Frameworks for Understanding Interactive Innovation Processes

Dr Karen. Manley

School of Construction Management and Property, Queensland University of Technology, Australia

Dr Karen Manley
Research Fellow
Construction Research Alliance
School of Construction Management and Property
Queensland University of Technology
GPO Box 2434
Brisbane, Qld. 4001
Australia

Ph. 61 7 3864 1762
Fax 61 7 3864 1170
Email: K.Manley@qut.edu.au

Key Words: innovation frameworks, innovation systems, business networks, clusters, value-chains

Frameworks for Understanding Interactive Innovation Processes

Abstract

In recent years there has been considerable activity, by business analysts and academics, in developing new approaches to understanding contemporary innovation processes. This has resulted in the emergence of a large number of conceptual alternatives, with many overlapping features. It is the aim of this paper to outline and compare the most popular of these frameworks, and develop a model incorporating their important features. The integrated model should assist businesses examining their innovation processes by providing a single-point guide to key issues; it should also help public-sector policy makers understand key leverage points for improving the environment for innovation.

Acknowledgments

This paper arises from research supported by the Queensland Department of Main Roads. Australia. Thanks are due to the Executive Director of the Roads Delivery Division, Dennis Wogan. Valuable assistance was also provided by David Thorpe, Principal Advisor, Road Delivery Division, and Keith Hampson, now Chief Executive Officer of the CRC in Construction Innovation, Australia.

Introduction

Technological and social advancements have resulted in the need for new forms of organisation for successful innovation. In the past, innovation processes may have been effectively managed by individual firms, however this is no longer true. Successful innovation is increasingly seen to be the result of a team effort between a collective of industry players.

Interactive innovation processes lie at the heart of success in the new economic circumstances. As the Bureau of Industry Economics (BIE) (1991:7) notes:

> For some time, studies of the innovation process have stressed the importance of networks to successful innovation, over-turning the traditional model which characterises innovation as a linear sequence running from basic research, through product development, to production and marketing. Innovation is now seen as an interactive process requiring intense traffic in facts, ideas and reputational information within and beyond the firm.

It is now clear that innovating firms 'cannot be analysed in isolation: innovation capability depends in fact also on the amount of information that each firm is able to receive from the environment in which it operates' (Antonelli 1996: 284). This 'interactive' view of innovation is the basis for many conceptual elaborations of the innovation process, all of

which emphasise the increasing complexity of successful innovation and the importance of external knowledge sources. Table 1 lists the leading models.

Table 1: Interactive Innovation Frameworks

- development blocks (Dahmen 1988);
- complexes (Glatz and van Tulder 1989; Marceau 1995);
- innovation milieux (Camagni 1991; Ratti et al. 1997);
- complex products and systems (Hobday et al. 2000b);
- competence blocs (Eliasson 1997);
- technological regimes (Nelson and Winter 1982);
- industrial filieres (van Tulder and Junne 1988);
- innovation districts (Pyke et al. 1990);
- sectoral innovation systems (Breschi and Malerba 2000);
- regional innovation systems (Cooke 1997);
- technological innovation systems (Carlsson and Stankiewicz 1991);
- national innovation systems (Lundvall 1992; Nelson 1993);
- innovation networks (De Bresson and Amesse 1991);
- business networks (BIE 1991);
- value-chains (Walters and Lancaster 2000); and
- clusters (Porter 1990).

Clearly there has been considerable activity in developing new approaches to understanding contemporary innovation processes. However, the breadth of alternatives, and their similarities, can be bewildering for entrepreneurs and policy makers seeking practical guidance. It is the aim of this paper to outline and compare the key frameworks, leading to the development of a model incorporating their important features. The integrated model should assist businesses examining their innovation processes by providing a single-point guide to key issues, it should also help public-sector policy makers understand key leverage points for improving the environment for innovation.

This paper focuses on four key approaches: systems, networks, value-chains and clusters. These frameworks have the highest profile in the academic and business literature and are best able to incorporate the main ideas associated with the approaches listed in Table 1. The discussion to follow summarises the four frameworks, before comparing them and developing an integrated model.

Innovation Systems

An innovation system can be defined as a collective of ‘organisations, institutions and people that interact in the production and diffusion of new economically useful knowledge (Lundvall 1992: 11). The original and most common approach to examining innovation systems is at the national level, an approach first promoted by Freeman (1987). Key contributions have since been made by Lundvall (1992), Nelson (1993) and Edquist (1997). Such literature reveals increasing interest among analysts in other levels of study, such as regional, local, sectoral and technological, where mapping and understanding key relationships is more manageable[1] (cf. Sornn-Friese 2000: 4).

Although the innovation system approach emerged only a decade or so ago, Edquist and McKelvey (2000: xi) note it has:

> … diffused surprisingly fast in the academic world as well as in the realms of public innovation policy making and firm innovation strategy formulation. The OECD has been particularly influential in using and further developing empirical analyses and research using this approach. 'Systems of innovation' is at the centre of modern thinking about innovation and the relations of innovation to economic growth, competitiveness and employment.

The innovation system approach differs from earlier analytical approaches in assuming that innovation relies primarily on interactions between institutions and people (Landry and Amara 1998: 261). Further, the innovation system approach looks beyond formal R&D programs as a key determinant of innovation. As Edquist (1999: 10) notes:

> … many if not most innovations emerge … through the learning process immanent in ordinary economic activities. In addition, innovations are not only developed but also produced, diffused, and used. They also change during these processes. All the factors and processes mentioned here are included in a system of innovation – but not in an R&D system!

All the features of innovation systems stem from the collective nature of successful innovation efforts. For any organisation, success relies on relationships with *external* parties. This view is supported by numerous empirical studies, an example of which is a rigorous examination of an innovation system by Landry and Amara (1998: 274). Their case-study work indicates that 'innovative firms develop more interactions with outside sources of ideas, information and technology than non-innovative firms do'. In many respects, an innovation system is a social system in which innovations emerge partly as a result of social interaction between economic actors (Cooke 1998: 11).

According to the OECD (1997a: 9), understanding the links between the actors in innovation processes is the key to improving technology performance. Innovation is seen as the result of a complex set of linkages between actors creating, applying and distributing various kinds of knowledge. Innovation performance depends critically on 'the way these actors relate to each other as elements of a collective system of knowledge creation and use … '.

System features will have a 'decisive impact on the extent to which firms can make innovation decisions, and on the modes of innovation which are undertaken' (Edquist 1999: 7-8). There are four key drivers of innovation in contemporary innovation systems – knowledge flows, institutions, economic competence and interactive learning. These are the main innovation inputs discussed in the systems literature.

Knowledge Flows

The current popularity of the innovation system approach reflects the increasing knowledge intensity of economic activity. The framework is often applied to measure the 'knowledge distribution power' of a particular system, which involves the system's ability to facilitate effective knowledge flows. Application of the framework involves tracking the linkages between industry, government and academia in the development of technological and

organisational innovations. The aim is to identify and evaluate the main channels of knowledge flow, to analyse bottlenecks and to suggest approaches to improve the effectiveness of knowledge diffusion (OECD 1997a: 11).

Institutions

Institutions are the 'rules of the game' which govern *how* knowledge moves between system participants and the way in which subsequent learning and innovation takes place. Examples of key institutions which affect the performance of innovation systems include: the finance system, the taxation system, the intellectual property-rights system, the education system, and the industrial relations system. Culture and norms of behaviour are also important, including particularly the conceptions of fairness and justice held by system participants (see Amable and Petit 1999):

Nooteboom (2000: 916) suggests that firm-level innovation outcomes are, *to a large extent*, dependent on the institutional context in which firms operate. For example, if the education and training systems are under-resourced by government, firms may find it difficult to access suitably skilled employees to support their innovation efforts.

Economic Competence

Another key feature of innovation systems, highlighted by Carlsson and Stankiewicz (1991), is the *economic competence* of a system's participants. The outcomes of interactive innovation process are 'a function of the level and content of economic competence on the part of various agents within the system' (Carlsson and Stankiewicz 1991: 113). This quality, or economic competence, is the microfoundation upon which the success of the system will rest. Economic competence is a 'scarce and unequally distributed resource … not all economic agents … are equally adept at generating new ideas or absorbing new ideas from outside' (Carlsson and Stankiewicz 1991: 94).

Interactive learning

Interactive learning implies a reliance on multiple sources of tacit knowledge in the learning process. Lundvall (1999: 3) notes that 'the last decade has witnessed a change in the mode of competition that implies that interactive learning, and forgetting, has become the most important process for determining the position of individuals, firms, regions and countries in competition'.

Interactive learning is essential for long-term survival. A firm that is both effective and efficient at a point in time eventually becomes neither unless it can adapt to changing circumstances (especially changing technology). Hence, it is important to keep options open by maintaining a broad array of innovation interests through multiple relationships.

Compared to the other frameworks examined, the innovation system approach encompasses the broadest range of relationships, looking not only at inter-firm relationships, but also focusing on technical support providers and regulatory framework providers. In many respects this emphasis on relationships with diverse players, and networking/learning in particular institutional contexts, are the features which make the system approach the most comprehensive of the four approaches examined here.

In closing this section on innovation systems, three key measures of a system's performance can be drawn out:

1. Linkages with external parties: best if dense, multistranded, long-term, knowledge-intensive, and based on a mix of market and non-market relationships;
2. Organisations: best if there is a diverse range of organisations with different types and high levels of economic competence; and
3. Outcomes: best if individual participants perceive benefits beyond what they could achieve in isolation, increasing the likelihood of a stable and productive system.

Networks

The concept of *networks* has traditionally been employed by engineers for understanding complex communications and transport systems. It was not until the 1980s that the concept was adopted by sociologists to explain human systems (De Bresson 1991: 363). Today, the network view has become popular with economists seeking to explain the organisation of industries, particularly in relation to innovation and growth. This literature on networks overlaps the literature on innovation systems, as a key feature of innovations systems is the networks they contain (Archibugi et al. 1999: 6).

According to the Bureau of Industry Economics (BIE) (1991: 5), networks can be defined as:

> … arrangements for inter-firm cooperation and collaboration, for example, where firms cooperate in production and marketing, to exchange know-how and market intelligence, to jointly train their employees, to develop research capacities and new markets, to purchase raw materials in bulk, to share equipment and infrastructure and so on.

Whether or not the purpose of collaboration is to innovate, the mere act of cooperating with related firms enhances innovation opportunities. In a simple sense, networks can be considered to be groups of cooperating firms; a particular group may constitute an innovation system, value-chain, cluster, or indeed any other constellation of inter-firm relations – depending on how the network is defined and analysed. This section deals with networks in a generic sense, examining the features of inter-organisational linkages that may apply in a variety of contexts.

Networks may involve only a couple of firms, or they may be quite dense, involving an entire industry sector. The focus of a network may be on one activity, such as training or a specific technical problem, or on the activities of an entire value-chain. The duration of a network may be limited to the life of a short project, or ongoing, across projects. A network may or may not be underpinned by formal relationships (BIE 1991: 5).

Networks are clearly very diverse. Networks are also so complex that theorists have not been able to identify an *ideal* network, although experience suggests that certain features may be advantageous (that is, lead to higher levels of innovation). A better performing network may be one in which key players are closely located; linkages are multi-stranded and stable; each linkage is a key part of participants' business strategies; there are dense informal relations; relationships are well coordinated; there is equality between network members; and the

number of players involved is large enough to provide a rich knowledge source and small enough to be manageable.

Networks are seen as a new way of organising economic activity that avoids the inefficiencies associated with large, highly integrated firms and the shortcomings of straightforward market contracts. Networks facilitate the benefits of specialisation (through easy access to external sources of expertise), without incurring the rising costs of trying to internally manage too many specialist departments (BIE 1991; DeBresson and Amesse 1991).

Empirical studies show that networking can greatly enhance innovation performance and economic outcomes for the parties involved, whether it is pursued formally or informally (see Freeman 1991: 499-501).

The last two frameworks reviewed, *value-chains* and *clusters*, focus on linkages, or in other words, networks. They refer to specific types of networks which may form part of a broader innovation system.

Value-Chains

The value-chains approach to analysing production and innovation performance places an emphasis on relationships between firms, as do the system and network approaches. The main difference is that the value-chains approach draws particular attention to the forward and backward linkages in the production process (Marceau 1995: 15). This focus tends to preclude attention to lateral relationships, that is, relationships between competitors in the same stage of the production process. It also draws particular attention to inter-*firm* activity, largely ignoring organisations that set framework conditions, such as regulators and R&D providers. The narrowness of the chains approach is useful in focusing attention on particular dimensions of innovation systems. It is considered particularly useful when core firms assemble complex products and lead the innovation activities of other players in the chain (Marceau 1995: 15). However, generally speaking, a more comprehensive picture of innovation activities can be gained by using the value-chains approach in conjunction with the system, network and/or cluster approaches (Normann and Ramirez 1993: 65).

Supply- and value-chains can be conceptualised to examine either a firm's internal production processes or its production processes in the context of the value-added by other firms in an overall supply- or value-chain. It is the latter approach that more closely mirrors the innovation system perspective.

The supply-chain and value-chain frameworks are mostly treated as identical in the literature, with a focus on vertical, backward and forward linkages between customers and suppliers, or between stages in an internal production process. The difference in terminology, shifting from supply to value, reflects the increasing innovativeness of firms in their search for better returns. A focus on supply management has given way to a broader, more innovative focus on value-creation.

The traditional supply-chain approach views firms as occupying a particular position along a vertical chain of production, from which they attempt to effectively manage external resources. This view focuses on operational efficiency in distribution activities. Wisner and Tan (2000: 33) note that the term supply-chain management:

> …was initially used in wholesaling and retailing to describe the integration of logistics and physical distribution functions with the goal of reducing delivery leadtimes. Manufacturers and service providers have used the same term to describe integration and partnership efforts with first- and second-tier suppliers to reduce cost and improve quality and delivery timing.

Later thinking often reflects an expanded view of the possibilities open to firms in chains of production. Firms are now seen as inter-dependently creating value, in part by strategically positioning themselves within the production chain. The value-chain approach is often used to provide significant insight into the management of business strategy; these days it is rarely used as a mere operational technique (Cox 1999: 167-169). The value-creating process has become the focus of analysis, with innovation seen as the result of firms working together to co-produce value, by reconfiguring their roles and relationships to 'mobilise the creation of value in new forms by new players' (Normann and Ramirez 1995: 66).

Value creation is facilitated through identification of customer benefits and costs, together with identifying the combinations of knowledge/organisations required to respond appropriately. Hence, effective management of information and relationships are the two key tasks of value-chain management, with value/cost drivers influencing the resource combinations chosen. Note that value-chain management involves combining activities undertaken internally and externally. The overriding goal is to 'create an ever improving fit between competencies and customers' (Walters and Lancaster 2000: 161).

Focusing on the relational aspect of value-chains draws attention to the quality of user-producer interaction. User-producer interaction, in relation to both production and innovation, tends to be a key feature of industry networks, in all their forms – including value-chains, clusters and systems. This is particularly true of value-chains, where user-producer interaction is the primary focus of study.

Indeed, although horizontal relationships in the form of competition between firms are a key driver of innovation, vertical relationships in the form of user-producer interactions have emerged over the past decade or so as similarly crucial to successful innovation outcomes (Lundvall 1988; von Hippel 1988; Fagerberg 1995). The key incentives for user-producer interaction are well summarised by Lundvall (1988: 352-353):

> The user … needs information about new products [and processes], and this information involves not only awareness but also quite specific information about how new 'use value' characteristics relate to his/her specific needs….
>
> The producer will have a strong incentive to monitor what is going on in user units. First, process innovations within user units might be appropriated by producers or represent a potential competitive threat. Second, … innovations at the user level may imply new demands for … equipment. Third, the knowledge produced by learning-by-using can only be transformed into new products if the producers have direct contact with users. Fourth, bottlenecks and technological interdependencies, observed within user units, will represent potential markets for the innovating producer. Finally, the producer might be interested in monitoring the competence and learning potential of users in order to estimate their respective capability to adopt new products.

This process of creating value in value-chains is one of developing innovations using the resources immediately available in the user-producer value-chain. The system/network views of production and innovation, and, to a lesser extent, the clusters view, place production and innovation processes in a broader context.[2]

Clusters

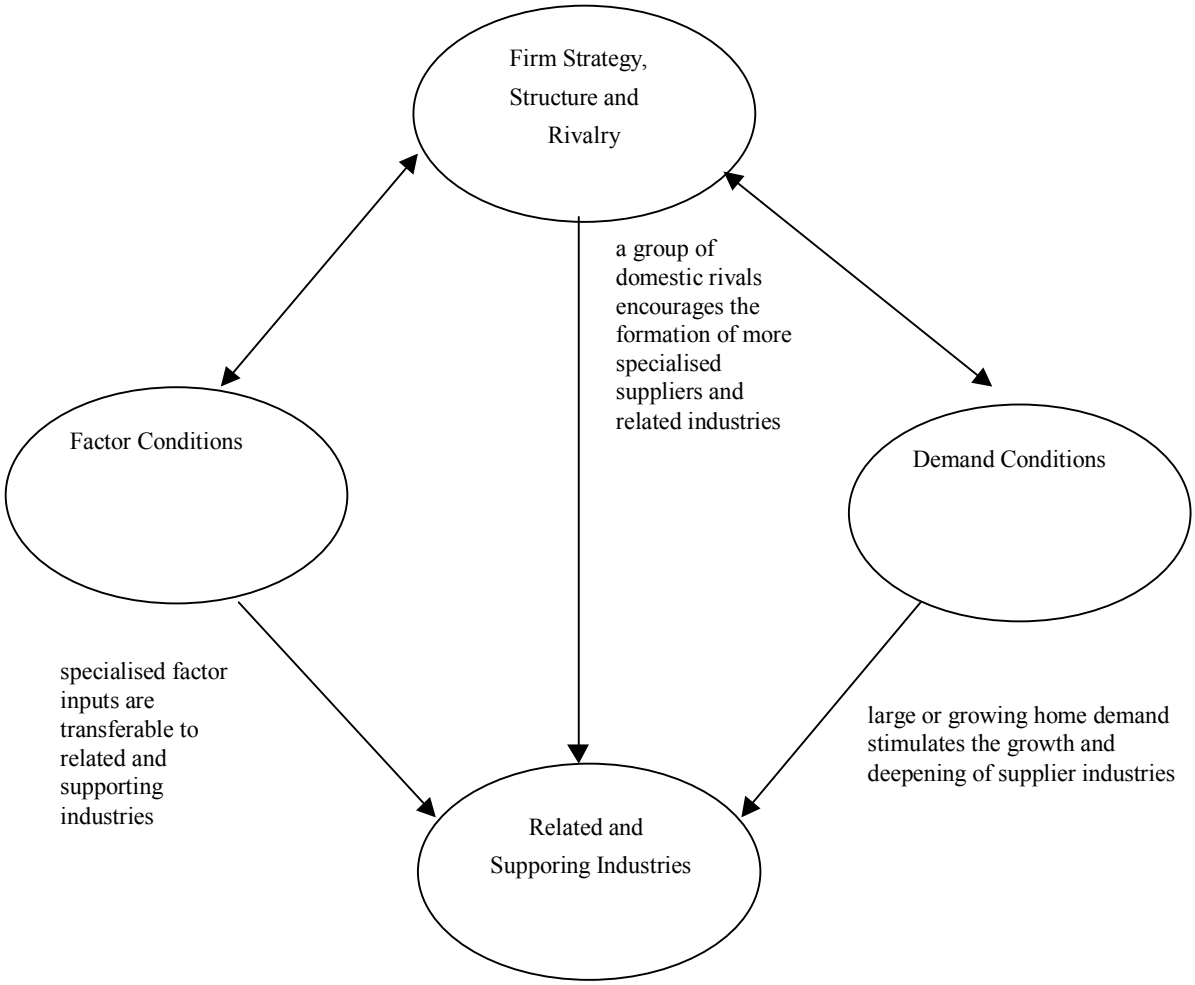
The cluster concept provides a different view of inter-firm relations, again dealing with production and innovation activities, but focusing on vertical *and horizontal* relationships. Clusters often 'extend downstream to … customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies or common inputs' (Porter 1998: 310). Clusters often consist of cross-sectoral lateral networks that contain dissimilar and complementary firms specialised around a knowledge base, or a specific link in the value-chain (OECD 1999c: 414).

Compared to the value-chains perspective, the cluster approach typically emphasises a broader array of players. Clusters are often defined to include the role of firm and non-firm players such as providers of infrastructure, R&D, education, training and regulation. Although this suggests a broader view than that provided by the chains perspective, in some ways cluster analysis is narrower, particularly because it is often applied to a *geographical concentration* of interconnected organisations (Porter 1998: 310). The cluster approach emphasises the flow of benefits between linked organisations operating in close geographical proximity to each other. Many of these benefits derive from shared tacit knowledge.

Porter's comprehensive 1990 study of competitive advantage played a key role in drawing the attention of business leaders, academics and policy-makers to the value of cluster analysis (Baptista 1998: 26). Porter's (1990b) famous *competitive diamond* is an empirically based analytical tool that can be applied to understand the strength of an economic system, whether it be at national or regional level. In recent years, his framework has been used extensively to examine both national systems and regional clusters.

Figure 1 below highlights the four points of Porter's diamond of competitive advantage.

Figure 1: Diamond of Competitive Advantage



Source: Based on Porter 1990b: 77.

Two specific factors drive the dynamism of a cluster – localised rivalry and geographical concentration. Rivalry between firms promotes the dynamism of the cluster, while geographical concentration increases the intensity of interactions within the cluster. Rivalry provides a major incentive for investment in three key resources: skilled labour, market-specific knowledge and specialised infrastructure. An effective cluster of firms will draw on common infrastructure and specialised inputs, with their combined demand assisting in upgrading the quality and increasing the supply of key factors of production. Rivalry and geographic concentration leads to dynamism that positively stimulates related and supporting industries, and also promotes the quality and strength of local demand.

Summary

The four key frameworks, systems, networks, value-chains and clusters is the innovation system approach. An innovation system can be thought of as a complex macro network, containing sub-networks, of which value-chains and clusters are two key types. The innovation system approach emphasises relationships between industry players and can be applied at various levels, including national, regional, local, sectoral and technological. It differs from the other approaches shown in that it has a more specific focus on innovation. It also typically includes consideration of the broadest range of industry players compared to the other frameworks, including, for example, public-sector regulators, public-sector R&D organisations, training institutions and finance providers, in addition to private-sector industry players.[2]

Networks can similarly be analysed at a number of levels, including national, regional, local, sectoral and technological. However, they are often interpreted to comprise economic relationships between a smaller set of industry players – typically just private-sector firms. A wide range of network types can be identified (see De Bresson and Amesse (1991), Freeman (1991); BIE (1991)), while value-chains and clusters can be interpreted as two broad types.

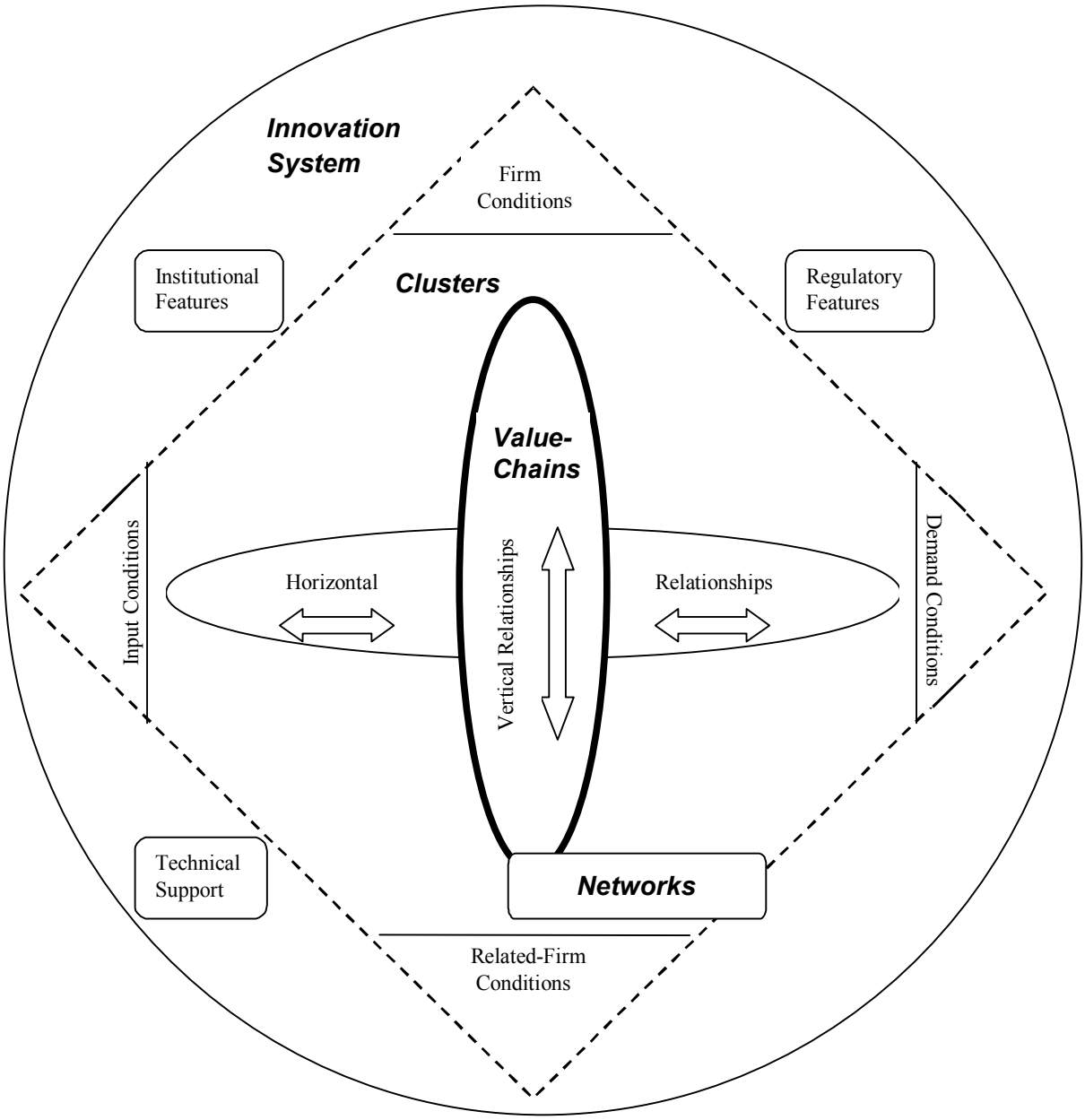
At one level, the *network* and *system* metaphors simply shift our attention from individual firms to groups of firms/organisations, the *relationships* between them, and their impact on economic activity – especially production and innovation. Networks/systems are groups of industry players pursing economic outcomes by means other than simple one-to-one market transactions.

The value-chain and cluster perspectives highlight the importance of relationships in more focused contexts than generic network and system approaches. The value-chain perspective takes a relatively narrow view of inter-firm relationships, focusing on players making up the vertical supply-chain (linking various levels of users and producers). The cluster concept adopts a broader scope, including relationships between players linked vertically *and* horizontally, the latter being relationships between organisations at the same stage in the supply-chain – for example, relationships between suppliers of complementary outputs. This includes relationships between firms in completely different industries serving the same market. Further, unlike the value-chain perspective, the cluster approach emphasises the importance of geographical co-location of players in enhancing overall innovation performance. As a result, the cluster approach tends to be applied at the local level (compared to, say, the national level), where particularly dense inter-firm relationships are evident.

Integration

The integrated framework shown in Figure 2 is intended to draw together the learnings associated with the four key frameworks discussed above.

Figure 2: The Integrated System Framework



The integrated framework concisely orders theoretical constructs drawn from the literature to arrive at a summary model. This approach combines the key features of four prominent options to overcome the limitations of using one, more narrowly focused framework. The integrated framework provides a useful guide for organising practical studies related to interactive innovation processes. In the context of sectoral, regional or national investigations, the integrated framework becomes the overarching guide incorporating cluster, value-chain, network and system-specific elements.

Focusing firstly on system-specific elements, attention is drawn to the area outside the cluster diamond. There are four system-specific elements, comprising the *technical support infrastructure* available to players in the system, and the *institutional* and *regulatory* features of the system that impact on innovativeness. The innovation system approach also evidences a comprehensive emphasis on *network(ing)* features (the diagram shows that the value-chain and cluster concepts also focus on these, though usually to a lesser extent). Hence the term *networks* in the diagram denotes both the network framework in its own right and the networking features of value-chains, clusters and systems.

The four system-specific elements – technical support, together with institutional, regulatory and networking features – are overviewed below.

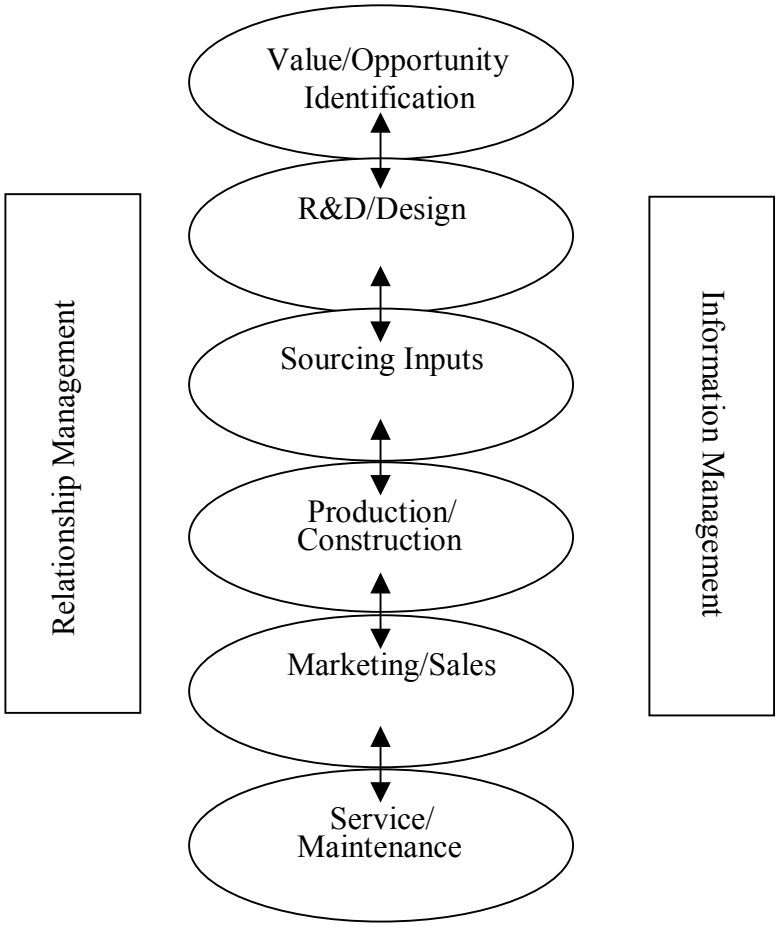
Table 2: Key Features Impacting on the Efficacy of Knowledge Flows and Competence Building in Innovation Systems

Technical Support	**Institutional Features**	**Regulatory Features**	**Networking Features**
• R&D centres • training/education bodies • professional associations • financial institutions • intellectual property rights	• rules of the game • conceptions of fairness • customs/traditions • routines	• technical specifications • safety standards • environmental regulation • industrial relations conventions	• linkage patterns and density • demand patterns • interactive learning • trust

The broad view of the innovation system approach reflected in the integrated framework draws our attention to these critical variables which can support or hinder the knowledge flows and economic competence at the nucleus of an innovation system. Their importance is highlighted in the concluding section to this paper.

Returning to Figure 2, within the system, *value-chains* are conceptualised as a vertical spine of critical inter-firm relationships. Value-chain relationships include both in-house and inter-firm linkages, organised around a value delivery process, such as the simplified version shown below.

Figure 3: Simplified Value-Delivery Process



The circles in the above diagram show simplified stages in a typical value-chain, with two-way vertical flows. Relationship and information management are shown separately as they have been identified as the most important functions in value-chain management, with value maximisation being the driving force guiding the process. User-producer interaction (not shown) has also been identified as a critical variable in value-chains, being a function of relationship management efforts.

Finally, Figure 2 shows a *cluster* diamond, which focuses on both vertical and horizontal relationships, paying particular attention to Porter's (1990) four critical factors – firm conditions, input conditions, demand conditions and related-industry conditions. The dynamism of the cluster can be enhanced by high levels of localised rivalry and geographic concentration. The cluster approach also expands on the value-chains approach by focusing on both firm *and* non-firm organisations (not shown).

Figure 2 uses existing concepts to develop a useful multi-referenced approach which emphasises, in an ordered way, the complexity of interactions between myriad players in innovation processes. The integrated framework provides a first-cut of the literature summarising key innovation drivers and their broad relationships.

Conclusions

This paper has outlined useful approaches to understanding innovation processes, for private-sector entrepreneurs and public-sector policy makers alike. Four key approaches have been investigated – systems, networks, chains and clusters. In order to better enable this material to guide practical investigations, a framework which integrates insights from each approach has been developed.

Systems thinking, together with network, value-chain and cluster thinking, has contributed a great deal to our understanding of effective innovation processes. Although the literature acknowledges that it is not possible to specify an ideal innovation process (Edquist 1997: 20), the following guidelines concerning the nature of well-performing processes are proposed:

- *Knowledge and Economic Competence*: An innovation system is more likely to be effective if it includes a diverse range of organisations with different types, and high levels of, economic competence. The system is likely to operate more effectively if it includes firm and non-firm organisations, demanding customers, and new industry players. Such features maximise complementarities between knowledge bases. The performance of the system will also be optimised if individual players effectively manage their value-chains.

- *Institutional Features*: It is best for the innovation system if there is a strong cultural emphasis on the importance of fairness and if local customs and routines reward innovativeness.

- *Technical Features*: Innovation system performance is critically affected by the quality and accessibility of the technical support infrastructure. R&D, training, education, finance and intellectual property arrangements need to be focused on innovation outcomes.

- *Regulatory Features*: Scope for innovation is maximised if technical, safety, environmental and other regulation is expressed in terms of ultimate performance requirements, instead of tightly specified prescriptive requirements.

- *Networking Features*: Maximum advantage will be gained if external linkages are dense, multistranded, long-term, knowledge-intensive, vertical *and* horizontal, market *and* non-market oriented, and inclusive of innovation, production and distribution relationships. Trust and robust user-producer relationships will also ideally be evident. Such factors support the development of effective dynamics within innovation systems.

- *Outcomes*: Innovation system outcomes will be maximised if individual participants perceive benefits beyond what they could achieve in isolation. The system is then more likely to be stable and productive.

In the rapidly changing environment of the 21st century, the ability of businesses and governments to generate growth and jobs will rest critically on their innovation performance. The integrated framework developed here is based on a new and increasingly popular 'interactive' approach to understanding and improving that performance. It provides a useful entry point for practical investigations of innovation processes.

Notes

[1] It is beyond the scope of this paper to highlight how the innovation system approach varies across these types. In any case, the features discussed here cut across the various applications which may be adopted.

[2]Readers interested in exploring the literature on user-producer relationships should see Tether (2000), Sornn-Friese (2000), Fagerberg (1995), Shaw (1994), DeBresson and Amesse (1991), Porter (1990) and Von Hippel (1988).

[3] Although the cluster approach can also incorporate a broad range of organisations, this feature is more strongly associated with the system perspective.

References

Alcorta, L. and Peres, W. (1998) 'Innovation Systems and Technological Specialisation in Latin America and the Caribbean'. *Research Policy*, 26: 857-881.

Amable, B. and Petit, P. (1999) *On Institutions, Innovation and Growth*. Provisional draft of paper presented at the Danish Research Unit for Industrial Dynamics Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, 9-12 June 1999.

Anderson, F. and Manseau, A. (1999) *A Systemic Approach to Generation/Transmission/Use of Innovation in Construction Activities*. Paper presented at the Third International Conference on Technology Policy and Innovation: Global Knowledge Partnership-Creating Value for the 21st Century, Austin, Texas, 30 August – 2 September 1999.

Anderson, F. and Schaan, S. (2001) *Innovation, Advanced Technologies and Practices in the Construction and Related Industries: National Estimates.* Survey of Innovation, Advanced Technologies and Practices in the Construction and Related Industries 1999, Draft Working Paper, Statistics Canada and National Research Council, Canada.

Antonelli, C. (1996) 'Localised Knowledge Percolation Processes and Information Networks'. *Journal of Evolutionary Economics*, 6: 281-295.

Archibugi, D., Howells, J. and Michie, J. (1999) 'Innovation Systems and Policy in a Global Economy'. In D. Archibugi, J. Howells and J. Michie (eds) *Innovation Policy in a Global Economy*, UK: University of Cambridge, 1-16.

Atkin, B. (1999) *Innovation in the Construction Sector.* European Council for Construction Research, Development and Innovation Study.

Arrow, K. (1962) 'Economic Welfare and the Allocation of Resources for Invention'. In *The Rate and Direction of Inventive Activity*. Princeton: Princeton University.

Arrow, K. (1975) 'Gifts and Exchanges'. In Phelps, E. (ed) *Altruism, Morality and Economic Theory*. New York: Russel Sage.

Aydalot, P. (ed) (1986) Milieux Innovateurs en Europe. Paris: GREMI.

Baptista, R. (1998) 'Clusters, Innovation, and Growth: A Survey of the Literature'. In G.M.P. Swann, M. Prevezer and D. Stout (eds) *The Dynamics of Industrial Clustering. International Comparisons in Computing and Biotechnology.* USA: Oxford University Press, 13-51.

Barlow, J. (2000) 'Innovation and Learning in Complex Offshore Construction Projects'. *Research Policy*, 29: 973-989.

Bianchi, P. and Bellini, N. (1991) 'Public Policies for Local Networks of Innovators'. *Research Policy*, 20: 487-497.

Bidault, F., Despres, C. and Butler, C. (1998) 'The Context of Early Supplier Involvement'. In *Leveraged Innovation: Unlocking the Innovation Potential of Strategic Supply*, Hampshire and London: Macmillan Press Ltd, 1-25.

Bidault, F., Despres, C. and Butler, C. (1998) 'The Strategic Implications of ESI'. In *Leveraged Innovation: Unlocking the Innovation Potential of Strategic Supply*, Hampshire and London: Macmillan Press Ltd, 161-176.

Boekema, F. Morgan, K., Bakkers, S. and Rutten, R. (2000) 'Introduction to Learning Regions: A New Issue for Analysis?'. In F. Boekema, K. Morgan, S. Bakkers and R. Rutten (eds) *Knowledge, Innovation and Economic Growth: The Theory and Practice of Learning Regions*, UK and USA: Edward Elgar Publishing Limited, 3-16.

Botham, R. (1998) *Cluster Strategies and Regional Development*. Paper presented at the OECD Conference on "Innovation Systems – Growth Engines for the 21st Century, Sydney, 19-20 November 1998.

Braczyk, H-J, Cooke, P. and Heidenreich, M. (1998) *Regional Innovation Systems: The Role of Governances in a Globalised World*, London: UCL Press.

Breschi, S. and Malerba, F. (2000) 'Sectoral Innovation Systems: Technological Regimes, Schumpeterian Dynamics, and Spatial Boundaries'. *In* C. Edquist (ed.) *Systems of Innovation: Technologies, Institutions and Organisations*, Chapter 6, London and Washington: Pinter, 130-156.

Brown, M.A. (1990) 'Process Innovation and the Structure of the Construction Industry'. *Habitat International*, 14(2/3): 63-65.

Budiawan, D. (2001) *Survey on Factors Affecting Contractor-Led Innovation*. Draft survey for Ph.D. work, School of Construction Management and Property and Construction Industry Institute Australia.

Bureau of Industry Economics, Australia (BIE) (1991) 'Networks: a third form of organisation'. *Bulletin on Industry Economics*, 10: 5-9.

Bureau of Industry Economics (BIE) (1995) *Beyond the Firm. An assessment of business linkages and networks in Australia*. Canberra: AGPS.

Burgess, R. and Turner, S. (2000) 'Seven Key Features for Creating and Sustaining Commitment'. *International Journal of Project Management*, 18: 225-233.

Camagni, R. (ed.) (1991) *Innovation Networks: Spatial Perspective's*. Belhaven: London.

Carassus, J. (2001) 'Innovation and "Construction Industry Meso-System" Analysis'. In *CIB World Building Congress*, April 2001, Wellington, New Zealand. Paper: Nov 35.

Carlsson, B. and Stankiewicz. (1991) 'On the Nature, Function and Composition of Technological Systems'. *Journal of Evolutionary Economics*, 1: 93-118.

Carlsson, B., Jacobsson, S., Jolmen, M. and Rickne, A. (1999) *Innovation Systems: Analytical and Methodological Issues*. Danish Research Unit for Industrial Dynamics Working Paper.

Casas, R., de Gortari, R. and Santos, M.J. (2000) 'The Building of Knowledge Spaces in Mexico: A Regional Approach to Networking'. *Research Policy*, 29: 225-241.

Cooke, P. (1992) 'Regional Innovation Systems: Competitive Regulation in the New Europe'. Geoforum, 23: 365-382

Cooke, P., Uranga, M.G., and Extebarria, G. (1997) 'Regional Innovation systems: Institutional and Organisational Dimensions'. *Research Policy*, 26: 475-491.

Dahmen, E. (1988) 'Development Blocks in Industrial Economics'. *Scandinavian Economic History Review and Economic History*, XXXVI(1): 3-14.

de la Mothe, J. and Paquet, G. (1998) 'Local and Regional Systems of Innovation as Learning Socio-Economics'. In J. de la Mothe and G. Paquet (eds) *Local and Regional Systems of innovation*, Boston, Dordrecht and London: Kluwer Academic Publishers, 1-16.

de la Mothe, J. and Paquet, G. (1998b) 'Some Lessons and Challenges for Model Builders, Data Gatherers and Other Tribes'. In J. de la Mothe and G. Paquet (eds) *Local and Regional Systems of innovation*, Boston, Dordrecht and London: Kluwer Academic Publishers, 327-334.

De Valence, G. (2001) 'Trends in Procurement and Implications for Innovation and Competitiveness of Australian Building and Construction'. In *CIB World Building Congress*, April 2001, Wellington, New Zealand. Paper: Nov 15.

DeBresson, C. and Amesse, F. (1991) 'Networks of Innovators: A Review and Introduction to the Issue'. *Research Policy*, 20: 363-379.

Dodgson, M. (1991) 'The Strategic Management of Learning'. In Dodgson, M., *The Management of Technological Learning: Lessons from a Biotechnology Company*. Berlin: de Gruyter, 107-141.

Dodgson, M. (1993a) 'Learning, Trust and Technological Collaboration'. *Human Relations,* 46(1): 77-95.

Dodgson, M. (1993b) 'Organisational Learning: A Review of Some Literatures'. *Organisation Studies*, 14(3): 375-394.

Dodgson, M. (1996) 'Technology and Innovation: Strategy, Learning and Trust'. In Sheehan, P., Grewal, B. and Kumnick, M. (eds) *Dialogues on Australia's Future*. Melbourne: Centre for Strategic Economic Studies, Victoria University.

Dodgson, M. (2000) *Systemic Integration of the Innovation Process within the Firm*. Contributed paper #2 at the National Innovation Summit, Melbourne, 9-11 February 2000.

Dohse, D. (2000) 'Technology Policy and the Regions — The Case of the BioRegio Contest'. *Research Policy*, 29: 1111-1133.

Dosi, G. (1988) 'The Nature of the Innovative Process', in Dosi et al. *Technical Change and Economic Theory*. London: Frances Pinter.

Dosi, G., Freeman, C., Nelson, R., Silverberg, G. and Soete, L. (eds) (1988) *Technical Change and Economic Theory*. London: Frances Pinter.

Easton, G. (1992) 'Industrial Networks: A Review'. In B. Axelsson and G. Easton (eds) *Industrial Networks: A New View of Reality*. London and New York: Routledge, 1-27.

Edquist, C. (1997) *Systems of Innovation: Technologies, Institutions and Organisations*. London: Pinter.

Edquist, C. (1999) *Innovation Policy – A Systemic Approach*. Incomplete draft of paper presented at the Danish Research Unit for Industrial Dynamics Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, 9-12 June 1999.

Edquist, C. and M. McKelvey. (2000) 'Introduction'. *Systems of Innovation: Growth, Competitiveness and Employment*, *Volume 1*. Cheltenham, UK: Edward Elgar Publishing Limited, xi-xxii

Eliasson, G. (1997) *Competence Blocks and Industrial Policy in the Knowledge Based Economy*. Stockholm: Department of Industrial Economics and Management, The Royal Institute of Technology.

Fagerberg J. (1994) 'Technology and International Differences in Growth Rates'. *Journal of Economic Literature*, 32: 1147-1175.

Fagerberg, J. (1995) 'User-Producer Interaction, Learning and Comparative Advantage'. *Cambridge Journal of Economics*, 19: 243-256.

Freeman, C. (1987) *Technology Policy and Economic Performance: Lessons from Japan*. London: Pinter.

Freeman, C. (1991) 'Networks of Innovators: A Synthesis of Research Issues'. *Research Policy*, 20: 499-514.

Freeman, C. and Louca, F. (2001) *As time goes by: from the industrial revolutions to the information revolution*. Oxford: Oxford University Press, 2001

Frenken, K. (2000) 'A Complexity Approach to Innovation Networks. The Case of the Aircraft Industry (1909-1997)'. *Research Policy*, 29: 257-272.

Gann, D.M. (1997) *Technology and Industrial Performance in Construction*. Paper prepared for OECD Directorate for Science, Technology and Industry.

Gann, D.M. (1998) *Learning and Innovation Management in Project-Based Firms.* Paper presented at 2nd International Conference on Technology Policy and Innovation, Lisbon, 3-5 August 1998.

Gann, D.M. and Salter, A.J. (2000) 'Innovation in Project-Based, Service-Enhanced Firms: The Construction of Complex Products and Systems'. *Research Policy*, 29: 955-972.

Garvin, D. A. (1993) 'Building a Learning Organisation'. *Harvard Business Review*, 71(July-August): 78-81.

Gertler, M. S., Wolfe, D. A. and Garkut, D. (1998) 'The Dynamics of Regional Innovation in Ontario'. In J. de la Mothe and G. Paquet (eds) *Local and Regional Systems of innovation*, Boston, Dordrecht and London: Kluwer Academic Publishers, 211-238.

Geyer, A. and Davies, A. (2000) 'Managing Project-System Interfaces: Case Studies of Railway Projects in Restructured UK and German Markets". *Research Policy*, 29: 991-1013.

Glatz, H. and van Tulder, R. (1989) *Ways out of the International Restructuring Race?* Project Proposal, Annex, B. University of Amsterdam, Amsterdam.

Green, R. (2000) *What Makes Global Regions: The Role and Significance of Regional Innovation Systems.* Contributed paper #7 at the National Innovation Summit, Melbourne, 9-11 February 2000.

Gu, S. (1999) *Concepts and Methods of NIS Approach in the Context of Less-Developed Economies. P*aper presented at the Danish Research Unit for Industrial Dynamics Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, 9-12 June 1999

Hakansson, H., Havila, V. and Pedersen, A. (1999) 'Learning in Networks'. *Industrial Marketing Management*, 28: 443-452.

Hakansson, H. and Johanson, J. (1988) 'Formal and Informal Cooperation Strategies in International Industrial Networks'. In Contractor, F. and Lorange, P. (eds) *Cooperative Strategies in International Business*. Lexington: Lexington Books.

Hampson, K. and Tatum, C. B. (1997) 'Technology Strategy and Competitive Performance in Bridge Construction'. *Journal of Construction Engineering and Management*, June 1997: 153-161.

Hobday, M. (2000) 'The Project-Based Organisation: An Ideal Form For Managing Complex Products and Systems?'. *Research Policy*, 29: 871-893.

Hobday, M., Rush, H. and Tidd, J. (2000a) 'Editorial'. *Research Policy*, 29: 793-804.

Hobday, M., Rush, H. Tidd, J. (2000b) *Innovation in Complex Products and Systems.* Special Issue. *Research Policy*, 29(7-8).

Howells, J. (1999) 'Regional Systems of Innovation?'. In D. Archibugi, J. Howells and J. Michie (eds) *Innovation Policy in a Global Economy*, UK: University of Cambridge, 67-93.

Howells, J. (2000) *Innovation and Services: New Conceptual Frameworks.* CRIC Discussion Paper No 38, Manchester: Centre for Research on Innovation and Competition.

Howells, J. and Roberts, J. (2000) 'From Innovation Systems to Knowledge Systems'. *Prometheus*, 18(1): 17-31.

Huggins, R. (2001) 'Inter-Firm Network Policies and Firm Performance: Evaluating the Impact of Initiatives in the United Kingdom'. *Research Policy*, 30: 443-458.

Lamboy, J. (2000) 'Learning and Agglomeration Economies: Adapting to Differentiating Economic Structures'. In F. Boekema, K. Morgan, S. Bakkers and R. Rutten (eds) *Knowledge, Innovation and Economic Growth: The Theory and Practice of Learning Regions*, UK and USA: Edward Elgar Publishing Limited, 17-37.

Landry, R. and Amara, N. (1998) 'The Chaudiere-Appalaches System of Industrial Innovations'. In J. de la Mothe and G. Paquet (eds) *Local and Regional Systems of innovation*, Boston, Dordrecht and London: Kluwer Academic Publishers, 257-276.

Leonard, D. and Sensiper, S. (1998) 'The Role of Tacit Knowledge in Group Innovation'. *California Management Review*, 40(3): 112-132.

Love, J.H. and Roper, S. (2001) 'Local and Network Effects on Innovation Success: Evidence for UK, German and Irish Manufacturing Plants'. *Research Policy*, 30: 643-661.

Lundvall, B- A (1988) 'Innovation as an interactive process: from user-producer interaction to the national system of innovation. In Dosi, G., Freeman, C., Nelson, R., Silverberg, G. and Soete, L. (eds) *Technical Change and Economic Theory*. London: Pinter.

Lundvall, B-A. (1992) *National Systems of Innovation*. London: Pinter.

Lundvall, B-A (1996) 'The Social Dimension of The Learning Economy'. *Working Paper No. 96-1*. Department of Business Studies, Aalborg University, Denmark.

Lundvall, B-A. (1999) *The Danish Innovation System. Discussion Paper on the Challenges and Opportunities for Innovation Policy. The Concluding DISKO Report*. Copenhagen: Erhvervsfremme Styrelsen.

Lundvall, B-A. and Christensen, J. L. (1999) *Extending and Deepening the Analysis of Innovation Systems – with Empirical Illustrations from the DISKO-Project.* Paper presented at the Danish Research Unit for Industrial Dynamics Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, 9-12 June 1999.

Maillat, D. and Vasserot, P. (1986) Les Milieux Innovateurs'. In Aydalot, P. (ed) Milieux Innovateurs en Europe. Paris: Gremi: 67-78

Malerba, F. (1999) *Sectoral Systems of Innovation and Production*. Paper presented at the Danish Research Unit for Industrial Dynamics Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, 9-12 June 1999.

Marceau, J. (1995) 'A Networked Nation or a Complexes Issue? Reshaping Industry Analysis'. *Journal of Industry Studies*, 2(2): 19-33.

Marceau, J. and Manley, K. (1999) 'Innovation Checkpoint 1999 – Innovation in Australian Businesses'. Australian Business Foundation, Sydney.

Marceau, J. (2000) 'Innovation and Industry Development: A Policy-Relevant Analytical Framework', *Prometheus*, 18(3): 283-301.

Marceau, J. and Dodgson, M. (2000) *Systems of Innovation*. Contributed paper # 1 at the National Innovation Summit, Melbourne, 9-11 February 2000.

Martin, S. and Scott, J. T. (2000) 'The Nature of Innovation Market Failure and the Design of Public Support for Private Innovation'. *Research Policy*, 29: 437-447.

Maskell, P. (1998) 'Learning in the village economic of Denmark. The role of institutions and policy in sustaining competitiveness'. In Braczyk, H-J., Cooke, P. and Heidenreich, M. (eds.) *Regional Innovation Systems. The Role of Governance in a Globalised World*. London: Taylor Francis.

Maskell, P, Eskelinen, P., Hannibalsson, I. and Malmberg, A. (1998) *Competitiveness, Localised Learning and Regional Development. Specialisation and Prosperity in Small Open Economies*. London: Routledge.

Metcalfe, J.S. (1999) *The Evolution and Development of Evolutionary Economics: Opening Remarks.* Paper presented at Conference on Self-Organisation and the Evolutionary Agenda, Department of Economics, University of Queensland, Australia, 12-14 July 1999.

Murphy, P. A., Pfister, N. and Wu, C.T. (1997) *Industry Cluster Strategies for Regional Economic Development*, NSW: Centre for Australian Regional & Enterprise Development, Southern Cross University.

Nelson, R. and Winter, S. (1982) *An Evolutionary Theory of Economic Change*. Cambridge, MA: Belknap Press.

Nelson, R. (Ed) (1993) *National Innovation Systems*. New York: Oxford University Press.

Nam, C.H. and Tatum, C. B. (1997) 'Leaders and Champions for Construction Innovation'. *Construction Management Economics*, 15: 259-270.

Nightingale, P. (2000) 'The Product-Process-Organisation Relationship in Complex Development Projects'. *Research Policy*, 29: 913-930.

Niosi, J., Saviotti, P., Bellon, B. and Crow, M. (1993) 'National Systems of Innovation: In Search of a Workable Concept'. *Technology in Society*, 15: 207-227.

Nooteboom, B. (2000) 'Institutions and Forms of Co-ordination in Innovation Systems'. *Organisation Studies*, 21(5): 915-939.

Nooteboom, B., deJong, G., Vossen, R.W., Helper, S. and Sako, M. (2000) 'Network Interactions and Mutual Dependence: A Test in the Car Industry'. *Industry and Innovation*, 7(1): 117-144.

Normann, R. and Ramirez, R. (1993) 'From Value Chain to Value Constellation: Designing Interactive Strategy'. *Harvard Business Review*, 71(July-August): 65-78.

OECD (1996) *The Knowledge-Based Economy*. Paris: OECD

OECD (1997a) *National Innovation Systems*: Paris: OECD.

OECD (1997b) 'OECD Workshop on Cluster Analysis and Cluster-Based Policies'. Amsterdam.

OECD (1999a) *The Knowledge-Based Economy: A Set of Facts and Figures*. Paris: OECD

OECD (1999b) *Managing National Innovation Systems*. Paris: OECD.

OECD (1999c) Boosting Innovation: The Cluster Approach. Paris: OECD.

OECD (2000) *A New Economy? The Changing Role of Innovation and Information Technology in Growth*. Paris: OECD.

Owen, M., Arnold, G., Donbavand, J. and McGuire, F. (1999) *Removing the Barriers to Innovation*. Paper presented at Options for Post Millennium Pavements Symposium, Taupo New Zealand, October 1999.

Patel, P. (2000) 'Technological Indicators of Performance'. In J. Tidd (ed.) *From Knowledge Management to Strategic Competence*, London: Imperial College Press, 129-154.

Patel, P. and Pavitt, K. (1994) 'National Innovation Systems: Why They Are Important, and How They Might Be Measured and Compared'. *Economics of Innovation and New Technology*, 3: 77-95.

Porter, M. (1990) *The Competitive Advantage of Nations*. New York: Free Press.

Porter, M. (1990b) 'The Competitive Advantage of Nations'. *Harvard Business Review*, March-April: 73-93.

Porter, M. E. (1998) 'Clusters and the New Economics of Competition'. *Harvard Business Review*, November-December: 77-90.

Pyke, F., Becattini, G. and Sengenberger, S. (1990) *Industrial Districts and Inter-Firm Cooperation in Italy*. Geneva: International Institute for Labour Studies.

Ratti, R., Bramanti, A. and Gordon, R. (1997) *The Dynamics of Innovative Regions*. England: Ashgate.

Roelandt, T.J.A. (1998) *Research Strategies and Policy Implications*. Paper presented at the OECD Conference on 'Innovation Systems – Growth Engines for the 21st Century', Sydney, 19-20 November 1998.

Rosenberg, N. (1982) *Inside the Black Box*. Cambridge: Cambridge University Press.

Sako, M. (1991) 'The Role of 'Trust' in Japanese Buyer-Supplier Relationships'. *Ricerche Economiche*, XLV(3-2): 375-399.

Saxenian, A. (1996) 'Inside-Out: Regional Networks and Industrial Adaptation in Silicon Valley and Route 128'. *Cityscape: A Journal of Policy Development and Research*, 2(2): 41-220.

Schienstock, G. (1999) *Regional Competitiveness: A Comparative Study of Eight European Regions*. Paper presented at the Danish Research Unit for Industrial Dynamics Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, 9-12 June 1999.

Seaden, G., Guolla, M., Doutriaux, J. and Nash, J. (2001) *Analysis of the Survey on Innovation, Advanced Technologies and Practices in the Construction and Related Industries, 1999*. Draft research paper commissioned by the Institute for Research in Construction of the National Research Council of Canada and by the Science, Innovation and Electronic Information Division of Statistics Canada.

Seadon, G. (1995) *Economics of Technology Development for the Construction Industry.* CIB Report, Publication 202.

Simmie, J. and Hart, D. (1999) *Innovation Projects and Local Production Networks: A Case Study of Hertfordshire*, European Planning Studies, 7(4): 445-462

Slaughter, E.S. (1998) 'Models of Construction Innovation'. *Journal of Construction Engineering and Management*, May/June 1998: 226-231.

Sornn-Friese, H. (2000) 'Frontiers of Research in Industrial Dynamics and National Systems of Innovation'. *Industry and Innovation*, 7(1): 1-13.

Statistics Canada (1999) *Innovation, Advanced Technologies and Practices in the Construction and Related Industries*. Survey for Science and Technology Redesign Project.

Statistics Canada (1999) *Survey of Innovation 1999*. Survey by Science, Innovation and Electronic Information Division, Statistics Canada.

Swann, G.M.P. and Prevezer, M. (1998) 'Introduction'. In G.M.P. Swann, M. Prevezer and D. Stout (eds) *The Dynamics of Industrial Clustering. International Comparisons in Computing and Biotechnology.* USA: Oxford University Press, 1-12.

Tether, B. (2000) *Who Co-operates for Innovation within the Supply-Chain, and Why? An Analysis of the United Kingdom's Innovation Survey.* CRIC Discussion Paper No 35, Manchester: Centre for Research on Innovation and Competition.

Tomlinson, M. (2000) *Innovation Surveys: A Researcher's Perspective*, Danish Research Unit for Industrial Dynamics Working Paper No 00-9.

UK Department of Trade and Industry (1999) *UK Competitiveness Indicators 1999* London: DTI.

van Geenhuizen, M. and Nijkamp, P. (2000) 'The Learning Capabilities of Regions: Conceptual Policies and Patterns'. In F. Boekema, K. Morgan, S. Bakkers and R. Rutten (eds) *Knowledge, Innovation and Economic Growth: The Theory and Practice of Learning Regions*, UK and USA: Edward Elgar Publishing Limited, 38-56.

van Tulder, R. and Junne, G. (1988) European Multinationals in Core Technologies. Chichester: Wiley.

Von Hippel, E. (1988) *The Sources of Innovation*. New York: Oxford University Press.

Walters, D. and Lancaster, G. (2000) 'Implementing Value Strategy Through the Value Chain'. *Management Decision*, 38(3): 160-178.

Wright, J. (2000) *Presentation of the Report of the UK Government Construction Task Force.* Text on website at www.m4i.org.co.uk.

Yoguel, G., Novick, M. and Marin, A. (2000) *Production Networks: Linkages, Innovation Processes and Social Management Technologies. A Methodological Approach Applied to the Volkswagen Case in Argentina*, Danish Research Unit for Industrial Dynamics Working Paper No 00-11.