A conceptual model and illustrative research framework for inter-organizational innovation

Thomas Matheus
Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

Abstract

Purpose – The purpose of this paper is to develop an integrated model, which incorporates the influence of different dimensions of power on various sub-components of continuous innovation in inter-firm networks using the product development process (PDP) as the unit of analysis.

Design/methodology/approach – A theoretical framework is developed initially. The theoretical framework is supported by two illustrative examples from the aerospace industry. Semi-structured interviews, observation and template analysis are proposed as suitable data collection and analysis methods.

Findings – The paper offers a view on how the PDP is facilitated and/or constrained due to this interweavement. The paper offers five tentative initial templates surrounding the themes discussed.

Research limitations/implications – The conceptual framework is still in its nascent stage and requires substantial empirical work. As the relationships between power and knowledge in inter-firm networks are currently under-researched it might be worthwhile considering a qualitative approach to widen our understanding of the interrelationships of the concepts before embarking on a quantitative research endeavour.

Originality/value – This paper provides a conceptual model of how four dimensions of power influence the integration of sub-components of continuous innovation throughout the high-phased stage-gate process in an inter-firm network.

Keywords Systems analysis, Integration, Continuous improvement, Organizational innovation

Paper type Research paper

Introduction

The aim of this paper is to develop an integrated model, which incorporates the influence of different dimensions of power on various sub-components of continuous innovation in inter-firm networks using the product development process (PDP hereafter) as the unit of analysis. Initially, networked innovation, systems integration, different types of knowledge, inter-firm networks, knowledge exploitation and exploration, continuous innovation, different dimensions of power and the high-phased PDP will be briefly discussed. Based on these discussions positions concerning these notions will be adopted. The adopted positions will be synthesized into a holistic framework and two illustrative examples will be used to partially underpin the conceptual framework. In the final section we propose semi-structured interviews, observation and template analysis as qualitative research methods as well as five tentative initial templates that could be helpful in generating additional empirical data to support the conceptual framework of this paper.

Networked innovation

Innovations tend to happen at the "interstices" of inter-firm networks (Powel *et al.*, 1996; Carlile, 2002; Swan and Scarbrough, 2005). Knowledge is spread across organizational boundaries and can be shared and integrated at these interstices in

order to be transformed into new products, processes and services (Jarillo, 1988; Swan and Scarbrough, 2005). Network innovation depends on the management of knowledge sharing, technology transfer and learning (Millar *et al.*, 1997). Networked innovation may be defined as innovation occurring through relationships that are negotiated in an ongoing communication process, and relies on networking internally and externally available invention and innovation services to develop and market customer-valued products and services (Phillips *et al.*, 2000; Radjou, 2005; Swan and Scarbrough, 2005; Valkokari and Helander, 2007).

The following definition for networked innovation will be adopted in this paper and focus on supply chain collaboration:

Networked innovation is "innovation that occurs through inter-organizational interaction processes and bonds with economic targets, directed to a sequence of exchanges that are negotiated in an ongoing communicative process, which in long-term relationships are less influenced by market and hierarchical governance mechanisms of control" (Gemünden, 1990; Jarillo, 1988; Sawhney and Zabin, 2002; Swan and Scarbrough, 2005; Low *et al.*, 2007). Relational modes of organizing are the third broader part of the networked innovation definition adopted.

As the industry focus of this paper is the aerospace industry, definitions of two additional notions, that of "complex products and systems" and that of the "systems integrator" are also introduced. Complex products and systems (CoPS) are high cost, technology-intensive, customised, capital goods, systems, networks, control units, software packages, constructs and services (Hobday *et al.*, 2000). CoPS manufacturing processes and projects involve the interactive integration of numerous collaborating organizations to achieve the knowledge and organizational integration to eventually deliver the final product (Brusoni and Prencipe, 2001; Hobday *et al.*, 2000). The coordination task is carried out by the systems integrator who erects the network and leads it from an organizational and technological viewpoint (Prencipe, 2005). Important systems integration skills in the defence industry include the art of conceiving, designing, and managing the development and deployment of large systems involving multiple disciplines and many participating organizations (Sapolsky, 2005). Further skills required at the technological level have also been identified (Gholz, 2005).

At the organizational level (as opposed to the "technical level") competence to manage inter-firm communication processes, to support a shared vision among network members and to establish a network identity are important (Dyer and Nobeoka, 2000). Numerous management practices that affect inter-firm supplier relationships have been researched: Integration of suppliers into customer project teams, direct cross-departmental inter-firm communication, secondment and co-location of customer-supplier personnel, sharing customer requirements, mutually agreeing on performance measurements and targets, formal supplier competence evaluations and formalized supplier selection and integration mechanisms (Ragatz *et al.*, 1997).

This paper, using the discussed elements of technical and organizational management of networks within supply chains argues that the integration and sharing of knowledge, which is dispersed among network partners, is influenced by different dimensions of power (Swan and Scarbrough, 2005).

Positioning: types of knowledge and inter-firm networks

Knowledge is arguably the most important resource of organizations (Grant, 1996). For CoPS, knowledge is distributed among network members (Brusoni and Prencipe, 2001).

Systems integrators require different types of knowledge to be able to decompose a particular product concept design into various modules and at a later stage, recompose the product within a set product architecture (Prencipe, 2005). This paper adopts a processual perspective of knowledge (Swan, 2007). Besides the decomposition and recomposition argument, we also focus on know-how, know-why, know-what and know-who knowledge (Lundvall, 1996; Sanchez, 1996, 1997; Simon, 1969).

Know-how represents an understanding of procedures required to manufacture each component and an understanding of how components should be put together to perform as a system (Garud, 1997; Lundvall, 1996). From a management perspective, the capability of producing a particular product and the amendment and improvement of manufacturing processes are enabled through this type of knowledge. Furthermore, the sharing and integration of know-why and know-what knowledge into manufacturing processes is an important management consideration (Newell *et al.*, 2005).

Know-why represents an understanding of the principles underlying the construction of each component and the interactions between them (Garud, 1997). Know-why reflects the theoretical understanding of why the components of a particular product work together to enable an overall purpose of a product, i.e. research and development (Sanchez, 1996). Know-why knowledge exists if an organization is able to alter a product design or to develop an innovative product design to generate new product alternatives (Sanchez, 1996).

Know-what represents an understanding of the specific system configurations that different customer groups may want and the different uses they may put these systems to (Garud, 1997). Subsequently, learning takes place through interactions between suppliers and customers (Garud, 1997; Von Hippel, 1988; Von Hippel and Tyre, 1993) and requires the integration of knowledge from different knowledge domains (Iansiti and Clark, 1994; Newell *et al.*, 2005; Okhuysen and Eisenhardt, 2002).

Know-who involves information about who knows what and who knows to do what (Lundvall, 1996). A particular important aspect of this kind of knowledge is the social capability to initiate relationships to certain groups or organizations to utilize their knowledge (Lundvall, 1996; Ritter, 1999).

The importance of the interrelationships between the four types of knowledge has been acknowledged in the literature (e.g. Araujo and Mota, 2004; Lundvall, 1996; Sanchez, 1996, 1997; Scarbrough, 2003; Von Hippel and Tyre, 1993). There are a number of studies that focused on shared knowledge of customers (Clark and Wheelwright, 1993; Cordell, 1997; Day, 1994; Slater and Narver, 1995), on internal design, process and manufacturing knowledge (Adler *et al.*, 2003; Clark and Wheelwright, 1993; Garvin, 1993) as well as on design, process and manufacturing knowledge of suppliers (Hahn *et al.*, 1990; Hartley, 1997; Ragatz *et al.*, 1997) separately. Other studies have emphasized knowledge at the technological level (e.g. Gholz, 2005; Prencipe, 2005; Sapolsky, 2005).

In summary, some of these authors focused on the production view and/or the technological level of knowledge. Subsequently, the social and organizational embeddedness of knowledge is under-researched (Lam, 2000; Tsoukas and Vladimirou, 2001).

Finally, for the purpose of this paper an inter-firm network is defined as "two (dyad) or more agents, at least in part autonomous, which give rise to an exchange relationship, according to certain modalities and forms" (Nassimbeni, 2004, p. 46). The rationale for this definition is that it incorporates the notion of two (or more) legally

independent but economically dependent organizations (i.e. the structure), the notion of an exchange relationship (i.e. the content) and the modalities of exchange governance (i.e. the mode of governance) (Nassimbeni, 2004).

After this definition of the different types of knowledge and inter-firm networks, a rationale for the adoption of the notions of exploitation and exploration are developed.

Exploration and exploitation

The notions of exploitation and exploration are now introduced and integrated[1]. The former is concerned with the exploitation of an organization's existing capabilities, whereas the latter is concerned with the exploration of new capabilities (Levinthal and March, 1993; March, 1991). In a product development context exploitation is defined as "the regular reduction in production cost with each new product introduction (learning curve behavior)" (Knott, 2002, p. 339). Subsequently, exploitation is associated with the improvement of current operations, elaboration of existing experiences, efficiencies and low variances in activities (March, 1991).

In the same context exploration is defined as "the addition of new characteristics or higher performance with each new product introduction" (Knott, 2002, p. 339). This associates exploration with expansions into new operations, the creation of a variety of experiences, experimenting, taking risks, play, flexibility, discovery and a high variance in activities (March, 1991).

Exploitation and exploration have been enduring themes in the management literature that address the tensions between being successful in a competitive environment and surviving in a changing environment (Cole, 2001; Levinthal and March, 1993). Concepts of exploitation and exploration absorb the notions of know-how, know-why, know-what and know-who knowledge. The rationale for the absorption of know-how knowledge into the concepts of knowledge exploration and exploitation is that the understanding of procedures necessary of how to manufacture a product or component may incorporate the adoption of radical process improvements but also the adoption of less radical and hence, incremental process improvements (Bessant, 2004). Research (exploration) and development (exploitation) are required in the context of technological knowledge acquisition (Garcia *et al.*, 2003; Li and Calantone, 1998; Peteraf, 1993). An example for the former is the adoption of new process methodologies and/or technologies to design and/or develop a product or service. An example for the latter is the incremental improvement of existing development procedures or in other words the small-scale improvement of the understanding of the principles of the interactions between components.

For know-what knowledge it might mean that customers require the improvement of existing products and services (knowledge exploitation) as well as the development of entirely new products and services (knowledge exploration). For know-who knowledge Ritter (1999), although he does not use the terms exploitation and exploration, provides a brief overview of various network management tasks that can be mapped with the exploitation – exploration terminology. Based on these network management tasks, exploration is the initiation of internal as well as external relationships (Ritter, 1999), whereas, exploitation is the improvement of exchange activities (Bagozzi, 1975) as well as the improvement of coordination activities (Mohr and Nevin, 1990).

Thus we see that different types of knowledge can be integrated into the concepts of exploration and exploitation. Furthermore, a connection between exploration and exploitation to the notions of continuous innovation and power can be developed. We will now include a discussion of the PDP literature which will further help understand the topic of continuous innovation.

Stage-gate PDP

The literature covering PDPs is quite extensive (Rothwell, 1994; Newell *et al.*, 2002; Cooper, 1990; Phillips *et al.*, 1999). For our purposes the framework in Figure 1 is adopted.

This framework reflects the complexity organizations in the aerospace industry are confronted with to some degree (Phillips *et al.*, 1999). The high-phased stage-gate process presented above consists of specific and separate stages, which are headed by review points or gates (Cooper, 1990; Cooper and Kleinschmidt, 1991). The rationale for the utilization of stages and gates is based on a predecessor, the phased review process. Here the PDP was broken down in separate phases. At the end of each phase funding requirements and the progression of the project were reviewed. Subsequently, the phased review process served as a measurement and control method that instilled discipline throughout the entire PDP. Furthermore, technical risks were reduced and task completion was ensured. Over time organizations integrated aspects, such as cross-functionality, joint decision-making (across departments), stronger market-orientation as well as parallel and concurrent processing (Cooper and Kleinschmidt, 1990; Reimann and Sarkis, 1996).

The difference between the conventional stage-gate PDP (Cooper, 1994) and the high-phased PDP is that an organization puts a strong emphasize on the initial stage, i.e. the preliminary concept development stage. The rationale for this approach is reflected in the organization's needs to survive in a highly competitive customer-focused marketplace, in which distinctive product characteristics are essential. Subsequently, the utilization of rigid monitoring techniques is vital in order to address and realize the customer requirements (Phillips *et al.*, 1999).

In stage 3 (Figure 1) high-phased organizations have additional control phases, in which the product definition is matched with the customer requirements. At this stage development budgets are exhausted and product costs have peaked. In spite of this occurrence, organizations stress the close monitoring and control of the aforementioned match beyond the development phase. As competitiveness of product and development costs are equally important, stage 2 should be divided into sub-phases. This enables organizations to monitor and control the progress during the development stage more closely in order to operate at the lowest possible cost (Phillips *et al.*, 1999).

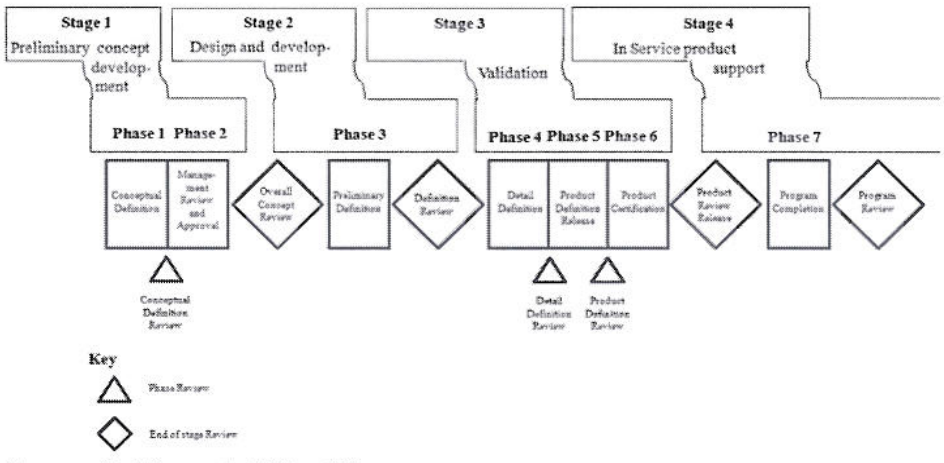


Figure 1.
The stage-gate development process

Sources: Phillips *et al.*, 1999, p. 295

In order to address the non-linear nature of the PDP in CoPS industries, we introduce the four fundamental Fs, i.e. fluidity, fuzzy gates, focused and flexible, which were coined by Cooper (1994). Fluidity is about the fluid, adaptable and overlapping character of the discrete stages and phases throughout the PDP for accelerated market entry. Fuzzy gates are about the conditional and situational character of "Go decisions" at all stages and gates, in contrast to absolute ones. Focused means that individual product development projects are prioritised out of a pool of projects, from which the most promising projects are pursued. Flexibility addresses the uniqueness of each product development project and reflects a reduced level of rigidity in comparison to preceding stage-gate processes (Cooper, 1994).

The next section, in further development of the conceptual framework will introduce different dimensions of power.

Power

Power is an elusive, complex and multifaceted notion that lacks an unanimously acknowledged definition (Haugaard, 2002). For the purpose of this paper, power is seen as "a force that effects outcomes, while politics is power in action" (Hardy, 1996).

Hardy (1994, 1996), based on Lukes (1974) makes an analytical distinction between four dimensions of power: power of resources (e.g. rewards, sanctions, coercion, authority, credibility, charisma, expertise, information and political affiliations (Benfari *et al.*, 1986)), power of processes (e.g. non-decision-making; manipulating of agendas (Bachrach and Baratz, 1962)), power of meaning, e.g. symbols, structure, values, language (Pfeffer, 1992), a dominant mode of organizing (Carter and Scarbrough, 2001), the legitimation of outcomes (Carter and Scarbrough, 2001; Hardy, 1996; Pfeffer, 1992) and power of the system, e.g. governmentality, which is the application of knowledge on how to affect people's behaviour; the way in which techniques of power produce truth on subjects, through for example performance measurements (Adler, 2005; Carter and Scarbrough, 2001; Cooper *et al.*, 1996; Drazin, 1990; Hardy, 1996; Sewell, 1999; Townley, 1993). The issues surrounding Hardy's (Hardy, 1994, 1996) third and fourth dimension of power in terms of "epistemological differences between the claims of false consciousness of Lukes (1974) and the denial of an essentialist reality postulated by Foucault and Gordon (1980)" (Carter and Scarbrough, 2001), will not be taken into consideration in this paper.

In reality the different dimensions of power are recursively intertwined. However, the rationale for choosing this framework of power is that it provides a useful analytical framework for exploring power effects (Swan and Scarbrough, 2005). Moreover, previous research combining power and inter-firm networks has focused merely on the resource-based view of power (e.g. Cox *et al.*, 2002, 2004; Handfield and Bechtel, 2004; Maloni and Bentton, 2000; Marshall and Brady, 2001). Subsequently, expanding the power framework may shed light on different aspects of the nature of power in the inter-firm context besides counterproductive effects in relation to collaboration and trust, which have been revealed using the resource-based view of power (Handfield and Bechtel, 2004).

Besides the research gaps concerning the different types of knowledge mentioned above, even less research has been done on how "power" facilitates and/or constrains the interrelationships between the four typologies of knowledge, knowledge exploration and exploitation, continuous innovation and how this subsequently influences the PDP. A potential research question to advance the areas covered in this paper is:

How do different dimensions of power influence the interrelationships between knowledge exploitation and exploration throughout the PDP in an inter-firm aerospace network?

In the following section the various concepts we have discussed will be integrated into a holistic framework and two illustrative examples will be described to offer a tentative answer to this question.

Discussion and illustrative examples

The network relationships presented in Figure 2 signify an inter-firm network and a high-phased stage-gate process. The relationships between the original equipment manufactures (OEMs), first tier suppliers and customers are not mutually exclusive, i.e. first tier suppliers collaborate amongst each other, with various OEMs as well as with numerous customers. The same applies to second and third tier suppliers, but are not included in the Figure 2.

The high-phased stage-gate process operates at an intra- and inter-organizational level. Furthermore, the integration of the different dimensions of knowledge is influenced by various dimensions of power. These power effects take place at an intra- and inter-organizational level. Power of the system permeates all aspects of the individual organizations, the network relationships, the high-phased stage-gate process and the knowledge sharing and integration activities within and between organizations.

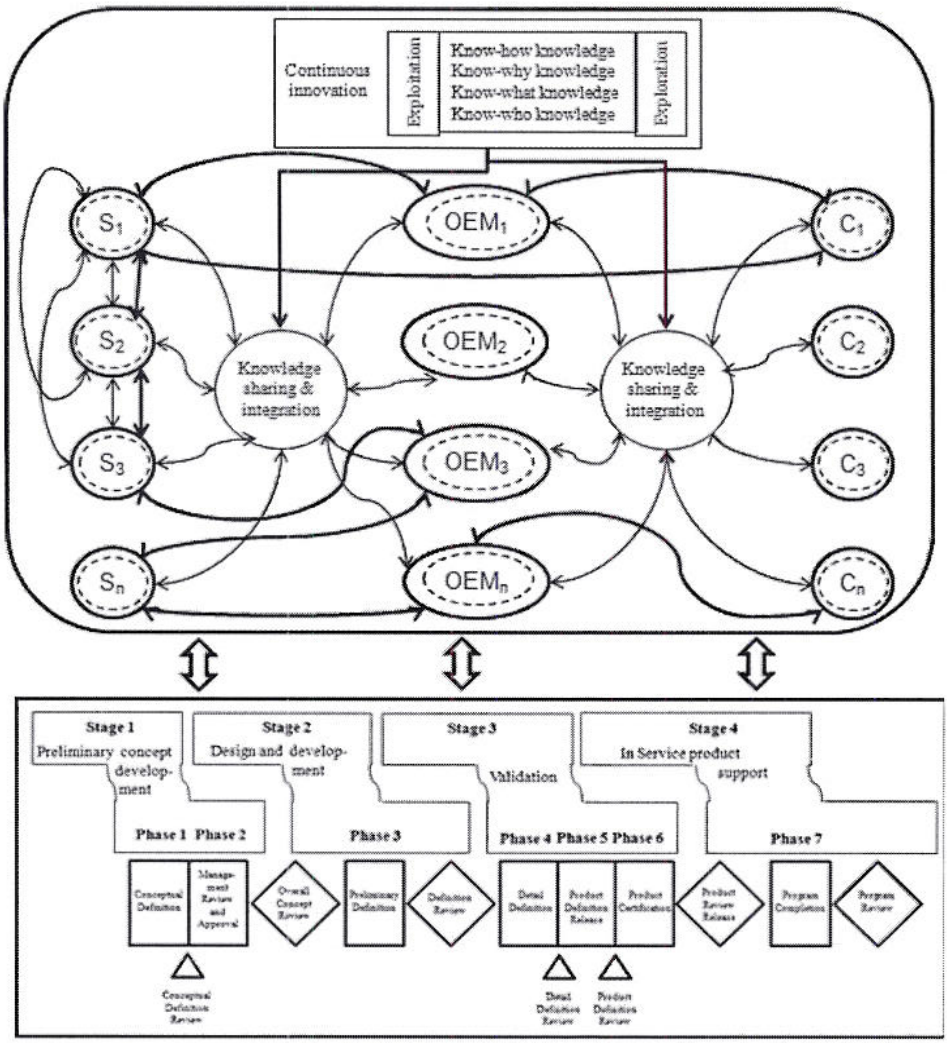
Two illustrative case examples were developed based on semi-structured interviews with four senior managers at the OEM, called Aerocomp and one project manager at Aerosupplier (the company names were altered due to confidentiality agreements). More interviews were carried out in this context. However, due to time constraints, the data could not be analysed using appropriate methods. Hence, the short case studies will merely serve as indicative examples.

Aerocomp is an organization operating in the aerospace industry. The aerospace industry is characterized through a high degree of outsourcing and through the complexity of its products (Barlow, 2000; Brusoni and Prencipe, 2001; Dodgson and Rothwell, 1994; Hobday *et al.*, 2005; Kazlauskaite *et al.*, 2005; Prencipe, 2005; Shaw, 1994). Therefore it serves as a cogent example for the discussion in this paper as different entities have to contribute different types of knowledge, from an exploration and exploitation perspective, in order to be able to deliver the ultimate product.

The first example is about Aerocomp being in the process of developing an entirely new aeroplane. A new supplier, Aerosupplier (a first tier supplier), was sourced (i.e. know who exploration). As Aerosupplier had not been doing business with Aerocomp, it was eager to secure the business Aerocomp had to offer. Power of resources in the form of future business opportunities as a reward as well as in terms of a credibility enhancement within the industry may have contributed to this eagerness. The knowledge sharing and integration efforts along the PDP between the two organizations went nearly seamless. The rationale for this may have been that Aerosupplier was highly committed to perform based on the targets set at each of the stages and phases of the high-phased PDP. From a power of the system perspective the PDP as well as the performance targets allocated to the stages and phases were used to "produce truth on the subject" (Carter and Scarbrough, 2001), i.e. testing Aerosupplier's capabilities to deliver according to certain norms, which were specified beforehand.

Furthermore, Aerosupplier may also have been committed to learn quickly in terms of how to adopt new business processes from a know-how, know-why, know-what and know-who perspective.

Subsequently, Aerosupplier had to exploit existing capabilities to perform as efficiently as required by Aerocomp, but it also had to explore new capabilities as it had not been working with Aerocomp previously. Thus, it had to continuously innovate its way of



Key to the upper part of the integrated framework:

S = First tier supplier OEM = Original Equipment Manufacturer C = Customer

——— = Knowledge sharing and integration between organizations

◯ = Knowledge sharing and integration within organizations

——— and ⬭ = Knowledge sharing and integration of different types of knowledge

– – – – = Occurrence of different dimensions of decision making

Key to the lower part of the integrated framework:

△ = Phase Review ◇ = End of stage Review

Figure 2.
Integrated inter-firm network and a high-phased stage-gate process

organizing along the high-phased stage-gate process. The rationale for continuous innovation may have been due to the allocation of sufficient resources (power of resources) to be able to meet deadlines and quality standards along the high-phased stage-gate process (Sewell, 1999). Furthermore, this positive knowledge exploration and exploitation may have been attributable to the symbolic value (power of meaning) of becoming a permanent supplier to Aerocomp. This might indicate that both the power of resources and meaning are exercised against the systemic dimension of power to accomplish knowledge exploitation and exploration across organizational boundaries and hence, inter-firm continuous innovation throughout the high-phased stage-gate process. A statement by one of the interviewees reflects this incentive to deliver:

"They [Aerocomp] do that by a quarterly evaluation against a set of key criteria. I mean from day to day they'll tell us okay and we'll look at each delivery, we look at the performance as we go through the project but then every quarter what happens is that there's a formal review of our activities against a set of pre-criteria, which then gets wrapped together with all the other work that we [Aerosupplier] do and then that'll get sent to the headquarters [of Aerocomp] to say this is how Aerosupplier are doing . . . [and if we don't meet the performance criteria], there is a mechanism there to say right well if you're not . . . if you get to a certain level of performance and you decrease at that level, Aerocomp will not give you work and you'll be taken off the product supplier list".

Additionally, the external recognition of Aerosupplier of being able to become a permanent supplier of Aerocomp and having been able to adhere to Aerocomp's performance standards along the high-phased stage gate process may have also emitted positive effects within the industry and hence, led to further business for Aerosupplier other than with Aerocomp. These consequences may be interpreted as systemic power, too (Cf. Lawrence *et al.* (2005) concerning knowledge exploration and power).

However, in the latter part of this example systemic power is not enacted through performance targets throughout the high-phased stage gate process but through an unconscious acceptance of values and norms within an industry. This approach means that the ability of Aerosupplier to meet Aerocomp's performance standards may have convinced other organizations in the industry to collaborate with Aerosupplier. Finally, this example supports the discussion regarding the positive effects (as opposed to only negative ones) surveillance might have on continuous innovation (refer to Sewell (1999) for a discussion).

In the second example the OEM (Aerocomp) selected a new supplier (from a different country than their own) based on the outcomes of a supplier selection process. Throughout this process the new supplier is assessed based on various hard and soft performance indicators (i.e. systemic power) (Hardy, 1996). In some cases, when Aerocomp has intentions of selling aircraft to the Ministry of Defence of a different country and/or to a government owned airline (in both cases non-UK), the results of the previous supplier selection process are discarded. This is due to an authoritative decision made by the respective government that Aerocomp must work with a particular supplier that would not have been considered because of non-conformance to the performance indicators of the supplier selection exercise (power of resources (Benfari *et al.*, 1986)). In the case reported in this research, the effects of such a decision by the non-UK government had negative effects on the sharing and integration of knowledge between Aerocomp and the respective supplier. However, the sharing and integration of knowledge in the instances discussed in the interviews was vital because the new supplier had to learn new engineering and design standards so that Aerocomp was able to meet the requirements for particular components and the final product laid upon it by

other external institutes (e.g. Airworthiness Authority). The non-UK supplier however, took advantage of the decision made by their national government because the supplier knew that no matter how well they would perform, they would not lose the contract with Aerocomp. These aspects were openly discussed between Aerosupplier and Aerocomp when specific issues regarding the supplier's non-conformance to requirements were raised by Aerocomp. Subsequently, the power of meaning was negatively impacted by the power of resources. The rationale for this was the authoritative decision by the non-UK government to use a particular supplier as well as the decision by Aerocomp to comply to the these demands to be able to complete the business deal with the non-UK Ministry of Defence (Hardy, 1996). In the case discussed throughout the interviews both, knowledge exploitation (e.g. the utilization of Aerocomp's existing knowledge to improve the supplier's performance) as well as exploration (e.g. the utilization of new ideas provided by Aerocomp to the supplier) were hindered due to the influence of the dimensions of power used for the purpose of this paper (Lawrence *et al.*, 2005).

In the following sections a number of research methods are proposed that might be an appropriate starting point to investigate the phenomena discussed so far.

Proposed data collection and analysis methods

Proposed data collection methods

In order generate qualitative data to identify the intricacies of the notions discussed in this paper so far, the use of semi-structured interviews would be effective. Semi-structured interviews are similar to directed conversations. The researcher uses a list of questions as well as scenarios to guide the interview. Furthermore, the researcher is not limited by a predetermined agenda (Holstein and Gubrium, 1995). In order to be able to conduct semi-structured interviews effectively, the interviewer needs to know a great deal about the local context (Gubrium and Holstein, 2001). This might be achieved by spending a certain amount of time in the participating organizations. In order to test the results of the interview and those of the subsequent analysis the information has to be checked with others in the same institution (or network if there is a meaningful connection) to corroborate information about business practices (Sayer, 1992).

In order to complement the findings from the semi-structured interviews, a recommendation of observing participants during product development activities and conversations with customers as well as suppliers concerning the concepts discussed in this paper. The observation approach suggested is a combination of "[r]esearch as the explicit role" (Easterby-Smith *et al.*, 1991, p. 98) and "interrupted involvement" (Easterby-Smith *et al.*, 1991, p. 100). Using this hybrid-mode of observation the researcher is on the research site over a period of time and periodically throughout the study (e.g. specific team meetings or other events, which may be useful for participant observation) (Easterby-Smith *et al.*, 1991).

The rationale for using observation is that one might illuminate "the delicate responses of meaning with which respondents garnish their responses" (Saunders *et al.*, 2003, p. 222).

Proposed data analysis method – template analysis

In order to achieve a thematic organization and analysis of the textual data throughout the research process application of a template analysis provides insight (King, 2004). Template-analysis is suitable for the examination of different perspectives of various groups within an organizational setting, e.g. the inter-organizational context of an inter-firm network (see King, 2004). The initial template is generated using the interview topic guide, i.e. the set of question areas and probes used by the researcher.

Main questions can be used as higher-order codes, whereas lower-order codes can be derived from probes and prompts. This process entails a fairly structured interview guide, hence, the utilization of semi-structured interviews as indicated earlier.

The initial templates presented in Figures 3-7, which incorporate some of the themes discussed in this paper, could be used as a basis for analysis.

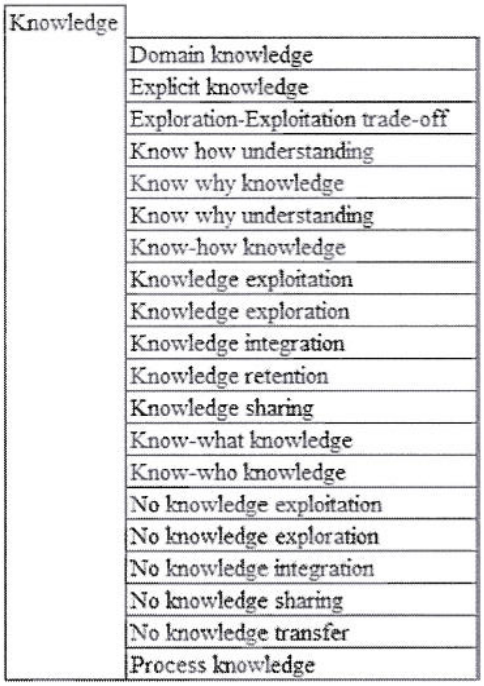


Figure 3.
Tentative initial template concerning knowledge

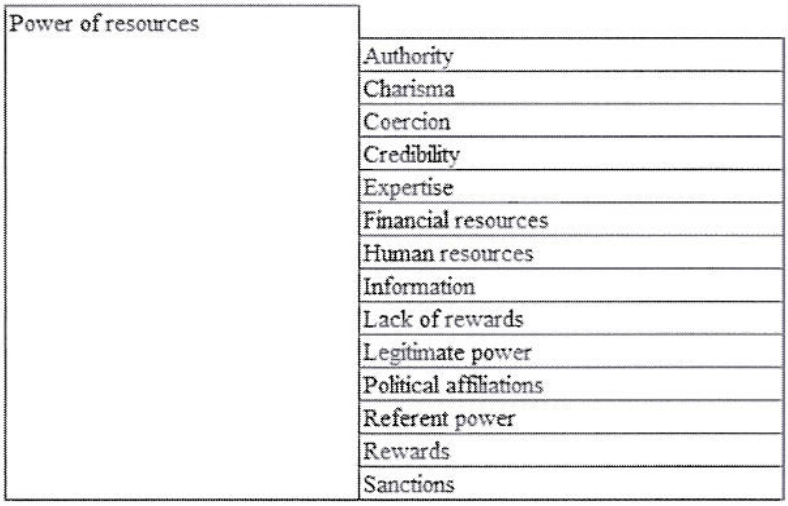


Figure 4.
Tentative initial template concerning power of resources

Power of processes		
	Biases in decision making	
		Authority bias
		Commitment and consistency
		Contrast bias
		Liking bias
		Reciprocation bias
		Scarcity bias
		Social proof bias
	Non-decision making	
		Allocation of responsibilities
		Criteria selection for decisions
		Ignorance
		Inconclusive consideration
		Manipulating of agendas
		Non-raising of issues

Figure 5.
Tentative initial template concerning power of processes

Power of meaning	
	De-legitimation of demands and outcomes
	Dominant mode of organizing
	Legitimation of demands and outcomes
	Perpetuating the status quo
	Beliefs
	Ideas
	Intentions
	Management systems
	Meanings
	Organizational structures
	Preferences
	Symbol
	Values
	Ritual

Figure 6.
Tentative initial template concerning power of meaning

Power of the system	
	Decision gate
	Fuzzy decision making gates
	Hierarchical observation
	No punishment
	Normalizing judgement
	Not measuring performance
	Performance measurements_Surveillance
	Product testing
	Punishment

Figure 7.
Tentative initial template concerning power of the system

After the interviews have been carried out the researcher works through the transcribed interview data and marks the relevant areas with the appropriate code from the initial template. Due to the nature of semi-structured interviews the initial template will have to be revised in the course of working through the transcripts (King, 2004). Findings from the participant observation can be integrated into the template throughout this process.

In order to help the researcher organize the transcript data the software package NVivo might be helpful (Gibbs, 2002). This will enable the researcher to work efficiently with complex coding templates and large amounts of transcribed text (King, 2004).

Conclusion

The conceptual framework presented here, and supporting research tools, is still in its nascent stage and requires substantial empirical work. Due to the fact that the research project this paper is based upon is in its early stages, the notion of the power of processes has not yet been reflected in the data. Nevertheless, the synthesis of the themes discussed in this paper and the illustrative examples provide a fertile basis for discussion. Furthermore, the ideas presented lend themselves to be researched from a qualitative perspective, but also from a quantitative perspective. However, due to the obvious intricacies as well as the causalities shown in the framework and the social embeddedness of knowledge exploration and exploitation and power relations, it might be worthwhile considering a qualitative approach, as suggested in the research methods section, to widen our understanding of the interrelationships of the concepts before embarking on a quantitative research endeavour.

Note

1. The CoPS literature uses two further analytical categories: synchronic is synonymous to exploitation, whereas diachronic is synonymous to exploration (Prencipe, 2005).

References

Adler, P.S. (2005), "The evolving object of software development", *Organization*, Vol. 12 No. 3, pp. 401-35.

Adler, P.S., Mandelbaum, A., Nguyen, V. and Schwerer, E. (2003), "Getting the most out of your product development process", *Harvard Business Review*, Vol. 1, March, pp. 134-52.

Araujo, L. and Mota, J. (2004), "Routines, 'learning-by-using' and networks: the case of aircraft maintenance", paper presented at the 20th IMP Conference, Copenhagen.

Bachrach, P. and Baratz, M.S. (1962), "Two faces of power", *The American Political Science Review*, Vol. 56 No. 4, pp. 947-52.

Bagozzi, R.P. (1975), "Marketing as exchange", *Journal of Marketing*, Vol. 39 No. 4, pp. 32-9.

Barlow, J. (2000), "Innovation and learning in complex offshore construction projects", *Research Policy*, Vol. 29, pp. 973-89.

Benfari, R.C., Wilkinson, H.E. and Orth, C.D. (1986), "The effective use of power", *Business Horizon*, May-June, pp. 12-16.

Bessant, J. (2004), "Supply chain learning", in New, S. and Westbrook, R. (Ed.), *Understanding Supply Chains*, Oxford University Press, Oxford, pp. 165-90.

Brusoni, S. and Prencipe, A. (2001), "Unpacking the black box of modularity: technologies, product and organizations", *Industrial and Corporate Change*, Vol. 10 No. 1, pp. 179-205.

Carlile, P.R. (2002), "A pragmatic view of knowledge and boundaries: boundary objects in new product development", *Organization Science*, Vol. 13 No. 4, pp. 442-55.

Carter, C. and Scarbrough, H. (2001), "Regimes of knowledge, stories of power: a treatise on knowledge management", *Creativity and Innovation Management*, Vol. 10 No. 3, pp. 210-20.

Clark, K.B. and Wheelwright, S.C. (1993), *Managing New Product and Process Development: Text and Cases*, Free Press, Maxwell Macmillan Canada, Maxwell Macmillan International, New York, NY.

Cole, R.E. (2001), "From continuous improvement to continuous innovation", *Quality Management Journal*, Vol. 8 No. 4, pp. 7-21.

Cooper, R.G. (1990), "Stage-gate systems: a new tool for managing new products", *Business Horizons*, Vol. 33 No. 3, pp. 44-54.

Cooper, R.G. (1994), "Perspective: third-generation new product process", *Journal of Product Innovation Management*, Vol. 11, pp. 3-11.

Cooper, R.G. and Kleinschmidt, E.J. (1990), *New Products: The Key Factors in Success*, American Marketing Association, Chicago, IL.

Cooper, R.G. and Kleinschmidt, E.J. (1991), "New product development processes at leading industrial firms", *Industrial Marketing Management*, Vol. 10 No. 2, pp. 137-47.

Cooper, D.J., Hinings, B., Greenwood, R. and Brown, J.L. (1996), "Sedimentation and transformation in organizational change: the case of Canadian law firms", *Organization Studies*, Vol. 17 No. 4, pp. 623-47.

Cordell, V.V. (1997), "Consumer knowledge measures as predictors in product evaluation", *Psychology and Marketing*, Vol. 14 No. 3, pp. 241-60.

Cox, A., Watson, G., Lonsdale, C. and Sanderson, J. (2004), "Managing appropriately in power regimes: relationship and performance management in 12 supply chain cases", *Supply Chain Management: An International Journal*, Vol. 9 No. 5, pp. 351-71.

Cox, A., Ireland, P., Lonsdale, C., Sanderson, J. and Watson, G. (2002), *Supply Chains, Markets and Power*, Routledge, London.

Day, G.S. (1994), "Continuous learning about markets", *California Management Review*, Vol. 36, Summer, pp. 9-31.

Dodgson, M. and Rothwell, R. (1994), *The Handbook of Industrial Innovation*, Edward Elgar, London.

Drazin, R. (1990), "Professionals and innovation: structural-functional versus radical-structural perspectives", *Journal of Management Studies*, Vol. 27 No. 3, pp. 245-63.

Dyer, J.H. and Nobeoka, K. (2000), "Creating and managing a high-performance knowledge sharing network: the Toyota case", *Strategic Management Journal*, Vol. 21 No. 3, pp. 344-68.

Easterby-Smith, M., Thorpe, R. and Lowe, A. (1991), *Management Research: An Introduction*, Sage Publications, London; Newbury Park, CA.

Foucault, M. and Gordon, C. (1980), *Power/Knowledge: Selected Interviews and Other Writings*, 1972-1977, Harvester, Brighton.

Garcia, R., Calantone, R. and Levine, R. (2003), "The role of knowledge in resource allocation to exploration versus exploitation in technologically oriented organizations", *Decision Sciences*, Vol. 34 No. 2, pp. 323-49.

Garud, R. (1997), "On the distinction between know-how, know-what and know-why", in Walsh, J.P., Huff, A.S., Shrivastava, P. and Dutton, J. (Eds), *Advances in Strategic Management*, JAI Press, Greenwich, CT; London, pp. 81-101.

Garvin, D.A. (1993), "Building a learning organization", *Harvard Business Review*, Vol. 71 No. 4, July/August, pp. 78-84.

Gemünden, H.G. (1990), *Innovationen in Geschäftsbeziehungen und Netzwerken*, Inst.f.Angewandte Betriebswirtschaftslehre & Unternehmensführung, Karlsruhe.

Gholz, E. (2005), "Systems integration in the US Defence Industry: who does it and why is it important?", in Prencipe, A., Davies, A. and Hobday, M. (Eds), *The Business of Systems Integration*, Oxford University Press, Oxford, pp. 114-32.

Gibbs, G. (2002), *Qualitative Data Analysis: Explorations with NVivo*, Open University Press, Buckingham.

Grant, R. (1996), "Prospering in dynamically-competitive environment: organizational capability as knowledge integration", *Organization Science*, Vol. 7, pp. 375-87.

Gubrium, J.F. and Holstein, J.A. (2001), *Handbook of Interview Research: Context & Method*, Sage Publications, Thousand Oaks, CA; London.

Hahn, C.K., Watts, C. and Kim, K.Y. (1990), "The supplier development program: a conceptual model", *Journal of Purchasing and Materials Management*, Vol. 26 No. 2, pp. 2-7.

Handfield, R.B. and Bechtel, C. (2004), "Trust, power, dependence, and economics: can SCM research borrow paradigms?", *International Journal of Integrated Supply Management*, Vol. 1 No. 1, pp. 3-32.

Hardy, C. (1994), "Power and politics in organizations", in Hardy, C. (Ed.), *Managing Strategic Action: Mobilizing Change*, Sage Publications, London, pp. 220-37.

Hardy, C. (1996), "Understanding power: bringing about strategic change", *British Journal of Management*, Vol. 7 No. 1, pp. 3-16.

Hartley, J.L. (1997), "Suppliers' contributions to product development: an exploratory study", *IEEE Transactions in Engineering Management*, Vol. 44 No. 3, pp. 258-67.

Haugaard, M. (2002), *Power: a Reader*, Manchester University Press, Manchester.

Hobday, M., Prencipe, A. and Davies, A. (2005), "Introduction", in Prencipe, A., Davies, A. and Hobday, M. (Eds), *The Business of Systems Integration*, Oxford University Press, Oxford, pp. 1-12.

Hobday, M., Rush, H. and Tidd, J. (2000), "Innovation in complex products and system", *Research Policy*, Vol. 29, pp. 793-804.

Holstein, J.A. and Gubrium, J.F. (1995), *The Active Interview*, London, SAGE Publications, Thousand Oaks, CA.

Hurst, D.K. (1995), *Crisis and Renewal*, Harvard Business School Press, Boston, MA.

Iansiti, M. and Clark, K.B. (1994), "Integration and dynamic capability: evidence from product development in automobiles and mainframe computers", *Industrial and Corporate Change*, Vol. 3 No. 3, pp. 557-605.

Jarillo, J. (1988), "On strategic networks", *Strategic Management Journal*, Vol. 8, pp. 31-41.

Kazlauskaite, J., Minhas, A. and Vogt, F.H. (2005), *Applying Service Oriented Architecture in the Aerospace Industry*, Telematics Department, Hamburg University of Technology, Hamburg.

King, N. (2004), "Using template analysis in the thematic analysis of text", in Cassell, C. and Symon, G. (Eds), *Essential Guide to Qualitative Methods in Organizational Research*, Sage Publications, London, pp. 256-70.

Knott, A.M. (2002), "Exploration and exploitation as complements", in Choo, C.W. and Bontis, N. (Eds), *The Strategic Management of Intellectual Capital and Organizational Knowledge*, Oxford University Press, Oxford, pp. 339-58.

Lam, A. (2000), "Tacit knowledge, organizational learning and societal institutions: an integrated framework", *Organization Studies*, Vol. 21 No. 3, pp. 487-513.

Lawrence, T.B., Mauws, M.K., Dyck, B. and Kleysen, R.F. (2005), "The politics of organizational learning: integrating power into the 4I framework", *Academy of Management Review*, Vol. 30 No. 1, pp. 180-91.

Levinthal, D.A. and March, J.G. (1993), "The myopia of learning", *Strategic Management Journal*, Vol. 14, pp. 95-112.

Li, T. and Calantone, R. (1998), "The impact of market knowledge competence on new product advantage: conceptualization and empirical examination", *Journal of Marketing*, Vol. 62, October, pp. 13-29.

Low, D.R., Chapman, R.L. and Sloan, T.R. (2007), "Inter-relationships between innovation and market orientation in SMEs", *Management Research News*, Vol. 30 No. 12, pp. 878-91.

Lukes, S. (1974), *Power: A Radical View*, Macmillan, London.

Lundvall, B.-Å. (1996), *The Social Dimensions of the Learning Economy*, Danish Research Unit for Industrial Dynamics, Department of Business Studies, Aalborg University, Aalborg.

Maloni, M. and Bentton, W.C. (2000), "Power influences in the supply chain", *Journal of Business Logistics*, Vol. 21 No. 1, pp. 49-73.

March, J.G. (1991), "Exploration and exploitation in organizational learning", *Organization Science*, Vol. 2 No. 1, pp. 71-87.

Marshall, N. and Brady, T. (2001), "Knowledge management and the politics of knowledge: illustrations from complex products and systems", *European Journal of Information Systems*, Vol. 10, pp. 99-112.

Millar, J., Demaid, A. and Quintas, P. (1997), "Trans-organizational innovation: a framework for research", *Technology Analysis & Strategic Management*, Vol. 9 No. 4, pp. 399-418.

Mohr, J. and Nevin, J.R. (1990), "Communication strategies in marketing channels: a theoretical perspective", *Journal of Marketing*, Vol. 54 No. 10, pp. 36-51.

Nassimbeni, G. (2004), "Supply chains: a network perspective", in New, S. and Westbrook, R. (Eds), *Understanding Supply Chains*, Oxford University Press, Oxford, pp. 43-68.

Newell, S., Robertson, M. and Swan, J. (2005), "Interactive innovation processes and the problems of managing knowledge", in Renzl, B., Matzler, K. and Hinterhuber, H. (Eds), *Future of Knowledge Management*, Palgrave, Basingstoke, pp. 115-36.

Newell, S., Robertson, M., Scarbrough, H. and Swan, J. (2002), *Managing Knowledge Work*, Palgrave, Basingstoke.

Okhuysen, G.A. and Eisenhardt, K.M. (2002), "Integrating knowledge in groups: how formal interventions enable flexibility", *Organization Science*, Vol. 13 No. 4, pp. 370-86.

Peteraf, M. (1993), "The cornerstone of competitive advantage: a resource-based view", *Strategic Management Journal*, Vol. 14 No. 3, pp. 179-91.

Pfeffer, J. (1992), *Managing with Power: Politics and Influence in Organizations*, Harvard Business School Press, Boston, MA.

Phillips, N., Lawrence, T.B. and Hardy, C. (2000), "Inter-organizational collaboration and the dynamics of institutional fields", *Journal of Management Studies*, Vol. 37 No. 1, pp. 23-43.

Phillips, R., Neailey, K. and Broughton, T. (1999), "A comparative study of six stage-gate approaches to product development", *Integrated Manufacturing Systems*, Vol. 10 No. 5, pp. 289-97.

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*, Vol. 41 No. 1, pp. 116-46.

Prencipe, A. (2005), "Corporate strategy and systems integration capabilities: managing networks in complex systems industries", in Prencipe, A., Davies, A. and Hobday, M. (Eds), *The Business of Systems Integration*, Oxford University Press, Oxford, pp. 114-32.

Radjou, N. (2005), "Networked innovation drives profits", *Industrial Management*, Vol. 47 No. 1, pp. 14-21.

Ragatz, G., Handfield, R. and Scannell, T. (1997), "Success factors for integrating suppliers into new product development", *Journal of Product Innovation Management*, Vol. 14 No. 3, pp. 190-202.

Reimann, M. and Sarkis, J. (1996), "An integrated functional representation of concurrent engineering", *Production Planning and Control*, Vol. 7 No. 5, pp. 452-61.

Ritter, T. (1999), "The networking company: antecedents for coping with relationships and networks effectively", *Industrial Marketing Management*, Vol. 28 No. 5, pp. 467-79.

Rothwell, R. (1994), "Towards the fifth-generation innovation process", *International Marketing Review*, Vol. 11 No. 1, pp. 7-31.

Sanchez, R. (1996), "Strategic product creation: managing new interactions of technology, markets, and organizations", *European Management Journal*, Vol. 14 No. 2, pp. 121-38.

Sanchez, R. (1997), "Managing articulated knowledge in competence-based competition", in Sanchez, R. and Heene, A. (Eds), *Strategic Learning and Knowledge Management*, John Wiley & Sons, Chichester, pp. 163-87.

Sapolsky, H.M. (2005), "Inventing systems integration", in Prencipe, A., Davies, A. and Hobday, M. (Eds), *The Business of Systems Integration*, Oxford University Press, Oxford, pp. 114-32.

Saunders, M., Lewis, P. and Thornhill, A. (2003), *Research Methods for Business Students*, 3rd ed., Financial Times/Prentice Hall, Harlow.

Sawhney, M. and Zabin, J. (2002), "Managing and measuring relational equity in the network economy", *Journal of the Academy of Marketing Science*, Vol. 30 No. 4, pp. 313-32.

Sayer, A. (1992), *Method in Social Science: A Realist Approach*, 2nd ed., Routledge, London; New York, NY.

Scarbrough, H. (2003), "Knowledge management, HRM and the innovation process", *International Journal of Manpower*, Vol. 24 No. 5, pp. 501-16.

Sewell, G. (1999), *On the Possibility of a Sociology of Workplace Surveillance*, University of Melbourne, Melbourne.

Shaw, B. (1994), "User/supplier links and innovation", in Dodgson, M. and Rothwell, R. (Eds), *The Handbook of Industrial Innovation*, Edward Elgar, London.

Simon, H.A. (1969), *The Science of the Artificial*, The MIT Press, London.

Slater, S.F. and Narver, J.C. (1995), "Market orientation and the learning organization", *Journal of Marketing*, Vol. 59 No. 3, pp. 63-74.

Swan, J. (2007), "Managing knowledge for innovation: production, process and practice", in McInerney, C.R. and Day, R.E. (Eds), *Rethinking Knowledge Management: From Knowledge Objects to Knowledge Processes*, Springer, London, pp. 147-70.

Swan, J. and Scarbrough, H. (2005), "The politics of networked innovation", *Human Relations*, Vol. 58 No. 7, pp. 913-43.

Townley, B. (1993), "Foucault, power/knowledge, and its relevance for human resource management", *The Academy of Management Review*, Vol. 18 No. 3, pp. 518-45.

Tsoukas, H. and Vladimirou, E. (2001), "What is organizational knowledge?", *Journal of Management Studies*, Vol. 38 No. 7, pp. 973-93.

Valkokari, K. and Helander, N. (2007), "Knowledge management in different types of strategic SME networks", *Management Research News*, Vol. 30 No. 8, pp. 597-608.

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

Von Hippel, E. and Tyre, M.J. (1993), "How learning by doing is done: problem identification in novel process equipment", *Research Policy*, Vol. 24, pp. 1-12.

Further reading

Boer, H. (2001), "And [Jethro] said ... learning: the link between strategy, innovation and production", *Inaugural Lecture, Aalborg University, Denmark*, 4 May.

Boer, H. and Gertsen, F. (2003), "From continuous improvement to continuous innovation: a (retro)(per)(spective)", *International Journal of Technology Management*, Vol. 26 No. 8, pp. 805-27.

Clegg, S. (1989), *Frameworks of Power*, Sage, London.

Coase, R. (1937), "The nature of the firm", *Economica*, Vol. 4, pp. 386-405.

Crossan, M.M., Lane, H.W. and White, R.E. (1999), "An organizational learning framework: from intuition to institution", *Academy of Management Review*, Vol. 24 No. 3, pp. 522-37.

Day, J. and Wendler, J.C. (1998), "The new economics of organization", *McKinsey Quarterly*, Vol. 1, pp. 4-18.

Foucault, M. (1977), *Discipline and Punish: The Birth of the Prison*, Allen Lane, London.

Kyriakopoulos, K. and Moorman, C. (2004), "Tradeoffs in marketing exploitation and exploration strategies: the overlooked role of market orientation", *International Journal of Research in Marketing*, Vol. 21 No. 3, pp. 219-40.

Menor, L.J., Tatikonda, M.V. and Sampson, S.E. (2002), "New service development: areas for exploitation and exploration", *Journal of Operations Management*, Vol. 20 No. 2, pp. 135-57.

Miller, D. (1990), *The Icarus Paradox: How Exceptional Companies Bring About Their Downfall*, Harper Business, New York, NY.

Pascale, R.T. (1990), *Managing on the Edge: How the Smartest Companies Use Conflict to Stay Ahead*, Simon and Schuster, New York, NY.

Williamson, O. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*, Free Press, New York, NY.

About the author

Thomas Matheus is a Senior Lecturer in Logistics and Supply Chain Management at Newcastle Business School, Northumbria University. He is also programme manager for various undergraduate programmes in international business administration. He is currently pursuing a PhD on a part-time basis. He has industry experiences in merchandise and sourcing in the fashion, retail and manufacturing industry. He has also worked in business and IT consulting. His main research interests are in supply chain learning, inter-organizational collaboration, inter-organizational knowledge management, inter-organizational change management, PDPs and innovation processes. He can be contacted at: thomas@tmatheus.com