, J. (1999). Venture capital as an economy of time. In Leenders, R. and Gabbay, S. (eds), *Corporate Social Capital and Liability.* Boston: Kluwer Academic Publishing, 460.
Frenken, K. (2000). A complexity approach to innovation networks. The case of the aircraft industry (1909-1997). *Research Policy*, **29** (2), 257.

Fritsch, M. (2001). Co-operation in regional innovation systems. *Regional Studies*, **35** (4), 297.

Furtado, A. (1997). 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*, **25** (8), 1243.

Gales, L. and Boynton, A. (1992). Information ties and innovation management: A qualitative assessment of information processing and the strength of weak ties. *The Journal of High Technology Management Research*, **3** (2), 169.

Gemser, G., Leenders M., and Wijnberg, N. (1996). The dynamics of inter-firm networks in the course of the industrial life cycle: The role of appropriability. *Technology Analysis and Strategic Management,* **8** (4), 439.

Gemünden, H., Heydebreck, P. and Herden, R. (1992). Technological interweavement: A means of achieving innovation success. *R & D Management*, **22** (4), 359.

Gemünden, H. G., Ritter, T., and Heydebreck, P. (1996). Network configuration and innovation success: An empirical analysis in German high-tech industries. *International Journal of Research in Marketing*, **13** (5), 449.

Glasmeier, A. (1991). Technological discontinuities and flexible production networks: The case of Switzerland and the world watch industry. *Research Policy*, **20** (5), 469-485.

Grandori, A. (1997). An organizational assessment of interfirm coordination modes. *Organization Studies,* **18** (6), 897.

Grandori, A. and Soda, G. (1995). Inter-firm networks: Antecedents, mechanisms and forms. *Organization Studies*, **16** (2), 183.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology,* **91**, 481.

Grotz, R. and Braun, B. (1997). Territorial or trans-territorial networking: Spatial aspects of technology-oriented co-operation within the German mechanical engineering industry. *Regional Studies,* **31** (6), 545.

Hagedoorn, J. and Duysters, G. (2002). External sources of innovative capabilities: the preference for strategic alliances or mergers and acquisitions. *Journal of Management Studies*, **39** (2),167.

Hanna, V. and Walsh, K. (2002). Small firm networks: A successful approach to innovation? *R & D Management,* **32** (3), 201.

Harding, R. (2000). Venture capital and regional development: Towards a venture capital system. *Venture Capital,* **2** (4), 287.

Haar, N., Starr, J. and MacMillan, I. (1988). Informal risk capital investors: Investment patterns on the East Coast of the U.S.A. *Journal of Business Venturing,* **3** (1), 11.

Harris, L., Coles, A. and Dickson, K. (2000). Building innovation networks: Issues of strategy and expertise. *Technology Analysis and Strategic Management,* **12** (2), 229.

Harrison, R. and Mason, C. (1992). International perspectives on the supply of informal venture capital. *Journal of Business Venturing*, **7** (6), 459.

Harrison, R. and Mason, C. (1996). Developments in the promotion of informal venture capital in the UK. *International Journal of Entrepreneurial Behaviour & Research*. **2** (2), 6.

Harryson, S. (1997). How Canon and Sony drive product innovation through networking and application-focused R&D. *The Journal of Product Innovation Management*, **14** (4), 288.

Hausler, J. Hohn, H. and Lutz, S. (1994). Contingencies of innovative networks: A case study of successful R & D collaboration. *Research Policy*, **23** (1), 47.

Hoang, H. and Antoncic, B. (2003). Network-based research in entrepreneurship: A critical review. *Journal of Business Venturing*. **18** (2), 165.
Hobday, M. (1994). The limits of Silicon Valley: A critique of network theory. *Technology Analysis & Strategic Management*, **6** (2), 231.
Izushi, H. (1997). Conflict between two industrial networks: Technological adaptation and inter-firm relationships in the ceramics industry in Seto, Japan. *Regional Studies,* **31** (2), 117.
Kash, D. E. and Rycroft, R. (2002). Emerging patterns of complex technological innovation. *Technological Forecasting and Social Change*, **69** (6), 581.
Kaufmann, A. and Tödtling, F. (2001). Science-industry interaction in the process of innovation: The importance of boundary-crossing between systems. *Research Policy,* **30** (5), 791.
Koch, C. (2003). Innovation networking between stability and political dynamics. *Technovation*. In Press, Corrected Proof.
Larson, A. (1991). Partner networks: Leveraging external ties to improve entrepreneurial performance. *Journal of Business Venturing*, **6**(3), 173.
Liebeskind, J., Porter, O., Zucker, L. and Brewer, M. (1996). Social networks learning and flexibility: Sourcing scientific knowledge in new biotechnology firms. *Organization Science,* **7** (4), 428.
Lincoln, J., Ahmadjian, C. and Mason, E. (1998). Organizational learning and purchase-supply relations in Japan: Hitachi, Matsushita and Toyota compared. *California Management Review,* **40** (3), 241.
Lipparini, A. and Sobrero, M. (1994). The glue and the pieces: Entrepreneurship and innovation in small-firm networks. *Journal of Business Venturing*, **9** (2), 125.
Liyanage, S. (1995). Breeding innovation clusters through collaborative research networks. *Technovation*. **15** (9), 553.
Lorenzoni, G. and Lipparini, A. (1999). The leveraging of interfirm relationships as a distinctive organizational capability: A longitudinal study. *Strategic Management Journal,* **20** (4), 317.
Love, J. and Roper, S. (2001). Location and network effects on innovation success: Evidence for UK, German and Irish manufacturing plants. *Research Policy,* **30** (4), 643.
Meyer-Stamer, J. (1995). Micro-level innovations and competitiveness. *World Development*, **23** (1), 143.
Munir, K. (2003). Competitive dynamics in face of technological discontinuity: A framework for action. *Journal of High Technology Management Research*, **14**, 93.
Nooteboom, B. (2000). Institutions and forms of co-ordination in innovation systems. *Organization Studies*, **21** (5), 915.
Ostgaard, T. A. and Birley, S. (1994). Personal networks and firm competitive strategy - a strategic or coincidental match. *Journal of Business Venturing*, **9** (4), 281.
Perez, M. and Sanchez, A. (2002). Lean production and technology networks in the Spanish automotive supplier industry. *Management International Review,* **42** (3), 261.
Phillimore, J. (1999). Beyond the linear view of innovation in science park evaluation – an analysis of Western Australian Technology Park. *Technovation,* **19** (11), 673.
Porter, M. and Ketels (2003), *UK Competitiveness: Moving to the Next Stage*, Management Research Forum, Summary report 6, Advanced Institute of Management, http://www.aimresearch.org/AIM
Powell, W. W., Koput, K. W. and Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, **41**(1), 116.

Ragatz, G., Handfield, R., and Scannell, T. (1997). Success factors for integrating suppliers into new product development. *The Journal of Product Innovation Management*, **14** (3), 190.

Ritter, T. and Gemünden, H. (2003). Network competence: Its impact on innovation success and its antecedents. *Journal of Business Research*. In Press, Corrected Proof.

Robertson M., Swan J., and Newell S. (1996). The role of networks in the diffusion of technological innovation. *The Journal of Management Studies*, **33** (3), 333.

Romijn, H. and Albu, M. (2002). Innovation, networking and proximity: Lessons from small high technology firms in the UK. *Regional Studies,* **36** (1), 81.

Rothschild, L. and Darr, A. (2003). Technological incubators and the social construction of innovation networks: An Israeli case study. *Technovation*. In Press, Corrected Proof.

Rothwell, R. (1991). External networking and innovation in small and medium-sized manufacturing firms in Europe. *Technovation*, **11** (2), 93.

Rothwell, R. and Dodgson, M. (1991). External linkages and innovation in small and medium-sized enterprises. *R&D Management,* **21** (2), 125.

Rychen, F. and Zimmermann, J. (2002). Birth of a cluster: The microelectronics industry in the Marseilles metropolitan area. *International Journal of Technology Management,* **27** (8), 792.

Saxenian, A. (1990). Regional networks and the resurgence of Silicon Valley. *California Management Review*, **33** (1), 89.

Shan, W., Walker, G. and Kogut, B. (1994). Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal,* **15**, 387.

Shaw, B. (1998). Innovation and new product development in the UK medical equipment industry. *International Journal of Technology Management*, **15**, 433.

Smeltzer, L., Van Hook, B. and Hutt, R. (1991). Analysis and use of advisors as information sources in venture startups. *Journal of Small Business Management,* **29** (3), 10.

Smilor, R. (1987a). Commercializing technology through new business incubators. *Research Management,* **31** (5), 36.

Smilor, R. (1987b). Managing the incubator system: Critical success factors to accelerate new company development. *IEEE Transactions and Engineering Management,* **34** (3), 146.

Staber, U. (2001). Spatial proximity and firm survival in a declining industrial district: The case of knitwear firms in Baden-Wurttemberg. *Regional Studies,* **35** (4), 329.

Teece, D. (1986). Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. *Research Policy,* **15**, 285.

Tomas, J. and Arias, G. (1995). Do networks really foster innovation? *Management Decision*, **33** (9), 52.

Verspagen, B. (1999). Large firms and knowledge flows in the Dutch R&D system: A case study of Philips Electronics. *Technology Analysis & Strategic Management*, **11** (2), 211.

Von Hippel, E. (1978). Successful industrial products from customer ideas: A paradigm, evidence and implications. *Journal of Marketing,* **42** (1), 39.

Walcott, S. (1999). High tech in the Deep South: Biomedical firm clusters in metropolitan Atlanta. *Growth and Change,* **30** (1), 48.

Walsh, V., Roy, R. and Bruce, M. (1988). Competitive by design. *Journal of Marketing Management,* **4** (2), 201.

Wetzel, Jr. W. E. (1987). The informal venture capital market: Aspects of scale and market efficiency. *Journal of Business Venturing*, **2** (4), 299.

APPENDIX 1 – INCLUSION CRITERIA

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

APPENDIX 2 – EXCLUSION 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-organisational networks
3	Network externalities	These are not inter-organisational networks
4	Network effects	These are not inter-organisational 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

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

APPENDIX 3 – QUALITY CRITERIA

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

TABLES

TABLE 1: The Number of Relevant Citations Found During Each Stage of the Review

Stage	Name	Included	Excluded	Duplicates
V	DATABASE ANALSIS:	628	-	-
Vi (a)	TITLE ANALYSIS:	375	157	96
Vi (b)	ABSTRACT ANALYSIS:	332	43	-
Vii	A ranked	179	-	-
	B ranked	-	76	-
	C ranked	-	77	-
Viii	POST ABSTRACT CODING:	174	-	5
X	NARRATIVE INCLUSIONS	20	-	-

TABLE 2: Industrial Analysis of the Papers Reviewed

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

TABLE 3: Thematic Analysis of the Papers Reviewed

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

TABLE 4: Network Configuration

Authors	Date	Summary
Koch	2003	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.
Kash and Rycroft	2002	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.
Baum, Calabrese and Silverman	2000	New firm alliance networks are studied to investigate the impact of variation in startups' alliance network composition on their early performance. An analysis of Canadian biotech startups' performance shows how variation in the alliance networks startups configure at the time of their founding produces significant differences in their early performance.
Gemünden, Ritter and Heydebreck	1996	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.
Ostgaard and Birley	1994	Show that entrepreneurs use networks differently depending on the strategic orientation of their business.
Burt	1992	Illustrates that an actor's informational advantage will be maximized 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.
Larson	1991	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.
Coleman	1988	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 ostracized.

TABLE 5: Degree of Innovation Improvement Resulting from Supplier Integration – Adapted from Ragatz et al. (1997)

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

TABLE 6: The Impact of Business-to-Business Networks on Innovation in the Market Interface

(A Sample of the Evidence)

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 differ 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. Winners of the Queens Award for Technological Achievement and the Best Design Award	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.

TABLE 7: The Role of Third Parties

Authors	Date	Summary
Hanna and Walsh	2002	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
Grotz and Braun	1997	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
Robertson et al.	1996	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
Conway	1995	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.

TABLE 8: The Role of Institutional Mechanisms

Authors	Date	Institutional Mechanism	Summary
Rothschild and Darr	2003	**Incubators**	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.
Staber	2001	**Clusters**	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.
Phillimore	1999	**Science Parks**	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 which existed at the Park are identified in terms of their interactive behavior. An overview of the literature suggests that Science Parks do not assist networking a great deal but Phillimore's results disagree.
Smilor	1987b	**Incubators**	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 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.
Smilor	1987a	**Incubators**	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.

FIGURES

FIGURE 1: Networking and Innovation: A schematic